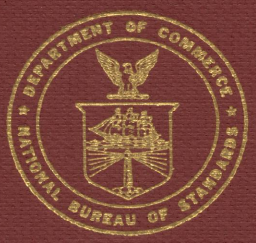
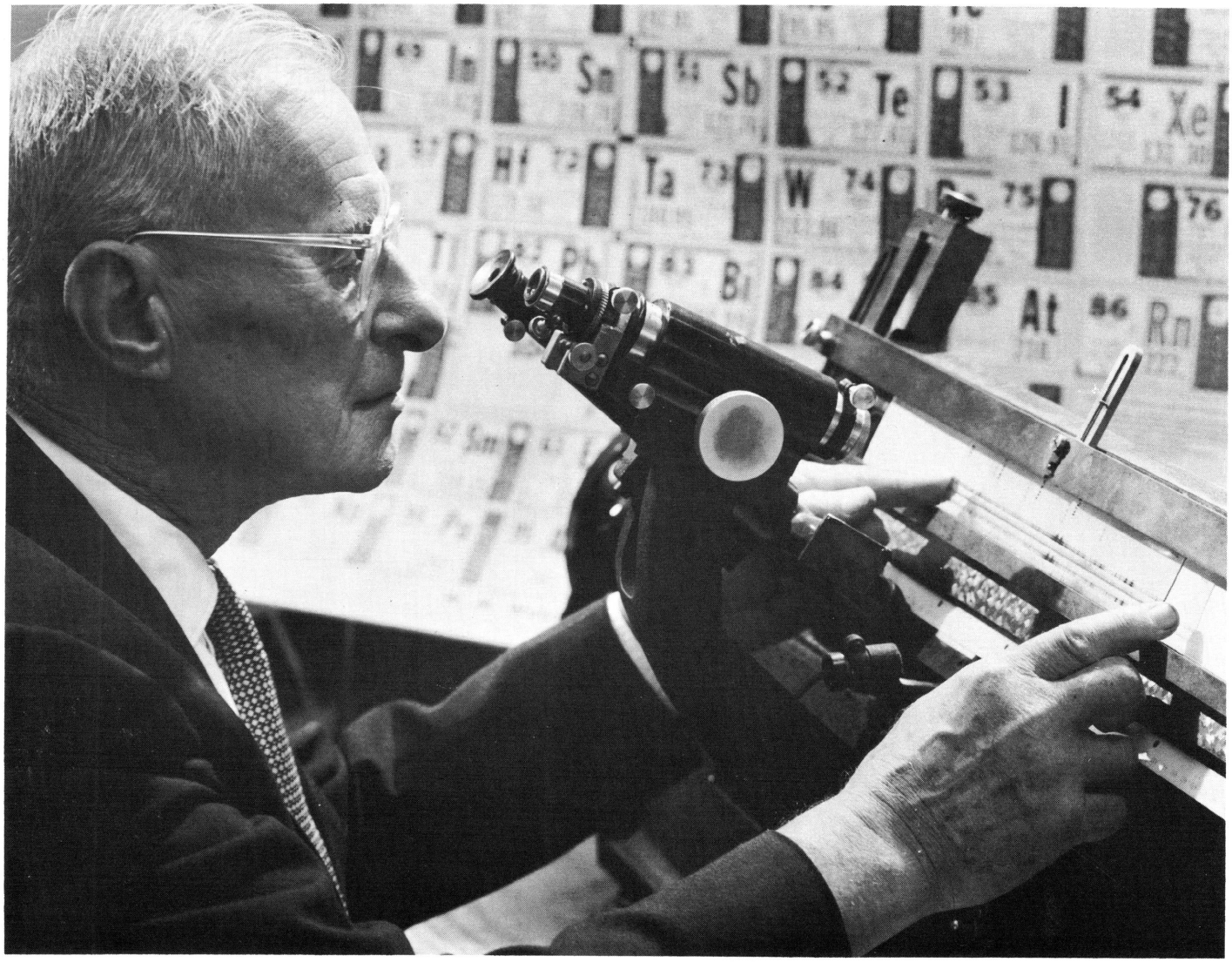
NBS MONOGRAPH 32 — Part I

Tables of Spectral-Line Intensities

Arranged by Elements



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS



W. F. Meggers prepares to measure one of the spectrograms on which these tables of spectral-line intensities are based.

UNITED STATES DEPARTMENT OF COMMERCE • Luther H. Hodges, *Secretary*
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

Tables of Spectral-Line Intensities

Part I

Arranged by Elements

The intensity, character, wavelength, and spectrum of 39,000 lines between 2000 A and 9000 A observed in copper arcs containing 0.1 atomic percent of each of 70 elements.

William F. Meggers, Charles H. Corliss, and Bourdon F. Scribner.

National Bureau of Standards Monograph 32 — Part I

Issued December 29, 1961

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25 D.C. - Price $4.

Contents

List of Tables

Chemical element	Symbol	Atomic number	Melting point*	Boiling point*	Page	Chemical element	Symbol	Atomic number	Melting point*	Boiling point*	Page
			°C	°C					°C	°C	
Aluminum	Al	13	660. 1	2450	3	Neodymium	Nd	60	1019	3180	191
Antimony	Sb	51	630. 5	1380	4	Nickel	Ni	28	1453	2730	207
Arsenic	As	33	817(28 atm)	613	5	Niobium	Nb	41	2468	4927	211
Barium	Ba	56	714	1640	6	Osmium	Os	76	2700	5500	227
Beryllium	Be	4	1277	2770	8	Palladium	Pd	46	1552	3980	239
Bismuth	Bi	83	271. 3	1560	9	Phosphorus	P	15	44. 25	280	241
Boron	B	5	2030	2550	10	Platinum	Pt	78	1769	4530	242
Cadmium	Cd	48	320. 9	765	11	Potassium	K	19	63. 7	760	245
Calcium	Ca	20	838	1440	12	Praseodymium	Pr	59	919	3020	246
Carbon	C	6	3727	4830	14	Rhenium	Re	75	3180	5900	262
Cerium	Ce	58	804	3470	14	Rhodium	Rh	45	1966	4500	273
Cesium	Cs	55	28. 7	690	42	Rubidium	Rb	37	38. 9	688	280
Chromium	Cr	24	1875	2665	43	Ruthenium	Ru	44	2500	4900	281
Cobalt	Co	27	1495	2900	53	Samarium	Sm	62	1072	1630	293
Copper	Cu	29	1083. 0	2595	61	Scandium	Sc	21	1539	2730	310
Dysprosium	Dy	66	1407	2330	62	Selenium	Se	34	217	685	315
Erbium	Er	68	1497	2630	77	Silicon	Si	14	1410	2680	316
Europium	Eu	63	826	1490	90	Silver	Ag	47	960. 80	2210	317
Gadolinium	Gd	64	1312	2730	97	Sodium	Na	11	97. 82	892	318
Gallium	Ga	31	29. 78	2237	113	Strontium	Sr	38	768	1380	319
Germanium	Ge	32	937	2830	114	Tantalum	Ta	73	2996	5425	321
Gold	Au	79	1063. 0	2970	115	Tellurium	Te	52	449. 5	990	336
Hafnium	Hf	72	2222	5400	116	Terbium	Tb	65	1356	2530	337
Holmium	Ho	67	1461	2330	125	Thallium	Tl	81	303	1457	355
Indium	In	49	156. 2	2000	136	Thorium	Th	90	1750	3850	356
Iridium	Ir	77	2454	5300	137	Thulium	Tm	69	1545	1720	380
Iron	Fe	26	1536. 5	3000	144	Tin	Sn	50	231. 91	2270	390
Lanthanum	La	57	920	3470	153	Titanium	Ti	22	1668	3260	391
Lead	Pb	82	327. 4	1725	161	Tungsten	W	74	3410	5930	402
Lithium	Li	3	180. 54	1330	162	Uranium	U	92	1132. 3	3818	416
Lutetium	Lu	71	1652	1930	163	Vanadium	V	23	1900	3400	437
Magnesium	Mg	12	650	1107	167	Ytterbium	Yb	70	824	1530	449
Manganese	Mn	25	1245	2150	168	Yttrium	Y	39	1509	3030	455
Mercury	Hg	80	−38. 36	357	173	Zinc	Zn	30	419. 50	906	461
Molybdenum	Mo	42	2610	5560	174	Zirconium	Zr	40	1852	3580	462

*Melting points and boiling points are quoted from *Metals Handbook*, 8th Edition, Vol. 1, pp. 46-47, Cleveland, Ohio, 1961.

Tables of Spectral-Line Intensities

William F. Meggers, Charles H. Corliss, and Bourdon F. Scribner

The relative intensities, or radiant powers, of 39,000 spectral lines with wavelengths between 2000 and 9000 Angstroms have been determined on a uniform energy scale for seventy chemical elements. This was done by mixing 0.1 atomic percent of each element in powdered copper, pressing the powder-mixture to form solid electrodes which were burned in a 10 ampere, 220 volt direct-current arc, and photographing the spectra with a stigmatic concave grating while a step sector was rotating in front of the slit. The sectored spectrograms facilitated the estimation of intensities of all element lines relative to copper lines which were then calibrated on an energy scale provided by standardized lamps, and all estimated line intensities were finally adjusted to fit this calibration. Comparisons with other intensity measurements in individual spectra indicate that the National Bureau of Standards spectral-line intensities may have average errors of 20 percent, but first of all they provide uniform quantitative values for the seventy chemical elements commonly determined by spectrochemists. These data are presented by element in part I, and all 39,000 observed lines are given in order of wavelength in part II.

1. Introduction

Spectrochemistry was born a century ago when Kirchhoff and Bunsen [1] [1] definitely demonstrated that chemical elements were uniquely identified by spectral radiations, or lines as seen in a spectroscope provided with a slit. This led immediately to the identification of many chemical elements in the sun and to the discovery of several new elements, but no quantitative chemical analyses were made until much later.

In 1874, Lockyer [2] stated that "while the qualitative spectrum analysis depends upon the *positions* of the lines, the quantitative analysis depends not upon their position but upon their *length, brightness, thickness,* and *number* as compared with the number visible in the spectrum of a pure vapor". Thus, position (or wavelength) and brightness (or intensity) are recognized as being the two most important properties of spectral lines; wavelengths identify chemical elements and intensities indicate the concentrations of identified elements in mixtures or chemical compounds.

During the past century there has been spectacular improvement in the accuracy of spectral wavelength determinations; the early ones were limited to 3 or 4 figures, the later use of diffraction gratings and wavelength standards permitted the specification of 5 or 6 figures. Since 1900 the application of interferometers and better gratings has refined many wavelengths to 7 figures, and recently some 8-figure values of wavelength standards have been provided. Unfortunately during this past century very little progress has been made in assigning uniform quantitative intensity values to spectral radiations. The great bulk of spectral observations have been made photographically because photographic emulsions provide detailed, permanent records of spectra not only in the visible but also in the invisible ultraviolet and infrared regions. But even if the light source is reproducible and standardized it is not easy to evaluate the spectral efficiencies of spectrographs and photographic emulsions so the usual procedure has been to make subjective visual estimates of relative intensities of spectral lines on an arbitrary scale based on the relative blackness and/or width of spectral-line images appearing on a developed photographic plate. Consequently, in thousands of individual papers and in numerous comprehensive compilations of spectral data we find only qualitative data on intensities which may have some meaning for adjacent lines in a given spectrum but none at all when comparing widely spaced lines, or lines of different spectra of the same element or of different chemical elements.

In the beginning, most intensity data were reported on an arbitrary scale of 10 steps, weak lines being assigned an intensity of 1, and the strongest line intensity 10. Even as late as 1945 extensive new spectral tables prepared by Gatterer and Junkes [3] displayed estimated intensities on this limited 1 to 10 scale. Since 1910 some spectroscopists have arbitrarily expanded this arbitrarily compressed scale. For example, in the very extensive spectral tables published by Exner and Haschek [4] the estimated intensities range from 1 to 1000. In wavelength tables compiled by Twyman and Smith [5] the maximum intensity is 20, in the compilation of Kayser and Ritschl [6] estimated intensities rise to 4000, and in the well-known M.I.T. Wavelength Tables [7] they soar to 9000. The most recent compilation of Tables of Spectrum Lines by Zaĭdel, Prokof'ev, and Raiskiĭ [8] quotes data from the M.I.T. Tables and more modern sources but adds nothing new on spectral line intensities.

[1] Figures in brackets indicate the literature references on page XII.

In or about the year 1925, microdensitometers were developed for the purpose of quantitative measurement of relative intensities among related lines in multiplets to test the sum rules derived from the quantum theory of spectral structure, but no general applications were made. Since then thousands of spectrochemists have applied microdensitometers to quantitative chemical analyses by calibrating intensity ratios of analysis- and internal-standard lines, but such measurements have contributed nothing to the basic data on spectral line intensities. Likewise, with few exceptions, the modern substitution of electronic photodetectors for photographic emulsions has added nothing to our knowledge of true line intensities over long ranges of different spectra of many chemical elements.

How may one hope to obtain, with a reasonable amount of labor, quantitative intensity data on the same scale for thousands of spectral lines representing practically all of the metallic elements? A hint was given in 1874 by Lockyer [2] who observed that "the lines of any constituent of a mechanical mixture disappeared from the spectrum as its percentage was reduced." Acting on this suggestion, Hartley [9], in 1884, began to study the spark spectra of metals in solutions with concentrations of 1 percent, 0.1 percent, 0.01 percent, and 0.001 percent, and proposed a method of quantitative spectrochemical analysis based on the lines that could be detected at each dilution. Similar studies were later made by Pollok and Leonard [10], by de Gramont [11], and by Löwe [12], all showing that with progressive dilution of an element its spectral lines weakened and vanished until only the most sensitive line remained to reveal its presence. In all these works the principle of quantitative spectrochemistry appeared to rest on the *number of lines* detectable rather than on their individual *intensities*. Casual observation must have shown lines of equal strength in spectra of solutions differing 1000 fold in concentration but no one mentioned it. It is difficult to understand why these early studies of residual spectra in quantitatively prepared mixtures or solutions did not suggest a method for obtaining physical intensities, but it is a fact that before our work had begun no one had attempted to express spectral line intensities as directly proportional to the number of radiating atoms or concentration of the element. The present monograph reports such an attempt [13].

Our method of deriving line intensities from arc spectra of elements diluted in copper was recently adopted by Allen [14, 15] to obtain oscillator strengths of some radiations from 3200 to 5400 A representing nine elements.

At various times since 1932 we have photographed the arc spectra of 70 chemical elements diluted in silver or in copper, and determined the line intensities of the diluted elements relative to selected lines of the matrix. An energy calibration of the latter finally led to physical intensities of 39,000 spectral lines representing 70 elements, all on the same energy scale. These experiments and results are based on the following propositions, regarded as fundamental for the quantitative description of residual spectra of diluted elements excited in ordinary d–c arcs.

1. *The limiting detectability of any line is defined as the atomic concentration that ensures positive detection of the line.* This limit is determined mainly by unavoidable background on a fully exposed spectrogram. The spectrum of an arc burning in air consists of discrete lines due to atoms, and of more or less extensive band systems from transient compounds (usually monoxides), all superposed on a continuous background arising from thermal radiation of incandescent oxides, from transitions in the continuum, and possibly from scattered light. This background sets a limit to the exposure for faint lines that may be given by any actual spectrograph. If this were not true, the exposure could be increased indefinitely to compensate for unlimited reduction in concentration, and detectability would always be infinite. Faint lines are not recorded by underexposure, and they cannot be recognized on a very dense background produced by overexposure. In order to guarantee positive recognition and unambiguous chemical identification a spectral line should be sufficiently well defined to permit accurate wavelength measurement. Experience shows that the minimum photographic density that meets this requirement is of the order of 0.05 above that of the background.

2. *The limiting detectability of any element in an arc depends on the matrix in which the element finds itself.* There is no doubt that in the conventional arc relative volatilities of the chemical elements as well as relative ionization potentials affect the relative strengths of their mixed spectra. In general, the elements with high-vapor pressure and/or low-ionization potential will be favored in spectral excitation, but elements with either high or low volatility may be underestimated if not uniformly present during the exposure, and easily ionized elements may appear less sensitive because of more complete ionization. In this connection it must be noted that large differences in apparent detectability are possible if concentrations are expressed in relative weights instead of numbers of atoms. Thus, 0.01 atomic percent of boron in uranium is equal to $<$ 0.0005 weight percent since the uranium atom is 22 times heavier than the boron atom.

3. *The primary substance (matrix) has no important effect on the relative intensities of lines due to a secondary substance.* It is conceded that the relative intensities of analogous spectra of different elements, and of successive spectra of the same element, may vary with the composition of the samples and/or with the type, or portion, of light source from which radia-

tion is taken, but there is no evidence that the relative intensities of lines in any particular spectrum of a given element are thereby greatly changed. It may be expected, therefore, that the relative intensities of lines observed in one metal arc will remain valid in any other metal arc, provided the arcs are at approximately the same temperature. The absolute intensities and the relative strengths of successive spectra may be altered by excitation conditions. For example, silicon may be more sensitive in carbon than in calcium, and it is well known that when easily ionized alkalies are present in sufficient quantity to influence discharge conditions they reduce the intensity of other spectra, especially those characteristic of ionized atoms.

4. *The order of lines arranged according to decreasing detectability in progressive dilution is the same as the order of decreasing intensity in the spectrum of the pure element.* In other words, emission line intensities in residual arc spectra (barring self-absorption) are proportional to the number of radiating atoms; and relative intensities may therefore be derived from concentrations at which different lines show the same intensity or limiting detectability.

Arc spectra usually exhibit a variety of lines, sharp or narrow ones, diffuse or wide ones (including band heads), strong ones accompanied by photographic spreading of developed images, others wide on account of hyperfine structure, and some partially reversed. All of these types, except the last, appear in residual arc spectra at low concentrations, and it may be questioned if it is possible to place them on a uniform intensity scale. It may be assumed that if total blackening integrated over the width of the line when recorded at a moderate level of density be considered in estimating relative intensities these will be on a uniform scale within the limits of precision in making such estimates on lines of different types.

5. *The order of spectral lines arranged according to decreasing intensity is the same when the intensities are decreased by rotating stepped sectors as when the intensity reduction is produced by successive dilution of the element in a matrix.* This was recognized by Löwe [12] who published an atlas of spark spectra of 44 elements diluted from 1 percent to 0.001 percent and later obtained practically the same results by observing spectra with stepped exposure times [16]. In our experiments the labor of preparing samples of 70 elements in four or more dilutions was greatly reduced by adopting only one dilution (0.1 atomic percent) and then producing further reductions of spectral-line intensities by means of rotating step sectors.

6. *Limiting detectability (as defined in 1.) may be adopted as a physical scale of intensities.* Such intensities may be fixed as follows: In a fully exposed spectrogram of copper containing 0.1 atomic percent of another element any faint but unmistakable line at a given wavelength is assigned unit intensity. Any similar line appearing with unit intensity in a spectrogram when the energy, or concentration, is reduced to $\frac{1}{5}$ is said to be 5 times as strong. Thus, all lines can be assigned relative intensities proportional to their limiting detectabilities by determining either the energy reduction or the concentration reduction at which the stronger lines finally show unit intensity. The atomic percent concentration at which any line will show unit intensity then results from dividing 0.1 by its required energy or concentration reduction. For example, a line of intensity 10 should show plainly at 0.01 atomic percent, while one of intensity 1000 should be easily seen at 0.0001 atomic percent (one in a million). Assuming the ratio concentration/intensity to be constant, the maximum intensity at 100 percent is easily obtained. Thus, a line of intensity 1000 at 0.1 atomic percent will have an intensity value of $1000 \times 100/0.1 = 1{,}000{,}000$ at 100 percent. This indicates a much larger range of spectral intensities than mentioned heretofore, but it is not unrealistic.

2. Experiments

Whereas all earlier experiments on residual spectra of diluted elements involved spark excitation of solutions or fused salts, we decided to employ d–c arc excitation for the following reasons. It has been shown [17] that the first ionization potentials of some seventy metallic elements range from 4 to 11 v and the strongest spectral lines of most of these elements have wavelengths between 2000 and 9000 A, which is the spectral region covered by the present investigations. Furthermore, it is known [18] that the second ionization potential of these elements ranges from 10 to 75 v and that the strongest lines of singly ionized atoms generally have shorter wavelengths than those of neutral atoms, nearly half of them being shorter than 2000 A so that they can be detected only in vacuum spectrographs. Because low-voltage arcs have less ionizing action than high-voltage sparks more atoms will remain in the neutral state and, in general, therefore, arc spectra will exhibit stronger lines and higher sensitivity than spark spectra.

The use of arc spectra in these experiments threatened to introduce errors on account of self-absorption of radiated energy in the arc aura or envelope which consists largely of unexcited neutral vapor atoms. In all spectra of arcs between metal electrodes this is the cause of conspicuous self-reversal of all lines involving the atom's ground state. However, this is a function of vapor density surrounding the arc and if this is reduced to 0.001, self-reversal is usually negligible (see fig. 2). This is our reason for making these experiments with individual elements diluted in copper in the ratio 1 to 1000. When ground-state lines of extra-

ordinary intensity were suspected of some self-absorption, intensity ratios were checked or corrected by examining our earlier spectrograms made with this element diluted to 0.0002 atomic percent in silver.

2.1. Dilution in Silver

Our preliminary experiments, begun in 1932, can be described briefly as follows: solutions of known strength of the elements under investigation were prepared and proper amounts added to pure silver oxide, which was then reduced to metal by heating to make samples containing 8 definite atomic ratios extending from 0.05 to 0.0002 atomic percent of the element added to silver, with a factor of about 2 between 7 successive dilutions. In order to save time and labor, each series of silver samples incorporated 3 to 6 chemical elements, in addition to zinc which supplied internal standards. These samples were burned on pure copper electrodes of a 220 volt d–c arc with 10 amperes. An image of the arc was projected onto the slit of a stigmatic concave grating spectrograph by means of a fused-quartz lens. Each series of excited samples was exposed on successive segments of the slit, and was photographed in four spectral regions ranging from 2000 to 9000 A (see fig. 1). A comparator was employed to measure wavelengths (relative to silver and copper lines) for the identification of the added elements, and relative intensities of all lines belonging to residual spectra of diluted substances were estimated and related to concentration. These results were not satisfactory for the following reasons: The use of silver as a matrix and of copper for arc electrodes precluded the possibility of getting any data for these two elements or for any lines masked by silver and copper lines. Also the inclusion of 3 or more elements in each series of samples resulted in the blending of many lines, especially in complex spectra, so that it was not possible to assign proper intensities in these cases. Furthermore, the method of sample preparation and observing appeared to be unsuited to very volatile elements, or compounds, because no residual spectra could be recorded for them even at concentrations of 0.1 atomic percent.

2.2. Dilution in Copper

In 1941 these preliminary experiments were abandoned in favor of a modified procedure which led to satisfactory results. The chief changes in procedure came with the availability and use of pure metal powders, and a hydraulic press to form solid electrodes of mixed powders. Instead of reducing spectral line intensities to the limit of detectability by successive dilutions of the element in different samples only one dilution (0.1 atomic percent) was prepared and line intensities were reduced by observing through rotating step sectors. The successful procedure may be outlined as follows: An element under investigation was mixed with pure copper powder in the atomic ratio of 1 to 1000. These mixtures were pressed into solid electrodes, and burned in a 220-volt, 10-ampere d–c arc which was imaged entirely on the collimator of a stigmatic grating spectrograph by a lens at the slit. A rotating step sector in front of the slit reduced the spectral intensities to one-fifth in each of four steps (see fig. 2). Spectral intensities of the element added to copper were estimated relative to those of selected copper lines, and this was done separately for each of 70 elements throughout the range of spectrum from 2000 to 9000 A. The true intensities of the selected copper lines above 3300 A that served as internal standards were then measured, by photographic photometry, relative to the known energy distribution in the spectrum of an incandescent tungsten-strip filament at a certain temperature (see fig. 3). Between 2000 and 3300 A a calibrated hydrogen lamp was used to determine the relative intensities of copper lines. Finally the apparent intensities of 39,000 spectral lines of 70 elements, relative to copper, were adjusted to fit the copper calibrations. These experiments thus provide empirically determined lists of the principal lines of all elements actually detectable under average conditions in arc spectra when their concentrations are 0.1 atomic percent, and the individual lines bear intensity numbers approximately proportional to their detectability or their relative energy. That these intensity numbers really represent physical intensities was proved by comparing them with earlier, accurately measured relative intensities of lines in multiplets and with published relative f-values or oscillator strengths of lines in different multiplets extending over a wide range of spectrum.

In order to provide intensity data for spectral lines that are partially or wholly obscured by copper lines a sectored spectrogram of the pure element excited with self-electrodes, or of a metallic compound or salt ex-

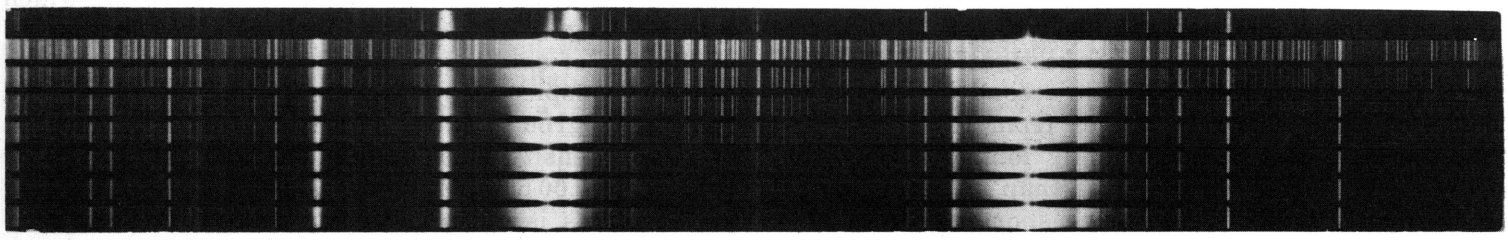


FIGURE 1. *Arc spectra of elements (V, Nb, Ta) diluted progressively in silver, and burned on copper electrodes.*
Spectral range 3880 to 4320 A.

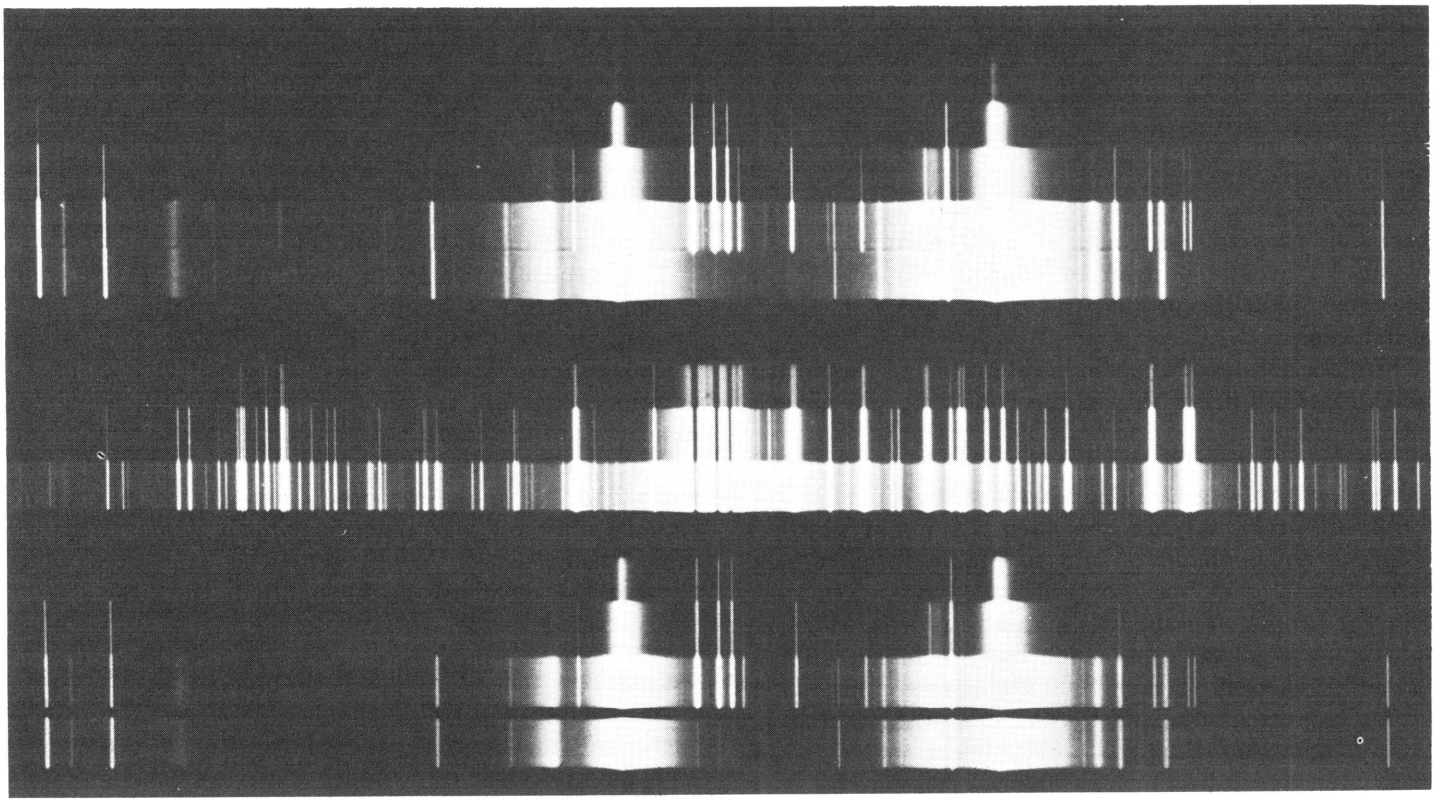


FIGURE 2. *Arc spectra of pure manganese (center), and of copper containing 0.1 percent Mn, (above and below), all through a rotating step sector.* Spectral range 3960 to 4105 A.

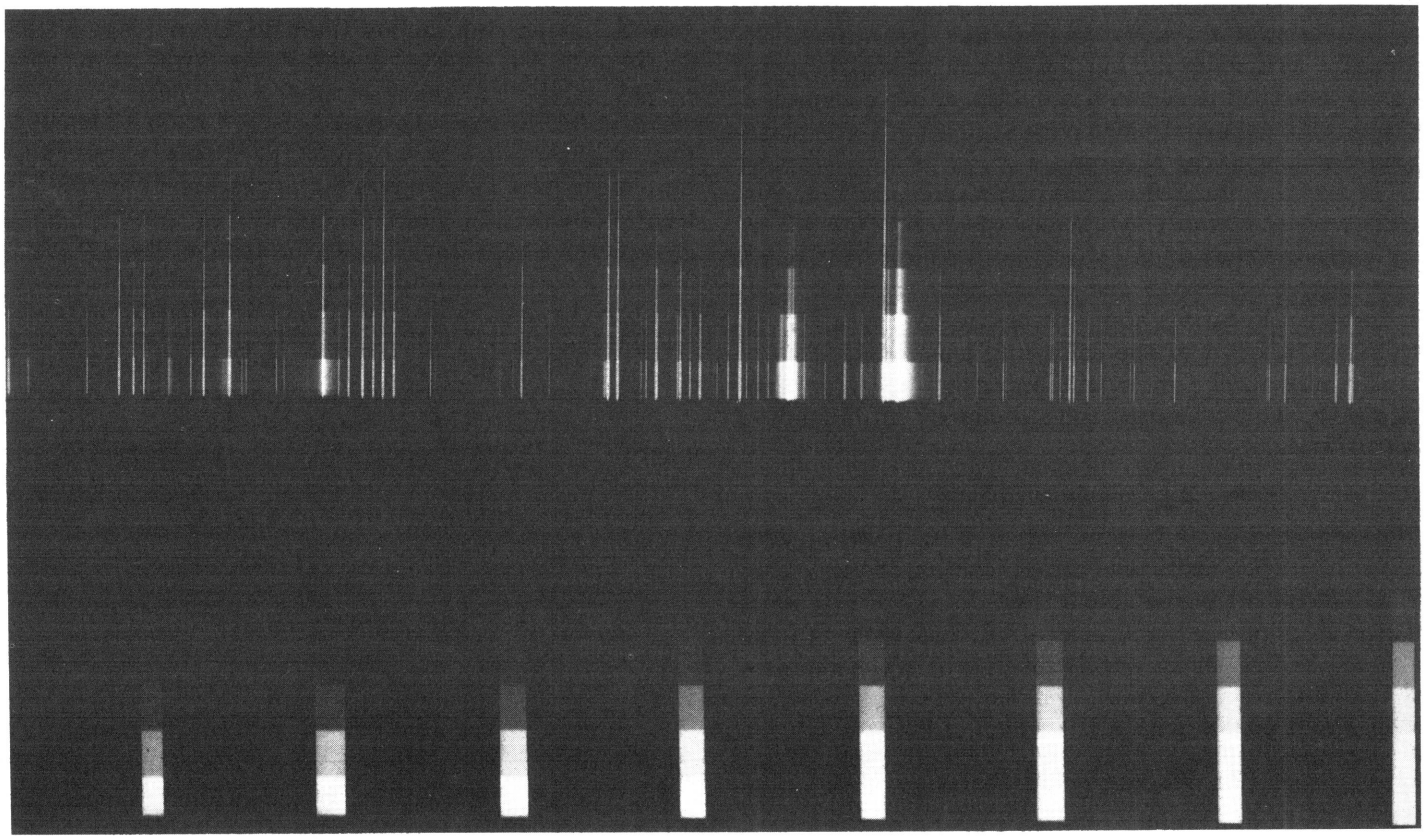


FIGURE 3. *Energy calibration of copper lines.* Above, arc spectrum of copper through rotating step sector. Spectral range 3400 to 3850 A. Below, standard-lamp spectrum at 50 A intervals through same step sector.

cited in a carbon arc, was photographed on every plate so that any lines blended with copper could be interpolated with proper estimates of their relative intensities. Comparison of relative intensities in copper and in carbon matrices also supplied new information on successive spectra, I and II, especially of rare-earth spectra. Similar data for copper itself were obtained by using pressed electrodes of pure silver powder to which 0.1 atomic percent of copper was added, plus the same quantities of gold and zinc to serve as internal standards.

Further details of experimental materials, apparatus, and procedure are given in the following paragraphs.

2.3. Arc Electrodes

For this investigation materials of high purity were acquired, preferably in the form of metal powders, although some elements, not available in pure powdered metal form, were obtained as oxides. In every case the proper amount was added to powdered copper to produce a mixture in which there was one atom of the added element to each 1000 atoms of copper. These mixtures were homogenized by mechanical shaking and then compressed into solid cylindrical pellets in an hydraulic press at 5000 psi. The pellets were ¼ in. in diameter, ¼ in. in length, and weighed about 1.5 gram. Two of a kind were mounted in massive water-cooled clamps in an arc stand and a direct current of 10 amperes passed between them from a 220 v line with ballast resistance. A 3-mm gap was maintained between the electrodes during the exposures which varied in duration from 1 sec to 5 min depending on spectrographic efficiency and sensitivity of photographic plates in different spectral regions.

The arc was imaged on the collimator of a concave-grating spectrograph by means of a quartz lens immediately in front of the slit to obtain uniform illumination along its length and collect light from all parts of the arc. Rotating step sectors were operated immediately in front of the collecting lens, one with 5 to 1 ratio was used for all line-intensity spectrograms, but a 2 to 1 step was used for the energy calibration of copper lines.

2.4. Spectrograph

The dispersing apparatus was a 6-in. grating with 15,000 lines per inch, and 22 ft radius of curvature in a Wadsworth-type mounting to give stigmatic images on photographic plates. All observations were made in the first-order spectrum in which the reciprocal dispersion was 5A/mm, and the practical resolving power about 50,000 with a slit width of 30 μ.

2.5. Photographic Plates

In order to determine, relative to copper, the intensities of all lines of 70 chemical elements diluted 1000 fold it was necessary to make many hundreds of spectrograms, and to employ 4 varieties of photographic plates to cover the wavelength range 2000 to 9000 A. The spectral range 2000 to 3000 A was recorded on Eastman 103–0 Ultraviolet Sensitive plates, 2600 to 4900 A on Eastman 33 plates, 4600 to 6900 A on Eastman II–F plates, and 6600 to 9000 A on Eastman I–N plates. Each plate was developed for 4 min in a rocking tray containing D–19 developer at 70 °F.

The exposure times in each spectral range were chosen by trial to obtain a suitable continuous background in the first step of the rotating step sector. Because of variations in spectral sensitivity of photographic materials and in spectrographic efficiency two exposures of the contaminated-copper arcs were usually made on each plate, with exposure durations in the ratio 2 to 1, and the sectored comparison spectrum of the contaminant was placed between them. Measurements were usually confined to the exposures which showed the optimum background in the first step of the rotating sector.

2.6. Energy Calibration of Copper Lines

In order to determine the factors necessary to convert the estimates of apparent intensities of the lines of 70 elements relative to copper into true relative intensities, it was necessary to determine the true relative intensities of selected reference lines in the spectrum of copper. The energy calibration of copper lines was performed as follows:

A G.E. tungsten ribbon filament lamp (type F339–85, 30 amp, 6v) equipped with a fused quartz window served as the reference standard of spectral energy distribution in the wavelength range 3300 to 9000 A. The brightness temperature of the filament at 6500 A was measured at two values of filament current by Henry Shenker in the National Bureau of Standards Pyrometry Laboratory. The true temperature T of the filament was determined from the brightness temperature by means of the following equation obtained from Wien's law

$$\frac{1}{T} = \frac{1}{T_B} + \frac{\lambda}{C_2} \ln A$$

where $C_2 = 1.438$ cm-deg and A is the product of the emissivity of tungsten (0.427) and the transmittance of the quartz window (0.916) at 6500 A.

TABLE 1. *Temperature of tungsten lamp*

Current	Brightness temperature	True temperature
amp	°K	°K
38.00	2492	2787
40.00	2567	2881

The energy distribution from blackbodies operated at these temperatures was taken from tables prepared by Stair and Smith [19] in the 2300 to 3500 A range, by Skogland [20] in the 3200 to 7600 A range and by

Lowan and Blanch [21] in the 7200 to 10000 A range. The data from these tables were adjusted to a common basis and multiplied by the emissivity of tungsten and the transmittance of fused quartz at intervals increasing from 50 A in the ultraviolet to 200 A in the infrared. The emissivity of tungsten was taken from a weighted mean curve of published values to which reference is made by Stair and Smith [19]. The transmittance of fused quartz was calculated from data on its index of refraction published by Sosman [22]. The final product, representing the relative energy distribution of the radiation emerging from the quartz window of the lamp, was plotted on a convenient scale to permit interpolation to any wavelength in the range 2300 to 10000 A.

Spectrograms of the pure copper arc and of the tungsten lamp were made under conditions identical with those described above except that for these a 2 to 1 step sector with 8 steps was used for closer calibration (fig. 3). Microphotometer measurements of transmittance were made in each step of the standard-lamp spectrum at intervals of 50 A and a family of calibration curves of transmittance versus log exposure (hereafter referred to as log J) was drawn up for each plate. The exposure of the standard-lamp J_s was read from the calibration curve for each wavelength at a transmittance of 40 percent (where the curve is linear) and then divided by the calculated intensity I_s at that wavelength. I_s is the calculated intensity emitted by the standard-lamp. A standardization curve of log J_s/I_s versus λ was plotted for each plate. Calibration curves of transmittance versus log J were then drawn from measurements on each of the selected copper lines and the log exposure (log J_{Cu}) of each copper line at a transmittance of 40 percent was read from each curve. Log J_s/I_s was then subtracted from the average of numerous values of log J_{Cu} to give log I_{Cu} which is the log of the true relative intensity of the copper line. The values of log I_{Cu} from plates in adjacent wavelength regions were adjusted to a common basis by means of lines common to both plates. The plot of log J_s/I_s versus λ is the relative response function of the plate-spectrograph combination and as such was itself useful in the infrared where the copper spectrum lacks lines suitable for use as an intensity reference.

From 2 to 24 determinations were made on each of 202 lines of Cu I between 2800 and 8100 A with an average of about 9 determinations per line. The values of I_{Cu} obtained by this procedure below 3300 A were systematically low because of the rapid decline in intensity from the standard lamp in the direction of short wavelengths. The intensity from the lamp at 5500 A is about 40 times the intensity at 3300 A and about 300 times the intensity at 2800 A. This fact introduces possible errors from scattered light of the intense visible radiation which tends to raise J_s and consequently depress I_{Cu}.

The spectrum of copper is composed of sharp lines and diffuse lines. Since the microphotometer measurements were made at the peaks of the lines rather than integrated over their widths, the measured intensities of the two groups of lines are on different relative scales, the scale of the diffuse lines being smaller than that of the sharp lines. The reference lines selected for calibration of the estimates of apparent intensity are all sharp lines.

The random error of the photometric procedure, including microphotometer error and irregularities of response of the "N" plates was determined from 92 measurements of apparent relative intensities in spectra of the standard lamp on two plates. The standard deviation of individual measurements from the mean was found to be about 1.5 percent. It is probable, therefore, that the uncertainties in these intensity measurements of the copper lines lie entirely in the systematic errors discussed above and in the random fluctuations of the arc under study.

Since the ribbon filament lamp was too faint in the region from 2000 to 3300 A to serve as a standard, recourse was taken to a Hanovia hydrogen arc lamp. Output from this lamp was compared by R. Stair in the Radiometry Section of the Bureau with a standard tungsten-in-quartz lamp and a standard mercury arc in the region from 2500 to 3800 A; this provided an independent overlapping calibration which carried us down to 2500 A.

The intensity numbers below 2500 A become less accurate as the short wavelength limit is approached. Lacking any reliable energy calibration for shorter waves, the intensity estimates from 2500 to 2000 A were necessarily adjusted by judicious extrapolation, guided by the declining densities of background in the spectrograms, caused by the increasing absorption in the apparatus and in the air at shorter wavelengths.

3. Results

Because these relative intensities of 39,000 lines of 70 elements are based on empirical detectability they will be generally applicable to spectrochemical analysis provided that proper corrections are made on account of different excitation in different matrices. Chemical elements differ in volatility, electron emission, spectral excitation, and spectral background, and consequently their spectral detectability in different mixtures or matrices depends on certain controlling factors. One of the important factors is the atomic ionization potential which ranges from 3.9 v for Cs to 11.3 v for C, and for the investigated 70 elements has an average value of 7.3

v. By mixing these 70 elements with copper, which has an ionization potential of 7.7 v, we obtained excitation conditions very near the average for all. To convert our intensity numbers from copper to any other matrix would require the empirical determination of the proper conversion factor for each element.

It should be pointed out that sensitivity of detection in spectrochemical analysis is commonly given in percent by weight. In order to find the weight percent from the atomic percent given in the tables the following simple relation applies,

$$C_w = \frac{C_a A_x}{A_{Cu}}$$

where C_w is the concentration in percent by weight, C_a is the atomic percent (0.1 in this case), A_{Cu} is the atomic weight of copper, and A_x is the atomic weight of the element X.

Although our original intention was to determine the relative strengths of many spectral lines from different chemical elements for purposes of quantitative spectrochemical analysis we believe that the results may also interest theoretical spectroscopists and astrophysicists. For instance, if our intensity numbers, based on concentration detectability and relative energy calibration, actually express relative energies then all may be converted to oscillator strengths, or to relative gf-values, or even to absolute f-values, if the proper conversion factors can be found.

Because of the low concentration of each element in the copper arc from which the spectra were observed, the lines were extraordinarily free from self absorption. This fact suggests that these emission intensities could be converted into relative gf-values, provided that a valid excitation temperature can be assigned to the copper arc.

The temperature of the copper arc can be determined by comparing the observed relative intensities of the lines of an element with the relative gf-values of those lines [23], provided that the arc can be shown to be in local thermodynamic equilibrium for the energy states under consideration. A preliminary investigation of this sort has been carried out by using relative gf-values determined by R. B. King and his coworkers for Ti I [24], Ti II [25], V I [26], Cr I [27], Fe I [28], [29] and Ni I [30] in the region above 3000 A. Figure 4 is a typical example of the correlation of intensities and gf-values indicating the temperature of the copper arc. The comparison shows that our copper arc is sufficiently in equilibrium to yield a temperature which may be useful in calculating approximate gf-values of some utility from our intensity numbers. A preliminary value of 5000 °K ±300 °K has been obtained as the average temperature of the 10 amp, 220 v, copper arc.

Because our intensity data represent single (sometimes two) personal subjective estimates of photographic densities in sectored spectrograms there is no possibility of deriving statistically any probable errors or standard deviations for individual values. However, an estimate of the accuracy or reliability of our data may be obtained by comparing them with quantitative results published by other investigators. For example, figure 4 shows the ratios of our intensities to the relative f-values (or intensities) reported by King and King [24] who measured the total absorptions of Ti I lines in furnace absorption spectra; they stated [28] that "The average deviations of the individual intensity measures from the mean values vary from 4 to 15 percent for different lines" measured between 4 and 16 times on different plates. Each little circle plotted in figure 4 represents a Ti I multiplet of 1 to 12 lines. The average of 59 deviations from the mean of all is 25 percent.

A second indication of the reliability of our intensities is obtained by comparing our values with the relative intensities of lines in multiplets of five elements (Cr, Fe, Mn, Ti, V) measured with photographic densitometry by Frerichs [31] to test the sum rules. Such a comparison in 21 different multiplets indicates deviations ranging from 5 to 22 percent, with an overall average of 14 percent.

A third estimate of the errors in our data results from their comparison with photoelectric intensity measurements in the iron arc by Crosswhite [32], who claims an accuracy of the order of 1 percent. The average difference between intensities of 330 iron lines (3175 to 5658 A) common to these two sets of observations is ±27 percent, but some of this difference may be due to temperature if this is not the same in both arcs.

Other comparisons could be made but the above three are different and typical; they suggest that the average

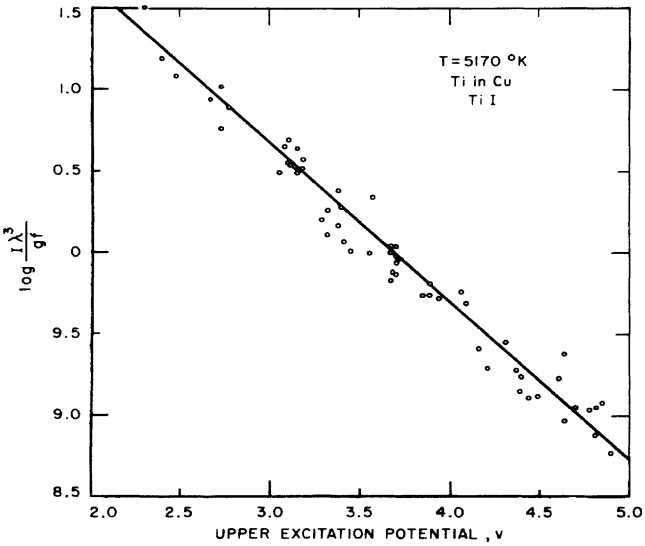


FIGURE 4. *Plot of log intensity* λ^3 *over* gf *versus upper excitation potential of* Ti I *lines.* The temperature of the arc is derived from the slope of the line which best fits the points.

error of our spectral-line intensities within a spectrum of each element is probably between 15 and 25 percent. The uniformity of the intensity scale between the spectra of the various elements is more difficult to assess. Considerable care was taken to obtain spectrograms under comparable conditions for all of the elements; however, differences in volatilities of the elements or their oxides, and differences in ease of excitation may possibly result in shifts of intensity scales between elements. An inspection of the intensities of the strongest lines of the elements indicates that the values are generally in the same order as sensitivity of detection of the elements where these are known. Although no high precision was expected in our mass-production of intensities it is emphasized that reasonably uniform, quantitative values are now available for 39,000 lines emitted by 70 chemical elements.

The tables of spectral-line intensities resulting from this investigation are presented in two parts. In part I the data are arranged by element in alphabetical order of chemical name. The heading of each table by element states the atomic symbol, atomic number, atomic weight, ratio of atomic weight to that of copper, the electron configuration and term symbol of the normal state of each spectrum and the corresponding ionization potential expressed in kaysers (cm^{-1}). Following the heading is a selected list of references. Under *Wavelengths* are listed all of the sources from which the wavelengths used in the table were compiled. Under *Classification* or *Spectrum Assignments* are listed the sources from which the assignment of spectrum and energy levels were obtained. A few spectra showed bands of metallic oxides. References to data about these bands are given under *Molecular Spectra*. In addition a few selected references to published experimental intensity measurements are given under *Intensities*.

Following the references there is abstracted from the main table a list of the strong lines arranged in order of decreasing intensity and giving, in addition to the data found in the main table, the electron configurations and spectral term designations of the energy levels that produce each line. These lists of the strong lines generally contain 2 percent or more of the lines in the main table.

Electron configurations and spectral term designations of quantum numbers are of unusual interest in the production of the strongest spectral lines, or *raies ultimes*. According to well-known rules governing the relative intensities of lines in multiplets, the strongest line arises from transitions between levels having the largest J and L values when $\triangle J = \triangle L = 1$. A rule relating to *raies ultimes* was expressed [33] a quarter of a century ago as follows: "A *raie ultime* in any spectrum originates with a simple interchange of a single electron between s and p states, usually preferring configurations in which only one electron occurs in such states". The above simple rules for the strongest lines appear to be valid for all spectra.

Then comes the main table, listing in order of wavelength, for every line of an element which appears on our plates, the intensity, character, wavelength, spectrum, and energy levels. The calibrated intensity numbers in the first column represent the relative radiant power emitted by our arc at each wavelength. Lines which differ in profile from a normal sharp symmetrical shape are described in the second column, with the notation suggested in the Transactions of the Joint Commission for Spectroscopy [34] as follows:

b — band head,
c — complex,
d — unresolved double line,
h — hazy,
l — shaded longward,
s — shaded shortward,
w — wide.

The wavelengths in column 3 are taken from the places noted in the list of references and are given to the nearest 0.01 A. They are all normal air wavelengths, even those below 2000 A. Column 4 gives the spectrum, I, II, or III (respectively from neutral, singly ionized and doubly ionized atoms) in which the line occurs or the molecule from which a band head originates and column 5 the numerical values, rounded off to the nearest wavenumber, of the levels between which the transition occurs. These data are taken from the *Classification* reference.

The wavelength of a doubly classified line appears before the first pair of energy levels and the second pair follows immediately. In these tables all energy levels are given in vacuum wavenumber units, cm^{-1}, for which the name kayser (K) has been proposed [35]. For all spectral lines explained as transitions between energy levels this serves as a mutual check since the wavelengths in normal air, when converted to vacuum wavenumbers by a conversion table [36], will coincide within one unit with the difference between the two energy levels. Furthermore these numbers serve as an index to the term designation in "Atomic Energy Levels" [37] where electron configurations, quantum numbers, and magnetic splitting factors are given.

A comparison of the excitation energies of any two classified lines may be made by directly comparing their larger energy levels in kaysers, and adding the ionization potentials in the case of lines from II or III spectra. This direct and simple procedure avoids the labor of converting all energy levels from kaysers to electron volts by means of the relation one ev = 8066 K.

In part II the intensity data are arranged in two tables in order of increasing wavelengths. In table 1 the strong lines of each element which were abstracted from the main tables in part I are here ar-

ranged in order of wavelength. Following this is table 2 in which the individual main tables of part I have been consolidated into a single table arranged by wavelength. This table contains about 39,000 lines of 70 elements. The intensities in the table are on a scale of relative radiant power and the scale is the same from element to element. Following the intensity numbers are given the wavelength, the element symbol, and the spectrum. The intensity of a double line appears before the first wavelength and the second wavelength follows immediately.

This investigation has extended over a period of 28 years, and represents a very considerable amount of intermittent labor contributed mainly by a relatively small number of individuals. The program was initiated by Meggers and Scribner, the latter prepared diluted-element mixtures, electrodes and spectrograms, while the former identified wavelengths, supplied many line classifications, and estimated relative intensities of some fifty thousand lines. In the production of the mixtures and the copper electrodes and spectrograms valuable assistance was given by Harriet E. Brown. Corliss contributed the copper calibration, the conversion of apparent intensities to relative radiant powers, and prepared the final tables. Mrs. Ruth Peterson carefully prepared and checked all the data on IBM cards so that it could be printed automatically. Valuable advice and assistance on the IBM machine operations was given by William Bozman. To all our able and reliable assistants the authors extend their sincere appreciation and thanks for cheerful and conscientious cooperation.

4. References

[1] G. Kirchhoff and R. Bunsen, Chemische Analyse durch Spectralbeobachtungen, Ann. d. Phys. 186, 161–189 (1860).

[2] J. N. Lockyer, Researches in spectrum-analysis in connection with the spectrum of the Sun, Phil. Trans. 164, 479–494 (1874).

[3] A. Gatterer and J. Junkes, Spektren der Seltenen Erden, 347 pp, Vatican City (1945).

[4] F. Exner and E. Haschek, Die Spektren der Elemente bei normalem Druck, 3 volumes, Franz Deuticke, Leipzig and Vienna (1911).

[5] F. Twyman and D. M. Smith, Wavelength tables for spectrum analysis, 2d ed. 180 pp, Adam Hilger, Ltd. London (1931).

[6] H. Kayser and R. Ritschl, Tabelle der Hauptlinien der Linienspektren aller Elemente, 2d ed. 269 pp, Julius Springer, Berlin (1939).

[7] G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables, 429 pp (John Wiley & Sons, Inc., New York, N.Y., 1939).

[8] A. N. Zaidel, V. K. Prokof'ev and S. M. Raiskii, Tables of Spectrum Lines, 550 pp, Veb Verlag Technik, Berlin (1955).

[9] W. N. Hartley, Researches in Spectrum Photography in Relation to new methods of Quantitative Chemical Analysis, Phil. Trans. 175, 49, 325 (1884).

[10] J. Pollok and A. H. Leonard, On the quantitative spectra of chemical elements, Proc. Roy. Soc. Dublin (2) 11, 217, 229, 257, 270, 331 (1908).

[11] A. de Gramont, Sur les indications quantitatives qui peuvent être fournies par les spectres de dissociation. Compt. rend. 147, 307 (1908).

[12] F. Löwe, Atlas der letzten Linien der wichtigsten Elemente, 44 pp. T. Steinkopff, Dresden and Leipzig (1928).

[13] W. F. Meggers, C. H. Corliss, and B. F. Scribner, Intensities of 30,000 spectral lines, Science 121, 624 (1955).

[14] C. W. Allen and A. S. Asaad, Oscillator strengths from arc spectra of diluted copper alloys, Monthly Notices, Roy. Astron. Soc. 117, 36–49 (1957).

[15] C. W. Allen, Absolute oscillator strength measurements in Mg, Ca and other atoms, Monthly Notices, Roy. Astron. Soc. 117, 622–628 (1957).

[16] F. Löwe, Atlas der Analysenlinien der wichtigsten Elemente, 40 pp T. Steinkopff, Dresden and Leipzig (1936).

[17] W. F. Meggers, The physical basis of spectrochemical analysis, J. Opt. Soc. Am. 31, 39–46 (1941).

[18] W. F. Meggers, The strongest lines of singly ionized atoms, J. Opt. Soc. Am. 31, 605–611 (1941).

[19] R. Stair and W. O. Smith, A tungsten-in-quartz lamp and its applications in photoelectric radiometry, J. Research NBS 30, 449–459 (1943).

[20] J. F. Skogland, Tables of spectral energy distribution and luminosity for use in computing light transmissions and relative brightnesses from spectrophotometric data, NBS Misc. Publ. 86, p. 23 (1929).

[21] A. N. Lowan and G. Blanch, Tables of Planck's radiation and photon functions, J. Opt. Soc. Am. 30, 70–81 (1940).

[22] R. B. Sosman, Properties of Silica (Chemical Catalog Co., New York, N.Y., 1927).

[23] H. Hemmendinger, Electrode concentrations and total intensity of spectral lines, J. Opt. Soc. Am. 31, 150–156 (1941).

[24] R. B. King and A. S. King, Relative f-values for lines of Fe I and Ti I, Astrophys. J. 87, 24–39 (1938).

[25] R. B. King, Relative f-values for lines of Ti II, Astrophys. J. 94, 27–29 (1941).

[26] R. B. King, Relative f-values for lines of V I, Astrophys. J. 105, 376–389 (1947).

[27] A. J. Hill and R. B. King, Relative f-values for lines of Cr I, J. Opt. Soc. Am. 41, 315–321 (1951).

[28] R. B. King and A. S. King, Relative f-values for lines of Fe I, Astrophys. J. 82, 377–395 (1935).

[29] W. W. Carter, Measurement of f-values in the iron spectrum, Phys. Rev. 76, 962–966 (1949).

[30] R. B. King, Relative gf-values of Ni I, Astrophys. J. 108, 87–91 (1948).

[31] R. Frerichs, Intensitätsmessungen an Multipletts, Ann. d. Physik 386, 807–845 (1926).

[32] H. M. Crosswhite, Photoelectric intensity measurements in the iron arc, Spectrochimica Acta 4, 122–151 (1950).

[33] W. F. Meggers and B. F. Scribner, Second spectrum of hafnium (Hf II), J. Research NBS 13, 657 (1934).

[34] Transactions of the joint commission for spectroscopy, J. Opt. Soc. Am. 43, 410–430 (1953).

[35] W. F. Meggers, Modern Interferometers, review, J. Opt. Soc. Am. 41, 1064 (1951).

[36] C. D. Coleman, W. R. Bozman and W. F. Meggers, Table of wavenumbers, NBS Mono. 3, 2 volumes (U.S. Government Printing Office, Washington, D. C., 1960).

[37] C. E. Moore, Atomic energy levels, NBS Circ. 467, Vol. 1 (1949), Vol. 2 (1952), Vol. 3 (1958). (U.S. Government Printing Office, Washington, D. C.)

WASHINGTON, D. C., January 1, 1961.

Tables of Spectral-Line Intensities

Arranged by Elements

ALUMINUM

Al, $Z=13$, $M=26.98$, Ratio $\frac{\text{Al}}{\text{Cu}}=0.425$

Al I Normal state of valence electrons $3s^2 3p^1\ {}^2P^o_{0\frac{1}{2}}=0$. I.P.= 48279 K
Al II Normal state of valence electrons $3s^2\ {}^1S_0=0$. I.P.=151860 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Al I, F. Paschen, Ann. Physik **12,** 516 (1932).

Intensities:
Y. I. Ostrovsky, Optika i Spektroskopiya **2,** 673 (1957).

Relative intensity of aluminum lines observed in an arc of copper containing 0.1 atomic percent of aluminum

Strong lines of aluminum

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	3961. 53	I	112–25348	$3s^2 3p^1\ {}^2P^o_{1\frac{1}{2}}$—$3s^2 4s^1\ {}^2S_{0\frac{1}{2}}$
650	3092. 71	I	112–32437	$3s^2 3p^1\ {}^2P^o_{1\frac{1}{2}}$—$3s^2 3d^1\ {}^2D_{2\frac{1}{2}}$
	3092. 84	I	112–32435	$3s^2 3p^1\ {}^2P^o_{1\frac{1}{2}}$—$3s^2 3d^1\ {}^2D_{1\frac{1}{2}}$

Aluminum — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7 d	2269. 09	I	112–44169	4	2575. 41	I	112–38929
	2269. 21	I	112–44166	15	2652. 49	I	0–37689
18	2367. 06	I	0–42234	20	2660. 39	I	112–37689
36	2373. 13	I	112–42238	320	3082. 16	I	0–32435
7	2373. 36	I	112–42234	650 d	3092. 71	I	112–32437
					3092. 84	I	112–32435
1. 8	2378. 41	I	112–42144				
24	2567. 99	I	0–38929	450	3944. 03	I	0–25348
48	2575. 10	I	112–38934	900	3961. 53	I	112–25348

ANTIMONY

Sb, $Z=51$, $M=121.76$, Ratio $\frac{Sb}{Cu}=1.916$

Sb I Normal state of valence electrons $5s^25p^3\ {}^4S_{1\frac{1}{2}}=0$. I.P.= 69700 K
Sb II Normal state of valence electrons $5s^25p^2\ {}^3P_0=0$. I.P.=133328 K

References

Wavelengths and classification:
Sb I, W. F. Meggers and C. J. Humphreys, J. Research NBS **28,** 463 (1942).

Relative intensity of antimony lines observed in an arc of copper containing 0.1 atomic percent of antimony

Strong lines of antimony

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
600	2598.05	I	8512–46991	$5s^25p^3\ {}^2D^{\circ}_{1\frac{1}{2}}$—$5s^25p^26s^1\ {}^2P_{0\frac{1}{2}}$
600	2598.09	I	9854–48332	$5s^25p^3\ {}^2D^{\circ}_{2\frac{1}{2}}$—$5s^25p^26s^1\ {}^4P_{2\frac{1}{2}}$
320	2528.52	I	9854–49391	$5s^25p^3\ {}^2D^{\circ}_{2\frac{1}{2}}$—$5s^25p^26s^1\ {}^2P_{1\frac{1}{2}}$
140	2877.92	I	8512–43249	$5s^25p^3\ {}^2D^{\circ}_{1\frac{1}{2}}$—$5s^25p^26s^1\ {}^4P_{0\frac{1}{2}}$

Antimony — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.5	2029.49	I	16396–65653	1.8	2474.57	I	18464–58863
5	2039.77	I	9854–58863	18	2478.32	I	16396–56733
14	2049.57	I	8512–57287	3.5	2480.44	I	16396–56699
55	2068.33	I	0–48332	3.0	2510.54	I	8512–48332
10	2098.41	I	8512–56152	320	2528.52	I	9854–49391
2.5	2118.48	I	18464–65653	1.2	2554.64	I	18464–57597
5	2127.39	I	0–46991	8	2574.06	I	16396–55233
10	2139.69	I	8512–55233	600	2598.05	I	8512–46991
5	2141.83	I			2598.09	I	9854–48332
10	2144.86	I	8512–55121	34	2612.31	I	18464–56733
38	2175.81	I	0–45945	32	2652.60	I	18464–56152
7	2179.19	I	9854–55728	38	2670.64	I	8512–45945
2.5	2201.32	I	16396–61809	14	2682.76	I	18464–55728
7	2208.45	I	9854–55121	5	2692.25	I	16396–53528
5	2220.73	I	8512–53528	17	2718.90	I	18464–55233
2.5	2224.93	I	8512–53443	5	2727.23	I	18464–55121
7	2262.51	I	16396–60581	90	2769.95	I	9854–45945
2.0	2288.98	I	9854–53528	7	2851.11	I	18464–53528
7	2293.44	I	9854–53443	140	2877.92	I	8512–43249
4	2306.46	I	16396–59738	50	3029.83	I	16396–49391
45	2311.47	I	0–43249	100	3232.52	I	18464–49391
2.0	2360.50	I	16396–58747	85	3267.51	I	16396–46991
4	2373.67	I	18464–60581	10	3383.15	I	16396–45945
4	2383.64	I	18464–60404	10	3637.83	I	18464–45945
4	2422.13	I	18464–59738	5	3722.79	I	16396–43249
6	2426.35	I	16396–57597	4	4033.55	I	18464–43249
18	2445.51	I	8512–49391				

ARSENIC

As, $Z=33$, $M=74.92$, Ratio $\frac{\text{As}}{\text{Cu}}=1.179$

As I Normal state of valence electrons $4s^2 4p^3\ {}^4S^\circ_{1\frac{1}{2}}=0$. I.P.= 79165 K
As II Normal state of valence electrons $4s^2 4p^2\ {}^3P_0=0$. I.P.=163000 K

References

Wavelengths and Classification:
As I, W. F. Meggers, A. G. Shenstone, and C. E. Moore, J. Research NBS **45,** 346 (1950).

Relative intensity of arsenic lines observed in an arc of copper containing 0.1 atomic percent of arsenic

Strong lines of arsenic

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
140	2780. 22	I	18648–54605	$4s^2 4p^3\ {}^2P^\circ_{1\frac{1}{2}}$—$4s^2 4p^2 5s^1\ {}^2P_{1\frac{1}{2}}$
90	2860. 44	I	18186–53136	$4s^2 4p^3\ {}^2P^\circ_{0\frac{1}{2}}$—$4s^2 4p^2 5s^1\ {}^2P_{0\frac{1}{2}}$

Arsenic — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
17	1936. 96	I	0–51610	16	2370. 77	I	18648–60815
28	1971. 97	I	0–50694	18	2381. 18	I	10915–52898
20	1989. 70	I	10592–60835	9	2437. 23	I	10592–51610
6	1990. 48	I	10592–60815	36	2456. 53	I	10915–51610
3. 0	1994. 78	I	18186–68301	44	2492. 91	I	10592–50694
28	2003. 34	I	10915–60815	44	2745. 00	I	18186–54605
4	2009. 19	I	18648–68403	140	2780. 22	I	18648–54605
3. 0	2013. 32	I	18648–68301	90	2860. 44	I	18186–53136
2. 0	2165. 52	I	18648–64812	20	2898. 71	I	18648–53136
44	2288. 12	I	10915–54605	3. 0	2990. 99	I	18186–51610
5	2344. 03	I	18186–60835	8	3032. 85	I	18648–51610
85	2349. 84	I	10592–53136	4	3119. 60	I	18648–50694
20	2369. 67	I	18648–60835				

BARIUM

Ba, $Z=56$, $M=137.36$, Ratio $\frac{\text{Ba}}{\text{Cu}}=2.162$

Ba I Normal state of valence electrons $5p^6\ 6s^2\ {}^1S_0 = 0$. I.P.=42032 K
Ba II Normal state of valence electrons $5p^6\ 6s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.=80687 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
F. Sullivan and K. Burns, Sci. Studies St. Bonaventure Coll. **9,** 7 (1941).
H. N. Russell and C. E. Moore, J. Research, NBS **55,** 299 (1955).

Classification:
Ba I, H. N. Russell and C. E. Moore, J. Research NBS **55,** 299 (1955).
Ba II, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

Intensities:
L. S. Ornstein, M. Coelingh, and J. G. Eymers, Z. Physik **44,** 653 (1927).
A. M. Kruithof, Physica **10,** 493 (1943).
H. Kopfermann and G. Wessel, Z. Physik **130,** 100 (1951).

Relative intensity of barium lines observed in an arc of copper containing 0.1 atomic percent of barium

Strong lines of barium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
6500	4554. 03	II	0–21952	$6s^1\ {}^2S_{0\frac{1}{2}}$—$6p^1\ {}^2P^\circ_{1\frac{1}{2}}$
2000	4934. 09	II	0–20262	$6s^1\ {}^2S_{0\frac{1}{2}}$—$6p^1\ {}^2P^\circ_{0\frac{1}{2}}$
2000	6141. 72	II	5675–21952	$5d^1\ {}^2D_{2\frac{1}{2}}$—$6p^1\ {}^2P^\circ_{1\frac{1}{2}}$
1200	6496. 90	II	4874–20262	$5d^1\ {}^2D_{1\frac{1}{2}}$—$6p^1\ {}^2P^\circ_{0\frac{1}{2}}$
650	5535. 48	I	0–18060	$6s^2\ {}^1S_0$ —$6s^1\ 6p^1\ {}^1P^\circ_1$

Barium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
28	2304.24	II	4874–48259
55	2335.27	II	5675–48484
6	2347.58	II	5675–48259
6	2528.51	II	20262–59799
10	2634.78	II	21952–59895
3.0	2702.63	I	0–36990
1.8	2771.36	II	21952–58025
18	3071.58	I	0–32547
50	3501.11	I	0–28554
7	3889.33	I	0–25704
140 l	3891.78	II	20262–45949
3.0	3892.66	I	11395–37077
10	3909.91	I	9034–34603
14	3935.72	I	9216–34617
3.5	3937.87	I	9216–34603
18	3993.40	I	9597–34631
3.0	3995.66	I	9597–34617
150 h	4130.66	II	21952–46155
6	4132.43	I	0–24192
20	4166.00	II	21952–45949
20	4283.10	I	11395–34736
7 h	4350.33	I	12637–35617
10	4402.54	I	12637–35344
15	4431.89	I	12266–34823
3.0	4488.97	I	13515–35785
3.5 h	4493.64	I	13515–35762
13	4505.92	I	12637–34823
5 h	4523.24	I	13515–35617
13	4524.93	II	20262–42355
6500	4554.03	II	0–21952
8	4573.85	I	12637–34494
14	4579.64	I	13515–35344
4	4599.75	I	12637–34371
2.0	4619.98	I	12266–33905
3.0	4673.62	I	9597–30987
13	4691.62	I	13515–34823
3.0	4700.43	I	12637–33905
8	4726.45	I	11395–32547
40	4899.97	II	21952–42355
1.8	4902.90	I	13515–33905
2000	4934.09	II	0–20262
3.0	4947.33	I	18060–38267
2.0	5054.98	I	18060–37837
6 h	5159.92	I	18060–37435
2.0 h	5267.03	I	18060–37041
22 hl	5424.55	I	12266–30696
1.4 h	5473.69	I	
32 hl	5519.05	I	12637–30751
650	5535.48	I	0–18060
2.0	5680.18	I	9216–26816
50 hl	5777.62	I	13515–30818
9 l	5800.23	I	13515–30751
7	5805.68	I	9597–26816
30	5826.28	I	11395–28554
280	5853.68	II	4874–21952
5	5907.64	I	9034–25957
50	5971.70	I	9216–25957
50	5997.09	I	9034–25704
50	6019.47	I	9034–25642
110	6063.12	I	9216–25704
170	6110.78	I	9597–25957
2000	6141.72	II	5675–21952
50	6341.68	I	9216–24980
36	6450.85	I	9034–24532
60	6482.91	I	11395–26816
1200	6496.90	II	4874–20262
160	6498.76	I	9597–24980
70	6527.31	I	9216–24532
65	6595.32	I	9034–24192
32	6675.27	I	9216–24192
32	6693.84	I	9597–24532
1.6 h	6771.85	I	23074–37837
6	6865.69	I	11395–25957
1.2 h	6867.85	I	22947–37504
140	7059.94	I	9597–23757
19	7120.33	I	9034–23074
0.6	7153.58	I	23757–37732
6	7195.24	I	12266–26160
2.0	7228.84	I	22065–35894
95	7280.30	I	9216–22947
11	7392.41	I	12637–26160
2.0	7417.53	I	9597–23074
3.0 hl	7459.78	I	22947–36349
17	7488.08	I	9597–22947
2.0	7610.48	I	23062–36200
1.0 hl	7636.90	I	23074–36165
4 hl	7642.91	I	23757–36837
50	7672.09	I	9034–22065
30	7780.48	I	9216–22065
0.8 h	7839.57	I	24980–37732
17	7905.75	I	13515–26160
8	7911.34	I	0–12637
6 h	8210.24	I	18060–30237
40 h	8559.95	I	11395–23074
3.0	8860.98	I	12637–23919
3.5	8914.99	I	12266–23480

BERYLLIUM

Be, $Z=4$, $M=9.013$, Ratio $\frac{\text{Be}}{\text{Cu}}=0.1418$

Be I Normal state of valence electrons $2s^2\ {}^1S_0 = 0$. I.P.= 75192 K
Be II Normal state of valence electrons $2s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.=146882 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Be I and Be II, F. Paschen and P. G. Kruger, Ann. Physik **8**, 1005 (1931).

Molecular Spectra:
BeO, A. Lagerqvist and R. Westoo, Arkiv Mat. Astron. Fysik **32A**, No. 10 (1945).

Intensities:
W. R. Bozman, C. H. Corliss, and W. F. Meggers, J. Research NBS **50**, 131 (1953).

Relative intensity of beryllium lines observed in an arc of copper containing 0.1 atomic percent of beryllium

Strong lines of beryllium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
480	3130.42	II	0–31935	$2s^1\ {}^2S_{0\frac{1}{2}}—2p^1\ {}^2P^\circ_{1\frac{1}{2}}$
320	3131.07	II	0–31929	$2s^1\ {}^2S_{0\frac{1}{2}}—2p^1\ {}^2P^\circ_{0\frac{1}{2}}$
300	2348.61	I	0–42565	$2s^2\ {}^1S_0—2s^12p^1\ {}^1P^\circ_1$

Beryllium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5.0 h	2174.94	I	21980–67944	480	3130.42	II	0–31935
	2175.07	I	21982–67944	320	3131.07	II	0–31929
300	2348.61	I	0–42565	60	3321.01	I	21979–52082
70	2494.56	I	21979–62055		3321.09	I	21980–52082
	2494.58	I	21980–62055	100	3321.34	I	21982–52082
100	2494.73	I	21982–62055	12	4572.67	I	42565–64428
140 c	2650.47	I	21980–59698	7 bl	4708.60	BeO	
	2650.55	I	21979–59696	4 h	8254.10	I	42565–54677
	2650.62	I	21980–59696				
	2650.64	I	21982–59698				
	2650.70	I	21980–59695				
	2650.78	I	21982–59696				

BISMUTH

Bi, $Z=83$, $M=208.99$, Ratio $\frac{\text{Bi}}{\text{Cu}}=3.289$

Bi I Normal state of valence electrons $6s^2 6p^3\ {}^4S^\circ_{1½}=0$. I.P.= 58790 K
Bi II Normal state of valence electrons $6s^2 6p^2\ {}^3P_0=0$. I.P.=134600 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), above 2000 A.
G. R. Toshniwal, Phil. Mag. **4,** 774 (1927), below 2000 A.

Classification:
Bi I, S. Mrozowski, Phys. Rev. **62,** 526 (1942).
Intensities:
N. N. Sobolev, J. Exptl. Theoret. Phys. (U.S.S.R.) **13,** 130 (1943).

Relative intensity of bismuth lines observed in an arc of copper containing 0.1 atomic percent of bismuth

Strong lines of bismuth

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3600	3067.72	I	0–32588	$6s^2 6p^3\ {}^4S^\circ_{1½}$—$6s^2 6p^2 7s^1\ {}^4P_{0½}$
400	2897.98	I	11418–45915	$6s^2 6p^3\ {}^2D^\circ_{1½}$—$6s^2 6p^2 7s^1\ {}^2P_{0½}$

Bismuth — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
17	1953.89	I	0−51158	400	2897.98	I	11418−45915
3.5	1959.48	I	0−51019	320	2938.30	I	15437−49461
8	2021.21	I	0−49461	280	2989.03	I	11418−44865
55	2061.70	I	0−48489	70	2993.34	I	11418−44817
10	2110.26	I	0−47371	240	3024.64	I	15437−48489
7	2133.63	I	11418−58272	6	3034.87	I	
3.0	2228.25	I	0−44865	3600 c	3067.72	I	0−32588
14	2230.61	I	0−44817	14	3076.66	I	11418−43912
5	2276.58	I	0−43912	55 c	3397.21	I	15437−44865
11	2400.88	I	15437−57075	50 c	3510.85	I	15437−43912
2.5	2515.69	I	11418−51158	38 c	3596.11	I	21660−49461
7	2524.49	I	11418−51019	14	4121.53	I	21660−45915
70	2627.91	I	11418−49461	14	4121.86		
28 c	2696.76	I	11418−48489	60 c	4722.19	I	11418−32588
14 d	2730.50	I	21660−58272		4722.55		
					4722.83		
36	2780.52	I	11418−47371				
14 c	2809.62	I	15437−51019	1.0 c	5552.35	I	

BORON

B, $Z=5$, $M=10.82$, Ratio $\frac{B}{Cu}=0.1703$

B I Normal state of valence electrons $2s^2 2p^1\ ^2P^0_{1/2}=0$. I.P.= 66930 K
B II Normal state of valence electrons $2s^2\ \ ^1S_0=0$. I.P.=202895 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
B I, H. E. Clearman, J. Opt. Soc. Am. **42,** 373 (1952).

Relative intensity of boron lines observed in an arc of copper containing 0.1 atomic percent of boron

Strong line of boron

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
480	2497. 73	I	16–40040	$2s^2 2p^1\ ^2P^0_{1/2}$—$2s^2 3s^1\ ^2S_{0 1/2}$

Boron — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	2088. 93	I	0–47857	240	2496. 78	I	0–40040
11	2089. 59	I	16–47857	480	2497. 73	I	16–40040

CADMIUM

Cd, $Z=48$, $M=112.41$, Ratio $\frac{\text{Cd}}{\text{Cu}}=1.769$

Cd I Normal state of valence electrons $4d^{10}5s^2\ {}^1S_0 = 0$. I.P.= 72539 K
Cd II Normal state of valence electrons $4d^{10}5s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.=136375 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology, Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Cd I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).
Cd II, A. G. Shenstone and J. T. Pittenger, J. Opt. Soc. Am. **39,** 219 (1949).

Intensities:
W. Kuhn, Naturwiss. **14,** 48 (1926).
A. Filippov, Phys. Z. Sowjetunion **1,** 289 (1932).
L. S. Ornstein, J. P. A. van Hengstum, and H. Brinkman, Physica **5,** 145 (1938).
R. B. King and D. C. Stockbarger, Astrophys. J. **91,** 488 (1940).
C. G. Matland, Phys. Rev. **91,** 436 (1953).
J. P. A. van Hengstum and J. A. Smit, Physica **22,** 86 (1956).

Relative intensity of cadmium lines observed in an arc of copper containing 0.1 atomic percent cadmium

Strong lines of cadmium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	2288. 02	I	0–43692	$4d^{10}5s^2\ {}^1S_0$—$4d^{10}5s^15p^1\ {}^1P_1^\circ$
360	3610. 51	I	31827–59516	$4d^{10}5s^15p^1\ {}^3P_2^\circ$—$4d^{10}5s^15d^1\ {}^3D_3$

Cadmium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
60		2144. 38	II	0 – 46619	5		3133. 17	I	30656 – 62563
110		2265. 02	II	0 – 44136	32		3261. 06	I	0 – 30656
2. 0		2267. 47	I	30656 – 74745	80		3403. 65	I	30114 – 59486
1500		2288. 02	I	0 – 43692	250		3466. 20	I	30656 – 59498
8		2306. 61	I	30656 – 73996	80		3467. 66	I	30656 – 59486
4		2312. 84	II	46619 – 89844	360		3610. 51	I	31827 – 59516
8	h	2329. 28	I	31827 – 74745	70		3612. 88	I	31827 – 59498
5		2572. 93	II	44136 – 82991	7		3614. 45	I	31827 – 59486
5	h	2836. 91	I	30114 – 65354	80		4678. 16	I	30114 – 51484
8	h	2880. 77	I	30656 – 65359	140		4799. 92	I	30656 – 51484
2. 0		2881. 23	I	30656 – 65354	280		5085. 82	I	31827 – 51484
16	h	2980. 63	I	31827 – 65367	26	h	6438. 47	I	43692 – 59220

CALCIUM

Ca, $Z=20$, $M=40.08$, Ratio $\frac{Ca}{Cu}=0.6308$

Ca I Normal state of valence electrons $4s^2\ {}^1S_0 = 0$. I.P.=49305 K
Ca II Normal state of valence electrons $4s^1\ {}^2S_{0\frac{1}{2}}=0$. I.P.=95748 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology, Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Ca I and Ca II
C. E. Moore, Atomic Energy Levels, NBS Circ. 467, Vol. 1 (1949).
C. E. Moore, A Multiplet Table of Astrophysical Interest, 1945 Ed., NBS Technical Note 36 (1959).
C. E. Moore, An Ultraviolet Multiplet Table, NBS Circ. 488, Sec. 1 (1950).

Intensities:
J. W. Schuttevaer, M. J. deBont, and T. H. van den Broek, Physica **10,** 544 (1943).
K. H. Olsen, P. M. Routly, and R. B. King, Astrophys. J. **130,** 688 (1959).

Relative intensity of calcium lines observed in an arc of copper containing 0.1 atomic percent calcium

Strong lines of calcium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
4200	3933. 67	II	0–25414	$3p^64s^1\ {}^2S_{0\frac{1}{2}}$—$3p^64p^1\ {}^2P^\circ_{1\frac{1}{2}}$
2200	3968. 47	II	0–25192	$3p^64s^1\ {}^2S_{0\frac{1}{2}}$—$3p^64p^1\ {}^2P^\circ_{0\frac{1}{2}}$
1100	4226. 73	I	0–23652	$3p^64s^2\ {}^1S_0$ —$3p^64s^14p^1\ {}^1P^\circ_1$

Calcium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
4		2398.56	I	0–41679
3.0		2721.64	I	0–36732
3.5		2994.96	I	15158–48538
2.0		2997.31	I	15210–48564
2.0		2999.64	I	15210–48538
2.0		3000.86	I	15210–48524
7		3006.86	I	15316–48564
3.0		3009.20	I	15316–48538
20		3158.87	II	25192–56839
50		3179.33	II	25414–56859
9		3181.28	II	25414–56839
5		3624.11	I	15158–42743
10		3630.75	I	15210–42745
10		3644.41	I	15316–42747
12		3706.03	II	25192–52167
15		3736.90	II	25414–52167
4200		3933.67	II	0–25414
1.2		3948.90	I	15158–40474
3.5		3957.05	I	15210–40474
2200		3968.47	II	0–25192
14		3973.71	I	15316–40474
1100		4226.73	I	0–23652
24		4283.01	I	15210–38552
22		4289.36	I	15158–38465
20		4298.99	I	15210–38465
110		4302.53	I	15316–38552
26		4307.74	I	15210–38418
40		4318.65	I	15316–38465
30		4425.44	I	15158–37748
65		4434.96	I	15210–37752
18		4435.69	I	15210–37748
140		4454.78	I	15316–37757
18		4455.89	I	15316–37752
1.0		4456.62	I	15316–37748
1.6	h	4526.94	I	21850–43933
2.5		4578.56	I	20335–42170
5		4581.40	I	20349–42171
8		4585.87	I	20371–42171
5	h	4878.13	I	21850–42344
6	h	5041.62	I	21850–41679
10	h	5188.85	I	23652–42919
11		5261.70	I	20335–39335
13		5262.25	I	20335–39333
11		5264.24	I	20349–39340
28		5265.56	I	20349–39335
48		5270.28	I	20371–39340
16		5349.47	I	21850–40538
2.5	h	5512.96	I	23652–41786
12		5581.97	I	20349–38259
70		5588.75	I	20371–38259
10		5590.11	I	20335–38219
36		5594.45	I	20349–38219
24		5598.47	I	20335–38192
12		5601.26	I	20371–38219
12		5602.84	I	20349–38192
22		5857.46	I	23652–40720
34		6102.72	I	15158–31540
95		6122.22	I	15210–31540
3.0		6161.29	I	20349–36575
140		6162.17	I	15316–31540
3.0	h	6163.76	I	20335–36555
6	h	6166.44	I	20335–36548
7		6169.05	I	20349–36555
14	h	6169.56	I	20371–36575
70		6439.07	I	20371–35897
18		6449.81	I	20335–35835
3.5		6455.60	I	20349–35835
70		6462.57	I	20349–35819
8		6471.66	I	20371–35819
32		6493.78	I	20335–35730
8		6499.65	I	20349–35730
2.0		6572.78	I	0–15210
4	h	6717.68	I	21850–36732
19		7148.15	I	21850–35835
9		7202.19	I	21850–35730
6	h	7326.15	I	23652–37298
12		8498.02	II	13650–25414
100		8542.09	II	13711–25414
55		8662.14	II	13650–25192

CARBON

C, $Z=6$, $M=12.011$, Ratio $\frac{C}{Cu}=0.1890$

C I Normal state of valence electrons $2s^2 2p^2\ ^3P_0 = 0$. I.P.= 90878 K
C II Normal state of valence electrons $2s^2 2p^1\ ^2P^o_{0\frac{1}{2}} = 0$. I.P.=196659 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
C I, A. Fowler and E. H. Selwyn, Proc. Roy. Soc. (London) **[A] 118,** 34 (1928).

Intensities:
H. Maecker, Z. Physik **135,** 13 (1953).
J. Richter, Z. Physik **151,** 114 (1958).

Relative intensity of carbon line observed in an arc of copper containing 0.1 atomic percent of carbon

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
10	2478. 57	I	21648–61982	$2s^2 2p^2\ ^1S_0$—$2s^2 2p^1 3s^1\ ^1P^o_1$

CERIUM

Ce, $Z=58$, $M=140.13$, Ratio $\frac{Ce}{Cu}=2.205$

Ce I Normal state of valence electrons $4f^2 6s^2\ \ ^3H_4 = 0$. I.P. $\approx$45000 K
Ce II Normal state of valence electrons $4f^1 5d^1 6s^1\ ^4H^3_{3\frac{1}{2}} = 0$.

References

Wavelengths:
A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945), below 7000 A.
C. C. Kiess, Sci. Papers BS **17,** 317 (1921), above 7000 A.
The references given above were supplemented as follows:
W. E. Albertson, unpublished wavelengths, 2500 to 7400 A.
C. H. Corliss, unpublished wavelengths, 6700 to 9000 A.
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
About 40 wavelengths in the region 4900 to 5500 A were measured on the plates of this investigation.

Classification:
Ce I (normal state) I. J. Spalding, unpublished material (May 1960).
Ce I (spectrum assignment only)
A. S. King, Astrophys. J. **68,** 194 (1928).
F. W. Paul, Phys. Rev. **49,** 156 (1936).
Ce II, G. R. Harrison, W. E. Albertson, and N. F. Hosford, J. Opt. Soc. Am. **31,** 439 (1941) and unpublished material.
G. Racah, Bull. Research Council Israel **5A,** No. 1 (1955).

Molecular Spectra:
CeO, W. W. Watson, Phys. Rev. **53,** 639 (1938).

Relative intensity of cerium lines observed in an arc of copper containing 0.1 atomic percent of cerium

Strong lines of cerium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
250	4186. 60	II	6968–30847	$4f^26s\ a\ {}^4H_{6½}$—$4f^26p\ z\ {}^4I^o_{7½}$
220	3952. 54	II	2642–27935	$11^o_{3½}$— $^4H_{4½}$
			6638–31931	$46^o_{4½}$— $159_{4½}$
200	3801. 53	II	7234–33531	$^4G^o_{5½}$— $179_{6½}$
200	3999. 24	II	2382–27380	$^4H^o_{4½}$— $^4I_{5½}$
190	3942. 75	II	6913–32269	$^4H^o_{6½}$— $^4I_{7½}$
190	4012. 39	II	4523–29439	$^4H^o_{4½}$— $^4G_{5½}$
190	4133. 80	II	6968–31152	$4f^26s\ a\ {}^4H_{6½}$—$4f^26p\ z\ {}^4G^o_{5½}$
170	4460. 21	II	3854–26268	$4f^26s\ a\ {}^4H_{3½}$—$4f^26p\ z\ {}^4H^o_{3½}$
160	3655. 85	II	2563–29909	$^4I^o_{5½}$— $^4H_{4½}$
150	4040. 76	II	3594–28335	$15^o_{4½}$— $117_{4½}$
150	4562. 36	II	3854–25766	$4f^26s\ a\ {}^4H_{3½}$—$4f^26p\ z\ {}^4I^o_{4½}$
140	3942. 15	II	0–25360	$^4H^o_{3½}$— $^4G_{2½}$
140	4137. 65	II	4166–28327	$4f^26s\ a\ {}^4H_{4½}$—$4f^26p\ z\ {}^4H^o_{5½}$
140	4289. 94	II	2642–25945	$11^o_{3½}$— $104_{3½}$
140	4296. 67	II	4166–27433	$4f^26s\ a\ {}^4H_{4½}$—$4f^26p\ z\ {}^4H^o_{4½}$
130	4073. 48	II	3854–28396	$4f^26s\ a\ {}^4H_{3½}$—$4f^26p\ z\ {}^4G^o_{2½}$
120	3882. 45	II	2596–28345	$^4F^o_{1½}$— $119_{0½}$
120	4391. 66	II	2596–25360	$^4F^o_{1½}$— $^4G_{2½}$
120	4628. 16	II	4166–25766	$4f^26s\ a\ {}^4H_{4½}$—$4f^26p\ z\ {}^4I^o_{4½}$
110	3560. 80	II	5969–34044	$^2I^o_{5½}$— $187_{4½}$
110	3716. 37	II	0–26900	$^4H^o_{3½}$— $^4H_{3½}$
110	4075. 71	II	5651–30180	$^4H^o_{5½}$— $^4I_{6½}$
110	4075. 85	II	4911–29439	$^2H^o_{5½}$— $^4G_{5½}$
110	4222. 60	II	988–24663	$^4H^o_{4½}$— $^4I_{4½}$
100	3854. 19	II	1874–27812	$^4H^o_{3½}$— $112_{2½}$
100	3854. 32	II	1874–27811	$^4H^o_{3½}$— $^4H_{3½}$
100	4151. 97	II	5514–29592	$4f^26s\ a\ {}^4H_{5½}$—$4f^26p\ z\ {}^4H^o_{6½}$
100	4471. 24	II	5617–27976	$4f^26s\ a\ {}^2H_{4½}$—$4f^26p\ z\ {}^2H^o_{4½}$
95	3577. 46	II	3794–31738	$^4I^o_{6½}$— $^4H_{5½}$
90	3201. 71	II	6913–38138	$^4H^o_{6½}$— $232_{5½}$
90	3272. 25	II	5651–36202	$^4H^o_{5½}$— $213_{4½}$
90	3838. 54	II	2642–28686	$11^o_{3½}$— $121_{2½}$
90	3878. 37	II	1410–27187	$^4I^o_{4½}$— $107_{3½}$
90	4165. 61	II	7341–31340	$4f^26s\ a\ {}^2H_{5½}$—$4f^26p\ z\ {}^2I^o_{6½}$
85	3709. 29	II	4204–31156	$^4H^o_{6½}$— $^4H_{6½}$
85	3709. 93	II	988–27935	$^4H^o_{4½}$— $^4H_{4½}$
85	3808. 12	II	2382–28634	$^4H^o_{4½}$— $120_{5½}$
85	3889. 99	II	5456–31156	$^4I^o_{7½}$— $^4H_{6½}$
80	3221. 17	II	4523–35559	$^4H^o_{4½}$— $^4G_{5½}$
80d	3623. 84	II	6390–33977	$43^o_{4½}$— $186_{3½}$
80	3660. 64	II	988–28298	$^4H^o_{4½}$— $^4G_{3½}$
80	3667. 98	II	2880–30135	$^4H^o_{5½}$— $^4H_{5½}$
80	4198. 67	II	7341–31152	$4f^26s\ a\ {}^2H_{5½}$—$4f^26p\ z\ {}^4G^o_{5½}$
	4198. 72	II	4166–27976	$4f^26s\ a\ {}^4H_{4½}$—$4f^26p\ z\ {}^2H^o_{4½}$
75	4071. 81	II	2635–27187	$10^o_{2½}$— $107_{3½}$
75	4248. 68	II	5514–29044	$4f^26s\ a\ {}^4H_{5½}$—$4f^26p\ z\ {}^4I^o_{6½}$
75	4572. 28	II	5514–27379	$4f^26s\ a\ {}^4H_{5½}$—$4f^26p\ z\ {}^4I^o_{5½}$
70	3539. 09	II	2581–30829	$^2G^o_{1½}$— $145_{3½}$
70	3786. 63	II	1410–27812	$^4I^o_{4½}$— $^4H_{3½}$
70	3848. 60	II	4204–30180	$^4H^o_{6½}$— $^4I_{6½}$
70	3853. 16	II	0–25945	$^4H^o_{3½}$— $104_{3½}$
70	3956. 28	II	4911–30180	$^2H^o_{5½}$— $^4I_{6½}$
70	4123. 87	II	6913–31156	$^4H^o_{6½}$— $^4H_{6½}$
70	4127. 37	II	5514–29735	$4f^26s\ a\ {}^4H_{3½}$—$4f^26p\ z\ {}^4G^o_{4½}$
70	4149. 94	II	5819–29909	$38^o_{4½}$— $^4H_{4½}$
70	4239. 91	II	3854–27433	$4f^26s\ a\ {}^4H_{3½}$—$4f^26p\ z\ {}^4H^o_{4½}$
70	4337. 78	II	2635–25682	$10^o_{2½}$— $103_{1½}$
70	4418. 78	II	6968–29592	$4f^26s\ a\ {}^4H_{6½}$—$4f^26p\ z\ {}^4H^o_{6½}$

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	2461.48		
9	2462.97		
4	2464.36		
3.0	2473.39		
3.0	2486.37		
4	2498.98		
6	2513.30		
8	2518.51		
3.0	2519.02	II	988–40674
6	2543.09		
14 d	2548.68		
2.0	2551.77		
2.5	2562.42		
4	2569.17		
2.5	2569.88		
5	2573.14		
2.0	2592.34	II	2635–41198
5	2609.50		
2.0	2609.90		
5	2613.90		
6	2635.15		
2.5	2647.11		
2.0	2648.30		
2.5	2649.33		
24	2651.01		
2.5	2656.84		
6	2666.50	II	3594–41085
4	2673.07	II	1410–38810
5	2682.73	II	3594–40858
2.5	2687.99		
2.5	2691.69		
15 d	2695.96	II	4911–41992
	2696.07	II	1874–38954
10	2706.88	II	4266–41198
3.0	2708.13	II	5119–42034
3.0	2709.41	II	5676–42573
9	2715.17	II	2581–39400
	2715.24		
3.0	2717.28		
3.0	2719.98	II	5819–42573
10	2723.38		
3.0	2724.95	II	2635–39322
2.5	2729.16	II	5943–42573
2.0 d	2730.70		
	2730.80	II	5965–42573
2.5	2732.04	II	4266–40858
4	2732.17		
5	2732.83		
3.0	2736.33		
9	2741.96		
6	2745.72		
8	2750.89	II	5651–41992
3.0	2756.80		
12	2761.42	II	0–36202
7	2762.22	II	8403–44595
3.0	2762.90	II	6390–42573
3.0	2767.01		
4	2780.01	II	2581–38542
3.0	2781.89	II	988–36924
3.0	2781.99	II	6638–42573
10	2784.27		
8	2785.35		
8	2790.53		
11	2791.42		
3.5	2803.04		
3.0	2810.18	II	2563–38138
2.5	2811.87	II	2581–38134
7	2814.81	II	6518–42034
5	2814.96	II	7059–42573
5	2817.50	II	5716–41198
22	2830.90	II	7259–42573
8	2833.31		
3.5	2835.60	II	5943–41198
2.5 d	2837.89	II	6521–41748
	2837.99	II	0–35226
3.0	2839.36	II	2596–37804
1.8	2841.72	II	8281–43461
2.5	2842.52	II	2635–37804
1.8	2842.83		
3.0	2845.45		
3.5	2849.03	II	3363–38453
7	2854.67	II	1874–36894
7	2854.88	II	2635–37652
3.5	2855.32		
3.5	2855.45	II	2642–37652
3.5	2855.72	II	2581–37588
6	2858.01		
3.0	2859.52	II	9634–44595
1.8	2861.35	II	988–35926
3.5	2861.62	II	2596–37531
4	2862.79	II	0–34921
3.0	2866.81	II	4523–39395
3.5	2871.08	II	988–35808
2.0	2871.63	II	0–34813
20	2874.14		
6	2880.64	II	5969–40674
3.0	2881.13	II	7294–41992
6	2882.61	II	6518–41198
4	2885.29		
3.5	2888.70		

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.0		2890.17		
1.4		2892.03	II	4266–38833
1.4		2892.15	II	6518–41085
4		2894.09	II	4266–38810
5		2894.22	II	2382–36924
7		2896.73	II	2382–36894
9		2908.42	II	4460–38833
2.5		2912.91	II	10275–44595
2.5		2915.56	II	3363–37652
3.5		2916.68	II	4266–38542
8		2918.67	II	2642–36894
2.0		2918.78	II	4202–38453
3.0		2922.37		
2.0		2922.58	II	4323–38529
6		2925.19	II	2880–37056
2.5		2929.11	II	4323–38453
2.0		2934.35	II	4460–38529
3.0		2939.54		
3.5	h	2940.79	II	3594–37588
5		2944.35		
4		2950.30		
3.5		2955.60	II	7259–41083
10		2955.94	II	2382–36202
2.5		2956.71	II	0–33812
4		2959.11		
9		2964.80	II	5676–39395
7		2965.27	II	5119–38833
3.5		2970.32	II	3996–37652
8		2972.58	II	4911–38542
4		2974.48		
4		2974.61	II	4845–38453
32		2976.91	II	4266–37849
12		2977.46	II	5819–39395
10		2980.41		
7		2981.91	II	4323–37849
4		2984.56	II	2642–36138
8		2985.82	II	4323–37804
		2985.91	II	3363–36844
2.0		2986.67	II	1874–35346
20		2990.87	II	2382–35808
3.0		2991.72		
2.0		2991.90		
9		2994.42	II	4266–37652
26		2995.64	II	5437–38810
4		2998.77	II	4511–37849
3.5		2999.43	II	3594–36924
		2999.48	II	4323–37652
6		3000.07	II	2880–36202
13		3002.14	II	3594–36894
15		3002.75	II	4511–37804
10		3003.56	II	2642–35926
7		3008.13	II	6638–39872
32		3008.79	II	2581–35808
4		3011.88	II	4460–37652
30		3017.20	II	5676–38810
6		3020.88	II	5716–38810
4		3021.04	II	5437–38529
2.5		3022.79		
5		3023.43	II	4523–37588
		3023.49	II	8928–41992
3.0		3024.57		
3.0		3026.62	II	4202–37232
2.0		3027.63	II	4323–37342
5		3028.96	II	6390–39395
14		3030.31	II	5819–38810
3.0		3032.73	II	2382–35346
6		3033.12	II	4845–37804
17		3037.73	II	4323–37232
3.5		3039.51	II	5651–38542
3.5		3044.40	II	5011–37849
5		3046.71	II	5716–38529
3.0		3050.59		
16		3051.98	II	4323–37079
28		3055.24	II	4511–37232
26		3056.78	II	2642–35346
3.5		3058.55	II	5119–37804
2.0		3059.74	II	4523–37196
55		3063.01	II	7234–39872
5		3068.68	II	4266–36844
7		3069.64	II	4511–37079
6		3071.11	II	1874–34426
7		3071.62	II	2382–34929
4		3072.39	II	2382–34921
8		3072.89	II	5119–37652
3.5		3076.25	II	4845–37342
5		3077.33	II	5651–38138
4		3077.64		
8		3079.64	II	5676–38138
7		3079.91	II	1874–34333
6		3080.64		
8		3082.30	II	3704–36138
26		3083.67	II	6390–38810
20		3084.44	II	5437–37849
16		3090.37	II	7523–39872
6		3090.52	II	2581–34929
5		3091.29	II	2581–34921
3.5		3095.59	II	5675–37971
14		3096.50	II	4911–37196
5		3096.88	II	1874–34155
3.0		3097.08		

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	3102.56	II	3704–35926	18	3199.28	II	5676–36924
30	3103.38	II	3594–35808	4 d	3200.52	II	4323–35559
7	3104.01	II	3996–36202	90	3201.71	II	6913–38138
16	3107.47	II	6638–38810	9	3205.96	II	7012–38195
8	3108.96	II	8928–41083	9	3210.95	II	6518–37652
26	3110.28	II	3996–36138	18	3218.38	II	3363–34426
24	3111.17	II	2635–34768	65	3218.94	II	6913–37971
3.5	3114.05	II	1874–33977	9	3220.87		
3.5	3123.57	II	4511–36517	80	3221.17	II	4523–35559
18	3127.53	II	3594–35559	4	3222.41	II	4202–35226
18	3130.33	II	4266–36202	4	3223.37	II	7818–38833
22	3130.87	II	0–31931	30	3225.67	II	8403–39395
13	3132.59	II	2382–34295	65	3227.11	II	2596–33574
15	3133.33	II	5943–37849	9	3229.12	II	4266–35226
15	3136.72	II	4266–36138	22	3229.36	II	2596–33553
9	3137.60	II	3363–35226	4	3230.08	II	988–31938
4	3138.30	II	3704–35559	44	3231.24	II	3996–34934
9	3142.31	II	988–32802	13	3233.44	II	2635–33553
18	3144.60	II	2635–34426	65	3234.16	II	2642–33553
26	3145.28	II	2642–34426	30	3234.89	II	7234–38138
4	3146.23	II	5119–36894	4	3235.01		
26	3146.41	II	2382–34155	7	3235.67	II	4911–35808
9	3148.46	II	3594–35346	36	3236.74	II	4460–35346
6	3148.65	II	7059–38810	36	3243.37	II	4523–35346
4	3149.43	II	4460–36202	9	3245.17	II	4460–35266
7	3151.13	II	5119–36844	18	3246.67	II	3363–34155
12	3154.51	II	2642–34333	9	3249.19	II	2642–33410
30 d	3155.69	II	4523–36202	4	3249.43	II	4460–35226
	3155.79	II	1874–33553	13	3252.48	II	7234–37971
26	3164.15	II	2382–33977	13	3254.01	II	3704–34426
13	3166.24	II	2581–34155	9	3258.87	II	7294–37971
9	3166.61	II	2596–34166	18	3260.98	II	8176–38833
4	3167.23	II	9634–41198	13	3263.45	II	8176–38810
4	3167.32	II	3996–35559	18	3263.88	II	3704–34333
26	3169.18	II	5651–37196	4	3265.42	II	7523–38138
26	3171.61	II	2635–34155	9	3271.15	II	3594–34155
4	3172.30	II	2642–34155	9	3271.55	II	6638–37196
12	3176.80	II	8403–39872	4	3271.96		
4	3177.14	II	4460–35926		3272.06	II	2596–33149
4	3178.75	II	3363–34813	90	3272.25	II	5651–36202
4	3180.82	II	2382–33812	30	3274.86	II	5676–36202
44	3183.52	II	4523–35926	13	3276.25	II	2635–33149
7	3184.21	II	2581–33977	13	3279.01	II	5437–35926
22	3186.13	II	5819–37196	18	3279.84	II	2382–32863
16	3188.79	II	3996–35346	7	3280.49	II	4460–34934
9	3189.64	II	2635–33977	4	3281.10		
18	3190.34	II	2642–33977	9	3283.35	II	7523–37971
4	3193.33			6	3283.68	II	2635–33080
65	3194.83	II	4911–36202	4	3284.22	II	5119–35559
4	3195.94	II	2596–33876	30	3285.22	II	3996–34426

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	3286.03	II	4511–34934
9	3290.34	II	3594–33977
4	3290.58	II	4845–35226
4	3293.59	II	4460–34813
22	3295.29	II	3996–34333
13	3296.19	II	7259–37588
18	3296.88	II	6521–36844
9	3299.99		
20	3300.15	II	5819–36112
22	3304.84	II	5676–35926
13	3306.63	II	5969–36202
13	3307.23	II	2635–32863
22	3308.02	II	2581–32802
	3308.09	II	988–31208
9	3309.27	II	5716–35926
13	3311.50	II	3363–33553
18	3312.22	II	8897–39079
6	3313.30	II	5965–36138
9	3314.04	II	0–30166
22	3314.72	II	3996–34155
18	3317.80	II	5676–35808
12	3318.96	II	5437–35559
4	3320.42	II	3704–33812
4	3325.06		
16	3325.33	II	8131–38195
4	3327.66	II	2596–32638
6	3327.90	II	5676–35716
13	3329.00	II	4737–34768
7	3330.48		
4	3331.22	II	4323–34333
9	3333.04	II	0–29994
9	3333.66	II	5819–35808
18	3334.46	II	10058–40040
9	3339.51	II	2382–32318
7 h	3340.89	II	5011–34934
22	3341.87	II	4511–34426
30	3343.86	II	5819–35716
40	3344.76	II	4266–34155
9	3346.52	II	4460–34333
13	3349.97	II	5716–35559
9	3352.28	II	4511–34333
16	3352.94	II	3594–33410
	3352.99	II	2382–32198
7	3353.33	II	6390–36202
18	3355.02	II	1410–31208
16	3356.41	II	3363–33149
22	3357.22	II	4266–34044
18	3360.54	II	11310–41059
16	3361.76	II	3794–33531
9	3364.35	II	988–30703
22	3366.55	II	4460–34155
5	3368.69	II	2642–32318
4	3368.79		
18	3371.17	II	4511–34166
18	3373.46	II	2563–32198
18	3373.73	II	4523–34155
7	3375.78	II	8928–38542
44	3377.13	II	4911–34514
13	3379.17	II	4460–34044
9	3381.49	II	6638–36202
18	3383.69	II	4266–33811
7	3387.78	II	5716–35226
9	3390.52	II	3594–33080
9	3393.92	II	4204–33660
6	3394.14	II	4523–33977
3.5	3396.72	II	3746–33177
4	3400.25	II	7523–36924
7	3403.60	II	4202–33574
3.5	3404.13		
18	3404.91	II	1874–31235
22	3405.98	II	4460–33812
4	3407.24	II	11743–41083
8	3416.56	II	5965–35226
13	3416.86	II	988–30246
26	3417.45	II	5676–34929
7	3417.90	II	8403–37652
9	3418.93		
13	3420.18	II	4323–33553
7	3422.51	II	8928–38138
55	3422.71	II	3594–32802
10	3423.85	II	9634–38833
7	3425.34	II	2382–31568
6	3425.94	II	7713–36894
36	3426.21	II	988–30166
7	3426.58	II	2563–31738
12	3430.32	II	7059–36202
6	3431.50	II	4911–34044
16	3433.09	II	10275–39395
7	3435.20	I	
	3435.21	II	5819–34921
7	3437.81	I, II	
13	3439.83	II	4511–33574
26	3441.21	II	2880–31931
13	3442.38	II	4511–33553
6	3442.96	II	5119–34155
8	3446.72	II	2563–31568
7	3451.56	II	5965–34929
4	3454.81	I	
4	3456.67	II	988–29909
9	3456.77	II	6638–35559

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	3459.83	II	9634–38529	6	3528.05	II	5819–34155
4	3460.16	II	2140–31033	4	3528.64		
9	3461.34	II	4266–33149	4	3529.04	II	5716–34044
4	3461.79	II	7259–36138	15	3530.02	II	2382–30703
9	3463.22	II	7059–35926	8	3530.95	II	4737–33050
9	3463.76	II	5651–34514	8	3531.59	II	4737–33045
16	3464.21	II	5119–33977	8	3532.61	II	7259–35559
4	3467.78	II	1874–30703	8	3532.88	II	0–28298
9	3468.11	II	4323–33149	55	3534.05	II	4204–32492
7 d	3468.89	II	988–29807	14	3534.44	II	7523–35808
	3469.00	II	9634–38453				
				8	3535.57	II	2880–31156
4	3470.41	II	988–29794	10	3536.70	II	10275–38542
7	3474.22	II	3363–32139	6	3537.13		
9	3475.68	II	1874–30637	10	3537.44	II	5716–33977
44	3476.84	II	10642–39395	6	3538.79	II	6518–34768
7	3477.45	II	7059–35808	70	3539.09	II	2581–30829
9	3479.61	II	0–28731	4	3541.66	II	3704–31931
13 d	3480.27	II	0–28725	8	3543.28	II	9634–37849
	3480.38	II	3594–32318	4	3543.52	II	5943–34155
7	3480.98	II	12366–41085	19	3545.60	II	2880–31076
7	3481.16	II	5437–34155	15	3545.78	II	2382–30577
13	3482.14	II	3704–32413	26	3546.19	II	1874–30065
22	3482.35	II	4845–33553	14	3547.00	II	4323–32508
12	3484.74	II	2880–31568	6	3548.84	II	9634–37804
65	3485.05	II	0–28686	8	3551.43		
16	3488.55	II	7059–35716	11	3551.66	II	3704–31851
13	3490.13	II	5651–34295		3551.78	II	4266–32413
8	3493.11	II	4460–33080	5	3552.07	II	3594–31738
9	3493.72	II	3704–32318	22	3552.73	II	2563–30703
7	3495.01	II	3594–32198	10	3554.63		
9	3495.94	II	4266–32863	38	3554.99	II	2581–30703
7	3496.33	II	2642–31235	6	3556.89		
5	3500.68			3.5	3558.71	II	5716–33808
15	3501.45	II	1874–30425	110	3560.80	II	5969–34044
4	3506.25	II	2563–31076	4	3561.54	II	4166–32235
19	3507.95	II	1410–29909	8	3562.09	II	4204–32269
8	3508.47	II	2581–31076	10	3563.82	II	4266–32318
6	3508.71	II	12366–40858	11	3568.13	II	9634–37652
5	3510.69	II	5819–34295	8	3569.32	II	5651–33660
11	3513.79	II	988–29439	4	3570.98	II	2581–30577
	3513.86						
				11	3572.43		
55	3517.38	II	7294–35716	8	3573.70	II	3594–31568
5	3518.37	II	10115–38529	4	3575.29	II	8176–36138
14	3519.08	II	2635–31043	19	3576.23	II	1410–29365
19	3520.52	II	1410–29807	95	3577.46	II	3794–31738
4	3520.98	II	5651–34044	8	3580.56	II	1874–29794
30	3521.88	II	4911–33297	8	3583.66	II	9634–37531
8	3524.07	II	5965–34333	10	3584.34	II	4911–32802
19	3526.68			8	3586.75	II	4266–32139
11	3527.85	II	0–28338	4	3587.22	II	5943–33812

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
18		3587.64	II	5943–33808
8		3588.13	II	7059–34921
19		3588.43	II	5437–33297
30		3590.60	II	5969–33812
6		3594.61	II	0–27812
10		3596.12	II	8403–36202
4		3596.73	II	4523–32318
14		3598.20	II	2382–30166
8		3599.97	II	4737–32508
15		3600.54	II	6390–34155
6		3603.36	II	5119–32863
14		3604.20	II	988–28725
36		3607.63	II	5437–33149
50		3609.69	II	7234–34929
11		3610.91	II	7341–35027
11		3611.34	II	2563–30246
4	h	3611.65	II	7878–35559
8		3612.32	II	4523–32198
38		3613.70	II	4266–31931
5		3615.63	II	5924–33574
11		3616.20	II	5651–33297
15		3618.58	II	4511–32139
6		3619.92	II	2563–30180
4		3621.15	II	5437–33045
40		3622.15	II	6913–34513
6		3622.44	II	3363–30962
80	d	3623.84	II	6390–33977
12		3624.18	II	2581–30166
8		3628.25	II	2581–30135
4		3628.62	I	
5		3630.42	II	10115–37652
18		3631.19	II	3704–31235
14		3632.11	II	2642–30166
4		3633.40	II	0–27515
8		3637.75	II	3594–31076
12		3638.28	II	5819–33297
4		3640.69	II	6518–33977
5		3642.83		
4		3644.29	II	5716–33149
12		3645.23	II	5437–32863
12		3645.45	II	2642–30065
14		3646.65		
32		3646.97	II	2382–29794
24		3647.75	II	7523–34929
24		3647.95	II	8403–35808
4		3649.73	II	4460–31851
8		3650.12	II	2596–29984
16		3650.88		
12		3652.11		
6		3652.26	II	11949–39322
38		3653.11	II	2880–30246
60		3653.67	II	3794–31156
28		3654.97	II	2642–29994
160		3655.85	II	2563–29909
4		3658.26	II	2581–29909
40		3659.23	II	1410–28731
32		3659.97	II	1410–28725
16		3660.16	II	10275–37588
80		3660.64	II	988–28298
12		3661.73	II	4266–31568
9		3662.99	II	4266–31559
8		3663.70	II	4911–32198
5		3664.73	II	5437–32717
7		3665.05	II	3854–31131
8		3666.02	I	
8		3667.28	II	5819–33080
80		3667.98	II	2880–30135
14		3668.72	II	0–27250
8		3670.49		
12		3671.94	II	2581–29807
20		3672.17	I, II	
32		3672.79	II	7294–34514
16		3673.64	II	2581–29794
8	d	3674.05	II	9634–36844
		3674.15		
8		3676.16	II	2596–29790
8		3679.16	II	2635–29807
20		3679.42	II	8176–35346
16		3680.08	II	2642–29807
4		3680.85	II	2635–29794
16		3681.38	II	8403–35559
16		3682.08	II	5651–32802
4		3686.04	I	
16		3687.80	II	3594–30703
6		3688.66	II	5943–33045
4		3689.16	II	4460–31559
8		3693.42	II	10275–37342
4		3693.71	II	8281–35346
24		3694.91	II	2382–29439
6		3695.96		
5		3696.12	II	3996–31043
10		3697.66	II	7259–34295
5		3698.13	II	4202–31235
9		3698.36	II	6521–33553
11		3698.66	II	2880–29909
12		3699.92	II	4911–31931
10		3702.79	II	3704–30703
18		3704.98	II	5819–32802
9		3706.94	II	4202–31171
7		3707.39	II	4166–31131

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
85	3709.29	II	4204–31156
85	3709.93	II	988–27935
4	3713.99	II	988–27905
9	3714.77		
3.0	3715.14		
10	3715.47	II	6390–33297
110	3716.37	II	0–26900
9	3716.93	II	7259–34155
6	3717.48		
34	3718.19	II	1410–28298
34	3718.38	II	4204–31090
17	3719.80	II	2563–29439
5	3722.10	II	5514–32373
12	3722.29	II	2581–29439
9	3722.76	II	2596–29450
3.5	3723.66	II	4323–31171
12	3724.64	II	5011–31851
34	3725.68	II	5969–32802
14	3726.96	II	988–27812
40	3728.02	II	5676–32492
9	3728.18	II	2635–29450
65	3728.42	II	5456–32269
4	3729.00	II	4266–31076
6	3729.92	II	3363–30166
11	3730.33	II	11742–38542
3.0 d	3731.17	I	
	3731.26	I	
9	3731.88	II	8928–35716
8	3732.46	II	2382–29167
5 d	3732.56	I	
	3732.58	II	2581–29365
12	3733.52	II	4266–31043
9	3737.52	II	4460–31208
13	3737.74	II	6913–33660
6	3740.13	II	10115–36844
6	3741.01	II	2642–29365
6	3741.73	II	7259–33977
3.0 h	3742.22	I	
8 d	3744.00	I	
	3744.05	II	5437–32139
5	3746.37	II	4523–31208
14	3746.40	I	
26	3748.06	II	5819–32492
14	3750.08	II	6638–33297
12	3751.00	II	3594–30246
20	3751.45	II	10275–36924
3.0	3751.76	II	2635–29281
11	3752.34	II	5676–32318
6	3753.77	II	12763–39395
16	3755.43	II	3363–29984
14	3755.72	II	5617–32235
13	3757.22	II	7818–34426
13	3757.86	II	2563–29167
4	3760.40	II	2581–29167
6	3760.69	II	4460–31043
24	3762.98	II	7341–33908
7	3763.61	II	4266–30829
55	3764.12	II	2880–29439
16	3765.04	II	4523–31076
7	3765.89	II	5651–32198
13	3766.51	II	3704–30246
4	3768.00	II	4511–31043
24	3768.76	II	8403–34929
8	3769.04	II	1410–27935
13	3769.94	II	8403–34921
17	3770.77		
24	3771.61	II	4323–30829
5	3772.65	II	5819–32318
7	3773.21	II	1410–27905
6	3773.44	II	5437–31931
6	3776.15		
20	3776.61	II	3594–30065
11	3777.67	II	1874–28338
3.5	3779.61	II	4511–30962
2.0	3781.10	II	5119–31559
50	3781.62	II	4266–30703
36	3782.53	II	3996–30425
8	3783.04	II	7234–33660
16	3783.58	II	5716–32139
70	3786.63	II	1410–27812
3.0	3787.46	II	11742–38138
8	3787.57	II	2635–29029
10	3787.91	II	988–27380
3.5	3788.21	II	4845–31235
42	3788.75	II	3794–30180
2.0	3790.34	II	5943–32318
6 d	3790.81		
	3790.88	II	7202–33574
7	3791.69	II	7294–33660
24	3792.33	II	3704–30065
8 d	3793.52	II	5965–32318
3.5	3793.86	II	7059–33410
8	3794.68	II	6518–32863
14	3795.26	II	3794–30135
4	3796.67	II	7713–34044
8 h	3799.04	II	3594–29909
	3799.10	II	4323–30637
200	3801.53	II	7234–33531
65	3803.10	II	2880–29167
4	3803.84	II	12260–38542

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	3804.16	II	5651–31931
10	3807.69	II	5676–31931
85	3808.12	II	2382–28634
40	3809.22	II	4911–31156
6	3809.50	II	4460–30703
3.0	3810.10	II	3746–29984
8	3810.90	II	5965–32198
5	3811.62	II	11743–37971
20	3812.21	II	4737–30962
3.0	3814.93	II	3704–29909
7	3815.01	II	2140–28345
40	3815.83	II	6518–32717
4	3816.31	II	5943–32139
38	3817.46	II	4845–31033
8	3818.69	II	4523–30703
24	3819.02	II	4460–30637
14	3821.27	II	2563–28725
15	3821.70	II	4266–30425
12	3823.70	II	8281–34426
38	3823.90	II	2581–28725
8	3827.21	II	5437–31559
10	3827.38		
13	3829.69	II	1410–27515
14	3830.03	II	6390–32492
38	3830.56	II	7713–33812
40	3831.08		
9	3832.23		
8	3832.75	II	2642–28725
40	3834.56	II	2563–28634
7	3834.78	II	3996–30065
4	3835.75	II	7234–33297
4	3835.90		
22	3836.11	II	1874–27935
9	3837.21	II	2581–28634
90	3838.54	II	2642–28686
10	3839.50	II	7259–33297
10	3841.72	II	10115–36138
4	3842.05	II	7059–33080
16	3843.77	II	8804–34813
5	3845.28	II	3996–29894
8	3845.48	II	10115–36112
18	3846.52	II	8176–34166
20	3848.11	II	4266–30246
70	3848.60	II	4204–30180
8	3849.49		
5	3849.57	II	1410–27380
10	3850.12	II	5965–31931
8	3852.11	II	2382–28335
70	3853.16	II	0–25945
100	3854.19	II	1874–27812
100	3854.32	II	1874–27811
50	3855.30	II	4204–30135
32	3857.02	II	5819–31738
14	3857.24	II	3363–29281
30	3857.64	II	2382–28298
6	3857.82	II	4511–30425
4	3857.94	II	3996–29909
16	3862.47	II	5676–31559
7	3865.39		
13	3866.82	II	988–26841
16	3868.14	II	3594–29439
13 h	3868.50	II	5716–31559
5	3869.57	II	9723–35559
13	3870.87	II	5514–31340
3.0	3871.81	II	7259–33079
5	3873.03		
5	3873.26	II	10115–35926
22	3874.68	II	8176–33977
22	3875.04	II	3996–29794
14	3876.14	II	4911–30703
50	3876.97	II	4460–30246
90	3878.37	II	1410–27187
10	3879.07	II	
5	3879.31	II	5437–31208
5	3879.61	II	12366–38134
5	3880.41	II	14276–40040
14	3881.87	II	2581–28335
120	3882.45	II	2596–28345
11	3883.57	II	2596–28338
8	3884.20	II	12457–38195
8	3886.50	II	4523–30246
18	3888.39	II	5119–30829
10	3889.00	II	4460–30166
6	3889.30	II	3746–29450
6	3889.48	II	2635–28338
85	3889.99	II	5456–31156
17	3890.76	II	2140–27835
17	3890.99	II	2642–28335
4	3891.77	II	4737–30425
14	3893.23	II	5283–30962
6	3893.87	II	7878–33553
6	3894.32	II	4323–29994
50	3895.12	II	3363–29029
48	3896.80	II	4511–30166
4	3897.43	II	10275–35926
40	3898.27	II	3794–29439
22	3898.94	II	1874–27515
4	3899.39	II	5514–31152
6	3900.20	II	8176–33808
10	3901.30	II	5943–31568

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	3901.68	II	9723–35346
16	3903.34	II	4523–30135
7	3903.93	II	12366–37974
20	3904.34	II	4460–30065
4	3904.58	II	7259–32863
14	3906.92	II	12260–37849
55	3907.29	II	8928–34514
11	3907.45	II	4166–29750
7	3908.09	II	4845–30425
40	3908.41	II	6913–32492
28	3908.54	II	3704–29281
8	3908.77		
2.5	3909.05	II	8403–33977
19	3909.31	II	3594–29167
9	3909.75	II	4166–29736
9	3909.93	II	7234–32802
10	3910.70	II	9634–35198
10	3911.30	II	6638–32198
16	3912.19	II	4511–30065
7	3912.44	II	2382–27935
8	3913.99	II	4523–30065
7	3914.95	II	3746–29281
28	3915.52	II	5676–31208
28	3916.14	II	4266–29794
10	3916.90	II	2382–27905
5	3917.25	II	3508–29029
16	3917.64	II	5119–30637
55	3918.28	II	5617–31131
34	3919.81	II	5651–31156
42	3921.73	II	5716–31208
40	3923.11	II	4511–29994
32	3924.64	II	4511–29984
5	3924.80	II	4323–29794
2.5	3927.00	II	7259–32717
8	3927.39	II	2880–28335
5	3927.57	II	11742–37196
11	3928.32	II	4460–29909
5	3929.96	II	5651–31090
8	3930.81	II	7059–32492
55	3931.09	II	1410–26841
22	3931.37	II	2382–27812
16	3931.83		
11	3932.15	II	5651–31076
22	3933.73	II	5676–31090
5	3934.08	I	
2.5	3934.75	II	5617–31024
3.5	3935.93	II	5676–31076
4	3937.15	II	12260–37652
3.5	3937.63	II	5819–31208
3.5	3937.81		
40	3938.09	II	4523–29909
4	3939.52	II	8532–33908
4	3939.66	II	1874–27250
55	3940.34	II	2563–27935
7	3940.64	II	3996–29365
22	3940.97	II	3363–28731
140	3942.15	II	0–25360
190	3942.75	II	6913–32269
11	3943.14	II	2581–27935
4	3943.50	II	8804–34155
55	3943.89	II	6390–31738
5	3944.84	II	10115–35457
6	3944.92	II	2563–27905
8	3946.68	II	7818–33149
22	3947.97	II	3363–28686
13	3949.39	II	1874–27187
7	3949.82	I	
13	3950.42	II	5119–30425
5	3950.80		
8	3951.62		
7	3952.11	II	4511–29807
220	3952.54	II	2642–27935
		II	6638–31931
24	3953.66	II	3996–29281
11	3953.95	II	4523–29807
22	3955.36		
11	3955.92	II	4523–29794
16	3956.06	II	5819–31090
70	3956.28	II	4911–30180
13 d	3956.77	I	
	3956.90	II	5437–30703
5	3957.15	II	2642–27905
	3957.21	I	
11	3957.97	II	7234–32492
16	3958.27	II	5819–31076
16	3958.87		
13	3959.62	II	4202–29450
11	3959.80	II	4737–29984
7	3960.38	II	5965–31208
55	3960.91	II	2596–27835
11	3962.09	II	7818–33050
7	3963.37	II	4911–30135
11	3964.18		
28	3964.50	II	2596–27812
55	3967.05	II	2635–27835
11	3967.18	II	5437–30637
8	3967.53	II	9723–34921
11	3970.04	II	11742–36924
4	3970.42	II	9634–34813
12	3970.64	II	2635–27812

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
32	3971.68	II	3996–29167
8	3971.88	II	2642–27812
19	3972.07	II	6390–31559
5	3973.03		
6	3974.00	I	
5	3974.19	II	5011–30166
19	3975.07	II	7713–32863
5	3976.78	II	7059–32198
2.5	3977.53	II	8774–33908
11	3977.77	II	5943–31076
55	3978.65	II	4323–29450
40	3980.88	II	5716–30829
3.0	3981.90	II	5969–31076
8	3982.17	I	
40	3982.89	II	6638–31738
22	3983.29	II	4166–29263
55	3984.68	II	7713–32802
4	3986.40	II	5965–31043
26	3989.44	II	7259–32318
2.5	3989.76		
13	3990.11	II	2880–27935
5	3990.69	II	5651–30703
5 d	3991.22		
	3991.33	II	5119–30166
5	3992.13	II	4323–29365
50	3992.39	II	3594–28635
26	3992.91	II	5924–30962
65	3993.82	II	7341–32373
8	3994.57	II	5676–30703
2.5	3995.42	II	3704–28725
5 d	3996.36		
	3996.49	II	4266–29281
3.5	3997.48		
10	3997.72	II	8804–33812
200	3999.24	II	2382–27380
1.2	4000.68		
1.2	4000.80	II	5437–30425
8	4001.06	II	5716–30703
16	4001.56	II	5011–29994
10	4001.73	II	3704–28686
13	4002.81	II	7294–32269
8	4002.97	II	3363–28338
8	4003.17	II	5011–29984
65	4003.77	II	7523–32492
4	4004.05		
7	4004.58	II	7234–32198
26	4005.64	II	988–25945
5	4007.45	II	5119–30065
15	4007.59	II	4845–29790
3	4008.66	II	7259–32198
4	4009.06	II	7202–32139
10	4010.14	II	6638–31568
7	4011.56	II	5716–30637
190	4012.39	II	4523–29439
65	4014.90	II	4266–29167
18	4015.88	II	8403–33297
10	4017.60	II	5819–30703
14	4019.04	II	8176–33050
10	4019.90	II	8176–33045
17	4022.27	II	9054–33908
2.5	4023.37		
10	4024.35	II	4523–29365
60	4024.49	II	3794–28634
17	4025.15	II	3508–28345
5	4027.05	II	6913–31738
12	4027.69		
60	4028.41	II	2563–27380
4	4030.16	II	10115–34921
18	4030.34	II	2382–27187
60	4031.34	II	2581–27380
4	4037.39	II	8774–33536
24	4037.67	II	5943–30703
12	4038.25	II	10870–35626
6	4039.89	II	8789–33536
150	4040.76	II	3594–28335
8	4041.27	II	5965–30703
4	4042.14	II	8928–33660
65	4042.58	II	3996–28725
22 d	4045.21	II	6521–31235
	4045.32	II	10314–35027
44	4046.34	II	4460–29167
9	4047.28	II	5283–29984
8	4049.03	II	3996–28686
6	4050.81	II	7059–31738
15	4051.43	II	5119–29794
15	4051.99	II	5965–30637
50	4053.51	II	0–24663
32	4054.99	II	2596–27250
6	4055.16	II	6518–31171
8	4055.84	I	
6	4056.90	II	8403–33045
6	4058.24	II	3704–28338
3.5	4058.78	II	3704–28335
8	4060.47		
3.5	4060.72	I	
2.0	4061.81	I	
20	4062.22	II	11016–35626
16	4062.94	II	2581–27187
8	4063.92	II	3746–28345
6	4064.91	II	3704–28298

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4065.16	II	7259–31851
6	4066.50	II	12260–36844
4	4066.91	I	
20	4067.28	II	8532–33111
6	4068.44		
30	4068.84	II	5676–30246
4	4070.09	II	
5	4070.84	II	12366–36924
6	4071.08	II	5437–29994
75	4071.81	II	2635–27187
19	4072.92	II	2642–27187
130	4073.48	II	3854–28396
15	4073.74	II	8449–32989
2.0	4074.65	II	1410–25945
110	4075.71	II	5651–30180
110	4075.85	II	4911–29439
15	4076.24	II	6518–31043
30	4077.47	II	2382–26900
38	4078.32	II	7722–32235
19	4078.52	II	7555–31967
6	4079.02	II	7059–31568
10	4079.67	II	7234–31738
19	4080.44	II	2880–27380
48	4081.22	II	3854–28350
65	4083.23	II	5651–30135
8	4083.48	II	9054–33536
8	4083.64		
32	4085.23	II	5437–29909
6	4086.42	II	4266–28731
18	4087.36	II	4266–28725
5	4087.57	II	8532–32989
3.0	4088.58	II	6638–31090
16	4088.85	II	5716–30166
5	4089.74	II	7294–31738
5	4089.86	II	6518–30962
9	4090.47	II	6521–30962
9	4090.95	II	6638–31076
3.5	4092.09	II	4204–28634
7	4092.72	II	5819–30246
3.5	4093.29	I	
11	4093.96	II	4266–28686
2.5	4098.15	I	
6	4098.98	II	5676–30065
3	4099.75	II	8695–33080
32	4101.77	II	6968–31340
5	4102.36	II	8928–33297
3.5	4104.43	II	5437–29794
18	4105.00	II	8532–32885
5	4106.13	II	5819–30166
9	4106.85		
	4106.92	II	3996–28338
36	4107.42	II	3996–28335
3.5	4107.80	II	8774–33111
1.8	4108.26	II	7234–31568
3.0	4109.56	II	3508–27835
14	4110.38	II	8789–33111
5	4110.84	II	2581–26900
18	4111.39	II	5819–30135
2.5	4111.93	II	6390–30703
7	4113.73	II	3996–28298
3.5	4114.15	II	7259–31559
30	4115.37	II	7455–31747
18	4117.01	II	10870–35152
14	4117.29	II	5965–30246
14	4117.59	II	10642–34921
55	4118.14	II	5617–29893
18	4119.02	II	4460–28731
22	4119.79	II	8774–33040
22	4119.88	II	2635–26900
32	4120.83	II	2581–26841
36	4123.24	II	5819–30065
36	4123.49	II	7722–31967
70	4123.87	II	6913–31156
36	4124.79	II	5514–29751
3.5	4125.78	II	3704–27935
4	4126.66	II	4460–28686
70	4127.37	II	5514–29735
18	4127.74	II	4511–28731
14	4128.07	II	3594–27812
13	4128.36	II	7523–31738
6	4129.18	II	5969–30180
38	4130.71	II	4523–28725
34	4131.10	II	2642–26841
2.0	4131.86		
7	4132.31	II	5716–29909
4	4132.64	II	6638–30829
190	4133.80	II	6968–31152
19	4135.44	II	4511–28686
4	4135.89	II	10642–34813
4	4136.77	II	5283–29450
6	4136.90	II	5969–30135
19	4137.47	II	5119–29281
140	4137.65	II	4166–28327
19	4138.10		
15	4138.35	II	10870–35027
4	4139.43	II	3363–27515
4	4140.75	II	4202–28345
55	4142.40	II	5617–29751
11	4142.83	II	12763–36894

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
28	4144.49	II	3854–27976
48	4145.00	II	5617–29735
34	4146.23	II	4523–28634
6	4148.16	II	5965–30065
20	4148.90	II	8789–32885
30	4149.79	II	5716–29807
70	4149.94	II	5819–29909
30	4150.91		
100	4151.97	II	5514–29592
4	4152.93		
16	4153.13	II	1874–25945
3.5	4153.93	II	3746–27812
6	4155.28		
13	4155.53	II	9054–33111
32	4159.03	II	8281–32318
10	4160.11	II	4266–28296
	4160.18	II	7059–31090
8	4161.18	II	7722–31747
11	4162.63	II	7059–31076
22	4163.52	II	11016–35027
90	4165.61	II	7341–31340
4	4166.20		
11	4166.65	II	4737–28731
44	4166.88		
18	4167.80	II	9054–33040
46	4169.77	II	5819–29795
	4169.88	II	4323–28298
4	4171.39	II	5943–29909
8	4172.16	II	2880–26841
8	4174.48	II	4737–28686
5	4175.24	II	5965–29909
9	4176.08	II	3996–27935
24	4176.70	II	9054–32989
5	4179.29	II	3594–27515
24	4181.08	II	5119–29029
24	4185.33	II	3363–27250
250	4186.60	II	6968–30847
38	4187.32	II	4460–28335
3.5	4189.18	II	5943–29807
4	4189.64	II	7294–31156
12	4190.63	II	7234–31090
4	4191.03		
40	4193.09	II	7234–31075
26	4193.28	II	8532–32373
26	4193.87	II	4460–28298
13	4194.91	II	9054–32885
5	4195.82	II	4511–28338
45	4196.34	II	3363–27187
10	4197.51	II	3996–27812
13	4197.67	II	3996–27811
20	4198.00	II	4911–28725
13	4198.43	II	4523–28335
80	4198.67	II	7341–31152
	4198.72	II	4166–27976
24	4201.24	II	7294–31090
	4201.32	II	8403–32198
65	4202.94	II	3594–27380
4	4203.51		
5	4204.74	II	6390–30166
4	4205.16		
2.5	4205.79	II	7059–30829
2.5	4205.89	II	10275–34044
19	4209.41	II	5514–29263
5	4210.00	II	5283–29029
7	4213.04	II	5437–29167
26	4214.04	II	4911–28634
22	4217.59	II	8532–32235
4	4221.17		
110	4222.60	II	988–24663
8	4223.88	II	4266–27935
3.0	4224.55		
7	4227.41	II	5716–29365
55	4227.75	II	5617–29263
6	4228.30	II	7059–30703
6 h	4230.12	II	4202–27835
28	4231.75	II	
7	4232.05		
10	4232.57	II	5819–29439
6	4233.20		
17	4234.21	II	4202–27812
6	4234.73	II	6638–30246
14	4236.02	II	4737–28338
6	4236.36	II	8774–32373
70	4239.91	II	3854–27433
6	4242.01	II	7523–31090
28	4242.72	II	2382–25945
6	4243.79	I	
22	4245.88	II	5819–29365
22	4245.98	II	4266–27812
6	4246.40		
28	4246.71	II	2141–25682
5	4247.45	II	3363–26900
5	4248.09	II	10275–33808
75	4248.68	II	5514–29044
2.5	4250.66	II	3996–27515
4	4251.60	II	8804–32318
4	4251.86	II	4323–27835
28	4253.36	II	3746–27250
5	4254.70	II	6638–30135
44	4255.78	II	5676–29167

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	4256.16	II	4323–27812	5	4326.83	II	5924–29029
8	4257.12	II	3704–27187	22	4330.45	II	2596–25682
9	4259.75	II	7234–30703	11	4331.76	II	9723–32802
8	4261.16	II	8774–32235	22	4332.71	II	5651–28725
14	4263.43	II	8403–31851	5	4334.87	II	8278–31340
5	4263.95	II	8789–32235	4	4335.49	II	8176–31235
12	4264.37	II	7259–30703	28	4336.26	II	5676–28731
7	4267.22			70	4337.78	II	2635–25682
4	4268.30	II	5943–29365	24	4339.32	II	10870–33908
10	4269.25	II	7818–31235	5	4340.56	II	8176–31208
44	4270.19	II	4523–27935	4	4342.14	II	4911–27935
28	4270.72	II	7722–31131	5	4342.49	II	10275–33297
9	4273.44	II	8804–32198	4	4343.56	I	
15	4275.56	II	4523–27905	16 d	4345.83	II	9634–32638
3.0	4278.25	II	10799–34166		4345.96	II	4511–27515
14	4278.87	II	2581–25945	5	4346.43		
10	4280.14	II	5924–29281	4 h	4347.60	II	8176–31171
8	4281.00	II	4460–27812		4347.71	II	4911–27905
6	4281.16	II	4460–27811	50	4349.79	II	4266–27250
20	4285.37	II	7341–30670	40	4352.71	II	4845–27812
14	4288.67	II	2635–25945	12	4353.37	I, II	
14	4289.45	II	3594–26900	2.5	4356.75	II	7234–30180
140	4289.94	II	2642–25945	4	4357.91		
8	4292.58	II	6518–29807	7	4359.07		
8	4292.77	II	4523–27812	7	4360.18	II	6521–29450
5	4294.76	II	10275–33553	5	4360.44	II	4323–27250
14	4296.07	II	8928–32198	2.5	4361.35		
3.0	4296.37	II	6521–29790	9	4361.66	II	4266–27187
140	4296.67	II	4166–27433	4 d	4363.39	II	5819–28731
5	4299.09	II	3996–27250		4363.49	II	10642–33553
42	4299.36	II	1410–24663	65	4364.66	II	3996–26900
55	4300.33	II	3594–26841	7	4367.00	II	11016–33908
3.0	4300.86			5	4367.56	II	8281–31171
6	4302.65	II	10642–33876	6	4368.23	II	7294–30180
8	4304.28			5	4369.24		
11	4304.72	II	5943–29167	7	4372.40	II	4323–27187
30	4305.14	II	6913–30135	3.5	4373.22	II	5437–28298
55	4306.72	II	4166–27379	2.5	4373.82	II	4523–27380
8	4309.58	II	5969–29167	3.5	4375.17	II	7059–29909
28	4309.74	II	3704–26900	38	4375.92	II	3996–26841
11	4310.70	II	3996–27187	8	4380.06	II	5011–27835
8	4311.59	II	7059–30246	8	4381.78	II	5819–28634
2.5	4313.10	II	5119–28298	65	4382.17	II	5514–28327
4	4314.93	II	6638–29807	5	4386.35	II	7202–29994
7	4315.41	II	7259–30425	12	4386.70	II	4460–27250
10	4317.33	II	8403–31559	50	4386.84	II	1874–24663
4	4317.99			22	4388.01	II	6968–29751
40	4320.72	II	3704–26841	12	4390.28	II	11742–34514
5	4324.60	I		120	4391.66	II	2596–25360
11	4324.79	II	7713–30829	11	4393.19	II	5969–28725

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4394.78	II	7059–29807
5	4396.58	II	7012–29751
14	4398.79	II	4460–27187
36	4399.20	II	2635–25360
5	4400.54	II	2642–25360
5	4400.87	II	5119–27835
4	4403.30	II	11341–34044
5	4405.47	II	5119–27812
12	4407.28	II	5651–28335
7 d	4408.87	II	7234–29909
25	4410.64	II	10870–33536
25	4410.76	II	7455–30120
9	4412.02	II	5676–28335
8	4413.19		
5	4413.80	II	7259–29909
22	4416.90	II	4266–26900
70	4418.78	II	6968–29592
5	4419.30	II	5676–28298
3.5	4423.44	I	
14	4423.68	II	8532–31131
22	4427.07	II	3363–25945
34	4427.92	II	4323–26900
22	4428.44	II	4266–26841
46	4429.27	II	8774–31345
5	4430.00		
4	4432.72	II	11742–34295
5	4432.92	II	5283–27835
3.5	4433.73	II	8281–30829
8	4437.61	II	6638–29167
6	4439.24	II	11016–33536
9	4440.88	II	6518–29029
11	4443.75	II	5437–27935
34	4444.39	II	7455–29949
32	4444.70	II	8532–31024
4	4446.15		
2.0	4447.69	I	
55	4449.34	II	4911–27380
7	4449.64		
44	4450.73	II	5514–27976
4	4452.55		
4	4453.16	II	4737–27187
6	4454.99	II	4460–26900
6	4455.66		
3.0	4457.78	II	8403–30829
170	4460.21	II	3854–26268
32	4461.14	II	7341–29751
30	4463.41	II	7722–30120
4	4464.17	II	7341–29735
10	4464.69	II	8278–30670
3.0	4465.44		
20	4467.54	II	4523–26900
100	4471.24	II	5617–27976
32	4472.72	II	3594–25945
3.0	4474.69	II	8789–31131
50	4479.36	II	4523–26841
50	4483.90	II	6968–29263
12	4484.82		
6	4485.52	II	7878–30166
60	4486.91	II	2382–24663
3.0	4488.81	II	8804–31076
3.0	4492.95	II	7341–29592
10	4494.22	II	6390–28634
9	4495.39	II	5011–27250
10	4496.23	II	8403–30637
18	4497.85	II	7722–29949
6	4500.34	II	9723–31938
1.8	4501.10	I	
7	4506.42	I	
5	4508.08	II	5011–27187
6 d	4509.14	II	7092–29263
	4509.26	II	7722–29892
4	4510.17	II	7818–29984
3.5	4510.92	II	8928–31090
6	4511.64	II	
8	4515.86	II	8532–30670
2.5	4518.02	I	
7	4519.59	II	10870–32989
3	4521.96	I	
1.6	4522.08	II	7059–29167
55	4523.08	II	4166–26268
60	4527.35	II	2581–24663
60	4528.47	II	6968–29044
6	4531.31	I	
3.0	4532.01	I	
8	4532.49		
2.0	4534.22		
6	4536.89	II	12260–34295
5	4537.88	II	7878–29909
8	4539.07	II	11016–33040
60	4539.75	II	2642–24663
15	4544.96	II	3363–25360
2.5	4545.87	II	5943–27935
3.0	4546.06	I	
4	4548.88	I	
5	4549.64	II	11016–32989
5	4550.30	II	9054–31024
18	4551.30	II	5969–27935
1.6	4552.07	I	
1.6	4553.06	I	
2.0	4554.56	II	3996–25945

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	4555.43		
1.8	4556.22		
5	4558.60	II	4911–26841
46	4560.28	II	7341–29263
22	4560.96	II	5514–27433
150	4562.36	II	3854–25766
2.0	4563.38	II	6390–28298
4	4565.24	I	
30	4565.84	II	8774–30670
3	4569.66		
75	4572.28	II	5514–27379
6	4572.79	II	11949–33812
4	4576.48	II	9723–31568
5	4578.78		
6	4579.28		
2.5	4581.09	I	
30	4582.50	II	5617–27433
1.6	4583.10	I	
9	4591.12	II	8928–30703
60	4593.93	II	5617–27379
4	4597.17		
1.6	4599.02		
2.5	4601.37	II	10646–32373
1.6	4604.21	II	8281–29994
2.5	4605.48	II	9317–31024
30	4606.40	II	7341–29044
5	4608.49	I	
4	4610.47	I	
6	4611.56	II	12366–34044
5	4613.02	II	7059–28731
5	4615.20	I	
30	4624.90	II	9054–30670
120	4628.16	II	4166–25766
3	4630.82		
12	4632.32	I	
2.5	4633.60	II	7059–28634
3 h	4636.74	II	5819–27380
5	4640.88	I	
5	4641.06	I	
6	4643.17	I	
5	4644.20	II	8281–29807
3	4647.28		
3	4647.38	II	5676–27187
5	4649.89	I	
8	4650.52	I	
9	4654.29	II	4202–25682
4	4659.40		
2.5	4659.94	II	7713–29167
3.0	4663.24		
2.5	4665.28		
2.5	4666.71	II	4523–25945
8	4669.50	II	
6	4670.74	II	5437–26841
5	4670.91	I	
6	4674.49	I	
13	4680.13	II	8532–29893
2.5	4680.99	II	11016–32373
24	4684.61	II	7294–28634
5	4685.23	II	7012–28350
6	4686.81		
7	4688.89	I	
1.6	4689.50	II	8928–30246
2.0	4690.17	II	7012–28327
2.5	4690.50	II	8278–29592
4	4690.71	I	
4	4692.06	II	5943–27250
6	4694.88	II	6518–27812
6	4696.52	I	
6	4701.45		
6	4702.01		
4	4707.01	I	
5	4707.28	I	
4	4707.94	II	7092–28327
2.0	4710.00		
18	4714.00	II	8928–30135
9	4714.81	II	8532–29735
8	4717.88	II	5651–26841
3.0	4722.30	II	4511–25682
3.0	4723.31	II	5676–26841
1.4	4724.32	I	
3.5	4724.85	I	
10	4725.09	II	4202–25360
1.4	4727.59	I	
7	4730.13	II	7202–28338
9	4733.52	II	10115–31235
3.0	4733.95	I	
3.5	4734.70	I	
2.0	4735.35	II	7523–28634
28	4737.28	II	8789–29893
3.5	4739.12	II	7202–28298
9	4739.53	II	10058–31152
4	4741.64	II	8281–29365
8	4744.82		
14	4747.14	II	11743–32802
1.4	4749.50	II	12763–33812
2.0	4750.84	I	
2.0	4751.53		
2.5	4752.24	II	12260–33297
2.0	4752.58	I	
5	4755.54	II	5819–26841

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
10		4757.84	II	7713–28725
1.4		4759.92	II	8804–29807
6		4763.90	II	8278–29263
2.0		4764.72	I	
9		4768.77	II	7012–27976
20		4773.94	II	7455–28396
3.0		4775.08	I	
2.5		4780.23	II	11949–32863
3.5		4783.94		
2.5		4784.78	I	
3.0		4786.54	I	
4		4787.14		
5		4788.43	I	
3.0		4789.69	II	5969–26841
4		4793.16		
6		4800.90		
4		4805.93	I	
2.5		4807.68	I	
3.0		4808.50	I	
4.0		4820.03	I	
2.5		4820.61	I	
10		4822.54	I	
3.5		4834.04	I	
4		4835.63	II	7722–28396
6		4836.67	I	
2.5		4837.49	I	
4		4843.03	I	
2.5		4844.29		
8		4845.52	I	
5		4846.57	II	7722–28350
12		4847.75	I	
5		4849.91	I	
1.8		4850.19		
4		4852.62	I	
3.5		4853.61	I	
3.5		4858.72	II	9317–29893
6		4859.48	I	
2.5		4861.73	I	
8	d	4863.20	CeO	
		4863.26	I	
3.0		4868.64	I	
6		4874.01	II	8928–29439
3.0		4874.35	I	
2.5		4881.54	I	
16		4882.46	II	
1.8		4886.13		
4		4889.59	I	
2.5		4891.90	II	10799–31235
2.0		4892.86	I	
8		4893.97	II	10704–31131
3.0		4897.08	I	
3.0		4898.21	I	
7		4899.90	I	
2.5		4901.68	I	
2.5	d	4904.88	I	
1.8		4908.12	I	
4		4914.94	II	7092–27433
5		4915.32	I	
4		4915.67	I	
2.5		4919.89	I	
4		4920.78	I	
2.0		4921.92	I	
4		4924.26	I	
2.0		4924.89		
2.0		4928.09	II	7092–27379
2.5	d	4930.54	I	
		4930.72	I	
6		4939.13	I	
3.0		4939.60		
2.0		4940.34		
12		4943.45	II	9726–29949
3.0		4943.84	II	7713–27935
10		4944.62	II	8131–28350
3.0		4948.67	I	
4		4949.55		
2.0		4951.92		
2.0		4954.04	I	
2.0		4955.97	I	
3.0		4960.90		
2.0		4961.49	II	5617–25766
2.0		4965.18	I	
3.0		4966.39	I	
3.0		4968.40		
3.0		4970.67	I	
14		4971.48	II	
3.0		4971.94	I	
5		4972.24	I	
3.0		4974.10	I	
5		4977.23	II	7294–27380
6	d	4984.51		
10		4986.42	II	8278–28327
7		4987.54	I	
4		4988.69	I	
6		4991.02	II	11310–31340
5		4992.40	I	
14		4994.61	I	
5		4998.13	1	
5		5002.80		
2.5		5004.78		
2.5		5006.43		

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22	5009.09	I	
11	5011.77	II	8449–28396
4	5012.51	I	
6	5013.76	I	
2.0	5014.28		
4	5016.51	I	
7	5021.44	I	
13	5022.87	II	8424–28327
2.5 h	5025.13		
2	5027.29	II	11455–31340
7	5028.30	I	
2.5 h	5030.64		
4	5031.74	I	
4	5031.97	II	11341–31208
5	5033.81	I	
5 h	5036.62	I	
13	5037.77	II	8131–27976
7 d	5039.75	I	
	5039.93		
13	5040.86	I	
5 d	5042.09	I	
2.5	5043.21		
19	5044.01	II	9772–29592
7	5048.82	I	
3.5	5050.99	I	
2.5	5053.27	I	
3.5	5053.53	I	
6	5054.17	I	
4	5055.78	I	
5	5063.92	I	
10	5065.88	I	
4	5067.15		
4	5071.49	I	
13	5071.77	I	
8	5074.71	I	
26	5075.30	II	7202–26900
7	5076.47	II	11458–31152
8	5077.82		
50	5079.68	II	11166–30847
7	5080.48	I	
2.5	5083.54	I	
2.5	5084.17	I	
2.0	5084.45		
4	5089.61		
4	5090.86		
5	5091.75	I	
3.5	5093.38		
2.5 h	5097.24	I	
2.5	5099.40	I	
5	5111.60	I	
14	5112.69	I	
10	5115.22	I	
7	5115.63	I	
17	5117.18	II	11310–30847
2.0	5117.95	II	10058–29592
5	5118.87		
5 h	5119.49		
7	5120.77	I	
5	5121.35		
7	5122.39	I	
3.0	5122.67	I	
7	5125.01	I	
2.5 h	5128.01		
18	5129.58	I	
6	5134.47	I	
4 d	5135.32	I	
5	5137.12	I	
2.5	5137.76		
2.5	5138.02	I	
2.0	5139.76	I	
5	5140.50	I	
12	5147.55	II	10314–29735
7	5149.65	I	
11	5149.99	I	
7	5150.41	I	
7	5153.95		
2.0	5154.39		
30	5159.69	I	
30	5161.48	I	
6	5163.27	II	11341–30703
8	5164.39	I	
2.0	5169.25		
3.5	5169.72	I	
20	5174.54	I	
2.0	5177.73	I	
3.0	5178.69	I	
8	5180.89	I	
2.5	5181.75	I	
5	5181.94	I	
4	5183.20	I	
40	5187.45	II	9772–29044
2.0	5188.53		
8	5188.65	I	
4	5189.25		
30	5191.68	II	7012–26268
2.0	5194.75	I	
4	5200.12	I	
6	5200.42	I	
6	5201.39	I	

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10 d	5202.46	I	
	5202.59	I	
6	5203.28	I	
6	5204.27	I	
4	5204.73	I	
3.5	5205.14	I	
4	5205.52	II	10058–29263
3.5	5208.74		
3.0	5208.90	I	
3.0	5210.34	II	7713–26900
3.5	5211.04	I	
20	5211.92	I	
4	5216.38	I	
5	5221.92	I	
5	5222.95	I	
28	5223.49	I	
4	5226.36	II	7713–26841
19	5229.75	I	
5	5230.14	I	
6	5230.84	I	
15	5232.91	II	10646–29751
2.0	5233.79	I	
6	5234.01	II	8278–27379
2.5	5235.77	II	11949–31043
5	5237.05	II	10646–29735
6	5238.49	I	
2.0	5238.91		
1.8	5239.83	II	9317–28396
2.0	5240.09		
7	5243.08	I	
10	5244.51	I	
2.0	5245.28	I	
28	5245.92	I	
2.0	5249.18	I	
3.5	5249.62	I	
4	5251.03		
8	5251.98		
8	5252.62	II	9317–28350
2.0	5253.40		
6	5254.84	I	
3.0	5255.95		
3.0	5258.40	II	5651–24663
3.0	5259.93	I	
9	5261.71	I	
9	5264.21	I	
14	5265.71	II	10058–29044
5	5269.52	I	
3.5	5271.06	I	
13	5271.88	I	
36	5274.24	II	8424–27379
3.5	5275.78	II	10314–29263
3.0	5276.26		
1.8	5277.54	I	
1.6	5278.43		
1.8	5281.38	I	
3.5	5286.84	I	
5	5290.94	I	
1.8	5291.31		
1.8	5292.40		
7	5294.07	I	
1.8	5294.87		
14	5296.60	I	
3.5	5298.29	I	
1.8	5299.10		
1.6	5302.19		
1.6	5303.15		
3.5	5303.35	I	
2.5	5308.32	I	
7	5308.55	I	
1.4	5309.93		
3.5	5313.93	I	
3.5	5314.40	I	
2.5	5314.90	I	
2.5	5314.99	I	
2.0	5317.58	I	
4	5323.32		
14	5328.05	I	
4	5329.50	I	
20	5330.58	II	7012–25766
3.0	5332.24		
1.8	5333.83		
1.8	5334.67		
8	5335.71	I	
7	5336.18	I	
1.8	5337.70		
2.5 d	5340.70		
1.8	5345.10		
2.5	5346.53		
3.5	5347.81	I	
1.6	5349.20		
4	5350.60		
2.0	5351.30		
4	5352.20		
48	5353.53	II	7092–25766
6	5355.18	I	
2.5	5355.62	I	
1.6	5355.96		
5	5357.20	I	
2.0	5359.30	I	
2.5	5359.48	II	11341–29994

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.0		5359.95	I	
1.6		5362.68		
8		5363.33	I	
1.6	d	5366.90		
2.5		5367.56		
1.6		5368.08		
4		5369.12	I	
2.5		5370.32		
2.0		5371.60	I	
2.5		5378.32		
3.0		5379.89	I	
1.2		5380.11		
4		5382.61	I	
1.6		5384.08		
8		5386.35	I	
6		5386.76		
5		5391.88	I	
32		5393.39	II	8897–27433
6		5394.84		
4		5395.24	I	
3.0		5395.70	I	
16		5397.64	I	
1.6		5397.96		
2.5		5399.04	I	
4		5399.57	I	
3.0		5401.21	I	
1.6		5402.54		
4		5404.23		
1.6		5406.61		
2.0		5407.66		
1.6		5408.36		
30	d	5409.22	II	8897–27379
1.6		5411.56		
2.0		5411.75	I	
3.0		5414.09	I	
1.6		5417.84	II	8928–27380
3.5		5418.70	I	
12		5420.38	I	
2.0		5421.33		
2.5		5422.20		
2.5		5423.42	I	
1.6		5426.37	I	
1.6		5426.61		
2.5		5427.25	I	
1.4		5428.28		
2.0		5429.50		
4		5430.24	I	
2.0		5430.54		
3.0		5431.33		
2.5		5433.34	I	
1.6		5436.09		
3.0		5437.90		
2.0		5438.43	I	
2.5		5445.43	I	
2.5		5446.20	I	
3.0		5446.45		
15		5449.22	I	
2.5		5450.04	I	
3.5		5451.72	I	
4		5453.95	I	
5		5456.41	I	
4		5457.21	I	
1.6		5457.89		
3.0		5458.81	I	
6		5459.21	II	13028–31340
6		5460.09	I	
6		5464.20	II	11455–29751
10		5465.34	I	
15		5468.37	I	
15		5472.30	II	10058–28327
3.0		5472.83		
6	d	5473.53	I	
1.6		5477.43		
3.0		5478.60	I	
2.0		5481.18		
6		5482.00	I	
3.0	h	5483.38		
3.0		5491.15	I	
5		5498.19	I	
1.0		5506.09		
1.4		5506.45	I	
3.0		5510.68	I	
28		5512.09	II	8131–26268
1.4	h	5513.11	II	11458–29592
2.0		5514.23		
3.0		5516.08	II	13028–31152
2.0		5517.40		
1.0		5517.86		
6		5518.49	II	9317–27433
4		5522.46	I	
1.4		5526.09		
3.5		5526.85		
2.5		5527.18	I	
10		5535.24	I	
4		5537.54	I	
3.0		5540.58		
3.0	d	5542.71		
2.0		5544.65	I	
2.0		5546.52		
1.4	h	5547.48		

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
7		5548.82	I	
3.5		5550.04	II	10314–28327
2.0		5550.64		
1.4		5551.41	I	
1.0		5552.30	I	
12		5556.25	I	
6		5556.95		
1.4		5558.66		
6		5559.22	I	
1.4	h	5560.06		
1.6	h	5561.46	II	11760–29735
1.4	h	5562.21	I	
5		5563.03		
4		5564.24	I	
18		5564.96	I	
3.0		5565.28		
14		5565.97	I	
2.0		5566.50		
5		5567.81	I	
1.4	h	5569.29		
2.0		5572.19	I	
1.4	h	5575.08		
2.0		5577.28		
3.5		5578.27		
3.0		5578.89	I	
8		5582.74	I	
3.5		5584.72	I	
2.0	h	5586.72		
1.4		5588.12		
3.0		5588.33	I	
1.0		5589.25		
1.0		5590.13		
1.4		5590.53	I	
3.0		5593.72	I	
7		5594.94	I	
11		5595.87	I	
3.5		5597.95	I	
2.5		5598.96	I	
26		5601.30	I	
4		5606.46	I	
1.2		5609.45	I	
8		5610.26	II	8449–26268
5		5610.92	I	
3.5		5613.70	II	11455–29263
8		5614.72	I	
1.8		5615.98	I	
1.0		5616.53		
1.8		5620.39	I	
1.0		5622.67		
1.4		5623.00		
1.2		5623.75	I	
1.2		5625.23		
1.2		5628.21		
3.0		5632.48		
5		5633.09	I	
2.0		5634.49	I	
5		5637.39	II	11310–29044
3.5		5638.19	I	
1.2		5638.41		
1.2		5638.63	I	
2.0		5640.11		
1.2		5640.79		
3.5		5646.58	I	
5		5650.60	I	
1.2		5652.96		
20		5655.13	I	
1.2		5656.21		
1.2		5659.78	I	
1.2		5663.18		
1.4		5663.48	I	
6		5663.99	I	
2.0		5664.68		
1.0		5665.38		
10		5668.94	II	8131–25766
26		5669.97	I	
1.2		5671.41		
3.5		5671.87	I	
2.5		5675.10	I	
6		5676.88		
1.2		5677.25		
13		5677.76	I	
1.2		5678.98		
1.8		5680.27		
1.2		5682.78	I	
1.4		5683.14		
3.0		5683.77	II	11455–29044
5		5685.86		
1.2		5687.82		
2.5		5688.49	I	
1.2		5691.47		
2.5		5692.13	I	
13		5692.94	I	
2.5		5695.74		
8		5695.84	I	
32		5697.00	I	
40		5699.23	I	
6		5702.39	I	
4		5703.23		
1.8		5709.06	I	
1.0		5710.07		

Cerium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	5711.45	II	11760–29263
1.8	5712.29	I	
4 h	5715.29	II	12457–29949
4	5716.50		
1.2	5718.36	I	
1.2	5718.59		
26	5719.04	I	
1.0	5719.56	I	
3.5	5721.96	I	
1.0	5725.85	I	
1.8	5726.14		
2.0	5727.25		
1.8	5729.38		
1.8	5733.94	I	
2.0	5735.69	I	
10	5743.53	I	
2.0	5744.69		
1.2	5746.49	I	
1.0	5748.29		
1.8	5748.95	I	
1.2	5752.52		
4	5758.24	I	
4	5758.30		
1.0	5760.58		
1.2	5763.00		
2.5	5764.77		
2.5	5765.34	I	
8	5768.90	II	10646–27976
2.5	5769.95	I	
3.5	5770.44	I	
1.4	5771.98	II	10058–27379
3.5	5772.22	I	
5	5772.88	I	
15	5773.12	I	
2.5	5773.59	I	
2.0	5775.00	I	
1.4	5775.80		
4	5782.44		
1.4	5782.81	I	
1.4	5783.99	II	11760–29044
5	5784.85	I	
1.2	5786.86		
1.4	5787.22		
13	5788.13	I	
1.2	5791.32		
1.8	5791.68		
1.0	5794.78	I	
4	5796.06		
2.0	5799.80		
10	5804.42	I	
6	5810.72	I	
1.2	5811.83		
13	5812.93	I	
1.2	5815.47		
3	5817.78	II	8176–25360
5	5820.40	I	
6	5822.99	I	
1.2	5823.46		
1.4	5830.03	I	
2.0	5830.13		
2.0	5831.39		
10	5831.93	I	
2.0	5834.24	I	
10	5835.84	I	
8	5838.16	I	
3.5	5839.38	I	
1.2	5843.11	I	
4	5843.75	I	
2.0 h	5845.98		
3.5	5848.34		
1.2	5848.86		
6	5851.06	I	
3.5	5853.07		
2.5	5853.36	I	
3.5	5853.67	I	
5	5857.13	I	
2.5	5858.15	I	
2.0 h	5858.56	II	10314–27379
5	5859.39	I	
10	5862.51	I	
1.2	5870.85		
8	5871.61	I	
1.4	5873.88	I	
2.5 d	5878.08		
4 d	5878.90	I	
2.0	5888.50		
1.4	5892.48	I	
4	5893.19	I	
1.2	5897.72		
1.4	5898.10		
1.2	5899.70		
1.2	5900.67	I	
4	5901.32	I	
2.5	5906.01	I	
1.2	5907.49		
6	5909.86	I	
6	5910.13	I	
5	5912.91	I	
1.2	5914.84	I	
5	5920.44	I	

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.5		5924.05	I	
2.0		5924.87		
6		5926.30	I	
9		5928.34	I	
2.0		5929.50		
3.0		5929.84	I	
2.5		5932.16	I	
1.8		5933.58		
10	d	5934.44		
10		5937.72	I	
2.0		5938.44	I	
25		5940.85	I	
30		5941.54		
3.0		5942.66	I	
3.0		5944.88	I	
2.5		5947.64	I	
2.5		5950.61	I	
1.2		5951.21	I	
2.5	d	5956.84		
3.5		5959.70		
2.5	d	5960.81		
1.2		5963.36	I	
1.8		5964.64		
8		5966.26	I	
3.0		5972.10		
1.2		5972.80	I	
8		5975.87	II	10704–27433
4		5975.98	I	
2.0		5979.40	I	
1.2		5981.20		
5		5989.38	I	
5		5992.66	I	
8	d	5995.35	II	10704–27379
2.0		5997.05	II	
1.2		6000.18	I	
6		6001.89		
1.2		6003.66		
6		6005.86	I	
1.6		6006.21	I	
6		6006.81	I	
2.0		6007.36		
8		6013.42	I	
2.5		6016.57	I	
1.0		6018.79	I	
1.0		6020.60	I	
12		6024.19	I	
1.6		6027.16	I	
1.2		6031.25	I	
2.5		6033.58	II	
3.5		6034.20	II	11760–28327
2.5		6034.59		
3.5		6035.49	II	13028–29592
12		6043.39	II	9726–26268
3.0		6045.43		
6		6047.39	I	
2.0		6051.80	II	
2.5		6057.49	I	
3.5		6057.99	I	
2.5		6066.71	I	
1.0		6068.63		
6		6069.47	I	
4		6072.00	I	
3.5		6076.60		
1.8		6077.14	I	
1.8		6080.37		
1.8		6081.28	I	
4		6088.92		
3.5		6093.20	I	
5		6098.34	II	14276–30670
1.2		6099.79	I	
3.0		6108.74	II	13527–29893
1.8	h	6111.95		
1.6		6118.55		
1.8		6118.89	I	
1.0		6119.74	I	
5		6123.67	I	
1.0		6124.31	I	
1.0		6130.13		
4	d	6132.00		
2.0		6135.52		
1.0		6137.23		
2.5		6139.03	I	
1.6		6142.91	I	
4		6143.36	II	
2.5		6146.42	I	
2.0		6147.85	I	
1.0		6149.58		
2.5		6151.73	I	
2.0		6159.82		
2.0		6162.17	I	
2.0		6165.47		
1.6		6172.87		
2.0		6175.29		
4		6186.16	I	
1.0		6186.92		
1.6		6187.91	I	
1.6		6195.25	I	
2.0		6195.55	I	
2.0		6198.05		
4		6208.99		

609065 O - 62 - 4

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.0		6209.56	I	
1.0		6211.06	I	
1.0	h	6212.50		
1.2		6216.84		
1.0		6223.25	I	
1.0		6228.23	I	
5		6229.00	I	
2.5		6232.45	II	9726–25766
3.0		6237.46	I	
1.4		6238.70	I	
1.4	d	6241.91	I	
1.4		6242.91		
1.6		6253.62	I	
1.0		6256.35		
1.4		6257.99		
1.6		6264.26		
1.0		6270.29		
5		6272.05	II	12457–28396
1.6		6276.46	I	
1.6	h	6286.40		
3.5		6295.57	I	
3.0		6299.51	II	15282–31152
2.5		6300.21	I	
1.4		6306.63	I	
3.5		6310.02	I	
0.9	h	6318.00		
0.9		6331.98	I	
2.5		6335.37	I	
1.2		6337.21	I	
1.4		6340.69	I	
3.5		6343.96	II	
0.6		6353.52		
0.6		6360.22		
3.5		6371.11	II	12705–28396
0.6		6372.99	I	
0.9	h	6386.16	I	
3.0		6386.86	I	
0.8		6390.32	I	
2.5		6393.02	II	
1.2		6395.12		
1.2		6396.26	I	
0.9	h	6399.91	I	
1.2		6425.30	II	
3.5		6430.07		
2.0		6434.40	I	
2.5		6436.41	I	
0.9		6439.97	I	
2.0		6446.15		
0.6		6451.98		
3.5		6458.05	I	
0.9		6461.89	I	
2.0		6466.90	II	14276–29735
3.0		6467.42	I	
0.6		6468.97	II	
4		6473.71		
1.8		6490.99	I	
0.6		6494.93		
1.2		6503.27	II	
0.8	h	6504.06	I	
1.2		6507.16		
0.8		6509.01	I	
2.5		6513.60	II	
2.0		6517.30	I	
0.6		6519.12		
0.6		6530.68	I	
0.6		6534.50		
0.8		6537.48	II	
2.0		6551.72	I	
5		6555.67		
0.6		6560.75		
0.8		6563.47		
0.8		6565.71		
1.0		6573.65	I	
0.5		6577.47	I	
2.5		6579.11		
0.7		6599.61	I	
0.7		6605.39	I	
1.6		6606.33	I	
1.6		6606.86	II	
3.0		6612.06		
1.4		6623.00	I	
4.0		6628.88	I	
1.8		6650.89		
0.8	h	6651.42	I	
3.0		6652.77	II	
1.4		6661.41	I	
1.8		6665.65	I	
1.4		6675.54	II	12457–27433
1.8		6679.81	I	
2.0		6686.59		
3.5		6700.70	I	
7	d	6704.38	I	
1.4		6706.03	I	
0.4		6710.16	I	
1.0		6713.48	I	
1.2		6720.32	II	
0.4		6726.52		
2.0		6728.71	I	
2.0		6729.54	I	
0.6		6733.21	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	6744.70	II	13527–28350
1.4	6746.89		
1.4	6749.44	I	
0.6	6755.08	II	13527–28327
0.8	6764.65	I	
0.8	6767.65	I	
0.5	6770.15		
4	6774.29	II	
5	6775.59	I	
1.4	6778.28	I	
1.2	6780.21		
1.2	6780.74	I	
0.8	6793.81		
0.7	6801.75		
0.7	6803.29	I	
2.4	6807.83	I	
1.4	6808.89	I	
0.8 h	6811.66		
1.2	6815.29		
2.0	6818.25	I	
1.0	6826.43	I	
1.0	6829.37		
1.4	6829.75		
0.8 h	6834.21		
0.7	6839.94		
1.2 d	6844.26		
	6844.49		
1.0	6846.78	II	
1.8	6847.25	I	
1.2	6853.60		
1.6	6856.55		
0.7 d	6885.51		
	6885.72		
1.4	6893.69		
1.0	6894.57	I	
1.4	6898.48		
1.2	6899.10		
0.8	6904.58		
0.5	6909.31		
1.2	6919.27	II	13527–27976
4	6924.83	I	
1.4	6939.44	I	
0.6 h	6970.40		
2.5	6973.50	II	
1.4	6983.83		
4	6986.04		
2.5	6999.92	I	
1.0	7013.36		
1.0	7014.80		
1.2	7017.24	I	
1.2	7018.75	I	
2.0	7031.04	I	
1.8 h	7049.73	I	
2.0	7054.50		
1.8	7058.68		
1.8	7060.01		
6	7061.75		
1.8	7064.50		
6	7086.36		
1.8	7105.04		
1.2	7113.15		
1.8	7115.08	II	14276–28327
1.2	7120.84		
1.0	7123.46		
1.6	7124.73		
1.2	7132.06		
1.2	7136.08		
2.5	7141.42		
1.2	7141.68		
3.0	7150.23	II	15282–29263
1.6	7151.67		
2.5	7155.24		
2.5	7156.99		
1.2	7174.98		
1.2	7177.43		
1.2	7182.29		
1.0	7186.21		
2.5	7189.40	II	13527–27433
1.6	7191.72	I	
1.8	7201.54		
2.5	7201.87		
1.6	7203.52		
2.0	7210.66		
0.9	7213.90		
3.0	7217.34		
2.5	7235.69	CeO	
3.5	7238.36	II	12457–26268
2.0	7241.66	CeO	
4	7252.72	I	
2.0	7262.64		
1.8 h	7277.91	I	
1.0	7279.94		
1.8	7296.16		
3.0	7301.43		
3.0	7313.45		
4	7329.92		
2.5	7330.67		
2.0	7343.45		
1.0	7345.63		
1.0 h	7361.89	II	12366–25945

Cerium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.0		7362.42		
1.0		7363.12		
1.0		7372.53		
1.0		7383.72		
1.4		7390.45	II	0–13527
1.0		7393.40		
4		7397.76	I	
1.8		7401.26		
2.0		7417.94		
1.0		7421.00		
1.8		7424.70	CeO	
2.0		7433.08		
1.8		7438.58		
1.0		7440.49		
2.0		7444.44		
1.0	h	7458.40		
1.4		7462.31		
1.6		7472.41		
1.0		7478.69		
2.5		7486.55		
1.4		7500.68		
1.0		7508.16	I	
1.4	h	7509.43	I	
1.8		7527.44		
1.8		7527.68		
1.6		7533.70		
1.4		7539.53		
1.6		7551.24		
2.0		7562.44	I	
1.6		7562.86		
1.6	h	7563.52	I	
1.4		7586.01		
1.6		7603.10		
4		7616.10		
1.2		7632.56		
2.0		7646.09		
1.6		7647.91		
1.2	h	7663.38		
1.2		7670.76	I	
1.2		7678.12		
2.0		7682.48		
4		7689.17		
1.4		7702.84		
0.9		7717.68		
0.9	h	7724.60		
1.6		7732.34	I	
0.8		7741.44		
0.7		7743.78		
0.6		7746.66		
2.5		7748.34	I	
0.7		7752.85		
0.8		7762.95		
0.9		7769.74		
0.8		7785.04		
1.6		7797.70	I	
0.6		7806.79		
1.2		7812.69		
1.4		7835.88		
0.6		7838.40		
2.0		7842.60	I	
3.5		7844.94		
2.5		7850.02		
2.5		7851.20		
3.5		7857.54		
2.0		7864.51		
1.6		7866.04		
0.8	d	7874.16		
2.5		7898.96	I	
1.8		7913.52		
1.6		7927.30	CeO	
1.6		7927.71	I	
1.6		7934.48		
0.8		7953.57		
1.4		7972.11		
1.2		7972.34	II	988–13527
3.0	d	8002.56		
		8002.69		
5		8025.56	II	0–12457
0.8		8030.69		
0.8		8031.43		
1.0		8040.01		
0.8	h	8066.90		
2.5		8070.70		
0.8		8079.36		
1.0		8090.66		
1.6		8094.43		
2.5		8120.38	I	
1.0		8171.41	I	
0.8		8175.59		
0.8		8199.20		
1.4		8220.71	I	
1.2		8223.62	I	
1.2		8224.28		
1.0		8239.48		
1.6		8241.54		
1.2		8245.20	I	
0.8		8246.82		
1.0		8250.64	II	1410–13527
2.0		8261.09	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.8	d	8300.58		
		8300.72		
1.4		8310.24	I	
1.2		8312.37		
0.8	h	8327.65		
0.9	h	8355.16		
1.4		8396.40		
0.9	d	8405.24	II	2382–14276
2.5		8418.24		
1.8		8495.82	II	
0.9	h	8511.34	II	
1.4	h	8523.34	I	
2.0		8539.08	II	
1.4	h	8564.58	I	
1.2	h	8567.48	I	
1.6		8612.65	I	
1.6	h	8647.66	I	
1.8	h	8702.38	II	3794–15282
1.2		8716.66	II	988–12457
4		8772.14	II	2880–14276
1.4		8782.17		
2.0		8810.86	I	
5		8891.20	I	

CESIUM

Cs, $Z=55$, $M=132.91$, Ratio $\frac{Cs}{Cu}=2.092$

Cs I Normal state of valence electrons $5p^6\ 6s^1\ ^2S_{0\frac{1}{2}}=0$. I.P.= 31407 K
Cs II Normal state of valence electrons $5p^6\quad ^1S_0=0$. I.P.=202263 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Cs I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

Intensities:
A. Filippov, Z. Physik **42,** 495 (1927).
H. J. Hubner, Ann. Physik **17,** 781 (1933).
L. S. Ornstein and J. Key, Physica **1,** 945 (1934).
M. Beutell, Ann. Physik **36,** 533 (1939).

Relative intensity of cesium lines observed in an arc of copper containing 0.1 atomic percent of cesium

Strong lines of cesium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	8521.10	I	0–11732	$5p^6 6s^1\ ^2S_{0\frac{1}{2}}$—$5p^6 6p^1\ ^2P^i_{1\frac{1}{2}}$
800	8943.50	I	0–11178	$5p^6 6s^1\ ^2S_{0\frac{1}{2}}$—$5p^6 6p^1\ ^2P^i_{0\frac{1}{2}}$

Cesium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
40	4555.36	I	0–21947	20 hs	6723.28	I	11178–26048
20	4593.18	I	0–21766	20 hs	6973.29	I	11732–26069
3.0 hs	5663.8	I	11178–28829	3.5	6983.49	I	11732–26048
2.5 hs	5844.7	I	11732–28836	4	7609.01	I	11178–24317
8 hs	6010.33	I	11178–27811	6 hl	8015.71	I	14500–26971
1.4 h	6034.09	I	11732–28300	8 hl	8079.02	I	14597–26971
12 hs	6212.87	I	11732–27823	1500	8521.10	I	0–11732
0.8	6217.27	I	11732–27811	55	8761.38	I	11178–22589
2.5 h	6354.98	I	11178–26911	800	8943.50	I	0–11178
3.0 h	6586.51	I	11732–26911				

CHROMIUM

Cr, $Z=24$, $M=52.01$, Ratio $\frac{Cr}{Cu}=0.819$

Cr I Normal state of valence electrons $3d^5\,4s^1\ {}^7S_3 = 0$. I.P.= 54570 K
Cr II Normal state of valence electrons $3d^5\ {}^6S_{2½} = 0$. I.P.=133060 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
Supplemented by lines from Kiess (below).

Classification:
Cr I, C. C. Kiess, J. Research, NBS **51,** 247 (1953).
Cr II, C. C. Kiess, J. Research, NBS **47,** 385 (1951).

Intensities:
R. Frerichs, Ann. Physik **81,** 807 (1926).
J. S. V. Allen and C. E. Hesthal, Phys. Rev. **47,** 926 (1935).
N. P. Penkin, J. Exptl. Theoret. Phys. (U.S.S.R.) **17,** 1114 (1947).
A. J. Hill and R. B. King, J. Opt. Soc. Am. **41,** 315 (1951).
F. B. Estabrook, Astrophys. J. **115,** 571 (1952).
L. Huldt and A. Lagerqvist, Arkiv Fysik **5,** 91 (1952).
M. Davis, P. Routly, and R. B. King, Conference on Stellar Atmospheres (Indiana University, 1954).
Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroscopiya **3,** 193 (1957).

Relative intensity of chromium lines observed in an arc of copper containing 0.1 atomic percent of chromium

Strong lines of chromium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2400	3578. 69	I	0–27935	$4s^1\ a\ {}^7S_3 - 4p^1\ y\ {}^7P^\circ_4$
2100	3593. 49	I	0–27820	$4s^1\ a\ {}^7S_3 - 4p^1\ y\ {}^7P^\circ_3$
1700	4254. 35	I	0–23499	$4s^1\ a\ {}^7S_3 - 4p^1\ z\ {}^7P^\circ_4$
1600	3605. 33	I	0–27729	$4s^1\ a\ {}^7S_3 - 4p^1\ y\ {}^7P^\circ_2$
1300	4274. 80	I	0–23386	$4s^1\ a\ {}^7S_3 - 4p^1\ z\ {}^7P^\circ_3$
900	5208. 44	I	7593–26788	$4s^1\ a\ {}^5S_2 - 4p^1\ z\ {}^5P^\circ_3$
850	4289. 72	I	0–23305	$4s^1\ a\ {}^7S_3 - 4p^1\ z\ {}^7P^\circ_2$
700	5206. 04	I	7593–26796	$4s^1\ a\ {}^5S_2 - 4p^1\ z\ {}^5P^\circ_2$
440	5204. 52	I	7593–26802	$4s^1\ a\ {}^5S_2 - 4p^1\ z\ {}^5P^\circ_1$
360	3017. 57	I	8095–41225	$4s^2\ a\ {}^5D_3 - 4p^1\ y\ {}^5F^\circ_4$
360	3021. 56	I	8308–41393	$4s^2\ a\ {}^5D_4 - 4p^1\ y\ {}^5F^\circ_5$
280	2835. 63	II	12497–47752	$4s^1\ a\ {}^6D_{4½} - 4p^1\ z\ {}^6F^\circ_{5½}$
240	2986. 47	I	8308–41782	$4s^2\ a\ {}^5D_4 - 4p^1\ y\ {}^5D^\circ_4$
200	2677. 16	II	12304–49646 12497–49838	$4s^1\ a\ {}^6D_{3½} - 4p^1\ z\ {}^6D^\circ_{3½}$ $4s^1\ a\ {}^6D_{4½} - 4p^1\ z\ {}^6D^\circ_{4½}$
190	2843. 25	II	12304–47465	$4s^1\ a\ {}^6D_{3½} - 4p^1\ z\ {}^6F^\circ_{4½}$
190	4351. 77	I	8308–31280	$4s^2\ a\ {}^5D_4 - 4p^1\ z\ {}^5F^\circ_5$
180	3014. 76	I	7811–40971	$4s^2\ a\ {}^5D_1 - 4p^1\ y\ {}^5F^\circ_2$
170	2986. 00	I	8095–41575	$4s^2\ a\ {}^5D_3 - 4p^1\ y\ {}^5D^\circ_3$
160	3919. 16	I	8308–33816	$4s^2\ a\ {}^5D_4 - 4p^1\ z\ {}^5D^\circ_4$
160	3963. 69	I	20520–45741	$4s^1\ a\ {}^5G_6 - 4p^1\ y\ {}^5H^\circ_7$
160	4344. 51	I	8095–31106	$4s^2\ a\ {}^5D_3 - 4p^1\ z\ {}^5F^\circ_4$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22	2055.52	II	0–48632
18	2061.49	II	0–48491
12	2065.42	II	0–48399
3.0 h	2364.71	I	0–42275
6	2383.33	I	8308–50253
9	2408.62	I	8308–49812
17	2496.31	I	7927–47975
11	2502.53	I	8095–48043
19	2504.31	I	8095–48014
5	2508.11	I	7927–47786
6	2508.98	I	7927–47772
4	2513.62	I	8095–47866
11	2516.92	I	8095–47814
8	2518.71	I	8095–47786
40	2519.52	I	8308–47986
19	2527.12	I	8308–47866
4	2530.45	I	8308–47814
7	2534.34	II	12497–51943
5	2545.64	I	7751–47022
16	2549.54	I	7811–47022
4	2553.06	I	7811–46968
8	2557.15	I	7927–47022
13	2560.69	I	7927–46968
15	2571.74	I	8095–46968
10	2577.65	I	8095–46878
5	2588.20	I	8095–46720
38	2591.85	I	8308–46878
4	2603.57	I	8308–46705
4	2622.86	I	8308–46422
2.5	2625.32	I	8095–46174
2.0	2626.60	I	8308–46368
2.0	2629.82	I	8095–46109
4	2642.12	I	24200–62037
28	2653.59	II	12033–49706
28	2658.59	II	11962–49565
8	2661.73	II	12148–49706
36	2663.42	II	12304–49838
8	2663.68	II	11962–49493
50	2666.02	II	12148–49646
32	2668.71	II	12033–49493
40	2671.81	II	12148–49565
32	2672.83	II	12304–49706
200	2677.16	II	12304–49646
		II	12497–49838
4	2678.16	I	7927–45255
36	2678.79	II	12033–49352
2.0	2680.34	II	40415–77714
26	2687.09	II	12148–49352
7	2688.04	I	8095–45286
6	2688.29	II	30157–67344
3.0	2690.26	I	8095–45255
32	2691.04	II	12497–49646
4	2693.52	II	30219–67334
4	2697.91	II	30299–67354
		II	39825–76879
20	2698.41	II	12304–49352
20	2698.69	II	11962–49006
2.0	2700.60	I	8095–45113
13	2701.99	I	8308–45306
2.0	2702.53	I	24200–61191
8	2703.48	I	8308–45286
	2703.55	II	30392–67369
4	2703.86	II	12033–49006
2.0	2705.43	I	24056–61008
7	2708.79	II	33521–70427
4	2709.31	II	33418–70317
16	2712.31	II	12148–49006
5	2716.18	I	8308–45113
6	2717.51	II	31083–67871
5	2718.43	II	31532–68306
19	2722.75	II	12033–48750
2.0	2724.04	II	31169–67868
48 h	2726.51	I	7593–44259
5	2727.26	II	31219–67876
32 h	2731.91	I	7593–44187
19 h	2736.47	I	7593–44126
8	2739.38	I	23934–60428
8	2740.10	II	12148–48632
11	2741.07	I	24056–60528
11	2742.03	II	12033–48491
11	2742.17	I	24200–60657
28	2743.64	II	11962–48399
4	2746.21	II	29952–66355
		II	38315–74718
12 h	2748.29	I	7751–44126
38	2748.98	II	12033–48399
44	2750.73	II	12148–48491
5	2751.60	I	7927–44259
32	2751.87	II	12304–48632
12 h	2752.88	I	7811–44126
4	2754.28	II	31086–67380
2.5	2754.90	I	24834–61123
2.5	2755.27	I	
2.5	2756.75	I	24897–61161
17	2757.10	I	7927–44187
40	2757.72	II	12148–48399
7	2758.98	II	38270–74505
9	2759.39	II	31219–67449
5	2759.73	II	31169–67394
10 h	2761.76	I	7927–44126

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
85		2762.59	II	12304–48491
2.5		2763.06	I	27817–63998
9	h	2764.35	I	8095–44259
85		2766.54	II	12497–48632
2.5		2767.54	I	25038–61161
28	h	2769.92	I	8095–44187
2.0		2771.45	I	23934–60005
5		2778.06	II	39825–75810
2.5		2779.14	I	25106–61078
9		2780.30	II	33521–69478
			II	38363–74319
70		2780.70	I	8308–44259
8		2785.70	II	33619–69506
4		2787.63	II	30865–66727
4		2787.84	I	
10		2792.16	II	33694–69498
6		2798.67	II	
8		2800.77	II	33694–69388
9		2812.01	II	33619–69171
			II	38563–74114
7		2818.36	II	33521–68993
5		2822.01	II	33418–68844
20		2822.37	II	30392–65813
2.5		2826.75	I	27817–63183
20		2830.47	II	30299–65618
8		2834.26	II	34631–69903
280		2835.63	II	12497–47752
5		2836.48	II	35608–70852
6		2838.79	II	38270–73486
13		2840.02	II	30219–65420
190		2843.25	II	12304–47465
2.5		2846.02	I	27704–62830
5		2849.29	I	27817–62903
			II	30299–65384
140		2849.84	II	12148–47228
14		2851.36	II	30157–65218
6		2853.22	II	30219–65257
			II	42898–77935
6		2855.07	II	32855–67871
			II	35569–70585
100		2855.68	II	12033–47041
10		2856.77	II	19631–54626
8		2857.40	II	19798–54785
70		2858.91	II	12497–47465
50		2860.93	II	11962–46906
90		2862.57	II	12304–47228
85		2865.11	II	12148–47041
6		2865.33	II	19528–54418
70		2866.74	II	12033–46906
10		2867.10	II	19631–54500
55		2867.65	II	11962–46824
24		2870.44	II	19798–54626
12		2871.63	I	8095–42908
18		2873.48	II	12033–46824
10		2873.82	II	19631–54418
36		2875.99	II	20024–54785
26		2876.24	II	12148–46906
20		2877.98	II	12304–47041
8		2878.45	II	12497–47228
14		2879.27	I	7927–42648
11		2880.87	II	19798–54500
3.5		2881.14	I	24056–58754
19		2887.00	I	7811–42439
6		2888.74	II	36273–70880
80		2889.29	I	
6		2889.82	II	32854–67449
6		2891.42	I	24200–58775
42		2893.25	I	8095–42648
22		2894.17	I	7751–42293
6		2896.46	II	32854–67369
			II	40228–74743
24		2896.75	I	7927–42439
6	d	2897.67	II	35608–70108
		2897.73	II	32845–67344
10		2898.54	II	31219–65710
9		2899.21	I	7811–42293
6		2899.48	II	32855–67334
3.0		2903.97	II	31118–65543
6		2904.68	I	24940–59358
20		2905.49	I	7811–42218
30		2909.05	I	7927–42293
30		2910.90	I	8095–42439
28		2911.14	I	8308–42648
5		2911.68	II	35569–69903
7		2913.73	I	25177–59488
2.5		2915.23	II	35611–69903
2.5		2915.46	II	39825–74114
10		2921.24	II	40202–74424
7		2921.82	II	31169–65384
7		2927.08	II	38563–72717
9		2928.15	II	30308–64449
11		2928.30	II	31219–65257
			II	38509–72649
3.0		2929.44	II	36273–70399
4		2930.85	II	29952–64063
3.0		2932.70	II	31169–65257
6		2933.97	II	31083–65157
10		2935.14	II	30865–64924
5		2940.22	II	42987–76988
7		2946.84	II	34813–68738

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	2953.36	II	29952–63802
5	2953.71	II	34631–68477
6	2961.73	II	30308–64062
		II	33694–67449
5	2966.05	II	31219–64924
55	2967.64	I	8095–41782
55	2971.11	I	7927–41575
24	2971.91	II	30392–64031
55	2975.48	I	7811–41409
3.5	2976.72	II	30865–64449
22	2979.74	II	30299–63849
40	2980.79	I	7751–41289
13	2985.32	II	30219–63707
55	2985.85	I	7927–41409
170	2986.00	I	8095–41575
240	2986.47	I	8308–41782
75	2988.65	I	7593–41043
18	2989.19	II	30157–63601
55	2991.89	I	7811–41225
26	2994.07	I	7593–40983
34	2995.10	I	7593–40971
80	2996.58	I	7927–41289
24	2998.79	I	7593–40930
120	3000.89	I	8095–41409
85	3005.06	I	8308–41575
18	3013.03	I	7751–40930
90	3013.71	I	7811–40983
90	3014.76	I	7811–40971
180	3014.92	I	7927–41083
90	3015.19	I	7751–40906
360	3017.57	I	8095–41225
55	3018.50	I	7811–40930
30	3018.82	I	7927–41043
55	3020.67	I	7811–40906
360	3021.56	I	8308–41393
140	3024.35	I	7927–40983
11	3026.65	II	35708–68738
22	3029.16	I	7927–40930
90	3030.24	I	8095–41086
18	3031.35	I	7927–40906
3.5	3032.93	II	21823–54785
50	3034.19	I	8095–41043
70	3037.04	I	8308–41225
10	3039.78	I	24200–57088
70	3040.85	I	8095–40971
	3040.91	II	34631–67506
7	3041.74	II	35611–68477
14	3050.14	II	34813–67589
90	3053.88	I	8308–41043
3.0	3059.52	II	21825–54500
11	3065.07	I	24940–57557
3.5	3067.16	II	21824–54418
11	3073.68	I	25177–57702
7	3077.83	I	25106–57587
3.5	3095.86	I	21841–54133
3.5	3109.34	I	24834–56986
3.5	3110.86	I	24897–57033
30	3118.65	II	19528–51584
6	3119.25	I	25038–57088
5	3119.71	I	24940–56986
55	3120.37	II	19631–51670
3.5	3122.60	II	33694–65710
60	3124.94	II	19798–51789
	3125.02	II	34659–66650
15	3128.70	II	19631–51584
75	3132.06	II	20024–51943
18	3136.68	II	19798–51670
18	3147.23	II	20024–51789
		II	33619–65384
11	3148.44	I	23934–55686
13	3155.15	I	24056–55741
13	3163.76	I	24200–55799
30	3180.70	II	20513–51943
4	3181.43	II	20520–51943
8 h	3188.01	I	24092–55451
28	3197.08	II	20520–51789
3.0	3198.11	I	24092–55353
4	3208.59	II	20513–51670
22	3209.18	II	20518–51670
18	3217.40	II	20513–51584
4	3229.20	I	27817–58775
3.5	3234.06	II	34631–65543
8	3237.73	I	23934–54811
15	3245.54	I	23934–54736
16	3251.84	I	24056–54799
16	3257.82	I	24200–54887
12	3259.98	I	24200–54866
4	3295.43	II	33694–64031
3.0	3307.02	II	33619–63849
7	3324.06	II	19631–49706
		II	38509–68583
3.5	3326.59	I	24940–54993
4	3328.35	II	19528–49565
4	3329.05	I	25177–55207
12	3336.33	II	19528–49493
16	3339.80	II	19631–49565
14	3342.59	II	19798–49706
4	3343.34	I	24897–54799
12	3346.02	I	24200–54078
12	3346.74	I	24056–53927

Chromium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
12		3347.84	II	19631–49493
8		3349.07	I	24282–54133
7		3349.32	I	25038–54887
4		3351.60	I	25038–54866
7		3351.97	I	0–29825
7	h	3353.03	I	31055–60871
		3353.13	II	20024–49838
22		3358.50	II	19798–49565
20		3360.30	II	25034–54785
8		3361.77	II	25047–54785
7		3362.21	I	20519–50253
55		3368.05	II	20024–49706
4		3376.40	I	31048–60657
7		3378.34	II	25034–54626
4		3379.17	I	20517–50102
4		3379.37	II	25043–54626
12		3379.83	II	25047–54626
18		3382.68	II	19798–49352
12		3391.43	II	19528–49006
7		3392.99	II	25036–54500
9		3393.84	II	25043–54500
7		3394.30	II	25047–54500
4		3402.40	II	25036–54418
22		3403.32	II	19631–49006
			II	25043–54418
45		3408.76	II	20024–49352
26		3421.21	II	19528–48750
34		3422.74	II	19798–49006
18		3433.31	II	19631–48750
34		3433.60	I	20519–49635
7		3434.11	I	20524–49635
20		3436.19	I	20524–49618
9		3441.12	I	20521–49573
18		3441.44	I	20524–49573
4		3443.79	I	23934–52963
22		3445.62	I	20524–49538
4		3447.02	I	20517–49520
22		3447.43	I	20521–49520
9		3447.76	I	20524–49520
24		3453.33	I	20517–49467
5		3453.74	I	20521–49467
16		3455.60	I	20524–49454
13		3460.43	I	24282–53172
8		3465.25	I	20521–49371
5		3467.02	I	24282–53117
9		3467.72	I	24056–52885
6		3469.59	I	24304–53117
2		3472.76	I	21841–50628
3		3472.91	I	23934–52720
5		3473.61	I	21848–50628
9		3481.30	I	21841–50557
7		3481.54	I	24200–52915
7		3494.97	I	24056–52660
5		3495.38	II	19798–48399
10		3510.54	I	24200–52678
5		3511.84	II	20024–48491
15		3550.64	I	25771–53927
10		3558.52	I	25206–53299
16		3566.16	I	25360–53394
16		3573.64	I	21848–49823
10		3574.04	I	21840–49812
42	h	3574.80	I	21857–49823
		3574.94	I	21848–49812
2400		3578.69	I	0–27935
20	h	3584.33	I	25771–53663
16		3585.30	II	21823–49706
2100		3593.49	I	0–27820
44		3601.67	I	21841–49598
5		3602.57	I	21848–49598
11		3603.74	I	21848–49589
		3603.78	II	21824–49565
1600		3605.33	I	0–27729
5		3608.40	I	31049–58754
5		3609.48	I	20521–48218
5		3610.05	I	20517–48210
9		3612.61	I	31055–58728
11		3615.64	I	0–27650
17		3632.84	I	20524–48043
44		3636.59	I	20524–48014
80		3639.80	I	20519–47986
11		3640.39	I	20523–47986
9		3641.47	I	20521–47975
28		3641.83	I	20524–47975
6		3646.16	I	20524–47942
11		3648.53	I	20517–47918
28		3649.00	I	20521–47918
22		3653.91	I	20517–47877
28		3656.26	I	20524–47866
6		3662.84	I	20521–47814
16		3663.21	I	20524–47814
6		3665.98	I	20524–47794
10		3666.64	I	20521–47786
6		3668.03	I	20517–47772
7		3676.32	I	24092–51287
4		3677.68	II	21823–49006
6		3677.89	II	21824–49006
4		3679.82	I	20521–47689
2.0		3681.69	I	24092–51247
13		3685.55	I	20519–47645
14		3686.80	I	20524–47640

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
14	3687.25	I	20517–47629
8	3687.54	I	20521–47631
2.0	3688.46	I	20517–47621
8	3712.95	II	21824–48750
4	3716.53	I	31393–58292
14	3730.81	I	0–26796
16	3732.03	I	0–26787
10	3742.97	I	20519–47229
50	3743.58	I	20524–47229
60	3743.88	I	20519–47222
9	3744.49	I	20524–47222
6	3748.61	I	20521–47190
36	3749.00	I	20524–47190
5	3757.17	I	20517–47126
24	3757.66	I	20521–47126
5	3758.04	I	20524–47126
2.0	3767.43	I	20519–47055
22	3768.24	I	20517–47047
8	3768.73	I	20521–47047
8	3788.86	I	24277–50663
8	3790.45	I	24286–50661
11	3791.38	I	24286–50655
11	3792.14	I	24300–50663
10	3793.29	I	24300–50655
11	3793.88	I	24304–50655
7	3794.61	I	24282–50628
12	3797.13	I	24300–50628
17	3797.72	I	24304–50628
44	3804.80	I	24282–50558
9	3806.83	I	27817–54078
9	3807.93	I	24304–50557
15	3815.43	I	21841–48042
6	3818.48	I	20524–46705
15	3819.56	I	21841–48014
6	3823.52	I	7751–33897
11	3826.42	I	21848–47975
11	3830.03	I	27825–53927
32	3841.28	I	21841–47866
16	3848.98	I	21841–47814
12	3849.36	I	24282–50253
24	3850.04	I	21848–47814
12	3852.22	I	7811–33762
16	3854.22	I	21848–47786
9	3855.29	I	21857–47788
12	3855.57	I	24282–50211
22	3857.63	I	21857–47772
6	3874.53	I	24300–50102
		I	27825–53628
55	3883.29	I	31352–57097
4	3883.66	I	24277–50019
		I	31355–57097
48	3885.22	I	7811–33542
32	3886.79	I	8095–33816
5	3891.93	I	23934–49621
22	3894.04	I	7751–33424
3.5	3897.65	I	
3.0	3902.11	I	
30	3902.92	I	7927–33542
5	3903.16	I	7811–33425
80	3908.76	I	8095–33672
10 hd	3911.82	I	27729–53284
	3912.00	I	27820–53375
10	3915.84	I	24282–49812
16	3916.24	I	7811–33338
3.0	3917.60	I	23163–48682
160	3919.16	I	8308–33816
50	3921.02	I	7927–33424
2.5	3926.65	I	36578–62038
50	3928.64	I	8095–33542
34	3941.49	I	8308–33672
2.5	3951.10	I	24286–49589
3.5	3952.40	I	24304–49598
3.0	3953.16	I	24300–49589
160	3963.69	I	20520–45741
10	3969.06	I	20519–45707
130	3969.75	I	20524–45707
7	3971.26	I	21848–47022
130	3976.66	I	20524–45663
7	3978.68	I	21841–46968
3.5	3979.80	I	21848–46968
7	3981.23	I	21857–46968
80	3983.91	I	20521–45615
16	3984.34	I	20524–45615
13	3989.99	I	31393–56449
80	3991.12	I	20517–45566
13	3991.67	I	20521–45566
16	3992.84	I	21841–46878
3.5	3993.97	I	21848–46878
13	4001.44	I	31378–56362
10	4012.47	II	45670–70585
2.5	4014.67	I	31378–56280
7	4022.26	I	31355–56210
6	4025.01	I	20521–45359
10	4026.17	I	20524–45354
7	4027.10	I	20524–45349
7	4030.68	I	31352–56155
16	4039.10	I	31048–55799
13	4048.78	I	31049–55741
10	4058.77	I	31055–55686

Chromium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	4065.72	I	20524–45113
		I	33113–57702
7	4066.94	I	21841–46422
		I	25039–49621
3.0	4074.86	I	35934–60468
3.5	4076.06	I	33060–57587
3.5	4077.09	I	21848–46368
3.5	4077.68	I	33040–57557
3.5	4104.87	I	20521–44875
		I	23934–48288
3.5	4109.58	I	21848–46174
3.5	4120.61	I	21848–46109
3.5	4121.82	I	24056–48310
3.0	4122.16	I	21857–46109
3.5	4123.39	I	24200–48446
12	4126.52	I	20519–44746
3.0	4127.30	I	33113–57335
3.5	4127.64	I	21857–46077
3.5	4131.36	I	31009–55207
2.5	4152.78	I	31028–55102
10	4153.82	I	20524–44591
7	4161.42	I	35934–59957
12	4163.62	I	20524–44534
6	4165.52	I	35884–59884
3.5	4169.84	I	33113–57088
3.0	4170.20	I	33060–57033
3.5	4172.77	I	37234–61192
14	4174.80	I	
2.5	4175.94	I	24286–48226
14	4179.26	I	25106–49028
3.0	4184.90	I	24897–48786
2.5	4186.36	I	31049–54929
3.0	4190.13	I	23163–47022
7	4191.27	I	20521–44373
3.0	4192.10	I	32097–55945
7	4193.66	I	31048–54887
6	4194.95	I	31055–54887
3.5	4197.23	I	31048–54866
7	4198.52	I	31055–54866
5	4203.59	I	20517–44300
3.5	4204.47	I	32097–55875
3.0	4208.36	I	31055–54811
9	4209.37	I	31049–54799
3.5	4209.76	I	25038–48786
3.5	4211.35	I	24304–48043
3.5	4216.36	I	24304–48014
7	4217.63	I	24282–47986
3.5	4221.57	I	24834–48515
		I	31055–54737
3.5	4222.73	I	24300–47975
3.5	4238.96	I	24282–47866
5	4240.70	I	24056–47630
		I	24940–48515
1700	4254.35	I	0–23499
6	4255.50	I	24200–47693
5	4261.35	I	23499–46959
9	4263.14	I	31048–54498
2.5	4271.06	I	25038–48445
3.5	4272.91	I	23386–46783
1300	4274.80	I	0–23386
7	4280.40	I	31049–54405
850	4289.72	I	0–23305
3.5	4291.96	I	27597–50890
7	4295.76	I	21841–45113
6	4297.74	I	31055–54317
3.0	4300.51	I	27704–50950
4	4301.18	I	27817–51060
2.5	4305.45	I	23305–46525
3.0	4319.64	I	23305–46449
5	4325.08	I	23934–47048
65	4337.57	I	7811–30859
95	4339.45	I	7927–30965
32	4339.72	I	7751–30787
5	4340.13	I	21841–44875
160	4344.51	I	8095–31106
6	4346.83	I	24056–47055
32	4351.05	I	7811–30787
190	4351.77	I	8308–31280
48	4359.63	I	7927–30859
6	4363.13	I	23934–46847
44	4371.28	I	8095–30965
		I	35884–58755
6	4373.25	I	7927–30787
9	4374.16	I	24200–47055
6	4375.33	I	24056–46905
4	4381.11	I	21848–44667
44	4384.98	I	8308–31106
5	4387.50	I	24092–46878
		I	24200–46986
6	4391.75	I	8095–30859
5	4403.50	I	32097–54800
2.0	4410.30	I	24300–46968
5	4411.09	I	24304–46968
3.0	4412.25	I	8308–30965
4	4413.87	I	28637–51287
5	4424.28	I	24282–46878
2.0	4428.50	I	24304–46878
4	4430.49	I	24282–46847
		I	28682–51247
4	4432.18	I	23163–45719

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	4458.54	I	24282–46705
		I	28637–51060
2.5	4459.74	I	24304–46720
2.5	4465.36	I	24300–46688
2.5	4482.88	I	27176–49477
3.5	4488.05	I	24092–46368
4	4489.47	I	28682–50950
5	4492.31	I	27223–49477
55	4496.86	I	7593–29825
4	4498.73	I	23512–45734
6	4500.30	I	24834–47048
4	4501.11	I	23512–45722
		I	28679–50890
1.8	4501.79	I	23512–45719
2.0	4506.85	I	33763–55945
8	4511.90	I	24897–47055
1.0	4514.37	I	33763–55908
3.0	4514.53	I	23499–45643
2.0	4521.14	I	33763–55875
2.0	4526.11	I	24897–46986
32	4526.47	I	20519–42606
6 d	4527.34	I	20524–42606
	4527.47	I	24092–46174
2.0	4529.85	I	20519–42589
32	4530.74	I	20524–42589
4	4535.15	I	20521–42565
20	4535.72	I	20524–42565
3.5	4539.79	I	20517–42539
20	4540.50	I	20521–42539
20	4540.72	I	25038–47055
3.0	4541.07	I	20524–42539
1.6	4541.51	I	24834–46847
2.0	4542.62	I	24897–46905
12	4544.62	I	20517–42515
		I	24300–46298
2	4545.34	I	20521–42515
50	4545.96	I	7593–29585
4	4556.17	I	25106–47048
1.8	4558.66	II	32854–54785
1.6	4564.17	I	38538–60441
10	4565.51	I	7927–29825
8	4569.64	I	25177–47055
10	4571.68	I	20519–42387
1.8	4575.12	I	27176–49027
30	4580.06	I	7593–29421
2.0	4586.14	I	25106–46905
30	4591.39	I	7811–29585
6	4595.59	I	33763–55517
4	4600.10	I	20519–42252
40	4600.75	I	8095–29825
4	4601.02	I	20524–42252
20	4613.37	I	7751–29421
50	4616.14	I	7927–29585
6	4619.55	I	24092–45734
7	4621.96	I	20524–42154
		I	31048–52678
6	4622.49	I	28637–50264
2.0	4622.76	I	24092–45719
46	4626.19	I	7811–29421
2.0	4632.18	I	28682–50264
3.5	4637.18	I	20521–42080
4	4637.77	I	20524–42080
4 d	4639.52	I	25089–46637
	4639.70	I	28637–50184
130	4646.17	I	8308–29825
2.0	4646.81	I	25011–46525
2.0	4648.13	I	20517–42026
2.0	4648.87	I	20521–42026
		I	28679–50184
3.0	4649.46	I	20524–42026
		I	28682–50184
48	4651.28	I	7927–29421
70	4652.16	I	8095–29585
3.0	4654.74	I	24971–46449
1.6	4656.19	I	24897–46368
3.5	4663.33	I	25011–46449
6	4663.83	I	25089–46525
8	4664.80	I	25206–46637
3.0	4665.90	I	28679–50105
1.8	4666.22	I	23934–45358
6	4666.51	I	25360–46783
4	4669.34	I	25549–46959
3.5	4680.54	I	25089–46449
1.6	4680.87	I	24940–46298
6	4689.37	I	25206–46525
5	4693.95	I	24056–45354
2.0	4695.15	I	24056–45349
		I	35808–57101
5	4697.06	I	21841–43125
20 d	4698.46	I	25360–46637
	4698.62	I	21848–43125
3.0	4700.61	I	21857–43125
16	4708.04	I	25549–46783
20	4718.43	I	25772–46959
4	4723.10	I	24834–46000
4	4724.42	I	24897–46058
4	4727.15	I	24200–45349
2.0	4729.72	I	
10	4730.71	I	24834–45966
12	4737.35	I	24897–46000

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.6	4745.31	I	21841–42908
6	4752.08	I	33763–54800
28	4756.11	I	25038–46058
4	4764.29	I	28637–49621
1.8	4766.63	I	28679–49653
2.5	4767.86	I	28682–49650
16	4789.32	I	20519–41393
8	4792.51	I	25106–45966
10	4801.03	I	25177–46000
9	4829.38	I	20524–41225
1.2	4836.86	I	25038–45707
1.4	4861.20	I	20521–41086
6	4861.84	I	20524–41086
12	4870.80	I	24834–45358
3.0	4885.78	I	20521–40983
1.6	4885.96	I	24897–45358
11	4887.01	I	24897–45354
1.6	4888.53	I	20521–40971
3.0	4903.24	I	20517–40906
22	4922.27	I	25038–45349
9	4936.33	I	25106–45358
6	4942.50	I	7593–27820
9	4954.81	I	25177–45354
3.0	4964.93	I	7593–27729
5	5013.32	I	21841–41782
1.4	5051.90	I	7593–27382
1.4	5065.91	I	21841–41575
3.5	5067.71	I	21848–41575
3.5	5072.92	I	7593–27300
2.5	5110.75	I	21848–41409
1.4	5113.13	I	21857–41409
1.4	5123.46	I	8308–27820
4	5139.65	I	27597–47048
1.2	5144.67	I	21857–41289
6	5166.23	I	27704–47055
3.0	5177.43	I	27650–46959
6	5184.59	I	27500–46783
6	5192.00	I	27382–46637
1.0	5193.49	I	27597–46847
7	5196.44	I	21848–41086
3.0	5200.19	I	27300–46525
440	5204.52	I	7593–26802
700	5206.04	I	7593–26796
900	5208.44	I	7593–26788
1.6	5214.13	I	27176–46349
2.5	5221.75	I	27223–46368
7	5224.94	I	27825–46959
1.0	5226.89	I	21857–40983
1.6	5238.97	I	21848–40930
2.5	5243.40	I	27382–46449
24	5247.56	I	7751–26802
5	5254.92	I	27500–46525
5	5255.13	I	27935–46959
1.6	5261.75	I	29825–48824
44	5264.15	I	7811–26802
2.5	5265.16	I	27650–46637
15	5265.72	I	7811–26796
3.0	5272.01	I	27820–46783
2.5	5273.44	I	27825–46783
8 h	5275.17	I	23305–42256
		I	27223–46174
3.0 h	5275.69	I	23305–42255
6 h	5276.03	I	23305–42253
1.6	5280.29	I	27176–46109
0.8	5287.19	I	27729–46637
28	5296.69	I	7927–26802
6 h	5297.36	I	23386–42258
55	5298.27	I	7927–26796
7	5300.75	I	7927–26788
1.4	5304.21	I	27935–46783
2.0	5312.88	I	27820–46637
2.0	5318.78	I	27729–46525
28 h	5328.34	I	23499–42261
6 h	5329.17	I	23499–42258
1.4 h	5329.72	I	23499–42256
1.2	5340.44	I	27729–46449
0.8	5344.76	I	27820–46525
65	5345.81	I	8095–26796
32	5348.32	I	8095–26787
2.5	5386.98	I	27176–45734
1.8	5387.57	I	27163–45719
0.8	5390.39	I	27176–45722
3.5	5400.61	I	27223–45734
1.8	5405.00	I	27223–45719
120	5409.79	I	8308–26787
1.0	5442.41	I	27597–45966
1.6	5463.97	I	27704–46000
1.6	5480.50	I	27817–46058
2.0	5628.64	I	27597–45358
0.6	5642.36	I	31106–48824
1.0 h	5649.37	I	30965–48661
2.0	5664.04	I	27704–45354
0.6 h	5681.20	I	
0.6 h	5682.48	I	30965–48559
2.0	5694.73	I	31106–48661
3.5	5698.33	I	31280–48824
2.0	5702.31	I	27817–45349
1.0	5712.64	I	36578–54078
2.0	5712.78	I	24282–41782
0.6	5719.82	I	24304–41782

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.6		5746.43	I	28679–46077
			I	31048–48445
0.6		5753.69	I	36552–53927
1.0	h	5781.20	I	24282–41575
			I	26796–44089
0.5	h	5781.81	I	23934–41225
			I	26802–44093
2.0	h	5783.11	I	28679–45966
			I	26802–44089
2.5	h	5783.93	I	26796–44081
2.0	h	5785.00	I	26787–44069
1.6	h	5785.82	I	26802–44081
5	h	5787.99	I	26796–44069
15	h	5791.00	I	26787–44051
3.0		6330.10	I	7593–23386
1.8		6362.87	I	7593–23305
1.8		6661.08	I	33816–48824
1.0		6669.26	I	33672–48661
0.5	h	6881.62	I	27729–42256
0.9	h	6882.38	I	27729–42255
2.0	h	6883.03	I	27729–42253
2.5	h	6924.13	I	27820–42258
1.6	h	6925.20	I	27820–42256
3.0	h	6978.48	I	27935–42261
1.2	h	6979.82	I	27935–42258
0.7		7185.52	I	31393–45306
0.6	h	7236.20	I	41393–55209
9		7355.90	I	23305–36896
14		7400.21	I	23386–36896
16		7462.31	I	23499–36896
1.2	h	7942.04	I	35398–47986
0.5	h	8163.18	I	35398–47645
0.9		8348.28	I	21841–33816
0.6		8450.26	I	21841–33672
0.3		8455.24	I	21848–33672
0.6		8548.86	I	21848–33542
4		8947.15	I	25039–36212
2.0		8976.83	I	24898–36034

COBALT

Co, $Z=27$, $M=58.94$, Ratio $\frac{Co}{Cu}=0.928$

Co I Normal state of valence electrons $3d^7\ 4s^2\ {}^4F_{4½}=0$. I.P.= 63438 K
Co II Normal state of valence electrons $3d^8\quad {}^3F_4=0$. I.P.=137572 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
Supplemented by references for Co I and Co II (below).

Classification:
Co I, H. N. Russell, R. B. King, and C. E. Moore, Phys. Rev. **58,** 407 (1940).
Co II, J. H. Findlay, Phys. Rev. **36,** 5 (1930); N. E. Hager Jr., unpublished material (1951).

Intensities:
L. S. Ornstein and T. Bouma, Phys. Rev. **36,** 679 (1930).
R. B. King, B. R. Parnes, M. H. Davis, and K. H. Olsen, J. Opt. Soc. Am. **45,** 350 (1955).
Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **5,** 345 (1958).

Relative intensity of cobalt lines observed in an arc of copper containing 0.1 atomic percent of cobalt

Strong lines of cobalt

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1300	3453. 50	I	3483–32431	$4s^1\ b\ {}^4F_{4½}—4p^1\ y\ {}^4G^o_{5½}$
700	3405. 12	I	3483–32842	$4s^1\ b\ {}^4F_{4½}—4p^1\ y\ {}^4F^o_{4½}$
600	3502. 28	I	3483–32028	$4s^1\ b\ {}^4F_{4½}—4p^1\ y\ {}^4D^o_{3½}$
550	3443. 64	I	4143–33173	$4s^1\ b\ {}^4F_{3½}—4p^1\ y\ {}^4G^o_{3½}$
550	3569. 38	I	7442–35451	$4s^1\ a\ {}^2F_{3½}—4p^1\ y\ {}^2F^o_{3½}$
500	3474. 02	I	0–28777	$4s^2\ a\ {}^4F_{4½}—4p^1\ z\ {}^4F^o_{3½}$
			4690–33467	$4s^1\ b\ {}^4F_{2½}—4p^1\ y\ {}^4F^o_{3½}$
460	3529. 81	I	4143–32465	$4s^1\ b\ {}^4F_{3½}—4p^1\ y\ {}^4G^o_{4½}$
440	3506. 32	I	4143–32654	$4s^1\ b\ {}^4F_{3½}—4p^1\ y\ {}^4D^o_{2½}$
420	3412. 34	I	4143–33440	$4s^1\ b\ {}^4F_{3½}—4p^1\ y\ {}^2G^o_{4½}$
420	3587. 19	I	8461–36330	$4s^1\ a\ {}^2F_{2½}—4p^1\ y\ {}^2F^o_{2½}$
400	3526. 85	I	0–28346	$4s^2\ a\ {}^4F_{4½}—4p^1\ z\ {}^4F^o_{4½}$
340	3894. 08	I	8461–34134	$4s^1\ a\ {}^2F_{2½}—4p^1\ y\ {}^2G^o_{3½}$
320	3462. 80	I	5076–33946	$4s^1\ b\ {}^4F_{1½}—4p^1\ y\ {}^4F^o_{2½}$
320	3465. 80	I	0–28845	$4s^2\ a\ {}^4F_{4½}—4p^1\ z\ {}^4G^o_{5½}$
300	3489. 40	I	7442–36092	$4s^1\ a\ {}^2F_{3½}—4p^1\ y\ {}^2D^o_{2½}$
300	3512. 64	I	4690–33151	$4s^1\ b\ {}^4F_{2½}—4p^1\ y\ {}^4D^o_{1½}$
300	3518. 35	I	8461–36875	$4s^1\ a\ {}^2F_{2½}—4p^1\ y\ {}^2D^o_{1½}$
300	3845. 47	I	7442–33440	$4s^1\ a\ {}^2F_{3½}—4p^1\ y\ {}^2G^o_{4½}$
280	3409. 18	I	4143–33467	$4s^1\ b\ {}^4F_{3½}—4p^1\ y\ {}^4F^o_{3½}$
280	3433. 04	I	5076–34196	$4s^1\ b\ {}^4F_{1½}—4p^1\ y\ {}^4F^o_{1½}$

Cobalt — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	2174.60	I	0–45971
3.0	2245.13	II	4029–48556
1.6	2268.17	I	4143–48217
1.6	2274.49	I	0–43952
5	2276.53	I	
1.6	2283.52	II	4029–47807
1.6	2284.85	I	816–44568
26	2286.16	II	3350–47078
5	2287.81	I	4143–47839
1.6	2291.46	I	4690–48317
2.0	2292.00	II	17772–61388
2.0	2293.39	II	4561–48151
2.0	2295.23	I	0–43555
1.6	2296.05	I	5076–48616
3.5	2296.71	I	4690–48217
1.6	2303.97	I	3483–46873
2.5	2304.18	I	816–44202
3.0	2305.18	I	816–44183
24	2307.86	II	4029–47346
24	2309.02	I	0–43295
16	2311.60	II	4561–47807
16	2314.05	II	4950–48151
13	2314.98	II	5204–48388
4	2316.16	I	1407–44568
5	2316.86	I	1407–44556
24	2323.14	I	816–43848
8	2324.32	II	4029–47039
6	2325.55	I	1407–44394
8	2326.14	II	4561–47537
8	2326.48	II	3350–46321
1.6	2329.10	II	18338–61260
6	2330.35	II	4950–47848
16	2335.99	I	1407–44202
8	2337.94	II	
20	2338.67	I	1809–44556
6	2339.05	I	816–43555
8	2344.26	II	5204–47848
8	2346.16	I	816–43426
12	2347.39	II	4950–47537
2.5	2350.28	I	4690–47225
2.0	2351.39	I	1407–43922
22	2352.85	I	3483–45971
30	2353.42	I	816–43295
		II	4561–47039
9	2355.48	I	1407–43848
8	2358.18	I	1809–44202
1.6	2361.53	II	5204–47537
30	2363.79	II	4029–46321
15	2365.07	I	0–42269
6	2369.68	I	4143–46330
4	2370.51	I	816–42988
3.0 h	2371.44	I	17234–59389
6	2371.86	I	1407–43555
1.6	2372.83	I	1407–43538
2.5	2373.38	I	
3.0	2375.18	II	4950–47039
4	2377.22	I	5076–47129
38	2378.62	II	3350–45379
28	2380.48	I	816–42811
3.0	2381.75	II	
36	2383.46	II	4029–45972
28	2384.86	I	0–41918
20	2386.36	II	4561–46453
3.0	2387.46	I	4690–46563
70	2388.92	II	3350–45198
14	2389.54	II	4950–46786
3.5	2391.37	I	
5	2392.60	II	
5	2393.90	II	4561–46321
3.0 h	2397.03	I	
14	2397.39	II	9813–51512
1.4	2400.84	I	4690–46330
28 d	2402.06	I	816–42434
	2402.17	I	1809–43426
10	2404.17	II	5204–46786
3.0	2406.27	I	4143–45688
140	2407.25	I	0–41529
7	2407.67	II	10708–52230
8	2408.75	II	4950–46453
6	2410.51	I	14036–55509
140	2411.62	I	816–42269
42	2412.76	I	1809–43243
3.0	2413.19	I	5076–46502
3.0	2413.58	I	14399–55819
14	2414.06	II	4561–45972
140	2414.46	I	1407–42811
140	2415.30	I	1809–43200
4	2416.90	II	11322–52684
4	2417.05	I	
28	2417.65	II	4029–45379
20	2419.12	I	
3.5	2420.73	II	
6	2422.56	I	13796–55061
3.5	2423.62	II	5204–46453
130	2424.93	I	0–41226
2.0	2425.59	I	4690–45905
5	2427.00	I	
3.5	2428.29	II	4029–45198
13	2428.60	I	
3.5	2429.23	I	816–41969

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
120		2432.21	I	816–41918
26		2435.09	I	
25		2435.83	I	0–41041
100		2436.66	I	1407–42434
2.5		2436.98	II	4950–45972
90		2439.05	I	1809–42797
20		2441.05	I	17234–58187
2.5		2449.16	II	4561–45379
4		2450.00	II	10708–51512
10		2456.24	I	3483–44183
1.2		2460.21	I	15184–55819
20		2460.81	I	1809–42434
2.5		2462.12	I	13796–54399
3.5		2463.78	I	1407–41983
3.5		2464.20	II	9813–50382
2.0		2464.62	I	1407–41969
12		2467.69	I	1407–41918
20		2470.28	I	3483–43952
5		2473.90	I	816–41226
20		2476.64	I	3483–43848
18		2483.61	I	4143–44394
1.2		2485.36	II	9813–50036
4		2486.44	II	10708–50914
3.0		2493.93	I	8461–48546
5		2494.73	I	3483–43555
16		2495.55	I	4143–44202
16		2496.71	I	4143–44183
1.2	h	2500.50	I	
1.2		2502.28	I	7442–47394
24		2504.52	I	3483–43399
24		2506.46	II	9813–49698
15		2506.88	I	4690–44568
12		2507.68	I	4690–44556
90		2511.02	I	3483–43295
1.2		2512.40	II	24075–63865
4		2512.90	I	7442–47225
5		2513.12	I	4143–43922
36		2517.87	I	4690–44394
12		2519.82	II	10708–50382
180		2521.36	I	0–39649
12		2524.96	II	11322–50914
48		2528.62	II	9813–49348
120		2528.97	I	816–40346
30		2530.13	I	4690–44202
36		2532.18	I	5076–44556
2.5		2535.36	I	7442–46873
120		2535.96	I	1407–40828
36		2536.49	I	4143–43555
8		2541.94	II	10708–50036
90		2544.25	I	1809–41102
10		2544.86	I	4143–43426
1.2		2546.74	II	24412–63665
18		2548.34	I	7442–46672
12		2549.30	I	1407–40622
12		2553.00	I	4690–43848
16		2553.37	I	4143–43295
16		2555.07	I	5076–44202
10		2556.76	I	4143–43243
12		2559.41	II	11322–50382
50		2562.15	I	1809–40828
16		2564.04	II	10708–49698
60		2567.35	I	1407–40346
5		2572.24	I	4690–43555
3.5		2573.40	I	4690–43538
4.0		2573.54	I	4143–42988
50		2574.35	I	816–39649
1.8		2574.86	II	13405–52230
1.8		2575.73	I	1809–40622
40		2580.33	II	9813–48556
6		2580.84	I	4690–43426
16		2582.24	II	11322–50036
6		2585.34	I	8461–47129
16		2587.22	II	10708–49348
8		2590.59	I	7442–46032
6		2591.69	I	4690–43264
4		2594.16	I	1809–40346
3.0		2600.98	I	3483–41918
5		2606.12	I	5076–43436
2.0		2610.76	I	4143–42434
5		2613.49	I, II	
4		2614.13	I	1407–39649
8		2614.36	II	17772–56011
6		2616.26	I	8461–46672
4		2617.86	I	5076–43264
5		2622.06	I	4143–42269
5		2622.43	I	4690–42811
14		2627.64	I	3483–41529
7		2632.24	II	18032–56011
3.0		2644.78	I	8461–46260
16		2646.42	I	4143–41918
40		2648.64	I	3483–41226
4		2649.94	I	8461–46186
5		2650.27	I	5076–42797
8		2663.53	II	9813–47346
6		2675.98	I	5076–42434
6		2679.76	I	8461–45767
9		2685.34	I	4690–41918
3.0		2694.68	II	10708–47807
10		2695.85	I	4143–41226
3.0		2705.85	I	13796–50742

Cobalt — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	2715.99	I	16468–53276
7	2731.12	I	16471–53075
12	2740.46	I	7442–43922
10	2745.10	I	16778–53196
5	2761.37	I	4143–40346
10	2764.19	I	3483–39649
7	2766.22	I	17234–53374
7	2778.82	I	15184–51160
2.0	2796.23	I	5076–40828
3.0	2797.08	I	8461–44202
5	2803.77	I	4690–40346
8	2815.56	I	4143–39649
1.2	2820.01	I	8461–43911
4	2837.15	I	16778–52014
3.0	2850.04	I	8461–43538
4	2862.61	I	1407–36330
1.4	2872.50	I	8461–43264
10	2886.44	I	816–35451
3.0	2899.82	I	16471–50945
1.4	2903.20	I	16468–50903
5	2927.67	I	16778–50925
1.6	2928.81	I	0–34134
5	2929.51	I	16468–50593
1.4	2957.68	I	16778–50579
36	2987.16	I	0–33467
36	2989.59	I	0–33440
1.6	2995.15	I	17234–50611
6	3000.55	I	816–34134
17	3013.60	I	0–33173
36	3017.55	I	816–33946
6	3026.37	I	15184–48217
3.0	3034.43	I	1407–34352
11	3042.48	I	816–33674
160	3044.00	I	0–32842
22	3048.89	I	1407–34196
6	3060.05	I	15774–48444
90	3061.82	I	816–33467
2.5	3062.20	I	816–33463
3.5	3064.37	I	816–33440
48	3072.34	I	1407–33946
34	3082.62	I	0–32431
42	3086.78	I	1809–34196
17	3089.60	I	816–33173
14	3098.20	I	1407–33674
17	3121.42	I	0–32028
6	3121.57	I	816–32842
22	3137.33	I	1809–33674
17	3139.94	I	816–32654
26	3147.06	I	1407–33173
6	3152.71	I	16196–47905
26 d	3154.68	I	16471–48160
	3154.79	I	15184–46873
22	3158.78	I	816–32465
8	3177.27	I	
8	3188.37	I	15774–47129
6	3219.15	I	816–31871
8	3232.87	I	16471–47394
14	3243.84	I	15184–46003
16	3247.18	I	15184–45971
24	3254.21	I	15184–45905
16	3260.82	I	16471–47129
8	3271.78	I	15774–46330
32	3283.46	I	16778–47225
5	3287.19	I	15774–46186
8	3307.15	I	15774–46003
12	3314.08	I	14036–44202
15	3319.48	I	23612–53728
15	3322.20	I	16471–46563
12	3325.24	I	16196–46260
22	3326.99	I	23612–53660
44	3334.14	I	3483–33467
12	3339.78	I	23856–53789
10	3342.73	I	16778–46685
12	3346.94	I	23856–53725
7	3348.11	I	16471–46330
38	3354.38	I	4143–33946
7	3361.56	I	24628–54367
7	3362.80	I	24628–54356
36	3367.11	I	3483–33173
7	3370.33	I	4690–34352
7	3373.23	I	18390–48026
60	3385.22	I	4143–33674
70	3388.17	I	4690–34196
140	3395.38	I	4690–34134
700	3405.12	I	3483–32842
280	3409.18	I	4143–33467
420	3412.34	I	4143–33440
140	3412.63	I	0–29295
32	3414.74	I	5076–34352
170	3417.16	I	4690–33946
14	3424.51	I	16778–45971
5	3428.23	I	24628–53789
160	3431.58	I	816–29949
280	3433.04	I	5076–34196
5	3438.91	I	26450–55521
100	3442.93	I	1407–30444
550	3443.64	I	4143–33173
7	3446.09	I	25938–54948
260	3449.17	I	4690–33674
130	3449.44	I	3483–32465

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1300	3453.50	I	3483–32431
65	3455.23	I	1809–30743
7	3456.93	I	816–29735
19	3461.18	I	25569–54452
320	3462.80	I	5076–33946
320	3465.80	I	0–28845
6	3471.38	I	25569–54367
500	3474.02	I	0–28777
			4690–33467
4	3478.56	I	18390–47129
6	3483.41	I	4143–32842
24	3485.37	I	25139–53822
300	3489.40	I	7442–36092
6	3490.74	I	
30	3491.32	I	1809–30444
150	3495.69	I	5076–33674
30	3496.68	I	4143–32733
600	3502.28	I	3483–32028
36	3502.62	I	1407–29949
440	3506.32	I	4143–32654
180	3509.84	I	4690–33173
90	3510.43	I	816–29295
300	3512.64	I	4690–33151
240	3513.48	I	816–29270
300	3518.35	I	8461–36875
20	3520.08	I	816–29216
170	3521.57	I	3483–31871
240	3523.43	I	5076–33449
400	3526.85	I	0–28346
170	3529.03	I	1407–29735
460	3529.81	I	4143–32465
120	3533.36	I	1809–30103
17	3543.26	I	15184–43399
6	3548.44	I	13796–41969
34	3550.60	I	1407–29563
6	3552.99	I	15774–43911
6	3558.78	I	4690–32782
70	3560.89	I	5076–33151
55	3564.95	I	4690–32733
550	3569.38	I	7442–35451
100	3574.96	I	4690–32654
160	3575.36	I	816–28777
3	3578.08	I	18390–46330
3 d	3578.90	I	14036–41970
	3579.03	I	14036–41969
65	3585.16	I	4143–32028
420	3587.19	I	8461–36330
120	3594.87	I	1407–29216
100	3602.08	I	1809–29563
50	3605.36	I	4143–31871
11	3611.70	I	18775–46455
4	3615.39	I	15774–43426
2.5	3620.43	I	18390–46003
2.0	3624.33	I	14399–41983
4	3624.96	I	5076–32654
55	3627.81	I	4143–31700
8	3631.39	I	816–28346
7	3632.84	I	23184–50703
8	3634.71	I	23208–50712
4	3636.72	I	15774–43264
11	3639.44	I	15774–43243
7	3641.79	I	16471–43922
8	3643.18	I	16471–43911
6	3647.66	I	1809–29216
10	3649.35	I	23184–50579
8	3652.54	I	1407–28777
3.5	3654.45	I	15774–43130
3.0	3656.97	I	4690–32028
15	3662.16	I	18390–45688
14	3676.55	I	23184–50376
20	3683.05	I	16778–43922
4	3684.48	I	16778–43911
3.5	3690.72	I	16468–43555
12	3693.11	I	16778–43848
12	3693.48	I	16471–43538
15	3702.24	I	23208–50211
36	3704.06	I	8461–35451
3.0	3707.47	I	16471–43436
12	3708.82	I	16471–43426
2.5	3712.18	I	16468–43399
1.2	3726.66	I	13796–40622
15	3730.48	I	15184–41983
20	3732.40	I	15184–41969
10	3733.49	I	16778–43555
5	3734.14	I	16471–43243
8	3735.93	I	16778–43538
12	3745.50	I	7442–34134
6	3749.94	I	16471–43130
2.5	3751.63	I	16778–43426
2.0	3754.35	I	20501–47129
6	3755.45	I	16778–43399
1.4	3760.39	I	14036–40622
3.0	3774.60	I	16778–43264
1.6	3777.54	I	16778–43243
3.0	3808.11	I	3483–29735
3.0	3814.46	I	15774–41983
6	3816.33	I	15774–41970
5	3816.47	I	15774–41969
2.5	3841.46	I	7442–33467
60	3842.05	I	7442–33463

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
300	3845.47	I	7442–33440
28	3861.16	I	8461–34352
240	3873.12	I	3483–29295
120	3873.96	I	4143–29949
12	3876.84	I	3483–29270
34	3881.87	I	4690–30444
5	3884.62	I	8461–34196
2.5	3885.29	I	7442–33173
1.2	3892.12	I	20501–46186
1.2 h	3893.07	I	18775–44455
340	3894.08	I	8461–34134
24	3894.98	I	5076–30743
1.2	3898.49	I	15184–40828
1.2 h	3904.05	I	28845–54452
6	3906.29	I	4143–29735
7	3909.93	I	0–25569
6	3917.11	I	18390–43911
3.5	3922.75	I	8461–33946
1.4	3925.16	I	21216–46685
1.2 h	3929.25	I	28346–53789
1.4	3933.91	I	4690–30103
65	3935.97	I	7442–32842
7	3940.89	I	5076–30444
11	3941.73	I	3483–28845
9	3945.33	I	7442–32782
2.0	3952.33	I	3483–28777
16	3952.92	I	7442–32733
9	3957.94	I	4690–29949
2.0	3961.00	I	21216–46455
4.5	3969.12	I	20501–45688
3.5	3972.53	I	28346–53512
4	3973.15	I	15184–40346
4	3974.73	I	4143–29295
1.2	3977.18	I	18775–43911
6	3978.66	I	4143–29270
5	3979.52	I	816–25938
2.0	3987.12	I	4143–29216
3.0	3990.30	I	15774–40828
3.0	3991.54	I	29270–54316
3.0	3991.69	I	4690–29735
2.0	3994.54	I	5076–30103
260	3995.31	I	7442–32465
42	3997.91	I	8461–33467
3.0	4013.94	I	16196–41102
1.0	4019.30	I	4690–29563
15	4020.90	I	3483–28346
1.0	4023.40	I	15774–40622
3.0	4027.04	I	1407–26232
4 h	4035.55	I	28845–53618
16	4045.39	I	8461–33173
2.5	4052.92	I	28845–53512
1.2	4057.20	I	1809–26450
3.5	4058.19	I	4143–28777
3.5	4058.60	I	16196–40828
15	4066.37	I	7442–32028
6	4068.54	I	15774–40346
12	4086.31	I	15184–39649
36	4092.39	I	7442–31871
1.4	4104.75	I	18775–43130
24	4110.54	I	8461–32782
120	4118.77	I	8461–32733
190	4121.32	I	7442–31700
1.2	4158.42	I	23184–47225
2.0 h	4162.17	I	28845–52864
1.2	4187.25	I	16471–40346
4	4190.71	I	0–23856
1.0	4234.00	I	0–23612
2.5	4252.31	I	816–24326
1.0	4285.79	I	1407–24733
1.0	4331.24	I	27497–50579
2.0	4339.62	I	20501–43538
1.0	4371.13	I	16778–39649
1.0 h	4373.63	I	28346–51204
0.8	4391.57	I	24326–47091
1.0	4417.40	I	24733–47365
0.8	4421.34	I	23612–46223
0.7	4431.62	I	23208–45767
0.8	4445.72	I	25041–47528
2.5	4466.89	I	24326–46707
4	4469.56	I	23856–46223
1.6	4471.55	I	24733–47091
0.9	4478.32	I	25041–47365
0.8	4483.93	I	25233–47528
0.7	4494.76	I	28471–50712
1.6	4517.11	I	25233–47365
10	4530.96	I	23612–45676
3.0	4533.99	I	25041–47091
2.5	4543.81	I	21920–43922
4	4549.66	I	24733–46707
6	4565.59	I	24326–46223
0.7 h	4570.02	I	29295–51170
0.7	4580.14	I	7442–29270
8	4581.60	I	23856–45676
1.6 h	4594.63	I	29295–51053
1.6 h	4596.90	I	29295–51042
0.6	4623.04	I	25740–47365
0.8 h	4625.78	I	29949–51561
5	4629.38	I	24628–46223
7	4663.41	I	25269–46707
4	4682.38	I	25740–47091

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.5		4693.21	I	26063–47365
0.9		4698.38	I	26250–47528
0.7		4727.94	I	3483–24628
0.6		4734.83	I	26250–47365
4		4749.68	I	24628–45676
0.7		4754.36	I	26063–47091
0.9		4768.08	I	25740–46707
3.0		4771.11	I	25269–46223
3.0		4776.32	I	26598–47528
4		4780.01	I	26450–47365
9		4792.86	I	26232–47091
6		4813.48	I	25938–46707
8		4840.27	I	25569–46223
0.9		4843.46	I	26450–47091
17		4867.88	I	25139–45676
1.6		4882.72	I	26232–46707
1.2		4899.52	I	16471–36875
1.2		5108.89	I	31700–51268
2.0		5122.77	I	29563–49078
1.6		5125.69	I	31700–51204
2.0		5126.20	I	29216–48719
2.0		5133.45	I	31700–51174
4		5146.74	I	28777–48202
2.0		5154.05	I	31871–51268
2.0		5156.34	I	32733–52121
2.5		5176.08	I	16778–36092
6		5212.71	I	28346–47524
6		5230.22	I	14036–33151
5		5235.21	I	17234–36330
6		5247.93	I	14399–33449
1.2		5250.00	I	33674–52717
1.0		5254.65	I	32028–51053
2.0		5257.62	I	32028–51042
1.0		5265.82	I	29216–48202
3.0		5266.30	I	29735–48719
5		5266.49	I	16468–35451
3.0		5268.52	I	30103–49078
2.0	h	5276.19	I	33173–52121
5	h	5280.65	I	29270–48202
1.0		5283.49	I	33173–52095
0.8		5287.57	I	29295–48202
0.9		5287.81	I	32654–51561
3.0		5301.06	I	13796–32654
0.5		5310.20	I	33946–52772
2.0	h	5312.66	I	33946–52764
1.2		5316.78	I	32465–51268
0.4		5321.72	I	33674–52460
1.8	h	5325.28	I	32431–51202
0.6		5325.95	I	33946–52717
2.5		5331.47	I	14399–33151
0.9		5332.67	I	28777–47524
0.9		5333.65	I	32431–51174
0.9		5334.84	I	32431–51170
1.4	h	5341.33	I	33440–52156
6		5342.71	I	32431–51143
3.0		5343.39	I	32465–51174
0.8		5347.49	I	33467–52162
0.8		5349.09	I	33467–52156
6		5352.05	I	28845–47524
3.0		5353.48	I	33440–52114
1.6		5359.18	I	33467–52121
2.5	h	5362.77	I	34134–52775
4		5369.58	I	14036–32654
0.7		5381.10	I	15774–34352
1.0	h	5381.75	I	34196–52772
1.6	h	5407.51	I	33674–52162
0.8	h	5436.99	I	33173–51561
2.5	h	5444.57	I	32842–51204
0.8		5452.30	I	30743–49078
2.0	h	5454.56	I	32842–51170
0.8		5469.30	I	15184–33463
1.0		5470.46	I	30444–48719
1.0		5477.08	I	29949–48202
5		5483.34	I	13796–32028
1.0		5483.96	I	29295–47524
0.9	h	5489.65	I	32842–51053
0.5		5495.67	I	27497–45688
1.4		5523.29	I	18775–36875
0.8	h	5524.98	I	33173–51268
2.0		5530.77	I	13796–31871
0.4		5558.82	I	28471–46455
1.8		5590.73	I	16471–34352
0.7	h	5636.12	I	33463–51201
2.0		5647.22	I	18390–36092
0.4		5659.11	I	16468–34134
0.5		5830.08	I	28777–45925
1.4		5890.48	I	16468–33440
1.4		5915.54	I	17234–34134
0.7		5935.39	I	15184–32028
0.6		5946.49	I	29563–46375
0.8	h	5984.08	I	14036–30743
2.0		5991.88	I	16778–33463
1.0		6000.67	I	29216–45877
0.7	h	6006.36	I	35451–52095
0.7	h	6007.67	I	36330–52971
0.7	h	6049.10	I	36330–52857
2.0		6082.44	I	28346–44782
0.8		6086.65	I	27497–43922
1.4		6093.13	I	14036–30444
1.0		6116.98	I	14399–30743

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.0	6122.65	I	28777–45106
1.4	6189.00	I	13796–29949
0.8	6230.97	I	14399–30444
1.0	6249.51	I	16468–32465
0.7 h	6257.58	I	29949–45925
0.6	6273.03	I	32782–48719
2.0	6282.63	I	14036–29949
0.7	6320.41	I	35451–51268
0.7 h	6347.83	I	35451–51200
0.6	6395.20	I	30743–46375
1.0	6417.82	I	18775–34352
0.6	6429.91	I	17234–32782
5	6450.24	I	13796–29295
2.5	6455.00	I	29295–44782
0.9 h	6477.88	I	30444–45877
0.7 h	6490.34	I	16468–31871
0.4	6551.44	I	15184–30444
1.8	6563.42	I	16468–31700
0.8	6595.90	I	29949–45106
1.8	6632.44	I	18390–33463
0.6	6678.81	I	15774–30743
2.0	6771.06	I	15184–29949
2.5	6814.94	I	15774–30444
2.5	6872.40	I	16196–30743
0.5	6937.81	I	21920–36330
2.0	7016.61	I	16196–30444
0.9	7027.81	I	31700–45925
5	7052.89	I	15774–29949
1.2	7054.04	I	21920–36092
11	7084.99	I	15184–29295
0.9	7113.56	I	31871–45925
0.8	7134.32	I	32733–46746
1.0	7154.71	I	16471–30444
1.0	7159.18	I	32782–46746
0.5	7193.60	I	32028–45925
0.7	7285.28	I	23153–36875
0.8	7354.59	I	15184–28777
1.2	7388.70	I	21920–35451
1.8	7417.38	I	16471–29949
1.2	7457.36	I	31700–45106
0.4	7533.48	I	32654–45925
1.0	7553.99	I	31871–45106
0.3	7564.96	I	39649–52864
0.5	7586.72	I	23153–36330
0.4 h	7590.57	I	16778–29949
0.8 h	7606.30	I	32782–45925
0.8 h	7610.24	I	21216–34352
1.8	7712.68	I	20501–33463
0.5	7734.23	I	33449–46375
0.4	7743.27	I	31871–44782
1.2	7838.17	I	32028–44782
0.5	7840.05	I	33173–45925
0.4	7855.85	I	33151–45877
0.3	7869.90	I	33173–45877
0.3	7871.39	I	33674–46375
1.6	7908.71	I	32465–45106
0.6	7926.55	I	34134–46746
2.0	7987.38	I	16778–29295
3.0	8007.27	I	33440–45925
0.6	8022.13	I	33463–45925
0.8	8029.26	I	32654–45106
1.2	8043.33	I	33946–46375
1.4	8056.06	I	33467–45877
0.3	8066.49	I	34352–46746
2.0	8093.96	I	32431–44782
0.4	8116.41	I	32465–44782
0.3	8152.11	I	32842–45106
1.0	8193.03	I	33674–45877
0.8	8208.66	I	34196–46375
2.0	8372.84	I	32842–44782
0.7	8378.39	I	33173–45106
0.4 h	8574.57	I	21780–33440
1.0	8575.35	I	22475–34134
0.3	8586.74	I	33463–45106
0.8	8589.73	I	33467–45106
0.4	8661.09	I	21920–33463
0.7	8819.15	I	41529–52864

COPPER

Cu, $Z=29$, $M=63.54$, Ratio $\frac{Cu}{Cu}=1.000$

Cu I Normal state of valence electrons $3d^{10}\,4s^1\,{}^2S_{0\frac{1}{2}}=0$. I.P.= 62317 K
Cu II Normal state of valence electrons $3d^{10}\quad {}^1S_0=0$. I.P.=163666 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
Classification:
Cu I, A. G. Shenstone, Phil. Trans. Roy. Soc. (London) **[A] 241,** 297 (1948).
Cu II, A. G. Shenstone, Phil. Trans. Roy. Soc. (London) **[A] 235,** 195 (1936).
Intensities:
R. B. King and D. C. Stockbarger, Astrophys. J. **91,** 488 (1940).
G. D. Bell, M. H. Davis, R. B. King, and P. M. Routly, Astrophys. J. **127,** 775 (1958).

Relative intensity of copper lines observed in an arc of silver containing 0.1 atomic percent of copper

Strong lines of copper

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
5000	3247.54	I	0–30784	$3d^{10}4s^1\,{}^2S_{0\frac{1}{2}}$—$3d^{10}4p^1\,{}^2P^{\circ}_{1\frac{1}{2}}$
2500	3273.96	I	0–30535	$3d^{10}4s^1\,{}^2S_{0\frac{1}{2}}$—$3d^{10}4p^1\,{}^2P^{\circ}_{0\frac{1}{2}}$

Copper — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	1999.69	II	21929–71920	24	2961.16	I	11203–44963
2.0	2024.34	I	0–49383	4	2997.36	I	13245–46598
1.5	2035.84	II	23998–73102	7	3010.84	I	11203–44406
2.0	2037.12	II	22847–71920	6	3036.10	I	13245–46173
4	2043.79	II	21929–70842	4	3063.41	I	13245–45879
1.5	2112.09	II	26265–73596	2.5	3093.99	I	11203–43514
6	2135.98	II	21929–68731	8	3194.10	I	13245–44544
2.0	2138.53	I	11203–57949	2.5	3208.23	I	13245–44406
6	2165.09	I	0–46173	5000	3247.54	I	0–30784
8	2178.94	I	0–45879	2500	3273.96	I	0–30535
6	2181.72	I	0–45821	4	3279.82	I	13245–43726
2.0	2192.26	II	22847–68448	8	3307.95	I	40909–71131
10 d	2199.58	I	11203–56651	7	3337.84	I	11203–41153
	2199.75	I	13245–58691	3.5	3599.13	I	43514–71291
4	2214.58	I	11203–56344	3.5	3602.03	I	43514–71268
3.5	2225.70	I	0–44916	2.0 h	4022.63	I	30535–55388
8	2227.78	I	13245–58119	4	4275.11	I	39019–62403
10	2230.08	I	11203–56030	2.0	4530.78	I	30784–52849
4	2247.00	II	21929–66419	8	4651.12	I	40909–62403
5	2293.84	I	11203–54784	40	5105.54	I	11203–30784
2.0	2369.89	II	26265–68448	20	5153.24	I	30535–49935
6	2441.64	I	0–40944	100	5218.20	I	30784–49942
36	2492.15	I	0–40114	16	5220.07	I	30784–49935
40	2618.37	I	11203–49383	4 h	5292.52	I	43514–62403
5	2700.96	II	73353–110366	10	5700.24	I	13245–30784
8	2766.37	I	13245–49383	40	5782.13	I	13245–30535
50	2824.37	I	11203–46598	20	7933.13	I	30535–43137
5	2882.93	I	11203–45879	40	8092.63	I	30784–43137

DYSPROSIUM

Dy, $Z=66$, $M=162.51$, Ratio $\frac{Dy}{Cu}=2.558$

Dy I Normal state of valence electrons $4f^{10}\ 6s^2\ {}^5I_8 = 0$. I.P. ≈ 50000 K

Dy II Normal state of valence electrons $4f^{10}\ 6s^1\ {}^6I_{8\frac{1}{2}} = 0$.

References

Wavelengths:

Below 5500 A:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945).

Supplemented by:

G. Eberhard, Publ. Astrophys. Observatory Potsdam **20,** Teil 3, 1 (1909).

J. M. Eder, Wien Ber. **127,** IIa, 1099 (1918).

A. S. King, Astrophys. J. **72,** 221 (1930).

A. S. King and C. E. Moore, Astrophys. J. **98,** 33 (1943).

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Above 5500 A:

C. C. Kiess, Sci. Papers BS **18,** 695 (1923).

Spectrum Assignments:

A. S. King, Astrophys. J. **72,** 221 (1930).

A. S. King and C. E. Moore, Astrophys. J. **98,** 33 (1943).

A. S. King, unpublished material.

Supplemented by assignments from our plates.

Classification:

Dy II, C. H. Corliss and E. L. R. Corliss, unpublished material cited by W. F. Meggers, J. Opt. Soc. Am. **36,** 431 (1946).

Molecular Spectra:

DyO, G. Piccardi, Spectrochim. Acta **1,** 532 (1941).

Relative intensity of dysprosium lines observed in an arc of copper containing 0.1 atomic percent of dysprosium

Strong lines of dysprosium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	3531.70	II	0–28307	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$—$4f^{10}6p^1\ {}^6K^0_{9\frac{1}{2}}$
1300	4211.72	I		
1100	3968.42	II	0–25192	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $25192^0_{7\frac{1}{2}}$
1000	3645.41	II	828–28252	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $28252^0_{8\frac{1}{2}}$
1000	4045.99	I		
950	4186.78	I		
850	3944.70	II	0–25343	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $25343^0_{8\frac{1}{2}}$
650	4000.48	II	828–25818	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $25818^0_{8\frac{1}{2}}$
600	3872.13	II	0–25818	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $25818^0_{8\frac{1}{2}}$
600	4077.98	II	828–25343	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $25343^0_{8\frac{1}{2}}$
550	4194.85	I		
500	3536.03	II		
500	3898.54	II	4756–30399	$4f^{10}6s^1\ {}^4I_{6\frac{1}{2}}$— $30399^0_{7\frac{1}{2}}$
480	3385.03	II		
480	3407.79	II	0–29336	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $29336^0_{8\frac{1}{2}}$
460	4167.99	I		
400	3460.97	II	0–28885	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $28885^0_{7\frac{1}{2}}$
400	3494.49	II	828–29437	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $29437^0_{7\frac{1}{2}}$
400	3523.98	II	4341–32710	$4f^{10}6s^1\ {}^6I_{7\frac{1}{2}}$— $32710^0_{7\frac{1}{2}}$
400	3534.96	II	828–29109	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $29109^0_{7\frac{1}{2}}$
400	3538.50	II	0–28252	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $28252^0_{8\frac{1}{2}}$
400	3550.22	II		
400	3576.25	II	4756–32710	$4f^{10}6s^1\ {}^4I_{6\frac{1}{2}}$— $32710^0_{7\frac{1}{2}}$
400	3694.81	II	828–27886	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $27886^0_{7\frac{1}{2}}$
400	3757.37	II	828–27435	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $27435^0_{7\frac{1}{2}}$
360	3630.25	II		
360	4218.09	I		
360	4221.10	I		
340	3393.59	II	828–30287	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $30287^0_{6\frac{1}{2}}$
340	3445.58	II	0–29014	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $29014^0_{8\frac{1}{2}}$
320	4103.34	II	828–25192	$4f^{10}6s^1\ {}^4I_{7\frac{1}{2}}$— $25192^0_{7\frac{1}{2}}$
300	3585.08	II	0–27886	$4f^{10}6s^1\ {}^6I_{8\frac{1}{2}}$— $27886^0_{7\frac{1}{2}}$
300	4215.15	I		
280	3786.21	II		

Dysprosium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2356.91	II	
1.6	2381.95		
3.5	2387.36	II	
4	2392.15		
6	2402.29	II	
8	2410.01	II	
6	2422.75	II	
13	2439.82	II	
5	2455.16	II	
6	2460.00	II	
5	2471.41	II	
6	2480.92	II	
9	2490.62	II	
5	2510.32	II	
9	2513.57	II	
9	2517.60	II	
7	2543.83	II	
5	2545.13	II	
8	2552.31	II	
10	2557.94	II	
5	2560.19	II	
5	2566.25	II	
12	2585.30	I	
5	2591.51	II	
4	2592.54	II	
7	2600.18	II	
7	2600.78	II	
4	2608.67	II	
20	2623.70	I	
24	2634.81	II	
6	2642.16	I	
6	2645.32	II	
6	2668.07	I	
4	2676.84	II	
3.5	2677.32	II	
6	2689.29	II	
6	2692.85	II	
4	2709.02	II	
4	2727.18	II	
6	2729.51	II	
4	2735.79	I	
3.0	2739.33	II	
6	2740.72	II	
16	2755.75	II	
4	2757.09	II	
5	2766.51	II	
5	2772.40	II	
8	2772.60	II	
3.0	2779.57	II	
4	2791.44	II	
9	2800.34	II	
8	2800.54	II	
8	2801.40	II	
6	2810.85	II	
3.5	2811.10	II	
6	2811.43	II	
4	2815.24	II	
22	2816.39	II	
10	2825.44	II	
4	2828.37	II	
3.5 d	2835.15	II	
	2835.33	II	
4	2837.00	II	
4	2837.61	II	
4	2842.05	II	
5	2848.94		
6	2856.42	II	
1.2	2857.00	II	
3.0	2857.12	II	
3.5	2859.73	II	
4	2860.17	II	
5	2860.65	II	
10	2862.70	I	
6	2866.28	II	
5	2867.61	II	
2.0	2869.82	II	
7	2876.41	II	
14	2877.88	II	
6	2878.72	II	
6	2881.08	II	
8	2884.29	II	
5	2884.83	II	
9	2885.51	II	
5	2890.46	II	
9	2890.75	II	
5	2891.03	II	
9	2900.83	II	
8	2904.69	II	
14	2906.39	II	
5	2909.36	II	
2.5	2909.72	II	
2.5	2909.89	II	
2.5	2913.73	II	
28	2913.96	II	
5	2918.65	II	
5	2927.08	II	
5	2930.99	II	
8	2934.31	II	
18	2934.52	II	
8	2941.05	II	

Dysprosium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	2944.56	II		7	3056.97	II	
6	2946.32	II		6	3059.48	II	
7	2946.77	II		8	3060.00	II	
11	2947.06	II		20	3060.65	II	
11	2947.22	II		9	3061.37	II	
18	2948.30	II		6	3061.51	II	
12	2950.32	II		8	3062.19	II	
8	2952.12	II		28	3062.62	II	
4	2953.03	II		16	3066.99	II	
10	2953.71	II		6	3070.44	II	
6	2957.75	II		24	3071.92	II	
6	2962.37	II		20	3073.55	II	
16	2964.63	I		4	3075.19	II	
4	2964.73	II		8	3076.90	II	
3.0	2975.57	II		10	3078.36	II	
6	2975.82	II		16	3078.69	II	
8	2977.42	II		11	3079.34	II	
3.5	2979.63	II		7	3080.92	II	
8	2985.93	II		10	3082.52	II	
2.5	2987.88	II		6	3084.66	II	
3.5	2988.71	II		9	3093.10	II	
5	2989.78	II		7	3093.80	II	
6	2991.35	II		9	3095.73	II	
5	2991.61	II		20	3101.91	II	
4	2992.41	II		16	3103.24	II	
3.5	2995.44	II		14	3103.84	II	
6	3002.38	II		13	3104.99	II	
8	3003.76	II	0−33382	30	3109.75	II	
4	3008.83	II		6	3110.75	II	
10	3015.06	II		3.5	3117.50	II	
16	3015.69	II		14	3120.17	II	
13	3016.97	II		12	3126.17	II	
12	3025.61	II		24	3128.39	II	
28	3026.16	II		60	3135.36	II	
6	3027.57	II		26	3140.63	II	
15	3029.83	II		36	3141.12	II	0−31826
8	3030.41	II		10	3142.29	II	
6	3031.18	II		7	3143.17	II	
7	3033.18	II		16	3143.81	II	
9	3036.70	II		10	3145.21	II	
44	3038.29	II		18	3146.15	II	
3.5	3042.08	II		9	3147.50	II	
20	3043.15	II		11	3151.88	II	
12	3043.45	II		9	3152.20	II	
5	3044.56	II		11	3152.35	II	
4	3046.38	II		9	3153.30	II	
15	3047.60	II		110	3156.51	II	
11	3049.14	II		6	3157.53	II	
13	3051.46	II		11	3160.50	II	
13	3052.32	II		10	3161.02	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
60		3162.81	II	
9	d	3164.05	II	
11		3167.42	II	
7	h	3167.77	II	
7		3168.10	II	
9		3168.92	I	
90		3169.97	II	
16		3170.73	II	
7		3170.92	II	
6		3171.38	II	
12		3174.88	II	
36		3177.87	II	
20		3178.35	II	
7		3181.92	II	
6		3183.19	II	
7	d	3184.19	II	
18		3184.77	II	828–32218
30		3186.37	II	
22		3187.67	II	
6		3188.66	II	
6		3192.98	II	
30		3193.31	II	0–31307
12		3205.46	II	
22		3206.39	II	
7		3206.62	II	
20		3207.10	II	
26		3208.81	II	
12		3212.03	II	
7		3212.43	II	
7		3212.67	II	
17		3214.63	II	
42		3215.19	II	
75		3216.62	II	
7		3217.36	II	
14		3220.45	II	
22		3221.50	II	
15		3221.62	II	
26		3223.29	II	
22		3225.08	II	828–31826
30		3225.98	II	
7		3226.05	II	
13		3226.38	II	
15		3228.97	II	
15		3229.36	II	
10		3229.95	II	
13		3232.64	II	
44		3235.89	II	
26		3236.64	II	
13		3240.88	II	
9	h	3243.78	II	
44		3245.16	II	
18		3248.37	II	
8		3250.99	II	
110		3251.28	II	
15		3251.90	II	
18		3252.20	II	
7		3253.91	II	
7		3254.47	II	
26		3256.26	II	
7		3257.35	II	
15		3260.01	II	
13		3260.70	II	
13		3261.22	II	
15		3266.00	II	
18		3266.21	II	
22		3269.12	II	
7		3272.08	II	
18		3272.74	II	
11		3275.89	II	
9		3279.49	II	
14		3279.67	II	
80		3280.08	II	828–31307
7		3281.63	II	
44		3282.79	II	
9		3282.89	II	
7		3284.37	II	
8		3286.58	II	
18		3287.97	II	
12		3288.65	II	
9		3291.12	II	
18		3293.83	II	
18		3296.31	II	
12		3297.62	II	
7		3300.90	II	
18		3305.40	II	
18		3305.51	II	
22		3306.19	II	
40		3308.79	II	
100		3308.88	II	
9		3310.97	II	
46		3312.72	II	
11		3313.30	II	
70		3316.34	II	
22		3317.11	II	
9		3318.15	II	
90		3319.88	II	0–30113
24		3326.18	II	
8	d	3326.43	II	
12		3327.08	II	
7		3327.30	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	3328.79	II	
9	3331.23	II	
12	3334.14	II	
6	3334.44	II	
17	3339.50	II	
70	3341.00	II	
12	3341.42	II	
24	3341.87	II	4341−34256
18	3347.81	II	
24	3352.70	II	
46	3353.59	II	
11	3355.07	II	
17	3356.22	II	
12	3358.26	II	
17	3358.61	II	
22	3359.48	II	
8	3360.64	II	
12	3365.80	II	
46	3368.10	II	
14	3370.86	II	
14	3371.69	II	
14	3371.81	II	
12	3372.75	II	
8	3374.28	II	
16	3375.75	II	
8	3376.01	II	
16	3376.36	II	
12	3376.62	II	
14	3377.11	II	
8	3378.20	II	
16	3378.42	II	
9	3378.88	II	
8	3381.56	II	
9 h	3384.10	II	
480	3385.03	II	
19	3386.59	II	
55	3388.87	II	4756−34256
9	3389.44	II	
13 d	3391.14	II	
19	3391.98	II	
8	3393.39	II	
340	3393.59	II	828−30287
13	3394.00	II	
120	3396.17	II	0−29437
8	3398.35	II	
8	3399.34	II	
10	3402.00	II	
13	3403.27	II	
10	3403.45	II	
19	3404.98	II	
24	3405.65	II	
10 h	3406.81	II	
34	3407.16	II	
480	3407.79	II	0−29336
38	3408.14	II	
9	3409.44	II	
13	3410.72	II	
10	3411.21	II	
10	3411.51	II	
120	3413.78	II	828−30113
48	3414.83	II	4341−33617
11	3415.68	II	
24	3417.15	II	
24	3418.13	II	
70	3419.63	II	
8	3420.81	II	
14	3421.32	II	
12	3422.58	II	
24	3422.86	II	
10	3423.25	II	
8 h	3423.82	II	
48	3425.06	II	
8	3425.35	II	
10 h	3429.01	II	
38	3429.45	II	
24	3431.79	II	
20	3432.57	II	
12	3432.86	II	
170	3434.37	II	0−29109
8	3435.27	II	
12	3435.92	II	
12	3436.07	II	
8	3436.95	II	
30	3438.96	II	
12	3439.32	II	
8	3440.45	II	
50	3440.94	II	
120	3441.45	II	828−29769
10 h	3442.52	II	
8	3443.46	II	
12	3444.26	II	
340	3445.58	II	0−29014
75	3447.00	II	
15	3447.27	II	
15	3447.78	II	
40	3449.90	II	
10	3450.22	II	
240	3454.35	II	
40	3454.52	II	
120	3456.57	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	3458.99	II	
20	3460.40	II	
10	3460.64	II	
400	3460.97	II	0–28885
8	3461.29	II	
17	3463.36	II	
18	3463.88	II	4756–33617
8	3467.86	II	
65	3468.44	II	
8	3468.78	II	
12	3470.18	II	
50	3471.14	II	
50 d	3471.53	II	
	3471.61	II	
34	3473.70	II	
20	3474.30	II	
120	3477.06	II	
8	3477.94	II	
8	3478.47	II	
8	3480.42	II	
20	3480.83	II	
10	3482.09	II	
20	3484.67	II	
17	3485.90	II	
12	3487.21	II	
15	3487.59	II	
10	3488.97	II	
12	3490.63	II	
20	3494.14	II	
400	3494.49	II	828–29437
50	3496.33	II	
8	3497.12	II	
36	3497.82	II	
75	3498.67	II	
20	3498.94	II	
13 d	3499.82	II	
	3499.92	II	
36	3501.45	II	
20	3501.86	II	
20	3502.09	II	
24	3503.18	II	
75	3504.52	II	
75	3505.45	II	
24	3505.84	II	
120	3506.81	II	828–29336
26	3511.69	II	
26	3512.56	II	
26	3512.70	II	
50	3517.27	II	
10	3519.76	II	
17	3521.13	II	
8	3522.28	II	
26	3522.86	II	
400	3523.98	II	4341–32710
15	3524.61	II	4341–32705
8	3524.92	II	
24	3525.75	II	
12	3526.61	II	
17	3526.92	II	
5	3528.93	II	
18	3529.02	II	
2000	3531.70	II	0–28307
13	3534.46	II	
400	3534.96	II	828–29109
500	3536.03	II	
26	3536.56	II	
26	3537.69	II	
400	3538.50	II	0–28252
36	3539.36	II	
10	3539.62	II	
14	3540.67	II	
150	3542.32	II	
8	3542.87	II	
36	3544.23	II	
36	3544.36	II	
130	3546.84	II	828–29014
10	3547.53	II	
8	3547.89		
30	3548.19	II	
13	3548.72	II	
12	3549.26	II	
400	3550.22	II	
17	3551.12	II	
200	3551.59	II	
8	3553.19	II	
12	3555.96	II	
10	3557.62	II	
40 h	3558.21	II	
40	3559.27	II	
26	3560.13	II	
200	3563.14	II	828–28885
50	3563.69	II	
20	3564.24	II	
8	3565.65	II	
18	3569.67	II	
9	3571.34	I	
8	3571.68	II	
70	3573.83	II	
130	3574.18	II	
10	3576.01	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
400	3576.25	II	4756–32710
8	3576.60	II	
150	3576.89	II	4756–32705
75	3577.98	II	
14	3579.12	II	
8	3579.42	II	
40	3580.03	II	
17	3582.01	II	
36	3584.43	II	
300	3585.08	II	0–27886
130	3585.77	II	
50	3586.11	II	4341–32218
32	3590.05	II	
26	3590.67	II	
100	3591.43	II	
50	3591.81	II	
50	3592.12	II	
9	3593.15	II	
20	3594.57		
160	3595.05	II	
14	3595.30	II	
36	3596.06	II	
9	3596.49	II	
20	3597.29	I	
10	3597.95	II	
10	3598.27	II	
10	3599.06	II	
9	3599.48	II	
16	3600.34	II	
50	3600.39	II	
32	3602.82	II	
13	3603.15	II	
8	3604.36	II	
160	3606.13	II	
9	3606.35	II	
12	3606.90	II	
10	3609.25	II	
10	3611.15	I	
26	3612.77	II	
20	3613.06	II	
26	3614.08	II	
9	3614.70		
9	3614.94		
12	3616.06	II	
10	3616.35	II	
12	3617.24	II	4341–31979
10	3617.65	II	
9	3617.74	II	
26	3618.08	II	
40	3618.45	II	
14	3619.47	II	
18	3619.96	II	
50	3620.18	II	
9	3620.56	II	
42	3624.25	II	
100	3629.43	II	
360	3630.25	II	
20	3630.47	II	
10	3630.64	II	
40	3632.79	II	
20	3633.03	II	
10	3633.77	II	
8	3634.15	II	
10	3634.32	II	
36	3635.26	II	
16	3636.22	II	
32	3637.27	II	4341–31826
20	3639.86	II	
100	3640.24	II	4756–32218
8	3640.80	II	
36	3643.89	II	0–27435
1000	3645.41	II	828–28252
32	3645.86	II	
16	3646.60	II	
14	3646.85	I	
16	3648.40	II	
90	3648.79	II	
10	3654.17	II	
12	3654.87	II	
10	3655.60	II	
14	3661.75	II	
60	3664.61	II	
16	3665.20	II	
34	3666.85	I	
13	3668.90	II	
13	3671.69	II	
85	3672.31	II	4756–31979
36	3672.66	II	
34	3673.15	II	0–27217
120	3674.09	II	
20	3674.45	II	
10	3676.00	II	
190	3676.56	II	
55	3678.48	I	
70	3684.83	I	
110	3685.81	I	
10	3688.36	II	
14	3693.84	I	
12	3694.41	II	
400	3694.81	II	828 -27886

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	3696.94	II	
32	3697.31	II	
85	3698.18	II	
20	3700.59	II	
46	3701.62	II	
28	3707.42	II	4341–31307
38	3707.57	II	
38	3708.20	II	
10	3708.36	II	
36	3710.08	II	
10	3710.73	II	
28	3711.65	II	
14	3713.84	II	
9	3715.27	II	
8	3715.54	II	
14	3716.93	II	
8	3717.29	I	
7	3718.10	II	
140	3724.42	II	4341–31183
8	3725.90	I	
26	3727.99	I	
10	3730.60	II	
80	3739.33	I	
9	3739.81	II	
100	3747.82	II	
11	3750.33	II	
14	3751.80	II	
120	3753.50	II	0–26634
120	3753.76	II	
8	3754.77	II	
100	3757.05	I	
400	3757.37	II	828–27435
8	3758.97	II	
55	3767.63	I	
28	3771.08	I	
8	3771.38	I	
14	3772.65	I	
55	3773.05	I	
20	3773.31	II	
6	3773.74	I	
32	3774.75	I	
8	3776.93	II	
19	3777.45	I	
8	3779.09	II	
13	3779.23	II	
8	3780.33	I	
8	3780.93	I	
36	3781.48	I	
16	3782.88	II	
13	3783.59	II	
13	3783.96	I	
28	3785.42	II	
280	3786.21	II	
10	3786.83	I	
11	3787.26	II	
140	3788.46	II	828–27217
60	3791.86	II	
10	3801.93	II	
44	3804.14	II	
10	3804.33	II	
50	3806.26	II	
9	3807.90		
24	3809.05	II	
18	3809.84		
15	3809.95		
40	3812.30	I	
14	3813.13		
40	3813.67	II	
20	3816.21		
120	3816.78	II	
16	3817.49		
10	3818.74		
10	3819.44		
8	3821.49		
9	3821.85		
24	3822.57	II	
8	3824.00		
60	3825.65	II	
16	3829.75		
8	3831.03		
18	3831.64	II	
13	3832.91		
200	3836.50	II	4341–30399
14	3838.67	II	
32	3840.91	I	
120	3841.32	II	
28	3842.02	I	
28	3844.30	I	
36	3846.33	II	
36	3846.99	I	
28	3849.38	II	
100	3853.03	II	4341–30287
36	3858.41	I	
18	3865.45	II	
32	3866.59	II	
8	3867.84	II	
48	3868.46	II	
140	3868.81	I	
26	3869.43	II	
70	3869.87	II	4341–30175

609065 O - 62 - 6

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	3871.64	II	
600	3872.13	II	0–25818
100	3874.00	II	828–26634
7	3875.15	II	
40	3879.10	II	4341–30113
26	3882.00	II	
9	3887.55	I	
16	3888.45	II	
16	3889.01	II	
24	3891.85	II	
24	3892.87	I	
7	3894.51	I	
14	3895.34	II	
500	3898.54	II	4756–30399
22	3899.15	I	
8	3901.35	I	
7	3903.30	I	
13	3904.21	II	
9	3905.56	II	
9	3905.95	I	
10	3912.52	I	
7	3912.86	II	
11	3913.62	I	
13	3913.98	II	
44	3914.86	II	4341–29878
44	3915.58	II	4756–30287
44 d	3917.30	I	
	3917.37	I	
9	3918.53	II	
11	3919.13	I	
26	3923.39	II	
9	3924.46	II	
34	3927.88	I	
11	3929.32	II	
44	3930.15	I	
15	3931.28	II	
170	3931.55	II	4341–29769
9	3932.05	II	
26	3932.22	II	
30	3932.97	II	4756–30175
26	3934.17	II	
13	3936.03	II	
7	3936.30	II	
34	3936.71	I	
11	3937.16	I	
22	3938.00	II	
17	3938.15	I	
44	3942.52	II	4756–30113
850	3944.70	II	0–25343
34	3946.92	II	
44	3950.40	II	
7	3953.13	II	
34	3954.56	II	
7	3956.24	I	
65	3957.79	II	
7	3959.35	II	
30	3962.58	I	
9	3963.16		
7	3963.80	II	
9	3966.39	I	
26	3967.50	I	
1100	3968.42	II	0–25192
13	3971.15	I	
7	3972.39	I	
13	3973.87	I	
220	3978.57	II	
22	3979.47	II	4756–29878
9	3981.37	I	
110	3981.92	II	
130	3983.67	II	4341–29437
65	3984.24	II	
7	3984.70	II	
7	3987.04	II	
10	3988.90	I	
6	3990.34	II	
44	3991.33	II	
14	3993.60	I	
7	3994.53	I	
7	3996.01	I	
130	3996.70	II	4756–29769
9	3998.08	II	
650	4000.48	II	828–25818
34	4005.86	I	
26	4006.09	I	
8	4007.75	II	
10	4010.08	II	
44	4011.32	II	
44	4013.80	I	
44	4014.72	II	
17	4015.18	II	
13	4020.88	II	
30	4023.70	I	
20	4024.45	II	
20	4024.87	I	
34	4027.79	II	
42 d	4028.32	II	
	4028.42	I	
7	4031.08	I	
42	4032.44	II	
13	4032.84	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
34	4033.67	II	
34	4036.34	II	4341–29109
20	4038.51	II	
15	4038.84	I	
26	4041.98	II	
1000	4045.99	I	
7	4047.73	I	
7	4048.35	II	
20	4048.90	I	
11	4049.35	I	
130	4050.58	II	4756–29437
20	4053.86	I	
42	4055.15	II	
10	4057.40	II	
7	4060.58	II	
8	4072.65	II	
200	4073.15	II	4341–28885
10	4074.02	II	
600	4077.98	II	828–25343
6	4079.27	I	
7	4083.10	I	
15	4085.14	I	
30	4085.36	I	
15	4087.22	II	
7	4087.38	I	
7	4089.49	I	
15	4091.53	II	
10	4091.77	II	
7	4093.66	I	
32	4096.12	I	
8	4096.69	I	
8	4099.87	I	
6	4101.94	II	
320	4103.34	II	828–25192
70	4103.88	I	
16	4105.05	II	4756–29109
6	4106.38	II	
120	4111.34	II	0–24316
10	4113.05	I	
16	4119.33	II	
40	4124.65	II	
12	4126.12	I	
32	4128.29	II	
28	4129.13	I	
80	4129.44	II	
28	4130.42	I	
10	4131.04	II	
6	4132.85	II	
14	4133.38	II	
32	4133.86	I	
20	4134.14	I	
8	4134.73	I	
12	4138.54	I	
10	4139.56	I	
38	4141.51	II	
100	4143.10	II	4756–28885
80	4146.07	I	
6	4147.95	I	
12 h	4152.43	II	
8	4153.11	I	
6	4154.23	I	
10	4159.34	I	
6	4160.24	I	
6	4162.25	I	
460	4167.99	I	
6	4169.24	II	
6	4170.55	I	
30	4171.93	I	
	4171.99	I	
11 d	4176.64	I	
	4176.81	I	
4	4181.25	I	
20	4183.61	I	
75	4183.73	I	
950	4186.78	I	
26	4190.90	I	
180	4191.60	I	
550	4194.85	I	
26	4195.22	I	
65	4198.02	I	
55	4201.32	I	
55	4202.25	I	
19	4205.03	I	
30	4206.54	II	0–23766
11	4207.68	I	
36	4211.23	I	
1300	4211.72	I	
150	4213.18	I	
7	4214.38	I	
300	4215.15	I	
360	4218.09	I	
360	4221.10	I	
6	4222.01		
44	4222.22	I	
6	4224.68	I	
220	4225.14	I	
55	4232.03	I	
6	4234.83	I	
55	4239.85	I	
6	4243.43	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
36	4245.92	I	
11	4247.36	II	
6	4248.44	II	
36	4256.33	II	828–24316
7	4258.14	I	
6	4267.90	I	
6	4268.29	I	
20	4276.74	I	
7	4279.76	I	
10	4291.94	I	
30 d	4294.94	II	
	4295.04	I	
6	4298.90	I	
6	4302.72	II	
85	4308.67	II	0–23203
5	4313.90	I	
6	4322.55	II	
11	4325.14	II	
26	4325.88	I	
8	4326.39	I	
10	4328.90	II	4341–27435
13	4339.68	II	
5 d	4346.33	II	
13	4347.69	I	
16	4358.46	II	828–23766
5	4361.39	II	
8	4364.22	II	
13	4366.73	I	
26	4374.24	II	0–22855
26	4374.80	II	
10	4375.33	II	
5	4384.30	II	
6	4389.78	I	
11	4394.98	II	
44	4409.38	II	
5	4426.87	I	
5	4431.00	II	
12	4444.61	I	
60	4449.71	II	0–22467
9	4455.59	II	
20	4468.17	II	828–23203
5	4484.37	I	
5	4503.26	II	
5	4516.94	I	
5	4518.53	II	
8 d	4527.63		
	4527.76	II	
8	4541.70	II	
5	4555.24	I	
11	4565.11	I	
5	4567.07	I	
5	4573.85	II	
34	4577.80	I	
6	4587.93	II	
170	4589.37	I	
5	4591.78	II	
80	4612.28	I	
4	4613.83	I	
4	4614.83	I	
5	4617.26	II	
11	4620.03	II	828–22467
4	4662.76	I	
9	4664.68	II	4341–25773
7	4673.62	II	
4	4682.02	II	
4	4689.77	II	
10	4698.71	II	
9	4721.23	I	
7	4727.14	II	
18	4731.85	II	
4	4745.79	II	
6	4755.01	II	
5	4760.02	II	4341–25343
6	4771.94	I	
5	4774.80	I	
12 h	4775.80	I	
8	4786.94	II	
10	4791.30	I	
3.0	4800.68	I	
5	4807.95	I	
4	4810.23	I	
5	4812.79	I	
8	4819.05	I	
9	4824.99	I	
8	4828.91	I	
5	4829.69	II	
7	4832.41	I	
3.5	4833.78	II	
8	4841.78		
4	4856.24	II	
4	4868.05	II	
4	4875.92	I	
9	4880.16	I	
4	4884.53	I	
10	4888.08	I	
4	4889.32	II	
8	4890.11	II	
5	4893.69	I	
3.0	4899.25	I	
7	4916.42	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4922.21	II	
8	4923.15	II	
60	4957.36	II	0–20166
3.0	4959.60	I	
3.5	4973.58	I	
5	4985.53	I	
6	5003.86	I	
7	5004.26	II	
3.0	5010.59	I	
3.0	5017.99	II	
9	5022.12	I	
4	5023.99	I	
3.0	5024.51	I	
5	5027.85	I	
6	5032.98	I	
20	5042.62	I	
3.0	5047.25	I	
6 h	5050.17	I	
2.0	5053.22	II	
4	5053.29	I	
3.0	5055.42	I	
12	5070.65	I	
15	5077.65	I	
10	5090.38	II	
10	5110.31	I	
16 h	5120.01	I	
4	5135.01	I	
24	5139.60	II	
5	5161.00	II	
5	5164.14	II	
6	5165.37	I	
14	5169.67	II	828–20166
2.5	5172.81	II	
10	5185.14	I	
5	5188.48	II	
36	5192.89	II	
12	5197.66	II	
4	5205.69	I	
6	5246.93	II	
2.0	5248.12	II	
2.0	5258.39	II	
9	5259.91	I	
16	5260.57	I	
7 bl	5263.3	DyO	
8	5267.13	I	
6	5272.25	II	
6	5275.31	II	
6	5279.71	II	
7	5282.07	I	
3.5	5284.99	II	
5	5297.83	II	
2.0	5301.59	I	
5	5309.02	II	
6	5324.70	II	
3.0	5337.43	II	
8	5340.31	I	
4	5352.13	I	
4	5368.20	II	
2.0	5369.26	II	
2.5	5385.65	II	
11	5389.58	II	
5	5395.58	I	
2.5 h	5398.26		
3.0	5399.94	II	4341–22855
6	5404.16	I	
10	5419.13	I	
2.0	5420.75	I	
9	5423.31	I	
4	5424.24	I	
5	5426.71	II	
4	5443.35	II	
12	5451.09	I	
4	5455.45	II	
3	5469.11	II	
2.0	5471.90	II	
3.5	5496.84	I	
3.0	5502.80	I	
3.5	5506.52	I	
3.0	5515.40	II	4341–22467
4	5528.03	I	
1.6	5542.19	I	
8	5547.28	I	
2.0	5562.50	I	
5 d	5600.71	II	
3	5605.64	I	
4	5613.24	I	
2.5	5627.49	I	
13	5639.53	I	
2.0	5641.52	II	
7 h	5646.02	I	
10	5652.01	I	
1.4	5666.42	I	
1.8	5671.25	I	
1.8	5677.69	I	
3.0	5685.60	I	
3.5 h	5693.67	II	
3.0 h	5694.10		
3.5 cw	5694.54	II	
3.5	5698.75	II	
3.0	5702.92	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.4		5705.95	II	
9	h	5718.48	I	
3.5	h	5725.84	II	
7	h	5728.64	II	
3.0	h	5738.73	II	
6		5740.19	I	
7		5745.54	I	
3.0		5750.50	I	
3.0		5758.82	I	
10	h	5832.01	II	
7	h	5833.85	II	
5	h	5834.86	I	
3.5	h	5844.41	II	
3.0		5845.65	II	
5	h	5848.05	II	
5		5855.56	II	
7	h	5868.10	II	
5		5915.17	II	
2.5		5924.54	II	
9		5945.81	I	
6	l	5964.50	I	
15		5974.50	I	
3.0		5984.86	I	
1.2		5985.99	I	
18		5988.57	I	
1.8		6000.86	I	
1.8		6003.26	I	
3.0	h	6005.75	II	
3.0	h	6006.54	II	
3.0	h	6006.97		
4.0		6008.92	I	
8		6010.80	I	
3.0		6017.27	I	
3.0		6031.00	I	
3.0	bl	6042.49		
3.0		6058.16	I	
4		6085.04	I	
17		6088.24	I	
3.0		6127.15	I	
3.0		6133.63	I	
3.0		6158.32	I	
13		6168.43	I	
2.5		6196.23	II	
34		6259.09	I	
4		6260.38	I	
1.8		6343.34	I	
5		6386.81	I	
3.0		6396.61	II	
6		6421.93	I	
1.6	h	6436.57	II	
1.0		6460.86	I	
1.2		6468.60	II	
1.4		6474.94	I	
2.5		6483.62	II	
3.5		6486.64	I	
1.0		6548.28	II	
2.5		6558.02	I	
20		6579.38	I	
1.8		6594.16	II	
0.8	h	6611.76	I	
0.9		6639.25	I	
2.0		6643.41	I	
1.0		6654.27	II	
3.0		6658.40	I	
4		6661.69	I	
10		6667.90	I	
1.2		6670.21	I	
1.4		6700.66	II	
1.0	h	6713.18	I	
0.8	h	6724.79	I	
0.8	h	6736.17	I	
0.9	h	6743.77	II	
4		6747.98	I	
1.0	h	6750.29	I	
1.4		6757.69	I	
6		6765.96	I	
0.8		6787.43	I	
1.0		6790.38	I	
1.1		6794.30	I	
1.1	h	6803.20	II	
1.1		6805.64	I	
1.2		6807.36	II	
1.6		6818.24	I	
1.2		6827.16	I	
0.6		6828.41	II	
24		6835.44	I	
0.5	h	6843.80	I	
1.0		6845.84	I	
0.6	h	6852.10	I	
11		6853.00	I	
3.0		6856.50	I	
0.5	h	6886.48	II	
3.0		6888.90	I	
0.6		6894.58	I	
0.6		6895.55	I	
2.0		6897.98	II	
9		6899.34	II	
3.0		6906.57	II	
1.0		6912.27	II	
0.9	h	6925.48	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		6929.54	I	
1.0		6932.62	II	
0.6		6939.72	I	
0.8		6942.17	I	
0.6	h	6945.35	I	
4		6950.29	II	
1.6		6951.49	I	
0.9		6953.00	II	
0.6		6957.63	I	
6		6958.08	I	
0.9		6970.51	I	
2.0	h	6982.47	I	
2.0		6991.31	I	
7		6998.10	I	
0.5	h	7014.66	II	
3.0		7017.43	I	
0.5	h	7036.38	I	
1.0		7037.61	I	
5		7055.95	II	
1.4	h	7062.33	I	
3.5		7075.15	II	
0.5	h	7100.61	II	
0.7		7101.70	II	
2.5		7109.30	II	
1.6		7120.93	II	
1.4		7121.31	I	
0.4		7141.52	II	
0.7		7149.31	II	
0.9	h	7156.51	I	
2.0		7175.16	II	
0.4	h	7198.75	I	
0.4	h	7206.89	I	
1.6		7213.32	I	
0.4		7222.62	I	
0.4		7223.00	I	
2.5	h	7230.11	I	
0.6	h	7234.72	II	
2.0		7250.04	I	
1.0		7261.76	I	
1.2		7273.60	II	
0.4		7279.97	I	
1.4		7288.26	II	
0.4	h	7300.31	I	
0.3	h	7314.74	II	
2.5		7345.18	II	
0.4		7349.66	I	
0.4	h	7354.42	II	
0.7		7361.58	II	
1.6		7370.26	II	
3.0		7376.06	I	
1.4		7381.60	I	
1.4	h	7403.17	I	
0.4		7403.99	I	
1.6		7407.62	I	
3.5		7412.42	I	
8		7426.99	II	
0.8	h	7428.62	I	
1.4		7451.08	II	
3.0		7457.05	II	
0.5	h	7459.97	I	
1.0		7483.01	I	
0.5		7509.59	I	
2.5		7516.59	II	
1.0	h	7533.14	I	
8		7543.76	I	
2.5	h	7553.03	I	
0.8	h	7557.81	I	
4		7559.81	I	
6		7562.96	II	
3.0	h	7577.47	II	
0.5		7587.76	I	
4	h	7591.36	I	
0.8	h	7594.95	I	
0.6		7609.25	I	
2.0	h	7611.54	I	
0.8	h	7616.21	I	
1.6	h	7617.73	I	
0.8	h	7635.29	II	
0.8	h	7639.25	I	
5	h	7641.15	I	
2.5		7645.87	I	
2.0		7646.66	I	
0.6		7648.12	II	
1.4		7661.47	I	
12		7662.35	I	
1.6		7666.78	II	
1.4	h	7676.74	I	
0.5		7693.85	I	
0.7		7696.50	I	
0.9		7711.93	II	
5		7715.35	I	
0.7	h	7721.08	I	
7		7729.78	II	
0.7	h	7739.38	II	
0.6		7750.14	I	
3.0		7751.61	II	
0.8		7757.34	I	
0.6		7760.07	I	
0.6		7780.92	I	
1.2		7790.05	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	7812.08	I	
0.6	7814.69	I	
1.0	7832.79	I	
1.0 h	7835.55	II	
1.2	7864.32	II	
1.2	7865.00	I	
4	7909.36	I	
0.7	7934.89	I	
0.5	7962.72	I	
1.6	7968.63	I	
1.4	7973.14	I	
1.8	7982.80	II	
0.6	8004.46	II	
1.2	8008.68	II	
1.4 h	8025.33	I	
0.9 h	8027.21	I	
0.9	8040.01	I	
0.6	8047.23	I	
0.6	8050.93	I	
1.2	8116.90	II	
0.5	8140.74	II	
0.6	8144.28	II	
2.0	8147.25	I	
0.6 h	8169.03	II	
4	8198.75	II	
15	8201.55	II	
0.5	8208.30	II	
1.2 h	8216.98	II	
1.6	8218.58	II	
0.9	8233.55	II	
0.6	8243.95	II	
3.0	8265.50	I	
0.6	8323.81	I	
5	8326.04	I	
0.7	8388.48	I	
5	8391.96	II	
1.8	8405.80	II	
3.0	8416.61	II	
3.5	8438.57	II	
1.4	8444.44	II	
0.7	8472.48	II	
0.6	8480.50	II	
0.7	8490.17	I	
1.4	8510.77	II	
0.6	8517.68	II	
1.0	8525.73	II	
0.6 h	8528.28	II	
1.2	8548.96	II	
1.4	8557.74	II	
1.0	8567.93	II	
1.2	8575.54	II	
1.6	8629.95	I	
1.4	8635.6	II	
4	8655.90	II	
2.5	8657.71	II	
1.0 h	8667.32	II	
1.0	8672.51	I	
2.5	8678.37	II	
0.8	8685.1	I	
1.6	8696.90	II	
1.6 h	8715.88	II	
3.0	8750.30	II	
1.8	8780.74	I	
7	8791.37	II	
1.0	8832.67	II	
2.0	8832.92	II	
3.5	8850.21	II	
7	8905.62	II	

ERBIUM

Er, $Z=68$, $M=167.27$, Ratio $\frac{\text{Er}}{\text{Cu}}=2.633$

Er I Normal state of valence electrons $4f^{12}\,6s^2\,{}^3H_6=0$. I.P. ≈ 50000 K
Er II Normal state of valence electrons $4f^{12}\,6s^1\,{}^4H_{6\frac{1}{2}}=0$.

References

Wavelengths:
Below 6880 A:
A. Gatterer and J. Junkes, Spektren der Seltenen Erden, (Specola Vaticana, Vatican, 1945).
Supplemented by: J. M. Eder, Wien Ber. **125,** IIa, 383 (1916).
Above 6880 A:
J. M. Eder, Wien Ber. **124,** IIa, 707 (1915).
About 60 lines above 6600 A were measured on our plates.

Spectrum assignments were all made from our plates.

Classification:
Er I, (normal state) I. J. Spalding, unpublished material (May 1960).
Er II, J. R. McNally and K. L. Vander Sluis, J. Opt. Soc. Am. **49,** 200 (1959).

Relative intensity of erbium lines observed in an arc of copper containing 0.1 atomic percent of erbium

Strong lines of erbium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1100	4007. 97	I		
850	3906. 34	II		
750	3372. 76	II	0–29641	$f^{12}s^1\,{}^4H_{6\frac{1}{2}}$—$29641{}^{\circ}_{7\frac{1}{2}}$
700	3692. 64	II	440–27514	$f^{12}s^1\,{}^2H_{5\frac{1}{2}}$—$27514{}^{\circ}_{6\frac{1}{2}}$
650	3499. 11	II	440–29011	$f^{12}s^1\,{}^2H_{5\frac{1}{2}}$—$29011{}^{\circ}_{4\frac{1}{2}}$
600	3862. 82	I		
550	4151. 10	I		
420	3896. 25	II	440–26099	$f^{12}s^1\,{}^2H_{5\frac{1}{2}}$—$26099{}^{\circ}_{6\frac{1}{2}}$
340	3892. 69	I		
320	3830. 53	II	0–26099	$f^{12}s^1\,{}^4H_{6\frac{1}{2}}$—$26099{}^{\circ}_{6\frac{1}{2}}$
300	3616. 58	II	0–27643	$f^{12}s^1\,{}^4H_{6\frac{1}{2}}$—$27643{}^{\circ}_{5\frac{1}{2}}$
280	4087. 65	I		
260	3264. 79	II	0–30621	$f^{12}s^1\,{}^4H_{6\frac{1}{2}}$—$30621{}^{\circ}_{6\frac{1}{2}}$
260	3937. 02	I		
260	3944. 41	I		
260	3973. 60	I		
240	4020. 52	I		
220	3230. 59	II		
220	3312. 42	II	440–30621	$f^{12}s^1\,{}^2H_{5\frac{1}{2}}$—$30621{}^{\circ}_{6\frac{1}{2}}$
220	3392. 00	II		
220	3973. 04	I		
170	3385. 08	II	440–29973	$f^{12}s^1\,{}^2H_{5\frac{1}{2}}$—$29973{}^{\circ}_{6\frac{1}{2}}$
170	3938. 65	II		
160	3786. 84	II		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.5	2341.82	II	
4	2358.51	II	0−42387
3.5	2377.83	II	
4	2383.28	II	440−42387
5	2386.58	II	
6	2387.17	II	
6	2396.38	III	
5	2397.30	II	
2.5	2400.30	II	
2.0	2404.41	II	
2.5	2410.53	II	
5	2420.28	II	
5	2425.23	II	
7	2427.28	II	
4	2439.45	II	
13	2446.39	II	0−40864
4	2458.03	II	
4	2459.75	II	
4	2460.71	II	
6	2464.63	III	
3.5	2467.26	II	
2.0	2477.59	II	
4	2478.32	II	440−40778
3.5	2485.17	II	
4	2487.47	II	
6	2491.56	II	
4	2492.27		
6	2493.27	II	
9	2499.67	I	
8	2503.48	II	
6	2507.64	II	
5	2513.94	II	
2.5	2520.95	II	
5	2534.99	II	
10	2537.02	II	
6	2544.90	II	
11	2547.28	II	
4	2564.78	II	
5	2579.59	II	
9	2581.56	II	
28	2586.73	II	
11	2587.03	II	
3.5	2587.34	II	
3.5	2591.91	II	
13	2592.57	II	
12	2595.03	II	
8	2602.66	I	
8	2604.86	I	
3.0	2606.69	II	
6	2612.37	II	
5	2614.54	II	
6	2616.87	II	
8	2621.72	II	
14	2624.18	II	
4	2627.77	II	
3.5	2637.81	III	
4	2647.14	II	
3.5	2651.35	II	
7	2653.73	II	
4	2654.11	II	
7	2655.25	II	
7	2656.10	II	
6	2657.00	II	
8	2665.04	II	
9	2666.30	II	
48	2670.26	II	
32	2672.26	II	
10	2675.35	II	
4	2688.40	II	
4	2689.93	II	
6	2698.39	III	
2.5	2700.67	II	
6	2701.69	II	
6	2711.53	II	
10	2712.12	II	
6	2713.25	II	
3.0	2716.60	II	
6	2720.74	II	
6	2721.59	II	
18	2726.22	II	
12	2730.10	II	
8	2731.53	II	
26	2739.30	II	
30	2750.18	II	
6	2750.90	II	
22	2754.96	II	
60	2755.64	II	
11	2765.61	II	
12	2766.38	II	
50	2769.98	II	
9	2774.61	II	
22	2778.97	II	
6	2779.59	II	
10	2781.18	II	
6	2781.57	II	
4	2782.12	II	
15	2784.95	II	
12	2786.11	II	
6	2787.41	II	
18	2787.71	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3	2788.34	II	
5	2788.45	II	
6	2792.52	III	
5	2793.85	II	
8	2799.54	II	
3.5	2799.73	II	
22	2802.53	II	0–35672
10	2802.88	II	
8	2803.55	II	
30	2804.37	II	
15	2806.75	II	
10	2818.85	II	
2.5	2819.35	II	
4	2819.83	II	
40	2820.19	II	
4	2820.47	II	
5	2824.33	II	
5	2824.91	II	
3.0	2825.67	II	
6	2829.38	II	
8	2830.41	II	
4	2831.21	II	
26 d	2833.93	II	
6	2837.12	II	7150–42386
38	2838.72	II	
10	2840.63	II	
5	2841.91	II	
12	2845.87	II	
6	2846.28	II	
4	2847.02	II	
8	2848.08	II	
26	2848.37	II	
5	2848.92	II	
15	2850.66	II	
24	2855.41	II	
12	2858.57	II	0–34972
30	2859.83	II	
4	2860.26	II	
4	2862.61	II	
3.0	2866.36	II	
3.0	2869.22	II	
3.0	2870.53	II	
9	2871.68	II	
6	2872.84	II	
15	2873.81	II	
11	2874.81	II	
8	2877.23	II	
5	2878.54	II	
6	2878.90	II	
3.0	2879.25	II	
3.0	2882.60	II	
8	2886.12	II	
10	2887.11	II	
10	2888.16	II	
5	2893.49	II	
15	2893.91	II	
5	2895.93	II	
6	2896.56	II	
30	2896.97	II	
38	2897.52	II	
8	2903.45	II	
100	2904.47	II	
12	2906.50	II	
10	2908.53	II	
20	2909.55	II	
150	2910.36	II	
7	2911.05	II	
3.0	2912.27	II	
4	2912.79	II	
10	2914.65	I	
26	2915.61	II	
4	2918.88	II	
10	2919.28	II	
8	2920.23	II	
8	2923.29	II	
6	2927.33	II	
15	2927.72	II	
16	2928.28	II	
11	2928.44	II	
34	2929.25	II	
10	2929.72	II	440–34563
12	2930.64	II	
8	2931.58	II	
6	2931.69	II	
3.5	2932.43	II	
3.0	2932.62	II	
8	2934.53	II	
6	2934.64	II	
5	2939.32	II	
6	2939.48	II	
12	2941.17	II	
9	2941.71	II	
14	2942.20	II	
10	2944.06	II	440–34397
26	2945.27	II	
4	2946.42	II	
22	2946.62	II	
15	2948.80	II	
3.0	2949.22	II	
8	2950.05	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	2951.24	II	
6	2955.34	II	
5	2955.60	II	
6	2956.42	II	
8	2956.95	II	
9	2958.88	II	
6	2960.11	II	
12 h	2962.49	II	
15	2963.70	II	
8	2963.90	II	
6	2964.24	II	
150	2964.52	II	
6	2964.88	II	
6	2965.21	II	7150–40864
8	2965.86	II	
6	2966.17	II	
8	2967.93	II	
6	2968.42	II	
40	2968.76	II	
15	2970.07	II	
6	2970.98	II	
5	2971.26	II	
8 d	2971.59	II	
	2971.71	II	
15	2972.27	II	
15	2973.73	II	
20	2974.47	II	
22	2975.68	II	
4	2979.95	II	
11	2983.06	II	
14	2983.24	II	
26	2983.79	II	
13	2985.50	I	
4	2987.32	II	
3.0	2988.22	II	
14	2989.29	II	
8	2989.56	II	
3.0	2994.10	II	
11	2994.48	I	
4	2995.44	II	
9	2996.37	II	
8	2997.89	II	
7	2998.05	II	
120	3002.39	II	
30	3002.64	II	
9	3003.84	II	
6	3005.05	II	
15	3008.17	II	
4	3009.46	II	
5	3009.70	II	
8	3010.29	II	
9	3011.16	II	
22	3012.47	II	
6	3013.77	II	
3.0	3013.95	II	
3.0	3014.62	II	
22	3016.84	II	
12	3017.73	II	
10	3019.76	II	0–33106
5	3020.33	II	
6	3022.71	II	
28	3025.92	II	
26	3028.28	II	
36	3031.31	II	
30	3036.21		
7	3048.41	II	
5	3049.18	II	
9	3049.29	II	
7	3049.98	II	
7	3050.84	II	
7	3053.77	II	
20	3054.41	II	
5	3061.28	II	
14	3061.69	II	
6	3064.84	II	0–32619
7	3064.97	II	
22	3066.23	II	
12	3069.23	II	
44	3070.75	II	
55	3072.53	II	
60	3073.34	II	0–32528
7	3078.23	II	
20	3078.87	II	
7	3081.38	II	
70	3082.08	II	
60	3084.03	II	0–32416
6	3087.12	II	
7	3087.79	II	
7	3088.75	II	
15	3093.14	II	
12	3095.88	II	
36	3099.19	II	
7	3099.60	II	
15	3102.69	II	
7	3104.46	II	
22	3106.79	II	440–32619
15	3110.88	II	
30 d	3113.54	II	
8	3115.10	II	
13	3115.52	II	440–32528

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
15	3116.94	II	0–32074
15	3118.83	II	
8	3119.05	II	
15	3121.90	II	0–32023
75	3122.67	II	
8	3123.09	II	
15	3125.19	II	
15	3125.65	II	
6	3127.38	II	
8	3131.07	II	
13	3132.03	II	0–31919
28	3132.51	II	
46	3132.78	II	
8	3135.62	II	
13	3137.85	II	
16	3138.49	II	
40	3141.13	II	440–32267
7	3141.81	II	
8	3142.80	II	
8	3143.63	II	
24	3144.33	II	
16	3144.51	II	
13	3150.53	II	
14	3152.37	II	
40	3154.28	II	
19	3160.34	II	440–32074
6	3161.35	II	
6	3164.52	II	
19	3167.09	II	
8	3171.52	II	
8	3172.62	II	
16	3175.52	II	
8	3179.62	II	
32 d	3181.68	II	
85	3181.92	II	
40	3183.42	II	440–31844
24	3185.26	II	
16	3187.79	II	
12	3192.63	II	
30	3200.57	II	
12	3203.42	II	
8	3203.95	II	
22	3205.15	II	
8	3208.05	II	
26	3214.45	II	
85	3220.73	II	
60	3223.31	II	
20	3227.16	II	
8	3229.93	II	
220	3230.59	II	
24	3232.03	II	
32	3237.98	II	
14	3240.48	II	
18	3243.25	II	
9	3243.48	II	
32	3249.34	II	
9	3256.34	II	
9	3258.48	II	
55	3259.06	II	
18	3262.81	II	
260	3264.79	II	0–30621
9	3266.63	II	
42	3267.14	II	
32	3269.41	II	
9	3273.33	II	
9	3277.70	II	0–30500
24	3278.22	II	
70	3279.33	II	
70	3280.22	II	
18	3286.18	II	
46	3286.77	II	
14	3287.97	II	
9	3291.27	II	
9	3301.94	II	
32 d	3303.95	II	
9	3304.07	II	
36	3305.58	II	
8	3307.46	II	
220	3312.42	II	440–30621
9	3313.49	II	
18	3313.66	II	
18	3314.44	II	
8	3314.95	II	
55	3316.39	II	
15	3317.52	II	
8	3318.24	II	
9	3318.78	II	0–30123
75	3323.20	II	
28	3329.67	II	
75	3332.71	II	
8	3336.76	II	
36	3337.26	II	
28	3337.80	II	
24	3340.03	II	
9	3340.49	II	
9	3341.62	II	
28	3341.85	II	
15	3343.70	II	
9	3344.37	II	
130	3346.04	II	440–30318

Erbium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
15	3346.35	II	
12	3347.64	II	
16	3347.86	II	
18	3348.14	II	0–29859
6	3348.76	II	
46	3350.06	II	
34	3350.27	II	5133–34972
18	3351.33	II	
9	3356.22	II	
18	3358.16	II	
15	3361.03	II	
9	3361.67	II	
140	3364.09	II	
19	3366.70	I	
140	3368.07	II	440–30123
44	3370.59	II	
750	3372.76	II	0–29641
95	3374.16	II	0–29628
9	3376.10	II	
8	3377.00	II	
7	3379.01	II	
13	3381.08	II	
28	3381.32	II	
22	3382.06	I	
170	3385.08	II	440–29973
15	3389.62	II	
44	3389.74	II	0–29492
220	3392.00	II	
9	3394.12	II	
9	3394.39	II	
19	3394.86	II	
34	3396.06	II	
28	3396.84	II	5133–34563
19	3398.28	II	440–29859
9	3401.21	II	
38	3401.83	II	
7	3406.96	II	
18	3408.69	II	
15	3409.88	II	
18	3417.28	II	
34	3417.64	II	
19	3420.18	II	
19	3422.87	I	
26	3425.08	II	440–29628
48	3428.41	II	
19	3429.91	II	
14	3431.06	I	
26	3433.12	II	0–29120
14	3434.64	II	
10	3437.65	II	
16	3438.32	II	
8	3438.47	II	
75	3441.15	II	440–29492
38	3442.65	I	
10	3443.72	II	
26	3446.88	I	
10	3447.53	II	
16	3448.07	II	5404–34397
16	3453.68	I	
18	3461.40	II	
24	3462.58	I	
26	3464.53	II	
48	3469.48	I	
26	3469.74	II	0–28812
95	3471.72	II	
10	3477.94	II	
60	3479.44	II	
28	3480.44	II	
10	3484.56	II	
19	3485.17	II	
95	3485.82	II	440–29120
34	3486.83	II	
26	3489.36	I	
14	3492.54	II	
34	3496.87	II	
650	3499.11	II	440–29011
60	3502.78	I	
26	3505.07	II	7150–35672
28	3505.70	I	
38	3508.40	II	
19	d 3508.81		
	3508.94		
48	3514.91	II	
38	3518.17	II	
20	3522.52	I	
60	3524.92	II	
26	3526.81	I	
10	3531.27		
60	d 3539.57		
24	3542.99		
26	3545.84		
26	3547.51		
30	3548.23		
20	3549.55		
80	3549.85		
14	3551.79		
30	3553.18	II	
20	3554.29		
10	3556.04		
16	3556.37		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	3556.80		
20	3557.07		
150	3558.02		
50	3558.72		
100	3559.89	II	
20	3563.49		
30	3565.15		
20	3569.25		
20	3569.91		
16	3570.60		
90	3570.74		
14	3573.85	II	5133–33106
30	3578.31		
19	3579.44		
100	3580.49	II	440–28361
36	3586.64		
20	3587.77	II	
20	3588.35		
60	3590.73	I	
40	3595.83	I	
60	3599.51	II	
100	3599.84	II	
20	3604.72	II	
50	3604.89	II	
16	3605.69	I	
20	3607.21	I	
40	3607.45	I	
300	3616.58	II	0–27643
50	3617.82	II	
50	3618.92	II	
10	3625.28	II	
70	3628.04	I	
30	3629.39	I	
20	3630.08	II	
14	3630.30	II	
14	3631.79	I	
44	3632.07	II	
10	3632.79	II	
26	3633.26	I	
100	3633.56	II	0–27514
50	3634.67	I	
20	3636.30	I	
24	3637.16	II	5133–32619
140	3638.69	I	
24	3641.26	II	
6	3641.89	II	
80	3645.93	II	
6	3646.79	II	7150–34563
46	3650.39	II	
32	3652.57	II	
44	3652.86	II	7195–34563
3.0	3656.34	II	
12	3659.56	I	
10	3660.78	II	
10	3662.03	II	
16	3662.86	I	
32	3664.44	I	
42	3669.01	II	7150–34397
7	3675.18	II	7195–34397
17	3676.51	II	
17	3678.95	I	
6	3680.09	II	
44	3682.71	II	
28	3684.01	I	
34	3684.27	II	5133–32267
14	3689.12	II	
700	3692.64	II	440–27514
40	3696.25	II	
14	3696.91	II	
9	3697.24	I	
34	3697.68	I	
48	3700.72	II	
17	3701.56	II	
3.0	3702.50	II	
9	3705.77	I	
14	3706.52	I	
46	3707.63	II	
3.0	3710.76	II	5133–32074
9	3711.81	II	
46	3712.39	II	
11	3715.96	I	
9	3717.26	II	
28	3719.31	I	
9	3721.45	II	5404–32267
6	3723.66	II	
15	3724.38	II	
8	3724.45	II	
20	3724.92	II	
120	3729.55	II	
40	3731.27	II	
5 d	3731.78	II	
4	3732.17	I	
17	3734.46	II	
24	3734.59	II	0–26769
6	3735.68	I	
48	3738.18	II	
16	3740.28	II	
30	3741.09	II	
80	3742.65	II	5133–31844
18	3744.99	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	3745.11	II	
5	3745.72	II	
80	3747.53	I	
5	3748.99	I	
17	3750.53	II	
3.0	3751.97	II	
48	3756.05	I	
3.0	3756.35	II	
20	3761.94		
20	3766.16	II	
6	3767.76	II	
14	3768.79		
24	3771.10	II	
10	3772.47	II	
8	3774.83	I	
10	3775.28	I	
20	3775.66	II	
14	3777.62	II	
10	3778.26	II	
12	3778.64	I	
36	3781.03	II	5404–31844
6	3783.85		
160	3786.84	II	
6	3787.42		
50	3787.90	II	0–26392
10	3791.16		
8	3791.53		
50	3791.84	II	
44	3792.81	I	
50	3797.07	II	440–26769
7	3798.24		
16	3798.65	I	
6	3803.68	I	
4	3806.11		
7	3807.09	II	
140	3810.33	I	
7	3817.73		
8	3818.71		
6	3827.36		
320	3830.53	II	0–26099
10	3832.30		
7	3832.46		
7	3835.65		
18	3837.66		
10	3838.39		
8	3839.39		
3.5	3842.99		
7	3848.32		
8	3849.32		
48	3849.91		
28	3851.60	II	7150–33106
60	3855.93		
48	3858.39	II	7195–33106
600	3862.82	I	
20	3864.81		
4	3868.22		
12	3874.73		
8	3875.87		
120	3880.60	II	
100	3882.87	II	7150–32896
8	3884.08	I	
4	3885.38	II	
12	3887.16	II	
20	3888.09	II	
12	3889.82	II	
32	3890.60	II	
340	3892.69	I	
13	3895.81	II	
420	3896.25	II	440–26099
20	3899.04	I	
65	3902.75	II	
4	3903.86	II	
20	3903.99	I	
20	3904.59	II	
100	3905.44	I	
850	3906.34	II	
8	3908.42	I	
9	3910.50	I	
9	3911.58	II	
4	3911.92	II	
11	3912.43	II	0–25552
4	3915.70	II	
7	3915.98	I	
22	3918.05	I	
17	3918.38	II	
22	3921.89	II	
65	3932.28	II	7195–32619
260	3937.02	I	
170	3938.65	II	
7	3938.92	II	
4	3939.36	II	
12	3942.56	I	
12	3943.21	II	
260	3944.41	I	
44	3948.07	II	
9	3950.96	I	
20	3951.50	I	
26	3956.43	I	
4	3959.91	II	
13	3961.21	I	

Erbium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	3963.36	II	
7	3964.52	I	
22	3966.35	I	
13	3969.45	II	
220	3973.04	I	
260	3973.60	I	
110	3974.72	II	
22	3976.74	I	
65	3977.03	I	
4	3979.14	II	
13	3980.17	II	
13	3980.61	I	
90	3982.33	I	
9	3983.15	II	
22	3987.53	I	
65	3987.66	I	
18	3991.16	I	
4	3994.87	II	
5	3995.26	II	
13 d	3999.16	II	
18	4004.07	I	
1100	4007.97	I	
18	4008.19	II	
22	4009.16	II	0–24936
12	4009.77	I	
90	4012.58	I	
4	4012.98	II	
28	4015.61	II	
9	4016.36	I	
240	4020.52	I	
36	4021.55	I	
9	4021.96	II	
15	4036.12	I	
14	4037.69	I	
6	4039.61	I	
18	4043.03	II	
80	4046.97	I	
22	4048.35	II	7150–31844
16	4049.48	II	
75	4055.47	II	
44	4059.51	I	
55	4059.81	II	
11	4072.39	I	
11	4074.02	II	
34	4077.88	I	
44	4081.21	II	440–24936
11	4083.09	I	
280	4087.65	I	
6	4091.78	I	
17	4092.90	I	
11	4094.66	II	
85	4098.11	I	
28	4100.58	II	
5	4104.00	II	5133–29492
5	4106.63		
10	4109.34	I	
11	4112.63	II	
26	4116.36	I	
26	4118.55	I	
11	4123.05	II	
11	4124.80	I	
48	4131.50	I	
44	4142.92	II	
550	4151.10	I	
5	4160.30		
15	4164.82	I	
10	4171.68		
11	4172.17	I	
11	4185.45	I	
22	4189.99	II	
80	4190.71	I	
11	4194.70	I	
5	4197.39	I	
10	4205.32	I	
110	4218.43	I	
16	4220.99	I	
5	4223.47	I	
5	4223.72	II	
26	4230.20	II	
5	4232.47	I	
11	4234.76	II	5404–29011
6	4235.17	I	
5	4237.03	I	
16	4251.93	II	
5	4263.64	I	
5	4264.85	I	
5	4269.93	I	
11	4276.45	II	
55	4286.56	I	
5	4288.50	I	
26	4298.91	I	
5	4301.26	I	
26	4301.61	II	440–23681
11	4303.81	II	5133–28361
5	4306.34	I	
9	4319.94	II	
10	4328.81	I	
4	4330.27	II	
9	4331.35	I	
5	4335.03	I	

609065 O - 62 - 7

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	4338.99	II	
11	4340.92	I	
15	4348.33	I	
4	4351.63	I	
9	4369.38	II	
5	4378.35	II	
5	4380.64	I	
13	4382.17	I	
24	4384.71	II	
24	4386.40	I	
5	4388.37	II	
6	4397.42	I	
8	4403.14	II	
65	4409.35	I	
6	4413.75	I	
5	4414.34	I	
14	4418.71	I	
46	4419.62	II	
9	4422.47	II	
26	4424.57	I	
30	4426.77	I	
4	4432.21	I	
9	4437.67	I	
4	4448.62	II	
8	4459.26	II	
8	4473.50	II	
7	4484.47		
2.5	4488.89		
4	4489.08		
10	4496.38		
16	4500.75	II	0−22212
3.5	4503.27	II	
3.0	4512.18	I	
3.0	4518.64	I	
6	4519.46	II	
10	4522.72	I	
3.0	4526.92	II	
3.0	4531.11	II	
10 d	4552.13	II	
4	4555.71	I	
13	4563.28	II	
3.0	4563.92	I	
4	4566.38	II	
3.0	4569.31	I	
6	4592.93	I	
3.5	4596.73	I	
6	4598.13	I	
5	4602.06	I	
80	4606.62	I	
6	4611.28	II	
2.5	4624.78	II	
13	4630.90	II	
9	4640.61	II	
3.0	4656.68	II	
9	4665.43	II	
2.5	4667.59	II	
3.5	4671.58	I	
25	4673.16	I	
46	4675.62	II	
12	4679.07	II	
3.0	4688.63	II	
6	4697.17	II	
3.0	4702.19	II	
2.5	4708.69	I	
3.0 d	4718.71	II	
22	4722.71	I	
8	4724.54	II	
14	4729.04	I	
8	4731.60	II	
4	4736.97	II	
6	4745.28	I	
12	4751.55	II	
16	4759.66	II	
6	4762.66	II	
9	4795.50	II	
18	4820.34	II	
3.0	4828.67	I	
2.0	4829.51	I	
8	4831.14	II	
2.0	4834.74	II	
6	4842.04	I	
8	4848.83	II	
3.0	4851.64	II	
4	4853.12	II	
3.0	4854.42	II	
13	4857.43	I	
5	4858.47	II	
3.5	4861.60	II	
14	4872.10	II	
3.0	4872.49	II	
3.0	4878.33	II	7150−27643
2.5	4879.90	II	
3.0	4886.30	II	
3.0	4888.86	I	
3.0	4896.96	II	
9	4898.16	II	
24	4900.10	II	
6	4903.63	II	
3.0	4904.42	II	
3.0	4917.06	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	4925.04	I	
5	4925.43	II	
2.0	4926.97	II	
2.5	4927.36	II	
8	4928.86	I	
24	4934.07	I	
14	4944.36	I	
20	4951.74	II	
5	4953.60	II	
3.0	4954.67	II	
4	4966.63	II	
7	4966.99	I	
6	4969.87	I	
14	4976.41	I	
4	4990.32	I	
5	4992.36	II	
10	5000.38	II	
28	5007.25	I	
10	5008.97	II	
5	5024.28	II	
16	5028.32	I	
13	5028.90	II	
4	5029.76	II	
22	5035.94	I	
24	5042.05	II	
14	5043.86	I	
14	5044.89	I	
4	5045.99	II	
6	5052.67	I	
8	5070.34	II	
14	5077.63	II	
8	5080.51		
7	5119.63	II	
13	5124.56	I	
15	5127.40	II	
13	5131.52	I	
15	5133.83	II	
7	5143.58	II	
4	5144.09	II	
6	5163.83	II	
19	5164.77	II	
14	5172.75	I	
3.0	5179.48	II	
18	5188.90	II	
17	5206.52	I	
7	5212.91	II	
3.5	5215.13	II	
3.5	5218.24	II	
5	5229.32	II	
16	5255.95	II	
2.5	5256.47	II	
3.0	5257.02	II	
4.0	5264.75	II	
9	5272.90	I	
6	5277.70	I	
3.0	5279.33	II	
5	5302.30	II	
6	5333.02	I	
3.0	5333.36	II	
3.0	5334.20	II	
2.5	5343.93	II	
3.5	5344.50	II	
10	5348.04	I	
5	5350.44	I	
4	5368.85		
4	5395.87	II	
7	5414.66	II	
2.0	5422.80	II	
2.0 h	5451.30		
4	5454.27	II	
20	5456.60	I	
4	5462.45	II	
10	5468.32	I	
2.0	5477.45	II	
9	5485.93	II	
3.0	5497.41	II	
3.0	5516.00	I	
9	5593.43	I	
5 d	5601.19	I	
5 h	5609.94	I	
7	5611.82	I	
8	5622.02	I	
9	5626.52	II	
3.5	5636.22	I	
10	5640.34	I	
2.5	5641.43	I	
2.5 h	5658.48	II	
8	5664.95	I	
5	5665.44	II	
6	5675.49	I	
1.6	5695.55	II	
3.0	5710.89	II	
6	5717.48	I	
8	5719.53	I	
6	5726.99	I	
2.5	5733.42	II	
2.5	5736.58	I	
2.5	5736.96	I	
11	5739.18		
4	5740.62	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
7		5748.65	I	
6		5752.53	I	
8		5757.62	II	
32		5762.79	I	
8		5769.92	I	
5		5782.81		
8		5784.64	I	
2.5		5791.12	II	
8		5800.77	I	
2.5		5806.13	II	
3.0	h	5814.28	I	
48		5826.79	I	
1.2		5833.95	II	
5		5835.82	I	
1.6		5839.95	I	
2.0		5841.14	I	
11		5850.06	I	
13		5855.32	I	
1.4		5860.73	II	
1.6		5871.67	II	
16		5872.35	I	
2.0		5873.52	I	
13		5881.14	I	
3.0		5886.48	II	
3.0		5902.09	II	
6		5906.07	I	
5		5909.25	I	
2.0		5916.46	I	
4		5933.50	I	
1.6		5937.20	II	
2.5		5946.36	I	
6		5968.70	I	
3.0		5975.50	I	
4		6006.80	II	
1.6	h	6007.95	II	
2.5		6008.76	II	
6		6014.83	I	
4		6015.76	II	
8		6022.56	I	
2.5		6032.14	II	
2.5		6045.65	II	
2.5		6048.13	II	
5		6054.84	I	
8		6061.26	I	
7		6076.44	II	
1.6		6105.20	II	
4		6116.00	I	
4		6125.32	I	
1.4		6149.30	II	
3.5		6170.05	II	
3.0		6183.20	II	
40		6221.01		
4		6230.90	I	
6		6262.56	I	
5		6267.94	I	
7		6268.86	I	
4		6274.96	I	
3.5		6286.86	I	
2.0		6288.61	I	
5		6299.41	I	
15		6308.79	I	
6		6326.11	I	
2.5		6347.17	II	
1.2		6351.57	II	
5		6388.19	II	
1.6		6398.13	I	
1.2		6413.59	II	
2.0	h	6423.10		
2.5		6432.50	I	
1.8		6441.31	II	
0.8		6451.52	I	
0.8		6454.02	II	
1.6		6481.77	I	
3.0		6485.87	I	
6		6492.35	I	
1.4		6520.51	I	
2.5		6541.53	I	
1.2		6556.31	II	
2.0		6557.78	I	
7		6583.46	I	
1.8		6593.52	I	
8		6601.10	I	
1.4		6616.75	II	
1.6		6637.62	I	
1.2	d	6648.98	I	
		6649.02	I	
1.2		6663.51	I	
1.5		6687.20	I	
0.8		6690.02	II	
0.8		6701.80	II	
1.2		6720.99	I	
3.0		6721.93	I	
1.5		6722.76	II	
8		6759.87	I	
1.4		6761.69	II	
2.5		6762.96	I	
1.2		6764.52	I	
1.2		6766.62	I	
1.0		6768.44	II	
2.0		6768.94	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	6773.40	I	
1.8	6776.14	II	
1.6	6779.86	I	
2.0	6780.73	I	
0.9	6787.90	I	
4	6790.93	I	
1.6	6796.93	II	
2.0	6803.87	II	
2.5	6825.46	I	
2.5	6825.99	I	
1.4	6835.92	I	
8	6848.11	I	
1.0	6857.21	I	
6	6865.20	I	
1.2	6873.12	I	
2.0	6873.74	I	
1.8	6874.77	I	
3.0	6880.01	I	
1.2	6884.13		
0.8	6892.45	I	
1.6	6897.53	II	
1.0	6908.26	I	
1.4	6926.08	I	
0.7	6926.29	I	
2.0	6938.36	I	
0.7	6944.95	II	
2.0	6951.87	I	
1.0	6973.03	I	
0.8	6989.32	I	
2.5	7001.44	I	
1.4	7058.52	I	
1.4 h	7065.00	I	
1.2	7070.96	II	
2.0	7101.23	I	
0.9	7109.60	I	
1.2	7155.37	II	
0.6	7161.89	I	
1.6 h	7196.99	I	
0.8 h	7264.96	II	
0.8 h	7284.03		
1.6	7329.79	II	
2.0	7355.34		
1.2	7356.40		
2.0	7428.65		
6	7459.53	I	
1.0	7460.42		
13	7469.46	I	
2.5	7532.32		
0.7 h	7539.14		
3.0	7556.24	I	
0.7 h	7574.11		
0.6 h	7590.44		
1.2	7597.26		
0.7	7607.15		
1.2	7613.48	I	
0.7	7623.45		
1.8 h	7645.62		
0.9	7650.58		
2.5	7654.43	II	
1.4 h	7658.02		
2.5	7659.23	I	
0.5	7665.63		
4	7680.00	I	
1.0	7722.12	II	
0.9	7726.18	II	
1.2 h	7747.38		
2.5	7754.61	I	
0.5	7762.09		
1.0	7796.59	I	
4	7797.42	I	
1.0	7838.70	I	
1.2	7843.95	I	
1.8	7847.52	I	
0.6	7875.31	I	
0.6	7879.32	I	
2.0	7899.54	I	
0.9	7913.11		
4	7921.78	I	
3.5	7937.73	I	
0.9	7952.98	I	
1.4	7964.57	I	
0.9	7979.09		
0.9	7980.95		
0.6	8023.11		
1.4	8036.04	I	
1.4	8181.90	I	
4	8312.90	I	
2.0	8328.63	II	
0.6	8367.62	II	
6	8410.00	I	
1.2	8466.11	II	
4	8472.39	I	
1.6	8517.66	II	
2.0	8521.35	II	
2.5	8768.58	I	
1.2 h	8776.59	I	
1.0	8866.89		

EUROPIUM

Eu, $Z=63$, $M=152.0$, Ratio $\frac{Eu}{Cu}=2.392$

Eu I Normal state of valence electrons $4f^7\,6s^2\,{}^8S^\circ_{3½}=0$. I.P.=45740 K
Eu II Normal state of valence electrons $4f^7\,6s^1\,{}^9S^\circ_4=0$. I.P.=90716 K

References

Wavelengths:
A. S. King, Astrophys. J. **89,** 377 (1939).

Classification:
Eu I, H. N. Russell and A. S. King, Astrophys. J. **90,** 155 (1939).
Eu II, H. N. Russell, W. Albertson, and D. N. Davis, Phys. Rev. **60,** 641 (1941).

Relative intensity of europium lines observed in an arc of copper containing 0.1 atomic percent of europium

Strong lines of europium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
4000 cw	4205. 05	II	0–23774	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^76p^1$ $z\ {}^9P_3$
3400 cw	3819. 67	II	0–26173	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^76p^1$ $z\ {}^9P_5$
2800 cw	3930. 48	II	1669–27104	$4f^76s\ a\ {}^7S^\circ_3$ —$4f^76p^1$ $z\ {}^7P_3$
2400 cw	3907. 10	II	1669–27256	$4f^76s^1\ a\ {}^7S^\circ_3$ —$4f^76p^1$ $z\ {}^7P_2$
2200 cw	4129. 70	II	0–24208	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^76p^1$ $z\ {}^9P_4$
2000 cw	3971. 96	II	1669–26838	$4f^76s^1\ a\ {}^7S^\circ_3$ —$4f^76p^1$ $z\ {}^7P_4$
1700 cw	3724. 94	II	0–26839	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^76p^1$ $z\ {}^7P_4$
900 cw	4435. 56	II	1669–24208	$4f^76s^1\ a\ {}^7S^\circ_3$ —$4f^76p^1$ $z\ {}^9P_4$
750	4594. 03	I	0–21761	$4f^76s^2\ a\ {}^8S^\circ_{3½}$—$4f^76s^16p^1$ $y\ {}^8P_{4½}$
650	4627. 22	I	0–21605	$4f^76s^2\ a\ {}^8S^\circ_{3½}$—$4f^76s^16p^1$ $y\ {}^8P_{3½}$
550	3688. 42	II	0–27104	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^76p^1$ $z\ {}^7P_3$
550	4661. 88	I	0–21445	$4f^76s^2\ a\ {}^8S^\circ_{3½}$—$4f^76s^16p^1$ $y\ {}^8P_{2½}$
420	2727. 78	II	0–36649	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^66s^16d^1$ $y\ {}^9P_5$
340	2813. 94	II	0–35527	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^66s^16d^1$ $y\ {}^9P_4$
320	2906. 68	II	0–34394	$4f^76s^1\ a\ {}^9S^\circ_4$ —$4f^66s^16d^1$ $y\ {}^9P_3$
200	4522. 57	II	1669–23774	$4f^76s^1\ a\ {}^7S^\circ_3$ —$4f^76p^1$ $z\ {}^9P_3$
200	2820. 78	II	0–35441	$4f^76s^1\ a\ {}^9S^\circ_4$ — 108_3
190	2802. 84	II	1669–37337	$4f^76s^1\ a\ {}^7S^\circ_3$ —$4f^66d^2$ $y\ {}^7P_2$
160	6645. 11	II	11128–26173	$4f^75d^1\ a\ {}^9D^\circ_6$ —$4f^76p^1$ $z\ {}^9P_5$
120	7370. 22	II	10643–24208	$4f^75d^1\ a\ {}^9D^\circ_5$ —$4f^76p^1$ $z\ {}^9P_4$
110	3212. 81	I	0–31116	$4f^76s^2\ a\ {}^8S^\circ_{3½}$— $113_{3½}$
100	3334. 33	I	0–29982	$4f^76s^2\ a\ {}^8S^\circ_{3½}$— $106_{3½,\ 4½}$

Europium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	2499.39	II	1669–41667
2.5	2554.78	II	16861–55991
2.5	2559.18	II	17004–56067
15	2564.17	II	17004–55991
10	2568.17	II	17141–56067
2.5	2574.76	II	17141–55968
22	2577.14	II	16861–55652
2.5	2581.86	II	17248–55968
2.5	2604.61	I	
3.0	2635.50	II	0–37932
95	2638.77	II	1669–39554
36	2641.27	II	0–37849
4	2653.61	II	
60	2668.34	II	1669–39135
10	2673.42	II	
24	2678.29	II	1669–38996
24	2685.66	II	0–37224
55	2692.03	II	1669–38805
70	2701.14	II	0–37011
80	2701.90	II	0–37000
24	2705.28	II	0–36954
18	2709.99	I	0–36890
70	2716.98	II	1669–38464
7	2723.96	I	0–36700
420	2727.78	II	0–36649
19	2729.33	II	0–36628
38	2729.44	II	1669–38296
5	2731.37	I	0–36601
4	2732.61	I	0–36584
8	2735.25	I	0–36549
16	2740.62	II	1669–38146
7	2743.28	I	0–36442
12	2744.26	II	0–36429
4	2745.61	I	0–36411
7	2747.29	II	1669–38058
8	2747.83	I	0–36381
9	2752.17	II	1669–37994
48	2781.89	II	1669–37606
190	2802.84	II	1669–37337
22	2811.75	II	1669–37224
3.0	2813.08	II	
340	2813.94	II	0–35527
55	2816.18	II	1669–37168
200	2820.78	II	0–35441
40 cw	2828.72	II	1669–37011
12	2829.30	II	1669–37003
14	2833.26	II	1669–36954
8	2843.96	II	1669–36821
6	2852.05	II	
26	2859.67	II	1669–36628
28	2862.57	II	0–34923
2.5	2864.42	II	11128–46029
6	2876.06	II	1669–36429
10	2878.87	I	0–34726
8	2887.85	II	0–34618
20	2892.54	I	0–34562
14	2893.03	I	0–34556
36	2893.83	I	
		II	0–34546
320	2906.68	II	0–34394
16	2908.99	I	0–34366
3.0	2917.44	II	1669–35936
85	2925.04	II	1669–35847
6	2947.29	II	0–33920
20 cw	2952.68	II	1669–35527
3.0	2958.91	I	0–33786
3.5	2959.47	II	0–33780
26	2960.21	II	1669–35441
30	2991.33	II	0–33420
3.5	2995.22	II	1669–35046
4	3006.26	II	1669–34923
3.5	3022.15	I	
3.0	3040.77	II	1669–34546
32 cw	3054.94	II	1669–34394
12	3058.98	I	0–32681
3.5	3069.11	II	24208–56781
3.5	3076.07	II	
22	3077.36	II	0–32486
3.5	3089.35	II	
12	3097.45	II	1669–33944
32	3106.18	I	0–32185
95	3111.43	I	0–32130
12	3130.73	II	
4	3132.16	I	
5	3149.88	II	
9	3173.61	II	0–31501
4	3185.54	I	0–31383
44	3210.57	I	0–31138
110	3212.81	I	0–31116
44	3213.75	I	0–31107
5	3235.13	I	0–30902
10	3241.40	I	0–30842
5	3246.03	I	0–30798
5	3247.32	II	
11	3247.55	I	0–30784
11	3266.39	II	23774–54380
16	3272.77	II	23774–54321
22	3277.78	II	23774–54274
16	3301.95	II	24208–54484
5	3304.50	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
15	3308.02	II	24208–54429
15	3313.33	II	24208–54380
7	3319.89	II	24208–54321
10	3321.86	II	11128–41223
9	3322.26	I	0–30091
100	3334.33	I	0–29982
5	3338.75	II	26838–56781
12	3350.40	I	0–29839
4	3351.56	II	
4	3354.38	II	
5	3367.64	II	10082–39768
15	3369.06	II	10643–40317
7	3380.25	II	24208–53783
8	3390.78	II	
20	3391.99	II	10082–39554
30	3396.58	II	26838–56271
5	3419.84	II	
7	3423.09	II	
16	3425.02	II	11128–40317
5	3426.44	II	9923–39099
5	3435.05	II	
7	3435.20	II	
4	3435.72	II	
5	3440.82	II	27256–56311
16	3441.00	II	10082–39135
5	3445.18	II	10082–39099
9	3457.05	I	0–28918
5	3457.56	II	10082–38996
14	3461.38	II	9923–38805
9	3467.88	I	0–28828
8	3477.07	I	
8 h	3505.30	II	1669–30189
50 cw	3521.09	II	26173–54565
8	3531.15	II	26173–54484
5	3532.23	II	27256–55559
7	3538.08	II	26173–54429
16	3542.15	II	9923–38146
9	3543.85	II	
5	3549.71	II	
19	3552.52	II	10643–38784
8	3589.27	I	0–27853
5	3591.31	II	
16	3603.20	II	10313–38058
8	3611.57	II	10313–37994
5	3616.15	II	26838–54484
10	3622.54	II	11128–38725
10	3632.18	II	10082–37606
5	3673.19	II	27104–54321
5	3674.63	II	10643–37849
5	3678.26	II	27256–54435
550	3688.42	II	0–27104
5	3710.87	II	10643–37584
8	3713.45	II	10082–37003
8	3714.90	II	10313–37224
3.0	3716.94	II	
3.0	3717.69	II	
3.5	3719.16	I	14564–41444
1700 cw	3724.94	II	0–26839
4	3729.68	II	
4	3729.74	II	11128–37932
1.8	3732.20	I	14068–40854
4	3738.08	II	
30	3741.31	II	11128–37849
9	3743.56	II	9923–36628
22	3761.12	II	10643–37224
8	3765.93	II	10082–36628
3.5	3774.10	I	16612–43101
5	3781.40	II	
3.5	3788.76	II	27104–53490
4	3791.50	II	10643–37011
11	3799.01	II	10313–36628
6	3801.36		
8	3807.54	II	
10	3811.33	I	14068–40298
10	3815.50	II	
3400 cw	3819.67	II	0–26173
10	3826.68	II	26838–52963
12	3844.23	II	10643–36649
16	3865.57	I	15582–41444
4	3872.72	I	15582–41396
6	3877.27	II	
13	3884.75	I	14564–40298
2.0	3896.78	I	
2.0	3900.18	I	
6	3900.51	I	13222–38852
2400 cw	3907.10	II	1669–27256
4	3915.24	II	
4	3916.00	I	
20	3917.29	I	13049–38569
2.0	3917.70	II	9923–35441
3.5	3918.52	I	13779–39291
9	3919.09	II	
3.5	3928.87	II	10082–35527
2800 cw	3930.48	II	1669–27104
3.5	3941.56	II	
2.0 h	3942.21	II	10082–35441
4	3942.94	II	
8	3943.08	II	23774–49128
2.0	3944.59	II	
2.0	3945.67	II	

Europium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	3949.13	II	
4	3949.60	I	13049–38361
3.0	3950.76	II	
3.5	3951.33	II	
4	3955.75	I	15582–40854
2.5	3957.92	II	
2.0	3963.61	I	15952–41175
8	3964.90	II	10313–35527
10	3966.59	II	
3.0	3967.18	I	14068–39268
2000 cw	3971.96	II	1669–26838
4	3978.42	I	13457–38586
2.0	3979.63	II	
3.5 h	3986.60	I	13457–38534
2.5	3988.24	II	
2.0	3993.93	II	
3.5	3995.98	II	
4	4003.71	II	
12	4011.69	II	24208–49128
10	4017.58	II	10643–35527
8	4039.19	I	
3.0 h	4078.24	I	13779–38292
8	4085.38	II	9923–34394
5	4096.80	II	10643–35046
4	4106.88	I	12924–37266
6 h	4112.04	II	10082–34394
3.0	4119.30	II	
5	4127.28	I	16080–40302
2200 cw	4129.70	II	0–24208
2.0	4136.59	II	
2.5	4137.07	I	16080–40245
2.0	4141.02	II	
4	4141.72	II	
2.0	4151.52	II	10313–34394
3.0	4151.64	II	
2.0	4157.72	I	13049–37094
7	4172.80	II	
2.0	4175.16	II	
7	4182.22	I	13222–37126
2.5	4195.36	II	
2.5	4196.18	II	
4000 cw	4205.05	II	0–23774
3.0	4221.08	II	
2.5	4223.88	II	
6 h	4227.40	II	
5	4229.33	II	
5	4232.45	II	
6	4237.51	II	
3.0	4238.69	II	
3.0	4244.74	I	13049–36601
3.0	4247.06	II	
3.0	4253.80	II	
2.0	4270.24	II	
10	4298.73	I	13779–37035
6	4329.36	I	13457–36549
5	4329.97	I	13779–36867
4	4330.61	II	
2.5	4331.18	I	12924–36006
6	4337.68	I	13457–36504
16	4355.09	II	26173–49128
1.8	4361.57	II	
3.5	4369.47	II	
3.0 h	4372.20	II	
5	4383.17	II	26838–49647
6	4387.88	I	13222–36006
1.4 h	4405.27	II	16861–39554
3.5	4407.07	II	
1.2	4419.66	II	
8	4434.81	II	27104–49647
900 cw	4435.56	II	1669–24208
5 h	4464.97	II	27256–49647
1.6	4485.15	II	26838–49128
200	4522.57	II	1669–23774
3 h	4535.59	I	15952–37994
750	4594.03	I	0–21761
1.4	4602.63	I	16080–37800
650	4627.22	I	0–21605
550	4661.88	I	0–21445
2.0	4713.59	I	15680–36890
1.8	4740.50	I	13457–34546
3.0	4792.59	I	13457–34317
2.5 h	4829.30	I	15680–36381
4	4830.33	I	17341–38037
2.5 h	4840.47	I	17341–37994
4 h	4849.64	I	15952–36567
7	4867.62	I	13779–34317
2.5 h	4884.05	I	16080–36549
6	4894.68	I	16080–36504
4	4900.86	I	14068–34467
10	4907.18	I	14068–34440
12	4911.40	I	14068–34423
3.5	4953.52	I	15891–36073
3.5	4960.21	I	15891–36045
3.5	4962.55	I	15952–36098
3.0	4975.76	I	17945–38037
12	5013.17	I	14564–34506
11	5022.91	I	14564–34467
7	5029.54	I	14564–34440
6	5033.55	I	15952–35813
5	5067.95	I	13222–32948

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5	h	5092.69	I	16612–36242
6	h	5096.44	I	19447–39063
11		5114.37	I	13049–32596
6		5124.77	I	15891–35398
11		5129.10	I	13457–32948
6		5130.08	I	15891–35378
14		5133.52	I	12924–32398
18		5160.07	I	13222–32596
14		5166.70	I	13049–32398
4		5193.74	I	17341–36589
13		5199.85	I	17341–36567
7		5200.96	I	15952–35174
8		5206.44	I	16612–35813
50		5215.10	I	13779–32948
20		5223.49	I	13457–32596
8		5239.24	I	13049–32130
13		5266.40	I	13779–32762
26		5271.96	I	15582–34545
7		5272.48	I	13457–32418
10		5282.82	I	15582–34506
3.5		5287.25	I	13222–32130
4		5289.25	I	17707–36608
8		5291.26	I	19273–38167
4		5293.68	I	15582–34467
8		5294.64	I	17707–36589
6		5303.85	I	16612–35461
2.0	h	5350.41	I	17945–36630
5	h	5351.69	I	15421–34102
2.5		5352.84	I	17945–36622
6		5355.10	I	16612–35280
36		5357.61	I	13457–32117
4		5360.83	I	15138–33786
8		5361.61	I	16080–34726
7		5376.94	I	16612–35205
8		5392.94	I	15249–33786
30		5402.77	I	13222–31726
3.0		5405.33	I	16612–35107
3.0		5411.86	I	17341–35813
3.5		5421.07	I	16612–35053
6		5426.94	I	15680–34102
2.5		5443.56	I	15421–33786
25		5451.51	I	13779–32117
17		5452.94	I	13049–31383
2.5		5457.62	I	19273–37591
6		5472.32	I	13457–31726
8		5488.65	I	12924–31138
3.0		5495.20	I	12924–31116
1.0		5500.83	I	15952–34126
8		5510.52	I	14068–32210
2.0		5526.63	I	13049–31138
2.0		5533.25	I	13049–31116
2.0		5542.54	I	17341–35378
13		5547.44	I	12924–30945
10		5570.33	I	13779–31726
13		5577.14	I	13457–31383
5		5579.63	I	14564–32481
8		5580.03	I	13222–31138
6		5586.24	I	13049–30945
5		5586.83	I	13222–31116
1.2		5592.25	I	12924–30801
1.2		5599.80	I	13049–30902
1.2		5605.86	I	17341–35174
2.5		5618.81	I	13222–31014
4		5622.44	I	14068–31849
5		5632.54	I	13049–30798
14		5645.80	I	0–17707
1.0		5651.11	I	17707–35398
4		5673.85	I	13222–30842
1.8		5681.10	I	13222–30819
1.8		5684.24	I	19447–37035
4		5730.87	I	13457–30902
4		5739.00	I	19447–36867
22		5765.20	I	0–17341
12		5783.69	I	14564–31849
1.0		5792.72	I	19631–36890
4		5800.27	I	13779–31014
11		5818.74	II	9923–27104
40	cw	5830.98	I	13779–30924
1.8		5845.77	I	19447–36549
1.8		5860.97	I	19447–36504
1.0		5864.77	I	19364–36411
6		5872.98	II	10082–27104
1.0		5895.31	I	19544–36502
1.8		5902.97	I	19764–36700
0.8		5909.94	I	15680–32596
5		5915.74	I	15582–32481
0.8		5925.30	I	19712–36584
1.8		5926.52	I	16080–32948
3.0		5942.72	I	19462–36285
1.8		5953.49	I	19794–36586
1.8		5953.84	II	10313–27104
2.0		5954.28	I	19794–36584
6		5963.76	I	15421–32185
22		5966.07	II	10082–26838
32	cw	5967.10	I	13457–30211
1.0	h	5968.43	I	19631–36381
2.0		5971.69	I	19544–36285
11		5972.75	I	15680–32418
1.0		5980.47	I	19364–36081
1.8		5983.14	I	15421–32130

Europium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.8	5983.78	I	19364–36072
16	5992.83	I	16080–32762
4	6004.36	I	15138–31788
1.0 h	6005.61	I	15680–32327
4 h	6012.20	I	15582–32210
7	6012.56	I	15249–31876
4	6015.58	I	19462–36081
28	6018.15	I	0–16612
4	6023.15	I	15138–31736
11	6029.00	I	15421–32003
4	6044.66	I	15249–31788
28	6049.51	II	10313–26838
9	6057.36	I	15680–32185
6	6075.58	I	15421–31876
2.0	6077.38	I	15680–32130
16	6083.84	I	13779–30211
16	6099.35	I	13222–29613
4	6108.15	I	19364–35732
8	6118.78	I	16080–32418
4	6124.67	I	15680–32003
22	6173.05	II	10643–26838
7	6178.76	I	19273–35453
17 cw	6188.13	I	13457–29613
9	6195.07	I	13049–29186
1.0 h	6207.60	I	16080–32185
1.0	6230.51	I	15680–31726
6 h	6233.73	I	16080–32117
3.5	6250.47	I	12924–28918
16	6262.25	I	13222–29186
3.5	6266.95	I	0–15952
1.0 h	6285.95	I	12924–28828
4	6291.34	I	0–15891
11	6299.77	I	13049–28918
15	6303.41	II	10313–26173
1.6 h	6313.78	I	13779–29613
1.0	6318.58	I	19631–35453
5	6335.82	I	13049–28828
8 cw	6350.04	I	12924–28667
4	6355.89	I	13457–29186
4	6369.25	I	13222–28918
3.5	6382.73	I	15138–30801
5	6383.86	I	15138–30798
8 cw	6400.93	I	13049–28667
2.5	6406.11	I	13222–28828
12	6410.04	I	12924–28520
9	6411.32	I	15249–30842
3.5	6428.29	I	15249–30801
55	6437.64	II	10643–26173
1.2	6439.93	I	15421–30945
8	6457.96	I	15421–30902
0.8	6470.70	I	14068–29518
1.2	6483.02	I	15421–30842
3.0	6501.55	I	15421–30798
4	6519.59	I	15680–31014
1.0	6522.72	I	15891–31217
0.5 h	6549.12	I	15952–31217
5	6567.87	I	15680–30902
3.0	6593.79	I	15680–30842
1.2 h	6603.55	I	15680–30819
160	6645.11	II	11128–26173
3.0	6685.21	I	14564–29518
11	6693.96	I	16080–31014
0.8 h	6701.06	I	19447–34366
1.4 h	6710.45	I	21761–36659
3.5	6744.88	I	16080–30902
3.5 h	6782.54	I	16080–30819
1.6 h	6787.48	I	15891–30619
16	6802.72	I	14068–28764
13	6816.06	I	15952–30619
1.3 h	6834.30	I	21445–36073
2.0	6840.93	I	21605–36219
2.0 h	6844.83	I	16612–31217
1.6 h	6847.04	I	21445–36045
42	6864.54	I	0–14564
2.5	6898.21	I	21605–36098
7 h	6903.67	I	21761–36242
1.6 h	6910.17	I	21605–36073
3.5 h	6914.82	I	21761–36219
20	7040.20	I	14564–28764
2.0	7074.54	I	16080–30211
55	7077.10	II	10082–24208
17	7106.48	I	0–14068
1.0	7164.66	I	21445–35398
5	7175.55	I	15680–29613
95	7194.81	II	10313–24208
95	7217.55	II	9923–23774
1.8 h	7224.68	I	21445–35282
2.5	7258.72	I	21605–35378
5	7262.77	I	15421–29186
1.8 h	7281.53	I	21445–35174
1.0 h	7297.56	I	21761–35461
90	7301.17	II	10082–23774
1.8	7310.46	I	21605–35280
2.0	7313.63	I	15249–28918
9 cw	7336.18	I	15891–29518
0.6	7346.25	I	21445–35053
0.6	7356.65	I	21445–35034
1.8	7362.25	I	15249–28828
9 cw	7369.60	I	15952–29518
120	7370.22	II	10643–24208

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.6	7387.36	I	16080–29613
2.0	7389.16	I	15138–28667
1.8 h	7404.41	I	21605–35107
50	7426.57	II	10313–23774
3.5 h	7436.59	I	21761–35205
1.4	7470.53	I	15138–28520
0.9 h	7491.00	I	21761–35107
8 cw	7528.70	I	17341–30619
0.9 h	7533.02	I	15249–28520
1.0	7547.32	I	15421–28667
26	7583.91	I	15582–28764
10 cw	7742.57	I	17707–30619
12	7746.19	I	16612–29518
1.4 h	7803.32	I	15952–28764
1.4	7818.21	I	19631–32418
6	7887.99	I	17945–30619
1.2	8015.47	I	19712–32185
4 cw	8209.80	I	17341–29518
2.5 cw	8226.81	I	16612–28764
1.0 h	8464.71	I	17707–29518
3.5 cw	8642.67	I	19447–31014
1.2	8727.77	I	19447–30902
1.0	8782.46	I	19631–31014
2.0 cw	8790.88	I	19447–30819
3.0	8870.30	I	19631–30902

GADOLINIUM

Gd, $Z=64$, $M=157.26$, Ratio $\frac{Gd}{Cu}=2.475$

Gd I Normal state of valence electrons $4f^7\,5d^1\,6s^2\ {}^9D^\circ_2 = 0$. I.P.= 49700 K
Gd II Normal state of valence electrons $4f^7\,5d^1\,6s^1\ {}^{10}D^\circ_{2\frac{1}{2}} = 0$. I.P.=100000 K

References

Wavelengths:
A. S. King, Astrophys. J. **97,** 323 (1943).

Classification:
Gd I and Gd II, H. N. Russell, J. Opt. Soc. Am. **40,** 550 (1950).

Molecular Spectra:
GdO, A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945).

Relative intensity of gadolinium lines observed in an arc of copper containing 0.1 atomic percent of gadolinium

Strong lines of gadolinium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
850	3768. 39	II	633–27162	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{4\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{4\frac{1}{2}}$
700	3422. 47	II	1935–31146	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{6\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{7\frac{1}{2}}$
600	3646. 19	II	1935–29353	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{6\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{6\frac{1}{2}}$
550	3350. 47	II	1159–30997	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{5\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}D_{6\frac{1}{2}}$
550	3362. 23	II	633–30367	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{4\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{8}D_{5\frac{1}{2}}$
550	3584. 96	II	1159–29045	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{5\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}D_{4\frac{1}{2}}$
500	3796. 37	II	262–26595	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{3\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{3\frac{1}{2}}$
500	3850. 97	II	0–25960	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{2\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{1\frac{1}{2}}$
440	3358. 62	II	262–30027	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{3\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{8}D_{4\frac{1}{2}}$
440	3545. 80	II	1159–29353	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{5\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{6\frac{1}{2}}$
440	3743. 47	II	1159–27865	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{5\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{5\frac{1}{2}}$
440	4225. 85	I	1719–25376	$4f^76s^25d^1\ a\ {}^{9}D^\circ_{5}$ —$4f^76s^15d^16p^1\ y\ {}^{9}F_{7}$
420	3852. 45	II	262–26212	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{3\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{2\frac{1}{2}}$
400	3549. 36	II	1935–30101	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{6\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}D_{5\frac{1}{2}}$
380	3654. 62	II	633–27988	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{4\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{8}P_{3\frac{1}{2}}$
360	3813. 97	II	0–26212	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{2\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{2\frac{1}{2}}$
320	3850. 69	II	633–26595	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{4\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}F_{3\frac{1}{2}}$
300	3100. 50	II	1935–34179	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{6\frac{1}{2}}$—$4f^75d^16p^1\ y\ {}^{10}P_{5\frac{1}{2}}$
300	3656. 15	II	1159–28502	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{5\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}P_{5\frac{1}{2}}$
300	3687. 74	II	2857–29966	$4f^76s\ 5d^1\ a\ {}^{8}D^\circ_{1\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{8}D_{2\frac{1}{2}}$
280	3439. 99	II	1935–30997	$4f^76s\ 5d^1\ a\ {}^{10}D^\circ_{6\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}D_{6\frac{1}{2}}$
280	3463. 98	II	3444–32304	$4f^76s^2\ \ a\ {}^{8}S^\circ_{3\frac{1}{2}}$—$4f^75d^16p^1\ y\ {}^{8}P_{4\frac{1}{2}}$
280	3783. 05	I	999–27425	$4f^76s^25d^1\ a\ {}^{9}D^\circ_{5}$ —$4f^76s^15d^16p^1\ x\ {}^{9}P_{4}$
260	3664. 60	II		
260	3712. 70	II	3082–30009	$4f^76s^15d^1\ a\ {}^{8}D^\circ_{2\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{8}D_{3\frac{1}{2}}$
260	4078. 70	I	533–25044	$4f^76s^25d^1\ a\ {}^{9}D^\circ_{4}$ —$4f^76s^15d^16p^1\ y\ {}^{9}D_{5}$
240	4053. 64	I	999–25661	$4f^76s^25d^1\ a\ {}^{9}D^\circ_{5}$ —$4f^76s^15d^16p^1\ y\ {}^{9}D_{6}$
240	4058. 22	I	215–24850	$4f^76s^25d^1\ a\ {}^{9}D^\circ_{3}$ —$4f^76s^15d\ 6p^1\ y\ {}^{9}D_{4}$
240	4098. 61	II	6605–30997	$4f^75d^2\ \ a\ {}^{10}F^\circ_{1\frac{1}{2}}$—$4f^75d^16p^1\ z\ {}^{10}D_{6\frac{1}{2}}$
240d	4325. 57	II	11067–34179	$4f^75d^2\ \ a\ {}^{10}P^\circ_{4\frac{1}{2}}$—$4f^75d\ 6p^1\ y\ {}^{10}P_{5\frac{1}{2}}$
	4325. 69	I	533–23644	$4f^76s^25d^1\ a\ {}^{9}D^\circ_{4}$ —$4f^76s^15d^16p^1\ y\ {}^{9}F_{4}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	2468.22	II	8551–49054
4	2471.58	II	8885–49332
2.5	2485.67	II	9329–49547
5	2487.46	II	9143–49332
8	2488.72	II	8885–49054
4	2493.29	II	9452–49547
2.5	2496.35	II	9452–49498
3.0	2499.04	II	9329–49332
2.0	2543.68	II	3444–42745
2.0	2586.13	II	3972–42628
2.0	2661.50	II	11492–49054
5	2720.50	II	
30	2750.22	II	3427–39777
40	2764.08	II	2857–39025
3.5	2768.51	II	3427–39537
28	2769.81	II	3444–39537
20	2770.17	II	3082–39170
1.8	2770.98	II	633–36711
4	2778.76	I	215–36192
4	2779.14	II	2857–38828
38	2781.40	II	3082–39025
6	2787.68	I	533–36395
34	2791.96	II	3444–39251
9	2794.66	II	2857–38629
80	2796.93	II	3427–39170
5	2808.38	II	3427–39025
65	2809.72	II	3444–39025
14	2810.93	II	3972–39537
4	2814.01	II	
26	2833.75	II	3972–39251
3.0	2836.69	II	
6	2837.00	II	3082–38320
48	2840.23	II	3972–39170
12	2841.33	II	3444–38629
3.5	2853.91	II	
5	2856.52	II	4027–39025
1.6	2859.78	II	4213–39170
10	2862.48	II	4852–39777
5	2865.06	II	3427–38320
3.5	2866.33	II	
3.5	2871.75	II	4213–39025
40	2881.33	II	4841–39537
3.5	2882.13	II	4484–39170
11	2885.60	II	
3.5	2903.75	I	1719–36147
40	2905.31	II	4841–39251
3.0	2906.26	II	4852–39251
3.0	2907.44	II	
15	2910.53	II	3972–38320
5	2913.08	II	4852–39170
4	2918.52	II	
8	2923.32	II	5340–39537
3.0	2924.25	II	
3.0	2928.34	II	2857–36996
3.0	2947.80	II	3082–36996
6	2948.01	II	5340–39251
3.0	2952.43	I	
3.0	2955.60	II	
6	2960.93	II	3082–36845
11	2963.60	II	
7	2965.43	II	4841–38553
2.5	2972.74	II	3082–36711
48	2980.15	II	633–34179
3.0	2983.74	II	
3.5	2991.52	II	3427–36845
8	2993.04	II	3444–36845
100	2999.04	II	262–33596
32	3002.86	II	
6	3003.58	II	3427–36711
9	3005.09	II	
6	3009.37	II	3427–36647
3.0	3009.65	II	4841–38058
180	3010.13	II	0–33212
7	3010.90	II	3444–36647
11	3012.19	II	4841–38030
3.5	3022.10	II	
160	3027.60	II	1159–34179
10	3028.98	II	4841–37846
4	3030.65	II	
180	3032.84	II	633–33596
140	3034.05	II	262–33212
5	3040.34	II	4852–37734
11	3043.01	I	999–33852
14	3046.48	I	533–33348
24	3053.57	II	3972–36711
9	3059.92	I	215–32886
90	3068.64	II	633–33212
6	3069.42	I	215–32785
48	3072.56	II	10092–42628
55	3076.92	II	0–32491
13	3077.08	II	3972–36461
180	3081.99	II	1159–33596
8	3083.35	II	262–32685
12	3084.01	II	
6	3085.06	II	
8	3087.05	I	0–32384
24	3089.95	II	10392–42745
12	3092.06	II	10633–42965
40	3098.64	II	0–32263
16	3098.90	II	0–32260

Gadolinium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
300	3100.50	II	1935–34179
10	3101.18	II	10392–42628
20	3101.91	II	262–32491
50	3102.55	II	8551–40773
11	3108.36	II	10803–42965
15	3111.19	I	1719–33852
14	3113.17	II	10633–42745
10	3118.60	II	10908–42965
10	3119.01	I	533–32585
44	3119.94	II	262–32304
9	3120.18	II	8885–40925
5	3123.69	II	
32	3123.99	II	262–32263
10	3124.25	II	262–32260
8	3127.25	I	999–32967
11	3128.56	II	9143–41097
8	3129.96	II	9452–41392
11	3130.81	II	9329–41260
9	3133.09	II	0–31908
40	3133.85	II	8885–40785
18	3135.03	II	262–32150
16	3136.93	I	0–31869
16	3137.30	I	0–31865
10	3138.71	I	533–32384
8	3142.90	II	9452–41260
20	3143.13	II	4841–36647
80	3145.00	II	1159–32946
32	3145.52	II	9143–40925
20	3146.88	II	9329–41097
100	3156.53	II	633–32304
20	3158.63	I	215–31865
14	3160.69	II	633–32263
100	3161.37	II	1935–33558
8	3167.20	I	999–32564
8	3169.47	II	
9	3171.09	II	1159–32685
22	3190.28	I	533–31869
9	3193.17	II	5340–36647
22	3199.30	I	1719–32967
16	3199.58	I	533–31778
11	3203.41	I	999–32207
7	3206.47	II	18369–49547
5	3215.26	I	999–32092
70	3223.74	II	1935–32946
	3223.78	I	1719–32730
11	3225.46	II	
16	3226.32	II	8551–39537
22	3232.78	I	533–31457
9	3238.62	II	10392–41260
10	3250.19	II	10633–41392
11	3259.25	II	10803–41476
55	3266.73	I	533–31136
26	3267.64	I	215–30809
14	3268.34	II	262–30850
11	3274.18	II	10392–40925
11	3279.53	II	10908–41392
10	3281.61	II	10633–41097
26	3282.25	I	999–31457
	3282.30	II	10803–41260
44	3291.48	I	1719–32092
38	3292.21	II	8885–39251
44	3294.08	I	533–30882
34	3313.73	II	3427–33596
20	3315.59	II	3444–33596
9	3316.56	II	
19	3320.44	II	9143–39251
13	3329.34	II	9143–39170
44	3330.34	II	
140	3331.38	II	0–30009
85	3332.13	II	8551–38553
9	3334.06	II	
110	3336.18	II	0–29966
9	3336.98	II	8551–38510
60	3345.98	II	0–29878
20	3350.10	II	9329–39170
550	3350.47	II	1159–30997
22	3357.61	I	533–30308
28	3358.43	II	3444–33212
440	3358.62	II	262–30027
80	3360.71	II	262–30009
550	3362.23	II	633–30367
28	3364.24	II	
20	3365.59	II	262–29966
15	3367.66	II	10092–39777
15	3369.62	II	8885–38553
10	3373.84	I	0–29631
22	3374.69	II	3972–33596
22	3379.76	II	10392–39971
10	3380.01	II	
22	3380.52	II	9452–39025
9	3390.88	II	9452–38934
110	3392.53	II	633–30101
15	3393.63	II	10633–40092
55	3395.12	II	10092–39537
22 d	3397.22	I	1719–31147
	3397.32	I	0–29426
20	3399.41	II	3082–32491
55	3399.99	II	2857–32260
11	3401.07	II	633–30027
55	3402.07	II	10392–39777

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
11		3403.08	II	9452–38828
9		3405.04	II	10803–40162
20		3406.92	I	533–29877
110	d	3407.56	II	10633–39971
		3407.61	II	4841–34179
26		3409.30	II	3427–32750
22		3411.02	I	999–30308
11		3412.02	II	9329–38629
22		3413.27	II	10803–40092
140		3416.95	II	3427–32685
13		3417.33	II	10908–40162
140		3418.73	II	0–29242
700		3422.47	II	1935–31146
40		3422.75	II	1159–30367
110		3423.90	I	999–30197
		3423.92	II	0–29198
85		3424.59	II	2857–32049
40		3425.93	II	3082–32263
10		3426.34	II	9143–38320
22		3428.47	II	10092–39251
11		3430.24	II	10633–39777
15		3430.98	II	
70		3432.99	II	2857–31977
170		3439.21	II	3082–32150
85		3439.78	II	3427–32491
280		3439.99	II	1935–30997
11		3441.79	II	3444–32491
40		3449.62	II	262–29242
140		3450.38	II	3972–32946
110		3451.23	II	3082–32049
55		3454.14	II	1159–30101
90		3454.90	II	262–29198
20		3455.27	I	1719–30652
20		3457.05	II	
22		3461.95	II	3427–32304
22		3463.00	II	1159–30027
280		3463.98	II	3444–32304
10		3466.50	II	5340–34179
34		3466.95	II	3427–32263
170		3467.27	II	3427–32260
15		3468.08	II	3082–31908
170		3468.99	II	3444–32263
8		3469.31	II	3444–32260
140		3473.22	II	262–29045
15		3476.31	II	
220		3481.28	II	4841–33558
170		3481.80	II	3972–32685
50		3482.60	II	3444–32150
22		3486.20	I	533–29209
11		3491.74	II	
100		3491.95	II	0–28629
170		3494.40	II	633–29242
9		3497.09	I	533–29120
10	h	3501.58	II	
8		3503.21	II	10633–39170
140		3505.51	II	3972–32491
80		3512.22	II	3444–31908
110		3512.50	II	10092–38553
85		3513.65	I	999–29451
9		3516.78	II	
10		3517.89	II	10092–38510
9		3522.45	II	
100		3524.20	II	262–28629
11		3525.15	I	999–29359
44		3528.54	II	3972–32304
10		3534.24	II	
15		3537.15	II	
55		3542.77	II	5340–33558
440		3545.80	II	1159–29353
400		3549.36	II	1935–30101
9		3553.72	II	10803–38934
140		3557.05	II	4841–32946
55		3558.19	II	8551–36647
44		3558.47	II	4852–32946
20		3564.05	II	4213–32263
9		3564.64	II	
11	d	3567.12	II	10803–38828
11		3567.65	II	4027–32049
10		3569.57	II	4484–32491
9		3570.41	II	
70		3571.93	II	0–27988
34		3574.74	II	10092–38058
10		3576.77	II	4027–31977
40		3578.36	II	4213–32150
10		3579.55	II	10392–38320
15		3580.62	II	10908–38828
100		3581.91	II	8551–36461
10		3583.65	I	215–28112
550		3584.96	II	1159–29045
9		3586.58	II	
15		3587.19	II	633–28502
8		3588.21	I	0–27861
55		3590.47	II	4841–32685
9		3591.44	II	4213–32049
13		3591.91	II	4852–32685
110		3592.71	II	8885–36711
20		3593.44	II	4484–32304
11		3596.84	I	999–28793
55		3600.96	II	8885–36647
10		3602.00	II	10092–37846

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
110		3604.87	I	1719–29451
28		3605.26	II	
26		3605.66	II	262–27988
13		3607.12	II	
85		3608.75	II	9143–36845
85		3610.76	II	10633–38320
22		3610.91	II	
8		3612.88	II	
55		3613.39	II	9329–36996
28	d	3614.21	II	5897–33558
		3614.42	I	
44		3617.16	II	10392–38030
40		3620.46	II	
19		3622.81	II	
28		3624.89	II	
17		3625.26	II	8885–36461
17	d	3626.32	II	9143–36711
		3626.41	II	
26		3629.51	II	9452–36996
9		3630.25	II	
13		3630.88	II	
34		3634.76	II	9143–36647
22		3639.05	II	
26		3640.18	II	4841–32304
34		3641.39	II	10392–37846
85		3645.62	II	3427–30850
600		3646.19	II	1935–29353
10		3648.48	I	1719–29120
30		3649.44	II	9452–36845
44		3650.95	II	9329–36711
16		3651.19	II	
60		3652.54	II	
380		3654.62	II	633–27988
300		3656.15	II	1159–28502
20		3658.19	I	533–27861
10		3661.66	II	
140		3662.26	II	0–27298
260		3664.60	II	
8		3668.32	II	
200		3671.20	II	633–27865
100		3674.05	I	215–27425
34		3679.21	I	533–27705
200		3684.13	I	0–27136
70		3686.33	II	
300		3687.74	II	2857–29966
20		3694.03	II	
13		3696.76	II	
10		3696.93	I	0–27042
200		3697.73	II	262–27298
130		3699.73	II	2857–29878
4		3703.51	II	
6		3709.13	II	6605–33558
260		3712.70	II	3082–30009
200		3713.57	I	215–27136
4		3715.23	II	
10		3715.92	I	215–27119
140		3716.36	II	262–27162
200		3717.48	I	533–27425
180	d	3719.45	II	
		3719.53	II	3972–30850
24		3722.07	II	13926–40785
6		3723.69	II	13926–40773
42		3725.47	I, II	
9		3726.57	I	215–27042
150		3730.84	II	3082–29878
26		3732.32	I	1719–28504
22		3732.45	II	633–27418
22		3732.67	I	533–27316
50		3733.08	II	
10		3736.44	I	1719–28475
48		3739.76	I	999–27731
32		3740.02	II	
9		3741.91	II	
440		3743.47	II	1159–27865
4		3744.14	I	
60		3744.83	I	1719–28415
4		3746.44	II	
12		3748.88	II	11067–37734
10		3751.10	I	215–26866
8		3755.24	II	
8		3755.56	II	10092–36711
22		3757.74	II	
100		3757.94	I	533–27136
140		3758.31	II	3427–30027
80		3759.00	II	0–26595
10		3759.98	I	
10		3760.47	I	7562–34147
60		3760.71	II	3444–30027
28		3760.92	II	3427–30009
85		3762.20	I	999–27572
15		3763.00	II	1935–28502
20		3763.33	II	3444–30009
36		3764.20	II	
16		3764.60	II	10092–36647
85		3767.04	II	3427–29966
850		3768.39	II	633–27162
60		3769.45	II	3444–29966
140		3770.69	II	
24		3771.26	I	533–27042
20		3773.45	I	7654–34147

Intensity and Character	Wave-length in A	Spec-trum	Energy Levels in K
16	3774.30	II	
20	3776.83	I	7235–33705
10	3779.83	II	
100	3782.34	II	
280	3783.05	I	999–27425
6	3783.73	II	
17	3787.15	I	
110	3787.56	II	3972–30367
19	3790.63	I	
75	3791.17	II	10092–36461
8	3791.72	II	4484–30850
48	3792.39	II	
8	3795.25	II	2857–29198
16	3795.75	I	999–27337
12	3795.93	II	
500	3796.37	II	262–26595
16	3798.39	II	10392–36711
70	3801.29	II	
15	3802.85	II	
20	3804.39	I	7427–33705
20	3805.09	II	
55	3805.52	II	
15	3807.65	II	10392–36647
4	3810.25	II	
360	3813.97	II	0–26212
42	3814.74	II	
75	3816.64	II	262–26455
42	3818.75	II	
6	3821.51	II	3082–29242
12	3822.17	II	4841–30997
12	3824.15	I	7562–33705
34	3826.05	II	3972–30101
22	3827.33	II	
22	3829.40	II	
18	3830.98	II	
36	3831.80	II	262–26352
20	3832.97	I	533–26615
32	3834.99	II	
95	3836.91	II	3972–30027
4	3838.90	I	999–27041
100	3839.64	II	3972–30009
12	3840.26	I	215–26248
120	3842.20	II	
140	3843.28	I	1719–27731
8	3843.80	II	4841–30850
140	3844.58	II	1159–27162
12	3845.47	II	4852–30850
15	3846.49	I	6976–32967
320	3850.69	II	633–26595
500	3850.97	II	0–25960
420	3852.45	II	262–26212
13	3854.18	II	4027–29966
44	3855.56	II	1935–27865
13	3858.45	I	6976–32886
15	3861.14	II	
23	3863.05	II	
12	3864.79	I	999–26866
150	3866.99	I	1719–27572
13	3867.26	II	4027–29878
13	3871.54	II	633–26455
13	3872.62	II	3427–29242
23	3873.57	I	6976–32785
15	3874.46	I	533–26336
20	3875.46	II	4213–30009
10	3881.84	II	3444–29198
6	3884.66	II	
7	3887.16	II	633–26352
7	3887.73	I	533–26248
14	3888.93	I	
8	3890.42	I	
5	3890.85	II	
4	3892.72	I	7103–32785
140	3894.70	II	0–25669
16	3895.23	II	4213–29878
42	3895.79	II	
6	3897.32	I	7235–32886
70	3902.40	II	3427–29045
28	3902.71	I	999–26615
22	3904.29	I	215–25821
42	3905.65	I	1719–27316
6	3907.12	I	
4	3909.25	I	
6	3909.94	I	
4	3911.62	I	
7	3912.75	I	7235–32785
6	3913.78	II	12776–38320
200	3916.51	II	4841–30367
11	3918.06	II	
11	3918.24	II	4852–30367
42	3923.25	II	4484–29966
10	3926.68	I	7427–32886
11	3932.98	II	
110	3934.79	I	533–25940
	3934.82	II	262–25669
20	3935.38	I	0–25403
7	3938.11	II	
10	3938.97	II	
42	3941.80	I	1719–27081
55	3942.63	I	215–25572
25	3943.24	I	0–25353

Gadolinium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
20	3943.62	I	7235–32585
130	3945.54	I	999–26337
		I	0–25338
5	3949.25	II	
28	3952.00	II	1159–26455
55	3953.37	I	533–25821
110	3957.67	II	4841–30101
10	3958.68	I	0–25254
70	3959.44	II	4852–30101
	3959.52	II	5897–31146
17	3960.11	I	6976–32221
5	3962.10	II	
20	3963.66	II	
7	3965.04	I	7235–32448
55	3966.28	I	1719–26925
55	3968.26	II	1159–26352
70	3969.00	I	215–25403
25	3969.29	II	4841–30027
6	3970.18	I	
13	3971.06	II	4852–30027
42	3971.75	II	4027–29198
8	3972.17	II	
36	3972.71	I	0–25165
55	3973.98	II	4852–30009
28	3974.81	I	1719–26870
11	3975.11	II	
70	3979.33	I	215–25338
14	3983.01	II	5897–30997
42	3987.21	II	3972–29045
44	3987.84	I	0–25069
9	3989.25	II	
30	3992.69	I	533–25572
20	3993.21	II	633–25669
60	3994.16	II	4213–29242
65	3996.32	II	
30	3997.76	II	8551–33558
6	4000.18	I	6786–31778
44	4001.26	II	4213–29198
6	4001.96	II	
6	4003.85	II	11492–36461
24	4004.94	II	
10	4006.96	I	215–25165
30	4008.33	I	999–25940
28	4008.91	II	
10	4009.22	II	
14	4013.43	I	7427–32336
28	4013.80	II	
8	4013.95	II	3082–27989
14	4015.22	I	7235–32133
19	4015.58	I	1719–26615
28	4017.25	I	7562–32448
40	4017.71	I	6976–31859
28	4019.73	I	533–25403
28	4022.33	II	
100	4023.14	I	1719–26568
75	4023.35	I	533–25381
20	4027.61	I	999–25821
100	4028.15	I	6976–31795
80	4030.88	I	6976–31778
65	4033.49	I	7235–32020
32	4035.40	I	215–24989
24	4036.84	I	7235–32000
130	4037.33	II	5340–30101
65	4037.90	II	4484–29242
10	4039.49	II	
16	4039.67	II	
6	4042.76	II	
38	4043.71	I	7427–32150
4	4044.02	I	533–25254
150	4045.01	I	0–24715
12	4045.15	II	4484–29198
25	4046.84	II	
25	4047.09	I	7654–32356
15	4047.81	II	
10	4048.60	II	
25	4049.20	I	7562–32252
120	4049.43	II	5340–30027
200	4049.86	II	
25	4050.37	I	7654–32336
75	4053.29	II	
240	4053.64	I	999–25661
75	4054.72	I	0–24656
240	4058.22	I	215–24850
10	4059.37	II	13926–38553
60	4059.88	I	7235–31859
25	4061.30	II	
60	4062.59	II	
180	4063.39	II	
50	4063.59	II	4027–28629
24	4066.04	I	7562–32150
48	4068.35	I	7427–32000
24	4068.74	I	7562–32133
70	4070.29	II	4484–29045
	4070.39	II	3427–27988
60	4073.20	II	3444–27988
28	4073.76	II	6605–31146
120	4078.44	II	4841–29353
260	4078.70	I	533–25044
18	4080.53	I	215–24715
48	4083.70	I	6976–31457

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4084.68	II	
140	4085.56	II	5897–30367
24	4087.69	II	
60	4090.41	I	215–24656
4	4091.75	I	7427–31859
100	4092.71	I	1719–26146
24	4093.72	I	7427–31848
24	4094.48	II	4213–28629
240	4098.61	II	6605–30997
48	4098.90	II	4852–29242
60	4100.26	I	999–25381
9	4104.99	I	7103–31457
7	4108.40	II	12662–36996
4	4110.43	II	
14	4110.60	II	
36	4111.44	II	
12	4111.74	II	
6	4112.94	I	7562–31869
4	4113.77	II	
7	4115.38	II	12704–36996
6	4119.21	I	
6	4119.38	II	
5	4125.78	I	8499–32730
4	4127.72	II	12776–36996
200	4130.37	II	5897–30101
25	4131.48	II	
100	4132.28	II	4852–29045
70	4134.16	I	533–24715
38	4137.10	II	
4	4138.03	I	6976–31136
11	4140.45	II	4484–28629
4	4141.02	II	12704–36845
4	4144.25	I	
26	4148.86	I	1719–25815
5	4149.48	I	7235–31328
4	4150.61	II	
3.5	4151.63	II	
10	4153.51	II	12776–36845
18	4154.86	II	8885–32946
18	4157.78	I	999–25044
3.5	4158.48	I	
50	4162.73	II	3972–27988
26	4163.09	II	5340–29353
26	4167.16	II	3427–27418
	4167.27	I	999–24989
12	4170.11	II	3444–27418
11	4171.71	I	11830–35795
11	4173.56	II	12892–36845
220	4175.54	I	1719–25661
9	4182.77	I	7235–31136
220	4184.25	II	3972–27865
8	4188.10	II	3427–27298
4	4188.82	I	
6	4190.20	I	
200	4190.78	I	999–24854
70	4191.07	II	3444–27298
70	4191.63	I	999–24850
7	4193.15	II	
10	4197.07	II	12892–36711
42	4197.68	II	
8	4202.52	II	
55	4204.86	II	4213–27988
5	4208.08	I	6550–30308
120	4212.00	II	3427–27162
90	4215.02	II	3444–27162
60	4217.20	II	5340–29045
4	4223.02	II	18955–42628
6	4224.27	I	7480–31147
30	4225.03	I	1719–25381
15	4225.15	II	4841–28502
450	4225.85	I	1719–25376
20	4227.14	II	4852–28502
20	4229.80	II	13076–36711
7	4232.47	II	
6	4232.93	I	
5	4235.07	II	8885–32491
8	4235.88	II	
60	4238.78	II	
9	4241.28	II	13076–36647
17	4243.84	II	
14	4245.34	I	7103–30652
19	4246.57	II	9143–32685
6	4250.28	I	6786–30308
160	4251.73	II	3082–26595
80	4253.37	II	4484–27988
60	4253.61	II	
75	4260.12	I	533–24000
150	4262.09	I	6786–30242
		II	5897–29353
60	4266.60	I	999–24430
44	4267.00	I	215–23644
15	4268.73	II	8885–32304
5	4270.28	I	6786–30197
5 h	4273.29	I	
28	4274.17	I	0–23390
5 h	4278.22	II	
85	4280.49	II	2857–26212
4	4282.79	II	
40	4285.82	I	6550–29877
28	4286.12	I	1719–25044

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		4289.88	II	
50		4296.08	II	4027–27298
13		4296.30	II	13378–36647
20		4297.17	II	
4		4298.43	II	
40		4299.29	I	6378–29631
12		4304.90	II	
100		4306.34	I	0–23215
3.0		4307.87	II	
24		4309.29	I	7947–31147
8		4310.98	II	3972–27162
170		4313.84	I	215–23390
48		4314.40	I	7480–30652
48		4316.05	II	5340–28502
6		4316.27	II	9143–32304
34		4320.52	I	7103–30242
70		4321.11	II	4852–27988
		4321.20	I	1719–24854
12		4322.20	II	3082–26212
12		4324.06	II	9143–32263
240	d	4325.57	II	11067–34179
		4325.69	I	533–23644
4		4326.32	II	17817–40925
180		4327.12	I	0–23104
			II	2857–25960
11		4328.94	I	7103–30197
34		4329.58	I	6786–29877
32		4330.61	II	4213–27298
22		4331.38	I	6550–29631
7		4333.24	I	
3.5		4335.29	II	17725–40785
3.5	d	4336.63	I	
		4336.78	I	
13		4337.51	I	6378–29426
			II	17725–40773
3.5		4340.60	I	
42		4341.28	II	3427–26455
85		4342.18	II	4841–27865
95		4344.30	II	4852–27865
200		4346.46	I	999–24000
85		4346.62	I	215–23215
20		4347.31	II	10600–33596
7		4353.79	I	
3.0		4354.06	II	
5		4359.15	II	4484–27418
3.0		4359.64	II	9329–32260
15		4360.92	II	3427–26352
15		4369.15	I	
28		4369.77	II	3082–25960
18		4370.18	I	6550–29426
90		4373.83	I	533–23390
8		4376.07	I	6786–29631
18		4378.56	I	7562–30395
13		4380.64	II	9329–32150
9		4382.06	II	4484–27298
13		4383.12	II	9452–32260
4		4386.20	I	
3.0		4387.17	I	
17		4387.67	II	3427–26212
17		4389.88	I	7103–29877
17		4390.00		
14		4390.95	II	3444–26212
6		4391.44	II	9143–31908
26		4392.06	I	7480–30242
2.5		4394.72	II	6605–29353
17		4397.51	II	
3.0		4400.18	II	9329–32049
8		4400.76	I	7480–30197
130		4401.86	I	1719–24430
48		4403.14	I	7947–30652
24		4406.67	II	11492–34179
24		4408.25	II	4484–27162
20		4409.25	I	8498–31172
48		4411.16	I	533–23196
2.5		4413.44	I	6976–29628
80		4414.16	I	8498–31147
65		4414.73	I	999–23644
32		4419.03	II	3972–26595
13		4421.24	II	10600–33212
130		4422.41	I	215–22821
4		4424.10	II	9452–32049
11		4425.01	I	
5		4426.15	II	3082–25669
4		4427.61	II	9329–31908
100		4430.63	I	0–22564
8		4431.76	I	7947–30505
4		4433.64	II	10633–33182
22	d	4436.10	I	
		4436.22	II	13926–36461
15		4438.27	II	5340–27865
3.0		4444.98	I	
7		4446.49	II	3972–26455
2.5		4449.02	I	
2.5		4449.41	I	
3.5		4452.73	I	12487–34938
3.5		4453.93	II	8551–30997
2.0	d	4458.32	I	
		4458.41	I	
3.0		4461.36	I	7427–29835
10		4462.83	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	4463.25	II	10092–32491
28	4464.74	I	
28	4466.55	II	4213–26595
	4466.60	I	6976–29359
48	4467.08	I	
7	4467.23	II	10803–33182
10	4471.29	II	10392–32750
6	4473.28	I	215–22564
65	4474.13	I	
80	4476.12	I	0–22335
20	4478.80	II	4841–27162
26	4481.06	II	4852–27162
20	4483.33	II	8551–30850
20	4484.70	I	
2.5	4485.48	I	533–22821
6	4486.35	II	18641–40925
26	4486.90	I	1719–24000
6 h	4488.40	II	10908–33182
46	4497.13	I	999–23229
20	4497.32	I	
16	4498.28	II	3444–25669
2.5	4503.79	I	999–23196
40	4506.21	I	533–22718
13	4506.33	II	4027–26212
5	4506.93	II	3427–25609
5	4509.08	II	10092–32263
13	4514.50	II	11067–33212
8	4516.98	I	
100	4519.66	I	215–22335
6	4520.07	II	10633–32750
5	4521.30	II	4484–26595
7	4521.94	II	18677–40785
28	4522.82	II	11492–33596
14	4524.12	I	
9	4536.97	I	
85	4537.81	I	533–22564
20	4540.02	II	18753–40773
28	4542.03	I	215–22226
6	4544.23	I	7427–29426
22	4548.00	I	
6	4550.95	II	5897–27865
4	4554.99	II	10803–32750
11	4558.08	II	4027–25960
2.5	4559.62	I	
4 d	4561.08	I	
2.5	4564.59	I	10884–32785
3.0 h	4570.98	II	10392–32263
8	4572.20	I	6976–28842
12	4573.81	I	0–21858
24	4575.91	I	7947–29795
26	4579.59	I	
8	4581.09	II	5340–27162
38	4581.29	I	999–22821
9	4582.38	II	10092–31908
12	4582.53	II	8551–30367
38	4583.07	I	7480–29294
8	4584.26	I	10576–32384
15	4586.99	I	
20	4596.98	II	4213–25960
30	4597.91	II	4852–26595
38	4598.90	I	7103–28842
32	4601.05	II	4484–26212
22	4602.93	I	999–22718
5 h	4606.06	I	
3.0	4608.03	II	19402–41097
2.5	4608.58	I	533–22226
5 h	4611.04	I	
48	4614.50	I	6786–28451
8 bl	4615.6	GdO	
6	4619.14	I	10222–31865
13	4624.42	I	6550–28169
40	4636.64	I	6550–28112
10	4639.00	II	8551–30101
16	4640.04	I	
16	4646.00	I	11830–33348
16	4647.64	II	1719–23229
16 d	4648.59	I	
	4648.70	I	10360–31865
40	4653.54	I	6378–27861
8	4654.99	II	8551–30027
4	4664.27	II	17817–39251
5	4666.45	II	11067–32491
13 h	4670.87	I	
5	4678.25	I	
16	4679.18	I	12487–33852
24	4680.04	I	7480–28842
6	4683.07	I	7103–28451
40	4683.33	I	7947–29294
6 h	4686.41	I	
13	4688.12	I	533–21858
8	4691.16	I	6550–27861
65	4694.33	I	8498–29795
16	4695.49	I	
40	4697.42	I	6378–27660
16	4703.13	I	
19	4709.78	I	999–22226
5	4711.98	II	8885–30101
3.0	4712.80	II	
10	4721.46	I	
14	4728.47	II	8885–30027

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	4728.64	I	533–21675
20	4732.60	II	8885–30009
4	4734.43	II	5340–26455
24	4735.75	I	6550–27660
6	4738.11	I	
38	4743.65	I	6786–27861
10	4745.82	I	7103–28169
3.0 h	4749.15	I	
3.0 d	4755.35	II	18001–39025
	4755.50	II	
4	4758.26	I	533–21543
30	4758.70	I	7103–28112
10	4760.74	I	1719–22718
12	4763.82	I	10884–31869
44	4767.24	I	7480–28451
6 d	4780.99	I	11297–32207
	4781.13	I	
17	4781.92	I	999–21905
3.5 d	4783.47	I	
	4783.56	I	11830–32730
28	4784.62	I	7947–28842
10	4786.75	I	7562–28448
4	4786.91	II	9143–30027
4	4791.15	II	9143–30009
13	4801.05	II	9143–29966
3.0	4802.58	II	4852–25669
3.5	4803.54	II	11492–32304
2.5	4805.82	II	8551–29353
20	4807.45	I	8498–29294
4 h	4808.01	I	13926–34719
5	4816.83	I	11830–32585
30	4821.69	I	
4	4829.94	I	
8	4834.23	II	9328–30009
12	4835.26	I	999–21675
10	4848.10	I	
4	4856.17	I	
6	4856.72	I	
7	4859.22	I	10884–31457
7	4861.78	I	11297–31859
10	4862.59	I	10576–31136
16	4865.02	II	9329–29878
8	4870.04	I	
11	4871.50	I	10360–30882
3.0	4873.34	II	9452–29966
8	4881.08	I	11297–31778
6	4881.36	I	12487–32967
2.5	4881.92	II	18151–38629
8	4883.19	I	10222–30695
2.5	4889.19	I	
6 bl	4892.1	GdO	
8	4894.30	II	9452–29878
7	4910.12	I	6976–27337
3.0	4915.83	I	7235–27572
4	4916.60	I	10222–30556
6	4923.58	II	17725–38030
8	4929.84	I	
6	4930.69	I	
26	4934.12	I	11830–32092
8	4936.01	I	
8	4936.33	I	10884–31136
20	4938.61	I	12487–32730
4	4948.56	I	
6	4950.11	I	10360–30556
3.0	4951.58	I	11830–32020
10	4952.47	I	1719–21905
6	4953.15	I	
3.5	4956.80	I	
6	4957.29	I	
12	4958.79	I	11297–31457
		II	8885–29045
3.5	4961.47	I	
2.5	4965.05	II	19402–39537
2.0	4968.58	II	17725–37846
9	4969.16	I	10576–30695
5	4972.61	I	6976–27081
1.8	4985.30	I	
5	4998.37	II	18319–38320
7	4999.07	I	10884–30882
6	5010.82	II	8551–28502
5	5011.74	I	11830–31778
70	5015.04	I	8498–28433
3.0	5019.36	II	10092–30009
2.5	5020.37	I	7562–27476
		II	9329–29242
5	5023.13	II	9143–29045
6	5031.29	II	13076–32946
3.5	5031.56	II	9329–29198
7	5039.09	I	11297–31136
1.8	5048.78	II	
6	5050.88	II	12892–32685
2.5	5061.06	II	
2.5	5062.86	II	9452–29198
3.0	5067.06	II	
4	5070.19	I	
4	5071.02	II	12776–32491
3.0	5072.99	I	
5	5073.74	I	
5	5082.80	I	
9	5092.25	II	13926–33558

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	5096.06	II	8885–28502
12	5098.38	II	13076–32685
5	5100.94	II	12892–32491
85	5103.45	I	7947–27536
17	5108.91	II	13378–32946
3.0	5123.65	II	
11	5125.56	II	11492–30997
6	5130.28	II	12776–32263
6	5135.59	I	
7	5136.04	I	7103–26568
8	5140.84	II	12704–32150
7	5141.50	I	7480–26925
7	5142.68	I	7427–26866
1.4	5149.38	II	13076–32491
3.0	5149.84	II	12892–32304
80	5155.84	I	7480–26870
5	5156.76	II	12662–32049
7	5158.48	I	7235–26615
4	5160.90	II	12892–32263
7	5163.70	I	6976–26337
5	5164.54	II	11492–30850
4	5171.69	I	0–19331
18	5176.28	II	8551–27865
3.5	5178.10	II	13378–32685
4	5178.84	II	19947–39251
3.5	5179.92	II	11067–30367
4	5186.92	II	12704–31977
5	5187.24	II	12776–32049
5	5187.88	I	6550–25821
5	5191.08	II	12892–32150
38	5197.77	I	7103–26337
4	5199.21	II	13076–32304
2.5	5200.55	II	19947–39170
5	5210.49	II	13076–32263
8	5217.48	I	999–20160
26	5219.40	I	6786–25940
7	5220.30	II	10092–29242
12	5233.93	I	7235–26336
2.0	5244.38	I	
6	5246.87	I	15665–34719
30	5251.18	I	8498–27536
11	5252.14	I	11067–30101
		II	6786–25821
8	5254.75	I	6378–25403
13	5255.80	I	6550–25572
2.0	5260.81	I	
3.0	5263.81	I	533–19525
2.0	5268.01	I	7947–26925
6	5268.78	I	533–19507
2.0	5271.79	I	6976–25940
3.0	5272.37	I	
5	5272.91	I	6378–25338
5	5282.48	I	10576–29502
26	5283.08	I	7947–26870
3.0	5298.58	I	10222–29090
26	5301.67	I	7480–26337
20	5302.76	I	6550–25403
5	5306.70	I	6976–25815
26	5307.30	I	7103–25940
4	5311.84	I	
2.0 h	5315.79	II	
3.0	5316.80	II	
4	5321.25	I	6550–25338
12	5321.50	I	6378–25165
26	5321.78	I	6786–25572
3.0	5322.37	I	10222–29006
4	5322.69	I	10576–29359
10	5327.32	I	10360–29126
6	5328.30	I	10222–28985
4	5331.92	I	
16	5333.30	I	10884–29628
5	5337.53	I	10360–29090
3.0	5341.17	I	7103–25821
3.0	5341.81	I	1719–20434
28	5343.00	I	11297–30007
8	5345.13	I	6550–25254
7	5345.68	I	999–19701
19	5348.67	I	6378–25069
28	5350.38	I	12487–31172
22	5353.26	I	11830–30505
4	5357.79	II	9329–27988
4	5359.18	I	
5	5361.66	I	10360–29006
9	5365.38	I	10576–29209
3.0	5367.70	I	10360–28985
3.0	5368.79	I	7947–26568
3.0	5369.61	I	10884–29502
9	5369.92	I	6786–25403
14	5370.63	I	10222–28837
	5370.74	I	6550–25165
3.5	5372.22	II	11492–30101
4	5384.15	I	10884–29451
4	5385.39	I	
8	5389.50	I	10576–29126
2.5	5411.20	I	10884–29359
2.0	5412.64	II	
8	5413.20	I	7103–25572
4	5413.39	I	6786–25254
8	5415.69	I	7480–25940
2.5	5419.88	II	10600–29045

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	5421.19	I	1719–20160
4	5436.30	I	7947–26337
2.5	5441.58	I	8499–26870
2.0	5447.74	II	
6	5453.46	I	11297–29628
3.0	5455.31	I	10884–29209
4	5469.72	I	7103–25381
		II	8885–27162
2.0	5475.72	I	6786–25044
2.0	5480.23	I	10884–29126
2.0	5482.01	I	10884–29120
2.0	5493.42	I	7947–26146
2.5	5498.75	I	7480–25661
3.5	5499.97	I	11830–30007
3.5	5500.43	II	11067–29242
2.5 h	5505.11	I	
2.0	5515.61	I	
2.5	5521.75	I	6550–24656
1.8	5524.60	II	
2.0	5533.37	I	6976–25044
2.5	5538.32	II	
2.5	5539.81	II	
2.0	5545.01	II	10600–28629
2.5 d	5548.20	I	12487–30505
1.8	5550.21	I	6976–24989
2.0	5559.73	I	1719–19701
3.0	5560.69	II	11067–29045
2.5	5572.53	I	7103–25044
3.5	5576.13	I	6786–24715
5	5583.68	II	8551–26455
1.2	5586.16	II	10092–27988
2.0	5586.32	I	7480–25376
5 d	5591.85	I	14669–32548
3.5	5594.13	I	14036–31907
1.8	5597.21	II	11492–29353
2.0	5614.45	I	1719–19525
2.5	5616.21	II	8551–26352
18	5617.91	I	0–17795
1.6	5621.43	II	18677–36461
6	5629.55	I	215–17974
10	5632.25	I	0–17750
3.0	5633.49	I	7103–24850
24	5643.24	I	215–17931
2.5	5644.84	II	8885–26595
1.2 h	5653.33	I	7654–25338
3.5 bl	5664.42	GdO	
3.0	5677.45	I	14298–31907
5 bl	5680.89	GdO	
3.5	5683.33	I	
2.5	5684.11	GdO	
2.0	5686.66	I	215–17795
3.5	5692.13	I	7480–25044
36	5696.22	I	533–18084
9	5701.35	I	215–17750
6	5709.42	I	0–17510
3.5	5710.32	I	14669–32176
2.0	5721.99	II	13378–30850
4	5724.75	I	11830–29294
11	5733.86	II	11067–28502
4	5735.98	I	7947–25376
4	5744.66	I	215–17618
8	5746.36	I	533–17931
3.5	5749.41	II	10600–27988
3.5	5751.88	I	0–17381
8 d	5754.17	I	7480–24854
2.0	5771.20	II	
1.6	5774.56	II	9143–26455
7	5776.02	I	12487–29795
22	5791.38	I	533–17795
6 h	5796.80	I	
5	5802.92	I	533–17761
2.5	5807.05	II	12662–29878
5 hs	5807.72	I	6786–24000
5 h	5809.22	I	15852–33061
5	5815.85	II	12776–29966
6 hs	5819.51	I	
4	5820.99	II	12704–29878
4 h	5823.97	I	215–17381
5	5840.47	II	12892–30009
2.0	5845.71	II	12776–29878
20	5851.63	I	999–18084
5	5855.24	II	12892–29966
26	5856.22	I	999–18070
4	5856.96	II	9143–26212
5	5860.73	II	8551–25609
6	5877.26	II	11492–28502
5	5886.46	I	
4	5897.62	II	13076–30027
5	5904.07	II	13076–30009
10	5904.56	I	999–17931
16	5911.45	II	
6	5913.55	II	
5	5916.77	I	7103–24000
8	5930.29	I	6786–23644
8	5936.84	I	6550–23390
6	5937.71	I	6378–23215
5 h	5940.95		
5 h	5942.78		
5	5951.60	II	11067–27865
5	5956.48	II	8885–25669

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
8		5977.25	I	6378–23104
10	h	5988.02	I	15852–32548
8		5999.08	I	6550–23215
6		6000.96	I	
7	h	6001.87	I	
5		6004.57	II	13378–30027
5		6008.71	I	
5		6021.13	I	6786–23390
5		6080.65	II	13926–30367
40		6114.07	I	1719–18070
5		6180.42	II	13927–30104
10	bl	6182.68	GdO	
10	bl	6200.86	GdO	
10	bl	6211.71	GdO	
10	bl	6220.93	GdO	
5	bl	6231.62	GdO	
7	bl	6241.66	GdO	
5	b	6252.12	GdO	
5	bl	6262.64	GdO	
4	b	6273.00	GdO	
8		6289.73	II	
3.0		6292.87	I	999–16886
7		6305.15	II	10600–26455
3.0		6309.11	II	
2.5		6317.19	I	999–16825
3.5		6331.35	I	18014–33804
1.6		6333.75	I	6550–22335
1.6		6336.34	I	6786–22564
2.5		6346.65	II	10600–26352
2.5	h	6351.72	I	17795–33535
1.6		6363.23	I	16196–31907
3.5		6380.95	II	13378–29045
1.6		6382.19	II	
2.0		6408.55	I	1719–17319
2.0		6422.42	II	
1.6		6424.52	I	7654–23215
1.8	h	6470.29	I	18084–33535
1.4		6480.11	II	13926–29353
3.5	h	6538.15	I	16886–32176
2.0		6549.25	I	17931–33195
5		6564.78	I	17319–32548
1.2		6568.00	II	17725–32946
1.2		6573.80	I	17750–32958
3.5		6591.60	I	1719–16886
1.8		6593.42	I	17795–32958
1.2		6610.04	II	13378–28502
1.0		6628.43	I	16825–31907
6		6634.36	II	10600–25669
4		6640.08	I	1719–16775
1.2		6642.76	I	12487–27536
3.5		6643.98	I	18014–33061
1.2		6646.85	I	11297–26337
1.2		6653.55	I	18509–33535
1.2		6679.56	II	
4		6681.23	II	11492–26455
1.2		6692.86	I	10884–25821
0.7		6694.92	II	
1.0		6702.12	II	18641–33558
1.2		6704.18	II	13076–27988
1.6		6718.14	II	18677–33558
2.0		6727.83	II	11492–26352
10		6730.73	I	999–15852
6		6752.67	II	18753–33558
1.6		6753.91	II	
1.0		6772.03	I	
1.6		6783.39	I	11830–26568
3.0		6786.33	II	
1.2		6787.18	I	
1.4		6814.56	I	7235–21905
3.0		6816.49	I	999–15665
2.0		6820.90	I	
12		6828.25	I	533–15174
4		6846.60	II	11067–25669
1.0		6849.89	I	20160–34755
3.5		6857.13	II	17725–32304
1.8		6864.25	I	
2.5		6887.63	II	
1.6		6900.73	II	17817–32304
12		6916.57	I	215–14669
2.5		6920.62	II	17817–32263
1.8		6924.99	II	
2.5		6926.49	I	10222–24656
2.0		6945.98	II	17870–32263
1.8		6957.74	II	
1.8		6959.24	II	18319–32685
1.6		6964.33	I	10360–24715
1.8		6971.66	II	18151–32491
1.4		6976.35	II	
1.2		6978.27	II	
3.0	h	6980.86	I	20434–34755
0.9	h	6983.53	I	11830–26146
6		6985.89	II	
1.2		6988.75	II	18641–32946
9		6991.92	I	0–14298
2.5		6993.18	I	10360–24656
7		6996.76	II	17972–32260
2.0		7000.75	II	17870–32150
5		7006.16	II	18677–32946
1.4		7016.60	I	7427–21675
1.0		7017.73	II	18245–32491

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.0		7037.26	II	
1.0		7045.02	II	
2.0		7051.00	II	17972-32150
1.0		7052.79	I	999-15174
1.8		7054.62	II	18319-32491
1.4		7058.02	II	18096-32260
1.4		7068.09	II	
1.0		7069.93	II	
2.5		7071.00	I	10576-24715
2.5		7073.63	I	1719-15852
0.7		7084.18	I	17795-31907
			II	18151-32263
1.0		7085.52	II	18151-32260
0.7		7093.90	I	18084-32176
2.0		7098.11	I	11297-25381
2.0		7098.73	I	215-14298
0.8		7099.44	I	12487-26568
1.0		7100.71	I	10576-24656
0.5		7101.73	II	17972-32049
1.4	h	7116.77	II	18001-32049
3.0		7118.86	II	18641-32685
5		7122.57	I	0-14036
1.2		7133.16	II	18245-32260
1.8		7135.73	II	
0.8	h	7141.17	II	18151-32150
0.9		7146.13	II	17988-31977
2.5		7147.31	II	
0.8		7150.77	I	7562-21543
1.8		7158.28	I	10884-24850
0.8		7164.30	II	
24		7168.37	I	1719-15665
3.0		7172.26	II	13926-27865
0.6		7173.40	II	17972-31908
4		7189.57	II	18245-32150
0.8		7191.49	II	
1.8		7197.08	II	18369-32260
0.8	h	7198.63	I	7562-21450
1.8		7201.41	II	
1.4		7228.02	I	10884-24715
3.5		7233.45	I	215-14036
0.9		7242.24	II	18245-32049
2.0		7252.70	II	13378-27162
4		7262.66	I	533-14298
2.0		7291.35	I	215-13926
0.6		7301.22	II	
3.0		7313.28	I	999-14669
2.5		7324.89	II	
1.2		7327.07	I	20160-33804
2.0		7373.81	I	11297-24854
2.0		7376.41	I	11297-24850
1.8		7377.27	II	
0.9		7377.77	I	11830-25381
1.8		7380.28	I	11830-25376
1.2		7385.97	II	18955-32491
1.8		7394.90	II	13076-26595
1.8		7430.19	I	1719-15174
0.6		7432.57	II	
0.7		7434.46	I	
5		7441.85	I	0-13434
6		7464.36	I	533-13926
0.8		7489.44	II	
0.8		7505.35	II	12892-26212
8		7562.97	I	215-13434
1.4		7563.19	II	
0.8		7566.10	I	11830-25044
1.4		7588.20	I	12487-25661
1.4		7611.78	I	11297-24430
3.0		7621.96	I	10884-24000
3.0		7650.32	I	10576-23644
3.5		7672.56	I	10360-23390
1.4		7676.06	I	11830-24854
1.0		7677.16	I	19525-32548
1.0	h	7683.36	I	19165-32176
1.8		7694.45	I	10222-23215
0.6		7717.66	I	7480-20434
11		7733.50	I	999-13926
0.9		7738.09	II	
0.4	h	7748.37	II	19402-32304
5		7749.30	I	533-13434
1.4		7755.97	I	12487-25376
1.4		7766.48	I	
1.0	h	7787.22	II	
1.2		7834.46	I	10884-23644
1.0		7838.84	II	
1.6	h	7844.87	I	10360-23104
1.4		7845.80	I	19165-31907
5		7846.35	II	
5		7856.93	I	6976-19701
0.7		7867.73	I	
2.0		7869.72	I	11297-24000
0.6		7884.39	I	7480-20160
0.6	h	7908.06	II	17725-30367
0.9		7910.08	I	10576-23215
3.5		7930.25	II	
0.9	h	7963.25	II	
0.5		7966.66	I	6976-19525
0.8		7978.15	I	6976-19507
0.9		7993.82	I	10884-23390
0.9		8006.26	I	7947-20434
0.9		8010.53	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.9		8019.82	I	7235–19701
0.6		8037.40	I	
0.8		8048.08	I	7103–19525
1.8		8077.59	I	7103–19480
0.4		8089.96	II	19947–32304
0.5	h	8144.00	I	
2.5		8146.15	I	7235–19507
0.6	h	8185.90	I	7947–20160
0.7		8209.07	I	
1.6		8218.08	I	7235–19400
1.4		8275.42	I	7427–19507
0.7	h	8315.02	II	
1.0		8316.38	II	
1.4		8349.73	I	7427–19400
0.6		8374.76	I	10884–22821
0.6		8377.79	I	11297–23229
1.6		8398.30	I	7427–19331
1.0		8442.58	II	
1.4		8445.47	I	7562–19400
1.8	h	8527.88	I	7562–19285
0.7		8559.11	I	10884–22564
0.8		8561.72	I	7653–19331
0.6	h	8579.77	II	
0.6		8615.97	II	
0.8	h	8659.66	II	
1.2	h	8661.48	I	
3.0		8668.63	I	6976–18509
0.7		8674.86	I	11297–22821
0.9		8752.77	I	11297–22718
1.6		8770.36	I	11830–23229
1.8		8784.85	I	6550–17931
1.4		8795.76	I	11830–23196
3.0	h	8832.06	II	
2.0	h	8849.14	I	6786–18084
2.5	h	8867.31	I	7235–18509

GALLIUM

Ga, $Z=31$, $M=69.72$, Ratio $\frac{\text{Ga}}{\text{Cu}}=1.097$

Ga I Normal state of valence electrons $4s^2\,4p^1\,{}^2P^\circ_{0\frac{1}{2}}=0$. I.P.= 48380 K
Ga II Normal state of valence electrons $4s^2\quad {}^1S_0=0$. I.P.=165458 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Ga I, A. Fowler, Report on Series in Line Spectra, (Fleetway Press, London, 1922).
R. A. Sawyer and R. J. Lang, Phys. Rev. **34,** 712 (1929).

Intensities:
Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **4,** 719 (1958).

Relative intensity of gallium lines observed in an arc of copper containing 0.1 atomic percent of gallium

Strong lines of gallium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	4172.06	I	826–24788	$4s^24p^1\,{}^2P^\circ_{1\frac{1}{2}}$—$4s^25s^1\,{}^2S_{0\frac{1}{2}}$
1000	4032.98	I	0–24788	$4s^24p^1\,{}^2P^\circ_{0\frac{1}{2}}$—$4s^25s^1\,{}^2S_{0\frac{1}{2}}$

Gallium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.6	2294.20	I	0–43574	34	2659.87	I	0–37585
2.0	2338.28	I	826–43578	80	2719.65	I	826–37585
1.8	2371.32	I	0–42158	500	2874.24	I	0–34782
8	2418.70	I	826–42158	950	2943.64	I	826–34787
75	2450.07	I	0–40803	150	2944.18	I	826–34782
130 h	2500.17	I	826–40811	1000	4032.98	I	0–24788
12	2500.70	I	826–40803	2000	4172.06	I	826–24788
2.5	2624.82	I	826–38913				

GERMANIUM

Ge, $Z=32$, $M=72.60$, Ratio $\frac{\text{Ge}}{\text{Cu}}=1.143$

Ge I Normal state of valence electrons $4s^2\ 4p^2\ {}^3P_0$ =0. I.P.= 63600 K
Ge II Normal state of valence electrons $4s^2\ 4p^1\ {}^2P^\circ_{0\frac{1}{2}}$=0. I.P.=128518 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), from 2000 to 5000 A.
C. W. Gartlein, Phys. Rev. **31,** 782 (1928), below 2000 A.
C. C. Kiess, J. Research NBS **24,** 1 (1940), above 5000 A.

Classification:
Ge I, K. R. Rao, Proc. Roy. Soc. (London) **[A] 124,** 465 (1929).
C. C. Kiess, J. Research NBS **24,** 1 (1940).

Relative intensity of germanium lines observed in an arc of copper containing 0.1 atomic percent of germanium

Strong lines of germanium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1200	2651. 18	I	1410–39118	$4s^24p^2\ {}^3P_2$—$4s^2\ 4p^15s^1\ {}^3P^\circ_2$
850	2709. 63	I	557–37452	$4s^24p^2\ {}^3P_1$—$4s^2\ 4p^15s^1\ {}^3P^\circ_0$
750	3039. 06	I	7125–40020	$4s^24p^2\ {}^1D_2$—$4s^2\ 4p^15s^1\ {}^1P^\circ_1$
650	2754. 59	I	1410–37702	$4s^24p^2\ {}^3P_2$—$4s^2\ 4p^15s^1\ {}^3P^\circ_1$

Germanium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
11	1954.49	I	557–51705	90	2497.96	I	0–40020
8	1961.40	I	7125–58091	70	2533.23	I	557–40020
14	1970.26	I	1410–52148	2.5	2556.30	I	16367–55474
8	1987.64	I	1410–51705	28	2589.19	I	1410–40020
26	1998.25	I	1410–51437	500	2592.54	I	557–39118
13	2019.05	I	557–50069	6	2644.19	I	16367–54175
24	2041.69	I	0–48962	1200	2651.18	I	1410–39118
16	2043.76	I	1410–50323	550	2651.58	I	0–37702
5	2054.45	I	1410–50069	500	2691.34	I	557–37702
2.5	2057.23	I	7125–55718	850	2709.63	I	557–37452
10	2065.20	I	557–48962	40	2740.43	I	16367–52847
34	2068.65	I	557–48882	650	2754.59	I	1410–37702
7	2086.00	I	557–48480	7	2793.94	I	16367–52148
36	2094.23	I	1410–49144	8	2829.01	I	16367–51705
5	2105.80	I	1410–48882	750	3039.06	I	7125–40020
2.5	2124.75	I	7125–54175	60	3067.01	I	16367–48962
20	2198.70	I	7125–52592	20	3124.82	I	7125–39118
2.0	2256.00	I	7125–51437	110	3269.49	I	7125–37702
4	2314.20	I	7125–50323	70	4226.57	I	16367–40020
6	2327.90	I	7125–50069	6	4685.84	I	16367–37702
9	2379.14	I	7125–49144	0.6	8789.87	I	37702–49076
85	2417.37	I	7125–48480				

GOLD

Au, $Z=79$, $M=197.0$, Ratio $\frac{\text{Au}}{\text{Cu}}=3.10$

Au I Normal state of valence electrons $5d^{10}\ 6s^1\ {}^2S_{0\frac{1}{2}}=0$. I.P.=74410 K
Au II Normal state of valence electrons $5d^{10}\ {}^1S_0=0$. I.P.=165000 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Au I and Au II, J. R. Platt and R. A. Sawyer, Phys. Rev. **60,** 866 (1941).

Relative intensity of gold lines observed in an arc of copper containing 0.1 atomic percent of gold

Strong lines of gold

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
340	2675.95	I	0–37359	$5d^{10}6s^1\ {}^2S_{0\frac{1}{2}}$—$5d^{10}6p^1\ {}^2P^\circ_{0\frac{1}{2}}$
200	2427.95	I	0–41174	$5d^{10}6s^1\ {}^2S_{0\frac{1}{2}}$—$5d^{10}6p^1\ {}^2P^\circ_{1\frac{1}{2}}$

Gold — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	2012.00	I	9161–58845	32	3029.20	I	9161–42164
2.0	2021.38	I	9161–58616	160	3122.78	I	9161–41174
6	2352.65	I	9161–51654	4	3897.89	I	42164–67812
6	2387.75	I	9161–51029	4	4040.94	I	21435–46174
200	2427.95	I	0–41174	7	4065.08	I	37359–61952
1.6	2544.19	I	21435–60729	2.0	4315.09	I	45537–68705
3.0	2590.04	I	21435–60033	1.2	4437.27	I	46174–68705
26	2641.49	I	9161–47007	2.5	4488.25	I	45537–67812
340	2675.95	I	0–37359	9	4607.34	I	47007–68705
3.0	2688.71	I	21435–58616	5	4792.60	I	41174–62034
8	2700.89	I	9161–46174	2.5	5837.40	I	37359–54485
110	2748.26	I	9161–45537	6	6278.18	I	21435–37359
1.6	2883.45	I	21435–56106	6	7510.75	I	41174–54485
1.6	2932.19						

HAFNIUM

Hf, $Z=72$, $M=178.50$, Ratio $\frac{Hf}{Cu}=2.809$

Hf I Normal state of valence electrons $5d^2\ 6s^2\ {}^3F_2\ =0$. I.P.= 55000 K
Hf II Normal state of valence electrons $5d^1\ 6s^2\ {}^2D_{1½}=0$. I.P.=120000 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
C. H. Corliss and W. F. Meggers, J. Research NBS **61,** 269 (1958).

Classification:
Hf I, W. F. Meggers, unpublished material.
Hf II, W. F. Meggers and B. F. Scribner, J. Research NBS **13,** 625 (1934).

Molecular Spectra:
HfO, W. F. Meggers, unpublished material.

Relative intensity of hafnium lines observed in an arc of copper containing 0.1 atomic percent of hafnium

Strong lines of hafnium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
260	3399. 80	II	0–29405	$5d^16s^2\ a\ {}^2D_{1½}$—$5d^16s^16p^1\ z\ {}^4F^o_{2½}$
240	2866. 37	I	0–34877	$5d^26s^2\ a\ {}^3F_2$ —$5d^26s^16p^1\ y\ {}^1F^o_3$
240	3072. 88	I	0–32533	$5d^26s^2\ a\ {}^3F_2$ —$5d^26s^16p^1\ y\ {}^3G^o_3$
220	2916. 48	I	4568–38845	$5d^26s^2\ a\ {}^3F_4$ —$5d^26s^16p^1\ x\ {}^3G^o_5$
220	2940. 77	I	0–33995	$5d^26s^2\ a\ {}^3F_2$ —$5d^26s^16p^1\ w\ {}^3F^o_2$
220	3682. 24	I	0–27150	$5d^26s^2\ a\ {}^3F_2$ —$5d^26s^16p^1\ y\ {}^3F^o_2$
200	2898. 26	I	2357–36850	$5d^26s^2\ a\ {}^3F_3$ —$5d^26s^16p^1\ w\ {}^3F^o_4$
160	2964. 88	I	2357–36075	$5d^26s^2\ a\ {}^3F_3$ —$5d^26s^16p^1\ x\ {}^3F^o_4$
150	3561. 66	II	0–28069	$5d^16s^2\ a\ {}^2D_{1½}$—$5d^16s^16p^1\ z\ {}^4F^o_{1½}$
140	2820. 22	II	3051–38499	$5d^16s^2\ a\ {}^2D_{2½}$—$5d^26p^1\ z\ {}^4G^o_{3½}$
140	2904. 41	I	4568–38988	$5d^26s^2\ a\ {}^3F_4$ —$5d^26s^16p^1\ v\ {}^3F^o_4$
140	2950. 68	I	2357–36237	$5d^26s^2\ a\ {}^3F_3$ —$5d^26s^16p^1\ x\ {}^1F^o_3$
140	3505. 23	II	8362–36882	$5d^26s^1\ a\ {}^4F_{4½}$—$5d^16s^16p^1\ z\ {}^4D^o_{3½}$
140	3777. 64	I	0–26464	$5d^26s^2\ a\ {}^3F_2$ —$5d^16s^26p^1\ z\ {}^1P^o_1$
140	3785. 46	I	4568–30977	$5d^26s^2\ a\ {}^3F_4$ —$5d^26s^16p^1\ z\ {}^3G^o_5$
130	3020. 53	I	2357–35454	$5d^26s^2\ a\ {}^3F_3$ —$5d^26s^16p^1\ w\ {}^3F^o_3$
130	3820. 73	I	4568–30733	$5d^26s^2\ a\ {}^3F_4$ —$5d^26s^16p^1\ y\ {}^3F^o_4$
120	2638. 71	II	0–37886	$5d^16s^2\ a\ {}^2D_{1½}$—$5d^16s^16p^1\ y\ {}^2D^o_{1½}$
120	2641. 41	II	8362–46209	$5d^26s^1\ a\ {}^4F_{4½}$—$5d^26p^1\ z\ {}^4G^o_{5½}$
120	2954. 20	I	4568–38408	$5d^26s^2\ a\ {}^3F_4$ —$5d^26s^16p^1\ w\ {}^3D^o_3$
120	2980. 81	I	0–33538	$5d^26s^2\ a\ {}^3F_2$ —$5d^26s^16p^1\ x\ {}^3F^o_2$
120	3012. 90	II	0–33181	$5d^16s^2\ a\ {}^2D_{1½}$—$5d^16s^16p^1\ z\ {}^2D^o_{2½}$
120	3016. 94	II	0–33136	$5d^16s^2\ a\ {}^2D_{1½}$—$5d^16s^16p^1\ z\ {}^2P^o_{0½}$
120	3057. 02	I	4568–37270	$5d^26s^2\ a\ {}^3F_4$ —$5d^26s^16p^1\ x\ {}^3G^o_4$
120	3569. 04	II	6344–34355	$5d^26s^1\ a\ {}^4F_{3½}$—$5d^16s^16p^1\ z\ {}^4D^o_{2½}$

Hafnium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2012.78	II	3051–52717
8	2028.18	II	13486–62775
2.5	2096.18	II	15084–62775
4	2210.82	II	36883–82101
4	2254.01	II	3645–47996
2.0	2255.15	II	3645–47973
3.5	2266.83	II	4905–49006
10	2277.16	II	0–43901
6	2321.14	II	4905–47973
16	2322.47	II	0–43044
8	2323.25	II	3645–46675
3.0	2324.50	II	12071–55077
8	2324.89	II	4905–47904
6	2332.97	II	3645–46495
6	2337.33	II	0–42771
8	2343.32	II	6344–49006
11	2347.44	II	6344–48931
20	2351.22	II	0–42518
4	2353.02	I	0–42485
4	2365.98	II	4905–47158
13	2380.30	II	3645–45643
5	2381.00	II	14360–56346
10	2393.18	II	12921–54693
26	2393.36	II	4905–46675
40	2393.83	II	0–41761
9	2400.78	II	3051–44691
5	2404.56	II	13486–55060
36	2405.42	II	6344–47904
9	2406.44	II	11952–53494
26	2410.14	II	8362–49841
7	2413.33	II	12071–53494
4	2415.96	II	11952–53331
26	2417.69	II	3051–44400
10	2425.98	II	13486–54693
3.5	2428.75	I	2357–43518
10	2428.99	II	12071–53227
12	2433.57	II	17369–58448
4	2434.74	II	17389–58448
4	2444.99	I	4568–45455
42	2447.25	II	3051–43901
16	2449.44	II	6344–47158
4	2452.30	II	11952–52717
12	2453.34	II	17369–58117
50	2460.49	II	3051–43681
8	2463.97	II	12921–53494
48	2464.19	II	8362–48931
10	2465.06	II	15084–55639
4	2465.67	I	4568–45112
16	2467.97	II	0–40507
24	2469.18	II	13486–53973
11	2473.92	II	12921–53331
6	2481.44	II	17830–58117
6	2482.65	I	0–40267
6	2487.16	I	0–40194
32	2496.99	II	3645–43681
8	2500.74	II	15084–55060
8	2502.66	I	2357–42302
65	2512.69	II	4905–44691
65	2513.03	II	6344–46125
15	2515.48	II	13486–53227
100	2516.88	II	3051–42771
8	2517.86	I	0–39704
8	2521.49	II	17830–57478
38	2531.19	II	4905–44400
9	2532.97	II	3051–42518
22	2537.33	II	3645–43044
12	2548.20	II	13486–52717
36	2551.40	II	17389–56572
3.0	2551.85	II	12921–52097
7	2559.02	I	2357–41422
14	2559.19	II	12071–51134
28	2563.61	II	4905–43901
6	2570.71	II	15084–53973
100	2571.67	II	3645–42518
36	2573.90	II	12071–50910
7	2574.89	I	
36	2576.82	II	8362–47158
34	2578.14	II	4905–43681
36	2582.54	II	3051–41761
14	2591.33	II	0–38579
3.5	2594.12	I	4568–43105
6	2599.22	II	15084–53546
6	2602.67	I	2357–40768
3.0	2602.87	I	0–38408
44	2606.37	II	3051–41407
50	2607.03	II	6344–44691
6	2607.24	II	14360–52703
13	2608.45	I	0–38325
4	2609.96	I	4568–42871
2.5	2612.59	I	5522–43786
26	2613.60	II	17389–55639
8	2614.29	II	15254–53494
10	2616.61	I	5639–43845
50	2622.74	II	3645–41761
4	2623.32	I	8984–47092
8	2626.95	II	6344–44400
3.0	2635.57	I	6573–44504
7	2635.79	II	17711–55639
18	2637.00	I	2357–40267
120	2638.71	II	0–37886

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
120	2641.41	II	8362–46209
8	2642.08	I	2357–40194
18	2642.75	I	4568–42396
75	2647.29	II	8362–46125
5	2649.15	II	14360–52097
11	2651.16	II	17369–55077
3.5	2652.86	II	41407–79090
7	2657.50	II	15084–52703
18	2657.84	II	4905–42518
24	2661.88	II	6344–43901
10	2665.97	II	12921–50420
10	2668.28	I	5639–43105
9	2669.00	II	3051–40507
5	2671.25	II	13486–50910
2.5	2676.63	II	17711–55060
2.0	2677.58	II	6344–43681
2.0	2678.43	II	17369–54693
4	2682.19	I	6573–43845
32	2683.35	II	15084–52340
6	2685.22	II	17830–55060
2.0	2686.36	I	6572–43786
2.0	2688.35	I	8984–46170
8	2696.18	I	2357–39435
7	2699.63	I	
75	2705.61	I	0–36949
12	2706.73	II	13486–50420
8	2711.83	I	8984–45848
5	2711.99	II	17830–54693
2.5	2712.14	II	12071–48931
24	2712.42	II	4905–41761
16	2713.84	I	2357–39194
7	2718.51	II	14360–51134
28	2718.59	I	0–36773
9	2726.70	I	5639–42302
8	2729.10	I	2357–38988
10	2730.71	I	0–36610
13	2730.85	I	4568–41175
4	2732.68	II	17389–53973
8	2737.83	I	5522–42036
80	2738.76	II	4905–41407
22	2743.64	I	5639–42076
4	2746.62	I	5639–42036
40	2751.81	II	8362–44691
7	2756.91	II	17711–53973
3.5	2758.31	I	10533–46776
10	2758.78	I	0–36237
50	2761.63	I	4568–40768
7	2762.69	I	5639–41825
18	2766.96	I	5639–41769
6	2770.46	II	12921–49006
5	2772.32	II	14360–50420
19	2773.02	I	2357–38408
110	2773.36	II	6344–42391
20	2774.02	II	8362–44400
6	2775.27	II	11952–47973
44	2779.37	I	2357–38325
8	2783.69	I	6572–42485
5	2786.30	II	15254–51134
11	2789.50	II	17389–53227
16	2789.73	II	17711–53546
	2789.80	II	12071–47904
26	2808.00	II	4905–40507
3.0	2812.32	I	10509–46056
26	2813.86	II	3051–38579
19	2814.48	II	13486–49006
10	2814.76	II	17711–53227
5	2815.82	I	6573–42076
5	2816.07	II	17830–53330
26	2817.68	I	8984–44464
16	2818.94	I	6572–42036
22	2819.74	I	0–35454
140	2820.22	II	3051–38499
6	2820.42	II	13486–48931
55	2822.68	II	6344–41761
9	2829.32	II	17369–52703
20	2833.28	I	0–35284
12	2834.13	I	8984–44258
8	2841.49	I	5522–40704
46	2845.83	I	5639–40768
30	2849.21	II	12071–47158
8	2850.15	II	12921–47996
30	2850.96	I	5639–40704
20	2851.21	II	6344–41407
6	2857.65	II	12921–47904
6	2860.31	II	17389–52340
20	2860.56	I	0–34948
85	2861.01	II	0–34942
85	2861.70	II	3645–38579
240	2866.37	I	0–34877
6	2867.70	I	8984–43845
15	2869.82	II	3051–37886
3.0	2873.65	I	
17	2876.33	II	15084–49841
5	2877.16	I	10509–45255
6	2879.11	II	11952–46675
6	2885.47	II	14360–49006
24	2887.14	I	4568–39194
11	2887.54	I	6572–41194
90	2889.62	I	0–34596
7	2892.56	I	

Hafnium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	2894.84	I	8984–43518
200	2898.26	I	2357–36850
15	2898.71	II	13486–47973
140	2904.41	I	4568–38988
100	2904.75	I	2357–36773
16	2909.91	II	0–34355
220	2916.48	I	4568–38845
3.5	2917.49	II	17830–52097
65	2918.58	I	2357–36610
36	2919.59	II	3645–37886
20	2924.62	I	5522–39704
7	2929.01	I	6572–40704
55	2929.63	II	0–34124
50	2929.90	I	8984–43105
80	2937.80	II	8362–42391
220	2940.77	I	0–33995
18	2944.71	I	0–33949
6	2947.13	II	15084–49006
140	2950.68	I	2357–36237
3.0	2951.90	I	10509–44375
120	2954.20	I	4568–38408
60	2958.02	I	5639–39435
7	2960.82	II	17369–51134
13	2961.80	II	12921–46675
160	2964.88	I	2357–36075
70	2966.93	I	6572–40267
16	2967.23	II	11952–45643
80	2968.81	II	4905–38579
12	2973.37	I	6572–40194
100	2975.88	II	4905–38499
8	2977.60	II	12921–46495
17	2979.28	I	5639–39194
120	2980.81	I	0–33538
24	2982.72	I	10533–44049
6	2984.05	I	8984–42485
19	3000.10	II	3051–36373
90	3005.56	I	10533–43795
9	3011.24	II	17711–50910
120	3012.90	II	0–33181
60	3016.78	I	0–33138
120	3016.94	II	0–33136
3.0	3017.37	I	6572–39704
110	3018.31	I	0–33122
130	3020.53	I	2357–35454
9	3024.60	I	8984–42036
9	3024.76	II	17369–50420
16	3025.29	II	8362–41407
46	3031.16	II	4905–37886
12	3046.08	II	15084–47904
9	3049.29	I	8984–41769
80	3050.76	I	5639–38408
9	3054.52	II	3645–36373
5	3055.44	II	15254–47973
120	3057.02	I	4568–37270
14	3063.78	I	5522–38152
14	3064.68	II	12071–44691
95	3067.41	I	2357–34948
10	3069.18	I	10532–43105
240	3072.88	I	0–32533
19	3074.10	I	2357–34877
28	3074.79	I	5639–38152
3.0	3075.30	I	10509–43016
17	3080.66	II	17389–49841
48	3080.84	I	2357–34806
10	3092.24	II	12071–44400
22	3096.76	I	4568–36850
38	3101.40	II	6344–38579
80	3109.12	II	6344–38499
14	3110.87	II	14360–46495
8	3116.95	II	15084–47158
14	3119.98	I	4568–36610
5	3126.29	II	4905–36883
10	3128.76	I	0–31952
8	3129.58	I	0–31944
80	3131.81	I	10533–42454
5	3133.50	II	41761–73665
95	3134.72	II	3051–34942
14	3137.51	I	10533–42396
19	3139.65	II	6344–38186
13	3140.76	II	12071–43901
25	3145.32	II	0–31784
25	3148.41	I	6572–38325
13	3151.63	I	8984–40704
4	3152.96	I	14092–45799
50	3156.63	I	4568–36237
30	3159.82	I	2357–33995
80	3162.61	II	12071–43681
5	3163.39	I	10509–42112
10	3165.73	I	6573–38152
50	3168.39	I	10509–42062
100	3172.94	I	4568–36075
50	3176.86	II	4905–36373
5	3178.43	I	14542–45995
4	3179.61	I	
25	3181.01	I	5522–36949
13	3181.15	I	4568–35994
15	3189.62	I	0–31342
40	3193.53	II	3051–34355
75	3194.19	II	3645–34942
7	3195.61	II	14360–45643

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22	3196.93	I	
15	3199.99	II	15254–46495
5	3203.67	II	13486–44691
35	3206.11	I	2357–33538
20	3210.98	I	5639–36773
10	3213.72	I	14542–45649
20	3217.30	II	3051–34124
20	3220.61	II	15084–46125
15	3230.06	I	
15	3239.44	I	
15	3243.35	I	16767–47590
40	3247.66	I	2357–33139
25	3249.53	I	2357–33121
100	3253.70	II	3051–33776
8	3254.86	I	14741–45455
30	3255.28	II	3645–34355
5	3261.90	I	14435–45083
13	3262.47	I	10533–41175
10	3265.29	I	15673–46290
8	3267.01	I	
8	3267.18	I	5639–36237
20	3273.66	II	6344–36883
30	3279.98	II	3645–34124
5	3283.38	II	12071–42518
18	3291.05	I	6572–36949
24	3306.12	I	4568–34806
13	3309.19	I	8984–39194
38	3310.27	I	6573–36773
5	3310.86	II	13486–43681
75	3312.86	I	2357–32533
8	3316.19	I	17901–48048
20	3317.99	II	3051–33181
5	3323.36	II	23146–53227
15	3328.21	II	4905–34942
5	3331.89	I	10509–40514
100	3332.73	I	0–29997
42	3352.06	II	8362–38186
10	3356.09	II	17369–47158
14	3356.78	I	15673–45455
8	3358.30	II	17389–47158
26	3358.91	I	14741–44504
20	3360.06	I	0–29753
16	3366.68	I	14092–43786
4	3372.21	I	5639–35284
20	3378.93	I	2357–31943
16	3384.14	II	14360–43901
26	3384.70	II	3645–33181
19	3386.21	I	16767–46290
90	3389.83	II	3645–33136
26	3392.81	I	15673–45139
26	3394.59	II	4905–34355
16	3394.98	II	17711–47158
26	3397.26	I	4568–33995
26	3397.60	I	8984–38408
260	3399.80	II	0–29405
19	3400.21	I	0–29402
20	3402.51	I	4568–33949
10	3407.14	I	8984–38325
16	3407.76	II	12071–41407
26	3410.17	II	15084–44400
7	3412.34	I	14542–43838
10	3413.74	II	13486–42771
26	3417.34	I	2357–31611
46	3419.18	I	5639–34877
5	3421.42	II	4905–34124
16	3427.44	I	8984–38152
22	3428.37	II	0–29160
28	3438.24	II	18898–47973
16	3438.43	I	5522–34596
11	3441.84	I	14741–43786
5	3448.29	I	
11	3452.31	I	5639–34596
16	3462.64	II	4905–33776
16	3467.60	I	15673–44504
80	3472.40	I	0–28790
22	3478.99	II	17389–46125
54	3479.28	II	3051–31784
5	3487.57	II	17830–46495
28	3495.75	II	6344–34942
9	3495.93	II	15084–43681
28	3497.16	I	
110	3497.49	I	0–28584
11	3498.98	I	4568–33139
140	3505.23	II	8362–36882
17	3513.28	I	10532–38988
15	3518.75	II	14360–42771
6	3521.56	I	17901–46290
110	3523.02	I	2357–30733
11	3530.87	I	19293–47606
11	3531.23	I	5639–33949
110	3535.54	II	4905–33181
85	3536.62	I	0–28267
20	3548.81	I	
60	3552.70	II	3645–31784
17	3554.00	I	14542–42671
150	3561.66	II	0–28069
17	3564.31	I	0–28048
30	3567.36	I	6572–34596
120	3569.04	II	6344–34355
17	3579.90	I	14435–42361

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	3583.28	I	5639–33538
24	3597.42	II	15254–43044
	3597.51	I	8984–36773
60	3599.87	I	16767–44537
12	3615.04	I	0–27654
90	3616.89	I	2357–29997
12	3617.68	I	14542–42176
10	3620.04	I	5522–33138
12	3624.00	II	12921–40507
36	3630.87	II	28105–55639
11	3635.43	I	5639–33138
6	3637.59	I	5639–33122
90	3644.36	II	6344–33776
36	3649.10	I	2357–29753
10	3650.53	I	19293–46678
22	3651.84	I	4568–31943
14	3661.05	II	15084–42391
8	3664.60	I	14018–41298
22	3665.35	II	11952–39226
10	3668.21	I	8984–36237
20	3672.27	I	
48	3675.74	I	15673–42871
220	3682.24	I	0–27150
28	3696.51	I	2357–29402
10	3698.40	II	17369–44400
24	3699.72	II	13486–40507
34	3701.15	II	17389–44400
10	3704.92	I	18381–45365
12	3705.40	II	17711–44691
100	3717.80	I	2357–29247
65	3719.28	II	4905–31784
14	3726.49	I	10509–37336
16	3729.10	I	20960–47769
46	3733.79	I	4568–31342
16	3737.88	II	18898–45643
12	3739.04	I	10533–37270
6	3743.99	I	18381–45083
10	3744.98	II	23146–49841
40	3746.80	I	14741–41422
8	3747.49	II	15084–41761
14	3753.22	I	17901–44537
6	3762.51	II	31878–58448
10	3765.05	I	18225–44778
10	3765.56	I	6572–33122
17	3766.92	II	20135–46675
20	3768.25	I	10509–37039
6	3771.36	II	12070–38579
6	3773.12	I	14018–40514
140	3777.64	I	0–26464
3.5	3782.43	I	5522–31952
7	3782.78	II	12070–38499
140	3785.46	I	4568–30977
3.5	3787.37	I	18381–44778
65	3793.37	II	3051–29405
10	3798.66	I	10532–36850
85 d	3800.38	I	0–26306
	3800.45	I	5639–31944
7	3804.53	I	
14	3806.07	II	21638–47904
32	3811.78	I	2357–28584
10	3817.20	II	17711–43901
10	3819.38	I	14092–40267
130	3820.73	I	4568–30733
14	3829.67	I	16767–42871
28	3830.02	I	14092–40194
80	3849.18	I	5639–31611
14	3849.52	II	17711–43681
60	3858.31	I	2357–28267
20	3860.91	I	8984–34877
7	3867.34	II	17830–43681
18	3872.55	II	12071–37886
14	3877.10	II	23146–48931
34	3880.82	II	3645–29405
18	3882.52	I	15673–41422
13	3883.77	II	13486–39226
18	3889.23	I	10532–36237
18	3889.33	I	5639–31342
6	3892.47	I	19791–45475
55	3899.94	I	0–25634
3.0	3900.65	II	30942–56572
4	3906.89	I	14542–40130
7	3909.18	I	19791–45365
7	3917.45	II	21638–47158
55	3918.09	II	3645–29160
18	3923.90	II	12921–38399
11	3926.42	I	10533–35994
13	3927.57	I	14741–40194
10	3929.54	II	28105–53546
28	3931.38	I	4568–29997
11	3935.65	II	17369–42771
11	3939.04	I	6572–31952
7	3950.80	I	
36	3951.83	I	2357–27654
7	3964.95	II	17830–43044
14	3968.01	I	0–25194
13 bl	3970.05	HfO	
18	3973.48	I	2356–27516
7	3979.40	II	28105–53227
16	4032.27	I	2357–27150
8	4044.39	I	16163–40882

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	4047.96	II	30942–55639
6	4049.45	II	17830–42518
6	4049.74	I	
20	4062.84	I	10509–35115
12	4066.21	I	14542–39128
16	4083.35	I	10509–34992
3.0	4087.96	I	16163–40619
48	4093.16	II	3645–28069
10	4104.23	I	5639–29997
12	4106.58	I	10532–34877
10	4113.53	II	12071–36373
3.0	4115.90	I	18381–42671
10	4118.60	I	10532–34806
6	4118.91	I	14018–38289
13	4127.80	II	14360–38579
12	4145.76	I	5639–29753
7	4158.88	II	17369–41407
13	4162.36	II	17389–41407
10	4162.69	I	4568–28584
100	4174.34	I	2357–26306
7	4187.66	II	18898–42771
11	4190.95	I	14435–38289
14	4206.58	II	20135–43901
17	4209.70	I	14542–38289
15	4228.08	I	0–23645
15	4232.44	II	18898–42518
7	4245.16	I	8984–32533
3.5	4245.84	II	20135–43681
11 bl	4252.08	HfO	
15	4260.98	I	10533–33994
18	4263.39	I	0–23449
15	4272.85	II	13486–36883
28	4294.79	I	2357–25634
7	4296.41	I	5522–28790
11	4318.14	I	5639–28790
7	4320.67	II	17369–40507
14	4330.27	I	4568–27654
3.5	4334.64	II	23146–46209
16	4336.66	II	21638–44691
3.0 h	4349.74	I	24785–47769
13	4350.51	II	23146–46125
3.5 h	4351.15	I	
7	4352.57	I	8984–31952
6	4353.34	I	16163–39128
22	4356.33	I	4568–27516
5	4356.99	I	5639–28584
6	4365.37	I	14435–37336
10	4367.90	II	13486–36373
16	4370.97	II	12071–34942
5 b	4408.81	HfO	
11	4417.35	II	15254–37886
14	4417.91	I	5639–28267
3.0	4418.25	I	8984–31611
3.0	4422.23	I	10532–33139
18	4438.04	I	5522–28048
5 h	4443.07	I	18381–40882
5	4453.00	I	0–22451
12	4457.34	I	2357–24785
12	4461.18	I	5639–28048
4	4466.40	II	20135–42518
5	4486.13	II	12071–34355
5	4499.65	I	6572–28790
4	4518.29	I	16163–38289
12	4540.93	I	5639–27654
7	4544.02	I	10532–32533
22	4565.94	I	5639–27534
2.0	4573.79	II	17369–39226
4 h	4597.90	I	
44 d	4598.80	I	0–21739
	4598.92	I	4568–26306
2.0	4605.77	II	12071–33776
8	4608.09	I	6573–28267
20	4620.86	I	4568–26203
6	4622.70	II	20135–41761
4 h	4630.61	I	19293–40882
16	4655.19	I	6572–28048
6	4664.12	II	12921–34355
2.0	4669.24	I	10532–31943
9	4699.01	I	18011–39286
3.0	4699.72	II	20135–41407
3.5 h	4708.84	I	22901–44132
3.5 h	4719.10	II	11952–33136
3.5 h	4731.37	II	17369–38499
3.0	4738.58	I	14018–35115
3.0	4757.58	I	8984–29997
7	4766.51	I	14018–34992
6	4773.72	I	5522–26464
2.0	4774.89	I	22901–43838
12	4782.74	I	18225–39128
3.0	4790.72	II	17711–38578
24	4800.50	I	5638–26464
2.5	4817.21	II	21638–42391
5	4818.87	I	18381–39128
3.0	4834.19	I	14435–35115
6	4837.23	I	5639–26306
1.6	4850.61	I	10509–31119
3.0	4858.41	I	6572–27150
10	4859.24	I	14542–35115
6	4863.27	I	14435–34992
1.6	4872.94	I	20960–41476

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4877.58	I	19293–39789
1.4	4915.26	I	19791–40130
1.6	4934.45	II	12921–33181
3.5	4948.94	I	10533–30733
1.6	4962.37	I	18143–38289
8	4975.25	I	2357–22450
1.0	4999.68	II	14360–34355
6	5018.20	I	20960–40882
1.0	5021.75	I	18381–38289
3.5	5040.82	II	11952–31784
6	5047.45	I	8984–28790
3.5 b	5074.74	HfO	
2.0	5079.65	II	18898–38579
3.5 b	5093.88	HfO	
1.0	5112.13	I	5639–25194
1.2	5128.53	II	17389–36883
2.0	5157.96	I	22901–42283
3.5	5167.42	I	24785–44132
5	5170.18	I	19791–39128
15	5181.86	I	0–19293
2.0	5186.84	I	22901–42176
2.0	5187.75	II	15084–34355
7	5243.99	I	8984–28048
3.5	5247.10	II	28105–47158
1.6	5260.44	II	17369–36373
2.0	5264.95	II	18898–37886
3.5	5275.04	I	16163–35115
1.4	5286.09	I	23449–42361
8	5294.87	I	4568–23449
3.0	5298.06	II	15254–34124
2.0	5307.82	I	23449–42283
3.0	5309.68	I	16163–34992
3.5	5311.60	II	14360–33181
0.8	5324.26	II	14360–33136
0.6	5346.30	II	28458–47158
7	5354.73	I	25462–44132
7	5373.86	I	2357–20960
2.5	5389.34	I	8984–27534
1.2	5391.36	II	17830–36373
1.2	5404.47	I	19791–38289
1.8	5424.02	I	22451–40882
0.8	5435.78	I	
2.5	5438.74	I	0–18381
0.9	5444.07	II	20135–38499
5	5452.92	I	4568–22901
2.0	5463.38	II	13486–31784
1.0	5497.30	I	29753–47938
1.0	5510.12	I	0–18143
1.0	5510.45	I	18381–36524
1.2	5524.35	II	15084–33181
3.0	5538.02	I	21739–39791
1.8	5538.26	I	10533–28584
15	5550.60	I	0–18011
15	5552.12	I	5639–23645
3.5	5575.86	I	26203–44132
0.9	5600.77	I	23449–41298
6	5613.27	I	5639–23449
1.6	5614.01	I	21739–39546
0.5	5628.27	I	23449–41211
1.2	5650.83	I	10509–28201
2.5 bl	5698.03	HfO	
1.6	5713.28	I	24785–42283
10	5719.18	I	8984–26464
1.6 bl	5720.16	HfO	
0.8	5748.72	I	24785–42176
0.9	5767.18	II	12071–29405
0.8	5809.50	II	11952–29160
1.2	5817.47	I	14435–31620
1.6	5842.23	II	17830–34942
1.6	5845.87	I	14018–31119
1.2	5847.77	I	22451–39546
1.4	5883.66	I	23645–40636
1.0	5926.47	I	23645–40514
4	5933.69	I	18143–34992
5	5974.28	I	18381–35115
1.6	5974.72	I	19791–36524
4	5978.66	I	18270–34992
1.6	5992.96	I	
3.0 c	6016.79	I	27516–44132
1.8 b	6021.12	HfO	
1.6 b	6043.19	HfO	
1.6	6054.17	I	14542–31055
6	6098.67	I	4568–20960
6	6185.13	I	0–16163
3.5	6210.70	I	24785–40882
1.8	6216.82	I	26203–42283
3.0	6238.58	I	2357–18381
4	6248.95	II	12071–28069
1.4 h	6299.54	I	26306–42176
1.6 h	6311.85	I	22451–38289
1.2	6318.33	I	19293–35115
2.0	6338.10	I	10532–26306
1.2 h	6380.19	I	15673–31342
4	6386.23	I	2357–18011
1.2 h	6409.52	I	21739–37336
1.0 h	6556.50	I	25634–40882
1.8	6587.23	I	16766–31943
3.0	6644.60	II	14360–29405
1.2	6647.06	II	23146–38186
1.0	6659.40	I	14741–29753

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	6713.48	I	16163–31055
0.6	6716.00	I	22451–37336
1.6	6754.61	II	14360–29160
1.0	6769.95	I	27516–42283
8	6789.27	I	4568–19293
15	6818.94	I	8984–23645
1.4	6826.56	I	23645–38289
1.2	6850.07	I	25194–39789
3.5	6858.70	I	16766–31342
4	6911.40	I	8984–23449
0.9	6926.19	I	14092–28526
1.8	6979.59	I	15673–29997
2.0	6980.91	II	15084–29405
0.8	7019.25	I	29247–43489
0.8	7030.33	II	20135–34355
0.9	7035.13	I	16767–30977
1.4	7061.90	I	25634–39791
1.8	7062.87	I	25634–39789
20	7063.83	I	5639–19791
1.4 h	7094.40	I	25194–39286
1.8	7100.54	I	15673–29753
7	7119.52	I	17901–31943
70	7131.81	I	0–14018
80	7237.10	I	4568–18381
50	7240.87	I	2357–16163
0.7	7262.62	I	14435–28201
9	7320.05	I	4568–18225
2.0	7321.76	I	5639–19293
0.7	7356.10	I	23449–37039
0.7	7365.28	I	15673–29247
2.5	7390.70	I	14741–28267
0.7	7423.69	I	8984–22450
3.0	7437.56	I	14092–27534
1.6	7463.86	I	23645–37039
0.8	7484.56	I	22880–36237
1.8	7556.37	I	16766–29997
9	7562.93	I	6572–19791
1.8	7564.22	I	34806–48022
1.4	7576.95	I	18381–31576
1.4	7592.96	I	23253–36419
1.6	7608.59	I	31943–45083
44	7624.40	I	10533–23645
2.5	7645.64	I	17901–30977
14	7740.17	I	10532–23449
1.0	7743.57	I	15673–28584
0.6	7757.89	II	18898–31784
5	7790.90	I	17901–30733
0.9	7796.81	I	23253–36075
4	7814.55	I	14741–27534
38	7845.35	I	5639–18381
0.9	7846.56	I	23253–35994
16	7920.71	I	5522–18143
3.5	7938.06	I	15673–28267
30	7994.73	I	5639–18143
0.8	8010.58	I	16766–29247
3.0	8056.52	I	14741–27150
3.0	8080.32	I	5639–18011
2.0	8173.89	I	20908–33139
16	8204.58	I	2357–14542
0.8	8248.81	I	36237–48357
7	8276.95	I	2357–14435
1.6	8305.91	II	17369–29405
3.0	8344.25	I	15673–27654
0.6	8380.06	I	28584–40514
0.6	8382.98	I	22880–34806
4	8460.01	I	16767–28584
18	8546.48	I	6572–18270
20	8640.06	I	6572–18143
5	8711.24	I	15673–27150
8	9004.73	I	14092–25194

HOLMIUM

Ho, $Z=67$, $M=164.94$, Ratio $\frac{\text{Ho}}{\text{Cu}}=2.596$

References

Wavelengths:
Below 7000 A
A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945).
About 50 wavelengths were measured on our plates, including all lines above 7000 A.

Classification:
W. R. Bozman and C. H. Corliss, unpublished (1961).

Spectrum Assignments:
From 3837 A to 4661 A: A. S. King, Astrophys, J. **72,** 221 (1930).
The rest of the assignments are from our plates.

Molecular Spectra:
HoO, A. Gatterer, Ricerche Spettroscop. **1,** 139 (1942).

Relative intensity of holmium lines observed in an arc of copper containing 0.1 atomic percent of holmium

Strong lines of holmium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1800 c	3456. 00	II		
1500 c	3891. 02	II		
1000 c	3796. 75	I		
1000 c	3810. 73	I		
1000	4103. 84	I	0–24361	
900 c	3398. 98	II		
900	4053. 93	I	0–24660	
900	4163. 03	I		
700	3484. 84	II		
600	3416. 46	II		
600 c	3474. 26	II		
600 c	4045. 44	II		
480	4127. 16	I		
460 c	3515. 59	II		
360	3453. 14	II		
360 cw	3748. 17	II		
340 c	3888. 96	II		
320	4108. 62	I		
300 c	3861. 68	II		
300	4040. 81	I	0–24740	
280 c	3494. 76	II		
280	4173. 23	I		
220 c	3425. 34	II		
220 c	3428. 13	II		
220	4227. 04	I		
200 c	3854. 07	II		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
11		2502.91	II	
5		2508.53	II	
7		2513.55	II	
6		2518.73	II	
11		2533.80	I	
8		2536.86	II	
5		2556.84	I	
5		2567.73	II	
5		2586.52	I	
4		2591.05	II	
6		2592.99	I	
12		2605.86	II	
7		2610.51	II	
6		2613.99	II	
4		2625.20	II	
5		2640.09	II	
5		2640.30	II	
4		2649.68	II	
7		2666.24	II	
6		2689.03	II	
4		2704.18	II	
4		2709.30	II	
18		2713.65	II	
4	c	2721.77	II	
4		2728.32	II	
20		2733.95	II	
4		2738.79	I	
24		2750.35	II	
4		2757.77	II	
10	c	2759.35	II	
10		2766.85	II	
24		2769.89	II	
6		2772.60	II	
10		2772.83	II	
6		2773.84	II	
12		2777.10	II	
5		2778.87	II	
5		2787.20	II	
5		2791.08	II	
5		2793.90	II	
12		2794.41	II	
9		2799.99	II	
9		2806.72	II	
6		2807.31	II	
7		2809.09	II	
14	c	2809.99	II	
19		2811.36	II	
16		2812.00	II	
7		2814.44	II	
17		2814.74	II	
6		2814.91	II	
4		2819.68	II	
8		2819.80	II	
7		2823.36	II	
6		2823.73	II	
26		2824.20	II	
12		2826.64	II	
5		2830.92	II	
24	c	2831.69	II	
5		2833.79	II	
18		2834.99	II	
10		2835.85	II	
5		2836.70	II	
6		2843.39	II	
10		2844.18	II	
9		2844.68	II	
24		2849.10	II	
4		2852.89	II	
3.5		2860.87	II	
9		2861.23	II	
22		2861.49	II	
13		2862.72	II	
8		2866.79	II	
18		2871.99	II	
8		2872.44	II	
6		2873.88	II	
20		2874.06	II	
14		2874.43	II	
32		2880.26	II	
40		2880.98	II	
5		2882.04	II	
3.0		2883.47	II	
7		2884.64	II	
6		2891.29	II	
30		2894.99	II	
14		2895.62	II	
15		2900.84	II	
5		2902.19	II	
50	c	2909.41	II	
5		2910.40	II	
6		2914.09	II	
4		2915.12	II	
15		2915.82	II	
26		2919.62	II	
5		2921.85	II	
6		2922.60	II	
10		2925.35	II	
14		2926.09	II	
8		2926.99	II	
26	c	2928.30	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		2936.24	II	
8		2940.99	I	
19		2942.05	II	
5		2942.59	II	
26		2944.49	II	
3.0		2945.04	II	
5		2945.83	II	
6		2952.36	II	
5		2952.73	II	
22	c	2953.11	II	
6		2954.28	II	
6	c	2954.94	II	
3.0		2955.27	II	
6		2957.41	II	
6	c	2964.40	II	
5		2972.43	II	
34		2973.00	II	
5		2975.24	II	
36	c	2979.63	II	
5		2980.64	II	
16		2981.46	II	
7		2984.07	II	
12		2985.48	II	
36		2987.64	II	
22		2990.27	II	
8	c	2992.71	II	
10		2995.86	II	
8		2998.29	II	
6		3000.69	II	
4		3005.29	II	
4		3007.08	II	
28	c	3008.10	II	
14		3009.48	II	
5		3012.07	II	
19		3014.60	II	
10		3016.21	II	
4		3017.73	II	
6		3018.16	II	
14		3023.14	II	
11	c	3024.38	II	
6	c	3026.13	II	
10		3028.18	II	
11		3033.44	II	
15		3035.65	II	
24		3038.69	II	
8		3044.40	II	
6		3046.44	II	
42	c	3049.38	II	
14		3050.73	II	
36	c	3054.00	II	
11	c	3054.87	II	
44	c	3057.45	II	
6		3060.24	II	
10	c	3062.53	II	
7		3063.14	II	
16		3064.19	II	
20		3074.30	II	
9		3075.53	II	
7	c	3078.41	II	
44	c	3082.34	II	
80		3084.36	II	
38	c	3086.54	II	
20		3102.69	II	
17		3105.18	II	
22		3108.31	II	
17		3108.65	II	
22	c	3109.91	II	
7		3111.85	II	
7		3114.36	II	
85		3118.50	II	
7		3129.21	II	
8		3130.77	II	
34	c	3130.99	II	
22	c	3134.39	II	
34	c	3144.36	II	
8		3146.13	II	
17	c	3148.85	II	
13		3149.94	II	
7	c	3153.04	II	
14		3153.82	I	
22		3156.18	II	
30		3156.97	II	
13		3157.35	I	
13		3158.40	II	
22	c	3159.67	II	
7		3160.47	II	
7		3164.06	II	
13		3165.69	II	
65	c	3166.62	II	
18		3167.89	II	
44	dl	3171.72	II	
9		3172.37	II	
90		3173.78	II	
44		3174.84	II	
30	c	3176.97	II	
90	c	3181.50	II	
44		3183.84	II	
30	cw	3184.48	II	
22		3186.37	I	
16		3187.39	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
18		3191.02	II	
8		3195.09	II	
16	c	3196.07	II	
7		3196.52	II	
44	c	3197.83	II	
12		3201.00	I	
44		3201.76	II	
18		3204.28	II	
11		3206.17	I	
22		3206.86	II	
30	c	3210.41	II	
13		3211.85	II	
9		3213.28	II	
16		3215.36	II	
22	c	3221.42	II	
9		3224.27	II	
7		3230.04	II	
9	c	3231.67	II	
36		3233.34	II	
9		3233.87	II	
22		3236.90	II	
22		3237.40	II	
7		3240.42	II	
9		3243.00	II	
9		3247.22	II	
9		3256.28	II	
22	c	3257.45	II	
13	c	3258.45	II	
9		3262.20	II	
8		3263.66	II	
9		3266.34	II	
10		3267.36	II	
9		3277.16	II	
44	c	3278.15	II	
30		3279.25	II	
13		3281.18	II	
110	c	3281.97	II	
16		3283.08	II	
44		3288.46	II	
30	c	3290.96	II	
13	c	3297.06	II	
10		3298.12	II	
14		3301.34	I	
22	c	3305.16	II	
14		3312.39	II	
16		3315.66	II	
22		3319.87	II	
26		3320.25	II	
9		3321.11	II	
12		3323.74	II	
13	c	3329.02	II	
22		3331.93	II	
18		3333.16	II	
70	c	3337.23	II	
44	c	3338.86	II	
18		3340.44	II	
9		3342.70	II	
110	c	3343.58	II	
22		3344.47	II	
7		3344.79	II	
12		3348.61	II	
40		3350.49	II	
36		3352.10	II	
36	cw	3353.55	II	
36		3354.58	II	
9		3356.98	II	
36		3357.91	II	
16		3360.87	II	
13		3363.41	II	
36		3364.27	II	
9	c	3368.36	II	
11		3369.89	II	
32		3370.87	II	
11		3372.43	II	
26		3374.16	II	
8		3374.36	II	
9		3380.49	II	
9		3386.41	I	
18	c	3389.56	II	
32	c	3390.75	II	
18	c	3392.05	II	
9		3392.47	II	
36	c	3394.60	II	
12		3397.33	II	
900	c	3398.98	II	
12		3400.60	II	
22		3401.59	II	
14		3402.18	II	
13		3406.27	II	
22		3408.21	II	
22	c	3409.06	II	
90	c	3410.26	II	
44	c	3410.65	II	
32		3411.55	II	
17		3412.87	II	
22	c	3414.25	II	
160	c	3414.90	II	
600		3416.46	II	
9	c	3418.19	II	
13		3418.47	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
130		3421.63	II	
32		3424.11	I	
220	c	3425.34	II	
26		3426.76	II	
220	c	3428.13	II	
70	c	3429.18	II	
36	c	3432.10	II	
16		3434.76	II	
16		3435.61	II	
18		3436.31	II	
32		3437.04	I	
14	c	3437.91	II	
7	c	3438.35	II	
18		3445.66		
14	c	3449.01	II	
44		3449.35	I	
16		3451.23	I	
360		3453.14	II	
12	c	3453.85	II	
90	c	3455.70	II	
1800	c	3456.00	II	
16		3461.36	II	
180		3461.97	II	
40	c	3467.07	II	
9		3468.13	I	
16		3469.40	II	
14	c	3470.76	II	
26	c	3472.31	II	
90	c	3473.91	II	
600	c	3474.26	II	
22		3477.75	II	
22	c	3478.06	II	
9		3483.89	II	
700		3484.84	II	
22	c	3485.87	II	
18	c	3486.34	II	
55		3489.58	II	
32	c	3490.95	II	
7		3492.11	I	
65	c	3493.09	II	
9		3493.60	I	
280	c	3494.76	II	
9		3497.65	II	
90	c	3498.88	II	
8		3505.43	II	
46	c	3506.95	II	
36		3509.37	II	
14		3507.99	I	
90		3510.73	I	
18		3511.76	II	
460	c	3515.59	II	
46	c	3519.94	II	
24	c	3520.16	II	
17		3532.76	I	
24		3538.89	II	
14	c	3539.35		
70		3540.76	II	
22		3541.41	I	
180		3546.05	II	
18		3548.53		
9	c	3550.60		
120	c	3556.78	II	
9	c	3558.15		
8		3559.03		
46		3560.15	II	
18	c	3563.45		
12		3567.32		
18		3568.79		
32		3570.44		
46	c	3573.24	II	
4		3574.20		
70	c	3574.80	II	
90		3579.12	I	
46		3580.75	II	
46		3581.83	II	
9	c	3582.80		
28	cw	3589.77		
17		3591.23	II	
70	c	3592.23	II	
19	c	3593.07	II	
120	cw	3598.77	II	
38		3599.48	I	
60	c	3600.95	II	
14	c	3602.65	II	
14		3605.77	I	
38		3613.31	II	
12	c	3616.93	II	
8		3618.08	II	
46		3618.43	I	
22		3619.41	II	
22		3623.59	I	
19	c	3625.46	II	
48	c	3626.69	II	
55		3627.25	II	
22		3630.91	I	
48	c	3631.76	II	
12		3632.95	II	
14	c	3634.67	II	
9	c	3635.35	II	
48	c	3638.30	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
14	c	3640.17	II	
24		3641.25	I	
9	c	3642.36	II	
10	c	3649.60	II	
24		3654.45	II	
22	c	3658.48	I	
180	c	3662.29	I	
48		3662.99	I	
80		3666.65	I	
14		3667.05	II	
160		3667.97	I	
36		3669.05	II	
50		3669.52	I	
10		3670.28	II	
8		3672.69	I	
16	c	3674.36	II	
50	c	3674.77	II	
20	cw	3677.64	II	
24		3678.59	II	
80		3679.19	I	
75		3679.70	I	
18	c	3680.00	II	
80		3682.65	I	
48		3685.16	II	
16	c	3686.65	II	
65		3690.65	I	
26	c	3691.32	II	
38		3691.95	I	
15		3694.66		
12		3695.69	I	
46		3700.04	I	
14		3701.27	I	
15		3701.78	II	
55	c	3702.35	II	
9		3704.54	II	
11		3706.90	II	
28		3709.27		
36		3709.76	I	
18	c	3710.74	II	
18		3711.31	II	
48		3712.88	I	
30		3718.62	I	
50		3720.72		
20	c	3721.32	II	
18	c	3721.80	II	
30		3724.45		
8		3725.05	I	
20	c	3725.98	II	
120		3731.40	I	
40		3732.09	I	
24		3732.59	I	
20		3734.99		
90		3736.35	I	
20		3737.65	II	
22		3742.40	I	
360	cw	3748.17	II	
12	c	3748.78	II	
10		3750.19	II	
11	c	3752.07	II	
15	c	3753.01	II	
36	c	3753.73	II	
18		3754.45	I	
30	c	3757.26	II	
10		3760.48	I	
38		3769.09	I	
28		3772.40	I	
12		3773.83	I	
24		3774.58	I	
20		3774.90	I	
15		3775.37	I	
28		3776.15	I	
15	hc	3778.00	I	
32		3780.37	II	
12	c	3780.99	II	
12		3782.65	II	
20		3785.23	II	
36		3788.08	II	
12		3788.44	II	
30		3791.00	II	
24		3791.55		
12		3791.97		
32		3792.95		
20		3794.69	I	
1000	c	3796.75	I	
22		3797.26	I	
24		3798.25	II	
32	c	3801.28	II	
28		3804.15		
12		3807.90		
15		3809.49	II	
12	c	3809.93	II	
1000	c	3810.73	I	
55		3811.86	I	
100	c	3813.25	II	
20		3818.69	II	
34		3821.73	II	
24		3825.64		
44		3829.27	I	
36	cw	3831.9	II	
46	c	3835.35	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
140	cw	3837.51	II	
24		3838.36	II	
46	c	3842.05	II	
120		3843.86	II	
55	c	3846.73	II	
34		3849.88		
26	h	3851.54		
36		3852.40	II	
200	c	3854.07	II	
44	cw	3856.94	II	
80		3857.72	II	
28		3859.34		
300	c	3861.68	II	
60		3862.62	I	
12		3864.91		
40		3872.05		
36	c	3874.09	II	
70		3874.68	II	
28		3879.59		
60		3881.61		
340	c	3888.96	II	
55		3890.42	I	
1500	c	3891.02	II	
32	c	3893.08	II	
11		3893.52	II	
60		3896.76	II	
30	c	3897.27	II	
14		3899.64	II	
14		3900.79	I	
32		3902.23	II	
36		3904.44	I	
140	cw	3905.68	II	
11		3909.56	I	
13		3910.30	I	
36		3911.80	I	
12		3912.44	II	
36		3919.45	I	
11	c	3923.28	II	
11		3924.55	II	
11		3925.64	II	
14	ch	3929.93	II	
36	c	3936.44	II	
24		3938.85	I	
36	cw	3940.53	II	
20		3942.54	I	
11		3949.00	I	
24		3950.56	I	
10		3951.14	I	
10	c	3955.05	II	
65		3955.73	I	
13		3957.39	I	
26	c	3959.51	II	
55		3959.68	I	
13		3963.29	II	
13		3967.33	I	
11		3972.64	II	
10		3973.83	II	
12		3974.55	I	
24		3975.88	I	
44	c	3976.93	I	
19		3976.97	II	
15		3982.04	II	
24	cw	3985.71	II	
18		3992.72	I	
24		3993.73	II	
9		3997.18	II	
15		3998.29	I	
42		3999.58	I	
9	c	4001.32	II	
18	cw	4002.59	II	
24		4003.39	I	
12		4013.50	I	
36		4014.20	II	
18	c	4018.09	II	
18	c	4022.76	II	
18	c	4023.94	II	
12		4025.39	I	
36		4027.21	I	
30		4028.86	I	
20	c	4031.80	I	
24		4037.62	I	
24	c	4038.87	II	
300		4040.81	I	
600	c	4045.44	II	
24	c	4047.52		
900		4053.93	I	
60		4054.48	II	
30		4057.55	I	
24		4060.31	I	
190		4065.09	II	
19		4067.57	I	
80		4068.05	I	
30		4071.83		
30		4073.13		
32		4073.51	I	
13	c	4080.23	II	
26		4083.67	I	
16		4085.09	I	
19		4087.35	I	
22		4087.59	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
16	4091.64	I	
13	4094.78	I	
26	4100.22	I	
10	4101.09	I	
1000	4103.84	I	
13	4105.04		
30	4106.50	I	
11	4107.36	I	
320	4108.62	I	
34	4112.00	I	
11	4112.72	I	
30	4116.73	I	
10	4118.94	I	
170	4120.20	I	
140	4125.65	I	
480	4127.16	I	
34	4134.54	I	
10	4135.08	I	
170	4136.22	I	
14	4139.34	I	
26	4142.19	I	
32	4148.97	I	
110 cw	4152.61	II	
900	4163.03	I	
18	4172.23	I	
280	4173.23	I	
60	4194.35	I	
11	4198.08	I	
14	4203.21	I	
7	4203.39	II	
11	4211.30	II	
10	4219.10	I	
32	4222.29	I	
32	4223.47	I	
220	4227.04	I	
44	4229.52	II	
14 h	4231.24	I	
32	4243.78	I	
10	4245.40	II	
140 cw	4254.43	I	
14 c	4258.61	II	
55	4264.05	I	
34	4266.04	I	
11	4273.63	II	
9	4284.58	II	
10	4290.18	II	
10 c	4298.47	II	
10	4299.15	I	
10	4301.09	II	
22	4311.04	I	
10	4315.03	II	
28	4330.64	II	
9 c	4332.55	II	
34	4337.13	II	
11 cw	4346.84	II	
140	4350.73	I	
32	4356.73	II	
16	4363.93	II	
8	4371.43	II	
8	4373.33	I	
9	4376.58	II	
19	4379.14	II	
10	4379.83	II	
20 c	4384.83	II	
8 c	4388.69	II	
8 h	4394.98	I	
17	4400.55	II	
13	4401.24	II	
20	4403.27	I	
22	4420.56	II	
6	4426.20	II	
9	4429.81	II	
8	4434.96	I	
14	4444.63	I	
8	4445.07	II	
9	4447.23	II	
7	4463.40	II	
8	4467.28	I	
8	4470.23	I	
11	4473.59	II	
34	4477.64	II	
13	4484.57	II	
16	4510.82	I	
10	4512.55	II	
11 c	4526.14	II	
19	4530.08	II	
19 c	4531.28	I	
15 c	4531.65		
19	4534.58	I	
7	4543.80	I	
10	4548.94	II	
5	4558.41	II	
22	4562.52	I	
7 c	4567.82	II	
6	4572.42	II	
10 c	4578.07	I	
8	4589.70		
10 c	4608.00	I	
5	4608.67	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
13 cw	4609.32	II	
	4609.52	II	
15	4613.37	I	
5	4613.99	II	
11	4618.84	I	
11 c	4628.22	I	
32	4629.10	II	
6 h	4632.84	I	
5 c	4638.19	II	
	4638.29	II	
8	4647.75	II	
22 c	4649.77	II	
5	4651.39		
4	4652.71	II	
15 c	4661.33	II	
16 c	4674.62		
6	4683.08	I	
6	4685.83	II	
5	4688.19	II	
8	4701.17	II	
9	4701.69	II	
14	4709.84	II	
7	4711.39	I	
15 c	4717.52	I	
4 c	4728.72	II	
4	4738.00	II	
32	4742.04	II	
4 c	4749.09	II	
4	4751.40	I	
11 c	4757.01	I	
4	4762.39	II	
4	4763.57	II	
6	4777.48	II	
3.5	4779.42	I	
8 c	4781.19	I	
7	4782.92	I	
6 c	4786.29	I	
4	4791.48	II	
4	4795.92	II	
5 h	4798.87	I	
3.0	4812.92	II	
6	4832.31	II	
3.5	4833.32	I	
3.5	4855.54	II	
5	4860.39	I	
3.0 c	4889.67	II	
3.5	4892.35	I	
4	4896.44	II	
6	4906.99	II	
5	4922.73	I	
6 c	4934.89	I	
32	4939.01	I	
3.0 c	4946.80	I	
5	4948.18	II	
7 c	4959.42	II	
4	4961.03	II	
6 cw	4966.73	II	
28 c	4967.21	II	
24	4979.97	I	
4 c	4988.96	I	
10	4995.05	I	
4 c	5012.42	I	
6	5013.28	II	
7	5026.53	I	
3.5	5028.17	I	
6	5032.95		
7 c	5037.60	I	
14	5042.37	I	
4	5044.73	I	
3.5	5051.44	II	
3.5	5054.92	II	
4 c	5060.75	I	
7	5074.34	I	
9	5093.07	I	
16	5127.81	I	
6	5129.27	II	
15	5142.59		
12	5143.22		
18	5149.59		
10 c	5167.88	I	
14 c	5182.11	I	
6	5187.85	I	
10	5190.11		
2.0	5195.23	I	
5	5221.54		
4 c	5244.47	I	
7	5251.82	I	
6	5275.48	I	
10	5301.25	I	
4	5319.24	I	
4	5319.65	I	
9	5330.11	I	
10	5359.99		
6	5381.40	I	
3.5	5384.56	I	
3.5	5384.97	I	
2.0 h	5393.85	I	
8	5403.17	I	
11	5407.08	I	
1.6	5413.62	II	

609065 O - 62 - 10

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.8	5434.39	II	
2.0	5435.87	I	
3.5	5445.39	I	
2.0	5449.8	II	
3.5 h	5451.9	I	
1.6	5454.0		
3.5 c	5498.57	I	
3.5	5504.51	I	
3.0	5515.56	II	
2.0	5516.45	II	
3.5	5534.33	I	
3.0	5553.14	I	
4 c	5560.94	I	
4 b	5563.6	HoO	
8	5566.52	I	
2.0	5573.96	II	
4 bl	5584.7	HoO	
6 b	5591.1	HoO	
6 bl	5592.3	HoO	
3.5 b	5607.1	HoO	
3.0	5613.64	I	
5 b	5626.4	HoO	
7	5627.60	I	
3.5	5628.24	II	
6	5640.62		
8 bs	5655.9	HoO	
7 b	5658.9	HoO	
16	5659.58	I	
8 c	5671.84		
7	5674.70	I	
16 c	5691.47	I	
8 bs	5696.3	HoO	
16 c	5696.57	I	
3.0	5734.02	I	
5	5736.4	HoO	
6	5739.24	I	
2.5	5749.58	I	
3.5	5766.64		
3.0 b	5803.8	HoO	
5 b	5819.2	HoO	
3.0 h	5821.90	I	
2.5	5839.47	I	
5 b	5849.4	HoO	
16 c	5860.28	I	
3.0 h	5864.42	I	
5	5870.85	I	
3.0 b	5879.6	HoO	
8 c	5882.99	I	
4 c	5892.56	I	
2.5	5904.29	I	
8	5921.76	I	
3.5 c	5933.71	I	
8 cw	5948.03	I	
5	5955.98	I	
8	5972.76	I	
10	5973.52	I	
2.5	5981.43	I	
26 c	5982.90	I	
6	6002.04	I	
3.0	6005.33	I	
4	6021.43	I	
1.8	6038.97	I	
3.0	6050.71	I	
5	6060.31	I	
13	6081.79	I	
8 cw	6133.60	I	
4	6156.38	I	
3.0	6156.58	I	
6	6191.68	I	
8	6208.65	I	
2.0	6234.17	I	
5 c	6255.75	I	
8 c	6305.36	I	
2.5	6306.68		
3.5	6321.94		
3.5 c	6354.35	I	
3.5 c	6372.59	I	
1.6 h	6373.86	I	
2.5 h	6413.41	I	
3.0 c	6471.77	I	
1.4	6479.17	I	
1.2	6515.30	I	
1.2 h	6538.99	I	
8	6550.97	I	
1.6	6560.08	I	
3.5 d	6600.58	I	
28	6604.94	I	
6	6607.47	I	
1.4	6628.35	I	
13	6628.99	I	
1.6	6632.24	I	
1.0 h	6652.98	I	
1.6	6662.52	I	
2.0 c	6680.46	I	
2.5 c	6681.62	I	
1.6 h	6682.02		
6 cw	6694.32	I	
1.6 cw	6722.34	I	
4	6745.05	I	
1.4	6766.74	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0 c	6774.68	I	
6 c	6785.43	I	
1.4	6793.7	I	
1.4 cw	6811.04	I	
1.6 cw	6820.38	I	
2.5	6821.64	I	
1.8 c	6825.72	I	
0.8 h	6826.62		
0.8 h	6852.97		
1.8 cw	6865.85	I	
1.0	6883.36	I	
1.4	6888.50	I	
1.6 c	6892.96	I	
1.8	6897.95	I	
1.6 h	6903.80	I	
1.6 cw	6913.47	I	
1.0	6916.70	I	
4 cw	6939.49	I	
5 cw	6950.39	I	
1.4 hl	6955.3	I	
2.0	6976.7	II	
1.0	6985.11		
0.9	6994.38		
1.4 h	7000.71		
1.0	7079.07		
1.2	7098.58		
0.9	7242.08	I	
0.9	7250.60	I	
1.4	7308.55		
2.5	7341.43		
1.8	7389.40		
0.5 h	7496.20		
1.0 h	7510.74	I	
14	7555.09	I	
1.8	7589.20	I	
2.5	7591.87	I	
0.9 h	7593.64	I	
0.7 h	7594.35	I	
1.2	7602.31	II	
1.6	7605.35	I	
1.2	7617.05	I	
1.4	7627.98	I	
4 c	7628.42	I	
0.9 c	7641.14	I	
0.4	7648.16	I	
1.4 c	7653.80	I	
1.2 c	7667.30	I	
2.0	7690.43	I	
5 c	7693.15	I	
4 cw	7715.06	I	
1.6	7719.05	I	
1.6 h	7738.98	I	
0.8 c	7752.01	I	
6 cw	7815.48	I	
4 cw	7823.63	I	
0.8 h	7879.22	I	
6	7894.64	I	
1.0 h	8464.66	I	
1.0 h	8482.67	I	
5	8512.94		
2.0	8545.61	II	
1.8	8601.84	II	
4	8670.19		
0.8 h	8697.32		
1.6 h	8805.48	II	
2.0 c	8834.49	I	
9	8915.98	II	

INDIUM

In, $Z=49$, $M=114.82$, Ratio $\frac{\text{In}}{\text{Cu}}=1.807$

In I Normal state of valence electrons $5s^2 5p^1\ ^2P^\circ_{0\frac{1}{2}}=0$. I.P.= 46670 K
In II Normal state of valence electrons $5s^2\ ^1S_0=0$. I.P.=152195 K

References

Wavelengths and Classification:
In I, F. Paschen, Ann. der Physik **32,** 148 (1938).
In II, F. Paschen and J. S. Campbell, Ann. der Physik **31,** 29 (1938).

Intensities:
Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **4,** 719 (1958).
S. Ch'en and A. Smith, Physica **25,** 1289 (1959).

Relative intensity of indium lines observed in an arc of copper containing 0.1 atomic percent of indium

Strong lines of indium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1800	4511.31	I	2213–24373	$5s^2 5p^1\ ^2P^\circ_{1\frac{1}{2}}$—$5s^2 6s^1\ ^2S_{0\frac{1}{2}}$
1700	4101.76	I	0–24373	$5s^2 5p^1\ ^2P^\circ_{0\frac{1}{2}}$—$5s^2 6s^1\ ^2S_{0\frac{1}{2}}$
1300	3256.09	I	2213–32916	$5s^2 5p^1\ ^2P^\circ_{1\frac{1}{2}}$—$5s^2 5d^1\ ^2D_{2\frac{1}{2}}$
800	3039.36	I	0–32892	$5s^2 5p^1\ ^2P^\circ_{0\frac{1}{2}}$—$5s^2 5d^1\ ^2D_{1\frac{1}{2}}$

Indium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	2306.06	II	0–43349	18 c	2836.92	I	2213–37452
2.0	2389.54	I	0–41836	3.0 c	2858.14	I	0–34978
6	2460.08	I	0–40637	110	2932.63	I	2213–36302
3.0 h	2468.02	I	2213–42718	2.0 c	2957.01	I	2213–36020
10	2521.37	I	2213–41862	800	3039.36	I	0–32892
110	2560.15	I	0–39048	1300	3256.09	I	2213–32916
20	2601.76	I	2213–40637	300	3258.56	I	2213–32892
160	2710.26	I	2213–39098	1700	4104.76	I	0–24373
30	2713.94	I	2213–39048	1800	4511.31	I	2213–24373
70	2753.88	I	0–36302	0.8 h	6847.44	I	24373–38972
4	2775.37	I	0–36020	0.4 h	6900.13	I	24373–38861

IRIDIUM

Ir, $Z=77$, $M=192.2$, Ratio $\frac{\text{Ir}}{\text{Cu}}=3.025$

Ir I Normal state of valence electrons $5d^7 6s^2\ {}^4F_{4½}=0$. I.P.=75000 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Ir I, W. Albertson, Phys. Rev. **54,** 183 (1938); T. A. M. van Kleef, Physica **23,** 843 (1957).

Ir II, (spectrum assignment only) T. A. M. van Kleef, unpublished material (1959).

Relative intensity of iridium lines observed in an arc of copper containing 0.1 atomic percent of iridium

Strong lines of iridium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
500	3220. 78	I	2835–33874	$5d^8 6s^1\ b\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^6F^\circ_{3½}$
380	2543. 97	I	2835–42132	$5d^8 6s^1\ b\ {}^4F_{4½}$—$5d^8\ 6p^1\ {}^4G^\circ_{5½}$
340	3133. 32	I	6324–38230	$5d^7 6s^2\ a\ {}^4F_{3½}$—$5d^7 6s^1 6p^1\ {}^4F^\circ_{4½}$
320	2924. 79	I	0–34180	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^6G^\circ_{5½}$
320	3513. 64	I	0–28452	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^6F^\circ_{5½}$
320	3800. 12	I	0–26308	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^6D^\circ_{4½}$
280	2849. 72	I	0–35081	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^6G^\circ_{4½}$
220	2694. 23	I	2835–39940	$5d^8 6s^1\ b\ {}^4F_{4½}$—$5d^6 6s^2 6p^1\ {}^6F^\circ_{5½}$
200	2502. 98	I	0–39940	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^6 6s^2 6p^1\ {}^6F^\circ_{5½}$
200	2664. 79	I	0–37515	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^4D^\circ_{3½}$
200	2943. 15	I	6324–40291	$5d^7 6s^1\ a\ {}^4F_{3½}$—$5d^7 6s^1 6p^1\ {}^4F^\circ_{3½}$
170	2639. 71	I	0–37872	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^4F^\circ_{4½}$
160	2475. 12	I	0–40390	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^6 6s^2 6p^1\ {}^6F^\circ_{4½}$
160	3068. 89	I	2835–35411	$5d^8 6s^1\ b\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ z\ {}^6G^\circ_{3½}$
130	2661. 98	I	2835–40390	$5d^8 6s^1\ b\ {}^4F_{4½}$—$5d^6 6s^2 6p^1\ {}^6F^\circ_{4½}$
120	2797. 70	I	2835–38568	$5d^8 6s^1\ b\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ {}^4D^\circ_{3½}$
120	3573. 72	I	7107–35081	$5d^8 6s^1\ b\ {}^4F_{3½}$—$5d^7 6s^1 6p^1\ z\ {}^6G^\circ_{4½}$
100	2481. 18	I	0–40291	$5d^7 6s^2\ a\ {}^4F_{4½}$—$5d^7 6s^1 6p^1\ {}^4F^\circ_{3½}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	2010.65	I	0–49719
3.5	2022.35	I	2835–52266
7	2033.57	I	0–49159
3.5	2052.22	I	6324–55036
3.0	2060.64	I	7107–55619
3.0	2083.22	I	5785–53772
2.5	2085.74	I	7107–55036
13	2088.82	I	0–47858
13	2092.63	I	2835–50606
3.0	2112.68	I	6324–53642
2.0	2119.54	I	0–47165
2.5	2125.44	I	7107–54141
6	2126.81	II	
2.5	2127.52	I	2835–49824
6	2127.94	I	0–46979
6	2148.22	I	7107–53642
4	2150.54	I	4079–50564
6	2152.68	II	
5	2155.81	I	0–46372
15	2158.05	I	2835–49159
4	2162.88	I	0–46220
12	2169.42	II	
10	2175.24	I	0–45957
6	2178.17	I	0–45896
4	2187.43	II	
3.0	2190.38	II	
2.0	2191.64	I	2835–48449
3.0	2208.09	II	
5	2220.37	I	2835–47858
3	2221.07	II	
12	2242.68	II	
3	2245.76	II	
11	2253.38	I	7107–51471
	2253.49	I	4079–48441
11	2255.10	I	2835–47165
8	2255.81	I	5785–50101
2.0	2258.51	I	9878–54141
8	2258.86	I	6324–50580
5	2264.61	I	2835–46979
7	2266.33	I	6324–50434
7	2268.90	I	10579–54639
5	2280.00	I	6324–50170
7	2281.02	II	
5	2281.91	I	9878–53687
2.5	2284.60	I	13940–57698
3.0	2295.08	I	5785–49342
7	2298.05	I	11831–55333
	2298.16	I	6324–49824
4	2299.53	I	7107–50580
8	2300.50	I	6324–49779
26	2304.22	I	2835–46220
4	2305.47	I	5785–49146
2.0	2307.27	I	7107–50434
9	2308.93	I	6324–49621
5	2315.38	I	0–43176
5	2321.45	I	7107–50170
5	2321.58	I	2835–45896
2.5	2327.98	I	12218–55161
7	2333.30	I	5785–48629
10	2333.84	I	6324–49159
8	2334.50	I	6324–49146
24	2343.18	I	5785–48449
11	2343.61	I	5785–48441
1.8	2352.62	I	12218–54711
10	2355.00	I	9878–52327
4	2357.53	II	
7	2358.16	I	4079–46472
9	2360.73	I	9878–52224
48	2363.04	I	6324–48629
7	2368.04	II	
70	2372.77	I	0–42132
6	2375.09	II	
5	2377.28	I	7107–49159
5	2377.98	I	7107–49146
11	2379.38	I	4079–46094
12	2381.62	I	6324–48299
5	2383.17	I	13088–55036
2.0	2383.79	I	9878–51815
3.0	2386.58	II	
30	2386.89	I	6324–48207
60	2390.62	I	2835–44652
70	2391.18	I	2835–44643
2.5	2401.77	I	13088–54711
7	2407.59	I	7107–48629
9	2409.37	I	4079–45571
9	2410.17	I	13088–54566
9	2410.73	I	12218–53687
17	2413.31	I	4079–45503
12	2415.86	I	5785–47165
22	2418.11	I	7107–48449
5	2424.32	I	10579–51815
5	2424.66	I	9878–51108
8	2424.89	I	5785–47011
14	2424.99	I	6324–47549
11	2425.66	I	6324–47537
6	2426.53	II	
2.0	2426.78	I	5785–46979
20	2427.61	I	4079–45259
22	2431.24	I	0–41119
55	2431.94	I	4079–45186

Iridium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	2432.36	I	7107–48207
4	2432.58	I	13940–55036
11	2435.14	I	13088–54141
3.5	2436.42	I	13088–54119
11	2445.34	I	6324–47206
2.0	2447.49	I	17779–58625
11	2447.76	I	6324–47165
9	2448.23	I	5785–46618
2.0	2449.02	I	12952–53772
44	2452.81	I	2835–43592
4	2454.12	I	12952–53687
65	2455.61	I	0–40711
11	2455.87	I	4079–44785
10	2457.03	I	5785–46472
10	2457.23	I	13088–53772
4	2462.36	I	13088–53687
4	2463.03	I	12218–52807
4	2464.90	I	11831–52388
6	2465.09	I	13088–53642
42	2467.30	I	4079–44597
160	2475.12	I	0–40390
10	2478.11	I	2835–43176
2.0	2479.16	I	13940–54264
100	2481.18	I	0–40291
5	2485.38	I	9878–50101
2.0	2486.37	I	18547–58754
2.0	2486.75	I	13940–54141
2.0	2489.20	I	16103–56265
30	2493.08	I	7107–47206
10	2496.27	I	6324–46372
4	2500.27	I	11831–51815
12	2502.63	I	9878–49824
200	2502.98	I	0–39940
8	2504.37	I	17779–57697
6	2505.74	I	6324–46220
4	2506.60	I	12506–52388
6	2507.63	I	10579–50445
4	2508.35	I	12952–52807
8	2509.71	I	12218–52052
8	2511.94	I	12506–52304
8	2512.58	II	
10	2513.71	I	6324–46094
6	2515.36	I	9878–49621
2.0	2524.88	II	
8	2525.05	I	10579–50170
2.0	2526.77	I	19061–58625
2.5	2532.20	I	18547–58027
6	2532.52	I	5785–45259
48	2533.13	I	9878–49342
55	2534.46	I	2835–42279
28	2537.22	I	5785–45186
8	2537.68	I	16103–55497
2.0	2538.88	I	12952–52327
2.0	2540.40	I	12952–52304
5	2541.48	I	11831–51166
28	2542.02	I	5785–45112
2.0	2542.80	II	
380	2543.97	I	2835–42132
7	2545.54	I	12952–52224
38	2546.03	I	7107–46372
6	2547.20	I	6324–45571
6	2547.69	I	13088–52327
10	2551.40	I	12952–52134
9	2554.40	I	13088–52224
10	2555.35	I	4079–43202
8	2555.88	I	7107–46220
7	2563.28	I	5785–44785
44	2564.18	I	7107–46094
10	2569.88	I	12952–51852
5	2570.62	I	12218–51108
3.5	2572.07	I	10579–49446
3.5	2572.37	I	12952–51815
11	2572.70	I	5785–44643
36	2577.26	I	7107–45896
5	2578.71	I	16565–55333
3.5	2578.91	I	13088–51852
1.8	2579.49	II	
1.8	2583.18	I	18547–57248
36	2592.06	I	0–38568
36	2599.04	I	7107–45571
7	2602.04	I	16565–54985
9	2604.55	I	13088–51471
9	2607.52	I	13088–51427
34	2608.25	I	6324–44652
85	2611.30	I	2835–41119
3.5	2612.04	I	6324–44597
10	2614.98	I	0–38230
3.5 d	2615.88	I	16103–54320
	2616.00	I	12952–51166
16	2617.78	I	4079–42268
10	2619.88	I	0–38158
3.5	2623.64	II	
12	2625.32	I	7107–45186
2.0	2625.67	I	16565–54639
5	2626.76	I	12506–50564
2.5	2628.20	I	16103–54141
2.0	2629.41	I	13088–51108
34	2634.17	I	12218–50170
8	2635.27	I	4079–42014
1.6	2638.97	I	12218–50101

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	2639.42	I	2835–40711
170	2639.71	I	0–37872
2.5	2640.38	I	10579–48441
10	2644.19	I	5785–43592
8	2653.76	I	9878–47549
3.5	2653.95	I	16103–53772
5	2656.81	I	10579–48207
1.6	2657.71	I	11831–49446
130	2661.98	I	2835–40390
26	2662.63	I	7107–44652
6	2663.31	I	7107–44643
200	2664.79	I	0–37515
10	2668.99	I	2835–40291
4	2669.46	I	16103–53553
38	2669.91	I	4079–41522
38	2671.84	I	5785–43201
24	2673.61	I	5785–43176
9	2676.83	I	13088–50434
7	2679.06	I	11831–49146
4	2681.10	I	5785–43072
2.0	2682.46	I	6324–43592
8	2684.04	I	10579–47825
4	2691.06	I	12952–50101
20	2692.34	I	4079–41210
2.0	2692.88	I	12218–49342
2.0	2693.49	I	17779–54895
220	2694.23	I	2835–39940
8	2704.03	I	2835–39806
3.0	2704.93	I	10579–47537
2.0	2706.88	I	17779–54711
12	2712.74	I	6324–43176
5	2720.45	I	6324–43072
2.5	2723.76	I	16103–52807
3.0	2729.56	I	10579–47204
4	2730.71	I	11831–48441
5	2732.67	I	12218–48802
2.5	2739.32	I	13940–50434
2.5	2740.00	I	7107–43592
2.5	2740.18	I	5785–42268
10	2744.00	I	10579–47011
2.0	2747.51	I	19593–55979
2.0	2749.32	I	17779–54141
6	2758.23	I	5785–42029
5	2759.32	I	12218–48449
4	2759.91	I	12218–48441
2.0	2767.65	I	16103–52224
6	2771.61	I	7107–43176
24	2772.46	I	13088–49146
2.0	2774.58	I	16103–52134
18	2775.55	I	9878–45896
6 d	2777.43	I	11831–47825
	2777.53	I	17779–53772
38	2781.29	I	6324–42268
24	2785.22	I	10579–46472
6	2796.46	I	16103–51852
40	2797.35	I	5785–41522
120	2797.70	I	2835–38568
28	2798.18	I	4079–39806
3.0	2799.74	I	16681–52388
30	2800.82	I	9878–45571
3.0	2812.80	I	13088–48629
50	2823.18	I	0–35411
90	2824.45	I	2835–38230
5	2830.17	I	2835–38158
4	2830.51	I	12218–47538
3.0	2831.36	I	9878–45186
8	2833.24	II	
8	2835.66	I	12952–48206
60	2836.40	I	4079–39324
12	2837.33	I	9878–45112
80	2839.16	I	13088–48299
	2839.24	I	4079–39289
60	2840.22	I	6324–41522
12	2842.28	I	7107–42279
280	2849.72	I	0–35081
3.0 d	2855.82	I	18547–53553
	2855.93	I	16103–51108
3.0	2860.66	I	12218–47165
8	2863.84	I	9878–44786
4	2866.69	I	12952–47825
2.5	2867.63	I	16565–51427
6	2869.70	I	10579–45415
28	2875.60	I	9878–44643
28	2875.98	I	12218–46979
20	2877.68	I	5785–40525
10	2879.41	I	9878–44597
4	2881.16	I	12506–47204
60	2882.64	I	2835–37515
48	2897.15	I	5785–40291
6	2899.63	I	16103–50580
2.5	2900.39	I	19593–54061
19	2901.95	I	13088–47538
19	2904.80	I	7107–41522
3.0	2905.64	I	4079–38485
15	2907.24	I	6324–40711
5	2909.56	I	13940–48299
32	2916.36	I	4079–38358
17	2918.57	I	12218–46472
320	2924.79	I	0–34180
6	2930.63	I	12506–46618

Iridium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
90	2934.64	I	6324–40390
65	2936.68	I	4079–38121
18	2938.47	I	5785–39806
14	2939.27	I	7107–41119
10	2940.54	I	16103–50101
3.0	2941.08	I	10579–44570
200	2943.15	I	6324–40291
17	2946.97	I	13088–47011
15	2949.76	I	13088–46979
85	2951.22	I	0–33874
11	2962.99	I	11831–45571
3.5	2965.20	I	9878–43592
2.5	2968.49	I	12218–45896
2.0	2974.10	I	4079–37693
15	2974.95	I	16565–50170
32	2980.65	I	5785–39324
11	2985.80	I	6324–39806
14	2990.62	I	11831–45259
22	2996.08	I	4079–37446
5	2997.19	I	11831–45186
13	2997.41	I	12218–45571
16	3002.25	I	9878–43176
44	3003.63	I	7107–40390
6	3005.21	I	13940–47206
3.0	3009.90	I	16565–49779
12	3011.69	I	9878–43072
9	3016.43	I	12952–46094
20	3017.31	I	13088–46221
10	3019.23	I	26307–59419
6	3020.01	I	26307–59410
6	3022.41	I	26307–59384
8	3025.82	I	13940–46979
28	3029.36	I	6324–39324
5	3032.41	I	12218–45186
3.0	3033.62	I	11831–44786
7	3037.75	I	12506–45415
24	3039.26	I	12218–45112
4	3040.47	I	18547–51427
2.5	3042.65	II	
22	3047.16	I	13088–45896
22	3049.44	I	5785–38568
3.0	3052.16	I	19061–51815
6	3053.60	I	11831–44570
22	3057.28	I	7107–39806
5	3061.41	I	17779–50434
4	3064.51	I	10579–43201
160	3068.89	I	2835–35411
19	3069.09	I	5785–38358
19	3069.71	I	12218–44785
17	3076.69	I	10579–43072
32	3083.22	I	12218–44643
24	3086.44	I	9878–42268
38	3088.04	I	5785–38158
7	3094.01	I	4079–36390
50	3100.29	I	2835–35081
50	3100.45	I	6324–38568
6	3114.05	I	16103–48206
9	3114.55	I	13088–45186
34	3120.76	I	6324–38358
20	3121.78	I	13088–45112
9	3122.38	I	13940–45957
7	3128.39	I	13940–45896
7	3133.09	I	5785–37693
340	3133.32	I	6324–38230
7	3140.41	I	12952–44786
7	3145.07	I	28452–60239
19	3150.61	I	5785–37515
7	3154.55	I	12952–44643
19	3154.74	I	10579–42268
19	3159.15	I	12952–44597
14	3168.18	I	13088–44643
48	3168.88	I	6324–37872
36	3177.58	I	7107–38568
17	3180.35	I	16103–47538
36	3198.92	I	7107–38358
60	3212.12	I	7107–38230
7	3213.55	I	19061–50170
7	3218.46	I	16103–47165
36	3219.51	I	7107–38158
500	3220.78	I	2835–33874
10	3221.28	I	28452–59487
30	3229.28	I	12218–43176
10	3230.76	I	10579–41522
6	3232.00	I	28452–59384
46	3241.52	I	4079–34920
8	3254.40	I	19061–49779
20	3262.01	I	9878–40525
38	3266.44	I	5785–36390
16	3277.28	I	13088–43592
6	3287.06	I	9878–40291
10	3287.59	I	7107–37515
16	3310.52	I	11831–42029
8	3312.13	I	11831–42014
20	3322.60	I	13088–43176
8	3322.87	I	19060–49147
13	3334.16	I	13088–43072
6	3338.37	I	10579–40525
55	3368.48	I	2835–32513
6	3419.42	I	13940–43176
65	3437.02	I	6324–35411

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	3437.50	I	16103–45186
40	3448.97	I	4079–33065
8	3476.46	I	6324–35081
6	3477.77	I	10579–39325
8	3484.48	I	9878–38568
320	3513.64	I	0–28452
22	3515.95	I	7107–35540
40	3522.03	I	4079–32464
16	3557.17	I	16681–44785
32	3558.99	I	5785–33874
6	3568.00	I	12506–40525
120	3573.72	I	7107–35081
32	3594.39	I	7107–34920
22	3609.77	I	2835–30530
19	3617.21	I	9878–37515
8	3625.71	I	12952–40525
16	3626.29	I	9878–37446
65	3628.67	I	6324–33874
22	3636.20	I	11831–39324
30	3661.71	I	13088–40390
30	3664.62	I	5785–33065
32	3674.98	I	13088–40291
20	3687.08	I	10579–37693
8	3698.10	I	19060–46094
14	3725.38	I	19060–45896
20	3731.36	II	
14	3738.53	I	6324–33065
55	3747.20	I	5785–32464
4	3750.40	I	32831–59487
4	3753.32	I	16565–43201
7	3768.68	I	11831–38358
5	3770.73	I	9878–36390
12	3793.79	I	13940–40291
3.5	3794.06	I	12218–38568
320	3800.12	I	0–26308
24	3817.24	I	6324–32513
18	3865.64	I	11831–37693
50	3902.51	I	2835–28452
10	3902.66	I	12952–38568
50	3915.38	I	9878–35411
44	3934.84	I	7107–32513
13	3946.27	I	16681–42014
7	3951.95	I	12218–37515
3.5	3952.62	I	17779–43072
3.5	3962.78	I	12218–37446
4	3966.09	I	12952–38158
65	3976.31	I	13088–38230
50	3992.12	I	9878–34920
20	4020.03	I	26307–51176
38	4033.76	I	13088–37872
14	4040.08	I	5785–30530
40	4069.92	I	12952–37515
16	4070.68	I	11831–36390
11	4092.61	I	13088–37515
15	4115.78	I	13940–38230
2.5	4127.92	I	13940–38158
3.0	4155.70	I	28452–52509
1.6	4166.04	I	9878–33874
10	4172.56	I	16565–40525
4	4182.47	I	32513–56416
1.6 h	4183.21	I	38230–62128
2.0	4185.66	I	12506–36390
2.5	4197.54	I	11831–35648
3.0	4217.76	I	16103–39806
1.4	4220.80	I	26365–50050
8	4259.11	I	2835–26308
3.0	4265.30	I	12952–36390
28	4268.10	I	7107–30530
2.5	4286.62	I	12218–35540
8	4301.60	I	16565–39806
6	4310.59	I	12218–35411
24	4311.50	I	9878–33065
2.0	4351.30	I	18547–41522
2.0	4352.56	I	19061–42029
2.0	4392.59	I	16565–39325
18	4399.47	I	16565–39289
7	4403.78	I	12218–34920
12	4426.27	I	9878–32464
1.6	4450.18	I	16103–38568
6	4478.48	I	13088–35411
1.8	4495.35	I	33065–55304
1.2 h	4496.03	I	34180–56416
6	4545.68	I	13088–35081
3.5	4548.48	I	30530–52509
1.4	4550.78	I	12952–34920
4	4568.09	I	10579–32464
2.0	4570.02	I	23310–45186
2.0	4604.48	I	35081–56793
7	4616.39	I	12218–33874
2.5	4656.18	I	13940–35411
1.6 h	4668.99	I	16103–37515
2.0	4708.88	I	19060–40291
5	4728.86	I	13940–35081
2.0	4731.86	I	16565–37693
2.5	4756.46	I	33874–54893
1.2	4757.96	I	16681–37693
6	4778.16	I	12952–33874
3.0	4795.67	I	12218–33065
1.0	4807.14	I	19593–40390
2.0	4809.47	I	13088–33874

Iridium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.0	4840.77	I	9878–30530
1.6	4845.38	I	11831–32464
5	4938.09	I	12218–32464
2.5	4970.48	I	12952–33065
2.0	4999.74	I	32513–52509
2.0	5002.74	I	6324–26308
1.4	5009.17	I	12506–32464
2.5	5014.98	I	13940–33874
1.4	5046.06	I	35081–54893
2.5	5123.66	I	12952–32464
1.6	5177.95	I	16103–35411
1.8	5238.92	I	16565–35648
1.0	5340.74	I	23310–42029
3.0	5364.32	I	19593–38230
6.0	5449.50	I	32831–51176
2.5	5454.50	I	34180–52509
0.6	5469.40	I	19593–37872
0.8	5620.04	I	37515–55304
3.5	5625.55	I	16103–33874
0.8	5828.55	I	38230–55382
0.8	5882.30	I	34180–51176
0.6	5887.36	I	23310–40291
3.0	5894.06	I	16103–33065
0.6	6026.10	I	13940–30530
1.0	6067.83	I	39940–56416
1.6	6110.67	I	16103–32464
1.0	6288.28	I	16565–32464
0.6	6334.44	I	16681–32464
0.4	6624.73	I	40291–55382
1.2	6686.08	I	39940–54893
0.6	6830.01	I	37872–52509
0.8	6929.88	I	16103–30530
0.7	7183.71	I	18547–32464
1.0	7834.32	I	42132–54893

IRON

Fe, $Z=26$, $M=55.85$, Ratio $\frac{\text{Fe}}{\text{Cu}}=0.879$

Fe I Normal state of valence electrons $3d^6 4s^2\ {}^5D_4 = 0$. I.P.= 63700 K
Fe II Normal state of valence electrons $3d^6 4s^1\ {}^6D_{4½} = 0$. I.P.=130524 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Fe I, H. N. Russell, C. E. Moore, and D. W. Weeks, Trans. Am. Phil. Soc. **34,**, 111 (1944).
Fe II, J. C. Dobbie, Ann. Solar Phys. Observatory, Cambridge, England, **5,** 1 (1938).

Intensities:

R. Frerichs, Ann. Physik **81,** 807 (1926).
J. B. van Milaan, Z. Physik **38,** 427 (1926).
R. B. King and A. S. King, Astrophys. J. **87,** 24 (1938)
R. B. King, Astrophys. J. **95,** 78 (1942).
W. W. Carter, Phys. Rev. **76,** 962 (1949).
H. M. Crosswhite, Spectrochim. Acta **4,** 122 (1950).
H. Kopfermann and G. Wessel, Z. Physik **130,** 100 (1951).
J. Aarts, D. Harting, and C. J. Bakker, Physica **20,** 1250 (1954).
G. D. Bell, M. H. Davis, R. B. King, and P. M. Routley, Astrophys. J. **127,** 775 (1958).
R. Hefferlin, J. Opt. Soc. Am. **49,** 948 (1959).

Relative intensity of iron lines observed in an arc of copper containing 0.1 atomic percent of iron

Strong lines of iron

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
700	3734. 87	I	6928–33695	$3d^7 4s^1\ a\ {}^5F_5 - 3d^7 4p^1\ y\ {}^5F^\circ_5$
600	3581. 20	I	6928–34844	$3d^7 4s^1\ a\ {}^5F_5 - 3d^7 4p^1\ z\ {}^5G^\circ_6$
600	3719. 94	I	0–26875	$3d^6 4s^2\ a\ {}^5D_4 - 3d^6 4s^1 4p^1\ z\ {}^5F^\circ_5$
500	3820. 43	I	6928–33096	$3d^7 4s^1\ a\ {}^5F_5 - 3d^7 4p^1\ y\ {}^5D^\circ_5$
420	3859. 91	I	0–25900	$3d^6 4s^2\ a\ {}^5D_4 - 3d^6 4s^1 4p^1\ z\ {}^5D^\circ_4$
400	3440. 61	I	0–29056	$3d^6 4s^2\ a\ {}^5D_4 - 3d^6 4s^1 4p^1\ z\ {}^5P^\circ_3$
400	3570. 10	I	7377–35379	$3d^7 4s^1\ a\ {}^5F_4 - 3d^7 4p^1\ z\ {}^3G^\circ_5$
400	3749. 49	I	7377–34040	$3d^7 4s^1\ a\ {}^5F_4 - 3d^7 4p^1\ y\ {}^5F^\circ_4$
340	3737. 13	I	416–27167	$3d^6 4s^2\ a\ {}^5D_3 - 3d^6 4s^1 4p^1\ z\ {}^5F^\circ_4$
320	3825. 88	I	7377–33507	$3d^7 4s^1\ a\ {}^5F_4 - 3d^7 4p^1\ y\ {}^5D^\circ_3$
300	3758. 24	I	7728–34329	$3d^7 4s^1\ a\ {}^5F_3 - 3d^7 4p^1\ y\ {}^5F^\circ_3$
300	4045. 82	I	11976–36686	$3d^7 4s^1\ a\ {}^3F_4 - 3d^7 4p^1\ y\ {}^3F^\circ_4$
280	2483. 27	I	0–40257	$3d^6 4s^2\ a\ {}^5D_4 - 3d^6 4s^1 4p^1\ x\ {}^5F^\circ_5$
280	2522. 85	I	0–39626	$3d^6 4s^2\ a\ {}^5D_4 - 3d^6 4s^1 4p^1\ x\ {}^5D^\circ_4$
280	3020. 64	I	0–33096	$3d^6 4s^2\ a\ {}^5D_4 - 3d^7 4p^1\ y\ {}^5D^\circ_4$
260	2488. 15	I	416–40594	$3d^6 4s^2\ a\ {}^5D_3 - 3d^6 4s^1 4p^1\ x\ {}^5F^\circ_4$
260	2719. 02	I	0–36767	$3d^6 4s^2\ a\ {}^5D_4 - 3d^6 4s^1 4p^1\ y\ {}^5P^\circ_3$
240	3745. 56	I	704–27395	$3d^6 4s^2\ a\ {}^5D_2 - 3d^6 4s^1 4p^1\ z\ {}^5F^\circ_3$
200	2599. 40	II	0–38459	$3d^6 4s^1\ a\ {}^6D_{4½} - 3d^6 4p^1\ z\ {}^6D^\circ_{4½}$
200	3608. 86	I	8155–35856	$3d^7 4s^1\ a\ {}^5F_1 - 3d^7 4p^1\ z\ {}^5G^\circ_2$
200	3618. 77	I	7986–35612	$3d^7 4s^1\ a\ {}^5F_2 - 3d^7 4p^1\ z\ {}^5G^\circ_3$
200	3631. 46	I	7728–35257	$3d^7 4s^1\ a\ {}^5F_3 - 3d^7 4p^1\ z\ {}^5G^\circ_4$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2084.12	I	0–47967
15	2166.77	I	0–46137
7	2178.09	I	416–46314
3.5	2191.84	I	704–46314
3.5	2196.04	I	888–46410
4	2297.79	I	416–43923
7	2332.80	II	385–43239
4	2338.00	II	863–43621
11	2343.49	II	0–42658
4	2348.10	II	1873–44447
4	2348.30	II	668–43239
4	2359.10	II	863–43239
4	2360.00	II	1873–44233
3.5	2360.29	II	2430–44785
8	2364.83	II	385–42658
4	2368.60	II	2838–45044
11	2373.73	II	0–42115
3.0	2375.19	II	3118–45207
7	2379.28	II	2430–44447
7	2380.76	II	668–42658
60	2382.04	II	0–41968
4	2383.24	II	2838–44785
3.0	2384.39	II	3118–45044
16	2388.63	II	385–42237
60	2395.62	II	385–42115
20	2399.24	II	668–42335
4	2404.43	II	863–42440
60	2404.88	II	668–42237
19	2406.66	II	863–42401
19	2410.52	II	863–42335
14	2411.07	II	977–42440
15	2413.31	II	977–42401
4	2424.14	II	22637–63876
3.0	2430.07	II	22810–63949
7	2439.74	I	19390–60366
5	2440.11	I	19788–60758
10	2442.57	I	19621–60549
5	2443.87	I	6928–47835
4	2444.51	II	20831–61726
3.0	2445.56	II	21812–62690
7	2447.71	I	0–40842
6	2453.47	I	7377–48123
18	2457.60	I	6928–47606
7	2458.78	II	25805–66464
11	2462.18	I	416–41018
70	2462.64	I	0–40594
3.5	2463.73	I	7728–48305
14	2465.15	I	7377–47930
3.5	2467.73	I	7728–48239
14	2468.88	I	6928–47420
14	2472.34	I	6928–47363
90	2472.88	I	704–41131
	2472.91	I	416–40842
22	2474.81	I	7728–48123
7	2479.48	I	7986–48305
100	2479.78	I	704–41018
280	2483.27	I	0–40257
90	2484.19	I	888–41131
9	2486.37	I	0–40207
7	2486.69	I	7728–47930
9	2487.06	I	8155–48351
3.5	2487.37	I	704–40895
260	2488.15	I	416–40594
180	2489.75	I	978–41131
180	2490.64	I	704–40842
140	2491.16	I	888–41018
18	2493.18	II	21430–61528
	2493.26	II	21252–61347
14	2496.53	I	7377–47420
10	2498.89	I	416–40422
		II	21582–61587
90	2501.13	I	0–39970
3.5	2501.70	I	6928–46889
10	2507.90	I	7728–47590
90	2510.83	I	416–40231
7	2511.76	II	21712–61513
7	2512.36	I	416–40207
9	2517.66	I	7986–47693
70	2518.10	I	704–40405
6	2519.63	I	8155–47831
280	2522.85	I	0–39626
14	2523.66	I	
50	2524.29	I	888–40491
6	2525.02	I	
7	2525.39	II	21252–60838
5	2526.30	II	20831–60402
140	2527.43	I	416–39970
50	2529.13	I	704–40231
6	2529.55	II	22637–62158
16	2529.83	I	888–40405
7	2530.69	I	704–40207
7	2533.63	II	21430–60888
6	2533.80	I	
6	2534.42	II	21712–61157
70	2535.60	I	978–40405
12	2536.82	II	21582–60990
12	2537.17		
7	2538.81	II	21430–60807
7	2539.00	II	21252–60625
80	2540.98	I	888–40231

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
16	2542.10	I	21039–60365
3.5	2543.38	II	21582–60888
16	2543.92	I	20875–60172
7	2544.71	I	20641–59927
80	2545.98	I	704–39970
65	2549.61	I	416–39626
2.5	2550.02	II	26353–65556
6	2551.09	I	
20	2562.53	II	7955–46967
13	2563.47	II	8392–47390
6	2566.91	II	8680–47626
6	2570.52	II	
4	2574.37	II	20831–59663
6	2575.74	I	
10	2576.69	I	6928–45726
9	2577.92	II	8847–47626
5	2582.30	I	
9	2582.58	II	8680–47390
26	2584.54	I	6928–45608
65	2585.88	II	0–38660
9	2588.00	I	
9	2591.54	II	8392–46967
3.0	2592.78	II	
9	2593.73	II	8847–47390
65	2598.37	II	385–38859
200	2599.40	II	0–38459
30	2599.57	I	7377–45833
8	2605.65	I	6928–45295
16	2606.82	I	7377–45726
65	2607.09	II	668–39013
80	2611.87	II	385–38660
32	2613.82	II	863–39109
32	2617.62	II	668–38859
12	2618.02	I	7728–45914
9	2620.41	II	863–39013
17	2621.67	II	977–39109
15	2623.53	I	7728–45833
44	2625.67	II	385–38459
32	2628.29	II	977–39013
4	2629.59	I	978–38996
55	2631.05	II	22810–60807
55	2631.32	II	668–38660
8	2632.24	I	7986–45965
16	2635.81	I	7986–45914
6	2641.65	I	7377–45221
12	2644.00	I	8155–45965
3.0	2647.56	I	416–38175
4	2656.15	I	19390–57028
3.0	2662.06	I	7728–45282
7	2664.66	II	27315–64832
5	2666.64	II	27620–65110
10	2666.82	I	6928–44415
18	2679.06	I	6928–44244
12	2689.21	I	7377–44551
8	2699.11	I	7377–44415
4	2703.99	II	27315–64286
6	2706.02	I	19390–56334
18	2706.58	I	7728–44664
7	2708.57	I	20641–57550
2.0	2710.55	I	12969–49851
8	2711.65	I	7377–44244
19	2714.41	II	7955–44785
10	2718.44	I	7986–44761
260	2719.02	I	0–36767
120	2720.90	I	416–37158
70	2723.58	I	704–37410
8	2724.96	I	7728–44415
8	2726.05	I	8155–44827
18	2727.54	II	8392–45044
6	2728.02	I	7377–44023
5	2728.82	I	19788–56423
9	2730.74	II	8680–45290
70	2733.58	I	6928–43500
3.0	2734.00	I	7986–44551
3.0	2734.27	I	17550–54112
28	2735.48	I	7377–43923
10	2736.97	II	8680–45207
70	2737.31	I	888–37410
75	2739.55	II	7955–44447
8	2742.26	I	7728–44184
55	2742.41	I	704–37158
28	2743.20	II	8847–45290
5	2743.56	I	7728–44166
30	2744.07	I	978–37410
6	2744.53	I	7986–44411
42	2746.48	II	8680–45080
38	2746.98	I	6928–43321
		II	8392–44785
12	2749.18	II	8680–45044
60	2749.32	II	8392–44754
70	2750.14	I	416–36767
3.0	2750.88	I	17550–53892
8	2753.29	II	26353–62662
4	2753.69	I	8155–44459
4	2754.04	I	7986–44285
75	2755.74	II	7955–44233
24	2756.26	I	416–36686
	2756.33	I	888–37158
8	2757.32	I	8155–44411
2.0	2759.82	I	8155–44378

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
15	2761.78	I	7986–44184
	2761.81	II	8847–45044
16	2762.03	I	7728–43923
5	2763.11	I	7986–44166
2.0	2764.33	I	17727–53892
2.0	2766.91	I	8155–44285
18	2767.50	II	26170–62293
	2767.52	I	7377–43500
18	2772.08	I	6928–42992
3.0	2773.24	I	
3.0	2774.73	I	8155–44184
15	2778.22	I	6928–42912
3.0	2778.84	I	
3.5	2781.84	I	7986–43923
70	2788.10	I	6928–42784
2.0	2789.80	I	21716–57550
2.5	2791.79	I	19621–55430
2.0	2795.01	I	0–35768
8	2797.78	I	7377–43109
15	2804.52	I	7377–43023
16	2806.98	I	7377–42992
42	2813.29	I	7377–42912
2.0	2817.51	I	7728–43210
50	2823.28	I	7728–43138
15	2825.56	I	7728–43109
3	2825.69	I	0–35379
2.5	2828.81	I	7986–43326
32	2832.44	I	7728–43023
2.5	2835.46	I	0–35257
10	2838.12	I	7986–43210
2.5	2840.42	I	416–35612
9	2843.63	I	7377–42533
26	2843.98	I	7986–43138
7	2845.60	I	7728–42860
1.6	2848.72	I	7986–43079
38	2851.80	I	8155–43210
5	2863.44	I	11976–46889
4	2863.86	I	704–35612
2.5	2866.63	I	7986–42860
8	2869.31	I	416–35257
5	2872.34	I	7728–42533
10	2874.17	I	0–34782
2.5	2875.30	I	11976–46745
5	2877.30	I	11976–46721
1.0	2887.81	I	21716–56334
8	2894.50	I	18378–52916
4	2895.04	I	12561–47093
4	2899.42	I	18378–52858
2.0	2901.92	I	19350–53800
2.5	2907.52	I	21999–56383
20	2912.16	I	0–34329
8	2918.03	I	26106–60366
5	2920.69	I	12969–47197
8	2923.29	I	26351–60549
5	2923.85	I	21716–55907
6	2926.59	II	7955–42115
20	2929.01	I	416–34547
80	2936.90	I	0–34040
13	2941.34	I	704–34692
3.5	2944.40	II	13673–47626
80	2947.88	I	416–34329
3.5	2948.43	I	21999–55906
60	2953.94	I	704–34547
32	2957.36	I	888–34692
8	2959.99	I	21716–55490
18	2965.26	I	978–34692
170	2966.90	I	0–33695
4	2969.36	I	888–34556
8	2969.48	I	6928–40594
34	2970.10	I	888–34547
60	2973.13	I	704–34329
120	2973.24	I	416–34040
1.0	2976.13	I	18378–51969
1.0	2980.54	I	22249–55791
28	2981.45	I	416–33947
1.2	2981.85	I	17550–51077
140	2983.57	I	0–33507
12	2984.78	I	6928–40422
	2984.83	II	13474–46967
1.2	2986.46	I	888–34363
12	2987.29	I	7377–40842
5	2990.39	I	21999–55430
120	2994.43	I	416–33802
1.0	2996.39	I	19552–52916
36	2999.51	I	6928–40257
5	3000.45	I	11976–45295
110	3000.95	I	704–34017
10	3003.03	I	7728–41018
3.5	3007.14	I	11976–45221
10	3007.28	I	704–33947
90	3008.14	I	888–34122
28	3009.57	I	7377–40594
5	3011.48	I	22249–55446
8	3016.18	I	7986–41131
20	3017.63	I	888–34017
18	3018.98	I	7728–40842
60	3020.49	I	704–33802
280	3020.64	I	0–33096
160	3021.07	I	416–33507
26	3024.03	I	888–33947

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
18		3025.64	I	19390–52431
38		3025.84	I	978–34017
18		3026.46	I	7986–41018
19		3030.15	I	19621–52613
19		3031.22	I	19788–52769
19		3031.64	I	8155–41131
95		3037.39	I	888–33802
17		3040.43	I	7377–40257
7		3041.64	I	12561–45428
12		3041.74	I	7728–40594
6		3042.02	I	8155–41018
19		3042.66	I	7986–40842
130		3047.60	I	704–33507
6		3055.26	I	12561–45282
65		3057.45	I	6928–39626
100		3059.09	I	416–33096
40		3067.24	I	7377–39970
34		3075.72	I	7728–40231
24		3083.74	I	7986–40405
20		3091.58	I	8155–40491
55	d	3099.90	I	8155–40405
		3099.97	I	7377–39626
26		3100.30	I	7986–40231
26		3100.67	I	7728–39970
6		3116.63	I	8155–40231
11		3125.65	I	7986–39970
7		3175.45	I	19351–50833
14		3180.23	I	19757–51192
6		3184.90	I	416–31805
7		3191.66	I	0–31323
7		3192.80	I	20020–51331
11		3193.23	I	0–31307
24		3196.93	I	19562–50833
14		3199.52	I	19562–50808
15		3200.48	I	19913–51149
11		3205.40	I	20020–51208
7		3210.83	I	19913–51048
15		3211.99	I	19351–50475
30		3214.04	I	19757–50862
6		3214.40	I	704–31805
7		3215.94	I	19913–50999
5		3217.38	I	19351–50423
12		3219.58	I	19757–50808
7		3219.81	I	19562–50611
34		3222.07	I	19351–50378
50		3225.79	I	19351–50342
19		3227.75	II	13474–44447
		3227.80	I	19562–50534
7		3230.97	I	19757–50699
7		3233.97	I	19562–50475
30		3239.44	I	19562–50423
22		3244.19	I	19562–50378
13		3265.62	I	17550–48163
15		3271.00	I	17727–48290
28		3286.76	I	17550–47967
28		3305.97	I	17727–47967
28		3306.35	I	17927–48163
6		3355.23	I	26627–56423
8		3369.55	I	21999–51668
12		3370.79	I	21716–51374
8		3383.98	I	17550–47093
7		3392.31	I	17727–47197
15		3392.66	I	17550–47017
22		3399.34	I	17727–47136
15		3404.36	I	17727–47093
30		3407.46	I	17550–46889
23		3413.14	I	17727–47017
15		3417.84	I	17927–47177
15		3418.51	I	17927–47172
8		3422.66	I	17927–47136
16		3424.29	I	17550–46745
7		3426.39	I	17550–46727
7		3426.64	I	17727–46902
32		3427.12	I	17550–46721
8		3428.20	I	17727–46889
400		3440.61	I	0–29056
80		3440.99	I	416–29469
40		3443.88	I	704–29733
16		3445.15	I	17727–46745
5		3447.28	I	17727–46727
8		3450.33	I	17927–46902
8		3451.92	I	17927–46889
8		3452.28	I	7728–36686
60		3465.86	I	888–29733
80		3475.45	I	704–29469
32		3476.70	I	978–29733
6		3485.34	I	17727–46410
80		3490.58	I	416–29056
6		3495.29	I	20641–49243
8		3497.11	I	17550–46137
24		3497.84	I	888–29469
6		3506.50	I	18378–46889
40		3513.82	I	6928–35379
36		3521.26	I	7377–35768
18		3526.04	I	704–29056
13		3526.17	I	7728–36079
8		3533.20	I	23245–51540
20		3536.56	I	23193–51461
24		3541.09	I	22997–51229
22		3542.08	I	23111–51335

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		3553.74	I	28820–56951
28		3554.93	I	22846–50968
65		3558.52	I	7986–36079
160		3565.38	I	7728–35768
400		3570.10	I	7377–35379
600		3581.20	I	6928–34844
13		3584.66	I	21716–49604
36		3585.32	I	7728–35612
30		3585.71	I	7377–35257
13		3586.11	I	26106–53983
40		3586.99	I	7986–35856
7		3589.11	I	6928–34782
8		3594.64	I	22997–50808
16		3603.21	I	21716–49461
24		3605.46	I	21999–49727
32		3606.68	I	21716–49434
200		3608.86	I	8155–35856
20		3610.16	I	22650–50342
13		3617.79	I	24336–51969
200		3618.77	I	7986–35612
24		3621.46	I	21999–49604
16		3622.00	I	22249–49851
8		3623.19	I	19390–46982
5		3625.15	I	22846–50423
200		3631.46	I	7728–35257
8		3632.04	I	24772–52297
13		3638.30	I	22249–49727
22		3640.39	I	21999–49461
6		3645.82	I	25091–52512
160		3647.84	I	7377–34782
16		3649.51	I	21716–49109
30		3651.47	I	22249–49628
8		3659.52	I	19788–47107
16		3669.52	I	21999–49243
20		3677.63	I	22249–49433
65		3679.92	I	0–27167
16		3682.21	I	28605–55754
11		3683.06	I	416–27560
11		3684.11	I	21999–49135
13		3686.00	I	23711–50833
80		3687.46	I	6928–34040
13		3689.46	I	23711–50808
24		3694.01	I	24507–51570
8		3695.05	I	20875–47930
30		3701.09	I	24181–51192
8		3704.46	I	21716–48703
80		3705.57	I	416–27395
28	d	3707.82	I	704–27666
		3707.92	I	17550–44512
85		3709.25	I	7377–34329
6		3716.45	I	23711–50611
600		3719.94	I	0–26875
80		3722.56	I	704–27560
8		3724.38	I	18378–45221
3.0		3726.92	I	24507–51331
75		3727.62	I	7728–34547
12		3732.40	I	17727–44512
70		3733.32	I	888–27666
700		3734.87	I	6928–33695
340		3737.13	I	416–27167
7		3738.31	I	26351–53094
60		3743.36	I	7986–34692
240		3745.56	I	704–27395
60		3745.90	I	978–27666
140		3748.26	I	888–27560
400		3749.49	I	7377–34040
7		3753.61	I	17550–44184
300		3758.24	I	7728–34329
6		3760.05	I	19390–45978
1.6		3760.53	I	17927–44512
170		3763.79	I	7986–34547
14		3765.54	I	26106–52655
120		3767.19	I	8155–34692
1.0		3774.83	I	17927–44411
1.0		3776.46	I	17550–44023
3.0		3785.95	I	19621–46027
3.0		3786.68	I	8155–34556
46		3787.88	I	8155–34547
6		3790.10	I	7986–34363
3.0		3794.34	I	19788–46136
65		3795.00	I	7986–34329
6		3797.52	I	26106–52431
32		3798.51	I	7377–33695
48		3799.55	I	7728–34040
12		3805.34	I	26628–52899
6		3806.70	I	26351–52613
3.0		3807.54	I	17927–44184
32		3812.96	I	7728–33947
160		3815.84	I	11976–38175
500		3820.43	I	6928–33096
7		3821.18	I	26351–52514
80		3824.44	I	0–26140
320		3825.88	I	7377–33507
130		3827.82	I	12561–38678
3.0		3833.31	I	20641–46721
130		3834.22	I	7728–33802
3.5		3839.26	I	24575–50614
80		3840.44	I	7986–34017
80		3841.05	I	12969–38996
6		3843.26	I	24575–50587

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	3846.80	I	26225–52213
50	3849.97	I	8155–34122
7	3850.82	I	7986–33947
2.0	3852.58	I	17550–43500
85	3856.37	I	416–26340
6	3859.22	I	19390–45295
420	3859.91	I	0–25900
34	3865.53	I	8155–34017
2.0	3867.22	I	24336–50187
34	3872.50	I	7986–33802
3.5	3873.76	I	19621–45428
50	3878.02	I	7728–33507
85	3878.58	I	704–26479
2.5	3885.51	I	19552–45282
180	3886.28	I	416–26140
35	3887.05	I	7377–33096
35	3888.52	I	12969–38678
3.5	3893.39	I	23784–49461
35	3895.66	I	888–26550
3.5	3897.90	I	21716–47363
3.5	3898.01	I	8155–33802
55	3899.71	I	704–26340
55	3902.95	I	12561–38175
1.8	3903.90	I	24119–49727
14	3906.48	I	888–26479
2.0	3916.73	I	26106–51630
4	3917.18	I	7986–33507
3.0	3918.65	I	24339–49851
36	3920.26	I	978–26479
55	3922.91	I	416–25900
70	3927.92	I	888–26340
75	3930.30	I	704–26140
2.0	3935.82	I	22838–48239
1.6	3940.88	I	7728–33096
1.4	3942.44	I	22947–48305
3.5	3948.78	I	26351–51668
3.5	3949.96	I	17550–42860
3.0	3951.17	I	26406–51708
2.0	3952.61	I	21716–47008
3.5	3956.46	I	26106–51374
7	3956.68	I	21716–46982
4	3966.07	I	12969–38175
3.0	3966.63	I	25900–51103
3.0	3967.42	I	26628–51826
55	3969.26	I	11976–37163
2.5	3971.33	I	21716–46889
6	3977.74	I	17727–42860
2.0	3981.77	I	21999–47107
4	3983.96	I	21999–47093
8	3997.40	I	21999–47008
3.0	3998.06	I	21716–46721
40	4005.25	I	12561–37521
3.5	4009.72	I	17927–42860
4	4014.53	I	28820–53722
4	4021.87	I	22249–47107
300	4045.82	I	11976–36686
3.0	4062.44	I	22947–47556
120	4063.60	I	12561–37163
100	4071.74	I	12969–37521
4	4107.49	I	22838–47177
3.0	4109.81	I	22947–47272
8	4118.55	I	28820–53094
2.0	4127.61	I	23052–47272
32	4132.06	I	12969–37163
4	4134.68	I	22838–47017
8	4143.42	I	24575–48703
40	4143.87	I	12561–36686
2.0	4147.67	I	11976–36079
4	4154.50	I	22838–46902
4	4156.80	I	22838–46889
3.5	4175.64	I	22947–46889
8	4181.76	I	22838–46745
3.0	4184.90	I	22838–46727
13	4187.04	I	19757–43634
13	4187.80	I	19562–43435
8	4191.44	I	19913–43764
11	4198.31	I	19351–43163
13	4199.10	I	24575–48383
34	4202.03	I	11976–35768
1.4	4203.99	I	22947–46727
4	4210.35	I	20020–43764
1.6	4216.19	I	0–23711
7	4219.36	I	28820–52514
4	4222.22	I	19757–43435
13	4227.43	I	26875–50523
11	4233.61	I	20020–43634
17	4235.94	I	19562–43163
3.0	4238.82	I	27395–50980
3.0	4247.43	I	27167–50704
12	4250.13	I	19913–43435
24	4250.79	I	12561–36079
36	4260.48	I	19351–42816
12	4271.16	I	19757–43163
100	4271.76	I	11976–35379
8	4282.41	I	17550–40895
14	4294.13	I	11976–35257
12	4299.24	I	19562–42816
100	4307.91	I	12561–35768
6	4315.09	I	17727–40895
95	4325.76	I	12969–36079

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
4		4337.05	I	12561–35612
4		4352.74	I	17927–40895
1.4		4369.77	I	24575–47453
6		4375.93	I	0–22846
170		4383.55	I	11976–34782
85		4404.75	I	12561–35257
48		4415.12	I	12969–35612
6		4427.31	I	416–22997
5		4442.34	I	17727–40231
2.0		4443.20	I	23052–45552
5		4447.72	I	17927–40405
5		4459.12	I	17550–39970
3.0		4461.65	I	704–23111
6		4466.55	I	22838–45221
6		4476.02	I	22947–45282
3.0	d	4482.17	I	888–23193
		4482.26	I	17927–40231
6		4494.57	I	17727–39970
10		4528.62	I	17550–39626
2.0		4531.15	I	11976–34040
2.5		4602.94	I	11976–33695
1.6		4736.78	I	25900–47006
2.0		4859.75	I	23193–43764
6		4871.32	I	23111–43634
3.5		4872.15	I	23245–43764
1.2		4878.22	I	23270–43764
3.5		4890.77	I	23193–43634
8		4891.50	I	22997–43435
1.0		4903.32	I	23245–43634
5		4919.00	I	23111–43435
12		4920.50	I	22846–43163
4		4957.31	I	22997–43163
13		4957.61	I	22650–42816
1.2		5001.87	I	31307–51294
1.0		5005.72	I	31323–51294
2.5		5006.13	I	22846–42816
1.2		5012.07	I	6928–26875
1.0		5041.76	I	11976–31805
2.0		5049.82	I	18378–38175
1.0		5051.64	I	7377–27167
1.0		5068.79	I	23711–43435
0.8		5083.34	I	7728–27395
1.0		5098.71	I	17550–37158
2.0		5110.41	I	0–19562
2.5		5133.68	I	33695–53169
2.5		5139.26	I	24181–43634
3.5		5139.48	I	23711–43163
13		5167.49	I	11976–31323
6		5171.60	I	11976–31307
4		5191.47	I	24507–43764
6		5192.36	I	24181–43435
3.0		5194.95	I	12561–31805
2.5		5202.34	I	17550–36767
2.5		5216.28	I	12969–32134
3.0		5226.88	I	24507–43634
12		5227.19	I	12561–31686
11		5232.94	I	23711–42816
5		5266.58	I	24181–43163
22		5269.54	I	6928–25900
8		5270.36	I	12969–31937
2.0		5281.80	I	24507–43435
4		5283.63	I	26140–45061
2.5		5302.31	I	26479–45334
7		5324.18	I	25900–44677
18		5328.05	I	7377–26140
2.5		5328.53	I	12561–31323
1.4		5339.94	I	26340–45061
1.8		5341.03	I	12969–31686
1.2		5364.88	I	35856–54491
1.4	h	5367.46	I	35612–54237
2.0		5369.96	I	35257–53874
12		5371.49	I	7728–26340
3.0		5383.37	I	34782–53353
2.0		5393.18	I	26140–44677
7		5397.13	I	7377–25900
3.5	h	5404.15	I	35768–54267
7		5405.78	I	7986–26479
1.8		5410.91	I	36079–54555
3.0	h	5415.21	I	35379–53841
3.5	h	5424.08	I	34844–53275
8		5429.70	I	7728–26140
5		5434.53	I	8155–26550
1.0	h	5445.04	I	35379–54379
6		5446.92	I	7986–26340
4		5455.61	I	8155–26479
1.6		5497.52	I	8155–26340
1.0		5501.47	I	7728–25900
2.0		5506.78	I	7986–26140
2.0		5569.62	I	27560–45509
3.0		5572.85	I	27395–45334
0.7		5576.11	I	27666–45595
4		5586.76	I	27167–45061
0.8		5602.96	I	27666–45509
5		5615.65	I	26875–44677
1.0		5624.55	I	27560–45334
1.2		5658.83	I	27395–45061
0.7		5763.01	I	33947–51294
0.8		6024.06	I	36686–53282
1.2		6065.49	I	21039–37521
3.0		6136.62	I	19788–36079

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	6137.70	I	20875–37163
2.0	6191.56	I	19621–35768
2.0	6230.73	I	20641–36686
0.7	6246.34	I	29056–45061
1.2	6252.56	I	19390–35379
0.5	6265.14	I	17550–33507
0.6	6301.52	I	29469–45334
0.5	6318.02	I	19788–35612
1.0	6393.60	I	19621–35257
1.6	6400.02	I	29056–44677
1.0	6411.66	I	29469–45061
0.8	6421.36	I	18378–33947
1.0	6430.85	I	17550–33096
3.0	6494.98	I	19390–34782
0.6	6546.24	I	22249–37521
0.9	6592.92	I	21999–37163
1.8	6677.99	I	21716–36686
0.4	6945.21	I	19552–33947
0.3	6978.86	I	20038–34363
0.6	7130.94	I	34017–48037
0.8	7164.47	I	33802–47756
2.0	7187.34	I	33096–47006
1.2	7207.41	I	33507–47378
0.6	7389.42	I	34692–48221
0.7	7411.18	I	34547–48037
1.4	7445.78	I	34329–47756
1.8	7495.09	I	34040–47378
3.0	7511.04	I	33695–47006
0.5	7531.17	I	35257–48532
0.3	7568.92	I	34547–47756
0.4	7583.80	I	24339–37521
1.0	7586.04	I	34782–47961
0.3	7620.54	I	38175–51294
0.2	7661.22	I	34329–47378
0.6	7664.30	I	24119–37163
1.0	7748.28	I	23784–36686
1.0	7780.59	I	36079–48928
1.4	7832.22	I	35768–48532
1.4	7937.17	I	34782–47378
1.4	7945.88	I	35379–47961
1.4	7998.97	I	35257–47756
0.3	8028.34	I	36079–48532
1.2	8046.07	I	35612–48037
1.0	8085.20	I	35856–48221
0.3	8198.95	I	35768–47961
3.0	8220.41	I	34844–47006
0.3	8232.35	I	35612–47756
4	8327.06	I	17727–29733
0.9	8331.94	I	35379–47378
0.4	8339.43	I	35768–47756
3.5	8387.78	I	17550–29469
1.2	8468.41	I	17927–29733
0.9	8514.08	I	17727–29469
0.3	8515.11	I	24339–36079
0.6	8611.81	I	22947–34556
3.5	8661.91	I	17927–29469
0.9	8674.75	I	22838–34363
7	8688.63	I	17550–29056
0.8	8757.19	I	22947–34363
0.8	8764.00	I	37521–48928
0.6	8793.38	I	37163–48532
4	8824.23	I	17727–29056
1.0	8866.96	I	36686–47961
2.5	8999.56	I	22838–33947

LANTHANUM

La, $Z=57$, $M=138.92$, Ratio $\frac{La}{Cu}=2.186$

La I Normal state of valence electrons $5d^16s^2\ ^2D_{1½}=0$. I.P.=45293 K
La II Normal state of valence electrons $5d^2\ \ ^3F_2=0$. I.P.=92240 K

References

Wavelengths:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945), below 7550 A.

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), above 7550 A.

Classification:

La I, La II and La III, H. N. Russell and W. F. Meggers, J. Research NBS **9,** 625 (1932).

Molecular Spectra:

LaO, W. F. Meggers and J. A. Wheeler, J. Research NBS **6,** 239 (1931).

Relative intensity of lanthanum lines observed in an arc of copper containing 0.1 atomic percent of lanthanum

Strong lines of lanthanum

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	3949. 10	II	3250–28565	$6s^1\ a\ ^3D_3—6p^1\ x\ ^3F^\circ_4$
550	4086. 72	II	0–24463	$5d^2\ a\ ^3F_2—6p^1\ y\ ^1D^\circ_2$
460	3794. 78	II	1971–28315	$5d^2\ a\ ^3F_4—6p^1\ y\ ^3D^\circ_3$
460	4333. 74	II	1394–24463	$6s^1\ a\ ^1D_2—6p^1\ y\ ^1D^\circ_2$
440	3790. 83	II	1016–27388	$5d^2\ a\ ^3F_3—6p^1\ y\ ^3D^\circ_2$
440	3988. 52	II	3250–28315	$6s^1\ a\ ^3D_3—6p^1\ y\ ^3D^\circ_3$
440	4123. 23	II	2592–26838	$6s^1\ a\ ^3D_2—6p^1\ x\ ^3F^\circ_3$
360	3995. 75	II	1394–26414	$6s^1\ a\ ^1D_2—6p^1\ x\ ^3F^\circ_2$
340	3871. 64	II	1016–26838	$5d^2\ a\ ^3F_3—6p^1\ x\ ^3F^\circ_3$
300	4042. 91	II	7473–32201	$5d^2\ a\ ^1G_4—6p^1\ x\ ^1F^\circ_3$
280	3759. 08	II	1971–28565	$5d^2\ a\ ^3F_4—6p^1\ x\ ^3F^\circ_4$
280	4031. 69	II	2592–27388	$6s^1\ a\ ^3D_2—6p^1\ y\ ^3D^\circ_2$
280	4077. 35	II	1895–26414	$6s^1\ a\ ^3D_1—6p^1\ x\ ^3F^\circ_2$
220	3929. 22	II	1394–26838	$6s^1\ a\ ^1D_2—6p^1\ x\ ^3F^\circ_3$
200	3337. 49	II	3250–33204	$6s^1\ a\ ^3D_3—6p^1\ x\ ^3P^\circ_2$
200	3380. 91	II	2592–32161	$6s^1\ a\ ^3D_2—6p^1\ x\ ^3P^\circ_1$
200	4429. 90	II	1895–24463	$6s^1\ a\ ^3D_1—6p^1\ y\ ^1D^\circ_2$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.2	2187.87	II	0–45692
8	2256.76	II	1394–45692
18	2297.78	III	1603–45111
1.8	2317.82	II	18895–62026
4	2319.44	II	2592–45692
1.8	2328.75	II	16599–59528
40	2379.38	III	0–42015
1.6	2438.01	II	18895–59900
6	2471.90	II	5250–45692
3.0	2472.44	II	17826–58259
3.0	2479.85	II	19215–59528
6	2487.59	II	17212–57400
4	2533.14	II	6227–45692
4	2560.37	II	19215–58259
1.6	2580.82	II	15699–54435
2.0	2582.56	II	14148–52858
4	2596.09	II	16599–55107
46	2610.34	II	7395–45692
6	2672.91	II	18580–55982
7	2695.47	II	19750–56838
6	2725.58	I	1053–37732
6	2791.51	II	22106–57919
6	2798.56	II	22537–58259
48	2808.39	II	10095–45692
1.2	2838.45	II	19215–54435
1.8	2840.51	II	29498–64693
5	2855.90	II	24523–59528
3.0	2862.98	II	20403–55321
10	2880.65	II	20403–55107
15	2885.14	II	21332–55982
18	2893.07	II	22283–56838
12	2950.50	II	28526–62408
24	3104.59	II	0–32201
8	3108.46	II	0–32161
18	3142.76	II	1394–33204
20	3171.68	III	13591–45110
10	3193.02	II	1895–33204
5	3215.81	I	1053–32141
70	3245.13	II	1394–32201
36	3249.35	II	1394–32161
75	3265.67	II	2592–33204
110	3303.11	II	1895–32161
200	3337.49	II	3250–33204
13	3342.23	I	1053–30965
120	3344.56	II	1895–31786
28	3376.33	II	2592–32201
200	3380.91	II	2592–32161
18	3452.18	II	1394–30353
24	3453.17	II	3250–32201
9	3461.18	I	1053–29937
10	3510.00	II	1016–29498
10	3512.93	II	1895–30353
6	3514.07	I	1053–29502
10	3517.14	III	13591–42015
6	3550.82	II	0–28155
9	3557.26	II	1394–29498
28	3574.43	I	0–27969
9	3601.06	II	2592–30353
6	3610.25	II	
9	3612.34	II	24463–52138
9	3613.08	I	0–27669
38	3628.83	II	1016–28565
4	3636.67	I	1053–28543
14	3637.15	II	5718–33204
20 d	3641.53	I	1053–28506
	3641.66	II	27388–54840
120	3645.42	II	0–27424
11	3649.53	I	0–27393
46	3650.18	II	0–27388
20	3662.08	II	1016–28315
2.0	3672.02	I	0–27225
4	3701.81	II	28315–55321
14	3704.54	I	1053–28040
38	3705.82	II	6227–33204
65	3713.54	II	1394–28315
16	3714.87	II	5250–32161
32	3715.53	II	2592–29498
11	3725.05	II	0–26838
4	3735.85	II	1394–28155
280	3759.08	II	1971–28565
9	3773.12	II	26838–53333
14	3780.67	II	5718–32161
8	3784.81	II	0–26414
440	3790.83	II	1016–27388
460	3794.78	II	1971–28315
8	3808.79	II	3250–29498
19	3835.08	II	5718–31786
60	3840.72	II	1394–27424
12	3846.00	II	1394–27388
160	3849.02	II	0–25973
13	3854.91	II	6227–32161
8	3864.49	II	28565–54435
340	3871.64	II	1016–26838
170	3886.37	II	2592–28315
5	3898.60	I	0–25643
3.5	3902.58	I	0–25617
4	3910.81	II	2592–28155
130	3916.05	II	1895–27424
110	3921.54	II	1895–27388
16	3927.56	I	0–25454

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
220	3929.22	II	1394–26838
18	3936.22	II	1016–26414
900	3949.10	II	3250–28565
4	3953.68	I	1053–26339
440	3988.52	II	3250–28315
360	3995.75	II	1394–26414
18	4015.39	I	1053–25950
9	4023.59	II	14376–39222
25	4025.88	II	2592–27424
280	4031.69	II	2592–27388
4	4036.59	II	7395–32161
14	4037.21	I	0–24763
300	4042.91	II	7473–32201
32	4050.08	II	15774–40458
22	4060.33	I	4122–28743
16	4064.79	I	3495–28089
6	4065.58	I	1053–25643
85	4067.39	II	1394–25973
11	4076.71	II	0–24523
280	4077.35	II	1895–26414
12	4079.18	I	0–24508
550	4086.72	II	0–24463
18	4089.61	I	3010–27455
28	4099.54	II	14148–38534
11	4104.87	I	2668–27023
5	4109.80	I	1053–25378
5	4117.68	I	
440	4123.23	II	2592–26838
11	4137.04	I	1053–25218
55	4141.74	II	3250–27388
110	4151.97	II	1895–25973
22	4152.78	II	14148–38221
4	4157.52	I	0–24046
10	4160.26	I	1053–25083
5	4172.32	I	3495–27455
7	4177.48	I	1053–24984
28	4187.32	I	0–23875
28	4192.36	II	14375–38221
150	4196.55	II	2592–26414
24	4204.04	II	5718–29498
30	4217.56	II	15699–39403
20	4230.95	II	15774–39403
160	4238.38	II	3250–26838
14	4249.99	II	15699–39222
5	4262.34	I	1053–24508
32	4263.59	II	15774–39222
48	4269.50	II	14375–37791
24	4275.64	II	2592–25973
30	4280.27	I	1053–24410
60	4286.97	II	15699–39019
60	4296.05	II	6227–29498
12	4300.44	II	0–23247
5	4315.90	II	3250–26414
44	4322.51	II	1394–24523
460	4333.74	II	1394–24463
2.0	4334.96	II	14148–37210
4	4340.73	I	8446–31477
55	4354.40	II	7395–30353
6	4354.80	I	9184–32141
11	4364.67	II	5250–28155
11 bl	4371.97	LaO	
11 bl	4375.84	LaO	
11	4378.10	II	14375–37210
6 bl	4379.72	LaO	
28	4383.44	II	14148–36955
10	4385.20	II	14375–37173
6	4389.87	I	9719–32493
5	4402.65	I	9044–31752
5	4411.21	II	28565–51229
22 bl	4418.24	LaO	
8	4419.16	II	16599–39222
16 bl	4423.17	LaO	
16	4423.90	I	9920–32518
26	4427.55	II	14375–36955
10 bl	4428.10	LaO	
200	4429.90	II	1895–24463
16 bl	4432.98	LaO	
5	4435.85	II	0–22537
10 bl	4438.01	LaO	
5 bl	4443.00	LaO	
10	4452.15	I	9961–32411
10	4455.80	II	5718–28155
4	4468.97	I	3010–25380
4	4486.06	I	7490–29776
4	4493.11	I	1053–23303
4	4494.71	I	2668–24910
9	4500.22	I	7680–29895
85	4522.37	II	10095–32201
17	4525.31	II	15699–37791
42	4526.12	II	6227–28315
3.0	4541.79	I	7490–29502
8	4549.50	I	3010–24984
40	4558.46	II	2592–24523
11	4559.29	II	6227–28155
16	4567.91	I	3495–25380
20	4570.02	I	4122–25997
40	4574.88	II	1394–23247
20	4580.06	II	5718–27546
3.0	4602.05	I	8052–29776
14	4605.78	II	5718–27424

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
36	4613.39	II	5718–27388
2.0	4615.07	I	7231–28893
36	4619.88	II	14148–35788
3.5	4636.43	II	18895–40458
10	4645.28	II	1016–22537
4	4646.34	I	9961–31477
6	4647.51	II	15699–37210
7	4648.65	I	2668–24174
3.0	4650.33	I	3010–24508
4	4652.08	I	3495–24984
48	4655.50	II	15699–37173
3.0	4660.70	I	8052–29502
32	4662.51	II	0–21442
20	4663.76	II	15774–37210
18	4668.91	II	14375–35788
14	4671.83	II	15774–37173
8	4691.18	II	1394–22705
20	4692.50	II	14148–35453
8	4699.63	II	3250–24523
3.0	4700.26	I	
3.0	4702.64	I	4122–25380
12	4703.28	II	15699–36955
3.0	4708.19	I	9184–30417
6	4712.93	II	3250–24463
15	4716.44	II	6227–27424
3.0	4717.59	II	16599–37791
12	4719.94	II	15774–36955
3.0	4724.43	II	6227–27388
20	4728.42	II	1394–22537
44	4740.28	II	1016–22106
34	4743.09	II	14375–35453
28	4748.73	II	7473–28526
4	4750.41	I	9920–30965
14	4766.89	I	0–20972
3.0	4770.43	I	7012–27969
2.5	4796.69	II	7473–28315
2.5	4800.00	I	9961–30788
2.0	4800.25	I	7680–28506
14	4804.04	II	1895–22705
14	4809.01	II	1895–22684
2.5 h	4817.17	I	9184–29937
18	4824.06	II	5250–25973
2.0	4826.88	II	1394–22106
6	4839.52	I	7012–27669
4	4840.01	II	2592–23247
4	4850.58	II	6227–26838
6	4850.82	I	1053–21663
2.0	4854.95	I	9184–29776
28	4860.91	II	1971–22537
2.5	4870.56	I	8446–28972
5	4878.86	I	8052–28543
2.0	4887.61	I	8052–28506
65	4899.92	II	0–20403
5	4901.87	I	1053–21448
2.0	4905.13	I	7012–27393
80	4920.98	II	1016–21332
80	4921.79	II	1971–22283
11	4934.83	II	10095–30353
2.0	4935.62	II	5718–25973
2.0	4945.85	I	7012–27225
8	4946.47	II	1895–22106
28	4949.77	I	0–20197
5	4952.07	II	19215–39403
26	4970.39	II	2592–22705
2.5	4977.95	I	0–20083
28	4986.83	II	1394–21442
11	4991.28	II	7395–27424
5	4993.88	I	0–20019
2.5	4996.82	II	19215–39222
55	4999.47	II	3250–23247
4	5001.79	I	8052–28040
2.5	5002.13	II	18236–38221
2.5 h	5019.51	I	
11	5046.88	I	3495–23303
2.0	5048.04	II	19215–39019
16	5050.57	I	3010–22804
13	5056.46	I	2668–22439
3.5	5062.92	II	6227–25973
3.5	5067.90	I	3495–23221
1.8	5078.92	I	
2.5	5079.38	I	
2.5 h	5080.21	II	15774–35453
1.8	5103.13	I	
15	5106.23	I	2668–22247
36	5114.56	II	1895–21442
3.5	5120.88	I	8446–27969
36	5122.99	II	2592–22106
1.6	5135.44	I	
1.8	5139.16	I	
34	5145.42	I	3010–22439
14	5156.74	II	1016–20403
14	5157.43	II	17826–37210
22	5158.69	I	0–19379
9	5163.62	II	1971–21332
6	5167.79	I	4122–23467
2.0	5172.91	II	18895–38221
6	5173.84	II	32201–51524
44	5177.31	I	3495–22804
1.8	5179.12	I	8446–27749
65	5183.42	II	3250–22537

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	5183.92	I	1053–20338
20	5188.22	II	19750–39019
13	5204.15	II	18580–37791
55	5211.86	I	4122–23303
2.5	5226.21	II	17826–36955
40	5234.27	I	4122–23221
2.5	5239.55	I	8052–27133
2.0	5240.83	I	
26	5253.46	I	1053–20083
2.5	5257.85	I	
8	5259.39	II	1394–20403
28	5271.19	I	1053–20019
4	5276.42	I	8446–27393
2.0	5279.13	II	18236–37173
11	5290.84	II	0–18895
28	5301.98	II	3250–22106
11	5302.62	II	16599–35453
14	5303.55	II	2592–21442
3.5	5304.02	I	7490–26339
1.8	5307.53	I	
1.2	5320.16	I	3495–22286
2.5	5323.57	I	8446–27225
8	5340.67	II	18236–36955
8	5357.86	I	7680–26339
1.6	5365.89	I	7012–25643
10	5377.09	II	18580–37173
1.6	5380.01	I	9961–28543
11	5380.99	II	7395–25973
6	5381.92	II	17212–35788
1.6 bl	5405.66	LaO	
1.8 bl	5407.69	LaO	
2.0	5415.68	I	7490–25950
3.0	5429.86	I	7231–25643
1.6	5437.54	I	7231–25617
38	5455.15	I	1053–19379
2.5	5458.69	II	18895–37210
3.5	5464.38	II	6227–24523
1.0	5466.92	I	8052–26339
3.0	5475.17	I	
2.0	5480.73	II	17212–35453
5	5482.27	II	0–18236
2.0	5491.07	I	7012–25218
3.0	5493.45	II	1016–19215
36	5501.34	I	0–18172
2.0	5502.25	I	9920–28089
1.4	5502.67	I	3495–21663
7	5503.81	I	4122–22286
4	5506.00	I	0–18157
3.0	5515.28	I	7490–25617
5	5517.34	I	9920–28040
1.4	5529.87	I	9961–28040
1.0	5532.06	I	
7	5535.67	II	10095–28155
5	5541.26	I	9184–27225
1.8	5544.91	I	9719–27749
4	5565.44	I	7680–25643
3.0	5565.72	I	3010–20972
1.8	5566.94	II	19215–37173
6	5568.46	I	3495–21448
1.2	5570.38	I	0–17947
6	5588.34	I	3495–21384
6 bl	5600.02	LaO	
8 bl	5602.50	LaO	
2.5 bl	5626.03	LaO	
3.5 bl	5628.60	LaO	
12	5631.22	I	3010–20763
5	5632.03	I	7012–24763
3.0	5639.31	I	7490–25218
18	5648.25	I	9920–27620
2.5 b	5654.82	LaO	
		I	7231–24910
1.2	5656.54	I	9719–27393
10	5657.72	I	2668–20338
4	5671.55	II	17826–35453
7	5696.19	I	1053–18604
1.0	5699.39	I	4122–21663
3.5	5703.33	II	5718–23247
0.8	5710.85	I	9719–27225
5	5712.40	II	1394–18895
3.0	5714.02	I	7012–24508
1.0	5714.55	I	9961–27455
3.5	5720.02	I	3495–20972
2.0	5727.29	II	5250–22705
3.0	5734.95	I	9961–27393
14	5740.66	I	2668–20083
1.4	5742.94	I	7231–24639
12	5744.41	I	7680–25083
12	5761.84	I	2668–20019
12	5769.07	II	10095–27424
28	5769.34	I	3010–20338
6	5769.99	I	8052–25378
24	5789.24	I	3495–20763
34	5791.34	I	4122–21384
17	5797.58	II	1971–19215
12	5805.78	II	1016–18236
0.8	5808.06		
4	5808.32	II	0–17212
11	5821.99	I	9961–27132
4	5823.83	I	8052–25218
1.8	5827.56	I	9184–26339

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	5829.72	I	7490–24639
1.2	5839.79	I	1053–18172
1.8	5845.03	I	1053–18157
5	5848.38	I	13260–30354
1.0	5848.95	II	21442–38534
2.5 h	5852.27	I	7680–24763
6	5855.58	I	3010–20083
6	5863.71	II	7473–24523
1.2 bl	5866.42	LaO	
1.2 bl	5869.50	LaO	
1.2	5869.95	I	8052–25083
1.6	5874.00	II	6227–23247
3.5	5874.73	I	7490–24508
1.6	5877.63	I	3010–20019
1.2	5877.99	I	
5	5880.64	II	1895–18895
1.2 bh	5893.57	LaO	
5	5894.85	I	7680–24639
1.2 bh	5896.67	LaO	
0.8	5900.75	I	7231–24174
1.2	5901.96	II	22283–39222
1.2	5904.30	I	8052–24984
3.5	5917.63	I	1053–17947
1.2 bh	5920.84	LaO	
1.2 bh	5923.97	LaO	
1.2	5927.71	II	22537–39403
1.6	5928.49	I	7012–23875
24	5930.62	I	1053–17910
	5930.68	I	0–16857
5	5935.24	I	3495–20338
4	5936.22	II	1394–18236
1.0	5940.83	I	7680–24508
1.4 h	5948.30	II	20403–37210
2.0	5960.59	I	8446–25218
1.2	5962.60	I	9184–25950
1.2	5965.30	I	
1.0	5971.09	II	10095–26838
3.5	5973.53	II	22283–39019
1.4 h	5975.75	I	7680–24410
2.0	5982.35	I	2668–19379
1.2	5992.36	I	7490–24174
5	6007.36	I	4122–20763
1.2	6017.16	I	13260–29875
4	6038.59	I	7490–24046
1.0	6041.55	I	
1.0	6067.14	II	6227–22705
3.5	6068.68	I	7231–23705
1.0	6072.05	I	8446–24910
1.2 h	6084.89	I	16857–33287
3.0	6100.38	II	5718–22106
1.2	6107.27	I	3010–19379
6	6108.48	I	7680–24046
3.5	6111.72	I	8052–24410
6	6126.09	II	10095–26414
2.0	6127.05	I	8446–24763
6	6129.56	II	6227–22537
4	6134.39	I	7231–23528
1.8 h	6142.98	I	
1.0	6145.30	I	15020–31288
1.4	6146.53	II	1971–18236
6	6165.70	I	7490–23705
2.5	6172.73	II	1016–17212
2.0	6188.09	II	23247–39403
1.2	6203.51	II	22106–38221
1.0	6218.20	I	9920–25997
2.5	6233.51	I	7490–23528
2.5 h	6234.86	I	9184–25218
1.4 h	6236.17	I	
1.0 h	6236.74	I	7231–23261
1.4 h	6238.59	I	7680–23705
55	6249.93	I	4122–20117
20 d	6262.30	II	3250–19215
7	6266.02	I	9920–25875
1.0	6273.76	II	24523–40458
1.4	6287.74	I	9184–25083
1.2	6288.56	I	9719–25617
5	6293.57	I	3495–19379
14	6296.09	II	10095–25973
1.6	6305.46	II	1971–17826
1.2	6310.14	I	
2.5	6310.92	II	21332–37173
1.2	6318.26	I	8052–23875
12	6320.39	II	1394–17212
8	6325.91	I	1053–16857
2.5	6358.13	II	5718–21442
2.5	6360.22	I	9044–24763
13	6390.48	II	2592–18236
34	6394.23	I	3495–19129
4	6399.05	II	21332–36955
16	6410.99	I	3010–18604
2.5	6446.61	II	22283–37791
1.6	6448.11	I	2668–18172
1.0	6450.34	I	9719–25218
7 c	6454.52	I	2668–18157
19	6455.99	I	1053–16538
1.0 h	6468.44	I	9184–24639
1.8 h	6485.55	I	8052–23467
3.0	6498.19	II	20403–35788
0.8	6506.23	I	14096–29461
1.6 h	6520.74	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
8		6526.99	II	1895–17212
0.8	h	6529.73	II	7395–22705
10		6543.16	I	2668–17947
2.0		6565.44	I	1053–16280
0.6		6570.96	II	6227–21442
11		6578.51	I	0–15197
0.8		6582.19	I	16099–31288
3.5		6593.46	I	3010–18172
2.5		6600.17	I	3010–18157
3.5		6608.26	I	9961–25090
4		6616.59	I	3495–18604
0.8		6631.21	I	
0.8		6636.53	II	7473–22537
2.0		6642.79	II	20403–35453
2.5		6644.41	I	1053–16099
1.4		6645.16	I	16243–31288
6		6650.81	I	0–15032
7		6661.40	I	4122–19129
3.0	c	6671.40	II	3250–18236
3.5		6692.87	I	3010–17947
0.7		6699.25	I	
0.8		6699.85	I	
15		6709.50	I	3010–17910
1.6		6714.09	II	22283–37173
0.6		6718.68	II	24523–39403
0.6		6732.78	II	22106–36955
3.0		6748.13	I	8446–23261
5		6753.04	I	0–14804
10		6774.26	II	1016–15774
0.6		6796.73	I	0–14709
2.5	h	6808.86	II	1016–15699
1.2		6813.66	II	22537–37210
4		6823.78	I	7012–21663
3.0		6834.05	II	1971–16599
2.0		6837.90	II	2592–17212
0.7	h	6859.03	II	3250–17826
1.8		6917.24	I	3495–17947
1.0		6918.30	I	1053–15504
6		6925.24	I	7012–21448
4		6935.01	I	3495–17910
0.7	h	6952.51	II	1394–15774
1.8	h	6954.52	II	0–14375
3.0		6958.10	II	10095–24463
1.0		6976.86	I	
1.2	b	6996.89	LaO	
1.2	b	7011.22	LaO	
7		7023.67	I	8052–22286
2.5		7032.05	I	9044–23261
2.5	b	7040.84	LaO	
10		7045.96	I	2668–16857
1.2	b	7054.80	LaO	
15		7066.23	II	0–14148
6		7068.37	I	1053–15197
2.0	bl	7070.79	LaO	
1.2		7076.38	I	
2.0	bl	7085.40	LaO	
2.5	bl	7101.02	LaO	
1.0	h	7116.8	II	7395–21442
1.8	bl	7131.58	LaO	
1.0		7149.77	I	7680–21663
4	h	7158.08	I	1053–15020
5		7161.25	I	7012–20972
1.0		7162.60	LaO	
2.0		7219.91	I	3010–16857
1.0	b	7257.16	LaO	
2.5		7270.09	I	7012–20763
1.0		7270.30	I	1053–14804
10	cw	7282.34	II	1971–15699
1.0		7320.91	I	1053–14709
10	cw	7334.18	I	0–13631
6		7345.34	I	8052–21663
5	bl	7379.71	LaO	
8	bl	7380.08	LaO	
3.5		7382.73	I	9719–23261
10	bl	7403.52	LaO	
20	bl	7403.75	LaO	
5	b	7411.34	LaO	
6	bl	7434.28	LaO	
10	bl	7434.36	LaO	
3.0	b	7442.92	LaO	
5	h	7463.08	I	8052–21448
5	bl	7465.25	LaO	
9	bl	7465.48	LaO	
7	cw	7483.50	II	1016–14375
4	bl	7496.50	LaO	
9	bl	7496.78	LaO	
5		7498.83	I	8052–21384
3.0	b	7506.79	LaO	
1.8	bl	7528.21	LaO	
5	bl	7528.39	LaO	
3.0		7533.59	I	3010–16280
8		7539.23	I	0–13260
3.5	bl	7560.09	LaO	
3.5	bl	7592.26	LaO	
1.8	h	7612.94	II	1016–14148
1.8	b	7624.99	LaO	
2.0		7664.34	I	3495–16538
1.4	h	7841.80	I	3495–16243
2.0	b	7876.87	LaO	
7	bl	7877.22	LaO	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
7	bl	7910.19	LaO	
14	bl	7910.54	LaO	
5	b	7944.61	LaO	
10	bl	7944.95	LaO	
4		7964.83	I	2668–15220
3.5	b	7979.34	LaO	
7	bl	7979.70	LaO	
3.5	h	8001.89	I	3010–15504
2.0	b	8014.43	LaO	
6	bl	8014.79	LaO	
3.0	b	8019.48	LaO	
3.5	hc	8051.39	I	4122–16538
7		8086.05	I	2668–15031
1.4	b	8122.20	LaO	
1.4	b	8159.02	LaO	
0.7	h	8203.38	I	3010–15197
5		8247.44	I	4122–16243
1.2	h	8316.04	I	3010–15031
8		8324.69	I	3495–15504
9		8346.53	I	4122–16099
0.8	h	8379.80	I	19129–31060
0.8	b	8453.55	LaO	
0.8	h	8467.62	I	20117–31924
2.5		8476.48	I	3010–14804
1.2	h	8507.37	I	8446–20197
1.2	h	8513.57	I	9920–21663
0.8	h	8514.65	II	7473–19215
1.6	b	8526.59	LaO	
1.6	c	8543.46	I	9961–21663
6		8545.44	I	3010–14709
1.4	b	8563.54	LaO	
0.9	h	8590.94	I	8446–20083
0.9	b	8600.81	LaO	
0.7	h	8624.22	I	7012–18604
1.4		8638.47	I	8446–20019
1.8	hw	8672.11	I	9920–21448
4		8674.43	I	3495–15020
1.2	h	8720.41	I	9920–21384
3.5		8748.38	I	2668–14096
1.8		8818.93	I	
3.5		8825.82	I	8052–19379
2.0		8839.63	I	3495–14804

LEAD

Pb, $Z=82$, $M=207.21$, Ratio $\frac{\text{Pb}}{\text{Cu}}=3.261$

Pb I Normal state of valence electrons $6s^26p^2\ {}^3P_0$ =0. I.P.= 59821 K
Pb II Normal state of valence electrons $6s^26p^1\ {}^2P^o_{0\frac{1}{2}}$=0. I.P.=121243 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
W. F. Meggers, unpublished material (1955).

Classification:
Pb I, W. F. Meggers, unpublished material (1955).
Pb II, L. T. Earls and R. A. Sawyer, Phys. Rev. **47,** 115 (1935).

Intensities:
H. Engler, Z. Physik **144,** 343 (1956).

Relative intensity of lead lines observed in an arc of copper containing 0.1 atomic percent of lead

Strong lines of lead

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3400	4057.83	I	10650-35287	$6s^26p^2\ {}^3P_2$—$6s^26p^17s^1\ {}^3P^o_1$
1400	3683.48	I	7819-34960	$6s^26p^2\ {}^3P_1$—$6s^26p^17s^1\ {}^3P^o_0$
1000	2801.99	I	10650-46329	$6s^26p^2\ {}^3P_2$—$6s^26p^16d^1\ {}^3F^o_3$
950	2833.06	I	0-35287	$6s^26p^2\ {}^3P_0$—$6s^26p^17s^1\ {}^3P^o_1$

Lead — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2022.02	I	0-49440	300	2663.16	I	10650-48189
8	2053.27	I	0-48687	1000	2801.99	I	10650-46329
22	2169.99	I	0-46069	410	2823.20	I	10650-46061
9	2203.53	II	14081-59448	950	2833.06	I	0-35287
2.0	2246.88	I	7819-52312	280	2873.32	I	10650-45443
2.0	2332.44	I	10650-53511	3.0	3220.57	I	21458-52500
1.8	2388.80	I	10650-52500	110	3572.74	I	21458-49440
90	2393.79	I	10650-52412	550	3639.58	I	7819-35287
1.8	2399.60	I	10650-52312	34	3671.51	I	21458-48687
36	2401.95	I	7819-49440	1400	3683.48	I	7819-34960
8	2411.73	I	10650-52102	280	3739.95	I	21458-48189
1.6 h	2428.63	I	21458-62621	40	4019.64	I	21458-46329
36	2443.84	I	7819-48726	3400	4057.83	I	10650-35287
65	2446.19	I	7819-48687	55	4062.14	I	21458-46069
130	2476.38	I	7819-48189	13	4168.03	I	21458-45443
110	2577.27	I	10650-49440	9	5005.44	I	29467-49440
50	2613.65	I	7819-46069	3.5	5201.47	I	29467-48687
700	2614.18	I	7819-46061	0.8 hl	6001.93	I	35287-51944
24	2628.28	I	10650-48687	14	7229.00	I	21458-35287
1.6	2657.09	I	7819-45443				

LITHIUM

Li, $Z=3$, $M=6.940$, Ratio $\frac{\text{Li}}{\text{Cu}}=0.1092$

Li I Normal state of valence electrons $1s^2 2s^1\ ^2S_{0\frac{1}{2}}=0$. I.P.= 43487 K
Li II Normal state of valence electrons $1s^2\ ^1S_0=0$. I.P.=610079 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
R. W. France, Proc. Roy. Soc. (London) **[A] 129,** 340 (1930).

Classification:
Li I, A. Fowler,, Report on Series in Line Spectra (Fleetway Press, London, 1922).

Intensities:
A. Filippov, Z. Physik **69,** 526 (1931).
G. Stephenson, Nature **167,** 156 (1951).

Relative intensity of lithium lines observed in an arc of copper containing 0.1 atomic percent of lithium

Strong line of lithium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3600	6707. 84	I	0–14904	$1s^2 2s^1\ ^2S_{0\frac{1}{2}}$—$1s^2 2p^1\ ^2P^0_{\frac{1}{2},1\frac{1}{2}}$

Lithium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2741.20	I	0–36470	320	6103.64	I	14904–31283
17	3232.61	I	0–30925	3600	6707.84	I	0–14904
13 hl	4602.86	I	14904–36623	48	8126.52	I	14904–27206
8 h	4971.99	I	14904–35012				

LUTETIUM

Lu, $Z=71$, $M=174.99$, Ratio $\frac{Lu}{Cu}=2.754$

Lu I Normal state of valence electrons $5d^16s^2\ ^2D_{1½}=0$. I.P.= 49600 K
Lu II Normal state of valence electrons $6s^2\ ^1S_0=0$. I.P.=118000 K
Lu III Normal state of valence electrons $6s^1\ ^2S_1=0$.

References

Wavelengths, Spectrum Assignments and Molecular Spectra (LuO):
W. F. Meggers and B. F. Scribner, J. Research NBS **19,** 31 (1937).

Classification:
Lu I, P. F. A. Klinkenberg, Physica **21,** 53 (1954).
Lu II, L. F. H. Bovey and R. W. B. Pearse, Atomic Energy Research Establishment C/R 1976 (Harwell, 1956).
Lu III, W. F. Meggers and B. F. Scribner, J. Research NBS **5,** 73 (1930).

Relative intensity of lutetium lines observed in an arc of copper containing 0.1 atomic percent of lutetium

Strong lines of lutetium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1200	2615. 42	II	0–38223	$6s^2\ a\ ^1S_0$ —$6s6p\ \ z\ ^1P^\circ_1$
600	2911. 39	II	14199–48537	$5d6s\ a\ ^3D_3$ —$6s6p\ \ z\ ^3F^\circ_4$
500	3077. 60	II	12435–44919	$5d6s\ a\ ^3D_2$ —$6s6p\ \ z\ ^3F^\circ_3$
480c	3507. 39	II	0–28503	$6s^2\ a\ ^1S_0$ —$6s6p\ \ z\ ^3P^\circ_1$
440	3281. 74	I	1994–32457	$5d6s^2\ \ ^2D_{2½}$—$32457^\circ_{1½,\ 2½}$
440	3359. 56	I	1994–31751	$5d6s^2\ \ ^2D_{2½}$—$5d6s6p\ \ ^2F^\circ_{3½}$
420	2894. 84	II	14199–48733	$5d6s\ a\ ^3D_3$ —$6s6p\ \ z\ ^3D^\circ_3$
360	3312. 11	I	0–30184	$5d6s^2\ \ ^2D_{1½}$—$5d6s6p\ \ ^2D^\circ_{1½}$
360	3376. 50	I	0–29608	$5d6s^2\ \ ^2D_{1½}$—$5d6s6p\ \ ^2F^\circ_{2½}$
340h	3081. 47	I	1994–34436	$5d6s^2\ \ ^2D_{2½}$—$6s^27p\ \ ^2P^\circ_{1½}$
340	4518. 57	I	0–22125	$5d6s^2\ \ ^2D_{1½}$—$5d6s6p\ \ ^2D^\circ_{1½}$

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
7	h	2195.54	II	0–45532
4		2236.17	III	0–44705
1.0		2276.94	II	27264–71169
2.5		2297.41	II	28503–72017
55		2392.19	II	17332–59122
5		2399.14	II	32453–74122
4		2419.21	II	38223–79547
3.5		2430.26	II	32453–73588
10		2459.64	II	12435–53079
6		2469.27	II	28503–68989
16	h	2481.72	II	32453–72736
28		2536.95	II	11796–51202
3.0		2546.87	II	32453–71705
3.0	d	2549.52	I	
2.5		2561.80	II	12435–51458
70		2571.23	II	14199–53079
130		2578.79	II	12435–51202
6	h	2582.13	II	32453–71169
38	c	2603.33	III	6304–44705
120		2613.40	II	11796–50049
1200		2615.42	II	0–38223
120		2619.26	II	11796–49963
6		2657.05		
180		2657.80	II	12435–50049
6	h	2677.25	I	
38	h	2685.08	I	4136–41368
6	h	2685.54	I	
280		2701.71	II	14199–51202
6	h	2715.91	I	
12	d	2719.09	I	
32	h	2728.95	I	0–36633
5	c	2738.17	II	27264–63774
240		2754.17	II	12435–48733
50	h	2765.74	I	4136–40282
26		2772.58	III	8648–44705
180		2796.63	II	17332–53079
2.5		2821.23	III	
18	c	2834.35	II	28503–63774
22	h	2845.13	I	1994–37131
200		2847.51	II	11796–46904
38	h	2885.14	I	
420		2894.84	II	14199–48733
300		2900.30	II	12435–46904
20		2903.05	I	0–34436
600		2911.39	II	14199–48537
18	h	2949.73	I	7476–41368
80		2951.69	II	17332–51202
4		2955.78	II	
280		2963.32	II	11796–45532
160		2969.82	II	11796–45458
120		2989.27	I	0–33443
200		3020.54	II	12435–45532
8		3027.29	II	12435–45458
140		3056.72	II	14199–46904
9		3057.90	III	6304–38997
500		3077.60	II	12435–44919
26		3080.11	I	0–32457
340	h	3081.47	I	1994–34436
200		3118.43	I	
140		3171.36	I	0–31523
6		3183.73	II	17332–48733
15		3191.80	II	32453–63774
80		3198.12	II	14199–45458
280		3254.31	II	14199–44919
220		3278.97	I	0–30489
440		3281.74	I	1994–32457
360		3312.11	I	0–30184
440		3359.56	I	1994–31751
360		3376.50	I	0–29608
55		3385.50	I	1994–31523
9	h	3391.55	I	
80		3396.82	I	
240		3397.07	II	11796–41225
280		3472.48	II	12435–41225
480	c	3507.39	II	0–28503
95		3508.42	I	1994–30489
280		3554.43	II	17332–45458
280		3567.84	I	0–28020
20		3596.34	I	7476–35275
65		3623.99	II	17332–44919
55		3636.25	I	0–27493
210		3647.77	I	4136–31542
5		3684.32	I	
5		3710.95	I	
9		3756.70	I	4136–30748
9		3756.79	I	4136–30747
2.5	h	3786.18	I	
12		3800.67	I	
6	h	3829.07	I	
220		3841.18	I	1994–28020
8		3843.61	I	
10		3853.29	I	
4		3874.61	I	4136–29938
55		3876.65	II	12435–38223
3.0		3911.77	I	
5		3918.86	I	
3.5	h	3926.62	I	
50		3968.46	I	0–25192
5		3991.38	I	
70		4054.45	I	4136–28793

Lutetium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8 bl	4096.13	LuO	
3.5 h	4107.44	I	
10 h	4112.67	I	0–24308
32	4122.49	I	
320	4124.73	I	7476–31714
16 c	4131.79	I	
48	4154.08	I	7476–31542
2.5	4158.98	I	
170	4184.25	II	17332–41225
16	4277.50	I	
26	4281.03	I	
34 d	4295.97	I	7476–30748
	4296.09	I	7476–30747
16	4309.57	I	1994–25192
8	4332.72	I	
3.0	4341.98	II	36098–59122
7 h	4420.96	I	21462–44076
20 c	4430.48	I	
3.5	4438.79	I	
20	4450.81	I	7476–29938
5 h	4471.55	I	
6 h	4498.85	I	0–22222
340	4518.57	I	0–22125
2.5 b	4560.95	LuO	
2.5 b	4575.31	LuO	
8 c	4605.39	I	18851–40559
9 h	4645.47	I	
10 h	4648.21	I	
9 h	4648.85	I	
6 b	4654.03	LuO	
100	4658.02	I	0–21462
8 h	4659.03	I	
60 bl	4661.75	LuO	
30 bl	4672.31	LuO	
40 bl	4684.16	LuO	
26 bl	4695.46	LuO	
18 bl	4708.00	LuO	
3.0	4716.70	I	0–21195
6 b	4720.86	LuO	
6 h	4726.20	I	
10 bl	4735.00	LuO	
7 bl	4749.11	LuO	
4 bl	4764.22	LuO	
14	4785.42	II	17332–38223
8	4815.05	I	0–20762
5 c	4839.62	II	11796–32453
1.6	4865.36	II	38575–59122
40	4904.88	I	4136–24518
16	4942.34	I	1994–22222
70	4994.13	II	12435–32453
70	5001.14	I	4136–24126
5 h	5057.60	I	17427–37194
12	5134.05	I	17427–36900
240	5135.09	I	1994–21462
11 bl	5170.11	LuO	
15	5196.61	I	18505–37743
8	5206.47	I	1994–21195
3.5	5304.40	I	20433–39279
7	5349.12	I	18505–37194
44	5402.57	I	0–18505
12 c	5421.90	I	1994–20433
9	5437.88	I	
3	5453.57	I	4136–22468
180	5476.69	II	14199–32453
0.8	5664.89	II	30889–48537
1.2	5713.49	II	29407–46904
48	5736.55	I	0–17427
5	5775.40	I	20433–37743
7	5800.59	I	
3.5 h	5860.79	I	22222–39279
0.8	5866.30	I	7476–24518
60 cw	5983.9	II	11796–28503
12	5997.13	I	22609–39279
120	6004.52	I	7476–24125
3.0 h	6041.66	I	21195–37743
38	6055.03	I	1994–18505
1.0	6140.71	I	21462–37743
13	6159.94	II	32504–48733
14	6199.66	II	29407–45532
180	6221.87	II	12435–28503
3.0	6228.14	II	29407–45458
7	6235.36	II	32504–48537
14	6242.34	II	30889–46904
1.4 h	6248.80	I	21195–37194
6 h	6345.35	I	23524–39279
1.6 h	6354.85	I	21462–37194
0.8	6365.79	I	21195–36900
1.4	6366.00		
1.9	6441.14	I	22222–37743
1.0	6444.89	II	29407–44919
95	6463.12	II	11796–27264
2.5	6477.67	I	1994–17427
5 c	6523.18	I	
3.0 cw	6611.28	II	17332–32453
	6611.58		
	6611.80		
	6611.95		
	6612.04		
1.0	6619.15	II	36098–51202
3.0 c	6677.14	I	22222–37194

609065 O - 62 - 12

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.2 h	6735.76	I	20433–35275
4 c	6793.77	I	4136–18851
1.4	6826.59	II	36557–51202
8	6917.31	I	
1.4	6943.96	II	35652–50049
4	7031.24	I	23524–37743
2.5 c	7096.34	I	25192–39279
8	7125.84	II	30889–44919
1.6	7142.79	I	
1.2	7143.10	I	
1.4	7165.94	II	36098–50049
2.5 ch	7237.98	I	21462–35275
0.8	7409.70	II	36557–50049
2.0 c	7441.52	I	24308–37743
1.4	7456.96	II	36557–49963
1.2 ch	7640.08	I	24109–37194
1.2 cw	7758.30	I	24308–37194
1.2 h	7815.9	I	24109–36900
1.6 c	8178.16	I	
3.0	8382.08	I	7476–19403
6	8459.19	II	29407–41225
1.8 d	8478.50	I	
5 c	8508.08	I	23524–35275
6 c	8610.98	I	22222–33832

MAGNESIUM

Mg, $Z=12$, $M=24.32$, Ratio $\frac{Mg}{Cu}=0.383$

Mg I Normal state of valence electrons $2p^6 3s^2\ {}^1S_0 = 0$. I.P.= 61669 K
Mg II Normal state of valence electrons $2p^6 3s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.=121267 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Mg I, F. Paschen, Sitzber. Preuss. Akad. Wiss., Physik. math. Kl. **32,** 709 (1931).
Mg II, A. Fowler, Report on Series in Line Spectra p. 118 (Fleetway Press, London, 1922).

Intensities:
J. A. H. Kersten and L. S. Ornstein, Physica **8,** 1124 (1941).

Relative intensity of magnesium lines observed in an arc of copper containing 0.1 atomic percent of magnesium

Strong lines of magnesium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
6000	2852.13	I	0–35051	$3s^2\ {}^1S_0$ —$3s^1 3p^1\ {}^1P^\circ_1$
1000	2795.53	II	0–35761	$3s^1\ {}^2S_{0\frac{1}{2}}$— $3p^1\ {}^2P^\circ_{1\frac{1}{2}}$
600	2802.70	II	0–35669	$3s^1\ {}^2S_{0\frac{1}{2}}$— $3p^1\ {}^2P^\circ_{0\frac{1}{2}}$

Magnesium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
38	2776.69	I	21870–57874	2.0 h	2942.11	I	21911–55892
32	2778.29	I	21850–57833	14 hl	3096.90	I	21911–54192
90	2779.83	I	21911–57874	6	3332.15	I	21870–51872
		I	21870–57833	9	3336.68	I	21911–51872
32	2781.42	I	21870–57813	140	3829.35	I	21850–47957
36	2782.97	I	21911–57833	300	3832.31	I	21870–47957
13	2790.79	II	35669–71491	500	3838.26	I	21911–47957
1000	2795.53	II	0–35761	7	4703.02	I	35051–56308
16	2798.06	II	35761–71490	75	5167.34	I	21850–41197
600	2802.70	II	0–35669	220	5172.70	I	21870–41197
6000	2852.13	I	0–35051	400	5183.62	I	21911–41197
1.6	2928.75	II	35669–69805	6 h	5528.46	I	35051–53135
3.0	2936.54	II	35761–69805	14	8806.79	I	35051–46403

MANGANESE

Mn, $Z=25$, $M=54.94$, Ratio $\frac{\text{Mn}}{\text{Cu}}=0.865$

Mn I Normal state of valence electrons $3d^5 4s^2\ {}^6S_{2\frac{1}{2}}=0$. I.P.= 59960 K
Mn II Normal state of valence electrons $3d^5 4s^1\ {}^7S_3=0$. I.P.=126147 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Mn I, O. G. Riquelme, Anales Soc. Esp. Fis. y Quim. **45A,** 435 and 547 (1949). M. A. Catalán, W. F. Meggers, O. G. Riquelme, and R. Velasco (monograph in preparation).
Mn II, C. W. Curtis, Phys. Rev. **53,** 474 (1938).
C. W. Curtis, J. Opt. Soc. Am. **42,** 300 (1952).

Intensities:

R. Frerichs, Ann. Physik **81,** 807 (1926).
R. S. Seward, Phys. Rev. **37,** 344 (1931).
L. Huldt and A. Lagerqvist, Arkiv Fysik **5,** 91 (1952).
Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **3,** 193 (1957).
G. D. Bell, M. H. Davis, R. B. King, and P. M. Routly, Astrophys. J. **129,** 437 (1959).

Relative intensity of manganese lines observed in an arc of copper containing 0.1 atomic percent of manganese

Strong lines of manganese

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	4030. 76	I	0–24802	$3d^5 4s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$3d^5 4s^1 4p^1$ $z\ {}^6P^o_{3\frac{1}{2}}$
1400	4033. 07	I	0–24788	$3d^5 4s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$3d^5 4s^1 4p^1$ $z\ {}^6P^o_{2\frac{1}{2}}$
1200	2576. 10	II	0–38807	$3d^5 4s^1$ $a\ {}^7S_3$ —$3d^5 4p^1$ $z\ {}^7P^o_4$
800	2593. 73	II	0–38543	$3d^5 4s^1$ $a\ {}^7S_3$ —$3d^5 4p^1$ $z\ {}^7P^o_3$
800	2794. 82	I	0–35770	$3d^5 4s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$3d^5 4s^1 4p^1$ $y\ {}^6P^o_{3\frac{1}{2}}$
800	4034. 49	I	0–24779	$3d^5 4s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$3d^5 4s^1 4p^1$ $z\ {}^6P^o_{1\frac{1}{2}}$
650	2798. 27	I	0–35726	$3d^5 4s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$3d^5 4s^1 4p^1$ $y\ {}^6P^o_{2\frac{1}{2}}$
550	2605. 69	II	0–38366	$3d^5 4s^1$ $a\ {}^7S_3$ —$3d^5 4p^1$ $z\ {}^7P^o_2$
480	2801. 06	I	0–35690	$3d^5 4s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$3d^5 4s^1 4p^1$ $y\ {}^6P^o_{1\frac{1}{2}}$
420	4041. 36	I	17052–41790	$3d^6 4s^1$ $a\ {}^6D_{4\frac{1}{2}}$—$3d^6 4p^1$ $z\ {}^6D^o_{4\frac{1}{2}}$
360	3806. 72	I	17052–43314	$3d^6 4s^1$ $a\ {}^6D_{4\frac{1}{2}}$—$3d^6 4p^1$ $z\ {}^6F^o_{5\frac{1}{2}}$
340	3569. 49	I	18705–46713	$3d^5 4s^1 4p^1$ $z\ {}^8P^o_{1\frac{1}{2}}$—$3d^5 4s^1 4d^1$ $e\ {}^8D_{3\frac{1}{2}}$
240	2949. 20	II	9473–43370	$3d^5 4s^1$ $a\ {}^5S_2$ —$3d^5 4p^1$ $z\ {}^5P^o_3$
240	3823. 51	I	17282–43429	$3d^6 4s^1$ $a\ {}^6D_{3\frac{1}{2}}$—$3d^6 4p^1$ $z\ {}^6F^o_{4\frac{1}{2}}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	1995.40	I	0–50099
9	1998.86	I	0–50013
12	2003.82	I	0–49888
3.0	2092.13	I	0–47782
4	2109.58		
2.0	2208.81	I	0–45259
4	2213.85	I	0–45156
6	2221.83	I	0–44994
8	2533.06	I	25266–64732
5	2543.45	II	27589–66894
8	2556.57	II	27583–66686
10	2558.59	II	27571–66643
15	2563.65	II	27547–66542
60	2572.76	I	18532–57389
50	2575.51	I	18402–57218
1200	2576.10	II	0–38807
70	2584.31	I	18705–57389
6	2589.71	II	32788–71390
32	2592.94	I	18532–57086
800	2593.73	II	0–38543
32	2595.76	I	18705–57218
12	2598.90	II	29951–68417
		II	32857–71323
5	2602.14	I	
6	2603.72	II	29889–68284
550	2605.69	II	0–38366
24	2610.20	II	27547–65847
18	2622.90	I	25281–63395
19	2624.04	I	25266–63363
5	2624.80	II	27571–65658
26	2625.58	II	27583–65658
12	2626.64	I	18402–56462
4	2630.26	I	25281–63289
8	2630.57	I	25285–63289
24	2632.35	II	27588–65566
16	2638.17	II	27589–65483
10	2639.84	II	32788–70657
3.5	2650.99	II	32788–70497
8	2655.91	II	32857–70497
6	2667.00	I	18705–56190
14	2672.59	II	29889–67295
7	2673.37	II	32836–70231
7	2674.43	II	33147–70527
4	2676.33	I	23549–60903
6	2680.34	II	33248–70546
5	2681.72	I	
6	2683.02	I	
3.0	2683.75	I	
7	2684.55	II	33278–70518
7	2685.94	II	30523–67744
14	2688.25	II	
11	2692.66	I	25266–62393
3.5	2693.19	II	29889–67009
7	2695.36	II	29919–67009
3.5	2698.97	II	29889–66929
11	2701.00	II	29889–66901
20	2701.70	II	27547–64550
16	2705.74	II	27571–64519
10	2707.53	II	27571–64494
14	2708.45	II	27583–64494
6	2709.96	II	27583–64473
10	2710.33	II	27588–64473
14	2711.58	II	27588–64456
7	2728.61	II	
4	2738.86	I	30354–66855
6 h	2760.93	I	17052–53261
4	2771.44	I	17052–53124
4 h	2776.23	I	17282–53291
4	2780.00	I	23297–59257
7	2789.20	I	17282–53124
8	2790.36	I	17282–53109
8	2791.08	I	17052–52870
800	2794.82	I	0–35770
650	2798.27	I	0–35726
28	2799.84	I	17052–52758
480	2801.06	I	0–35690
9	2804.10	I	17452–53103
8	2806.14	I	25266–60891
7	2808.02	I	17282–52884
14	2809.11	I	17282–52870
8	2812.84	I	17568–53109
9	2813.47	I	17568–53101
8	2815.02	II	35004–70518
11	2817.97	I	17282–52758
5	2818.77	I	17637–53103
7	2821.45	I	17452–52884
7	2822.55	I	17452–52870
10	2830.79	I	17568–52884
3.5	2836.31	I	17637–52884
8	2870.08	II	
10	2879.49	II	33147–67866
5	2882.90	I	17452–52129
9	2886.68	II	33278–67910
20	2889.58	II	33248–67846
7	2892.39	II	33248–67812
10	2900.16	II	36274–70745
5	2907.22	I	25266–59653
18 h	2914.60	I	18402–52702
24 h	2925.57	I	18532–52703
3.5	2928.68	I	25281–59416

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
140	2933.06	II	9473–43557
3.5	2934.02	I	25288–59361
190	2939.30	II	9473–43485
32 h	2940.39	I	18705–52705
	2940.48	I	18705–52703
8	2941.04	I	25266–59257
240	2949.20	II	9473–43370
5	3007.66	I	25281–58520
5	3011.16	I	25286–58486
5	3011.38	I	25288–58486
5	3014.67	I	25266–58427
8	3016.45	I	25286–58427
9	3022.75	I	25266–58339
7	3031.06	II	34762–67744
12	3040.60	I	25281–58160
3.5	3042.73	I	25281–58137
11	3043.36	I	25288–58137
42	3044.57	I	17052–49888
15	3045.59	I	25286–58110
26	3047.04	I	25266–58075
5	3048.86	I	25286–58075
32	3054.36	I	17282–50012
18	3062.12	I	17452–50099
22	3066.02	I	17282–49888
22	3070.27	I	17452–50012
20	3073.13	I	17569–50099
14	3079.63	I	17637–50099
8	3081.33	I	17569–50012
3.5	3082.05	I	17452–49888
6	3097.06	I	27248–59527
6	3110.68	I	27201–59339
9 h	3148.18	I	18403–50158
14 h	3161.04	I	18532–50158
22 h	3178.50	I	18705–50158
34	3212.88	I	17052–48168
10	3216.95	I	0–31076
160	3228.09	I	17052–48021
46	3230.72	I	17282–48226
130	3236.78	I	17282–48168
50	3243.78	I	17452–48271
100	3248.52	I	17452–48226
16	3251.14	I	17569–48318
48	3252.95	I	17569–48301
10	3254.04	I	17052–47774
48	3256.14	I	17569–48271
34	3258.41	I	17637–48318
28	3260.23	I	17637–48301
28	3264.71	I	17282–47904
10	3296.88	I	17452–47774
10	3298.22	I	27201–57512
10	3320.69	I	17282–47388
11	3330.67	I	17452–47467
110	3441.99	II	14326–43370
55	3460.33	II	14594–43485
55 h	3474.04	II	14594–43370
	3474.13	II	14781–43557
44	3482.91	II	14781–43485
28	3488.68	II	14901–43557
22	3495.84	II	14960–43557
8	3496.81	II	14781–43370
16	3497.54	II	14901–43485
55	3531.85	I	18402–46708
	3532.00	I	18402–46707
170	3532.12	I	18402–46706
200	3547.80	I	18532–46710
170	3548.03	I	18532–46708
60	3548.20	I	18532–46707
340	3569.49	I	18705–46713
110	3569.80	I	18705–46710
	3570.04	I	18705–46708
220	3577.88	I	17052–44994
110	3586.54	I	17282–45156
44	3595.12	I	17452–45259
65	3607.54	I	17282–44994
65	3608.49	I	17452–45156
55	3610.30	I	17569–45259
44	3619.28	I	17637–45259
34	3623.79	I	17569–45156
22	3629.74	I	17452–44994
16	3660.40	I	37420–64732
11	3670.52	I	17052–44289
11	3676.96	I	37631–64820
8	3682.09	I	37737–64888
32	3693.67	I	34139–61205
20	3696.57	I	23297–50341
8	3701.73	I	17282–44289
24	3706.08	I	34251–61226
15	3718.93	I	34344–61226
6	3728.89	I	23549–50359
15	3731.93	I	41404–68192
30	3790.22	I	17052–43429
6	3799.26	I	17282–43596
12	3800.55	I	31001–57306
6	3801.91	I	25266–51561
360	3806.72	I	17052–43314
80	3809.59	I	17282–43524
6	3810.69	I	25281–51516
10	3816.75	I	17452–43644
240	3823.51	I	17282–43429
44	3823.89	I	17452–43596

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
15	3829.68	I	17568–43673
36	3833.86	I	17568–43644
100	3834.36	I	17452–43524
26	3839.78	I	17637–43673
50	3841.08	I	17568–43596
26	3843.98	I	17637–43644
5	3918.32	I	34139–59653
9	3926.47	I	31001–56462
5	3952.84	I	33825–59117
4	3975.89	I	34845–59990
5	3977.08	I	34463–59600
10	3982.58	I	25281–50383
11	3985.24	I	25288–50373
14	3986.83	I	25266–50341
11	3987.10	I	25286–50359
110	4018.10	I	17052–41933
11	4026.44	I	25266–50095
2000	4030.76	I	0–24802
1400	4033.07	I	0–24788
800	4034.49	I	0–24779
110	4035.73	I	17282–42054
4	4038.73	I	30354–55108
420	4041.36	I	17052–41790
16 d	4045.13	I	34939–59653
	4045.21	I	34139–58853
80	4048.76	I	17452–42144
6	4049.00	I	35041–59732
4	4051.73	I	
5	4052.47	I	35115–59784
11	4055.21	I	35165–59818
140	4055.54	I	17282–41933
16	4057.95	I	24779–49415
80	4058.93	I	17569–42199
11	4059.39	I	24788–49415
55	4061.74	I	24802–49415
55	4063.53	I	17452–42054
6	4065.08	I	34251–58843
6	4068.00	I	17569–42144
22	4070.28	I	17637–42199
55	4079.24	I	17282–41790
55	4079.42	I	17637–42144
80	4082.94	I	17569–42054
80	4083.63	I	17452–41933
5	4089.94	I	34423–58867
4	4105.36	I	34939–59290
15	4110.90	I	34939–59257
11	4131.12	I	34139–58339
9	4135.04	I	34251–58427
6	4141.06	I	34344–58486
4	4147.53	I	27202–51306
6	4148.80	I	34423–58520
11	4176.60	I	34139–58075
9	4189.99	I	34251–58110
5	4201.76	I	34344–58136
5	4211.75	I	34423–58160
28	4235.14	I	23549–47155
38	4235.29	I	23297–46901
14	4239.72	I	23720–47299
22	4257.66	I	23819–47299
22	4265.92	I	23720–47155
20	4281.10	I	23549–46901
5	4284.08	I	23819–47155
5	4312.55	I	23720–46901
3.5	4374.95	I	27248–50099
3.5	4381.70	I	38670–61485
4	4411.88	I	38009–60668
26	4414.88	I	23297–45941
4	4419.78	I	38120–60739
16	4436.35	I	23549–46084
60	4451.59	I	23297–45754
12	4453.00	I	23720–46170
10	4455.01	I	24779–47220
12	4455.32	I	24779–47218
8	4455.82	I	24779–47216
4	4457.04	I	24788–47218
16	4457.55	I	24788–47216
20	4458.26	I	24788–47212
4	4460.38	I	24802–47216
11	4461.08	I	24802–47212
38	4462.02	I	24802–47207
22	4464.68	I	23549–45941
15	4470.14	I	23720–46084
10	4472.79	I	23819–46170
3.0	4479.40	I	
13	4490.08	I	23819–46084
18	4498.90	I	23720–45941
18	4502.22	I	23549–45754
6	4605.36	I	38120–59828
6	4626.54	I	38009–59617
2.5	4671.69	I	23297–44696
4	4701.16	I	23549–44815
13	4709.72	I	23297–44524
14	4727.48	I	23549–44696
10	4739.11	I	23720–44815
80	4754.04	I	18403–39431
14	4761.53	I	23819–44815
60	4762.38	I	23297–44289
24	4765.86	I	23720–44696
40	4766.43	I	23549–44524
75	4783.42	I	18532–39431

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
80	4823.52	I	18705–39431
2.0	4844.32	I	31001–51638
3.0	4965.88	I	23297–43429
1.6	5004.91	I	23549–43524
2.5	5074.79	I	27202–46901
5	5117.94	I	25281–44815
4	5150.89	I	25288–44696
4	5196.59	I	25286–44524
7	5255.32	I	25266–44289
13	5341.06	I	17052–35770
1.6	5349.88	I	43314–62001
8	5377.63	I	31001–49591
8	5394.67	I	0–18532
4	5399.49	I	31076–49591
8	5407.42	I	17282–35770
3.0	5413.69	I	31125–49591
7	5420.36	I	17282–35726
3.0	5432.55	I	0–18402
1.0	5457.47	I	17452–35770
5	5470.64	I	17452–35726
3.5	5481.40	I	17452–35690
2.5	5505.87	I	17568–35726
4	5516.77	I	17568–35690
3.5	5537.76	I	17637–35690
1.8	5551.98	I	44289–62295
0.7	5567.76	I	44523–62479
0.6	5573.01	I	35165–53103
0.7	5573.68	I	35165–53101
0.6	5738.29	I	34139–51561
0.6	5780.19	I	34251–51546
0.6	5816.84	I	34344–51531
12	6013.50	I	24779–41404
17	6016.64	I	24788–41404
24	6021.80	I	24802–41404
0.6	6384.67	I	30426–46084
1.4	6440.97	I	30420–45941
2.0	6491.71	I	30354–45754
1.2 h	6942.52	I	41789–56190
1.0	6989.96	I	42054–56356
1.2	7069.84	I	37420–51561
1.0	7184.25	I	37631–51546
0.8	7247.82	I	37737–51531
2.0 h	7283.82	I	35690–49415
3.0 h	7302.89	I	35726–49415
4.0	7326.51	I	35770–49415
1.0	7680.20	I	44289–57306
0.8	7712.42	I	44524–57486
0.8 h	7764.72	I	43314–56190
0.8 h	8670.92	I	35690–47220
1.0 h	8672.06	I	35690–47218
0.8 h	8673.97	I	35690–47216
1.0 h	8701.05	I	35726–47216
1.4 h	8703.76	I	35726–47212
2.5 h	8740.93	I	35770–47207

MERCURY

Hg, $Z=80$, $M=200.61$, Ratio $\frac{Hg}{Cu}=3.157$

Hg I Normal state of valence electrons $5d^{10}6s^2\ {}^1S_0 = 0$. I.P.= 84184K
Hg II Normal state of valence electrons $5d^{10}6s^1\ {}^2S_{0\frac{1}{2}}=0$. I.P.=151280K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Hg I, K. Burns, K. B. Adams, and J. Longwell, J. Opt. Soc. Am. **40,** 339 (1950).

Intensities:
R. Ladenburg and G. Wolfsohn, Z. Physik **65,** 207 (1930).
J. W. Schouten and J. A. Smit, Physica **10,** 661 (1943).

Relative intensity of mercury lines observed in an arc of copper containing 0.1 atomic percent of mercury

Strong lines of mercury

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	2536. 52	I	0–39412	$5d^{10}6s^2\ {}^1S_0$—$5d^{10}6s^16p^1\ {}^3P_1^\circ$
400	4358. 35	I	39412–62350	$5d^{10}6s^16p^1\ {}^3P_1^\circ$—$5d^{10}6s^17s^1\ {}^3S_1$

Mercury — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1500	2536.52	I	0–39412	30	3654.83	I	44043–71396
6	2752.78	I	37645–73961	8	3662.88	I	44043–71336
10	2893.60	I	39412–73961	24	3663.28	I	44043–71333
120	2967.28	I	37645–71336	180	4046.56	I	37645–62350
20	3021.50	I	44043–77129	12	4077.81	I	39412–63928
40	3125.66	I	39412–71396	400	4358.35	I	39412–62350
32	3131.55	I	39412–71336	320	5460.74	I	44043–62350
32	3131.83	I	39412–71333	24 hs	5769.59	I	54069–71396
6	3341.48	I	44043–73961	28 h	5790.65	I	54069–71333
280	3650.15	I	44043–71431				

MOLYBDENUM

Mo, $Z=42$, $M=95.95$, Ratio $\frac{\text{Mo}}{\text{Cu}}=1.510$

Mo I Normal state of valence electrons $4d^5 5s^1\ {}^7S_3 = 0$. I.P.= 57260 K
Mo II Normal state of valence electrons $4d^5\ {}^6S_{2½} = 0$. I.P.=130300 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley Sons, New York, 1939).
Supplemented by Kiess, cited below.

Classification:
Mo I, C. C. Kiess, unpublished material.
Mo II, C. C. Kiess, J. Research NBS **60,** 375 (1958).

Intensities:
E. I. Nikonova and V. K. Prokofiev, Optika i Spektroskopiya **1,** 290 (1956).

Relative intensity of molybdenum lines observed in an arc of copper containing 0.1 atomic percent of molybdenum

Strong lines of molybdenum

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3200	3798. 25	I	0–26320	$4d^5 5s^1\ a\ {}^7S_3 - 4d^5\ 5p^1\ z\ {}^7P^\circ_4$
2800	3864. 11	I	0–25872	$4d^5 5s^1\ a\ {}^7S_3 - 4d^5\ 5p^1\ z\ {}^7P^\circ_3$
1800	3132. 59	I	0–31913	$4d^5 5s^1\ a\ {}^7S_3 - 4d^4 5s^1 5p^1\ y\ {}^7P^\circ_4$
1800	3902. 96	I	0–25614	$4d^5 5s^1\ a\ {}^7S_3 - 4d^5\ 5p^1\ z\ {}^7P^\circ_2$
1100	3170. 35	I	0–31533	$4d^5 5s^1\ a\ {}^7S_3 - 4d^4 5s^1 5p^1\ y\ {}^7P^\circ_3$
950	3193. 97	I	0–31300	$4d^5 5s^1\ a\ {}^7S_3 - 4d^4 5s^1 5p^1\ y\ {}^7P^\circ_2$
750	3158. 16	I	0–31655	$4d^5 5s^1\ a\ {}^7S_3 - 4d^4 5s^1 5p^1\ z\ {}^7D^\circ_3$
480	5506. 49	I	10768–28924	$4d^5 5s^1\ a\ {}^5S_2 - 4d^5\ 5p^1\ z\ {}^5P^\circ_3$
400	3447. 12	I	12346–41348	$4d^4 5s^2\ a\ {}^5D_4 - 4d^5\ 5p^1\ y\ {}^5F^\circ_5$
380	3208. 83	I	0–31155	$4d^5 5s^1\ a\ {}^7S_3 - 4d^4 5s^1 5p^1\ z\ {}^7D^\circ_2$
320	5533. 05	I	10768–28837	$4d^5 5s^1\ a\ {}^5S_2 - 4d^5\ 5p^1\ z\ {}^5P^\circ_2$
280	4143. 55	I		
240	3384. 62	I	11859–41396	$4d^4 5s^2\ a\ {}^5D_3 - 4d^5\ 5p^1\ y\ {}^5F^\circ_4$
240	4188. 32	I		
240	4411. 57	I	16784–39445	$4d^5 5s^1\ a\ {}^5G_6 - 4d^5\ 5p^1\ z\ {}^5G^\circ_5$
	4411. 70	I	16785–39445	$4d^5 5s^1\ a\ {}^5G_5 - 4d^5\ 5p^1\ z\ {}^5G^\circ_5$
220	2775. 40	II	13461–49481	$4d^4 5s^1\ a\ {}^6D_{4½} - 4d^4\ 5p^1\ z\ {}^6P^\circ_{3½}$
220	2816. 15	II	13461–48960	$4d^4 5s^1\ a\ {}^6D_{4½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{5½}$
220	2848. 23	II	12900–47999	$4d^4 5s^1\ a\ {}^6D_{3½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{4½}$
220	2871. 51	II	12417–47232	$4d^4 5s^1\ a\ {}^6D_{2½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{3½}$
220	4069. 88	I	16784–41348	$4d^5 5s^1\ a\ {}^5G_6 - 4d^5\ 5p^1\ y\ {}^5F^\circ_5$
200	3358. 12	I	11454–41224	$4d^4 5s^2\ a\ {}^5D_2 - 4d^5\ 5p^1\ y\ {}^5F^\circ_3$
180	4381. 64	I	16784–39600	$4d^5 5s^1\ a\ {}^5G_6 - 4d^5\ 5p^1\ z\ {}^5H^\circ_7$
170	3112. 12	I	0–32123	$4d^5 5s^1\ a\ {}^7S_3 - 4d^4 5s^1 5p^1\ z\ {}^7D^\circ_4$
170	3581. 89	I	16785–44695	$4d^5 5s^1\ a\ {}^5G_5 - 4d^4 5s^1 5p^1\ y\ {}^5H^\circ_6$
170	3624. 46	I	16748–44330	$4d^5 5s^1\ a\ {}^5G_5 - 4d^4 5s^1 5p^1\ z\ {}^5I^\circ_5$
160	2890. 99	II	12034–46614	$4d^4 5s^1\ a\ {}^6D_{1½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{2½}$
160	2923. 39	II	12417–46614	$4d^4 5s^1\ a\ {}^6D_{2½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{1½}$
160	3344. 75	I	11143–41032	$4d^4 5s^2\ a\ {}^5D_1 - 4d^5\ 5p^1\ y\ {}^5F^\circ_2$
160	3405. 94	I		
160	3694. 94	I	16641–43698	$4d^5 5s^1\ a\ {}^5G_2 - 4d^4 5s^1 5p^1\ y\ {}^5H^\circ_3$
160	3833. 75	I	12346–38423	$4d^4 5s^2\ a\ {}^5D_4 - 4d^4 5s^1 5p^1\ z\ {}^5D^\circ_4$
150	5570. 45	I	10768–28715	$5d^5 5s^1\ a\ {}^5S_2 - 4d^5\ 5p^1\ z\ {}^5P^\circ_1$
140	2911. 92	II	12900–47232	$4d^4 5s^1\ a\ {}^6D_{3½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{3½}$
140	2930. 50	II	12034–46148	$4d^4 5s^1\ a\ {}^6D_{1½} - 4d^4\ 5p^1\ z\ {}^6F^\circ_{1½}$
140	3233. 14	I	16784–47705	$4d^5 5s^1\ a\ {}^5G_6 - 4d^4 5s^1 5p^1\ y\ {}^5G^\circ_6$
140	3289. 02	I	11454–41850	$4d^4 5s^2\ a\ {}^5D_2 - 4d^5\ 5p^1\ y\ {}^3F^\circ_3$
140	3680. 60	I	16784–43946	$4d^5 5s^1\ a\ {}^5G_6 - 4d^5\ 5p^1\ z\ {}^3G^\circ_5$
	3680. 68	I	16785–43946	$4d^5 5s^1\ a\ {}^5G_5 - 4d^5\ 5p^1\ z\ {}^3G^\circ_5$
140	4232. 59	I	16748–40367	$4d^5 5s^1\ a\ {}^5G_4 - 4d^5\ 5p^1\ z\ {}^5H^\circ_5$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	2015.11	II	0–49609
40	2020.30	II	0–49481
24	2038.44	II	0–49041
24	2045.98	II	0–48861
9	2081.68	II	0–48022
5	2089.52	II	15199–63041
5	2092.50	II	15331–63105
9	2093.11	II	15447–63207
7	2100.84	II	15428–63012
4	2104.29	II	15447–62954
3.5	2108.02	II	23248–70670
7	2269.69	II	15447–59492
4	2304.25	II	27627–71011
4	2306.97	II	15427–58761
4	2325.94	I	12346–55328
8	2330.46	I	
4	2332.12	II	15330–58197
7	2340.47	I	
7	2341.59	II	15199–57892
3.5	2352.61	I	12346–54839
3.5	2355.22	I	11143–53589
3.5	2355.42	II	15699–58141
3.5	2364.37	I	11454–53736
2.5	2366.09	II	15890–58141
7	2372.27	I	11454–53595
6	2380.41	I	11859–53855
9	2383.52	I	11859–53800
7	2389.20	II	23853–65695
10	2403.61	II	23833–65425
6	2404.66	II	24509–66082
10	2405.86	I	
3.0	2408.39	I	12346–53855
3.5	2412.84	II	22444–63877
10	2413.01	II	15890–57320
6	2415.33	I	12346–53736
7	2417.96	II	16796–58141
6	2419.01	II	23934–65261
7	2420.18	II	24138–65444
7	2424.00	II	23833–65075
7	2430.43	I	12346–53479
7	2435.96	II	22864–63904
7	2440.28	II	17174–58141
5	2461.81	II	24836–65444
6	2466.68	II	22864–63392
6	2466.97	II	16796–57320
6	2468.78	II	23833–64326
4	2470.04	II	23853–64326
19 h	2471.97	I	10768–51210
9	2477.57	II	26041–66391
9 h	2481.81	I	10768–51049
8	2482.57	II	23934–64203
5	2484.75	II	23934–64168
5 h	2485.31	I	
3.0	2496.24	II	22444–62492
11	2498.28	II	15691–55706
5	2500.44	II	22444–62425
8	2502.84	II	12900–52843
6 h	2508.67	I	
6	2509.56	I	12346–52182
6	2511.80	II	12417–52217
4	2513.33	I	
8	2515.08	II	22980–62728
3	2515.66	I	12346–52085
6 h	2517.46	I	11454–51165
3.0	2517.83	I	
12 h	2524.81	I	11454–51049
9	2527.14	II	24836–64395
6	2530.34	II	24659–64168
9	2532.31	II	22864–62342
9	2536.85	I	12346–51753
55	2538.46	II	13461–52843
6	2539.44	II	24509–63877
14 h	2540.45	I	11859–51210
42	2542.67	II	12900–52217
8	2543.35	I	11859–51165
5	2543.61	II	22444–61746
42	2548.22	I	10768–49999
14 h	2550.85	I	11859–51049
8	2555.42	II	23833–62954
5	2556.75	II	23853–62954
10	2558.88	II	24836–63904
	2558.94	I	11858–50926
8	2562.08	II	27725–66744
11	2564.34	II	25342–64326
5	2566.26	II	12417–51373
32	2567.05	I	10768–49712
2.5	2571.45	II	26406–65282
40	2572.34	I	12346–51210
6	2574.42	II	12900–51732
5	2575.77	I	11858–50670
5	2576.56	II	24138–62937
5	2578.36	II	26488–65261
12	2578.77	I	11858–50625
32	2582.16	I	10768–49484
4	2585.95	II	23833–62492
8	2588.78	II	23934–62551
5	2591.77	II	23853–62425
9	2591.98	I	11143–49712
32	2593.70	II	12034–50577
13	2595.40	I	10966–49484

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		2596.77	I	21343–59841
4		2597.22	I	10768–49259
5		2597.38	II	23853–62342
6		2599.64	I	12346–50802
10		2601.69	I	
32		2602.80	II	11783–50192
3.5		2603.32	I	10768–49169
5		2605.08	II	26739–65115
5		2605.93	II	17344–55706
32		2607.37	I	11143–49484
4		2608.86	I	20930–59250
24		2611.20	I	20951–59236
36		2613.08	I	11454–49712
16		2615.39	I	10966–49190
50		2616.78	I	11143–49346
9		2619.34	II	11783–49949
18		2621.07	I	11859–49999
40		2627.55	I	11143–49190
20		2628.74	I	11454–49484
10		2628.97	I	11143–49169
55		2629.85	I	11454–49468
8		2631.50	I	10966–48956
9		2635.57	I	11859–49790
42		2636.67	II	12034–49949
32		2638.30	I	11454–49346
90		2638.76	II	12417–50302
4		2639.49	I	
4		2639.68	I	
10		2640.28	I	
52		2640.99	I	11859–49712
5		2643.81	I	11143–48956
75		2644.35	II	12900–50706
4		2645.79	I	
46		2646.49	II	12417–50192
4		2647.25	I	10768–48532
4		2649.25	I	11454–49190
80		2649.46	I	11859–49591
5		2650.68	I	11454–49169
60		2653.35	II	12900–50577
70	h	2655.03	I	12346–49999
5		2655.93	I	10768–48409
5		2656.49	I	11143–48775
36		2658.11	I	11859–49468
80		2660.58	II	12034–49609
14		2665.10	I	11859–49370
6		2666.75	I	11859–49346
8		2670.32	I	10768–48206
7		2671.83	II	15427–52843
90		2672.84	II	12900–50302
32		2673.27	II	15447–52843
2.5		2673.84	I	
4		2678.67	I	11454–48775
130		2679.85	I	12346–49651
12		2681.36	II	23833–61116
4		2682.62	I	11143–48409
80		2683.23	II	11783–49041
110		2684.14	II	13461–50706
70		2687.99	II	12417–49609
6		2688.64	I	21343–58526
4		2692.61	II	27725–64852
3.5		2693.04	I	12346–49468
2.5		2693.53	I	
7		2695.22	II	23833–60925
8		2696.07	I	10768–47848
4		2696.83	II	33601–70671
11		2697.81	I	10966–48022
7		2699.41	II	22444–59478
8		2700.21	I	12346–49370
17		2701.03	I	11858–48870
60		2701.42	II	12034–49041
4		2701.87	II	26041–63041
4		2704.93	II	33045–70004
6		2705.24	I	11454–48409
12		2706.12	I	11143–48085
6		2709.25	I	
5		2710.19	II	15330–52217
8		2710.74	I	11143–48022
4		2711.49	II	23833–60702
6		2712.35	II	33146–70004
24		2713.51	II	13461–50302
6		2715.17	I	10768–47588
10		2717.16	I	
36		2717.35	II	15428–52217
10		2720.17	I	11454–48206
14		2724.41	I	16784–53479
22		2725.15	I	11143–47827
6		2725.95	I	11859–48532
3.5		2726.65	I	21154–57818
11		2726.97	II	26069–62728
2.0		2728.34	I	
11		2728.70	I	11143–47779
7		2729.13	I	11454–48085
17		2729.68	II	12417–49041
10		2730.20	II	26488–63105
42		2732.88	II	12900–49481
32		2733.39	I	11454–48028
3.5		2735.65	I	16784–53327
3.0		2735.88	I	11858–48399
3.5		2736.42	I	18356–54889
20		2736.96	II	15691–52217

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10 h	2737.88	II	35406–71920
6	2738.60	II	27627–64130
5	2741.32	II	26739–63207
7	2741.62	II	24509–60973
30	2743.07	I	11143–47588
12	2743.71	I	10966–47402
10	2745.09	I	10768–47186
5	2745.38	I	16784–53198
36	2746.30	II	15330–51732
7	2748.49	I	11454–47827
40	2751.47	I	11859–48192
4	2754.29	I	10768–47064
4	2755.37	I	10966–47248
14	2756.07	II	
8 d	2758.63	II	11783–48022
3.5	2759.58	I	11859–48085
2.5	2760.53	II	26739–62954
24	2761.53	I	12346–48547
8	2762.70	I	12346–48532
8	2763.03	I	11143–47324
28	2763.62	II	15199–51373
5	2763.93	I	11859–48028
14	2766.26	I	11143–47282
5	2766.72	I	11454–47588
4	2767.22	I	10768–46895
5	2768.09	I	
30	2769.76	II	27114–63207
3.5	2771.36	I	10966–47039
20	2773.78	II	15691–51732
24	2774.39	II	15699–51732
220	2775.40	II	13461–49481
16	2777.74	I	11858–47848
8	2777.86	II	12034–48022
9	2779.48	I	11143–47110
110	2780.04	II	12900–48861
50	2784.99	II	16947–52843
4	2786.11	I	
22	2787.83	I	12346–48206
9	2788.94	I	12346–48192
3.0	2790.01	I	16748–52579
12	2790.31	I	11454–47282
	2790.41	II	23853–59680
5	2791.54	II	30019–65831
10	2792.96	I	11454–47248
4	2796.78	I	24096–59841
30 d	2797.93	I	11454–47184
	2798.01	I	11859–47588
28	2801.47	I	10768–46453
	2801.55	I	
4	2807.36	I	11454–47064
50	2807.76	II	12417–48022
9	2808.37	I	11454–47052
4	2809.96	I	11143–46720
3.0	2810.43	I	18229–53800
4	2811.50	I	
3.5	2812.58	II	23934–59478
3.0	2814.67	II	28877–64395
4	2815.54	I	18229–53736
9	2815.91	I	11454–46956
220	2816.15	II	13461–48960
28	2817.44	II	15890–51373
	2817.50	I	23516–58999
5	2818.30	I	11454–46926
6	2822.03	II	11783–47208
4	2822.43	I	11454–46874
3.0	2822.86	I	18229–53644
6	2825.67	I	18356–53736
30	2826.54	I	24823–60191
6	2826.75	I	18229–53595
10	2827.74	II	27627–62980
5	2828.79	I	24096–59437
5	2829.79	I	11858–47186
9	2829.94	I	11858–47184
5	2831.44	II	33601–68909
4	2832.07	II	24836–60135
10	2834.39	II	16947–52217
10	2835.33	II	15447–50706
2.5	2835.91	I	11858–47110
1.2	2836.03	I	16641–51891
5 h	2837.32	I	
6	2837.90	I	21154–56381
7	2839.58	I	11858–47064
20	2842.15	II	12034–47208
8	2842.37	I	
3.0	2843.73	II	33895–69050
28	2844.39	I	24466–59612
220	2848.23	II	12900–47999
20	2849.38	I	
8 d	2850.79	I	11859–46926
	2850.90	I	10768–45835
4	2851.18	I	12346–47409
46	2853.23	II	27114–62152
5	2853.58	I	16641–51675
5 d	2854.87	I	24823–59841
6	2856.00	II	27724–62728
6	2859.57	I	20948–55908
4	2862.84	I	
3.0	2863.20	II	24138–59053
46	2863.81	II	26739–61648
20	2864.31	I	24096–58998

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	2864.66	I	11859–46756
5	2865.62	II	15691–50577
28	2866.69	II	17344–52217
5	2868.11	II	26069–60924
5	2868.32	II	26604–61457
9	2869.56	I	12346–47184
3.5	2870.18	I	12346–47177
3.5	2870.90	I	21154–55976
220	2871.51	II	12417–47232
3.5	2871.89	I	
11	2872.88	II	27628–62425
5	2873.64	I	24823–59612
6	2876.54	I	21154–55908
5	2878.38	I	11858–46590
28	2879.05	II	30391–65115
5	2882.54	I	20158–54839
8	2885.74	I	25549–60192
11	2886.61	I	21343–55976
3.5	2887.62	I	10768–45389
8	2888.15	II	33146–67760
5	2889.84	I	11858–46453
160	2890.99	II	12034–46614
12	2891.28	II	16796–51373
24	2892.81	II	17174–51732
8	2893.23	I	25639–60192
120	2894.45	II	13461–47999
3.5	2896.44	I	12346–46861
3.5	2896.97	I	
17	2897.63	II	15691–50192
10	2898.65	I	20350–54839
9	2900.80	II	29034–63498
36	2903.07	II	26488–60924
20	2905.27	I	12346–46756
8	2906.06	I	20130–54531
10	2907.12	II	17344–51732
3.5	2907.78	I	11454–45835
3.0	2908.16	I	21154–55530
75	2909.12	II	11783–46148
140	2911.92	II	12900–47232
9	2913.52	I	10768–45081
7	2913.81	II	28989–63298
6	2915.26	I	25549–59841
7	2915.38	I	20281–54572
6	2916.10	I	11143–45425
15	2918.83	II	15699–49949
3.0	2919.20	I	11143–45389
7	2919.38	I	12346–46590
160	2923.39	II	12417–46614
17	2924.32	II	26041–60227
8	2927.54	II	30019–64168
6	2930.06	II	28883–63002
140	2930.50	II	12034–46148
7	2930.77	II	30019–64130
6	2931.08	I	12346–46453
100	2934.30	II	11783–45853
8	2934.84	I	25549–59612
8	2935.20	II	15890–49949
10	2936.50	I	21343–55387
15	2937.66	I	
5	2938.30	II	28989–63012
12	2940.10	II	27114–61116
6	2940.98	I	20350–54343
14	2941.22	II	30213–64203
7	2942.85	I	11454–45425
18	2944.21	I	0–33955
19	2944.82	II	35099–69047
10	2945.43	I	20948–54889
18	2945.66	I	11143–45080
	2945.95	II	30391–64326
24	2946.01	I	11454–45389
18	2946.42	I	
18	2946.69	II	30213–64140
12	2947.28	II	29034–62954
6	2953.56	I	16784–50631
12	2955.84	II	26406–60227
30	2956.06	II	12034–45853
9	2956.90	II	35099–68909
11 h	2957.75	I	
10	2959.48	I	20158–53938
10	2959.80	I	11859–45635
12	2960.24	II	13461–47232
18	2962.89	I	
32	2963.79	II	12417–46148
6	2964.96	II	28877–62595
26	2965.27	II	12900–46614
9	2971.91	II	26041–59680
32	2972.61	II	16947–50577
10	2972.96	I	11454–45081
10	2975.40	II	29699–63298
6	2977.27	I	20158–53736
22	2978.28	I	11859–45425
15	2981.52	I	11858–45389
6	2983.04	I	19970–53483
8	2983.81	I	20350–53855
6	2985.16	I	12346–45836
6	2985.84	I	25517–58999
14	2987.92	I	20130–53588
10	2988.23	I	20281–53736
20	2988.68	I	20350–53800
24	2989.80	I	20158–53595

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
12		2992.84	II	17174–50577
6		2993.52	II	16796–50192
6		3000.23	I	20158–53479
24		3002.21	I	0–33299
5		3004.46	II	26406–59680
6		3010.26	I	12346–45556
16		3013.39	I	18229–51405
18	h	3013.76	I	
10		3016.78	I	21154–54292
32		3025.00	I	18356–51405
12		3027.77	II	17174–50192
6		3035.33	I	18229–51165
13		3036.31	I	18480–51405
6		3039.82	I	25639–58526
38		3041.70	I	16784–49650
19		3046.80	I	16784–49596
26		3047.31	I	16785–49591
26		3055.32	I	16748–49468
13		3060.78	II	16947–49609
20		3061.59	I	16693–49346
100		3064.28	I	16784–49408
32		3065.04	II	38054–70670
13		3068.00	I	16785–49370
32		3070.90	I	16748–49302
11		3071.44	I	16641–49190
100		3074.37	I	16784–49302
11		3077.66	II	35406–67889
19		3079.88	I	23515–55975
26		3080.41	I	16693–49147
5		3081.16	I	18480–50926
100		3085.62	I	16748–49147
34		3087.62	II	27114–59492
13		3089.12	I	16784–49147
13		3089.71	I	16641–48997
24		3092.07	II	15691–48022
70		3094.66	I	16693–48997
14		3099.93	I	16748–48999
14		3100.88	I	23668–55908
70		3101.34	I	
7		3106.34	I	
170		3112.12	I	0–32123
7		3117.54	I	24823–56891
36		3122.00	II	26740–58761
1800		3132.59	I	0–31913
5		3135.60	I	
7		3135.89	I	24096–55976
12		3136.46	I	16748–48622
6		3136.75	I	23516–55387
14		3138.72	II	26041–57892
7		3144.34	I	
28		3147.35	I	16784–48547
28		3152.82	II	26488–58197
7		3155.64	II	29022–60702
7		3156.51	I	11858–43530
750		3158.16	I	0–31655
12		3163.90	I	16641–48238
15		3164.53	I	11454–43046
1100		3170.35	I	0–31533
7		3171.38	I	
12		3172.03	II	17344–48860
5		3172.37	I	16693–48206
20		3172.74	II	15699–47208
12		3177.90	I	16748–48206
12		3179.77	I	
46		3183.03	I	16785–48192
15		3184.57	I	16693–48085
46		3185.10	I	11858–43246
22		3185.71	I	16641–48022
15	d	3187.59	II	23853–55216
		3187.68	I	18229–49591
8		3188.09	I	23668–55026
8		3188.40	I	23534–54889
12		3191.52	I	21343–52667
12		3192.80	I	21154–52465
950		3193.97	I	0–31300
8		3194.87	I	24096–55387
36		3195.96	I	16748–48028
15		3198.85	I	12346–43598
8		3200.21	I	18229–49468
8		3200.89	I	18480–49712
5		3201.50	II	16796–48022
42		3205.22	I	10966–42156
15		3205.54	I	11858–43046
110		3205.88	I	12346–43530
380		3208.83	I	0–31155
30		3210.97	I	16693–47827
15		3212.59	I	
8		3213.32	I	11858–42970
15		3214.44	I	16748–47848
70		3215.07	I	11143–42237
8		3220.86	I	10768–41807
44		3221.74	I	18229–49259
8		3223.49	I	11143–42156
110		3228.22	I	11454–42422
75		3229.79	I	12346–43299
140		3233.14	I	16784–47705
24		3235.38	I	12346–43246
120		3237.08	I	20281–51165
14		3237.98	I	16784–47659
24		3240.49	I	12346–43197

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	3240.71	II	17174–48022
6	3244.47	I	18356–49169
8	3245.92	I	27727–58526
8	3249.92	I	16641–47402
120	3256.21	I	11454–42156
14	3259.16	I	24466–55140
8	3260.48	I	16748–47409
38	3262.63	I	16641–47282
14	3263.83	I	10768–41398
60	3264.40	I	16785–47409
16	3265.14	I	
100	3270.90	I	11859–42422
8	3279.44	I	16692–47177
3.0	3285.02	I	10966–41398
4	3285.36	I	16748–47177
8	3287.38	I	16641–47052
140	3289.02	I	11454–41850
24	3289.84	I	16784–47172
120	3290.82	I	11858–42237
24	3292.31	II	25342–55706
16	3294.85	I	11143–41484
13	3296.40	I	11858–42186
13	3303.34	I	16693–46956
22	3304.22	I	11143–41398
40	3305.56	I	10768–41012
16	3305.90	I	21619–51859
40	3307.12	I	11859–42088
20	3310.77	I	10768–40964
12	3312.33	I	16693–46874
13	3313.62	II	28884–59053
16	3319.59	I	16693–46808
16	3319.79	I	16641–46755
24	3320.90	II	25112–55216
80	3323.95	I	12346–42422
45	3325.67	I	10768–40829
45	3327.30	I	10966–41012
8	3329.04	I	
8	3331.40	I	16748–46756
16	3336.51	I	18229–48192
30	3340.17	I	10768–40698
12	3343.72	I	
160	3344.75	I	11143–41032
12	3346.40	II	25342–55216
40	3347.02	I	11143–41012
8	3349.19	I	18356–48206
16	3350.30	I	12346–42186
16	3354.99	I	10768–40566
200	3358.12	I	11454–41224
32	3361.37	I	12346–42088
16	3362.37	I	10966–40698
120	3363.78	I	10768–40488
8	3369.25	I	18356–48028
8	3375.22	I	18229–47848
8	3375.65	I	21619–51234
16	3378.20	I	11143–40736
16	3378.46	I	25549–55140
120	3379.97	I	11454–41032
8	3382.29	I	11454–41012
40	3382.48	I	11143–40699
240	3384.62	I	11859–41396
8	3385.88	I	26636–56162
12	3387.75	I	11454–40964
20	3389.80	I	18356–47848
12	3392.17	I	21154–50625
20	3393.65	I	21343–50802
16	3395.36	II	36289–65732
20	3397.69	I	11143–40566
16	3402.81	I	27766–57144
8	3403.35	I	11454–40829
80	3404.34	I	11859–41224
8	3405.20	I	18229–47588
160	3405.94	I	
30	3418.52	I	11454–40698
6	3418.96	I	20350–49591
32	3420.04	I	18356–47588
24	3421.25	I	10768–39989
32	3422.31	I	20158–49370
24	3424.60	I	10768–39960
12	3424.76	I	16748–45939
12	3425.19	I	20281–49468
16	3425.48	I	16784–45969
16	3426.00	I	18229–47409
20	3426.79	I	11859–41032
10	3427.90	I	27727–56891
12	3432.87	I	16748–45870
12	3434.04	I	11454–40566
48	3434.79	I	11859–40964
40	3435.45	I	25639–54739
80	3437.22	I	16785–45870
32	3438.87	I	10966–40037
32	3441.44	I	12346–41396
8	3442.66	I	20130–49169
32	3443.26	I	11454–40488
12	3445.04	I	20350–49370
24	3445.26	I	16693–45710
16	3446.08	II	23833–52843
400	3447.12	I	12346–41348
80	3449.07	I	11859–40844
12	3449.85	I	20281–49259
38	3451.75	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
32	3452.60	I	18229–47184
13	3454.22	I	16693–45635
24	3456.15	I	18356–47282
120	3456.39	I	0–28924
8	3458.15	I	20281–49190
20	3459.92	I	11143–40037
16	3460.23	I	18356–47248
8	3460.78	I	16748–45635
40	3466.83	I	0–28836
8	3466.97	I	18229–47064
32	3467.85	I	18356–47184
40	3469.22	I	16641–45458
8	3469.63	I	24823–53637
24	3470.92	I	18480–47282
8	3473.22	I	16641–45425
24	3475.03	I	18480–47248
22	3479.43	I	16693–45425
13	3480.09	I	18229–46956
13	3481.79	I	20158–48870
24	3482.40	I	11859–40566
12	3483.67	I	18229–46926
24	3483.84	I	18356–47052
30	3485.93	I	11143–39821
16 d	3491.77	I	18480–47110
	3491.87	I	11858–40488
16	3493.34	I	12346–40964
100	3504.41	I	18229–46756
30	3505.32	I	20350–48870
70	3508.12	I	12346–40844
13	3510.78	I	28241–56717
13	3513.70	I	18356–46808
16	3517.56	I	25517–53938
16	3518.22	I	18480–46895
60	3521.41	I	20158–48547
8	3522.37	I	
13	3524.23	I	11454–39821
24	3524.65	I	25821–54184
30	3524.98	I	18229–46590
80	3537.28	I	
40	3542.17	I	18229–46452
12	3554.20	I	20281–48409
8	3555.43	I	20281–48399
65	3558.10	I	18356–46453
50	3563.14	I	11859–39916
8	3563.76	I	19970–48022
38	3566.05	I	20158–48192
30	3570.65	I	25639–53637
40	3573.88	I	18480–46452
14	3580.54	I	28241–56162
170	3581.89	I	16785–44695
8	3586.86	I	25456–52327
13	3588.95	I	20350–48206
25	3590.74	I	20350–48192
8	3592.02	I	16693–44525
13	3595.55	I	20281–48085
8	3595.71	I	20608–48411
26	3598.88	I	25549–53327
12	3600.28	I	16693–44461
34	3602.94	I	20281–48028
8	3604.07	I	25997–53736
26	3608.37	I	11454–39160
17	3612.00	I	20350–48028
13	3612.45	I	20948–48622
17	3613.37	I	11454–39122
13	3613.64	I	21154–48819
8	3615.15	I	26639–54292
8	3615.74	I	20130–47779
9	3616.84	I	18229–45870
25	3623.23	I	
170	3624.46	I	16748–44330
42	3626.18	I	12346–39916
8	3628.35	I	20158–47711
13	3628.66	I	16641–44192
3.0	3629.31	I	25639–53184
3.5	3635.14	II	25342–52843
130	3635.43	I	16693–44192
8	3637.52	I	11143–38626
20	3638.20	I	18356–45835
17	3640.62	I	20951–48411
12	3640.99	I	20130–47588
9	3642.20	I	20951–48399
9	3648.61	I	16641–44041
17	3651.35	I	11143–38522
50	3657.35	I	16641–43975
9	3660.92	I	26336–53644
22	3661.78	I	11858–39160
17	3662.99	I	25906–53198
17	3663.30	I	20948–48238
9	3664.30	I	16693–43975
60	3664.81	I	18356–45635
32	3666.72	I	16748–44012
12	3666.94	I	11858–39122
7	3668.00	I	20951–48206
8	3668.49	I	20158–47409
24	3669.34	I	21154–48399
4	3670.42	I	20350–47588
65	3672.82	I	26636–53855
10	3675.36	I	25997–53198
2.5	3675.98	I	18229–45425
10	3676.24	I	20130–47324

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	3677.70	I	
140	3680.60	I	16784–43946
	3680.68	I	16785–43946
10 d	3681.55	I	20930–48085
	3681.72	I	20158–47311
5	3684.22	II	36741–63877
	3684.33	I	20951–48085
4	3686.11	I	20281–47402
7	3688.31	II	25112–52217
8	3688.97	I	25906–53006
26	3690.59	I	20951–48039
2.5	3692.08	I	18480–45556
20	3692.64	II	24659–51732
18	3693.38	I	11454–38522
160	3694.94	I	16641–43698
10	3696.04	I	29982–57030
6	3698.53	I	20281–47311
8	3700.01	I	20158–47177
24	3702.03	I	16693–43698
20	3702.55	I	20281–47282
		II	24372–51373
6	3705.41	I	20130–47110
9	3707.17	I	20281–47248
9	3708.56	I	23668–50625
6	3710.14	I	18480–45425
3.0	3711.51	I	10966–37902
9	3712.95	I	19970–46895
9	3713.47	I	20130–47052
8	3714.55	I	21619–48532
24	3715.65	I	16693–43598
15	3716.07	I	
9	3716.87	I	20281–47177
6	3718.48	I	26759–53644
13	3719.55	I	
	3719.74	I	20951–47827
8	3720.25	I	25707–52579
8	3723.51	I	
4	3723.81	I	
20	3725.56	I	20350–47184
15	3726.22	I	20281–47110
	3726.32	I	20951–47779
55	3727.69	I	
18	3728.30	I	23668–50482
16	3728.50	I	
3.0	3730.56	I	20158–46956
36 d	3732.71	I	
	3732.80	I	16748–43530
13	3733.03	I	21619–48399
9	3733.40	I	21343–48121
9	3734.37	I	20281–47052
9	3735.62	I	25906–52667
10	3735.91	I	20350–47110
3.0	3736.17	I	20281–47039
20	3737.91	I	16784–43530
3.0	3740.76	I	18356–45081
26	3742.28	I	20350–47064
6	3743.81	I	20158–46861
3.0	3744.10	I	20350–47052
9	3744.37	II	
3.0	3744.94	I	
10	3745.48	I	18229–44921
12	3747.19	I	
16	3748.49	I	26636–53306
14	3751.20	I	20158–46808
15	3755.10	I	25821–52444
3.5	3755.54	I	21619–48238
3.5	3755.84	I	23516–50134
20	3758.52	I	20158–46756
3.5	3759.60	I	26636–53227
10	3760.88	I	25997–52579
10	3761.76	I	20350–46926
6	3762.09	I	21619–48192
16	3763.35	I	11859–38423
6	3764.44	I	21154–47711
10	3765.22	I	16748–43299
6	3765.74	I	
3.5	3767.73	I	21343–47877
7	3768.62	I	20281–46808
7	3768.74	I	27766–54292
7	3770.00	I	27774–54292
40	3770.45	I	16784–43299
	3770.52	I	11454–37968
20	3771.95	I	16693–43197
16	3772.82	I	16748–43246
3.5	3775.65	I	19970–46448
3.5	3776.10	I	25707–52182
3.5	3776.55	I	20930–47402
7	3777.72	I	28241–54704
6	3777.96	I	
24	3779.77	I	16748–43197
40	3781.59	I	11143–37579
7	3782.19	I	20158–46590
6	3783.53	I	
10	3785.03	I	16785–43197
6	3785.51	I	26336–52747
10	3788.26	I	26189–52579
12	3793.62	I	16693–43046
10	3794.43	I	23516–49864
6	3796.04	I	24466–50802
28	3797.30	I	10966–37293

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3200	3798.25	I	0–26321
32	3801.84	I	20158–46453
10	3804.52	I	16693–42970
10	3805.93	I	25821–52088
	3805.99	I	23534–49801
6	3807.65	I	21154–47409
10	3811.39	I	21619–47848
10	3812.47	I	16748–42970
7	3818.66	I	20930–47110
13	3819.87	I	20281–46452
18	3822.98	I	11143–37293
7	3825.32	I	23516–49651
50	3826.70	I	11454–37579
9	3827.16	I	23668–49790
90	3828.87	I	11859–37968
7	3830.82	I	25795–51891
3.5	3831.07	I	27384–53479
3.5	3831.76	I	16693–42783
14	3832.11	I	25997–52085
160	3833.75	I	12346–38423
4	3834.97	I	25517–51585
7	3835.31	I	21343–47409
6	3843.90	I	20948–46956
11	3845.95	I	16748–42742
36	3847.25	I	11143–37128
18	3848.30	I	24823–50802
7	3851.99	I	25906–51859
2800	3864.11	I	0–25872
3.5	3866.69	I	25821–51675
55	3869.08	I	11454–37293
55	3886.82	I	11859–37579
7	3888.18	I	20158–45870
7	3888.88	I	21154–46861
3.5	3890.71	I	26189–51884
3.5	3893.32	I	20158–45836
3.5	3896.38	I	20281–45938
3.5	3896.85	I	21154–46808
36	3901.77	I	12346–37968
1800	3902.96	I	0–25614
7	3906.92	I	
	3906.98	I	25997–51585
13	3908.25	I	20130–45710
7	3909.55	I	
7	3911.09	I	16784–42345
3.5	3911.94	I	26336–51891
7	3913.36	I	26636–52182
10	3915.44	I	22876–48409
7	3916.92	I	22876–48399
14	3917.54	I	20350–45870
7	3917.78	I	20930–46448
7	3922.32	I	19970–45458
11	3923.75	I	23668–49147
6	3928.79	I	21619–47064
3	3931.40	I	20281–45710
3.5	3935.02	I	23516–48922
6	3941.48	II	25342–50706
22	3943.04	I	20281–45635
3.5	3943.51	I	20951–46302
7	3945.25	I	16748–42088
3.5	3947.17	I	20130–45458
7	3950.99	I	16784–42088
11	3953.93	I	20350–45635
6	3955.49	I	30113–55387
3.5	3958.60	I	24096–49351
3	3963.53	I	26636–51859
3	3963.99	I	26639–51859
3.5	3965.76	I	16641–41850
7	3968.75	I	21619–46808
14	3973.77	I	29982–55140
11	3973.93	I	16693–41850
6	3975.96	I	20281–45425
6	3977.90	I	
3.5	3979.22	I	27342–52465
7	3980.20	I	26759–51876
7	3982.05	I	23516–48622
3.5	3982.60	I	16748–41850
13	3986.20	I	25517–50596
3.5	3991.39	I	25549–50596
3.5	3991.85	I	20930–45974
3.5	3993.93	I	23516–48547
3.5	3998.29	I	22244–47248
6	4000.39	I	20948–45938
11	4000.50	I	26415–51405
7	4006.05	I	26321–51276
3.0	4008.05	I	24466–49408
11	4009.37	I	24466–49400
6	4011.97	I	25872–50791
4	4017.38	I	24466–49351
12	4021.02	I	29842–54704
16	4024.09	I	16641–41484
6	4028.65	I	21154–45969
4	4032.50	I	16693–41484
4	4033.63	I	21154–45938
4	4037.30	I	20948–45710
8	4037.78	I	20951–45710
12	4038.08	I	16641–41398
3.0	4041.12	I	27727–52465
12	4042.87	I	25549–50277
3	4050.09	I	20951–45635
26	4056.01	I	16748–41396

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	4056.32	I	26759–51405
4	4057.58	I	25639–50277
18	4059.61	I	21343–45969
130	4062.08	I	16785–41396
8	4066.37	I	24823–49408
220	4069.88	I	16784–41348
18	4075.25	I	16693–41224
5	4075.54	I	
18	4076.19	I	24096–48622
120	4081.44	I	
90	4084.38	I	16748–41224
14	4086.02	I	20948–45415
17	4096.81	I	21154–45556
5	4098.18	I	20130–44525
14	4098.74	I	16641–41032
24	4102.15	I	16641–41012
14	4105.08	I	24466–48819
5	4105.53	I	21619–45969
70	4107.47	I	16693–41032
8	4114.93	I	
9	4118.96	I	16693–40964
60	4120.10	I	
13	4123.65	I	20281–44525
13	4124.54	I	24823–49062
5	4126.53	I	
14	4128.28	I	16748–40964
7	4128.83	I	21343–45556
17	4131.92	I	25456–49651
7	4132.23	I	18229–42422
4	4135.38	I	
280	4143.55	I	
22	4148.94	I	16748–40844
7	4151.88	I	25517–49596
24	4155.28	I	16785–40844
17	4155.58	I	16641–40698
4	4156.79	I	22876–46926
19	4157.40	I	25549–49596
17	4162.68	I	25549–49565
4	4164.08	I	18229–42237
4	4166.28	I	24823–48819
8	4169.82	I	23516–47492
8	4171.07	I	
14	4177.26	I	22876–46808
19	4178.27	I	25639–49565
8	4181.05	I	20130–44041
4	4184.39	I	25517–49408
46	4185.82	I	25517–49400
5	4186.28	I	18356–42237
240	4188.32	I	
9	4190.00	I	25549–49408
24	4194.56	I	25517–49351
5	4200.57	I	18356–42156
5	4201.32	I	16693–40488
9	4205.81	I	25639–49408
5	4211.02	I	16748–40488
4	4219.40	I	18480–42173
3.5	4222.41	I	18480–42156
140	4232.59	I	16748–40367
4	4233.49	I	24096–47711
3.5	4235.03	I	21154–44760
8	4237.16	I	20930–44525
9 d	4239.07	I	16784–40367
	4239.19	I	16785–40367
13	4240.08	I	18229–41807
13	4240.28	I	24823–48400
18	4240.83	I	20951–44525
3.5	4242.80	I	24096–47659
18	4246.02	I	25517–49062
16	4251.87	I	28241–51753
13	4254.96	I	26639–50134
9	4260.36	I	26336–49801
4	4260.66	I	25906–49370
3.0	4261.44	I	
9	4266.18	I	20608–44041
7	4268.08	I	25639–49062
26	4269.28	I	21343–44760
3.0	4272.06	I	26189–49591
12	4273.07	I	16641–40037
85	4276.91	I	16693–40068
110	4277.24	I	12346–35719
4	4281.83	I	
8 h	4284.60	I	
11	4287.08	I	16641–39960
130	4288.64	I	11859–35169
13	4289.42	I	21154–44461
4 h	4290.18	I	25517–48819
4	4291.20	I	26415–49712
65	4292.13	I	11143–34435
85	4293.21	I	11454–34740
34	4293.88	I	10966–34248
4	4296.16	I	25549–48819
3.0	4296.62	I	16693–39960
3.0	4298.90	I	18229–41484
3.0	4301.26	I	
4	4304.92	I	16693–39916
8	4310.39	I	24466–47659
4	4312.80	I	16641–39821
4	4312.97	I	20350–43530
16	4317.93	I	
7	4321.97	I	16785–39916

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
80	4326.14	I	16641–39750
24	4326.74	I	11143–34248
3.0	4329.63	I	20951–44041
4	4332.51	I	27727–50802
11	4334.81	I	26284–49346
4	4338.71	I	18356–41398
4	4339.82	I	27767–50802
8	4340.75	I	26759–49790
12	4341.42	I	20948–43975
3.0	4344.66	I	26336–49346
22	4350.34	I	11454–34435
3.0	4351.55	I	
7	4353.31	I	20281–43246
4	4357.34	I	24466–47409
3.0	4359.62	I	26415–49346
4	4362.02	I	18480–41398
4	4362.71	I	11858–34774
8	4364.47	I	26284–49190
7	4366.54	I	20350–43246
22	4369.04	I	11859–34740
3.5	4373.32	I	24096–46956
4	4374.89	I	25549–48400
7	4375.01	I	27774–50625
14	4380.29	I	12346–35169
3.5	4380.59	I	16641–39463
180	4381.64	I	16784–39600
7	4382.41	I	20158–42970
2.5	4385.89	I	11454–34248
7	4391.54	I	24096–46861
7	4392.12	I	25639–48400
5	4394.32	I	27384–50134
5	4394.47	I	20948–43697
13	4396.66	I	16784–39522
14	4397.29	I	18229–40964
3.5	4402.49	I	27774–50482
7	4402.90	I	24466–47172
3.0	4404.55	I	16748–39445
3.5	4406.87	I	29982–52667
3.5	4409.44	I	
7	4409.95	I	24823–47493
240	4411.57	I	16784–39445
	4411.70	I	16785–39445
10	4412.77	I	18356–41012
3.5	4422.06	I	18356–40964
20	4423.62	I	18229–40829
16	4426.67	I	20158–42742
95	4434.95	I	16748–39290
10	4436.89	I	18480–41012
6	4438.96	I	27342–49864
19	4442.20	I	16784–39290
10	4443.07	I	11454–33955
8	4446.43	I	29982–52465
2.0	4447.23	I	27384–49864
32	4449.74	I	16693–39160
3.0	4452.56	I	23516–45969
2.0	4455.30	I	27363–49801
46	4457.36	I	16693–39122
3	4458.65	I	23516–45938
6	4460.62	I	16748–39160
6	4464.77	I	20350–42742
18	4468.28	I	16748–39122
5	4471.66	I	21619–43975
5	4472.04	I	28241–50596
12	4473.18	I	18480–40829
60	4474.56	I	16641–38983
	4474.65	I	18356–40698
9	4475.62	I	18229–40566
14	4484.97	I	16693–38983
8	4487.05	I	22244–44525
3.0	4489.00	I	23668–45938
6	4490.19	I	20158–42422
22	4491.28	I	18229–40488
3.0	4491.66	I	33904–56162
5	4499.44	I	18480–40698
5	4501.29	I	18356–40566
11	4504.90	I	25997–48189
5	4506.67	I	26636–48819
13	4512.15	I	11143–33299
8	4515.18	I	20281–42422
22	4517.13	I	18356–40488
5	4517.41	I	10768–32899
2.0	4518.44	I	20158–42282
5	4522.19	I	20130–42237
22	4524.34	I	11859–33955
8	4526.37	I	18480–40566
3 h	4528.62	I	27093–49169
11	4529.40	I	20350–42422
4	4535.38	I	20130–42173
38	4536.80	I	28241–50277
4	4541.56	I	
5	4553.32	I	21343–43299
2.5	4553.80	I	25456–47409
10	4558.11	I	10966–32899
2.5	4558.74	I	20158–42088
8	4560.13	I	23534–45458
8	4567.68	I	20350–42237
2.0	4569.02	I	23668–45548
5	4570.13	I	20281–42156
4	4574.48	I	25639–47493
	4574.61	I	21343–43197

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
20		4576.50	I	11454–33299
2.5		4577.78	I	18229–40068
2.5		4582.35	I	31510–53327
2.5		4582.50	I	21154–42970
2.5		4586.06	I	25906–47705
2.5		4586.57	I	22244–44041
2.0		4586.79	I	
2.5	h	4590.38	I	
4		4592.21	I	26639–48409
13		4595.16	I	11143–32899
2.5		4597.88	I	30113–51856
2.0		4598.25	I	27867–49608
4		4599.16	I	20350–42088
2.5		4608.71	I	20158–41850
28		4609.88	I	18229–39916
4		4611.15	I	18356–40037
2.5		4616.62	I	25517–47172
2.5		4617.95	I	22876–44525
8		4621.38	I	18356–39989
2.5		4623.46	I	25549–47172
2.5		4624.24	I	29171–50790
36		4626.47	I	12346–33955
8		4627.48	I	18356–39960
4		4630.02	I	18229–39821
3.5		4633.10	I	28274–49852
2.5		4642.70	I	25639–47172
6		4647.81	I	18480–39989
2.5		4649.12	I	25906–47409
5		4651.05	I	29781–51276
6		4661.93	I	11454–32899
17		4662.76	I	11859–33299
10		4671.90	I	21343–42742
2.5		4683.83	I	25517–46861
2.5		4685.81	I	27727–49062
2.0		4686.10	I	28274–49608
10		4688.22	I	28241–49565
3.0		4690.86	I	25549–46861
3.0		4693.93	I	
2.5		4696.51	I	20951–42237
4		4700.49	I	28837–50105
6		4706.06	I	23516–44760
50		4707.26	I	20158–41396
12		4708.22	I	18229–39463
2.5		4714.51	I	20951–42156
17		4717.92	I	20158–41348
3.0		4718.88	I	28667–49852
2.0		4723.06	I	32688–53855
1.6		4725.34	I	27766–48922
8		4729.14	I	20948–42088
55		4731.44	I	21154–42283
8		4750.39	I	20350–41396
3.5		4758.50	I	29781–50790
60		4760.19	I	21343–42345
6		4764.42	I	18480–39463
6		4773.44	I	20281–41224
3.0		4774.22	I	21343–42283
5		4775.66	I	21154–42088
12		4776.34	I	18229–39160
4		4782.94	I	20130–41032
			I	20948–41850
7		4785.12	I	18229–39122
3.0		4786.46	I	10768–31655
1.6		4788.18	I	18480–39358
5		4792.74	I	20948–41807
5		4793.41	I	20951–41807
1.6		4793.82	I	27384–48238
8		4796.52	I	21343–42186
1.4		4804.91	I	20158–40964
2.5		4805.58	I	18356–39160
2.5		4808.09	I	23668–44461
7		4811.06	I	30496–51276
1.4		4814.47	I	10768–31533
2.0		4817.70	I	20281–41032
32		4819.25	I	21343–42088
1.4		4822.42	I	20281–41012
2.0		4828.47	I	
32		4830.51	I	21154–41850
3.0		4832.92	I	20158–40844
2.0		4833.96	I	20350–41032
1.2		4838.11	I	24096–44760
1.4		4839.59	I	
1.6		4845.17	I	27766–48399
3.5		4858.22	I	28241–48819
2.0		4860.05	I	
28		4868.00	I	20948–41484
4		4869.20	I	10768–31300
1.8		4878.37	I	20350–40844
2.0		4886.47	I	23516–43975
1.6		4889.22	I	20951–41398
1.6		4897.26	I	25456–45870
5		4903.81	I	10768–31155
2.0		4907.43	I	31485–51856
1.6		4909.19	I	24096–44461
1.4		4924.78	I	30502–50802
2.5		4926.19	I	24466–44760
2.5		4926.43	I	18229–38522
5		4933.10	I	12346–32612
5		4941.66	I	25906–46136
7		4950.62	I	18229–38423
9		4957.54	I	18356–38522

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.6	4964.19	I	25997–46136
2.5	4964.41	I	20350–40488
1.4	4973.36	I	20930–41032
13	4979.12	I	10768–30847
1.6	4985.56	I	21343–41395
1.4	4995.32	I	23516–43530
7	4999.91	I	24466–44461
1.2	5010.81	I	26639–46590
11	5014.60	I	24823–44760
1.6	5016.78	I	27384–47311
1.2	5019.85	I	25795–45710
5	5029.00	I	24096–43975
4	5030.78	I	25997–45870
1.4	5038.91	I	25795–45635
1.6	5046.52	I	21154–40964
6	5047.71	I	20930–40736
3.0	5055.00	I	12346–32123
2.0	5058.01	I	27727–47492
12	5059.88	I	20157–39916
2.0	5062.52	I	20951–40699
1.8	5064.64	I	18229–37968
2.0	5079.87	I	26189–45870
6	5080.02	I	20281–39960
2.0	5081.26	I	11859–31533
2.5	5090.97	I	25997–45635
2.0	5091.34	I	20930–40566
2.0	5092.16	I	
2.5	5095.89	I	20948–40566
6	5096.65	I	20951–40566
8	5097.52	I	18356–37968
2	5098.03	I	20350–39960
8	5109.71	I	20350–39916
5	5114.97	I	18356–37902
2.0	5116.97	I	20951–40488
1.8	5123.83	I	27415–46926
9	5145.38	I	20608–40037
7	5147.39	I	18480–37902
5	5163.19	I	31913–51276
6	5167.76	I	21619–40964
10 d	5171.08	I	25614–44947
	5171.25	I	20130–39463
14 h	5172.94	I	25614–44941
10 h	5174.18	I	25614–44936
2.5	5191.44	I	31533–50790
7	5200.17	I	21619–40844
3.0	5200.74	I	18356–37579
1.6	5210.44	I	12346–31533
3.0	5211.86	I	20281–39463
5	5219.40	I	22244–41398
4	5231.06	I	27342–46453
1.6	5232.36	I	20930–40037
6	5234.26	I	18480–37579
28 h	5238.20	I	25872–44957
14 h	5240.88	I	25872–44947
7 h	5242.81	I	25872–44941
6	5245.51	I	20930–39989
9	5259.04	I	20951–39961
1.0	5260.17	I	30847–49852
4	5261.14	I	20158–39160
1.2	5268.95	I	
2.0	5271.80	I	20158–39122
2.0	5276.28	I	21619–40566
4	5279.65	I	16784–35719
13	5280.86	I	22876–41807
1.2	5283.84	I	26636–45556
3.5	5292.08	I	16828–35719
2.0	5293.46	I	18480–37366
3.5	5295.47	I	20281–39160
1.0	5302.35	I	25906–44760
1.2	5306.26	I	20281–39122
3.5	5313.89	I	18480–37293
2.0	5315.04	I	20350–39160
1.2	5319.89	I	31485–50277
1.2	5324.47	I	26639–45415
2.0	5327.06	I	23516–42283
1.0	5334.79	I	23668–42408
1.0	5337.20	I	24466–43197
1.0	5349.79	I	
1.2	5352.35	I	27774–46453
5	5354.88	I	23516–42186
2.0	5355.51	I	32123–50790
4	5356.48	I	32612–51276
34 hl	5360.56	I	26321–44970
7 hl	5364.28	I	26321–44957
2.0 hl	5367.11	I	26321–44947
2.0	5372.40	I	22876–41484
1.6	5388.69	I	31300–49852
4	5394.52	I	20930–39463
2.0	5397.38	I	22876–41398
3.0	5400.47	I	20951–39463
2.0	5405.79	I	27342–45836
2.0	5406.39	I	22244–40736
1.0	5414.67	I	
2.5	5417.38	I	22244–40699
1.4	5426.89	I	16748–35169
0.7	5427.55	I	23668–42088
1.0	5431.02	I	20951–39359
3.5	5435.68	I	20130–38522
4	5437.75	I	16785–35169
0.9	5439.71	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.5		5450.51	I	21619–39961
0.9		5453.03	I	23516–41850
2.0		5456.46	I	22244–40566
1.6		5460.53	I	31300–49608
1.4		5465.57	I	
0.8		5473.37	I	20157–38423
2.0		5475.90	I	
0.8		5488.67	I	27342–45556
2.0		5490.28	I	20951–39160
1.2		5492.17	I	21619–39821
1.6	h	5493.80	I	31655–49852
0.8	h	5496.94	I	24096–42283
1.6		5498.49	I	23668–41850
3.0		5501.54	I	20350–38522
1.4		5501.87	I	20951–39122
1.6	h	5503.54	I	
480		5506.49	I	10768–28924
0.7		5511.49	I	23668–41807
1.4		5520.04	I	31485–49596
1.6		5520.64	I	27727–45836
0.8		5521.17	I	
2.5		5526.52	I	24096–42186
2.5		5526.97	I	22876–40964
320		5533.05	I	10768–28837
2.5		5539.41	I	16692–34740
0.8		5541.65	I	25906–43946
3.0		5543.12	I	20948–38983
2.5		5544.49	I	27384–45415
0.6		5552.19	I	21154–39160
3.5		5556.28	I	16748–34740
1.6		5556.72	I	24096–42088
0.7		5562.49	I	
1.2		5564.05	I	21154–39121
2.5		5568.62	I	22876–40829
1.6		5569.48	I	23534–41484
150		5570.45	I	10768–28715
2.0		5575.19	I	19970–37902
1.2		5591.58	I	24466–42345
0.6		5596.32	I	23534–41398
0.5		5598.47	I	34810–52667
0.9		5601.05	I	33904–51753
2.5		5602.76	I	25456–43299
1.4		5608.62	I	26636–44461
1.4		5609.23	I	26189–44012
6		5610.93	I	24466–42283
1.4		5613.07	I	20158–37968
1.2		5618.45	I	16641–34435
0.6		5618.77	I	22244–40037
1.4		5619.38	I	27766–45556
20		5632.47	I	10966–28715
3.0		5634.86	I	16693–34435
14		5650.13	I	11143–28837
0.7		5651.87	I	30160–47848
0.7		5664.34	I	29842–47492
		5664.38	I	27766–45415
0.8		5667.30	I	27774–45415
0.6		5672.07	I	35042–52667
1.4		5673.63	I	20281–37902
3.5		5674.47	I	20350–37968
2.5		5677.89	I	16641–34248
2.0		5682.89	I	20930–38522
0.6		5687.64	I	22244–39821
28		5689.14	I	11143–28715
0.6		5694.39	I	23668–41224
0.8		5696.03	I	30160–47711
0.7		5698.27	I	29642–47186
1.4		5699.28	I	21619–39160
0.7		5702.11	I	25997–43530
5		5705.72	I	24823–42345
1.4		5711.80	I	21619–39122
13		5722.74	I	11454–28924
0.7		5723.11	I	29642–47110
1.4		5728.77	I	25795–43246
1.6	d	5729.45	I	20130–37579
		5729.59	I	
0.9		5729.87	I	23516–40964
1.0		5734.06	I	12346–29781
0.7		5739.66	I	27342–44760
0.9		5741.71	I	31510–48922
1.0		5747.67	I	25906–43299
38		5751.40	I	11454–28837
0.6		5769.75	I	23517–40844
0.6		5771.05	I	19970–37293
1.4		5774.55	I	11858–29171
0.6		5778.19	I	25997–43299
2.5		5779.36	I	20281–37579
0.6		5780.11	I	23668–40964
1.4	h	5783.33	I	25456–42742
0.6		5785.69	I	
32		5791.85	I	11454–28715
1.4	h	5795.77	I	34740–51990
1.6		5800.46	I	20130–37366
2.0		5802.67	I	20350–37579
0.5		5803.98	I	25821–43046
0.6		5806.19	I	22244–39463
1.0		5806.69	I	26759–43975
0.6		5808.23	I	11454–28667
0.5		5809.03	I	34435–51644
0.6		5813.86	I	39521–56717
1.0		5815.52	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.6		5815.74	I	29982–47172
0.6		5820.69	I	23668–40844
1.4		5825.20	I	20130–37293
1.4		5835.59	I	11143–28274
1.2		5839.99	I	27342–44461
1.2	h	5848.86	I	28715–45806
3.5	h	5849.73	I	28715–45805
3.0	h	5851.52	I	28715–45800
32		5858.27	I	11859–28924
1.2		5861.38	I	26189–43246
0.8		5868.76	I	25707–42742
3.0		5869.33	I	27727–44760
1.6		5876.59	I	20281–37293
0.6		5881.53	I	20130–37128
0.6		5882.72	I	27766–44760
50		5888.33	I	11859–28837
0.7	h	5891.56	I	28837–45806
1.4		5892.29	I	25456–42422
3.0	h	5893.38	I	28837–45800
1.2		5898.78	I	
		5898.82	I	27093–44041
2.5		5901.47	I	18229–35169
0.5		5912.12	I	26336–43246
0.6	h	5923.79	I	28924–45800
2.5	h	5926.36	I	28924–45793
10	h	5928.88	I	28924–45786
1.0		5937.91	I	25906–42742
0.6		5965.57	I	
0.5		5968.48	I	27774–44525
0.9		5974.26	I	27727–44461
1.0		5982.93	I	26336–43046
2.5		5988.17	I	27767–44461
1.0		5989.47	I	33904–50596
0.6		5990.01	I	
0.6		5991.35	I	27774–44461
2.0		6025.49	I	27384–43976
1.0		6027.27	I	22876–39463
80		6030.66	I	12346–28924
1.2		6047.83	I	25707–42237
1.2		6054.81	I	18229–34740
1.2		6079.58	I	23516–39960
0.6		6081.27	I	25906–42345
2.5		6101.87	I	18356–34740
0.6		6130.63	I	
0.6		6197.66	I	32688–48819
1.2		6217.89	I	18356–34435
0.6		6264.27	I	33904–49864
1.0		6265.88	I	18480–34435
0.9		6290.74	I	18356–34248
0.8		6301.75	I	24096–39961
0.7		6323.54	I	30160–45969
2.5		6357.22	I	18229–33955
1.0		6389.11	I	26636–42283
0.7		6391.12	I	
2.0		6401.07	I	
1.6		6409.11	I	18356–33955
0.6		6412.39	I	
6		6424.37	I	20158–35719
1.2		6446.34	I	25456–40964
1.2		6471.20	I	23534–38983
1.2		6473.99	I	25906–41348
0.6		6493.13	I	30160–45556
1.4		6519.84	I	30502–45836
0.4		6590.90	I	26639–41807
0.9	h	6611.20	I	25707–40829
14		6619.13	I	10768–25872
0.6		6624.57	I	26759–41850
0.3		6637.16	I	26336–41398
4		6650.38	I	25456–40488
1.0		6659.68	I	20158–35169
0.3	h	6678.89	I	25872–40840
0.4		6687.87	I	26450–41398
1.4		6690.47	I	18356–33299
0.3		6691.08	I	27342–42283
0.7		6728.04	I	25707–40566
8		6733.98	I	10768–25614
1.6		6746.08	I	18480–33299
4		6746.27	I	20350–35169
2.5		6753.97	I	27384–42186
1.0		6763.50	I	25707–40488
0.3		6764.92	I	29982–44760
0.6		6787.98	I	26284–41012
0.6		6788.94	I	26759–41484
0.8	h	6799.88	I	26759–41398
0.8		6802.62	I	26336–41032
0.8		6812.03	I	26336–41012
1.0		6825.63	I	30113–44760
1.4	d	6828.87	I	26759–41398
		6829.05	I	26189–40829
3.0		6838.88	I	27727–42345
1.2		6848.92	I	26415–41012
1.6		6886.28	I	27766–42283
1.2		6892.36	I	25456–39960
0.8		6898.01	I	31300–45793
0.8		6898.98	I	25997–40488
1.0		6908.20	I	11143–25614
2.5		6914.01	I	20281–28924
0.7		6931.40	I	20350–34774
1.0		6934.10	I	11454–25872
0.4		6946.75	I	27093–41484

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.8		6947.39	I	20350–34740
0.6		6953.78	I	26189–40566
0.8		6960.64	I	26336–40698
0.6		6961.48	I	25707–40068
1.2		6978.71	I	26639–40964
0.6		6980.37	I	27766–42088
0.5		6984.67	I	27774–42087
2.0		6988.94	I	20130–34435
0.7		6991.69	I	26189–40488
0.9		6999.13	I	26415–40699
0.6		6999.88	I	25707–39989
1.2		7001.60	I	19970–34284
0.8		7016.44	I	26450–40698
0.6		7018.43	I	
0.6		7025.32	I	26336–40566
2.0		7037.98	I	26639–40844
0.8	h	7045.29	I	26639–40829
2.0		7060.21	I	11454–25614
1.2		7063.34	I	20281–34435
1.2		7081.22	I	20130–34248
0.8		7102.65	I	27774–41850
10		7109.87	I	25614–39675
0.7		7122.65	I	27363–41398
2.5		7134.08	I	11858–25872
0.7		7240.46	I	26759–40566
14		7242.50	I	25872–39675
3.5		7245.85	I	20158–33950
2.0		7267.62	I	11858–25614
0.6		7281.53	I	25906–39635
1.6		7300.19	I	
0.7		7322.25	I	26336–39989
0.7		7322.79	I	
0.7		7333.71	I	26189–39821
1.2		7348.49	I	20350–33955
0.5		7360.38	I	25707–39290
1.2		7361.65	I	27384–40964
0.9	h	7364.41	I	
0.7		7365.25	I	
3.5		7391.36	I	12346–25872
0.9		7434.10	I	25997–39445
1.2		7447.34	I	31533–44957
1.2	h	7452.85	I	25707–39122
0.6		7475.43	I	27363–40736
13		7485.74	I	26320–39675
0.5		7501.62	I	25795–39122
1.2		7504.47	I	26639–39960
0.6		7571.53	I	27363–40566
1.0		7572.64	I	26759–39960
0.6		7579.58	I	27774–40964
0.6		7591.66	I	20130–33299
1.0	h	7595.16	I	25997–39160
1.0		7601.84	I	27415–40566
0.6		7649.52	I	27774–40844
0.5		7653.26	I	26759–39821
1.6	h	7656.76	I	31913–44970
1.2		7679.49	I	20281–33299
0.8		7709.54	I	25456–38423
2.5		7720.77	I	20350–33299
0.8		7723.63	I	27093–40037
0.8		7732.49	I	19970–32899
0.4		7752.34	I	27093–39989
1.6		7829.65	I	20130–32899
1.4		7854.45	I	27093–39821
0.7		7887.74	I	27363–40037
0.5		7917.62	I	27363–39989
1.0		7923.15	I	20281–32899
0.8		7968.85	I	27415–39960
0.4		7984.35	I	26639–39160
1.4		7986.60	I	25906–38423
0.6		8027.32	I	20158–32612
0.4		8058.22	I	45786–58193
0.5		8104.67	I	39521–51856
0.8		8153.45	I	25707–37968
0.4	h	8192.60	I	23516–35719
2.0	h	8245.06	I	28715–40840
3.5	h	8328.44	I	28836–40840
0.8		8351.15	I	25997–37968
4	h	8389.32	I	28924–40840
4	h	8483.39	I	25795–37579

NEODYMIUM

Nd, $Z=60$, $M=144.27$, Ratio $\frac{\text{Nd}}{\text{Cu}}=2.270$

Nd I Normal state of valence electrons $4f^4 6s^2\ {}^5I_4 = 0$. I.P. ≈ 44000K
Nd II Normal state of valence electrons $4f^4 6s^1\ {}^6I_{3\frac{1}{2}} = 0$.

References

Wavelengths:

Below 5000 A:

A. S. King, Astrophys. J. **78,** 9 (1933).

Supplemented by A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945).

F. Exner and E. Haschek, Spektren der Elemente bei Normalen Druck (Franz Deuticke, Leipzig and Vienna, 1911).

From 5000 to 6900 A:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945).

Supplemented by C. C. Kiess, Sci. Papers BS **18,** 201 (1922).

Above 6900 A:

C. C. Kiess, Sci. Papers BS **18,** 201 (1922).

Supplemented by G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

W. Albertson, G. R. Harrison, and J. R. McNally, Phys. Rev. **61,** 167 (1942).

Classification:

Nd I, F. W. Paul, Phys. Rev. **49,** 156 (1936) (Spectrum assignment only).
P. F. A. Klinkenberg, Thesis, Univ. of Amsterdam (1955).

Nd I and Nd II, A. S. King, Astrophys. J. **78,** 9 (1933) (Spectrum assignment only).

Nd II, W. E. Albertson, G. R. Harrison, and J. R. McNally, Phys. Rev. **61,** 167 (1942).

Relative intensity of neodymium lines observed in an arc of copper containing 0.1 atomic percent of neodymium

Strong lines of neodymium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
320	4303. 58	II	0–23230	$4f^4 6s\ a\ {}^6I_{3\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{4\frac{1}{2}}$
280	4061. 09	II	3802–28419	$4f^4 6s\ a\ {}^6I_{7\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{8\frac{1}{2}}$
220 d	3863. 33	II	0–25877	$4f^4 6s\ a\ {}^6I_{3\frac{1}{2}} - 17^{\circ}_{4\frac{1}{2}}$
	3863. 40	II	0–25876	$4f^4 6s\ a\ {}^6I_{3\frac{1}{2}} - 4f^4 6p\ y\ {}^6H^{\circ}_{2\frac{1}{2}}$
220	4012. 25	II	5086–30002	$4f^4 6s\ a\ {}^6I_{8\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{9\frac{1}{2}}$
180	4040. 80	II	1470–26211	$4f^4 6s\ a\ {}^6I_{5\frac{1}{2}} - 18^{\circ}_{6\frac{1}{2}}$
180	4156. 08	II	1470–25524	$4f^4 6s\ a\ {}^6I_{5\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{5\frac{1}{2}}$
150	3805. 36	II		
150	4109. 46	II	2585–26913	$4f^4 6s\ a\ {}^6I_{6\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{7\frac{1}{2}}$
140	3784. 25	II		
140 d	3851. 66	II		
	3851. 74	II	1470–27425	$4f^4 6s\ a\ {}^6I_{5\frac{1}{2}} - 23^{\circ}_{4\frac{1}{2}}$
140	4177. 32	II	513–24445	$4f^4 6s\ a\ {}^6I_{4\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{5\frac{1}{2}}$
120	3900. 21	II		
120	3911. 16	II		
120	3941. 51	II	513–25877	$4f^4 6s\ a\ {}^6I_{4\frac{1}{2}} - 17^{\circ}_{4\frac{1}{2}}$
120	3951. 16	II	1470–26772	$4f^4 6s\ a\ {}^6I_{5\frac{1}{2}} - 21^{\circ}_{5\frac{1}{2}}$
120	4247. 38	II	0–23537	$4f^4 6s\ a\ {}^6I_{3\frac{1}{2}} - 4f^4 6p\ z\ {}^6I^{\circ}_{4\frac{1}{2}}$
100	3838. 98	II	0–26041	$4f^4 6s\ a\ {}^6I_{3\frac{1}{2}} - 26041^{\circ}_{3\frac{1}{2}}$
100 d	3848. 24	II	1470–27449	$4f^4 6s\ a\ {}^6I_{5\frac{1}{2}} - 4f^4 6p\ y\ {}^6I^{\circ}_{6\frac{1}{2}}$
	3848. 31	II		
100	3905. 89	II		
90	3848. 52	II		
85	3990. 10	II	3802–28857	$4f^4 6s\ a\ {}^6I_{7\frac{1}{2}} - 4f^4 6p\ y\ {}^6I^{\circ}_{7\frac{1}{2}}$
80	3775. 50	II		
80	3963. 12	II	3802–29027	$4f^4 6s\ a\ {}^6I_{7\frac{1}{2}} - 29027^{\circ}_{8\frac{1}{2}}$
80	4109. 08	II	513–24843	$4f^4 6s\ a\ {}^6I_{4\frac{1}{2}} - 12^{\circ}_{5\frac{1}{2}}$
80	4451. 57	II	3067–25524	$4f^4 6s\ a\ {}^4I_{5\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{6\frac{1}{2}}$
80	5249. 59	II	7869–26913	$4f^4 5d\ a\ {}^6L_{8\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{7\frac{1}{2}}$
75	3889. 93	II		
75	3890. 58	II		
75	3890. 94	II		
75	3901. 84	II		
75	4232. 38	II	513–24134	$4f^4 6s\ a\ {}^6I_{4\frac{1}{2}} - 4f^4 6p\ z\ {}^6I^{\circ}_{5\frac{1}{2}}$
75	5130. 60	II	10517–30002	$4f^4 5d\ a\ {}^6L_{10\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{9\frac{1}{2}}$
75	5293. 17	II	6637–25524	$4f^4 5d\ a\ {}^6L_{7\frac{1}{2}} - 4f^4 6p\ z\ {}^6K^{\circ}_{8\frac{1}{2}}$

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		2702.46		
5		2704.54		
5		2764.98	I	
4		2785.79	I	
3.0		2863.95		
3.0		2921.26		
3.5		2962.88	II	
4		2963.58	II	
5		2993.20	II	
2.5		2994.73		
6		3007.97	II	
6		3014.19	II	
6		3018.35	II	
5		3026.47		
3.0		3038.98	II	
3.0		3043.29		
3.0		3051.11	II	
5		3052.15	II	
9		3056.71	II	
8		3069.73	II	
4	d	3071.43	II	
		3071.50	II	
10		3075.38	II	
6		3079.38	II	
6		3080.94	II	
6		3092.73		
15		3092.92	II	
9		3098.48	II	
3.5		3099.52	II	
8		3105.43	II	
6		3106.18	II	
4		3108.01	II	
16		3115.18	II	
12		3116.15	II	
3.0		3119.75	II	
10		3123.06	II	
12		3124.58	II	
17		3133.60	II	
13		3134.90	II	
6		3137.24	II	
10		3141.46	II	
10		3142.44	II	
6		3144.55	II	
6		3144.82	II	
6		3148.51	II	
6		3149.29	II	
6		3149.51	II	
6		3162.62	II	
6		3175.99	II	
3.0		3181.54	II	
3.0		3188.73	II	
3.0		3200.62	II	
9		3203.47	II	
5		3211.00	II	
6		3217.12	II	
3.0		3222.62	I	
3.0		3228.04	II	
3.5		3234.62		
2.5		3237.91	II	
6		3254.08	II	
3.0		3256.91	II	
13		3259.24	II	
6		3260.66	II	
13		3265.12	II	
3.0		3265.38	II	
10		3267.25	II	
6		3273.18	II	
19		3275.22	II	
3.0		3281.49		
3.0		3282.78	II	0–30453
17		3285.10	II	
6		3286.62	II	
3.0		3289.52		
6		3290.65	II	
4		3293.84	II	
4		3294.68	II	
4		3298.61		
18		3300.16	II	
8		3300.91	II	
4		3304.66	II	
5		3305.33		
6		3310.38	II	
8		3310.91	II	
12		3312.75	II	
6		3313.16	II	
6		3316.02	II	
12		3325.90	II	
4	h	3326.26		
3		3327.69		
24		3328.28	II	0–30037
15		3331.57	II	
17		3334.48	II	1470–31451
17		3339.07	II	513–30453
5		3345.71		
5		3347.56	II	
6		3347.89		
10		3348.17	II	
19		3353.59	II	
5		3354.60	II	1650–31451
12		3355.93	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	3356.55		
10	3359.76	II	
16	3364.96	II	
5	3375.23	II	
4	3386.29		
6	3386.52	II	
6	3388.03	II	
4	3389.33		
4	3392.31		
17	3393.63	II	
9	3410.25	II	
4	3412.39		
3	3415.55		
11	3425.22	II	
10	3428.93	II	
6	3432.99		
3	3435.43		
6	3443.32	II	
3	3454.38	II	
3	3461.83		
7	3468.42	II	
7	3470.86	II	1650–30453
9	3481.44	II	
7 h	3484.88	I	
7	3510.70	II	
7	3522.05	II	3067–31451
12	3527.53	II	
5 h	3531.71	II	
10	3533.59	II	
11	3541.60	II	
17	3543.35	II	
4	3553.99		
12	3555.77	II	
24	3560.75	II	
4	3561.61	II	
20	3568.87	II	
4	3576.16		
11	3582.63		
6	3582.88		
5	3586.82		
28	3587.51	II	
7	3588.23		
5	3592.09	II	
18	3592.59	II	
7	3595.41		
7	3595.91		
20	3598.02	II	
4	3600.12		
18	3600.91	II	
4	3606.30		
7	3607.72		
19	3609.79	II	
5	3612.75		
22	3615.82	II	1650–29298
18	3618.96	II	
11	3624.65	II	
7	3626.18		
7	3627.41		
5	3629.59		
10	3629.94	II	
18	3631.02	II	
4	3633.47		
20	3634.30	II	
10	3634.87	II	
4	3635.11		
14	3637.00	II	
14	3637.23	II	
11	3637.79	II	
4	3638.70		
14	3640.24	II	
11	3641.50	II	
4	3642.46		
11	3643.63	II	
4	3645.63		
14	3645.78	II	
7	3647.93		
20	3648.20	II	
14	3649.46		
14	3650.42	II	
3	3650.69		
11	3651.59		
7	3652.45		
24	3653.15	II	
14	3654.16		
7	3655.03	II	
7	3659.94	II	
7	3660.97		
28	3662.26	II	
5	3663.03		
32	3665.18	II	
9	3668.79		
11	3669.45		
5	3669.75		
9	3670.92	I	
7	3671.66		
32	3672.36	II	
34	3673.54	II	
6	3674.65		
5	3677.60		
14	3678.18	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		3678.88		
5		3684.29		
70		3685.80	II	
7		3686.07		
26		3687.30	II	
24		3689.69	II	
18		3694.81	II	
7		3697.17		
24		3697.56	II	
6		3701.75		
14		3702.84		
7		3703.88		
14		3704.95		
12		3712.81		
28		3713.70	II	
22		3714.20	II	
38	d	3714.73	II	
		3714.81	II	513–27425
15		3715.04	II	
12		3715.39	II	
28		3715.68	II	
5		3716.58		
24		3718.54		
5		3719.21		
8		3720.54		
24		3721.35	II	
13		3722.42		
46		3723.50	II	
24		3724.87	II	
15		3726.90		
42		3728.13	II	
28		3730.58	II	
10		3731.22	II	
5		3731.63		
6		3732.02		
16		3732.78	II	
60	d	3735.54	II	
		3735.60	II	
26		3737.10		
60		3738.06	II	
16		3741.42	II	
7		3742.59		
8		3744.24		
9		3749.10		
12		3749.85	II	
19		3750.31		
6		3750.74		
7		3752.29	I	
34		3752.49	II	
22		3752.67	II	0–26640
15		3754.83		
22		3755.60	II	
6		3756.83		
30		3757.82	II	
55		3758.95	II	
18		3759.79	II	
8		3761.58		
5		3762.09		
55		3763.47	II	
7		3765.34	II	
7		3765.92		
18		3766.59		
6		3768.71		
30		3769.65	II	1650–28170
8		3772.40	I	
8		3772.93		
11		3773.18		
6		3774.93		
80		3775.50	II	
15		3776.34		
8		3777.00		
42		3779.47	II	
34		3780.40	II	3802–30247
30		3781.32	II	
18		3783.78		
140		3784.25	II	
16		3784.73		
11		3784.85	II	
9		3785.11	II	
7		3785.40		
7		3788.97		
20		3791.50	II	
9		3792.81		
20		3795.45	II	
7		3796.49		
10		3799.24		
14		3799.55		
22		3801.12		
12		3801.38	II	
20		3802.30		
70		3803.47	II	
12		3804.10		
150		3805.36	II	
20		3805.55	II	
28		3807.23	II	513–26772
8		3808.25		
32		3808.77	II	
26		3809.06	II	
34		3810.49	II	
14		3811.06	II	3067–29298

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
16		3811.77	II	0–26227
12		3812.53		
42		3814.73	II	
11		3817.38	II	
6		3818.84		
14		3819.70		
24		3822.47	II	
5		3823.26		
70		3826.42	II	513–26640
14		3828.00	II	
32		3828.85	II	
26		3829.16	II	
30		3830.47	II	
6		3832.76		
44		3836.54	II	
20		3837.91	II	
100		3838.98	II	0–26041
20		3839.51	II	
24	h	3841.95		
6		3844.18		
6		3845.74		
11		3846.71		
6		3846.97		
100	d	3848.24	II	1470–27449
		3848.31	II	
90		3848.52	II	
28		3850.22	II	
140	d	3851.66	II	
		3851.74	II	1470–27425
20		3858.55		
7		3859.42		
16		3860.94		
18		3862.52	II	
220	d	3863.33	II	0–25877
		3863.40	II	0–25876
10		3865.98	II	
14		3866.52	II	
13		3866.81	II	
50		3869.07	II	1470–27309
14		3875.74	II	
28		3875.87	II	
65		3878.58	II	
60		3879.55	II	
46		3880.38	II	
70		3880.78	II	513–26274
12		3881.59		
6		3883.76		
6		3884.08		
6		3884.74		
5	h	3886.09	I	
32		3887.87	II	513–26227
22	h	3889.66	II	
75		3889.93	II	
10		3890.22	II	
75		3890.58	II	
75		3890.94	II	
34		3891.51	II	
28		3892.06	II	
48		3894.63	II	513–26182
8		3895.37	II	
5		3895.91		
16		3896.13	II	
26		3897.63	II	
120		3900.21	II	
75		3901.84	II	
8		3902.51	I	
7		3903.51		
6		3905.56		
100		3905.89	II	
8		3906.09	II	
6		3907.50		
12		3907.64		
30		3907.84	II	
120		3911.16	II	
50		3912.23	II	
20		3913.69	II	
26		3915.13	II	
36		3915.95	II	
20		3917.65		
5		3918.90		
13		3919.92	II	
65		3920.96	II	
8		3924.49	II	
5		3924.98		
5		3925.63		
4		3926.62	II	
30		3927.10	II	
12		3929.26	II	
9		3934.09	II	
36		3934.82	II	
24		3936.11	II	
8		3937.00	I	
4		3937.57	II	0–25389
30		3938.86	II	
8		3939.52	II	
120		3941.51	II	513–25877
5		3942.12	II	
9		3942.62	II	
4		3946.81		
6		3947.61	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	3948.32	II	
4	3950.42		
120	3951.16	II	1470–26772
48	3952.20	II	0–25295
19	3952.87	II	
5	3953.40	II	
19	3953.52	II	
6	3954.41		
3.5	3955.09		
7	3955.95	II	
14	3957.45	II	
35	3958.00	II	513–25772
30	3962.21	II	
80	3963.12	II	3802–29027
16	3963.90	II	
7	3967.06	II	
9	3967.75	II	
10	3968.88		
7	3969.67		
65	3973.30	II	5086–30247
44	3973.69	II	2585–27744
9	3975.20		
7	3976.09	I	
44	3976.85	II	0–25138
6	3977.33		
3.5	3977.99		
4	3979.03		
44	3979.49	II	1650–26772
3.5	3980.98		
8	3981.24	II	
19	3982.36	II	3067–28170
5	3983.41	II	
4	3983.58		
28	3986.25	II	
3.5	3987.25		
3.0	3987.81	II	
4	3988.82	II	
85	3990.10	II	3802–28857
60	3991.74	II	0–25045
5	3992.16		
5	3992.28		
10	3992.60	II	
65	3994.72	II	
8	3995.26	II	
4	3997.44	II	
4	3997.78		
10	3997.93		
5	3998.16		
10	3998.69		
24	4000.50	II	1650–26640
32	4004.02	II	
6	4004.26		
24	4007.43	II	
5	4008.75		
6	4010.45	II	
9	4011.09	II	
220	4012.25	II	5086–30002
32	4012.70	II	
8 h	4013.25	II	
4	4015.56		
22	4018.81	II	513–25389
7	4019.79	II	
5	4020.05	II	
60	4020.87	II	2585–27449
60	4021.34	II	2585–27446
60	4021.78	II	
70	4023.03	II	
20	4024.78	II	513–25352
24	4030.47	II	1470–26274
70	4031.82	II	
7	4033.50		
6	4033.90		
4	4034.01	II	513–25295
16	4038.12	II	1470–26227
180	4040.80	II	1470–26211
12	4041.06	II	
5	4042.51		
5	4043.05		
24	4043.59	II	2585–27309
5	4044.35	II	
24	4048.81	II	
50	4051.15	II	3067–27744
5	4054.86	II	
5	4056.83	II	
50	4059.96	II	1650–26274
280	4061.09	II	3802–28419
5	4067.73	I	
65	4069.28	II	513–25081
6	4071.46	II	
8	4074.42	II	
42	4075.12	II	1650–26182
28	4075.28	II	513–25045
14	4077.62		
28	4080.23	II	513–25014
8	4082.55	II	
14	4085.82	II	0–24468
4	4086.82		
5	4088.56	II	
4	4089.12	II	
7	4089.68	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		4091.00	II	
8		4094.62	II	
5		4095.43	II	
16		4096.13	II	
6		4096.71	II	
13		4098.18	II	
6		4098.91	II	
11		4100.24	II	3067–27449
5		4101.45	II	
5		4102.53	II	
9		4104.23	II	
3.0		4104.54	II	
12		4106.59	II	4512–28857
7		4107.44	II	
7		4107.96	II	
80		4109.08	II	513–24843
150		4109.46	II	2585–26913
30		4110.48	II	0–24321
18	h	4113.83	II	1470–25772
4		4116.34		
2.0		4116.77	II	
5		4120.66	II	5986–30247
5		4121.94	II	
24		4123.88	II	3067–27309
3.0		4125.05	II	
5		4128.70	II	
3.0		4129.87	I	
3.0		4130.72	II	
5		4132.56	II	
28		4133.36	II	2585–26772
5		4134.72	II	
30		4135.33	II	
6		4136.76	II	
10		4144.56	II	1650–25772
8		4146.13	II	
10		4151.68	II	
6		4153.73	II	
180		4156.08	II	1470–25524
30		4156.26	II	
4		4157.58	II	
8		4159.57	II	
20		4160.57	II	
3.5		4164.41		
3.5		4164.85	I	
9		4165.04	II	
24		4168.00		
4		4168.76	II	
6		4170.46	II	
6		4170.76	II	
6		4173.38	II	513–24468
3.5		4174.46		
48		4175.61	II	5086–29027
140		4177.32	II	513–24445
10	d	4178.44	II	
		4178.53	II	
12		4178.64	II	
38		4179.59	II	1470–25389
5		4182.52	II	
4		4183.13	I	
15		4184.98	II	
5		4185.77		
8		4186.04	II	1470–25352
4		4187.11		
4		4188.26		
2		4195.03	II	
5		4198.17	II	
7		4199.11	II	513–24321
4		4200.04	II	
4	h	4203.43	II	
7		4205.25	II	
28		4205.60	II	5086–28857
28		4211.29	II	1650–25389
4		4212.75	II	
5		4213.07	II	
5		4213.22	II	
6		4214.22	II	
6		4214.60	II	
7		4217.28	II	3067–26772
4		4218.55	II	
4		4219.56	II	
17		4220.25	II	2585–26274
10	h	4221.14	I	
7		4223.21	II	
8		4224.84	II	
4		4226.99	II	
26		4227.73	II	3802–27449
11		4228.03	II	1650–25295
11		4228.20	II	3802–27446
6		4229.50	II	
75		4232.38	II	513–24134
6		4233.15		
15		4234.19	II	1470–25081
17	h	4235.24	II	
17		4239.84	II	
8		4241.21	II	
5		4244.56		
5		4244.96	II	
7		4246.88	II	513–24053
120		4247.38	II	0–23537
5		4248.15		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
50		4252.44	II	
7	h	4252.88		
6		4253.87	II	
17		4254.29		
4		4256.24	II	1650–25138
6		4256.47	I	
6		4256.82	II	
10		4257.79	II	
4		4259.62	II	
24		4261.84	II	
9		4262.24	II	
9		4263.44	II	
9	h	4263.91		
		4264.00		
20		4266.71	II	1650–25081
14		4270.56	II	0–23410
20		4272.79	II	0–23397
20		4275.09	II	
8		4277.29	II	1470–24843
4		4280.17		
28		4282.44	II	
14		4282.57	II	513–23857
42		4284.52	II	5086–28419
7		4290.96	II	
5	h	4294.19		
4		4297.36	II	
16		4297.80	II	
5		4299.71	II	
4		4301.22	I	2367–25609
320		4303.58	II	0–23230
20		4304.45	II	
4		4305.48	II	
7		4306.75	II	
12		4307.78	II	3067–26274
6		4310.51	II	1650–24843
5		4311.25	I	
5		4313.36	II	
10		4314.38	II	
28		4314.52	II	0–23171
65		4325.76	II	3802–26913
30		4327.93	II	
32		4338.70	II	5986–29027
8		4342.07	II	513–23537
4		4343.50	I	0–23016
5		4349.10		
4		4350.21	II	
40		4351.29	II	1470–24445
9		4356.02	II	
50		4358.17	II	2585–25524
5		4358.70	II	4512–27449
4		4359.25	II	4512–27446
4		4360.87	II	
3	h	4361.40		
7		4364.14	II	
14		4366.38	II	
20		4368.64	II	513–23397
3.5		4372.14	II	
3.5		4372.28	II	
3.5	h	4372.73	II	
28	d	4374.93	II	1470–24321
		4375.04	II	0–22851
3.0		4376.45	II	
3.5		4377.40	II	
7		4382.74	II	3067–25877
42		4385.66	II	1650–24445
15		4390.66	II	
4		4391.10	II	2585–25352
2.5		4392.12		
2.5		4394.18	II	
2.5		4395.50		
2.5		4395.89		
3.0		4398.03		
2.5		4399.58		
32		4400.83	II	513–23230
7		4407.08	II	
30		4411.06	II	1470–24134
8		4412.27	II	513–23171
4		4414.44	II	513–23160
8		4416.89	II	
3.0	d	4420.11	I	
2.5		4420.52		
2.0		4426.83	II	1470–24053
3.5		4432.30	II	
5		4439.00	II	
2.0		4444.29	II	
3.5		4444.99	I	0–22491
34		4446.39	II	1650–24134
80		4451.57	II	3067–25524
12		4451.99	II	0–22456
18		4456.40	II	5986–28419
10		4462.42	II	1650–24053
44		4462.99	II	4512–26913
6		4465.07	II	0–22390
7		4465.60	II	1470–23857
5		4467.85	II	
8		4469.26	II	
5		4470.97	II	5086–27446
5		4471.41	II	
2.5		4475.57	II	513–22851
1.8		4475.84	I	2367–24703

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	4477.46	II	
8	4477.88	I	
8	4480.97	I	1128–23438
4	4481.90	I	1128–23434
2.5	4485.95	II	3067–25352
5	4493.42	II	
2.5	4497.27	II	
2.5	4497.40	I	
5	4497.93	II	
24	4501.82	II	1650–23857
12	4506.59	II	513–22697
10	4513.34	II	
15	4516.36	II	
4	4522.84	II	
2.5	4523.58	II	
7	4527.25	I	5049–27131
4	4529.94	I	
20	4541.27	II	3067–25081
5	4542.06	I	0–22010
20	4542.61	II	
2.5	4544.26	II	
2.0	4545.33	II	
5	4548.24	I	3682–25662
2.5	4549.02	II	
2.0	4554.97	II	3067–25014
3	4555.14	II	
6	4556.14	II	513–22456
5	4556.74	II	1470–23410
10	4559.67	I	2367–24292
3.5	4560.42	I	
3.5	4561.18	II	
4	4561.86	I	
20	4563.22	II	
5	4567.61	II	1650–23537
12	4578.89	II	
12	4579.32	II	
2.5	4584.04	II	
6	4586.62	I	
3.5	4586.96	I	
5	4594.45	II	1650–23410
12	4597.02	II	1650–23397
6	4603.82	I	5049–26764
2.5	4607.38	II	4512–26211
6	4609.87	I	1128–22815
2.0	4612.47	II	513–22188
18	4621.94	I	2367–23996
5	4624.21	I	
5	4626.50	I	1128–22737
6	4627.98	I	2367–23968
3.5	4629.91	II	
3.5	4631.29	I	
3.0	4632.64	II	1650–23230
30	4634.24	I	0–21572
3.5	4637.20	I	0–21559
5	4638.72	II	
5	4639.14	I	1128–22678
20	4641.10	I	
15	4645.77	II	
12	4646.40	I	
18	4649.67	I	
3.5	4652.39	I	
12	4654.73	I	1128–22606
4 h	4664.45	II	
11	4670.56	II	
4	4671.10	I	1128–22530
2.0	4673.97	I	2367–23756
5	4675.52	I	3682–25064
14	4680.74	II	513–21871
26	4683.45	I	0–21346
9	4684.04	I	1128–22471
1.2	4688.55	I	
9	4690.35	I	0–21314
16	4696.44	I	3682–24968
11	4703.57	II	3067–24321
40	4706.54	II	0–21241
12	4706.96	I	1128–22367
16	4709.71	II	1470–22697
16	4715.59	II	1650–22851
5	4717.08	II	
20	4719.02	I	
16	4724.35	II	
2.5	4726.55	I	
12	4731.77	I	1128–22256
3.0	4734.90	I	
1.6	4736.20	II	
2.5	4749.03		
2.5	4749.56	II	
6	4749.75	I	3682–24730
4	4755.85	I	3682–24703
2.0	4759.10	I	
1.8	4760.45	I	1128–22129
4	4763.62	II	3067–24053
7	4763.87	II	1470–22456
6	4770.20	I	
2.0	4771.73		
1.6	4772.26	I	
3.5	4772.88	II	
3.5	4777.72	II	
1.2	4778.40	I	
10	4779.46	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4783.80	II	
3.5	4786.06	II	
1.8	4787.40	I	1128–22010
14	4789.41	II	
10	4797.15	II	4512–25352
5	4799.42	II	0–20830
3.5	4806.62	I	1128–21927
20	4811.34	II	513–21292
3.0	4817.17	II	
2.0	4818.96	II	
1.2	4819.64	II	
12	4820.34	II	1650–22390
1.2	4824.18	II	4512–25235
30	4825.48	II	1470–22188
2.0 d	4827.57	I	
	4827.74	I	
4	4828.58	II	
11	4832.28	II	
2.5	4835.66	I	2367–23040
6	4835.98	II	0–20673
5	4836.62	I	
9	4849.06	II	
7	4853.33	I	1128–21727
3.0	4855.31	I	1128–21718
24	4859.02	II	2585–23160
2.5	4859.58	I	
2.0	4861.77	I	
4	4864.78		
16	4866.74	I	0–20542
4	4867.84	II	1650–22188
4	4869.27	I	3682–24213
3.0	4871.44	I	
3.0	4874.37	I	
5 d	4875.73	I	
	4875.84	II	
2.0	4876.12	II	4512–25014
4	4879.79	I	
2.5	4882.88	II	
30	4883.81	I	
4	4885.01	I	
12	4889.10	II	
19	4890.70	II	
20	4891.07	I	
4	4893.23	I	1128–21559
24	4896.93	I	1128–21543
10	4901.53	I	
18	4901.84	I	
9	4902.03	II	513–20907
2.5	4907.26	I	2367–22739
2.5	4907.78	I	2367–22737
5	4910.05	I	0–20361
16	4913.41	I	
14	4914.37	II	3067–23410
28	4920.68	II	513–20830
3.0	4921.14	I	3682–23996
3.0	4922.45	I	
40	4924.53	I	0–20301
3.0	4930.72	II	6637–26913
3.0	4942.95	II	5986–26211
5	4943.90	II	1650–21871
22	4944.83	I	
7	4947.02	II	
4	4949.03		
4	4950.29	I	
3.0	4950.67	I	
6	4952.46	I	1128–21314
32	4954.78	I	0–20177
6	4958.10	II	3067–23230
32	4959.13	II	513–20673
16	4961.39	II	5086–25235
9	4963.33	I	
4	4969.75	I	
4	4970.93	II	2585–22697
4	4972.82		
2.5	4973.40	I	
10	4975.50	I	
3.0	4980.88	I	
8	4981.28	II	
4	4982.89	I	
10	4987.17	II	
4	4989.46		
28	4989.94	II	
10	4998.55	II	
8	5000.44	II	
6	5011.67	II	
7	5014.55	I	
2.0	5015.40		
2.0	5022.67	I	
10	5027.15	I	
7	5027.85	II	4438–24321
10	5029.45	I	1128–21005
16	5033.52	II	9166–29027
3.0	5039.92	I	
6	5040.20	I	1128–20963
5	5051.06	I	
10	5056.89	I	0–19770
3.0	5060.04	I	
12	5063.73	II	
4	5066.85		
7	5071.87	I	1128–20839

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	5073.87	I	3682–23385
4	5074.52	I	
40	5076.59	II	
8	5077.16	II	
6	5079.09	I	
3.5	5081.89		
16 h	5089.84	II	1650–21292
40	5092.80	II	3067–22697
7	5096.52	II	4438–24053
20	5102.39	II	5488–25081
8	5103.11	I	
16 d	5105.21	II	
	5105.35	I	
40	5107.59	II	6637–26211
3.0	5114.53	I	
4.0	5119.61	II	5488–25014
4.0	5121.30		
38	5123.79	II	
75	5130.60	II	10517–30002
19	5132.33	II	
2.5	5134.23		
5	5136.83		
9	5143.33	II	1470–20907
5	5156.01		
8	5161.71	II	
19	5165.14	II	5488–24843
10	5167.92	II	4512–23857
2.5	5170.91		
9	5176.79	II	
2.0	5178.75	I	1128–20432
3.5	5179.78	II	
14	5181.17	II	6932–26227
13	5182.60	II	6005–25295
2.0	5187.05	I	
55	5191.45	II	1650–20907
70	5192.62	II	9166–28419
6	5195.60	I	2367–21608
6	5198.07	I	1128–20361
36	5200.12	II	
7	5204.38	I	0–19209
34	5212.37	II	1650–20830
17	5213.23	I	2367–21543
10	5215.65	II	
7	5221.57	II	
14	5225.05	II	6005–25138
14	5228.43	II	3067–22188
50	5234.20	II	4438–23537
28	5239.79	II	
80	5249.59	II	7869–26913
22	5250.82	II	6005–25045
40	5255.51	II	1650–20673
2.5	5257.35		
4	5264.22	I	
3.0 h	5265.74		
2.5 h	5266.64	I	
13	5269.48		
10	5269.78	II	
6	5270.09	I	
6	5270.69		
3.0	5272.00		
65	5273.43	II	5488–24445
16	5276.88	II	6932–25877
6	5286.68	I	
4	5287.13		
12	5291.67	I	
75	5293.17	II	6637–25524
2.5	5298.88	I	
3.0	5300.58	I	1128–19989
18	5302.28	II	11392–30247
3.0	5302.61	I	
7	5303.21	II	
12	5306.47	II	6932–25772
3.0	5308.28	I	
3.0	5308.42	II	10195–29027
5	5310.01		
24	5311.46	II	7950–26772
4	5314.55		
6	5316.60	II	
5	5319.11		
55	5319.82	II	4438–23230
3.0	5320.79	I	
4	5324.59	I	
3.0	5329.11		
2.0	5329.88	I	
3.0	5332.43	I	
3.0	5334.33	I	0–18741
10	5336.55	II	4438–23171
5	5338.01		
1.8	5343.65	I	
9	5345.71	II	9043–27744
2.5	5349.26	I	
4	5349.58	I	1128–19816
20	5356.98	II	10195–28857
5	5361.17	II	4512–23160
32	5361.47	II	5488–24134
4	5365.12	II	
1.6	5370.16		
17	5371.94	II	11392–30002
4	5377.79	I	
2.5	5378.23	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	5383.85	II	
12	5385.90	II	
2.5	5388.23		
2.0	5396.72		
2.5	5399.12	II	7525–26041
3.5	5400.20	I	
3.0	5402.90	I	
5	5406.17	II	
2.0	5411.93	I	2367–20839
3.5	5414.74	I	
2.0	5415.31	I	
8	5416.38	II	6932–25389
2.0	5420.66	I	
9	5421.56	II	6005–24445
2.0	5424.07	I	
2.0	5429.30	I	
8	5430.79	I	
18	5431.53	II	9043–27449
4	5432.36	II	9043–27446
4	5441.26		
10	5442.27	II	5488–23857
3.0	5447.28	I	
4	5447.56	II	8420–26772
6	5449.24	I	
12	5451.12	II	
8	5455.82	II	7950–26274
3.5	5456.56		
2.0	5458.60		
4	5473.08	II	9043–27309
5	5474.73	II	7950–26211
3.0	5478.61	I	
2.0	5483.12	II	7950–26182
5 h	5485.10	II	
19	5485.70	II	10195–28419
2.5	5487.03	II	8420–26640
4	5492.30	I	
1.6	5493.34	I	
7	5494.01	II	
2.0	5496.42	I	
1.4	5498.86	I	
4	5501.47	I	0–18172
2.0	5507.66		
4	5508.40	II	6932–25081
2.0	5516.29	I	
3.0 d	5520.60		
1.4	5522.17	I	
2.0	5523.94	I	
5	5525.72	I	
4	5528.33	II	
2.0	5529.07	I	1128–19209
10	5533.82	I	2367–20432
6	5535.27	II	
2.5	5537.77	II	
3.0	5539.26	II	6005–24053
6	5543.24	I	
5	5545.91	II	
6	5548.47	II	4438–22456
3.0	5548.68		
3.0	5550.09	II	
4	5557.62	II	
6	5561.17	I	0–17977
4	5569.96	II	
3.0	5575.50	I	
3.0	5576.70	I	3682–21608
3.0	5577.70	I	
2.5	5578.66		
3.5	5581.60	II	6932–24843
3.0	5587.61	I	
2.0	5587.96	II	
3.5	5588.91		
2.0	5592.67	I	
26	5594.43	II	9043–26913
2.0	5595.81		
6	5601.43	I	
5	5601.92	I	
4	5602.68	II	
3.0	5603.65	II	3067–20907
4	5614.30	II	8420–26227
2.0	5615.35	I	
4	5617.71	II	
3.0	5619.00		
24	5620.54	I	0–17787
1.2	5623.62	I	
4	5625.72	II	7525–25295
7	5635.76	I	
5	5639.54	I	
2.0	5647.98	I	
4	5653.57	I	
4	5659.78	II	
2.0	5662.46	I	
1.2	5665.26	I	
8	5668.87	II	11392–29027
7	5669.77	I	
15 d	5675.97	I	1128–18741
6	5676.33	I	
1.2	5681.16	I	
24	5688.53	II	7950–25524
2.5	5689.51	I	
1.2	5695.23	I	
5	5698.93	II	12460–30002

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.5		5701.57	I	
14		5702.24	II	6005–23537
9		5706.21	II	7525–25045
18		5708.28	II	6932–24445
9		5718.12	II	11373–28857
3.5		5719.09	I	
7		5726.83	II	8420–25877
11		5729.29	I	
1.8		5731.05	I	
2.5		5734.55		
5		5739.96	II	
8		5740.86	II	9358–26772
3.0		5741.28		
5		5742.08	II	
3.0		5742.76		
3.5		5743.20	II	10337–27744
1.2		5744.14	II	6005–23410
5		5744.77	II	7950–25352
3.5		5748.15	II	6005–23397
3.0		5749.06		
6		5749.19	I	
3.0		5749.66	I	
3.0		5753.53	II	
2.0		5760.00		
3.5		5761.70	II	8420–25772
1.6		5762.08	I	
1.2		5764.23	I	3682–21025
2.5		5767.33	I	
4		5769.87	II	
5		5770.50	II	8717–26041
5		5776.12	I	
5		5784.96	I	2367–19648
5		5788.22	I	
3.0		5795.17	II	
5		5800.09	I	
18		5804.02	II	6005–23230
5		5809.25	I	
9		5811.57	II	6931–24134
5		5813.89	I	
1.8		5815.44	I	
3.0		5820.37	I	1128–18304
5	d	5823.37	II	
3.0	d	5823.72	I	
		5824.00	I	
8		5825.87	II	8717–25877
3.5		5826.74	I	3682–20839
1.8		5830.72	I	
9		5842.39	II	10337–27449
1.8		5843.23		
3.5		5844.66	I	
2.5		5845.95	I	
1.8		5846.36	II	
1.4		5847.59	I	
3.5		5857.52	II	
6		5858.91	I	
4		5865.06	II	11373–28419
4		5867.08	I	
3.5		5868.90	I	
3.0		5871.04		
3.0		5877.83	II	
3.0		5882.78	II	
3.5		5883.29	I	
2.5		5886.24	I	
3.5		5887.91	I	
4		5891.53	II	8420–25389
2.0		5899.49	I	
2.5		5900.43	II	7525–24468
3.0		5906.65	II	6932–23857
4		5909.87	II	
1.0		5914.40	I	
3.0		5921.22	I	
1.0		5922.79	I	
3.0		5934.75	II	6005–22851
3.5		5943.22	II	
1.6		5949.64	I	
3.0		5955.87	I	
1.6		5961.16	I	
3.5		5989.34	II	6005–22697
3.5		5994.76	I	
3.0		5996.47	I	
5		6007.67	I	
1.6		6009.30	II	
1.0		6025.54	I	
4		6031.27	II	10337–26913
3.0		6033.29	I	
5		6034.24	II	12460–29027
6		6066.03	I	
3.0		6071.70	I	
3.5		6073.97	I	
1.6		6101.75	I	
1.6		6108.41	II	9674–26041
2.5	d	6133.47	I	
3.0		6149.28	I	0–16258
3.0		6155.06	I	
1.6		6156.16	I	
4		6157.83	II	
2.5		6166.67	II	
4		6170.49	II	9674–25877
5		6178.59	I	
3.0		6183.91	II	9358–25524

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	6201.74	II	
1.4	6208.01		
3.0	6208.24	I	
1.0	6210.68	II	
1.4	6216.69	I	
5	6223.39	I	
3.0	6226.50	I	2367−18423
2.5	6238.50	II	8420−24445
4	6244.08	I	
1.4	6248.28	II	
1.0	6250.43	II	
2.5	6257.49	I	
3.0	6258.73	II	
2.0	6263.23	II	
2.0	6269.42	I	
1.4	6270.27	I	
2.5	6277.29	II	
2.0	6282.00	I	
3.0	6285.79	I	
2.5	6292.84	II	
2.5	6297.07	I	
1.8	6298.42	II	7525−23397
2.0 h	6301.97	I	
1.2	6308.26	I	
6	6310.49	I	2367−18209
2.0	6319.69	II	
1.2	6321.22	I	
2.0	6330.17	II	
3.0	6341.51	II	
1.0	6355.95	I	
2.0	6361.43	II	
2.0	6362.09	II	8420−24134
2.0	6365.55	II	7525−23230
1.2	6375.97	I	
2.5	6382.07	II	
7	6385.20	I	1128−16785
2.0	6390.00	II	
1.4	6403.20	I	
2.0	6425.79	II	
2.0	6428.65	II	
0.7	6429.84	I	
1.8	6432.65	I	
1.0	6445.79	II	
1.6	6451.23	I	
0.8	6454.80	I	
1.4	6457.13	I	
1.6	6463.58	I	
1.2	6465.24	II	
1.4	6480.21	II	
0.6	6482.28	II	
4	6485.69	I	0−15414
1.8	6492.35	II	
0.8	6495.59	II	
1.8	6500.16	I	
0.9	6504.46	II	9675−25045
1.8	6514.96	II	
1.4	6519.86	II	
0.8	6523.15	II	7525−22851
1.4	6539.94	II	6005−21292
1.6	6549.54	II	
1.6	6550.19	II	
1.4	6553.07	II	6932−22188
1.4	6558.97	II	
0.8	6568.47		
1.4	6572.65	II	
2.0 h	6580.94	II	
2.0	6585.71	II	
1.8	6588.03	II	
1.2	6591.43	II	
1.8	6601.76	I	
2.0	6611.99	I	
1.2	6615.88	I	
1.8 c	6618.53	I	
2.0	6619.35	I	
5	6630.14	I	0−15078
1.0	6636.15		
2.0	6637.19	II	
4	6637.96	II	
7	6650.57	II	
5	6655.67	I	
1.6	6669.65	II	8420−23410
1.6	6670.37	I	2367−17354
1.8	6678.52	II	
3.0	6680.14	II	
1.0	6698.65	II	
1.6	6712.27	I	
1.0	6714.15		
3.0	6727.74	II	
4	6737.79	II	
6	6740.11	II	
4	6742.54	I	
1.6	6763.01	I	
1.4	6763.78	I	
1.4	6764.61		
5	6790.41	II	
1.8	6801.34	I	
2.5	6803.06	I	
5	6804.00	II	
2.0 h	6812.30	II	
2.0	6816.02	II	6005−20673

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.4		6825.35	I	
2.5		6842.66	II	
4		6846.72	II	
1.7		6846.93		
1.7		6852.23	I	
1.5		6857.00	I	
1.5		6873.07		
2.2		6874.62	II	
1.2		6876.00	II	
1.5		6886.86	I	
2.2		6896.68	I	
2.0		6897.29		
6		6900.43	II	
1.7		6901.33		
2.0		6906.07	I	
3.5		6923.86	I	
2.5		6926.87	II	
1.4		6932.16	I	
1.8		6936.44		
2.5		6938.67		
3.5		6940.14		
5		6941.39	II	
2.5	d	6964.64	I	
1.8		6982.65		
1.4	h	6985.25	I	
1.8	h	6995.27	I	
3.5	h	7010.80		
1.6		7018.85		
3.5		7020.92		
3.5		7024.58		
2.0		7033.21		
7		7037.30		
1.4		7052.16		
1.4		7054.72		
1.4		7061.48		
8		7066.89		
1.6		7082.92		
2.5	h	7089.84		
2.5	h	7092.09		
2.5	h	7092.74		
2.5	h	7092.94		
3.5	h	7093.98	I	
4	h	7095.42		
6		7129.35		
2.5	h	7142.04		
2.0		7143.72		
1.6		7151.03		
1.2		7153.09		
1.2	h	7185.01		
2.0		7189.02		
5		7189.42	I	
4		7192.01	I	
2.0		7198.83	I	
1.6	h	7227.01		
3.0		7236.52		
1.4	h	7261.64	II	8420–22188
1.8		7285.29	II	9675–23397
1.8		7288.56	II	7525–21241
1.2		7291.38		
1.4		7298.77		
2.5		7316.80		
1.4	h	7321.43		
1.4		7323.10		
1.2		7334.56	I	
1.2		7357.16		
1.2		7374.04		
1.4		7381.81		
1.8		7401.31	I	
2.0		7406.62		
1.2		7411.20		
2.0		7418.18		
1.8		7427.41		
1.8		7448.76		
1.0		7481.37	I	
2.5		7511.16		
3.5		7513.77	II	7525–20830
1.4	h	7514.44		
1.4		7516.01		
1.8		7526.49		
2.5		7529.01		
2.0		7538.27		
1.0		7540.98		
1.4		7547.00	I	
1.0		7577.54		
1.4		7587.66	II	9675–22851
1.2		7590.49		
1.2		7603.75	II	7525–20673
1.0		7605.94		
1.0		7614.69		
1.8		7639.79		
1.6		7645.98		
1.2		7663.48		
2.5		7696.61		
1.2		7718.15		
0.9		7743.87		
0.9		7749.02		
2.0		7750.97		
1.2		7773.03		
1.4		7792.24	II	9358–22188
1.2		7796.42	II	10337–23160

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.6		7797.32		
1.0		7798.40		
2.0		7808.50		
1.4		7818.86		
1.0		7825.20	II	12460–25235
2.5		7862.84		
1.0	h	7872.03		
1.4		7886.60		
0.8	h	7896.50		
1.8		7900.38		
1.0	h	7906.03		
2.5		7917.01		
2.0		7925.03		
1.0		7947.95		
2.0		7949.65		
1.0	h	7955.38		
2.5		7958.93		
2.5		7965.69		
3.0		7982.09	II	8717–21241
2.5		7982.67		
2.5		8000.75		
1.8		8007.72	I	
0.8	h	8020.08		
1.6		8026.41		
2.0		8043.33	I	1128–13557
1.6		8051.30		
1.0		8064.00		
2.0		8099.09		
2.0		8120.85		
2.5		8122.08		
2.5		8141.72		
2.5		8143.29		
1.4	h	8164.97	I	
1.6		8172.49		
1.8		8179.83		
1.8		8182.41		
0.8		8185.63		
1.4	h	8205.36		
2.0		8231.47		
0.8		8248.77		
1.0	h	8249.70		
0.9	h	8262.80		
1.4	h	8266.71		
0.9		8272.75		
0.9	h	8302.74		
2.0		8307.72		
1.2		8324.51		
0.9		8332.01		
2.5		8346.35		
1.6	h	8375.23		
0.9		8394.72		
1.4		8400.79		
1.0	h	8456.80		
0.9		8530.44		
1.0		8582.03		
1.0		8591.43		
1.4		8594.84		
1.6	c	8643.48	II	9675–21241
1.0		8667.00		
1.0		8677.48		
1.2		8691.30		
1.2		8695.07		
1.2		8712.84		
1.2		8715.01		
3.5		8838.96		

NICKEL

Ni, $Z=28$, $M=58.71$, Ratio $\frac{\text{Ni}}{\text{Cu}}=0.924$

Ni I Normal state of valence electrons $3d^8 4s^2\ {}^3F_4$ $=0$. I.P.= 61579 K
Ni II Normal state of valence electrons $3d^9\ \ {}^2D_{2½}=0$. I.P.=146408 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Son, New York, 1939), below 6000 A.
K. Burns and F. Sullivan, Sci. Studies St. Bonaventure Coll. **13,** 2 (1947), above 6000 A.

Classification:

Ni I, H. N. Russell, Phys. Rev. **34,** 821 (1940).
Ni II, A. G. Shenstone, Phys. Rev. **30,** 255 (1927).

Intensities:

W. A. M. Dekkers and A. A. Kruithof, Z. Physik **66,** 491 (1930).
L. S. Ornstein and T. Bouma, Phys. Rev. **36,** 679 (1930).
R. B. King, Astrophys. J. **108,** 87 (1948).
F. B. Estabrook, Astrophys. J. **113,** 684 (1951).
R. L. Heid and G. H. Dieke, J. Opt. Soc. Am. **44,** 402 (1954).

Relative intensity of nickel lines observed in an arc of copper containing 0.1 atomic percent of nickel

Strong lines of nickel

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
750	3414. 76	I	205–29481	$3d^9 4s^1\ a\ {}^3D_3$—$3d^9 4p^1\ \ z\ {}^3F^\circ_4$
750	3524. 54	I	205–28569	$3d^9 4s^1\ a\ {}^3D_3$—$3d^9 4p^1\ \ z\ {}^3P^\circ_2$
600	3515. 05	I	880–29321	$3d^9 4s^1\ a\ {}^3D_2$—$3d^9 4p^1\ \ z\ {}^3F^\circ_3$
600	3619. 39	I	3410–31031	$3d^9 4s^1\ a\ {}^1D_2$—$3d^9 4p^1\ \ z\ {}^1F^\circ_3$
500	3492. 96	I	880–29501	$3d^9 4s^1\ a\ {}^3D_2$—$3d^9 4p^1\ \ z\ {}^3P^\circ_1$
460	3458. 47	I	1713–30619	$3d^9 4s^1\ a\ {}^3D_1$—$3d^9 4p^1\ \ z\ {}^3F^\circ_2$
460	3461. 65	I	205–29084	$3d^9 4s^1\ a\ {}^3D_3$—$3d^8 4s^1 4p^1\ z\ {}^5F^\circ_4$
460	3566. 37	I	3410–31442	$3d^9 4s^1\ a\ {}^1D_2$—$3d^9 4p^1\ \ z\ {}^1D^\circ_2$
440	3446. 26	I	880–29888	$3d^9 4s^1\ a\ {}^3D_2$—$3d^9 4p^1\ \ z\ {}^3D^\circ_2$
320	3002. 49	I	205–33501	$3d^9 4s^1\ a\ {}^3D_3$—$3d^8 4s^1 4p^1\ y\ {}^3D^\circ_3$
300	3012. 00	I	3410–36601	$3d^9 4s^1\ a\ {}^1D_2$—$3d^8 4s^1 4p^1\ y\ {}^1D^\circ_2$
300	3380. 57	I	3410–32982	$3d^9 4s^1\ a\ {}^1D_2$—$3d^9 4p^1\ \ z\ {}^1P^\circ_1$
300	3392. 99	I	205–29669	$3d^9 4s^1\ a\ {}^3D_3$—$3d^9 4p^1\ \ z\ {}^3D^\circ_3$
280	3050. 82	I	205–32973	$3d^9 4s^1\ a\ {}^3D_3$—$3d^8 4s^1 4p^1\ y\ {}^3F^\circ_4$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	2289.98	I	0–43655
8	2300.78	I	205–43655
30	2310.96	I	0–43259
26	2312.34	I	1332–44565
22	2313.66	I	
22	2313.98	I	2217–45419
7	2316.04	II	8394–51558
22	2317.16	I	1332–44475
44	2320.03	I	0–43090
30	2321.38	I	2217–45281
4	2322.68	I	
26	2325.79	I	1332–44315
17	2329.96	I	2217–45122
9	2337.49	I	0–42768
3.0	2337.82	I	1713–44475
26	2345.54	I	0–42621
4.0	2346.63	I	1332–43933
9	2347.52	I	0–42585
4	2360.63	I	2217–44565
5	2362.06	I	1332–43655
8	2386.58	I	880–42768
12	2394.52	II	13550–55300
10	2416.14	II	14995–56371
12	2419.31	I	1332–42654
4	2421.23	I	1332–42621
4	2423.33	I	1332–42585
4	2423.66	I	2217–43464
4	2424.03	I	1713–42954
6	2437.89	II	13550–54557
6	2453.99	I	2217–42954
11	2472.06	I	2217–42656
6	2476.87	I	0–40361
3.0	2696.49	I	3410–40484
12	2798.65	I	880–36601
20	2821.29	I	205–35639
4	2865.50	I	1713–36601
5	2907.46	I	2217–36601
2.0	2914.01	I	1332–35639
40	2943.91	I	205–34163
46	2981.65	I	880–34409
20	2984.13	I	0–33501
40	2992.60	I	205–33611
80	2994.46	I	205–33590
320	3002.49	I	205–33501
180	3003.63	I	880–34163
300	3012.00	I	3410–36601
28	3019.14	I	0–33112
10	3031.87	I	0–32973
140	3037.94	I	205–33112
12	3045.01	I	1332–34163
280	3050.82	I	205–32973
120	3054.32	I	880–33611
150	3057.64	I	1713–34409
40	3064.62	I	880–33501
38	3080.76	I	1713–34163
24	3097.12	I	1332–33611
19	3099.12	I	1332–33590
240	3101.55	I	880–33112
120	3101.88	I	3410–35639
20	3105.47	I	2217–34409
25	3114.12	I	880–32982
260	3134.11	I	1713–33611
5	3145.72	I	1332–33112
5	3181.74	I	15610–47030
9	3184.37	I	2217–33611
5	3195.57	I	2217–33501
14	3197.11	I	1713–32982
5	3202.14	I	25754–56974
16	3214.06	I	25754–56858
16	3217.83	I	25754–56821
9	3221.27	I	30923–61958
14	3221.65	I	0–31031
19	3225.02	I	3410–34409
100	3232.96	I	0–30923
26	3234.65	I	880–31786
55	3243.06	I	205–31031
9	3248.46	I	205–30980
11	3250.74	I	3410–34163
9	3271.12	I	880–31442
11	3282.70	I	1332–31786
60	3315.66	I	880–31031
30	3320.26	I	1332–31442
28	3322.31	I	3410–33501
30	3361.56	I	880–30619
30	3365.77	I	3410–33112
30	3366.17	I	1332–31031
6	3366.81	I	27261–56954
6	3367.89	I	205–29888
260	3369.57	I	0–29669
36	3371.99	I	1332–30980
24	3374.22	I	205–29833
12	3374.64	I	27261–56885
300	3380.57	I	3410–32982
22	3380.85	I	2217–31786
120	3391.05	I	0–29481
300	3392.99	I	205–29669
12	3409.58	I	0–29321
30	3413.48	I	1332–30619
		I	28542–57829
30	3413.94	I	880–30163

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
750	3414.76	I	205–29481
150	3423.71	I	1713–30913
240	3433.56	I	205–29321
90	3437.28	I	0–29084
440	3446.26	I	880–29888
120	3452.89	I	880–29833
460	3458.47	I	1713–30619
460	3461.65	I	205–29084
18	3467.50	I	1332–30163
22	3469.49	I	2217–31031
150	3472.54	I	880–29669
50	3483.77	I	2217–30913
12	3485.89	I	1713–30392
500	3492.96	I	880–29501
60	3500.85	I	1332–29888
6	3502.60	I	0–28542
5	3507.69	I	1332–29833
240	3510.34	I	1713–30192
24	3513.93	I	1713–30163
600	3515.05	I	880–29321
60	3519.77	I	2217–30619
750	3524.54	I	205–28569
10	3527.98	I	1332–29669
30	3548.18	I	2217–30392
5	3551.53	I	1332–29481
6	3561.75	I	0–28068
460	3566.37	I	3410–31442
90	3571.87	I	1332–29321
12	3587.93	I	205–28068
120	3597.70	I	1713–29501
120	3610.46	I	880–28569
48	3612.74	I	2217–29888
600	3619.39	I	3410–31031
12	3624.73	I	0–27580
18	3664.10	I	2217–29501
12	3669.24	I	1332–28578
16	3670.43	I	1332–28569
24	3674.15	I	205–27415
16	3688.42	I	2217–29321
8	3693.93	I	880–27944
12	3722.48	I	1713–28569
15	3736.81	I	3410–30163
6	3739.23	I	1332–28068
60	3775.57	I	3410–29888
70	3783.53	I	3410–29833
70	3807.14	I	3410–29669
12	3831.69	I	3410–29501
130	3858.30	I	3410–29321
3.5	3889.67	I	1713–27415
4	3972.17	I	3410–28578
12	3973.56	I	3410–28569
12	4401.55	I	25754–48467
9	4459.04	I	26666–49086
2.0	4462.46	I	27944–50346
6	4470.48	I	27415–49778
4	4592.53	I	28578–50346
2.0	4600.37	I	29013–50745
7	4605.00	I	28068–49778
2.0	4606.23	I	29013–50717
8	4648.66	I	27580–49086
2.5	4686.22	I	29013–50346
10	4714.42	I	27261–48467
2.0	4715.78	I	28578–49778
3.0	4756.52	I	28068–49086
1.4	4763.95	I	29481–50466
4	4786.54	I	27580–48467
2.0	4807.00	I	29669–50466
2.0 h	4829.03	I	28569–49271
1.8	4831.18	I	29084–49778
4	4855.41	I	28569–49159
3.0	4866.27	I	28542–49086
1.6	4873.44	I	29833–50346
3.5	4904.41	I	28569–48953
2.0	4918.36	I	30980–51306
1.2	4935.83	I	31786–52040
3.5	4980.16	I	29084–49158
3.5	4984.13	I	30619–50678
1.2 h	5000.34	I	29321–49314
1.4	5012.46	I	29833–49778
4	5017.59	I	28542–48467
8	5035.37	I	29321–49175
1.2	5048.85	I	31031–50832
8	5080.52	I	29481–49158
5	5081.11	I	31031–50706
2.0 h	5084.08	I	29669–49333
1.4	5099.32	I	29481–49086
2.0 h	5099.95	I	29669–49271
1.6	5115.40	I	30923–50466
1.4 h	5129.38	I	29669–49159
1.8	5137.08	I	13521–32982
1.8 h	5142.77	I	29888–49328
3.0 h	5146.48	I	29888–49314
3.0 h	5155.76	I	31442–50832
1.2	5168.66	I	29833–49175
1.0	5176.56	I	31442–50754
0.6	5435.87	I	16017–34409
14	5476.91	I	14729–32982
0.5	5510.00	I	31031–49175
0.5	5578.73	I	13521–31442
0.7	5587.86	I	15610–33501

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.0	5592.28	I	15734–33611
0.7	5614.79	I	33501–51306
0.4 h	5625.33	I	32982–50754
0.3	5649.70	I	33611–51306
0.4	5664.02	I	36601–54251
0.9	5682.20	I	33112–50706
0.6	5695.00	I	32982–50537
1.8	5709.56	I	13521–31031
0.8	5711.90	I	15610–33112
0.8	5715.09	I	32973–50466
1.2	5754.68	I	15610–32982
0.6	5760.85	I	33112–50466
0.8	5857.76	I	33611–50678
0.8	5892.88	I	16017–32982
0.8	6108.12	I	13521–29888
0.8	6176.81	I	32973–49158
0.8	6191.18	I	13521–29669
1.0	6256.36	I	13521–29501
0.8	6314.66	I	15610–31442
1.8	6643.64	I	13521–28569
2.5	6767.77	I	14729–29501
1.0	6772.32	I	29501–44263
1.2	6914.56	I	15734–30192
0.8	7110.90	I	15610–29669
4	7122.20	I	28569–42606
1.0	7182.00	I	30192–44112
0.8	7197.02	I	15610–29501
0.8	7261.93	I	15734–29501
0.7	7291.45	I	15610–29321
0.6	7385.24	I	22102–35639
2.5	7393.60	I	29084–42606
2.5	7409.35	I	30619–44112
0.8	7414.51	I	16017–29501
3.5	7422.28	I	29321–42790
2.0	7522.76	I	29501–42790
1.4	7525.12	I	29321–42606
3.0	7555.60	I	31031–44263
1.2	7574.05	I	30913–44112
3.5	7617.00	I	29481–42606
1.4	7619.21	I	29669–42790
2.5	7714.32	I	15610–28569
0.8 h	7715.58	I	29833–42790
3.0	7727.61	I	29669–42606
3.0	7748.89	I	29888–42790
1.6	7788.94	I	15734–28569
2.0	7797.59	I	31442–44263
0.3	7917.44	I	30163–42790
0.3	8809.42	I	31442–42790
1.4	8862.55	I	32982–44263

NIOBIUM

Nb, $Z=41$, $M=92.91$, Ratio $\frac{\text{Nb}}{\text{Cu}}=1.462$

Nb I Normal state of valence electrons $4d^4 5s^1\ {}^6D_{0½}=0$. I.P.= 54600 K
Nb II Normal state of valence electrons $4d^4\ \ {}^5D_0=0$. I.P.=113000 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Supplemented by Humphreys' and Meggers' paper cited below.

Classification:

Nb I and Nb II, C. J. Humphreys and W. F. Meggers, J. Research NBS **34,** 477 (1945).

Relative intensity of niobium lines observed in an arc of copper containing 0.1 atomic percent of niobium

Strong lines of niobium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1700	4058. 94	I	1050–25680	$5s\ a\ {}^6D_{4½}—5p\ y\ {}^6F^\circ_{5½}$
1200	4079. 73	I	695–25200	$5s\ a\ {}^6D_{3½}—5p\ y\ {}^6F^\circ_{4½}$
700	4100. 92	I	392–24770	$5s\ a\ {}^6D_{2½}—5p\ y\ {}^6F^\circ_{3½}$
600	3580. 27	I	1050–28973	$5s\ a\ {}^6D_{4½}—5p\ y\ {}^6P^\circ_{3½}$
550	4123. 81	I	154–24397	$5s\ a\ {}^6D_{1½}—5p\ y\ {}^6F^\circ_{2½}$
460	4152. 58	I	695–24770	$5s\ a\ {}^6D_{3½}—5p\ y\ {}^6F^\circ_{3½}$
460	4163. 66	I	154–24165	$5s\ a\ {}^6D_{1½}—5p\ y\ {}^6F^\circ_{1½}$
420	4164. 66	I	392–24397	$5s\ a\ {}^6D_{2½}—5p\ y\ {}^6F^\circ_{2½}$
360	3791. 21	I	1050–27420	$5s\ a\ {}^6D_{4½}—5p\ y\ {}^6D^\circ_{4½}$
360	4168. 13	I	0–23985	$5s\ a\ {}^6D_{0½}—5p\ y\ {}^6F^\circ_{0½}$
340	3713. 01	I	1050–27975	$5s\ a\ {}^6D_{4½}—5p\ y\ {}^6D^\circ_{4½}$
280	3726. 24	I	154–26983	$5s\ a\ {}^6D_{1½}—5p\ x\ {}^6D^\circ_{2½}$
280	3739. 80	I	695–27427	$5s\ a\ {}^6D_{3½}—5p\ x\ {}^6D^\circ_{3½}$
280	3798. 12	I	392–26713	$5s\ a\ {}^6D_{2½}—5p\ x\ {}^6D^\circ_{1½}$
280	3802. 92	I	695–26983	$5s\ a\ {}^6D_{3½}—5p\ x\ {}^6D^\circ_{2½}$
280	4139. 71	I	1050–25200	$5s\ a\ {}^6D_{4½}—5p\ y\ {}^6F^\circ_{4½}$
240	3535. 30	I	0–28278 695–28973	$5s\ a\ {}^6D_{0½}—5p\ y\ {}^6P^\circ_{1½}$ $5s\ a\ {}^6D_{3½}—5p\ y\ {}^6P^\circ_{3½}$
240	4137. 10	I	0–24165	$5s\ a\ {}^6D_{0½}—5p\ y\ {}^6F^\circ_{1½}$
220	3094. 18	II	4146–36455	$5s\ a\ {}^5F_5\ —5p\ z\ {}^5G^\circ_6$
200	3349. 06	I	2154–32005	$5s^2\ a\ {}^4F_{3½}—5p\ x\ {}^4G^\circ_{4½}$
200	3358. 42	I	2805–32573	$5s^2\ a\ {}^4F_{4½}—5p\ x\ {}^4G^\circ_{5½}$
180	3130. 79	II	3542–35474	$5s\ a\ {}^5F_4\ —5p\ z\ {}^5G^\circ_5$
180	3575. 85	I	695–28653	$5s\ a\ {}^6D_{3½}—5p\ y\ {}^6P^\circ_{2½}$
180	3742. 39	I	0–26713	$5s\ a\ {}^6D_{0½}—5p\ x\ {}^6D^\circ_{1½}$
180	3787. 06	I	154–26552	$5s\ a\ {}^6D_{1½}—5p\ x\ {}^6D^\circ_{0½}$
170	2927. 81	II	4146–38291	$5s\ a\ {}^5F_5\ —5p\ z\ {}^5D^\circ_4$
170	2950. 88	II	4146–38024	$5s\ a\ {}^5F_5\ —5p\ z\ {}^5F^\circ_5$
160	3697. 85	I	392–27427	$5s\ a\ {}^6D_{2½}—5p\ x\ {}^6D^\circ_{3½}$
150	2697. 06	II	1225–38291	$4d^4\ a\ {}^5D_4\ —5p\ z\ {}^5D^\circ_4$
150	3341. 97	I	1143–31057	$5s^2\ a\ {}^4F_{1½}—5p\ x\ {}^4G^\circ_{2½}$
150	3343. 71	I	1587–31485	$5s^2\ a\ {}^4F_{2½}—5p\ x\ {}^4G^\circ_{3½}$
150	3537. 48	I	392–28653	$5s\ a\ {}^6D_{2½}—5p\ y\ {}^6P^\circ_{2½}$
140	3163. 40	II	3030–34632	$5s\ a\ {}^5F_3\ —5p\ z\ {}^5G^\circ_4$
140	3790. 15	I	1050–27427	$5s\ a\ {}^6D_{4½}—5p\ x\ {}^6D^\circ_{3½}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2029.32	II	
5	2032.99	II	3542–52715
8	2109.42	II	
8	2125.21	II	3030–50069
5	2126.54	II	3542–50552
8	2131.18	II	2629–49537
12	2295.68	II	1225–44771
10	2302.08	II	801–44227
13	2376.40	II	801–42869
10	2387.09	II	10836–52715
13	2387.52	II	7901–49772
4	2388.27	II	7901–49759
16	2398.48	II	10247–51927
6	2405.34	II	10653–52215
6	2405.85	II	10836–52389
17	2412.46	II	8320–49759
19	2416.99	II	10919–52280
18	2418.69	II	10604–51936
12	2433.80	II	9510–50585
6	2435.95	II	9813–50852
5	2436.33	I	2154–43187
7	2437.42	II	7506–48520
6	2442.14	II	10247–51182
5	2442.68	II	16219–57145
12	2451.87	II	12263–53036
12	2453.95	II	13690–54429
10	2458.09	II	14791–55461
12	2462.89	I	2805–43396
6	2466.73	I	2805–43333
10	2469.08	I	2154–42643
20	2477.38	II	6192–46545
12	2478.29	II	10247–50585
12	2479.94	II	10186–50498
6	2483.88	II	10604–50852
5	2502.49	II	10604–50552
20	2504.65	I	2805–42719
20	2511.00	II	5562–45375
7	2520.51	I	
20	2521.40	II	9510–49158
5	2524.99	I	1143–40735
16	2525.81	II	10919–50498
10	2530.97	II	14626–54125
5	2531.25	II	14678–54173
16	2540.62	II	14661–54010
16	2541.42	II	1225–40561
70	2544.80	II	7261–46545
5	2548.63	II	13055–52280
20	2551.38	II	6192–45375
10	2555.63	II	9510–48627
24	2556.94	II	7261–46359
14	2558.94	I	1143–40210
24	2562.41	II	6192–45207
24	2565.41	I	1587–40555
13	2567.51	I	1143–40079
18	2569.03	I	9329–48242
5	2570.78	I	1587–40474
5	2571.05	I	1587–40470
20	2571.33	II	1225–40104
13	2572.10	I	1143–40010
8	2574.84	II	159–38984
10	2576.60	I	2154–40953
10	2578.20	I	1587–40362
36	2578.74	I	2154–40921
8	2580.28	II	9510–48253
11	2583.11	I	8827–47528
8	2583.22	I	2154–40854
70	2583.99	II	9813–48501
5	2589.27	I	
70	2590.94	II	10186–48771
48	2592.20	I	2805–41371
8	2594.34	II	801–39335
17	2594.74	II	7901–46429
8	2597.14	I	1587–40079
13	2601.29	II	10186–48617
6	2601.84	I	1587–40010
5	2602.01	I	
4	2603.31	I	2154–40555
5 h	2608.84	I	2154–40474
5	2608.96	II	9813–48130
13	2610.28	I	1587–39886
11	2612.38	I	2154–40422
2.0	2613.85	II	438–38685
19	2616.48	I	2154–40362
12	2620.45	II	7506–45656
2.0	2622.00	I	8827–46954
20	2623.51	I	1143–39248
19	2627.44	I	2805–40854
19	2628.49	I	1587–39620
14	2632.52	II	8320–46296
6	2634.71	I	1587–39530
5	2637.98	II	10604–48501
14	2640.92	I	2154–40009
4	2641.06	II	10919–48771
30	2642.24	II	9510–47345
48	2646.26	II	438–38216
50	2647.50	I	1143–38903
36	2649.52	I	2154–39886
13	2651.12	II	10919–48627
5	2652.94	I	8827–46510
14	2653.38	I	2805–40482

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
50	2654.45	I	1587–39248
6	2655.70	I	8827–46471
46	2656.08	II	159–37797
10	2656.98	I	9329–46954
24	2657.62	I	2805–40422
4	2658.88	II	8320–45919
4	2660.04	II	10919–48501
6	2661.86	I	2805–40362
4	2663.56	II	9813–47345
16	2665.25	II	10247–47756
17	2666.59	II	801–38291
6	2667.15	II	8320–45802
17	2667.30	II	0–37480
13	2667.76	II	10604–48078
19	2668.29	I	2154–39620
60	2671.93	II	801–38216
30	2673.57	II	15396–52788
30	2675.94	II	438–37797
4	2677.66	II	10919–48253
10	2678.66	II	159–37480
14	2679.01	I	1587–38903
7	2680.06	II	8320–45622
4	2682.13	I	2154–39427
10	2686.39	II	18508–55722
19	2687.15	I	2805–40009
24	2691.77	II	159–37298
14	2695.04	I	2154–39248
6	2696.05	I	2805–39886
150	2697.06	II	1225–38291
48	2698.86	II	438–37480
6	2700.15	II	7901–44925
3.0	2700.56	II	3542–40561
48	2702.20	II	801–37797
22	2702.52	II	1225–38216
6 h	2704.26	II	13480–50447
14	2706.40	II	438–37377
5	2707.83	II	9510–46429
3.0	2714.20	I	2805–39638
4	2715.34	II	16219–53036
4	2715.50	I	2805–39620
4	2715.69	I	1143–37955
6	2715.88	II	13055–49864
10	2716.10	I	1587–38393
9	2716.31	II	159–36963
70	2716.62	II	1225–38024
5	2717.33	II	
4	2717.63	II	9510–46296
4	2720.02	I	5965–42719
4	2720.26	II	3030–39780
6	2721.63	II	0–36732
70	2721.98	II	801–37528
4	2722.31	I	1143–37865
5	2723.66	II	13055–49759
9	2723.98	I	2154–38854
8	2726.08	I	1143–37815
4	2727.43	II	13119–49772
5	2728.08	I	1587–38232
4	2729.83	I	2805–39427
8	2730.32	II	13119–49733
46	2733.26	II	801–37377
12	2733.46	II	159–36732
3.0	2734.35	II	7506–44067
16	2737.09	II	438–36963
13	2740.18	II	9813–46296
6	2741.15	I	8827–45297
4	2744.96	II	10653–47073
9	2745.30	II	4146–40561
10	2745.73	II	9510–45919
30	2746.91	I	1143–37537
30	2748.85	I	1587–37955
28	2753.01	I	
11	2753.14	II	15396–51707
4	2754.07	I	
10	2754.52	II	438–36732
14	2755.29	I	8827–45110
12	2755.64	I	1587–37865
9	2757.26	II	12263–48520
42	2758.61	I	2154–38393
4	2758.78	II	10836–47073
8	2761.00	I	
12	2763.38	I	2805–38982
8	2764.56	II	801–36963
10	2765.28	II	1225–37377
5	2765.93	II	7506–43649
2.5	2766.18	I	12102–48242
36	2768.13	II	438–36553
2.5	2769.57	II	10247–46343
10	2771.40	II	21073–57145
3.0	2771.65	II	13690–49759
46	2773.20	I	2805–38854
8	2779.36	I	1143–37112
10	2779.72	I	
40	2780.24	II	4146–40104
20	2782.36	I	9329–45259
4	2790.57	II	10604–46429
12	2791.74	II	9813–45622
17	2793.05	II	3542–39335
4	2795.14	II	13480–49246
3.0	2795.86	I	1587–37344
9 c	2797.69	II	11340–47073

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	2798.91	II	7901–43618
5	2799.36	I	2154–37866
6	2800.32	I	1587–37287
3.0	2802.07	I	2154–37832
9	2803.81	II	3030–38685
6	2808.05	I	1587–37188
4	2809.17	II	2629–38216
11	2810.81	II	8320–43887
6	2811.63	I	11525–47081
4	2816.68	II	13666–49158
8	2819.21	I	
6	2820.80	II	2357–37797
3.0	2821.92	I	2805–38232
11	2825.18	I	2154–37540
3.5	2825.86	II	10919–46296
10	2826.48	I	2154–37524
28	2827.08	II	159–35521
6	2829.75	II	1225–36553
14	2835.12	II	3030–38291
22	2836.24	I	
16	2840.94	I	2154–37344
38	2841.15	II	3030–38216
3.5	2842.02	I	5298–40474
42	2842.65	II	2629–37797
4	2843.64	II	10186–45342
4	2844.44	II	14626–49772
8	2845.80	II	9510–44639
24	2846.28	II	2357–37480
3.5	2847.24	II	14661–49772
10	2848.30	II	14661–49759
11	2849.56	II	438–35521
16	2851.45	I	10238–45297
13	2851.98	I	12102–47155
10	2854.17	I	2805–37832
7	2857.29	I	5965–40953
6	2859.04	II	10836–45802
14	2859.96	I	2805–37761
36	2861.09	II	2357–37298
15	2864.32	I	
15	2865.61	II	0–34886
6	2866.67	I	1143–36016
75	2868.52	II	2629–37480
14	2874.57	I	1143–35920
120	2875.39	II	3030–37797
40	2876.95	II	3542–38291
80	2877.03	II	2629–37377
10	2878.74	II	159–34886
7	2879.36	II	801–35521
7	2879.49	I	2805–37524
15	2880.72	II	10919–45622
85	2883.18	II	3542–38216
10	2884.97	I	12503–47155
3.5	2887.69	II	14626–49246
42	2888.83	II	2357–36963
5	2889.90	I	1587–36180
6	2894.42	II	10836–45375
70	2897.81	II	3030–37528
60	2899.24	II	3542–38024
14	2903.65	I	1587–36016
70	2908.24	II	2357–36732
12	2908.88	II	14791–49158
100	2910.59	II	3030–37377
70	2911.74	II	2629–36963
10	2917.05	II	10653–44925
170	2927.81	II	4146–38291
16	2931.47	II	2629–36732
5 h	2932.66	II	10836–44925
4	2935.29	II	9510–43568
5	2937.33	II	10604–44639
14	2938.07	I	2154–36180
130	2941.54	II	3542–37528
16 h	2945.88	II	10836–44771
17	2946.12	II	3030–36963
16	2946.90	II	2629–36553
170	2950.88	II	4146–38024
3.0	2954.02	II	14678–48520
6	2954.53	II	14791–48627
5	2955.45	I	10238–44063
6	2956.89	II	7901–41710
3.0	2959.97	I	2154–35928
6	2963.68	I	4998–38730
12	2965.48	I	4998–38710
5 d	2970.40	II	12263–45919
	2970.47	II	13690–47345
60	2972.57	II	11340–44971
48	2974.10	II	10919–44532
32	2977.68	II	10653–44227
9	2978.94	II	17292–50852
8	2979.88	II	21473–55021
14	2980.72	II	12263–45802
10	2981.64	I	2805–36334
30	2982.11	II	3030–36553
6	2983.14	I	1143–34655
8	2985.05	II	13055–46545
13	2987.29	I	5298–38763
10 d	2988.69	I	9439–42889
	2988.79	I	4998–38447
50	2990.26	II	11340–44771
12	2991.95	II	10653–44067
70	2994.73	II	4146–37528

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	3000.12	I	
10	3002.21	II	11340-44639
5	3005.14	I	1587-34854
8	3005.77	II	17292-50552
5	3010.38	II	15949-49158
5	3010.69	II	17292-50498
8	3020.67	I	5298-38393
8	3022.74	II	17425-50498
17	3024.74	II	10836-43887
42	3028.44	II	3542-36553
4	3029.74	II	12806-45802
36	3032.77	II	10604-43568
4	3039.41	II	2629-35521
8	3039.68	I	5965-38854
5	3039.82	II	11340-44227
12	3044.76	II	13666-46500
18	3048.10	I	5965-38763
13	3053.09	I	5965-38710
12	3055.52	II	16053-48771
9	3056.62	I	
4	3061.11	I	9329-41987
4	3061.24	I	5298-37955
9	3063.79	II	13666-46296
26	3064.53	II	10247-42869
9	3065.26	II	10836-43450
4	3066.10	II	13690-46296
13	3069.68	II	13055-45622
12	3070.90	II	14791-47345
4	3071.18	II	15949-48501
13	3071.56	II	11340-43887
5	3072.41	I	4998-37537
8	3072.51	II	13119-45656
12	3073.24	II	2357-34886
48	3076.87	II	3030-35521
13	3080.35	II	10836-43290
9	3087.86	II	12263-44639
220	3094.18	II	4146-36455
8	3096.50	I	1587-33872
17	3099.19	II	2629-34886
18	3111.45	I	1587-33717
9	3116.36	I	10238-42317
8	3122.65	I	2154-34169
32	3127.53	II	17425-49390
4	3129.64	II	10653-42597
180	3130.79	II	3542-35474
9	3133.08	I	8827-40735
9	3136.97	I	1143-33011
9	3140.50	II	12806-44639
46	3145.40	II	8320-40104
17	3151.87	I	2154-33872
8	3152.16	II	21073-52788
140	3163.40	II	3030-34632
5	3172.51	I	1143-32654
9	3173.20	II	14791-46296
18	3175.78	II	10653-42133
	3175.86	II	7506-38984
46	3180.29	II	7901-39335
8	3181.40	II	7261-38685
9	3184.22	II	15949-47345
9	3186.54	I	4998-36371
24	3187.49	I	2805-34169
9	3189.28	II	17425-48771
36	3191.10	II	4146-35474
18	3191.43	II	17292-48617
120	3194.98	II	2629-33919
8	3200.53	I	2154-33390
14	3203.35	II	17292-48501
36	3206.34	II	7506-38685
9	3210.29	I	9329-40470
46	3215.60	II	3542-34632
11	3217.29	I	5298-36371
8	3217.86	I	1587-32654
9	3223.32	II	8320-39335
95	3225.48	II	2357-33351
17	3229.56	II	7261-38216
48	3236.40	II	3030-33919
5	3246.78	I	1143-31934
24	3247.47	II	7901-38685
14	3248.94	II	6192-36963
19	3249.52	I	1143-31908
9	3251.62	I	2154-32899
38	3254.07	II	2629-33351
9	3260.14	I	1143-31808
28	3260.56	II	17470-48130
19	3263.37	II	21073-51707
19	3264.59	I	2805-33428
9	3267.05	I	8827-39427
14	3270.47	I	
12	3270.76	I	1143-31708
24	3272.07	I	1587-32140
9	3272.22	II	14791-45342
19	3277.67	I	1587-32088
24	3283.46	II	16053-46500
28	3285.66	I	1587-32013
24	3287.59	I	1143-31551
19	3287.92	I	5965-36371
10	3291.06	II	3542-33919
19	3292.02	II	15551-45919
10	3294.36	II	15949-46296
38	3296.01	I	2805-33136

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
19	3299.61	I	2154–32452
14	3304.83	I	13146–43396
14	3308.05	I	1587–31808
14	3310.47	I	2805–33004
10	3311.34	I	12982–43173
48	3312.60	I	2154–32333
24	3315.22	I	8827–38982
24	3318.98	I	1587–31708
14	3319.26	I	2805–32924
14	3319.58	II	7261–37377
5	3320.81	II	15551–45656
29	3326.62	I	9329–39381
20	3329.36	I	8827–38854
13	3332.16	I	2154–32156
15	3341.60	II	10186–40104
150	3341.97	I	1143–31057
150	3343.71	I	1587–31485
10	3343.96	II	8320–38216
15	3346.93	I	4998–34868
200	3349.06	I	2154–32005
50	3349.52	I	11525–41371
5	3352.59	I	2154–31973
40	3354.74	I	2805–32605
15	3357.04	I	2154–31934
200	3358.42	I	2805–32573
15	3365.58	II	8320–38024
40	3366.96	I	9329–39021
10	3367.38	I	8705–38393
15	3369.16	II	15949–45622
8	3369.83	I	9043–38710
20	3371.33	I	2154–31808
8	3372.09	I	2805–32452
8	3372.56	II	10919–40561
5	3374.25	II	7901–37528
42	3374.92	I	8827–38449
8	3376.34	I	12137–41746
10	3376.73	I	11248–40854
8	3380.05	I	2805–32382
32	3380.41	I	1143–30716
16	3380.86	I	5298–34868
	3380.93	II	16053–45622
10	3383.80	I	8411–37955
10	3384.66	I	12018–41555
20	3386.24	II	9813–39335
10	3387.75	I	5298–34808
10	3390.63	I	9498–38982
5	3391.33	I	12137–41615
42	3392.34	I	1587–31057
5	3394.98	II	12263–41710
20	3395.93	I	1587–31026
10	3398.25	I	
14	3399.40	I	2805–32214
10	3399.71	II	14661–44067
10	3403.02	I	
28	3405.41	I	9498–38854
16	3406.13	I	9043–38393
32	3408.38	I	2154–31485
28	3408.68	II	6192–35521
22	3409.19	II	5562–34886
9	3409.91	I	11044–40362
28	3412.94	II	7261–36553
11	3414.07	I	2805–32088
22	3415.97	I	9498–38763
11	3417.86	I	8705–37955
11	3420.63	II	7506–36732
22	3423.76	I	2805–32005
28	3425.42	II	10919–40104
16	3425.85	I	13012–42194
28	3426.57	II	10604–39780
28	3427.45	I	2805–31973
5	3428.79	I	10923–40079
16	3429.04	I	5965–35120
5	3432.42	I	8411–37537
22	3432.70	II	16219–45342
9	3433.09	I	9329–38449
11	3436.96	II	15551–44639
11	3439.92	II	7901–36963
22	3440.59	II	8320–37377
8	3442.65	I	8827–37866
4	3442.79	I	12102–41140
11	3445.68	I	12358–41371
11	3452.35	II	14661–43618
	3452.37	I	11525–40482
9	3456.54	I	9329–38251
11	3457.79	I	9043–37955
9	3458.95	I	5965–34868
11	3459.70	I	9498–38393
6	3462.65	I	2154–31026
20	3463.81	I	13012–41874
22	3465.86	I	1143–29987
11	3467.47	I	8705–37537
15	3469.44	I	9329–38144
12	3471.19	I	16919–45719
17	3473.02	I	13146–41931
6	3475.58	I	12982–41746
34	3478.69	I	5965–34704
	3478.78	II	10247–38984
24	3479.56	II	10604–39335
6	3481.05	I	4998–33717
12	3484.05	II	6192–34886

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	3485.93	I	13515–42194
9	3489.09	II	7901–36553
28	3491.03	I	1143–29779
6	3491.48	I	1143–29776
9	3496.03	I	12358–40953
24	3497.81	I	392–28973
60	3498.63	I	5298–33872
12	3503.20	I	9329–37866
6	3505.81	I	9439–37955
55	3507.96	I	154–28653
24	3510.26	II	16053–44532
10	3511.19	I	10238–38710
24	3515.42	II	10247–38685
6	3516.20	I	9329–37761
10	3516.86	I	9439–37865
24	3517.67	II	16219–44639
	3517.76	I	5298–33717
24	3520.06	I	1587–29987
10	3525.23	I	13012–41371
12	3533.66	I	154–28445
6	3534.12	I	5965–34253
240	3535.30	I	0–28278
		I	695–28973
150	3537.48	I	392–28653
12	3539.65	I	9043–37287
30	3540.96	II	8320–36553
12	3541.90	I	13146–41371
6	3542.56	I	2805–31026
11	3542.98	I	1143–29360
60	3544.02	I	0–28208
30	3544.65	I	5965–34169
12	3548.13	I	1587–29763
6	3549.26	I	13405–41572
36	3550.45	I	392–28549
30	3554.52	I	2154–30279
120	3554.66	I	154–28278
6	3559.12	I	4998–33087
75	3563.50	I	154–28208
75	3563.62	I	392–28445
6	3568.51	II	7506–35521
12	3568.72	I	4998–33011
22	3569.47	I	2154–30162
6	3575.13	I	12018–39981
180	3575.85	I	695–28653
24	3577.72	I	10238–38180
600	3580.27	I	1050–28973
10	3582.36	I	5965–33872
60	3584.97	I	392–28278
90	3589.11	I	695–28549
60	3589.36	I	2805–30658
60	3593.97	I	392–28208
6	3597.26	I	12288–40079
6	3598.35	I	0–27783
18	3599.28	I	13146–40921
18	3599.63	I	1587–29360
60	3602.56	I	695–28445
6	3604.08	I	695–28434
18	3615.50	I	12358–40009
11	3617.71	I	17476–45110
6	3618.44	I	154–27783
11	3618.90	I	4998–32623
36	3619.51	II	7901–35521
6	3619.73	II	15949–43568
24	3621.03	I	2154–29763
17	3625.17	I	10238–37815
17	3625.71	I	12982–40555
18	3630.62	I	12102–39638
12	3633.00	I	12692–40210
11	3633.31	II	16053–43568
18	3633.71	I	154–27666
12	3634.44	I	8827–36334
12	3635.32	I	12503–40003
12	3636.96	I	12358–39846
12	3637.54	I	12137–39620
18	3637.83	I	
12	3638.79	I	2805–30279
24	3639.33	I	13012–40482
18	3640.64	I	154–27614
10	3643.34	I	12982–40422
10	3643.72	I	15282–42719
12	3644.94	I	9439–36867
6	3647.31	I	13012–40422
50	3649.85	I	392–27783
30	3650.81	I	1050–28434
48	3651.19	II	7506–34886
12	3655.98	I	154–27499
12	3657.11	I	13146–40482
24	3659.61	II	15551–42869
70	3660.37	I	2805–30117
6	3661.68	I	10238–37540
10	3662.05	I	1143–28442
100	3664.70	I	695–27975
6	3666.53	I	11248–38514
5	3667.00	I	12358–39620
6 d	3667.66	I	10923–38180
	3667.76	I	
14	3668.62	I	4998–32249
24	3669.01	I	5298–32546
11	3669.74	I	12288–39530
4	3671.37	I	12018–39248

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6 hc	3672.44	I	392–27614
3.0	3673.23	I	13146–40362
30	3674.78	I	392–27597
3.0	3675.17	I	
10	3676.31	I	12692–39886
10	3677.08	I	11044–38232
12	3677.78	I	9329–36511
3.0	3678.72	I	15467–42643
9	3686.56	I	2154–29272
3.0	3687.44	I	12137–39248
12	3687.97	II	17425–44532
9	3688.18	II	10919–38024
12	3688.70	I	695–27797
9	3689.04	I	11044–38144
16	3693.37	I	4998–32066
16	3694.67	I	11525–38583
10	3695.90	II	14661–41710
13	3697.39	I	5965–33004
160	3697.85	I	392–27427
10	3699.93	I	
13	3703.16	I	13012–40008
13	3703.91	I	13012–40003
15	3704.14	I	11525–38514
7	3707.80	I	1587–28549
20	3709.25	II	11340–38291
	3709.42	I	5298–32249
7	3710.45	I	10923–37866
34	3711.34	I	0–26937
5	3711.78	I	5965–32899
340	3713.01	I	1050–27975
20	3713.82	I	695–27614
9	3716.21	I	695–27597
50	3716.99	I	11248–38144
	3717.06	II	13666–40561
14	3717.54	I	10923–37815
9	3720.46	II	13690–40561
7	3721.52	I	12982–39846
10	3722.32	I	13146–40003
10	3722.95	I	
7	3725.22	I	9498–36334
280	3726.24	I	154–26983
14	3727.23	I	11044–37866
10	3732.03	I	11044–37832
7	3733.32	I	18332–45110
7	3733.62	I	1143–27919
28	3738.42	I	10238–36979
280	3739.80	I	695–27427
70	3740.73	II	13055–39780
	3740.84	I	695–27420
28	3741.78	I	0–26718
180	3742.39	I	0–26713
20	3744.00	I	10923–37625
14	3746.91	I	
18	3748.55	I	8827–35496
7	3750.63	I	1143–27797
26	3753.18	I	695–27332
4	3755.28	I	1587–28208
22	3755.77	I	11248–37866
14	3759.55	I	392–26983
4	3760.64	I	11248–37832
18	3761.13	I	11044–37625
4	3762.45	I	
55	3763.49	I	154–26718
16	3764.12	I	154–26713
36	3765.08	I	0–26552
26	3766.13	I	392–26937
18	3769.15	I	1143–27666
14	3769.98	I	12503–39021
8	3770.71	I	11248–37761
14	3770.87	I	
55	3771.85	I	392–26897
11	3773.15	I	11044–37540
7	3774.44	I	5965–32452
14	3775.45	I	11044–37524
4	3776.60	I	1143–27614
5	3777.28	I	2805–29272
6	3777.67	I	15282–41746
90	3781.01	I	392–26832
11	3781.38	II	13666–40104
14	3783.84	I	10923–37344
14	3786.22	I	2805–29209
180	3787.06	I	154–26552
7	3787.48	I	2154–28549
7	3789.50	I	2154–28535
140	3790.15	I	1050–27427
360	3791.21	I	1050–27420
9	3794.47	I	12102–38449
14	3795.54	I	
11	3796.44	I	15282–41615
11	3796.59	I	1587–27919
11	3796.85	I	13515–39846
280	3798.12	I	392–26713
18	3800.94	I	9329–35631
28	3801.30	I	11044–37344
280	3802.92	I	695–26983
70	3803.88	I	1050–27332
55	3804.74	I	11248–37524
		II	17292–43568
18	3806.20	I	10923–37188
6	3806.63	I	14211–40474

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
70		3810.49	I	11525–37761
55		3811.03	I	154–26386
3.5		3813.47	I	
55		3815.51	I	695–26897
7		3816.34	I	1587–27783
22		3818.86	II	12806–38984
22		3819.15	I	4998–31175
3.5		3821.19	I	8705–34868
70		3824.88	I	695–26832
11		3827.01	I	13515–39638
3.5		3828.24	II	13666–39780
3.5		3830.00	I	8705–34808
18		3831.84	II	13690–39780
3.5		3833.26	I	12503–38583
36		3835.18	I	0–26067
26		3836.45	I	9439–35497
7		3837.08	I	14899–40953
18		3841.81	I	13405–39427
14		3842.71	I	9329–35345
3.5		3843.93	I	5965–31973
7		3844.08	I	11248–37254
22		3845.90	I	392–26386
11		3853.38	I	10923–36867
3.5		3854.70	I	11044–36979
7		3855.15	I	11044–36976
7		3855.45	I	0–25930
30		3858.95	I	154–26061
3.5		3860.86	I	12358–38251
14	d	3862.93	I	0–25880
		3863.05	II	12806–38685
36		3863.38	I	5298–31175
7		3865.02	II	13119–38984
		3865.04	I	13515–39381
28		3867.92	I	1050–26897
7		3871.19	I	9043–34868
3.5		3875.42	I	12018–37815
18		3875.76	I	1143–26937
14		3876.96	I	12358–38144
55		3877.56	I	1050–26832
90		3878.82	I	392–26166
		3878.97	I	1587–27360
7		3879.35	II	14791–40561
70		3883.14	I	695–26440
110		3885.44	I	11525–37254
70		3885.68	I	11248–36976
22		3886.07	I	154–25880
4		3889.63	I	
3		3889.80	I	2154–27855
60		3891.30	I	695–26386
5		3893.73	I	392–26067
5		3894.03	I	11044–36717
4		3894.70	I	392–26061
18		3895.90	I	9439–35100
11		3898.28	II	13690–39335
11		3898.56	I	2154–27797
7		3899.25	I	15282–40921
12		3904.18	I	12018–37625
9		3906.91	I	8827–34416
4		3908.59	I	13405–38982
22		3908.97	I	1143–26718
7		3909.60	I	13012–38583
13		3913.01	I	11318–36867
70		3914.70	I	10923–36460
7		3919.00	I	9329–34838
7		3919.16	I	12358–37866
3.5		3919.72	II	13480–38984
55		3920.20	I	13012–38514
11		3922.35	I	12137–37625
7		3924.49	I	12358–37832
18		3925.00	I	695–26166
7		3926.61	I	2154–27614
13		3929.29	I	2154–27597
3.5		3931.46	I	9439–34868
3.5		3934.14	I	10923–36334
10		3934.41	I	1143–26552
9		3935.45	I	12137–37540
6		3936.45	I	1587–26983
70		3937.44	I	1050–26440
10		3937.96	I	12137–37524
18		3941.27	I	695–26061
54		3943.67	I	1587–26937
10		3947.53	I	12018–37344
7	d	3949.33	I	9439–34753
		3949.46	II	14791–40104
6		3949.94	I	1587–26897
7		3952.37	II	13690–38984
10		3953.08	I	11044–36334
11		3955.68	I	2154–27427
7		3959.36	I	12982–38232
3.5		3960.98	I	13012–38251
3.5		3964.66	I	9439–34655
26		3965.69	I	5965–31175
95	d	3966.09	I	12137–37344
		3966.25	I	2154–27360
7		3970.65	I	2154–27332
22		3971.85	I	12018–37188
		3971.93	I	2805–27975
18		3972.52	I	12358–37524
11		3973.62	I	16829–41987
13		3976.67	I	15282–40422

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
11		3977.94	I	13012–38144
11		3978.75	I	1587–26713
7		3979.37	I	12692–37815
4		3980.48	I	1050–26166
3.5		3982.06	I	13146–38251
3.0		3984.81	I	15467–40555
6		3985.18	I	11248–36334
11		3988.16	I	16829–41896
3.0		3990.67	I	12137–37188
11		3991.68	I	
3.0		3994.43	I	11248–36276
15		3999.18	I	13146–38144
4		4000.60	II	14791–39780
8		4001.13	I	12358–37344
3.0		4002.26	I	
4	d	4005.93	I	
14		4008.28	I	10238–35179
14		4009.71	I	12692–37625
7		4012.06	I	1143–26061
20		4013.27	I	16919–41829
3.0		4014.93	I	12288–37188
4		4016.08	I	
12		4017.56	I	12982–37866
3.0		4020.24	I	
3.0		4022.39	I	13012–37866
16		4023.14	I	12982–37832
7		4027.31	I	12288–37112
7		4027.98	I	13012–37832
3.0		4029.22	I	
4	h	4030.35	I	
110		4032.52	I	2805–27597
3.0		4033.20	I	1143–25930
7		4035.10	I	13405–38180
7		4035.93	I	15439–40210
4	h	4038.18	I	
9		4039.10	I	11525–36276
26		4039.53	I	13012–37761
7	h	4040.47	I	2154–26897
9		4042.57	I	12137–36867
9		4043.16	I	15282–40009
17		4044.10	I	13146–37866
13		4044.71	I	13515–38232
18		4049.76	I	13146–37832
18		4051.52	I	9329–34004
3.5		4056.94	I	12982–37625
3.0		4057.27	I	15439–40079
1700	c	4058.94	I	1050–25680
22		4059.51	I	10126–34753
12		4060.31	I	2805–27427
36		4060.79	I	154–24773
4		4061.26	I	10238–34854
14		4061.54	I	2805–27420
9		4064.81	I	12692–37287
9		4066.12	I	11044–35631
18		4067.16	I	12137–36717
22		4068.26	I	10923–35496
3.0		4070.04	I	
14		4070.96	I	12982–37540
4		4072.07	II	13666–38216
9		4073.51	I	15439–39981
		4073.64	I	12982–37524
6		4076.09	I	2805–27332
8		4077.09	I	15461–39981
5		4078.35	I	392–24905
4		4078.60	I	13012–37524
1200		4079.73	I	695–25200
4		4083.78	I	1587–26067
9		4084.18	I	5298–29776
28		4084.86	I	1587–26061
9		4086.63	I	9439–33902
4		4087.05	I	13405–37865
14		4090.16	I	12018–36460
5		4095.56	I	13405–37815
4	h	4097.64	I	17476–41874
5		4098.22	I	13146–37540
18		4099.07	I	154–24543
46		4100.40	I	392–24773
700		4100.92	I	392–24770
8		4106.18	I	9043–33390
3.5		4106.78	I	1587–25930
4		4109.88	I	5298–29623
14		4112.13	I	16829–41140
5		4113.35	I	12982–37287
18		4113.94	I	11044–35345
32		4116.90	I	0–24283
9		4119.28	II	21073–45342
12		4122.81	I	11248–35496
550		4123.81	I	154–24397
8		4125.25	I	10923–35157
5		4125.58	I	2154–26386
5		4126.90	I	
9		4127.45	I	16919–41140
70		4129.43	I	695–24905
80		4129.93	I	
9		4131.53	I	12137–36334
18		4134.59	I	11318–35497
8		4135.42	I	12692–36867
240		4137.10	I	0–24165
8		4137.59	I	12018–36180
5		4138.30	I	18036–42194

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
46	4139.44	I	392–24543
280	4139.71	I	1050–25200
5	4142.24	I	11044–35179
36	4143.21	I	154–24283
5	4146.00	I	11044–35157
17	4147.19	I	11525–35631
9	4148.74	I	8827–32924
90	4150.12	I	
12	4152.04	I	695–24773
460	4152.58	I	695–24770
3.5	4156.68	II	16053–40104
18	4158.01	I	12137–36180
5	4160.80	I	2805–26832
8	4161.25	I	13515–37540
5	4162.81	I	10238–34253
90	4163.47	I	2154–26166
460	4163.66	I	154–24165
420	4164.66	I	392–24397
9	4165.85	I	12018–36016
360	4168.13	I	0–23985
18	4169.57	I	12358–36334
12	4173.95	I	18036–41987
9	4174.34	I	8705–32654
5	4177.44	I	10238–34169
9	4179.76	I	12358–36276
9	4181.34	I	11248–35157
32	4184.44	I	392–24283
8	4186.10	I	13405–37287
6	4189.99	I	18036–41896
9	4190.65	I	9043–32899
120	4190.88	I	1050–24905
90	4192.07	I	695–24543
6	4193.83	I	8411–32249
90	4195.09	I	154–23985
140	4195.66	I	8827–32654
5	4196.95	I	11525–35345
5	4197.61	I	16919–40735
32	4198.51	I	695–24507
8	4198.85	I	11044–34854
3.5	4200.99	I	5965–29763
36	4201.52	I	11044–34838
7	4203.41	I	13405–37188
7	4204.32	I	8827–32605
90	4205.31	I	392–24165
9	4206.13	I	12692–36460
16	4208.16	I	154–23911
9	4212.04	I	12982–36717
9	4212.53	I	10923–34655
9	4213.26	I	12288–36016
4	4213.46	I	16829–40555
36	4214.73	I	1050–24770
44	4217.94	I	695–24397
4	4222.68	I	9329–33004
8	4226.22	I	8411–32066
4	4227.51	I	9438–33087
44	4229.15	I	9498–33136
18	4229.83	I	2805–26440
13	4230.32	I	12288–35920
18	4231.95	I	392–24015
8	4237.81	I	11248–34838
9	4241.45	I	9329–32899
12	4242.63	I	18332–41896
13	4246.30	I	8705–32249
3.0	4248.66	I	154–23684
13	4249.46	I	0–23526
17	4252.97	I	9498–33004
15	4253.70	I	9043–32546
13	4254.69	I	8411–31908
26	4255.44	I	10923–34416
4	4255.94	I	
9	4258.91	I	9329–32802
9	4261.71	I	9043–32501
80	4262.05	I	1050–24507
44	4266.02	I	8705–32140
9	4268.67	I	154–23574
30	4270.69	I	9043–32452
3.5	4272.97	I	10923–34319
3.0	4273.36	I	12102–35496
8	4274.69	I	8827–32214
13	4277.50	I	154–23526
8	4279.50	I	8705–32066
4	4279.71	I	12137–35496
17	4280.60	I	5298–28653
8	4286.22	I	12692–36016
42	4286.99	I	695–24015
20	4289.44	I	5965–29272
15	4291.19	I	8411–31708
8	4292.04	I	392–23684
15	4292.48	I	9043–32333
11	4295.62	I	12358–35631
12	4296.16	I	
60	4299.60	I	5298–28549
60	4300.99	I	5965–29209
3.0	4303.88	I	8705–31934
8	4306.28	I	9439–32654
4	4308.12	I	9043–32249
8	4308.69	I	8705–31908
12	4309.56	I	12982–36180
40	4311.27	I	13146–36334
	4311.39	I	13146–36334

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	4311.70	I	1587–24773
12	4312.45	I	392–23574
4	4313.88	I	16829–40003
4	4316.48	I	12018–35179
4	4318.01	I	10238–33390
3.0	4323.47	I	9329–32452
36	4326.33	I	9498–32605
12	4327.38	I	8705–31808
10	4328.43	I	9043–32140
8	4329.73	I	154–23244
40	4331.37	I	4998–28079
3.0	4337.56	I	9498–32546
3.0	4338.70	I	12137–35179
14	4342.82	I	12137–35157
10	4345.32	I	0–23007
4	4346.12	I	8705–31708
4	4347.31	I	13515–36511
14	4348.65	I	695–23684
11	4349.03	I	12358–35345
4	4350.30	I	8827–31808
30	4351.57	I	8827–31801
6	4353.27	I	1050–24015
3.0	4354.19	I	11044–34004
3.0	4356.85	I	12982–35928
7 c	4359.85	I	9043–31973
3.5	4361.65	I	4998–27919
4.0	4367.97	II	13666–36553
22	4368.43	I	9329–32214
2.5	4369.62	I	695–23574
6	4370.36	I	2805–25680
4	4374.78	I	391–23244
3.0	4375.25	I	10238–33087
14	4377.96	I	12018–34854
7	4379.52	I	9329–32156
4	4381.13	I	13515–36334
2.5	4382.49	I	12288–35100
3.5	4382.84	I	1587–24397
7	4384.86	I	12358–35157
7	4387.74	I	4998–27783
13	4388.36	I	5298–28079
17	4392.69	I	9329–32088
7	4397.04	I	12102–34838
3.5	4400.35	I	16919–39638
6	4400.83	I	12137–34854
3.5	4402.05	I	
3.5	4406.55	I	5965–28653
34	4410.21	I	4998–27666
10	4411.52	I	10238–32899
2.5	4412.18	I	8827–31485
3.0	4414.88	I	9043–31688
2.5	4416.41	I	12018–34655
20	4419.44	I	5298–27919
6	4419.83	I	2154–24773
6	4420.45	I	2154–24770
10	4420.64	I	392–23007
3.0	4423.87	I	16829–39427
10	4426.68	I	5965–28549
10	4429.44	I	5965–28535
24 c	4437.22	I	
2.5	4437.90	I	17476–40003
2.0	4440.43	I	12982–35496
6	4441.81	I	9498–32005
6	4445.85	I	1050–23537
8	4446.17	I	13146–35631
30	4447.18	I	5965–28445
15	4456.80	I	1143–23574
15	4457.42	I	1587–24015
6	4458.12	I	13405–35829
5	4460.20	I	
9	4460.42	I	13515–35928
9	4464.15	I	2805–25200
2.5	4465.92	I	10238–32623
2.5	4466.42	I	1143–23526
5	4469.32	I	5298–27666
14	4469.71	I	12288–34655
14	4471.29	I	9329–31688
14	4472.53	I	2154–24507
3.0	4475.28	I	
3.0	4481.44	I	10238–32546
2.0	4492.96	II	21040–43290
5	4494.57	I	5965–28208
2.0	4497.25	I	8827–31057
8	4499.80	I	12102–34319
16	4503.04	I	5298–27499
2.5	4503.42	I	13146–35345
5	4508.41	I	12982–35157
8	4511.09	I	17476–39638
2.0	4512.13	I	9329–31485
55	4523.41	I	1143–23244
8	4524.12	I	1587–23684
2.5	4527.65	II	12806–34886
2.5	4529.42	I	11318–33390
4	4542.80	I	0–22007
50	4546.82	I	1587–23574
2.5	4547.85	I	9043–31026
9	4553.84	I	5965–27919
4	4556.84	I	4998–26937
2.0	4559.42	I	
38	4564.53	I	12102–34004
2.5	4570.95	I	12982–34854

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
75		4573.08	I	2154–24015
2.0		4574.33	I	11044–32899
8		4574.84	I	154–22007
4		4575.37	I	10238–32088
2.5		4579.45	II	13690–35521
50		4581.62	I	12503–34323
8		4582.29	I	5965–27783
2.5		4599.48	I	9439–31175
10		4600.21	I	12503–34235
2.0		4602.86	I	4998–26718
120		4606.77	I	2805–24507
2.5		4608.58	I	13146–34838
2.0		4610.69	I	10923–32605
3.0		4612.12	I	11248–32924
18		4616.17	I	1587–23244
2.0		4627.48	I	
34		4630.11	I	11525–33116
5		4638.10	I	11248–32802
2.0		4643.31	I	2154–23684
5	c	4643.68	I	11044–32573
4		4646.95	I	18332–39846
34		4648.95	I	1143–22647
8		4649.27	I	
2.5		4658.18	I	5965–27427
34		4663.83	I	1587–23023
2.0		4665.33	I	12288–33717
26		4666.24	I	11248–32672
18		4667.22	I	2154–23574
2.5		4669.87	I	11044–32452
44		4672.09	I	2805–24203
2.5		4673.59	I	18036–39427
40		4675.37	I	2154–23537
8		4678.48	I	8411–29779
2.0		4682.66	I	16672–38021
24		4685.14	I	11044–32382
5		4694.51	I	16981–38277
5		4695.47	I	10923–32214
7		4697.47	I	8705–29987
10	c	4706.14	I	
20		4708.29	I	10923–32156
2.5		4713.05	I	8411–29623
11		4713.50	I	2805–24015
5		4715.83	I	16672–37871
5		4718.02	I	
4		4723.80	I	17937–39101
4		4727.33	I	11525–32672
5		4730.31	I	11248–32382
6		4733.48	I	392–21512
8	c	4733.89	I	9043–30162
4		4735.33	I	11044–32156
5		4736.49	I	17476–38583
5		4740.61	I	5298–26386
5		4743.84	I	8705–29779
6		4744.62	I	12358–33428
17	c	4749.70	I	11525–32573
5		4751.42	I	16981–38021
2		4755.32	I	13146–34169
5		4766.81	I	17304–38277
2.5		4771.85	I	9329–30279
6		4773.25	I	9043–29987
1.6		4777.62	I	12503–33428
2.0		4785.70	I	12982–33872
5		4789.96	II	19690–40561
2.0		4802.45	I	695–21512
3.0		4807.06	I	12102–32899
4		4809.37	I	12137–32924
6	c	4810.60	I	9498–30279
8		4816.38	I	11248–32005
4		4829.30	I	17937–38638
5		4833.37	I	154–20838
2.0		4837.62	I	18435–39101
2.0		4837.99	I	9498–30162
4		4842.15	I	12358–33004
4		4845.17	I	12503–33136
8	c	4848.37	I	9498–30117
6		4868.99	I	18876–39409
7		4890.75	I	11044–31485
4		4892.50	I	12018–32452
2.0		4895.58	I	5965–26386
5		4900.79	I	12102–32501
5		4904.53	I	0–20384
6		4910.95	I	13515–33872
2.5		4928.98	I	13146–33428
1.4		4941.52	I	12102–32333
1.4		4953.13	I	9439–29623
4	c	4965.37	I	10923–31057
6	c	4967.78	I	13012–33136
2.5		4971.93	I	0–20107
5		4973.14	I	12503–32605
2.5		4975.14	I	12358–32452
9		4988.97	I	695–20734
3.0		4994.30	I	
3.5		4997.88	I	12137–32140
4		5000.95	I	13146–33136
3.0		5002.25	I	12102–32088
2.0		5013.27	I	12982–32924
11		5017.75	I	392–20316
2.0		5019.51	I	12982–32899
7		5026.36	I	12018–31908
2.0		5030.13	I	13515–33390

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
10		5039.04	I	154–19994
2.0		5047.96	I	14899–34704
8		5058.01	I	0–19765
3.0		5059.35	I	12692–32452
6		5065.25	I	695–20432
2.0		5077.40	I	12018–31708
36		5078.96	I	1050–20734
2.0	c	5094.41	I	0–19624
20		5095.30	I	695–20316
8		5100.16	I	392–19994
8		5120.30	I	392–19917
4		5121.80	I	12982–32501
4		5127.66	I	10126–29623
2.0		5133.34	I	5298–24773
10		5134.75	I	154–19624
3.5		5140.58	I	12692–32140
3.5		5147.54	I	15282–34704
1.8		5150.64	I	11248–30658
3.5		5152.63	I	9043–28445
12		5160.33	I	392–19765
12		5164.38	I	2154–21512
11		5180.31	I	695–19994
5		5186.98	I	154–19428
9		5189.20	I	1050–20316
8		5193.08	I	1587–20838
7		5195.84	I	1143–20384
3.0		5203.22	I	8705–27919
1.6		5205.13	I	9329–28535
4	c	5219.10	I	9498–28653
3		5225.16	I	11525–30658
7		5232.81	I	9329–28434
4	c	5237.43	I	8411–27499
1.4		5240.39	I	8705–27783
7	d	5251.62	I	0–19037
		5251.81	I	392–19428
3.5		5253.03	I	11248–30279
4		5253.93	I	8827–27855
2.5		5269.92	I	8827–27797
13		5271.53	I	1143–20107
1.2		5272.48	I	8705–27666
6	c	5276.20	I	9498–28445
1.4	c	5279.43	I	9498–28434
2.5		5285.26	I	
1.6		5296.34	I	14211–33087
2.5		5315.55	I	5965–24773
0.8		5317.01	I	11044–29846
12		5318.60	I	1587–20384
2.5		5319.49	I	8705–27499
3.5		5334.87	I	9043–27783
1.2		5336.81	I	695–19428
2.5		5340.80	I	11044–29763
1.2		5343.58	I	
22		5344.17	I	2805–21512
16		5350.74	I	2154–20838
2.0		5353.28	I	20734–39409
1.2		5355.31	I	12358–31026
2.0		5355.70	I	11525–30191
1.4		5359.19	I	8705–27360
0.8		5362.01	I	392–19037
1.8		5375.27	I	11248–29846
2.0		5381.34	I	5965–24543
0.8		5388.30	I	9043–27597
1.0		5395.86	I	4998–23526
1.4		5396.33	I	8411–26937
1.4		5411.24	I	11044–29519
1.0		5416.30	I	11318–29776
3.0		5422.44	I	10923–29360
1.0		5431.26	I	1587–19994
5		5437.27	I	5298–23684
0.9		5448.31	I	10923–29272
0.9		5456.19	I	20316–38638
1.8		5458.04	I	9043–27360
0.9	h	5468.10	I	19994–38277
1.8		5481.00	I	18036–36276
0.6		5483.09	I	
0.9		5483.49	I	8705–26937
0.6		5491.06	I	20432–38638
0.8		5499.53	I	1587–19765
2.0		5504.58	I	2154–20316
0.8		5509.12	I	13405–31551
1.6	c	5512.82	I	
0.8		5517.39	I	
2.5		5523.57	I	9498–27597
1.2		5541.47	I	10238–28278
4		5551.35	I	4998–23007
1.4		5563.00	I	10238–28208
0.8	c	5571.44	I	18332–36276
1.6	c	5576.16	I	2805–20734
1.6		5578.29	I	12358–30279
2.5		5586.97	I	1143–19037
0.8	c	5590.95	I	
0.6		5594.89	I	17476–35345
0.8	c	5599.59	I	9043–26897
2.0		5603.52	I	1587–19428
0.6		5603.93	I	2154–19994
1.2		5628.26	I	2154–19917
3.0		5629.17	I	12358–30117
1.6	c	5635.42	I	
8		5642.11	I	5965–23684
1.6		5645.30	I	5298–23007

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.8	5654.14	I	10238–27919
6	5664.71	I	1143–18791
8	5665.63	I	13012–30658
0.8	5666.86	I	15282–32924
3 cw	5671.02	I	11345–28973
4	5671.91	I	12137–29763
1.2	5677.47	I	5965–23574
1.2	5693.09	I	5965–23526
1.6 d	5697.90	I	13629–31175
	5698.03	I	10238–27783
2.0	5706.16	I	15282–32802
4	5706.48	I	8411–25930
1.4	5709.33	I	13515–31026
0.8	5715.59	I	12288–29779
3.0	5716.35	I	12358–29846
1.2	5725.66	I	18036–35496
6	5729.19	I	1587–19037
1.0	5737.36	I	
0.6	5738.20	I	
4	5751.44	I	12137–29519
5	5760.34	I	8705–26061
3.0	5764.99	I	12018–29360
1.4	5771.08	I	15282–32605
2.5 c	5776.07	I	11345–28653
0.8	5780.34	I	12692–29987
4	5787.54	I	2154–19428
0.8	5789.79	I	13012–30279
2.5	5794.24	I	12018–29272
2.5	5804.03	I	8705–25930
1.4 h	5815.33	I	12018–29209
5	5819.43	I	13012–30191
1.6	5820.62	I	16829–34004
3.5	5834.90	I	13146–30279
1.2	5838.15	I	11318–28442
6 d	5838.64	I	9043–26166
2.5	5842.47	I	2805–19917
0.8	5846.09	I	11345–28445
3.0	5866.47	I	5965–23007
1.6	5874.70	I	9043–26061
0.8	5877.79	I	4998–22007
2.0	5893.44	I	14211–31175
9 cw	5900.62	I	9498–26440
2.0 c	5903.80	I	11345–28278
1.4	5927.41	I	15467–32333
2.0 c	5934.16	I	17476–34323
2.0	5957.70	I	12982–29763
7	5983.22	I	5298–22007
3.0	5986.08	I	13146–29846
4 cw	5997.93	I	9498–26166
2.5	6029.75	I	12692–29272
2.5	6031.84	I	15439–32013
2.5	6045.50	I	12982–29519
1.2	6048.72	I	17476–34004
1.4	6056.65	I	15467–31973
1.4	6107.71	I	15439–31808
2.0	6142.51	I	14899–31175
2.5	6148.13	I	13515–29776
2.5	6164.32	I	13405–29623
1.4	6213.06	I	15461–31551
3.5	6221.96	I	8705–24773
2.0 c	6251.76	I	18332–34323
1.0	6260.77	I	18036–34004
4 c	6430.46	I	5965–21512
2.5 c	6433.22	I	5298–20838
0.8	6497.84	I	4998–20384
3.0	6544.61	I	9498–24773
0.7	6574.73	I	8705–23911
0.9 cw	6591.00	I	
0.9	6606.16	I	
0.9	6607.28	I	13405–28535
1.6	6614.15	I	8411–23526
0.9	6626.98	I	5298–20384
10 cw	6660.84	I	9498–24507
7 cw	6677.33	I	9043–24015
3.0	6701.20	I	13515–28434
6 c	6723.62	I	8705–23574
3.5	6739.88	I	8411–23244
1.2	6795.31	I	
4	6828.11	I	9043–23684
1.2 c	6849.35	I	8411–23007
0.9	6870.92	I	
1.8	6876.36	I	8705–23244
1.2 c	6902.89	I	9043–23526
1.6	6908.07	I	9439–23911
2.0	6918.32	I	13405–27855
0.8	6946.07	I	13405–27797
0.8	6972.49	I	14211–28549
1.2	6986.09	I	14899–29209
4	6990.32	I	8705–23007
0.8 c	6996.11	I	13629–27919
1.0	7023.48	I	14211–28445
0.8	7038.04	I	12692–26897
9 c	7046.81	I	9498–23684
0.4	7066.41	I	12018–26166
0.4	7075.23	I	5298–19428
1.8 c	7098.94	I	12358–26440
0.8 cw	7102.01	I	9498–23574
0.9	7119.31	I	12018–26061
0.7	7122.95	I	
1.6	7126.17	I	12137–26166

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.8	7130.06	I	12692–26713
6	7159.43	I	9043–23007
0.8	7191.37	I	
0.9 c	7208.94	I	14211–28079
2.5	7252.35	I	10126–23911
0.7	7274.81	I	15467–29209
0.6	7317.03	I	24905–38568
0.8 c	7323.92	I	14899–28549
1.4 cw	7328.38	I	12288–25930
3.0 c	7353.16	I	8411–22007
9 cw	7372.50	I	11345–24905
0.6	7419.83	I	12692–26166
0.7	7436.02	I	
0.9	7478.20	I	12692–26061
3.0	7515.93	I	8705–22007
1.4 c	7519.77	I	13146–26440
8 c	7574.58	I	11345–24543
0.8 c	7583.21	I	12982–26166
0.6	7639.81	I	
0.6	7647.71	I	24770–37842
1.2	7703.33	I	25200–38178
3.5 c	7726.68	I	11345–24283
1.2	7757.31	I	25680–38568
0.3	7787.11	I	
0.6 cw	7873.41	I	14899–27597
1.6	7885.31	I	11525–24203
1.2	7938.89	I	11318–23911
0.4	7954.76	I	9439–22007
1.8	8135.20	I	11248–23537
0.6 cw	8240.00	I	8705–20838
1.4 cw	8320.93	I	9498–21512
1.4	8346.08	I	11044–23023
0.5	8350.04	I	8411–20384
0.8	8439.77	I	12358–24203
0.8 cw	8475.98	I	9043–20838
1.2	8526.99	I	10923–22647
0.6 c	8547.25	I	8411–20107
0.8 c	8560.54	I	8705–20384
0.8	8575.87	I	12358–24015
1.0 c	8697.55	I	13012–24507
1.0	8740.96	I	12137–23574
1.0	8767.97	I	8705–20107
1.4 cw	8815.56	I	9498–20838
1.6	8905.78	I	12018–23244

OSMIUM

Os, $Z=76$, $M=190.2$, Ratio $\frac{Os}{Cu}=2.993$

Os I Normal state of valence electrons $5d^6 6s^2\ {}^5D_4 = 0$. I.P.=70450 K
Os II Normal state of valence electrons $5d^6 6s^1\ {}^6D_{4½} = 0$.

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
W. Albertson, unpublished material.
T. A. M. van Kleef, Proc. Koninkl. Ned. Akad. Wetenschap. B. **63,** 501–601 (1960).

Classification:
Os I, W. Albertson, Phys. Rev. **45,** 304 (1934).
Os I and Os II, T. A. M. van Kleef, Proc. Koninkl. Ned. Akad. Wetenschap. B. **63,** 501–601 (1960).

Relative intensity of osmium lines observed in an arc of copper containing 0.1 atomic percent of osmium

Strong lines of osmium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	2909. 06	I	0–34365	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^5F_5^\circ$
900	3058. 66	I	0–32685	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^7F_4^\circ$
800	3301. 56	I	0–30280	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^7F_5^\circ$
480	2838. 63	I	5144–40362	$5d^7 6s^1\ a\ {}^5F_5 - 5d^6 6s^1 6p^1\ {}^3F_4^\circ$
460	3018. 04	I	0–33124	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^7P_3^\circ$
440	4260. 85	I	0–23463	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ z\ {}^7D_5^\circ$
440	4420. 47	I	0–22616	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ z\ {}^7D_4^\circ$
380	2488. 55	I	5144–45316	$5d^7 6s^1\ a\ {}^5F_5 - 5d^7\ 6p^1\ {}^5G_6^\circ$
360	2637. 13	I	0–37909	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^5D_4^\circ$
360	3752. 52	I	2740–29382	$5d^6 6s^2\ a\ {}^5D_2 - 5d^6 6s^1 6p^1\ {}^7F_3^\circ$
320	3156. 25	I	5144–36818	$5d^7 6s^1\ a\ {}^5F_5 - 5d^6 6s^1 6p^1\ {}^5F_5^\circ$
320	3262. 29	I	4159–34804	$5d^6 6s^2\ a\ {}^5D_3 - 5d^6 6s^1 6p^1\ {}^5F_4^\circ$
320	3167. 94	I	0–30591	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^7P_4^\circ$
300	3040. 90	I	2740–35616	$5d^6 6s^2\ a\ {}^5D_2 - 5d^6 6s^1 6p^1\ {}^5P_3^\circ$
280	2714. 64	I	0–36826	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^5D_4^\circ$
260	2806. 91	I	0–35616	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^5P_3^\circ$
220	2498. 41	I	8743–48756	$5d^7 6s^1\ a\ {}^5F_4 -$ 48756$_4^\circ$
220	2844. 40	I	5144–40290	$5d^7 6s^1\ a\ {}^5F_5 - 5d^6 6s^1 6p^1\ {}^5G_6^\circ$
220	4135. 78	I	4159–28332	$5d^6 6s^2\ a\ {}^5D_3 - 5d^5 6s^2 6p^1\ {}^7P_4^\circ$
200	2513. 25	I	5144–44921	$5d^7 6s^1\ a\ {}^5F_5 - 5d^7\ 6p^1\ {}^5G_5^\circ$
200	2689. 82	I	5144–42310	$5d^7 6s^1\ a\ {}^5F_5 - 5d^6 6s^1 6p^1\ {}^5G_4^\circ$
200	2912. 33	I	4159–38486	$5d^6 6s^2\ a\ {}^5D_3 - 5d^5 6s^2 6p^1\ {}^5P_3^\circ$
200	2919. 79	I	2740–36980	$5d^6 6s^2\ a\ {}^5D_2 - 5d^6 6s^1 6p^1\ {}^5D_3^\circ$
200	3232. 06	I	4159–35090	$5d^6 6s^2\ a\ {}^5D_3 - 5d^6 6s^1 6p^1\ {}^5P_2^\circ$
200	3782. 20	I	4159–30591	$5d^6 6s^2\ a\ {}^5D_3 - 5d^6 6s^1 6p^1\ {}^7P_4^\circ$
180	2644. 11	I	0–37809	$5d^6 6s^2\ a\ {}^5D_4 - 5d^6 6s^1 6p^1\ {}^5F_3^\circ$
180	2658. 60	I	5144–42747	$5d^7 6s^1\ a\ {}^5F_5 - 5d^7\ 6p^1\ {}^5D_4^\circ$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2001.45	I	0–49947
7	2003.73	I	4159–54050
5	2004.78		
10	2010.15		
19	2018.14	I	0–49534
19	2020.26		
10	2022.76	I	2740–52162
10	2028.23	I	4159–53447
14	2034.44	I	0–49138
24	2045.36		
7	2048.28	I	2740–51546
7	2049.42	I	4159–52938
9	2058.69		
	2058.78	I	4159–52716
14	2061.69	I	2740–51229
9	2067.21	II	3593–51952
5	2070.67	II	3929–52206
9	2076.95	I	0–48132
9	2078.09		
18	2079.97	I	0–48062
4	2082.54	I	4159–52162
4	2089.03	I	0–47854
4	2089.21	I	2740–50589
9	2097.60	I	5144–52802
9	2100.63	I	2740–50330
4	2117.66	I	2740–49947
9	2117.96	I	0–47200
13	2119.79		
4	2123.84	I	4159–51229
13	2137.11	I	4159–50937
7	2149.97		
8	2154.59	I	2740–49138
4	2157.84	I	0–46328
4	2158.53	I	2740–49054
8	2161.00		
11	2166.90	I	4159–50294
4	2167.75		
8	2171.65	I	2740–48773
4	2184.68	I	0–45759
4	2194.39	II	3593–49149
4	2202.49	I	0–45389
4	2227.98	I	0–44870
8	2234.61	I	2740–47477
12	2252.15	I	8743–53131
19	2255.85	I	2740–47052
		II	0–44315
15	2264.60	I	4159–48303
4	2268.28	I	2740–46813
11	2270.17	I	2740–46776
18	2282.26	II	0–43802
11	2283.67	I	4159–47935
8	2289.32	I	4159–47828
6	2297.31	I	0–43516
11	2308.31	I	
3.5	2313.75	II	5592–48799
11	2320.18	I	
6	2323.98	I	
13	2324.24	I	0–43011
3.5	2325.51	I	5144–48132
7	2326.99	I	6093–49054
7	2334.56	I	2740–45562
17	2336.80	II	3593–46374
11	2338.63	I	0–42747
7	2340.69	I	5144–47854
11	2343.74	I	4159–46813
7	2345.75	I	4159–46776
11	2347.38	I	8743–51329
6	2350.23	II	5592–48128
1.6	2351.55	I	10166–52678
1.6	2351.72	I	11378–53887
10	2352.99	I	8743–51229
3.5	2355.28	II	3929–46374
7	2356.92	I	
7	2357.25	I	8743–51152
10	2362.41	I	0–42317
28	2362.77	I	0–42310
6	2363.33	I	8743–51043
16	2367.35	II	3929–46157
10	2369.24	I	8743–50937
17	2370.70	I	4159–46328
17	2371.18	I	8743–50903
3.0	2374.33	I	4159–46264
3.5	2374.51	I	11031–53131
3.5	2375.06	II	
100	2377.03	I	5144–47200
10	2377.61	I	11378–53424
3.5	2378.14	I	5766–47802
3.5	2378.74	I	12774–54800
34	2379.39	I	5144–47158
7	2379.64	I	4159–46170
7	2379.84		
3.5	2380.82	I	2740–44730
7	2382.46	I	11378–53338
10	2384.62	I	2740–44663
70	2387.29	I	0–41876
15	2394.29	I	11378–53131
13	2395.39	I	2740–44475
48	2395.88	I	0–41726
10	2396.78	I	12774–54484
3.0	2397.61	I	11378–53073

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2398.18	I	11031–52716
48	2401.13	I	8743–50377
13	2402.23	I	4159–45775
10	2403.54	I	10166–51759
16	2403.85	I	8743–50330
5	2405.08	II	
14	2405.45	I	11378–52938
10	2405.96	I	8743–50294
19	2408.67	I	11031–52535
13	2410.98	I	13020–54484
5	2411.90		
5	2414.10	I	8743–50154
16	2414.52	I	2740–44144
10	2415.32		
32	2417.99	I	4159–45503
5	2418.35	I	11378–52716
32	2418.53	I	2740–44075
3.0	2419.63		
6	2420.02	II	13137–54445
3.0	2421.15	I	12774–54064
5	2421.86		
5	2421.94		
13	2423.07	II	7892–49149
5	2424.02	II	13204–54445
3.0	2424.19		
32	2424.56	I	0–41232
95	2424.97	I	0–41225
4	2426.19	I	8743–49947
16	2426.81	I	
5	2427.90	II	13204–54379
3.0	2429.67	I	10166–51311
26	2431.19	I	5144–46264
26	2431.61	I	11378–52491
10	2435.51	I	5766–46813
10	2435.65	I	13020–54064
2.0	2436.51	I	13020–54050
5	2437.73		
3.0	2440.68	I	11378–52338
6	2442.00	I	13365–54302
6	2445.88	I	12774–53647
28	2446.02	I	2740–43611
3.0	2449.88		
75	2450.74	I	8743–49534
6	2451.19	I	11378–52162
44	2451.73	I	2740–43516
5	2453.29	I	5766–46515
44	2453.90	I	8743–49483
9	2454.91	II	3593–44315
44	2456.46	I	2740–43437
6	2457.16	I	13365–54050
6	2458.76		
9	2459.84	I	5766–46407
150	2461.42	I	5144–45759
9	2464.00		
15	2464.50	I	12774–53338
6	2465.16		
9	2468.09	I	10166–50671
9	2468.90	II	11460–51952
5	2470.82		
24	2472.28	I	5766–46202
24	2474.78	I	8743–49138
9	2475.69	I	11378–51759
75	2476.84	I	0–40362
2.5	2480.71	I	11031–51329
15	2481.79		
30	2482.43	I	2740–43011
3.0	2484.04	I	5144–45389
5	2485.32		
44	2486.24	II	3593–43802
380	2488.55	I	5144–45316
6	2489.04	I	10166–50330
24	2491.02	I	8743–48875
24	2491.69	I	11031–51152
30	2492.42	I	6093–46202
15	2493.62		
5	2493.83	I	0–40087
6	2496.45		
5	2496.61		
220	2498.41	I	8743–48756
28	2499.92	I	14339–54328
8	2500.72		
8	2500.91	I	14091–54064
5	2501.84	I	14091–54050
28	2502.29	I	11378–51329
3.0	2503.16		
8	2503.67		
42	2504.39	I	2740–42658
22	2504.51	I	4159–44075
7	2506.38		
7	2506.66		
3.0	2507.18	II	3929–43802
14	2508.61	I	11378–51229
6	2509.71	II	17569–57403
14	2509.94	I	12774–52604
55	2512.87	I	8743–48526
200	2513.25	I	5144–44921
55	2515.04	I	5144–44893
3.0	2517.61	I	13365–53073
42	2517.92	I	4159–43863
55	2518.44	I	5144–44839

609065 O - 62 - 16

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
17	2519.29	I	2740–42422
28	2519.79	I	
6	2524.79	I	4159–43755
14	2526.01	I	2740–42317
6	2526.83	I	12774–52338
11	2527.09	I	8743–48303
17	2532.44	I	14852–54328
10	2534.17	I	10166–49615
65	2538.00	II	0–39390
20	2538.10	I	12774–52162
11	2539.73	I	14091–53454
14	2540.14	I	4159–43516
15	2540.74	I	11031–50377
6	2541.65	I	14091–53424
85	2542.51	I	8743–48062
11	2543.80	I	11031–50330
13	2546.17	I	11031–50294
12	2547.70	I	13365–52604
13	2548.10	I	14339–53572
2.5	2548.83	II	17569–56791
26	2554.46	I	2740–41876
13	2555.11	I	11378–50503
10	2555.27	I	11031–50154
13	2555.80	I	14339–53454
9	2556.08	I	8743–47854
8	2557.77	I	8743–47828
10	2558.09	I	15223–54302
4	2560.19		
4	2560.47		
13	2562.66	I	13365–52375
16	2563.16	II	13204–52206
10	2564.37	I	12774–51759
11	2565.17	I	10166–49138
5	2565.72	I	5766–44730
50	2566.49	I	11378–50330
24	2566.88	I	10166–49112
40	2568.83	I	11031–49947
7	2571.14	I	12774–51656
32	2571.78	I	8743–47615
7	2572.48		
7	2573.09	I	4159–43011
4	2573.48	I	14091–52938
2.5	2574.74	I	15223–54050
8	2578.16	I	11378–50154
14	2578.32	II	15606–54379
12	2580.03	II	13204–51952
34	2581.05	I	5144–43876
70	2581.96	I	5144–43863
10	2582.62	I	5766–44475
12	2586.08		
12	2587.49	I	13020–51656
4	2588.26	I	14091–52716
8	2588.44		
8	2589.39	I	10166–48774
5	2589.51	I	14848–53454
95	2590.76	I	4159–42747
19	2591.98	I	11378–49947
3.0	2593.90	I	16212–54753
14	2594.14	I	12774–51311
16	2596.00	II	24466–62974
2.5	2596.37	I	11031–49534
14	2596.69	I	4159–42658
14	2597.20	I	2740–41232
	2597.29	I	14848–53338
12	2597.58	I	0–38486
10	2599.13	I	14339–52802
14	2599.91	I	11031–49482
10	2600.45	I	12774–51218
6	2600.75	I	
9	2602.33	I	8743–47158
6	2603.22		
6	2603.80	I	13365–51759
18	2604.60	I	6093–44475
4	2604.96	I	14339–52716
20	2609.20	I	8743–47057
36	2609.56	I	5766–44075
38	2610.78	I	13365–51656
10	2611.33	I	14848–53131
44	2612.63	I	0–38264
170	2613.06	I	5144–43402
5	2614.06	I	10166–48409
2.5	2614.50	I	11378–49615
6	2615.96	I	12774–50990
5	2617.18	I	13020–51218
5	2619.28		
75	2619.94	I	4159–42317
22	2620.62	I	2740–40888
50	2621.82	I	0–38130
6	2623.61	I	11378–49482
6	2624.57	I	16212–54302
36	2628.48	I	8743–46776
2.5	2631.22	II	24981–62974
10	2632.89	I	13020–50990
6	2634.29	I	14852–52802
6	2634.44	I	15391–53338
360	2637.13	I	0–37909
6	2637.98	I	12774–50671
2.5	2639.98	I	14848–52716
6	2641.17	I	15223–53073
16	2641.60	I	11031–48875

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	2643.63	I	12774–50590
180	2644.11	I	0–37809
32	2646.89	I	10166–47935
36	2647.73	I	2740–40498
36	2649.34	I	11378–49112
6	2650.68	I	15223–52938
14	2652.98	I	15391–53073
14	2653.78	I	5766–43437
6	2655.19	I	13020–50671
5	2655.78	I	14848–52491
46	2656.68	I	
180	2658.60	I	5144–42747
60	2659.83	I	8743–46328
9	2660.92	I	13020–50590
36	2661.18	I	4159–41726
4	2661.93	I	12774–50330
10	2662.55	I	15391–52938
10	2663.22	I	12774–50312
4	2664.29	II	25452–62974
11	2665.99		
11	2666.21	I	11031–48526
14	2669.53	I	10166–47615
55	2674.57	I	11378–48756
38	2674.88	I	10166–47540
5	2679.38	I	15391–52702
7	2679.74	I	13365–50671
10	2682.19	I	11031–48303
7	2684.36	I	16212–53454
	2684.41		
10	2688.08	I	14852–52043
10	2689.35	I	12774–49947
200	2689.82	I	5144–42310
14	2692.70	I	14091–51218
13	2694.52	I	11031–48132
6	2694.75	I	12774–49873
4	2696.61	I	4159–41232
8	2697.24		
48	2699.59	I	2740–39772
10	2700.75	I	8743–45759
7	2702.83	I	13020–50007
7	2704.45	I	13365–50330
55	2706.70	I	2740–39675
17	2707.42	I	11378–48302
10	2708.18		
18	2709.86	I	10166–47057
280	2714.64	I	0–36826
55	2715.36	I	5766–42583
14	2715.64	I	14339–51152
6	2716.80	I	11031–47828
10	2718.71	I	15391–52162
10	2718.91		
120	2720.04	I	2740–39494
80	2721.86	I	4159–40888
6	2722.60		
14	2727.94	I	10166–46813
11	2728.27	I	2740–39383
55	2730.61	I	5144–41754
4	2731.36	II	15606–52206
55	2732.80	I	5144–41726
8	2736.39	I	5766–42300
5	2738.33	I	13365–49873
6	2738.46	I	15391–51897
16	2740.32	I	14848–51329
13	2740.61		
12	2740.75	I	11378–47854
6	2741.38	I	11378–47845
4	2742.69	I	11378–47828
14	2747.91	I	14848–51229
12	2748.86	I	15391–51759
12	2749.18	I	12774–49138
8	2751.15	I	12774–49112
6	2753.72	I	14848–51152
10	2755.59	I	12774–49054
16	2757.81	I	13365–49615
13	2758.82	I	11378–47615
14	2761.08	I	6093–42300
65	2761.42	I	4159–40362
44	2763.27	I	8743–44921
14	2763.94	I	11031–47200
32	2765.04	I	15391–51546
6	2765.45	I	8743–44893
12	2767.12	I	11031–47158
15	2769.88	I	13020–49112
10	2770.10	I	14848–50937
90	2770.71	I	5144–41225
4	2771.04		
11	2773.07	I	14852–50903
11	2774.02	I	14339–50377
10	2774.38	I	13020–49054
10	2774.90	I	11031–47057
28	2776.91	I	2740–38741
4	2778.57		
70	2782.55	I	4159–40087
4	2783.88	II	7892–43802
4	2785.04		
60	2786.31	I	5144–41023
12	2786.80	I	2740–38614
6	2790.90	I	15223–51043
22	2793.99	I	11378–47158
22	2794.19	I	14852–50630

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	2796.11	I	13020–48774
50	2796.73	I	2740–38486
3.5	2799.53		
9	2801.93	I	11378–47057
30	2804.07	I	15391–51043
260	2806.91	I	0–35616
4	2807.48	I	10166–45775
4	2807.80		
3.0	2808.24	I	15391–50990
44	2808.94	I	2740–38331
2.0	2811.56	I	
40	2813.84	I	14848–50377
70	2814.20	I	2740–38264
4	2814.84	I	4159–39675
4	2815.27	I	13365–48875
28	2815.78	I	2740–38244
4	2817.51	I	14848–50330
13	2820.18	I	15223–50671
9	2820.56	I	14091–49534
18	2821.25	I	11378–46813
12	2824.17	I	11378–46776
4	2824.67		
2.0	2829.03	I	10166–45503
40	2829.27	I	4159–39494
2.0	2831.59	I	14848–50154
12	2832.24	I	11031–46328
22	2837.42	I	11031–46264
44	2838.17	I	4159–39383
480	2838.63	I	5144–40362
10	2840.44	I	14339–49534
70	2841.60	I	2740–37922
220	2844.40	I	5144–40291
8	2844.68	I	14339–49482
40	2846.39	I	5766–40888
14	2846.55	I	8743–43863
40	2848.25	I	14848–49947
9	2849.05	I	15223–50312
4	2849.30	I	10166–45252
140	2850.76	I	2740–37809
12	2855.34	I	8743–43755
5	2857.54	I	18902–53887
10	2860.06	I	16212–51166
140	2860.96	I	5144–40087
3.5	2863.37	II	11460–46374
4	2864.26	I	15391–50294
8	2865.68	I	11378–46264
4	2867.59		
4	2869.39	I	12774–47615
16	2872.40	I	0–34804
16	2873.42	I	11378–46170
9	2874.15	I	13020–47802
4	2874.59	I	16212–50990
34	2874.96	I	8743–43516
18	2877.35	I	11031–45775
28	2878.40	I	5766–40498
3.5	2879.39	II	11654–46374
3.0	2880.20	II	17242–51952
3.0	2883.94	I	14091–48756
8	2884.41	I	8743–43402
2.0	2886.06	I	19411–54050
4	2886.50	I	14848–49482
4	2890.85	I	4159–38741
5	2891.83	I	25013–59583
8	2892.35	I	10166–44730
9	2895.06	I	11031–45562
24	2896.06	I	13020–47540
6	2901.32	I	13020–47477
6	2903.07	I	18902–53338
12	2903.21	I	14091–48526
18	2905.73	I	6093–40498
10	2905.97		
3.0	2908.03	I	16212–50590
900	2909.06	I	0–34365
10	2909.67	I	11031–45389
3.5	2911.34	I	19109–53447
200	2912.33	I	4159–38486
13	2913.84	I	10166–44475
7	2914.71	I	18417–52716
50	2917.26	I	8743–43011
12	2917.83	I	5144–39406
200	2919.79	I	15223–49461
5	2921.07	I	15391–49615
3.5	2923.18		
10	2924.49	I	11378–45562
4	2925.28	I	13365–47540
28	2925.57	I	4159–38331
34	2929.51	I	0–34126
10	2930.19		
11	2930.57	I	22616–56729
48	2931.28	I	4159–38264
4	2932.45	I	15391–49482
4	2933.98	I	18301–52375
24	2934.64	I	2740–36806
2.5	2936.81	I	14091–48132
12	2936.99	I	12774–46813
4	2938.38	I	19109–53131
10	2942.20	I	10166–44144
19	2942.85	I	4159–38130
100 h	2948.23	I	5766–39675
130	2949.53	I	2740–36634

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
20 d	2949.81	I	11031–44921
	2949.90	I	15223–49112
12	2952.34	I	11031–44893
8	2955.00	I	15223–49054
9	2957.08		
5	2958.34	I	14339–48132
28	2961.01	I	4159–37922
50	2962.15	I	4159–37909
10	2962.33	I	15391–49138
42	2964.06	I	5766–39494
5	2964.62	I	15391–49112
3.5	2965.10		
3.0	2968.45	I	14848–48526
3.5	2970.69	I	15223–48875
70	2970.97	I	4159–37809
10	2972.25	I	25013–58648
12	2973.06	I	18417–52043
10	2975.34		
42	2977.64	I	8743–42317
10	2978.21	I	8743–42310
9	2978.53	I	21303–54868
8	2979.43	I	12774–46328
7	2982.56		
48	2982.90	I	11378–44893
32	2983.49		
12	2985.61	I	15391–48875
6	2988.26	I	14848–48303
10	2989.13	I	19893–53338
14	2992.11	I	13365–46776
10	2993.57	I	12774–46170
24	2997.65	I	10166–43516
16	3003.48	I	11378–44663
10	3007.90	I	18902–52138
34	3013.07	I	2740–35920
12	3015.65	I	13365–46515
60	3017.25	I	8743–41876
460	3018.04	I	0–33124
50	3019.38	I	5766–38876
10	3020.86		
120	3030.70	I	5144–38130
12	3031.01	I	8743–41726
8	3031.30	I	14848–47828
10	3032.81	I	13365–46328
300	3040.90	I	2740–35616
12	3042.74	II	11460–44315
22	3043.50	I	5766–38614
12	3043.64	I	10166–43011
6	3044.07	I	16212–49054
6	3044.41	I	13365–46202
16	3044.91	I	11031–43863
6	3045.32		
10	3049.04	I	12774–45562
24	3049.46	I	6093–38876
22	3050.39	I	22616–55389
12	3051.17	I	5144–37909
10	3054.97	I	11031–43755
16	3055.21	I	14091–46813
900	3058.66	I	0–32685
30	3060.30	I	4159–36826
60	3062.19	I	4159–36806
8	3066.12	I	15223–47828
22	3069.94	I	5766–38331
38	3074.08	I	6093–38614
30	3074.96	I	22616–55127
19	3077.06	I	8743–41232
30	3077.44	I	11031–43516
120	3077.72	I	8743–41225
38	3078.11	I	5766–38244
24	3078.38	I	4159–36634
16	3083.74	I	22616–55034
6	3084.60	I	13365–45775
6	3086.27	I	15223–47615
24	3090.08	I	14848–47200
15	3090.30	I	2740–35090
12	3090.49	I	14852–47200
6	3091.25	I	17667–50007
28	3093.59	I	18902–51218
32	3101.53	I	13020–45253
10	3104.98	I	13365–45562
38	3105.99	I	4159–36346
6	3107.38	I	14091–46264
32	3108.98	I	5766–37922
65	3109.38	I	6093–38244
26	3111.09	I	10166–42300
12	3114.81	I	12774–44870
12	3116.48	I	14091–46170
10	3118.12	I	22616–54677
32	3118.33	I	11378–43437
13	3129.23	I	17667–49615
50	3131.12	I	14848–46776
10	3140.31	I	15223–47057
10	3152.07	I	11031–42747
26	3152.67	I	10166–41876
30	3153.61	I	12774–44475
320	3156.25	I	5144–36818
26	3156.78	I	23463–55132
14	3157.24	I	23463–55127
13	3161.44	I	19049–50671
12	3161.73	I	8743–40362
9	3164.61	I	15223–46813

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
32	3166.51	I	23463–55034
13	3168.28	I	15223–46776
13	3173.20	I	13365–44870
19	3173.93	II	7892–39390
44	3178.06	I	4159–35616
11	3180.12	I	19893–51329
24	3181.88	I	14339–45758
18	3182.57	I	14091–45503
24	3185.33	I	2740–34126
32	3186.98	I	11378–42747
6	3187.34	I	13365–44730
32	3189.46	I	8742–40087
32	3194.23	I	14091–45389
20	3195.38	I	11031–42317
13	3195.97	I	11378–42658
16	3213.31	II	13204–44315
200	3232.06	I	4159–35090
30	3238.63	I	5766–36634
20	3241.04	I	11031–41876
13	3248.00	I	13365–44144
20	3254.91	I	14848–45562
20	3256.92	I	11031–41726
20	3260.30	I	8743–39406
320	3262.29	I	4159–34804
40	3262.75	I	8743–39383
320	3267.94	I	0–30592
65	3269.21	I	5766–36346
20	3272.16	I	15223–45775
55	3275.20	I	5766–36290
34	3277.97	I	5766–36264
7	3280.92		
7	3286.67	I	13020–43437
20	3288.84	I	28372–58769
130	3290.26	I	2740–33124
800	3301.56	I	0–30280
26	3306.23	I	12774–43011
65	3310.91	I	11031–41225
13	3315.42	I	5766–35920
10	3315.69	I	13365–43516
10	3316.69		
26	3324.33	I	13365–43437
32	3327.42	I	14848–44893
100	3336.15	I	4159–34126
11	3351.74	I	6093–35920
13	3353.91		
24	3357.97	I	14091–43863
26	3361.15	I	8743–38486
20	3364.12	I	2740–32457
13	3370.20	I	14091–43755
100	3370.59	I	5144–34804
17	3372.08	I	13365–43011
13	3378.68	I	19893–49482
32	3384.00	I	12774–42317
9	3384.60	I	14339–43876
20	3385.94	I	12774–42300
9	3386.14	I	14339–43863
65	3387.84	I	10166–39675
7	3394.59		
10	3395.72	I	15223–44663
13	3401.17	I	23323–52716
65	3401.86	I	8743–38130
26	3402.51	I	0–29382
10	3406.28		
10	3406.67	I	14091–43437
13	3408.76	I	10166–39494
13	3412.74	I	13365–42658
13	3421.69	I	10166–39383
7	3427.44	I	23323–52491
16	3427.67	I	8743–37909
7	3435.26	I	12774–41876
10	3439.49	I	8743–37809
26	3440.60	I	11031–40087
13	3444.46	I	14852–43876
17	3445.55	I	14848–43863
32	3449.20	I	11378–40362
7	3455.03	I	13365–42300
13	3458.38	I	14848–43755
13	3465.44	I	17667–46515
13	3478.53	I	17667–46407
13	3482.11	I	10166–38876
7	3482.23	I	11378–40087
7	3487.25	I	14848–43516
13	3487.46		
13	3490.33		
10	3491.50	I	19893–48526
5	3495.62		
17	3498.54	I	10166–38741
26	3501.16	I	14848–43402
65	3504.66	I	4159–32685
46	3512.99	I	12774–41232
10	3513.86	I	16212–44663
7	3516.63	I	19049–47477
32	3518.72		
12	3520.00		
50	3523.64	I	0–28372
13	3526.04	I	11031–39383
130	3528.60	I	0–28332
24	3530.06	I	10166–38486
24	3532.80	I	4159–32457
13	3533.41	I	15223–43516

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	3541.91	I	14091–42317
24	3542.71	I	14091–42310
10	3555.97	I	12774–40888
100	3559.79	I	8743–36826
130	3560.86	I	8743–36818
13	3562.34	I	8743–36806
32	3569.78	I	11378–39383
13	3574.08	I	14339–42310
7	3586.51	I	18902–46776
13	3587.32	I	13020–40888
7	3592.32	I	23323–51152
65	3598.11	I	2740–30525
20	3601.83	I	10166–37922
10	3604.48	II	11654–39390
7	3609.15		
26	3616.57	I	10166–37809
13	3619.43	I	15391–43011
7	3629.95	I	5144–32685
44	3640.33	I	14848–42310
5	3648.81	I	19760–47158
22	3654.49	I	15391–42747
32	3656.90	I	2740–30078
12	3666.31	I	18902–46170
46	3670.89	I	11031–38264
12	3675.45	I	15223–42422
8	3681.57	I	19109–46264
24	3689.06	I	11031–38130
3.5	3698.83	I	14848–41876
18	3703.25	I	17667–44663
12	3706.56	I	23323–50294
12	3709.14	I	11378–38331
8	3712.84	I	15391–42317
22	3713.73	I	15391–42310
8	3718.34	I	11378–38264
20	3719.52	I	14848–41726
22	3720.13	I	8743–35616
3.5	3721.96	I	24292–51152
6	3729.22	I	17667–44475
8	3730.73	I	14091–40888
17	3746.47	I	14339–41023
360	3752.52	I	2740–29382
10	3757.12	I	12774–39383
13	3766.30	I	11378–37922
12	3768.14	I	11378–37909
12	3774.40	I	18902–45389
11	3774.62	I	15391–41876
12	3776.25	I	13020–39494
28	3776.99	I	10166–36634
200	3782.20	I	4159–30592
8	3789.11	I	14848–41232
60	3790.14	I	14848–41225
17	3790.73	I	14852–41225
36	3793.91	I	18902–45252
4	3794.66	I	28332–54677
8	3795.67	I	24292–50630
8	3827.14	I	22616–48737
24	3836.06	I	8743–34804
13	3840.30	I	29099–55132
13	3841.29	I	25013–51039
7	3843.66	I	15223–41232
17	3849.94	I	12774–38741
20	3857.09	I	4159–30078
20	3865.47	I	25275–51138
65	3876.77	I	11031–36818
22	3881.86	I	10166–35920
3.5	3886.75	I	13020–38741
3.5	3895.18	I	15223–40888
12	3900.39	I	2740–28372
17	3901.71	I	8743–34365
3.0	3907.65	I	14091–39675
3.0	3911.81	I	12774–38331
3.0	3918.97	I	27954–53464
3.0	3922.03	I	12774–38264
3.0	3925.10	I	12774–38244
3.0	3926.77	I	18417–43876
4	3928.41	I	11378–36826
4	3928.54	I	5144–30592
9	3930.00	I	14852–40291
7	3931.52	I	11378–36806
22	3938.59	I	8743–34126
8	3939.57	I	13365–38741
9	3949.78	I	13020–38331
5	3952.77	I	14091–39383
4	3955.37	I	15223–40498
8	3960.51	I	24292–49534
18	3961.02	I	14848–40087
90	3963.63	I	4159–29382
9	3964.96	I	2740–27954
13	3969.67	I	14852–40036
10 h	3975.44	I	12774–37922
65	3977.23	I	5144–30280
4	3979.36	I	30280–55403
9	3988.18	I	14339–39406
3.5	3988.62	I	19411–44475
3.5	3991.49	I	2740–27787
4	3994.93	I	21303–46328
3.5	3996.80	I	0–25013
5	3998.93	I	19893–44893
13	4003.48	I	15391–40362
9	4004.02	I	11378–36346

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
13	4005.16	I	18902–43863
6 h	4015.04	I	13365–38264
14	4018.26	I	13365–38244
5 h	4029.32	I	30592–55403
8	4032.92	I	23985–48773
9	4037.84	I	5766–30525
5	4038.64	I	19109–43863
25	4041.92	I	19411–44144
14	4048.05	I	15391–40087
5	4051.43	I	16212–40888
85	4066.69	I	22616–47199
22	4070.86	I	14848–39406
17	4071.56	I	14852–39406
20	4074.68	I	14848–39383
6	4088.44	I	15223–39675
44	4091.82	I	6093–30525
5	4098.10	I	14091–38486
11	4100.30	I	8743–33124
5	4103.62	I	27787–52149
110	4112.02	I	5766–30078
16	4124.60	I	11378–35616
16	4128.96	I	4159–28372
220	4135.78	I	4159–28332
13	4137.84	I	15223–39383
6	4158.78	I	14091–38130
6	4159.96	I	12774–36806
16	4172.57	I	10166–34126
110	4173.23	I	5144–29099
55	4175.63	I	8743–32685
11	4184.13	I	18417–42310
28	4189.91	I	12774–36634
5	4195.14	I	14091–37922
16	4201.45	I	4159–27954
22	4202.06	I	14339–38130
110	4211.86	I	23463–47199
11	4213.86	I	25013–48737
9	4215.16	I	14091–37809
5	4226.53	I	15223–38876
15	4233.46	I	13020–36634
440	4260.85	I	0–23463
9	4264.75	I	13365–36806
11	4269.61	I	18902–42317
5	4277.15	I	19049–42422
9	4285.90	I	13020–36346
50	4293.95	I	14848–38130
6	4296.22	I	13365–36634
5	4308.88	I	19109–42310
50	4311.40	I	5144–28332
10	4326.25	I	15223–38331
30	4328.68	I	11031–34126
9	4338.75	I	15223–38264
9	4351.53	I	18902–41876
6 h	4354.46	I	10166–33124
4	4357.98	I	15391–38331
6	4358.14	I	30525–53464
19	4365.67	I	13020–35920
10	4370.66	I	15391–38264
4	4376.90	I	37809–60649
8	4391.08	I	19109–41876
46	4394.86	I	11378–34126
14	4397.26	I	14091–36826
5	4400.58	I	32685–55403
14	4402.74	I	28332–51039
5	4404.21	I	15223–37922
3.5	4411.13	I	16212–38876
440	4420.47	I	0–22616
9	4432.41	I	13365–35920
26	4436.32	I	2740–25275
4.5	4437.09	I	15391–37922
9	4439.64	I	15391–37909
3.5	4445.69	I	14339–36826
20	4447.35	I	14339–36818
7 d	4459.53	I	15391–37809
3.0	4462.29	I	21034–43437
3.0	4465.94	I	38264–60649
8	4479.81	I	12774–35090
11	4484.76	I	10166–32457
3.5	4488.60	I	2740–25013
3.0	4518.89	I	19109–41232
3.0	4520.32	I	19109–41225
6	4524.87	I	11031–33124
6	4529.67	I	13020–35090
2.5	4537.62	I	16212–38244
6	4539.92	I	25594–47615
10	4548.66	I	14848–36826
48	4550.41	I	14848–36818
12	4551.30	I	14852–36818
3.0	4579.04	I	19893–41726
8	4595.04	I	29382–51138
8	4597.16	I	11378–33124
2.5	4605.04	I	16212–37922
15	4616.78	I	11031–32685
15	4631.83	I	15223–36806
3.0	4634.77	I	23323–44893
3.0	4641.83	I	8743–30280
12	4663.82	I	15391–36826
2.5	4682.31	I	12774–34126
6	4692.06	I	11378–32685
2.5	4732.80	I	15223–36346
2.0	4738.04	I	25070–46170

Osmium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	4738.35		
4	4743.89	I	17667–38741
2.5	4752.16	I	34365–55403
3.0	4763.10	I	38613–59602
60	4793.99	I	4159–25013
2.0	4813.80	I	14848–35616
2.0	4815.50	I	13365–34126
4	4815.96	I	30280–51039
2.0	4826.66	I	14091–34804
2.0	4843.87	I	8743–29382
10	4865.60	I	30592–51138
4	4899.22	I	28332–48737
6	4912.60	I	12774–33124
2.5	4935.81	I	17667–37922
2.5	4942.94	I	15391–35616
3.5	4979.32	I	16212–36290
5	5031.83	I	15223–35090
4	5039.12	I	18902–38741
3.0	5072.88	I	16212–35920
3.0	5074.77	I	15391–35090
3.0	5079.09	I	12774–32457
8	5103.50	I	8743–28332
5	5110.81	I	11031–30592
2.0	5122.23	I	14848–34365
2.0	5145.54	I	18902–38331
12	5149.74	I	15391–34804
2.5	5152.01	I	36818–56223
2.5	5168.98	I	38486–57827
3.5	5193.52	I	11031–30280
24	5202.63	I	10166–29382
3.0	5203.23	I	11378–30592
1.8	5250.46		
4	5255.82	I	19109–38130
5	5265.15	I	23323–42310
1.8	5283.89	I	19411–38331
1.8	5295.65	I	16212–35090
3.5	5298.78	I	28332–47199
1.2	5302.58	I	19411–38264
1.6	5336.23	I	15391–34126
1.0	5346.03	I	11378–30078
1.2	5352.25	I	17667–36346
10	5376.79	I	14091–32685
1.4	5403.43	I	36346–54847
1.2	5412.14	I	21033–39505
11	5416.34	I	30280–48737
4	5416.69	I	4159–22616
2.5	5417.51	I	32685–51138
1.4	5441.82	I	19893–38264
5	5443.31	I	14091–32457
2.0	5446.93	I	32685–51039
1.0	5447.76	I	11031–29382
1.8	5449.37	I	14339–32685
1.8	5453.40	I	23985–42317
2.0	5457.30	I	5144–23463
2.5	5470.00	I	14848–33124
1.2	5474.58	I	25602–43863
1.2	5475.13	I	21124–39383
0.8	5477.27	I	17667–35920
1.4	5481.85	I	19893–38130
2.0	5509.33	I	30592–48737
0.8	5516.01	I	28140–46263
24	5523.53	I	29099–47199
2.0	5546.82	I	34125–52149
0.8	5549.79	I	33124–51138
1.2	5552.88	I	11378–29382
1.0	5560.62	I	35616–53595
1.4	5580.66	I	33124–51039
7	5584.44	I	15223–33124
0.7	5600.50	I	36826–54677
3.0	5620.08	I	10166–27954
0.8	5637.41	I	15391–33124
2.0	5642.56	I	19109–36826
2.5	5645.25	I	19109–36818
0.6	5648.98	I	19109–36806
0.8	5660.21		
0.6	5674.38	I	18301–35920
2.5	5680.88	I	34804–52402
1.0	5709.37	I	37909–55419
15	5721.93	I	5144–22616
0.7	5737.89	I	17667–35090
0.7	5739.72	I	25594–43011
2.0	5765.05	I	11031–28372
15	5780.82	I	15391–32685
3.5	5800.60	I	15223–32457
0.7	5842.49	I	22564–39675
10	5857.76	I	15391–32457
2.5	5860.64	I	13020–30078
1.0	5882.92	I	11378–28372
1.0	5903.98	I	19893–36826
1.0	5906.84	I	19893–36818
0.6	5908.95	I	30280–47199
0.6	5981.36	I	18902–35616
1.0	5983.22	I	25602–42310
6	5996.00	I	34365–51039
1.8	6015.79	I	21303–37922
0.6	6054.63	I	27351–43863
1.8	6144.53	I	8743–25013
1.0	6158.03	I	34804–51039
3.0	6227.70	I	32685–48737
0.6	6241.70	I	13365–29382

Osmium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	6269.41	I	43012–58957
1.0	6274.94	I	40291–56222
1.0	6286.83	I	18902–34804
0.8	6398.86	I	25602–41225
2.0	6403.15	I	33124–48737
0.8	6448.13	I	41225–56729
0.5	6520.85	I	21303–36634
0.6	6528.87	I	21034–36346
0.6	6533.14	I	15223–30525
1.0	6538.30	I	14091–29382
1.0	6576.83	I	15391–30592
0.7	6614.56	I	24292–39406
0.4	6615.43	I	40291–55403
0.6	6661.81	I	13365–28372
3.0	6729.56	I	15223–30078
2.0	6791.53	I	8743–23463
1.6	6806.61	I	15391–30078
0.6	6878.70	I	14848–29382
0.5	6901.58	I	25602–40087
1.2	6956.02	I	34365–48737
0.8	6984.95	I	16212–30525
2.0	7060.67	I	15223–29382
3.0	7145.54	I	15391–29382
1.4	7149.89	I	11031–25013
0.6	7184.10	I	38486–52402
1.4	7206.33	I	8743–22616
0.7	7209.96	I	16212–30078
1.2	7251.16	I	21303–35090
0.8	7253.49	I	18902–32685
0.8	7375.07	I	18902–32457
1.2	7407.95	I	23323–36818
3.5	7602.95	I	15223–28372
0.6	7701.46	I	15391–28372
1.0	7789.96	I	34365–47199
1.0	7852.17	I	15223–27954
0.8	7981.20	I	24292–36818
0.9	8041.29	I	11031–23463

PALLADIUM

Pd, $Z=46$, $M=106.4$, Ratio $\frac{\text{Pd}}{\text{Cu}}=1.674$

Pd I Normal state of valence electrons $4d^{10}\ {}^1S_0 = 0$. I.P.= 67236 K
Pd II Normal state of valence electrons $4d^9\ {}^2D_{2½} = 0$. I.P.=156700 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Pd I, A. G. Shenstone, Phys. Rev. **36,** 669 (1930).
Pd II, A. G. Shenstone, Phys. Rev. **32,** 30 (1928).

Relative intensity of palladium lines observed in an arc of copper containing 0.1 atomic percent of palladium

Strong lines of palladium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2600	3404. 58	I	6564–35928	$5s^1\ {}^3D_3$—$5p^1\ {}^3F^\circ_4$
2200	3609. 55	I	7755–35451	$5s^1\ {}^3D_2$—$5p^1\ {}^3F^\circ_3$
2200	3634. 70	I	6564–34069	$5s^1\ {}^3D_3$—$5p^1\ {}^3P^\circ_2$
1400	3421. 24	I	7755–36976	$5s^1\ {}^3D_2$—$5p^1\ {}^3D^\circ_2$
1300	3516. 94	I	7755–36181	$5s^1\ {}^3D_2$—$5p^1\ {}^3P^\circ_1$
1300	3553. 08	I	11722–39858	$5s^1\ {}^1D_2$—$5p^1\ {}^1F^\circ_3$
1200	3242. 70	I	6564–37394	$5s^1\ {}^3D_3$—$5p^1\ {}^3D^\circ_3$
1100	3481. 15	I	10094–38812	$5s^1\ {}^3D_1$—$5p^1\ {}^3F^\circ_2$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
65	2447.91	I	0 – 40839
100	2476.42	I	0 – 40369
3.0	2486.53	II	27094 – 67299
8	2488.92	II	25081 – 65247
3.5	2498.78	II	32278 – 72285
160	2763.09	I	0 – 36181
2.0	2854.58	II	32278 – 67299
44	2922.49	I	6564 – 40771
55	3002.65	I	6564 – 39858
4	3009.78	I	25101 – 58317
130	3027.91	I	7755 – 40771
95	3065.31	I	7755 – 40369
220	3114.04	I	7755 – 39858
30	3142.81	I	25101 – 56911
1200	3242.70	I	6564 – 37394
300	3251.64	I	10094 – 40839
380	3258.78	I	10094 – 40771
50	3287.25	I	6564 – 36976
400	3302.13	I	10094 – 40369
550	3373.00	I	7755 – 37394
2600	3404.58	I	6564 – 35928
1400	3421.24	I	7755 – 36976
550	3433.45	I	11722 – 40839
700	3441.40	I	11722 – 40771
850	3460.77	I	6564 – 35451
1100	3481.15	I	10094 – 38812
220	3489.77	I	11722 – 40369
1300	3516.94	I	7755 – 36181
1300	3553.08	I	11722 – 39858
500	3571.16	I	10094 – 38088
2200	3609.55	I	7755 – 35451
2200	3634.70	I	6564 – 34069
600	3690.34	I	11722 – 38812
150	3718.91	I	10094 – 36976
160	3799.19	I	7755 – 34069
160	3832.29	I	10094 – 36181
240	3894.20	I	11722 – 37394
160	3958.64	I	11722 – 36976
32	4087.34	I	11722 – 36181
10	4169.84	I	10094 – 34069
280	4212.95	I	11722 – 35451
20	4473.59	I	11722 – 34069
6 h	4788.18	I	34069 – 54948
5 h	4817.51	I	34069 – 54821
4	4875.43	I	34069 – 54574
6	5110.81	I	35451 – 55012
8	5117.02	I	38812 – 58349
17	5163.84	I	35451 – 54811
6	5234.86	I	35928 – 55025
13	5295.63	I	35928 – 54806
2.0	5312.57	I	36181 – 54998
1.6	5345.10	I	39858 – 58562
4	5395.24	I	39858 – 58388
6	5542.80	I	36976 – 55012
4	5547.02	I	36976 – 54998
3.0	5619.44	I	40771 – 58562
1.7	5642.69	I	40839 – 58556
1.5	5655.42	I	40771 – 58448
8	5670.07	I	37394 – 55025
1.2	5690.14	I	40839 – 58408
6 h	5695.09	I	37394 – 54948
2.0	5736.61	I	37394 – 54821
2.5	6774.54	I	25101 – 39858
7	6784.52	I	34069 – 48804
0.4 h	6833.42	I	40369 – 54998
1.2	7016.44	I	38088 – 52336
1.4 h	7310.06	I	38812 – 52488
8	7368.12	I	35451 – 49020
3.0	7391.92	I	38812 – 52336
1.8	7486.90	I	35451 – 48804
13	7764.03	I	35928 – 48804
3.0	7786.67	I	36181 – 49020
5	7915.80	I	39858 – 52488
2.0	7961.08	I	28214 – 40771
6	8132.82	I	25101 – 37394
5	8300.83	I	36976 – 49020
1.0 h	8353.58	I	40369 – 52336
2.0 h	8532.74	I	40771 – 52488
1.8 h	8599.10	I	37394 – 49020
7	8761.35	I	37394 – 48804

PHOSPHORUS

P, $Z=15$, $M=30.975$, Ratio $\frac{P}{Cu}=0.487$

P I Normal state of valence electrons $3s^2 3p^3\ {}^4S^\circ_{1½}=0$. I.P.= 84580 K
P II Normal state of valence electrons $3s^2 3p^2\ {}^3P_0=0$. I.P.=159100 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
P I, C. C. Kiess, J. Research NBS **8,** 393 (1932) RP425.
P I and P II, W. C. Martin, J. Opt. Soc. Am. **49,** 1071 (1959).

Relative intensity of phosphorus lines observed in an arc of copper containing 0.1 atomic percent of phosphorus

Strong lines of phosphorus

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
60	2535.65	I	18748–58174	$3s^2 3p^3\ {}^2P^\circ_{1½}$—$3s^2 3p^2 4s^1\ {}^2P_{1½}$

Phosphorus — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.0	2135.47	I	11362–58174	22	2534.01	I	18722–58174
10	2136.20	I	11376–58174	60	2535.65	I	18748–58174
9	2149.11	I	11362–57877	38	2553.28	I	18722–57877
1.0	2152.95	I	18722–65157	15	2554.93	I	18748–57877
2.0	2154.08	I	18748–65157				

PLATINUM

Pt, $Z=78$, $M=195.09$, Ratio $\frac{Pt}{Cu}=3.070$

Pt I Normal state of valence electrons $5d^9 6s^1\ ^3D_3 = 0$. I.P.= 72300 K
Pt II Normal state of valence electrons $5d^9\ ^2D_{2½} = 0$. I.P.=149700 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Pt I, A. C. Haussman, Astrophys. J. **66,** 333 (1927).
J. J. Livingood, Phys. Rev. **34,** 185 (1929).
Pt II, A. G. Shenstone, Phil. Trans. Roy. Soc. (London) **[A]237,** 453 (1938).

Relative intensity of platinum lines observed in an arc of copper containing 0.1 atomic percent of platinum

Strong lines of platinum

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
320	3064. 71	I	0–32620	$5d^9 6s^1\ a\ ^3D_3$—$5d^9 6p^1$ $1\frac{1}{2}$
280	2659. 45	I	0–37591	$5d^9 6s^1\ a\ ^3D_3$—$5d^9 6p^1$ $7\frac{1}{4}$
200	2702. 40	I	776–37769	$5d^9 6s^1\ a\ ^3D_2$—$5d^9 6p^1$ $8\frac{3}{4}$
180	2733. 96	I	776–37342	$5d^9 6s^1\ a\ ^3D_2$— $6\frac{3}{4}$
180	2997. 97	I	776–34122	$5d^9 6s^1\ a\ ^3D_2$—$5d^9 6p^1$ $3\frac{3}{4}$
170	2929. 79	I	0–34122	$5d^9 6s^1\ a\ ^3D_3$—$5d^9 6p^1$ $3\frac{3}{4}$
160	2705. 89	I	824–37769	$5d^8 6s^2\ a\ ^3F_4$—$5d^9 6p^1$ $8\frac{3}{4}$
140	2830. 30	I	0–35322	$5d^9 6s^1\ a\ ^3D_3$—$5d^8 6s^1 6p^1$ $4\frac{3}{4}$
130	2719. 04	I	824–37591	$5d^8 6s^2\ a\ ^3F_4$—$5d^9 6p^1$ $7\frac{1}{4}$
110	2628. 03	I	776–38816	$5d^9 6s^1\ a\ ^3D_3$— $10\frac{3}{4}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2030.63	I	
4	2032.41	I	
6	2049.37	I	0–48779
2.0	2067.50	I	0–48352
5	2084.59	I	824–48779
2.0	2103.33	I	824–48352
2.5	2128.61	I	776–47741
6	2144.23	I	0–46622
		II	4787–51408
2.5	2165.17	I	0–46170
7	2174.67	I	
2.5	2202.22	I	776–46170
2.5	2222.61	I	6568–51546
1.6	2249.30	I	0–44444
2.5	2268.84	I	
4	2274.38	I	776–44730
2.5	2289.27	I	776–44444
2.5	2292.40	I	824–44433
5	2308.04	I	6568–49881
2.0	2315.50	I	
5	2318.29	I	824–43946
2.5	2326.10	I	6568–49545
5	2340.18	I	6568–49286
10	2357.10	I	776–43188
7	2368.28	I	6568–48779
6	2383.64	I	10132–52072
2.0	2386.81	I	776–42660
6	2389.53	I	824–42660
2.0	2396.17	I	13496–55217
4	2401.87	I	10132–51752
12	2403.09	I	6140–47741
7	2418.06	I	13496–54839
6	2428.04	I	6568–47741
4	2428.20	I	10117–51287
2.0	2429.10	I	10132–51287
15	2436.69	I	776–41803
60	2440.06	I	0–40970
6	2450.97	I	0–40788
44	2467.44	I	0–40516
3.5	2471.01	I	13496–53953
100	2487.17	I	0–40194
2.5	2488.74	II	
20	2490.12	I	824–40970
16	2495.82	I	6568–46623
24	2498.50	I	776–40788
5	2505.93	I	
12	2508.50	I	6568–46420
5	2514.07	I	10117–49881
6	2515.03	I	10132–49881
24	2515.58	I	776–40516
14	2524.30	I	6568–46170
4	2529.41	I	13496–53019
5	2536.49	I	10132–49545
16	2539.20	I	824–40194
1.8	2549.46	I	13496–52708
5	2552.25	I	10117–49286
5	2596.00	I	15502–54011
7	2603.14	I	10132–48536
5	2619.57	I	6568–44730
110	2628.03	I	776–38816
13	2639.35	I	6568–44444
100	2646.89	I	0–37769
50	2650.86	I	824–38536
2.0	2658.17	I	10132–47741
280	2659.45	I	0–37591
4	2674.57	I	6568–43946
44	2677.15	I	0–37342
20	2698.43	I	6140–43188
200	2702.40	I	776–37769
160	2705.89	I	824–37769
6	2713.13	I	10117–46965
130	2719.04	I	824–37591
13	2729.92	I	6568–43188
180	2733.96	I	776–37342
7	2738.48	I	10117–46623
7	2747.61	I	13496–49881
8	2753.86	I	10132–46434
20	2754.92	I	10132–46420
3.0	2769.84	I	6568–42660
50	2771.67	I	776–36845
4	2773.24	I	13496–49545
2.0	2774.00	I	10132–46170
5	2793.27	I	13496–49286
1.6	2794.21	II	13311–49089
14	2803.24	I	6140–41803
1.0	2808.51	I	15502–51098
5	2818.25	I	824–36296
140	2830.30	I	0–35322
7	2834.71	I	10132–45398
1.6	2853.11	I	13496–48536
2.5	2888.20	I	10117–44730
2.5	2893.22	I	15502–50055
60	2893.86	I	776–35322
30	2897.87	I	824–35322
6	2905.90	I	6568–40970
12	2912.26	I	10117–44444
12	2913.54	I	10132–44444
7	2919.34	I	13496–47741
3.0	2921.38	I	6568–40788
170	2929.79	I	0–34122

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2942.76	I	30157–64129
3.0	2944.75	I	6568–40516
2.5	2959.10	I	15502–49286
6	2960.75	I	
180	2997.97	I	776–34122
22	3002.27	I	824–34122
3.0	3017.88	I	13496–46623
13	3036.45	I	13496–46420
80	3042.64	I	824–33681
320	3064.71	I	0–32620
3.0	3071.94	I	10117–42660
13	3100.04	I	6568–38816
32	3139.39	I	776–32620
14	3156.56	I	10132–41803
12	3200.71	I	13496–44730
32	3204.04	I	6568–37769
3.0	3230.29	I	13496–44444
2.0	3233.42	I	15502–46420
2.0	3250.36	I	
4	3251.98	I	10132–40874
16	3255.92	I	6140–36845
2.5	3268.42	I	
2.5	3281.97	I	33681–64141
12	3290.22	I	10132–40516
50	3301.86	I	6568–36845
6	3315.05	I	0–30157
3.5	3323.80	I	10117–40194
34	3408.13	I	824–30157
3.5	3427.93	I	13496–42660
6	3483.43	I	10117–38816
16	3485.27	I	10132–38816
12	3628.11	I	6568–34122
7	3638.79	I	10117–37591
7	3643.17	I	18567–46007
3.5	3699.91	I	13496–40516
1.8	3706.53	I	
2.0	3801.05		
8	3818.69	I	10117–36296
4	3900.73	I	34122–59751
11	3922.96	I	30157–55641
3.5	3948.40	I	13496–38816
10	3966.36	I	10117–35322
2.0	3996.57	I	15502–40516
11	4118.69	I	13496–37769
8	4164.56	I	10117–34122
4	4192.43	I	13496–37342
1.8	4327.06	I	33680–56784
1.8	4391.83	I	21967–44730
8	4442.55	I	10117–32620
1.4	4445.55	I	10132–32620
2.5	4498.76	I	30157–52379
1.2	4520.90	I	37769–59882
3.5	4552.42	I	33680–55641
1.2	4879.53	I	36296–56784
1.4	5044.04	I	15502–35322
3.0	5059.48	I	32620–52379
3.5	5227.66	I	13496–32620
4	5301.02	I	36782–55641
1.2	5368.99	I	15502–34122
1.2	5390.79	I	34122–52667
1.4	5475.77	I	34122–52379
1.4	5478.50	I	38536–56784
0.6	5763.57	I	35322–52667
2.0	5840.12	I	15502–32620
0.8	5844.84	I	38536–55641
0.6	6026.04	I	40194–56784
0.7	6318.37	I	36845–52667
0.8	6326.58	I	21967–37769
0.9	6523.45	I	37342–52667
1.0	6710.42	I	37769–52667
2.0	6760.02	I	37591–52379
6	6842.60	I	37769–52379
2.0	7113.73	I	18566–32620
1.0	8224.74	I	21967–34122

POTASSIUM

K, $Z=19$, $M=39.100$, Ratio $\frac{K}{Cu}=0.615$

K I Normal state of valence electrons $3p^6 4s^1\ ^2S_{0\frac{1}{2}}=0$. I.P.= 35010 K
K II Normal state of valence electrons $3p^6\ \ ^1S_0=0$. I.P.=256637 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
K I, A. Fowler, Report on Series in Line Spectra, p. 101 (Fleetway Press, London, 1922).

Intensities:
A. Filippov, Phys. Z. Sowjetunion **5,** 1 (1934).
E. F. M. van der Held and J. H. Heierman, Physica **3,** 31 (1936).

Relative intensity of potassium lines observed in an arc of copper containing 0.1 atomic percent of potassium

Strong lines of potassium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1800	7664. 91	I	0–13043	$3p^6 4s^1\ ^2S_{0\frac{1}{2}}$—$3p^6 4p^1\ ^2P^\circ_{1\frac{1}{2}}$
900	7698. 98	I	0–12985	$3p^6 4s^1\ ^2S_{0\frac{1}{2}}$—$3p^6 4p^1\ ^2P^\circ_{0\frac{1}{2}}$

Potassium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
32	4044.14	I	0–24720	2.5 hl	6911.30	I	12985–27451
16	4047.20	I	0–24701	5 hl	6938.98	I	13043–27451
1.0 l	5782.60	I	12985–30274	1800	7664.91	I	0–13043
1.4 l	5801.96	I	13043–30274	900	7698.98	I	0–12985

609065 O - 62 - 17

PRASEODYMIUM

Pr, $Z=59$, $M=140.91$, Ratio $\frac{\text{Pr}}{\text{Cu}}=2.218$

Pr I Normal state of valence electrons $4f^3\ 6s^2\ {}^4I^\circ_{4\frac{1}{2}}=0$. I.P. $\approx$45000 K
Pr II Normal state of valence electrons $4f^3\ 6s^1\ {}^5I^\circ_4=0$.

References

Wavelengths:
A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945). Supplemented by the following:
F. Exner and E. Haschek, Spektren der Elemente bei Normalen Druck (Franz Deuticke, Leipzig and Vienna, 1911).
A. S. King, Astrophys. J. **68,** 194 (1928).
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
N. Rosen, G. R. Harrison, and J. R. McNally, Phys. Rev. **60,** 722 (1941).
Numerous lines were measured on the plates of this investigation.

Classification:
Pr I and Pr II, (Spectrum assignment only)
A. S. King, Astrophys, J. **68,** 194 (1928).
R. Zalubas, unpublished material (1961).
Pr II, N. Rosen, G. R. Harrison, and J. R. McNally, Phys. Rev. **60,** 722 (1941).

Molecular Spectra:
PrO, W. W. Watson, Phys. Rev. **53,** 639 (1938).

Relative intensity of praseodymium lines observed in an arc of copper containing 0.1 atomic percent of praseodymium

Strong lines of praseodymium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
460	4179. 42	II	1649–25569	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^5K_7$
340	4222. 98	II	442–24115	$4f^36s\ a\ {}^5I^\circ_5$—$4f^36p\ z\ {}^5K_6$
340	4225. 33	II	0–23660	$4f^36s\ a\ {}^5I^\circ_4$—$4f^36p\ z\ {}^5I_4$
320	3908. 43	II	2998–28578	$4f^36s\ a\ {}^5I^\circ_7$—$4f^36p\ z\ {}^3I_7$
300	4062. 82	II	3403–28010	$4f^36s\ a\ {}^3I^\circ_6$—$4f^36p\ z\ {}^3K_7$
260 c	4100. 75	II	4437–28816	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^5K_9$
240	4143. 14	II	2998–27128	$4f^36s\ a\ {}^5I^\circ_7$—$4f^36p\ z\ {}^5K_8$
220	4189. 52	II	2998–26861	$4f^36s\ a\ {}^5I^\circ_7$—$4f^36p\ z\ {}^5I_7$
220 c	4206. 74	II	4437–28202	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^5I_8$
200	4054. 85	II	1744–26398	$4f^36s\ a\ {}^3I^\circ_5$— 22_6
200	4056. 54	II	5079–29724	$4f^36s\ a\ {}^3I^\circ_7$—$4f^36p\ z\ {}^3K_8$
190 c	3982. 06	II	3403–28509	$4f^36s\ a\ {}^3I^\circ_6$—$4f^36p\ z\ {}^5H_6$
180 c	3877. 23	II		
170	4008. 71	II	5079–30018	$4f^36s\ a\ {}^3I^\circ_7$—$4f^36p\ z\ {}^5H_7$
150 c	4118. 48	II	442–24716	$4f^36s\ a\ {}^5I^\circ_5$—$4f^36p\ z\ {}^5I_5$
150 c	4164. 19	II	1649–25657	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^5I_6$
150	4408. 84	II	0–22675	$4f^36s\ a\ {}^5I^\circ_4$—$4f^36p\ z\ {}^5K_5$
140	3816. 17	II		
140 c	3964. 83	II	442–25657	$4f^36s\ a\ {}^5I^\circ_5$—$4f^36p\ z\ {}^5I_6$
140	3994. 83	II	442–25468	$4f^36s\ a\ {}^5I^\circ_5$—$4f^36p\ z\ {}^5H_4$
130 c	3918. 86	II	2998–28509	$4f^36s\ a\ {}^5I^\circ_7$—$4f^36p\ z\ {}^5H_6$
130 c	4141. 26	II	4437–28578	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^3I_7$
130	4305. 76	II	442–23660	$4f^36s\ a\ {}^5I^\circ_5$—$4f^36p\ z\ {}^5I_5$
120 c	3850. 83	II		
120	3989. 72	II	442–25500	$4f^36s\ a\ {}^5I^\circ_5$— 16_5
120	4333. 91	II	1649–24716	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^5I_5$
110	4368. 33	II	0–22886	$4f^36s\ a\ {}^5I^\circ_4$— 5_5
100	3830. 72	II		
100	3852. 81	II		
100	3925. 46	II	0–25468	$4f^36s\ a\ {}^5I^\circ_4$—$4f^36p\ z\ {}^5H_4$
100 c	3965. 26	II	1649–26861	$4f^36s\ a\ {}^5I^\circ_8$—$4f^36p\ z\ {}^5I_7$
100	4297. 76	II	0–23261	$4f^36s\ a\ {}^5I^\circ_4$— 7_5
100	4351. 85	II	1744–24716	$4f^36s\ a\ {}^5I^\circ_5$—$4f^36p\ z\ {}^5I_5$

Praseodymium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		2558.55	II	
2.0		2578.32		
2.5		2579.30		
3.0	h	2598.05		
2.0		2608.89		
2.0		2615.75	II	
2.0		2648.47		
2.5		2654.75		
2.0		2666.67		
1.6		2672.48		
2.5		2685.18	II	
3.5		2685.70		
5		2698.92		
6		2700.35		
3.0		2702.22		
10	h	2707.35	II	
2.0		2714.18	II	
6		2720.18	II	
3.0		2721.87	II	
5		2726.49	II	
1.2		2731.77	II	
2.5		2733.13	II	
5		2734.30	II	
2.5		2737.85	II	
4		2742.10	II	
2.5		2744.66	II	
2.0		2746.24	II	
6		2760.39	II	
5		2769.60	II	
5	d	2775.93	II	
		2776.05	II	
4		2778.82	II	
5		2783.32	II	
3.0		2789.08	II	
3.5		2792.50	II	
5		2802.06	II	
2.0		2823.11	II	
2.0		2824.10	II	
2.0		2828.32	II	
2.0		2843.01	I	
2.0		2844.03	II	
2.0		2850.64	I	
2.5		2854.02	II	
3.0		2865.65		
5		2881.62	I	
3.0		2882.33	II	
3.0		2884.90	II	
3.0		2943.95	II	
3.0		2967.58		
3.0		2971.11	II	
4	d	2971.40	II	
		2971.45		
5		2985.02	II	
3.0		2986.19	II	
3.0		2990.22	II	
8		3013.46	II	
5		3029.28	II	
2.5		3032.69		
5		3045.21	II	
4		3046.77		
2.0		3049.21		
8		3053.26	II	
4		3062.06	II	
8		3063.66	II	
3.5		3068.68		
6		3069.24	II	
2.5		3074.56		
3.5		3078.99		
11		3082.11	II	
3.0		3084.90	II	
		3085.03	II	
5		3085.86	II	
3.5		3091.34	II	
5		3097.78	II	
8		3098.50	II	
4	d	3101.27	II	
2.0		3103.10	II	
4		3105.40	II	
4		3109.76	II	
4		3110.58	II	
10		3111.34	II	
3.0		3114.14	II	
3.0		3119.03	II	
14		3121.57	II	
4		3123.00	II	
10		3129.20	II	
3.0		3135.35	II	
5		3136.79	II	
6		3146.47	II	
7		3151.54	II	
7		3153.20	II	
6		3153.83	II	
10		3158.65	II	
16		3163.74	II	
9		3164.82	II	
32		3168.24	II	
3.0		3169.37	II	
2.5		3171.23	I	
19		3172.31	II	
10		3182.45	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
13		3191.41	II	
8		3191.69	II	
24	d	3196.04	II	
13		3199.05	II	
3.5		3204.81	II	
12		3207.89	II	
6		3213.58	II	
4		3214.40	II	
22		3219.55	II	
4		3230.22	II	
12		3234.22	II	
3.0		3235.43	II	
5		3238.87	II	
12		3245.46	II	
6		3276.67	II	
9		3295.53	II	
3.0		3296.39	II	
3.0		3303.19	II	
5		3314.38	II	
5		3324.55	II	
2.5		3341.47	II	
5		3350.28	II	
16		3355.67	II	
2.5		3359.27	II	
5	h	3363.25	II	
5	d	3370.30	II	
5		3372.51	II	
5		3376.66	II	
5		3379.76	II	
4		3383.38	II	
5		3383.73	II	
5		3388.04	II	
13		3394.61	II	
2.5		3403.57	II	
8		3415.71	I	
8		3418.47	II	
4		3419.24	II	
2.5		3421.11	II	
5		3427.59	II	
10		3430.28	II	
5		3430.51	II	
2.5		3431.62	II	
10	h	3433.55	II	
3.5		3434.76	II	
3.5		3442.76	II	
4	h	3447.84	I	
5		3448.21	II	
5		3449.83	II	
3.0		3451.48	II	
6		3455.97	II	
3.0		3460.66		
13		3465.76	II	
5		3466.75		
4		3467.04	II	
8		3473.85	II	
6		3487.57	II	
3.0		3491.53		
3.0		3491.94	II	
3.0		3494.30	II	
7		3499.09	II	
6		3499.57	II	
8		3503.06	II	
6		3504.27	II	
6		3508.21	II	
3.0		3537.31	II	
6	h	3539.92	II	
4		3542.39		
3.0		3548.09	II	
3.0		3549.53	II	
6	d	3551.41	I	
3.0		3551.96	II	
5		3555.20	II	
3.0		3557.70	II	
5		3562.22	II	
5		3562.55	II	
3.0		3568.67	II	
6		3569.56	II	
3.0		3570.56	I	
6		3574.96	II	
3.0		3575.54		
9	d	3577.47	II	
3.0	h	3579.09		
6	h	3579.95	II	
6	h	3582.25	II	
24		3584.26	II	
5	d	3587.87	II	
3.0		3588.60	II	
6		3589.47	II	
3.0	h	3593.04	II	
9		3596.19	II	
9		3600.75	II	
11		3605.05	II	
6		3605.96		
3.0	h	3607.82	II	
15		3611.94	II	
3.0		3612.72	II	
6		3615.16	II	
9		3616.68	II	
3.0		3618.08		
3.0		3619.10	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	3621.09	II	
8 h	3622.38	II	
3.0 h	3622.74		
20	3630.97	II	
3.0	3634.47		
11	3635.28	II	
5	3637.65	II	
3.0	3638.58	II	
11	3641.62	II	
8	3643.32	II	
3.0	3644.54	II	
12	3645.54	II	
30	3645.66	II	
30	3646.30	II	
12	3648.30	II	
8	3650.18	II	0–27388
6	3651.04	II	
4	3652.38	II	
6	3657.42	II	
6	3658.21	II	
9	3659.04	II	
5	3660.08	II	
18 c	3660.38	II	
12	3661.62	II	
5	3662.46	I	
5	3664.64	I	
3	3667.14	II	
11	3667.67	II	
44	3668.83	II	
5	3669.52		
5	3670.26	II	
5	3671.92	II	
6	3674.14	II	
2.5	3674.88	I	
6	3679.99		
6 h	3681.86	II	
3	3685.27	II	
30	3687.04	II	
18	3687.20	II	
12	3689.71	II	
6	3691.48		
6	3693.36	I	
6	3693.49	II	
3	3696.66		
16	3698.07	II	
6	3699.51	I	
10	3701.81	II	
4	3704.32	II	
24	3706.77	II	
18 c	3711.10	II	442–27380
6	3712.35	II	
6	3713.28	II	
30	3714.06	II	
6	3715.62	I	
10	3716.20	II	
6	3717.84	II	
6	3718.02		
6	3719.44	II	
3.0	3720.22	II	
3.0	3722.07	II	
4	3723.58	I	
8	3725.03	II	
5	3726.31	II	
3.5	3729.11	II	
5	3729.40	II	
9 c	3730.58	II	
5	3731.50	II	
12 c	3733.03	II	
22 c	3734.41	II	
6	3735.31	II	
26	3735.76	II	
20	3736.50	II	
42	3739.19	II	
15	3741.01	II	
12	3743.99	II	
3.5	3747.27		
4	3747.47	II	
3.0	3748.50	II	
6	3748.82		
8	3750.13	II	
8	3750.49	II	
20	3751.00	II	
5 c	3751.60	II	
6	3752.29	II	
6	3753.38	II	
5	3754.41		
9 c	3754.98	II	
5	3756.81		
14	3759.61	II	
12	3760.08	II	
70	3761.87	II	
3.5	3762.37	II	
3.0	3762.56	I	
6	3763.03		
3.0	3764.09	II	
24	3764.81	II	
3.0	3765.99	I	
6	3766.48	II	
24	3768.93	II	
10	3769.70	II	442–26962

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		3770.48	II	
18	d	3772.76	II	
		3772.84	II	
18		3774.06	II	
8		3776.09	I	
6	c	3777.10	II	
14		3777.63	II	
6		3778.75	II	
9		3780.27	II	
18		3780.66	II	
3.0		3781.93	II	
5		3782.35	II	
5	c	3783.40	II	
3.5		3783.86		
		3783.99	II	
15		3785.50	II	
4		3785.97	II	
16		3786.88	II	
2.5		3788.06	II	
4		3790.60	II	
22		3792.52	II	
5		3792.93	I	
6		3793.42	II	
20		3794.95	II	
5		3795.77		
4		3796.30		
70		3800.30	II	
10	c	3801.35	II	
3		3802.30	II	
30		3804.85	II	
6		3806.13	II	
14		3809.16	II	
6		3809.96		
40		3811.85	II	
4		3813.89	II	
140		3816.17	II	
12		3817.63		
10		3817.87	II	
70		3818.28	II	
4		3818.71		
12		3819.07	II	
32		3821.82	II	
6		3822.80	II	
16	c	3823.18	II	
4		3823.57	II	0–26146
10		3824.07	II	
10	c	3826.29	II	
12		3826.71	II	3893–30018
4		3828.71	II	
3.5	c	3829.35	II	
100		3830.72	II	
6		3831.76		
8		3833.04		
8		3833.60		
14		3834.92	II	
50		3841.01	II	
28		3842.36	II	
6		3843.39	II	
6		3843.76	II	
16	c	3844.56	II	
60		3846.61	II	
10		3846.91	II	
120		3850.83	II	
75	c	3851.62	II	
3.5		3852.11		
100		3852.81	II	
10		3855.88	II	
10	c	3857.00	II	
		3857.11		
12		3858.26	II	
11		3859.14	II	
8		3861.31	II	
8		3862.05	II	
8		3864.06	II	
50	c	3865.46	II	
22		3867.55	II	
7		3868.58	II	0–25842
8		3869.16	II	
10		3869.91	II	
8		3870.35	II	
22		3870.73	II	
4		3872.72	I	
5		3873.02	II	
3.5		3873.40	II	
10		3874.45	II	
50		3876.18	II	
180	c	3877.23	II	
10		3878.31	II	1649–27425
28		3879.21	II	
70		3880.47	II	
8		3880.78	II	
9		3882.32	II	
4	h	3884.04	II	1649–27388
46	c	3885.19	II	1649–27380
3.5		3888.06	II	
5		3888.29	II	
46	c	3889.33	II	442–26146
		3889.42		
2.5	h	3889.97		
12	c	3891.70	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	3892.52	II	
3.0	3894.14	II	
3	3894.94	I	
5	3895.08	II	
4	3896.84	II	
7	3897.04	II	
20	3897.28	II	
4	3897.72	II	
22	3898.84	II	
9 c	3899.56	II	1744–27380
26	3902.47	II	
7	3903.91	II	
3.5	3904.80	II	
7	3906.09	II	
3.0	3907.30		
80 c	3908.03	II	4437–30018
320	3908.43	II	
11	3909.62	II	
4	3911.31		
3.5	3911.80		
4	3911.99	II	
5	3912.27	II	
7	3912.61	II	
65	3912.90	II	1649–27198
32	3913.56	II	
22	3914.76	II	
18	3915.47	II	
2.5	3916.80	II	
10	3917.23	II	
8 c	3917.92	II	
130 c	3918.86	II	2998–28509
44	3919.62	II	
26	3920.52	II	0–25500
7	3922.25	II	
10	3923.56	II	
13	3924.14	II	
5	3925.00		
100	3925.46	II	0–25468
50	3927.45	II	1744–27198
12	3927.71	II	
9	3928.62	II	
7	3928.91	II	
38	3929.26	II	
9	3929.88	II	
3.5	3930.62		
3.0	3932.13		
13	3932.98	II	
5	3934.26	II	
11 c	3935.13	II	
38	3935.82	II	442–25842
3.0	3936.69	II	
3.0	3937.03	II	
26	3938.31	II	
10 c	3940.15	II	
3.0	3941.51		
12	3942.26	II	
5	3942.92	I	
5 c	3943.37	I	
6	3943.75	II	
8	3944.05	II	
3.0	3944.62	II	
6	3944.90	II	
6	3945.42	I	
10	3945.66	II	
16	3946.95	II	
65 c	3947.63	II	1649–26974
80 c	3949.44	II	1649–26962
4 c	3950.66	II	
6	3951.18		
3.0	3951.84	I	
6	3952.02	II	
4	3952.36	II	
80 c	3953.52	II	4437–29724
3.5	3955.00		
5	3955.42	II	
5 hc	3956.52	II	
34	3956.76	II	
5	3957.68		
6	3958.19		
6	3958.50		
17	3959.41	II	
	3959.52		
4	3959.78		
8 c	3960.60	II	
5	3961.28	II	
42	3962.45	II	1744–26974
14 c	3963.15	II	
4	3963.71		
50	3964.26	II	1744–26962
140 c	3964.83	II	442–25657
100 c	3965.26	II	1649–26861
4	3965.62	I	
50 c	3966.57	II	2998–28202
14	3967.13	II	
14	3968.16	II	
5	3970.07	II	
44	3971.16	II	3403–28578
28	3971.69	II	
55 c	3972.16	II	442–25610
5	3973.12	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5	c	3973.90		
8	c	3974.37	II	
28		3974.86	II	
5		3976.29		
7		3976.56	II	
9		3976.83	II	
5		3977.42		
3.5	h	3977.71	I	
3.5		3979.69		
8		3980.23	II	
8		3980.88		
6	h	3981.20	II	
190	c	3982.06	II	3403−28509
9	h	3982.50	II	
8	h	3983.58		
8		3984.27	II	
8	c	3985.66	II	
6		3986.17	II	
11		3987.37		
8		3988.02	II	
120	c	3989.72	II	442−25500
4		3991.26	II	
20		3991.89	II	
30		3992.18	II	
6	h	3992.92	II	
4	c	3993.19		
8		3994.01		
140		3994.83	II	442−25468
24		3995.85	II	
50	c	3997.05	II	2998−28010
20		3997.96	II	
28		3999.19	II	
55	c	4000.19	II	1649−26641
10		4000.48	II	
8	c	4000.91		
6		4001.47	I	
4		4003.75		
65		4004.71	II	
13		4006.70	II	
6		4007.78	II	
170		4008.71	II	5079−30018
8		4009.24	II	
6		4009.97	I	
55		4010.64	II	
8		4013.23		
10		4013.43	II	
8		4014.35		
65		4015.39	II	1744−26641
2.5		4016.75	II	
55		4020.99	II	
8		4022.20	II	
42		4022.74	II	
10		4024.41	II	
6		4025.19	I	
32		4025.55	II	
20		4026.84	II	
20		4029.04	II	
32	c	4029.73	II	
6		4030.46		
13		4031.09	II	
65	c	4031.76	II	1649−26445
20		4032.49	II	
13		4032.97	II	
85		4033.86	II	2998−27782
20		4034.30	II	1744−26524
6	c	4036.54		
6		4037.22		
20		4038.19	II	
65		4038.47	II	0−24755
5		4038.90		
42		4039.36	II	1649−26398
120		4044.82	II	0−24716
20		4045.71	II	
20		4046.64	II	
30		4047.10	II	
16		4048.14	II	
40		4051.15	II	
8		4052.58	II	
200		4054.85	II	1744−26398
200		4056.54	II	5079−29724
12		4058.19	II	
40		4058.78	II	
10		4059.37	II	
10	h	4061.34	II	5108−29724
20		4062.23	II	
300		4062.82	II	3403−28010
19		4068.80	II	
15		4070.26	II	
17		4072.52	II	
8		4074.84	II	
5		4076.21		
44	c	4079.79	II	
44	c	4081.02	II	1649−26146
70		4081.90	II	
44		4083.34	II	
9	c	4084.74	II	
9		4085.13	II	
5		4085.34	II	
5		4086.24	II	
6		4086.75		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18 c	4087.21	II	
3.5	4088.87		
3.5	4089.07		
5	4089.47	II	
5	4089.87	II	
7	4090.74	II	
7 h	4092.63	II	
3.5	4092.85		
8 c	4094.97	II	
7	4095.97	II	
7	4096.34	II	
50	4096.82	II	1744–26146
34	4098.41	II	
5	4098.65		
14	4100.22	II	2998–27380
260 c	4100.75	II	4437–28816
3.0	4104.86	II	
10	4105.73	II	
2.5	4107.11		
3.0	4107.50		
8	4107.75	II	
6	4108.34	II	
3.0	4109.09		
3.0	4109.41		
2.5 h	4110.11	II	
5	4110.47	II	
4	4110.92	I	
13 c	4111.87	II	442–24755
2.5 h	4112.74		
24 c	4113.89	II	
5	4114.84		
4	4115.83	II	
150 c	4118.48	II	442–24716
4	4119.37		
8	4119.80	II	
3 h	4120.00	I	
2.5	4120.96		
8	4124.06		
8	4124.35	II	
8	4125.06	II	
5 h	4126.15	II	
22	4129.15	II	
30	4130.77	II	
15 c	4132.23	II	1649–25842
18	4133.62	II	
3.0	4137.16		
3.0	4138.19		
2.5 h	4140.32		
130 c	4141.26	II	4437–28578
6	4142.00	II	
240	4143.14	II	2998–27128
2.5	4144.23	II	
24 c	4146.54	II	
2.5	4147.14		
4	4147.55		
24	4148.46	II	1744–25842
3.5	4149.32	II	
7	4150.04	II	
3.5	4151.01	II	
2.5	4151.74	II	
8	4154.05	II	
18	4156.52	II	
3	4156.90		
5	4157.77	II	
3.5	4159.47		
2.5	4159.83		
4	4160.47	II	
150 c	4164.19	II	1649–25657
24	4168.08	II	3403–27388
20	4169.46	II	3403–27380
55	4171.82	II	2998–26962
65	4172.27	II	1649–25610
3.5	4173.70	II	
22	4175.30	II	
22	4175.64	II	
9	4176.33	II	
18	4178.64	II	
460	4179.42	II	1649–25569
3.5	4180.40	II	
6	4180.68	II	1744–25657
3.5	4182.33	II	
3.5	4182.67	II	
5	4182.92	II	
10	4184.24	II	
3.5	4184.62	II	
12	4185.15	II	
4	4185.82	II	
5	4186.40	II	
6	4187.79	II	
220	4189.52	II	2998–26861
4	4190.64	II	
50 c	4191.62	II	1649–25500
4 c	4192.50	II	
5	4194.62	II	
5 c	4195.52	II	
5	4195.96	II	
10	4196.79	II	
3.0	4197.10	II	
2.0	4197.29	II	
26	4201.18	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
10	c	4201.53	II	
220	c	4206.74	II	4437–28202
11		4207.81	II	
44		4208.31	II	1744–25500
28		4211.86	II	
4		4213.26	II	
16		4213.57	II	
5		4213.96	II	1744–25468
11	hc	4216.04	II	
7		4217.19	II	
28		4217.81	II	
14		4219.65	II	
340		4222.98	II	442–24115
8		4223.51	II	
340		4225.33	II	0–23660
14	h	4225.54	I	
8	c	4228.50	II	
8	c	4229.10	II	
6		4229.80	II	
8		4230.67	I	
28		4233.13	II	
28	c	4236.21	II	1649–25249
12		4236.64	II	
6		4237.01	I	
6		4238.35	II	
24		4240.03	II	
85		4241.02	II	4437–28010
15	c	4241.30	II	
30		4243.53	II	3403–26962
6		4245.46	II	
6		4246.15	II	
75	c	4247.66	II	442–23978
8		4249.08	II	
8		4249.48	II	2998–26524
17		4250.40	II	
14	c	4251.49	II	
6		4253.03	I	
44		4254.42	II	5079–28578
12	c	4261.80	II	3403–26861
17		4262.31	II	
8		4262.80	II	
8		4263.15	II	
24	c	4263.81	II	2998–26445
9		4267.78	II	
28		4269.10	II	
14		4271.76	II	
70	c	4272.27	II	2998–26398
8	c	4275.17	II	
		4275.32	II	
8		4275.82	II	
11		4276.19	II	
11		4278.04	II	
8		4278.99	II	
42	c	4280.11	II	
70	c	4282.44	II	4437–27782
4		4285.54		
4		4286.98	II	
4	c	4288.46	II	
7		4289.42	II	
11		4289.89	II	
5		4290.40	II	
5		4290.99	II	1649–24947
7	h	4291.63	II	
10	c	4293.14	II	
12		4293.58	II	
14	c	4294.70	II	
8		4295.11	II	
100		4297.76	II	0–23261
40	c	4298.92	II	
9	c	4302.10	II	3403–26641
26		4303.59	II	
130		4305.76	II	442–23660
10		4306.08	II	
4		4307.67	II	
9	c	4308.89	II	
7		4311.10	II	
4		4311.92	II	
7		4315.52	II	
7		4316.06	II	
4		4317.05	II	
8		4317.84	II	
10		4319.00	II	
5	h	4320.17	II	
19		4323.55	II	5079–28202
5		4328.20		
16		4328.42	II	
14		4328.99	II	
24		4329.42	II	1744–24835
5		4330.44		
5		4331.29	II	
5		4333.15	II	
120		4333.91	II	1649–24716
8		4334.62	II	
18		4335.75	II	
32		4338.69	II	3403–26445
6		4339.68	II	
7	c	4342.81	II	
4		4343.89	II	
55	cw	4344.33	II	
4		4346.89	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
42	c	4347.49	II	3403–26398
30		4350.40	II	
100		4351.85	II	1744–24716
40		4354.91	II	
4		4355.19	II	
4		4357.50	II	
12		4359.11	II	
36	c	4359.80	II	5079–28010
4		4361.26	II	
4		4361.82	II	
9		4362.98	II	
9		4363.22	II	
110		4368.33	II	0–22886
8		4370.80	II	
28		4371.61	II	
7		4373.82	II	
11		4374.41	II	
3.5		4379.34	II	
10		4380.32	II	
14		4382.42	II	
5	c	4382.82	II	
10	c	4384.14	II	
7		4384.80	II	
3.5	d	4385.31		
		4385.48	I	
4		4391.51	II	
16		4395.01	II	
16		4395.79	II	3403–26146
24		4396.12	II	
2.5		4396.87	II	
5		4398.27	II	
16		4399.33	II	
8		4400.03	II	
7		4400.25	II	
6		4403.28	II	
15		4403.61	II	5079–27782
9		4405.15	II	
38		4405.85	II	4437–27128
6		4406.67	II	
150		4408.84	II	0–22675
7	h	4412.16	II	2998–25657
36		4413.77	II	1744–24394
7		4414.40	II	
14		4419.06	II	
17		4419.67	II	
14	c	4421.23	II	2998–25610
2.0		4424.18	II	
14		4424.60	II	
110	c	4429.24	II	2998–25569
2.0		4431.89	I	
10		4432.34	II	
2.0		4434.85		
8		4438.18	II	
5	c	4444.01	II	
6		4445.87	II	
8		4446.99	II	
65		4449.87	II	1649–24115
7	c	4450.21	II	
12		4451.95	II	
6		4454.38	II	442–22886
12		4454.70	II	
8	h	4458.34	II	4437–26861
6	h	4461.29	II	
9		4465.98	II	
85		4468.71	II	1744–24115
2.0		4469.66		
5		4472.93	II	
5		4473.84	II	5079–27425
12	c	4477.26	II	1649–23978
3.0		4483.49	II	
4.0		4485.54		
2.5		4487.82	II	442–22718
6		4488.17	II	
5	c	4492.43	II	3403–25657
3.0	d	4492.93	I	
		4493.12	II	2998–25249
3.0		4493.71	II	
3.0		4494.19	II	
95		4496.43	II	442–22675
3.5		4501.83	II	3403–25610
5	c	4504.59	II	
70		4510.16	II	3403–25569
2.0		4516.46	II	
18	c	4517.60	II	442–22571
5		4520.78	II	
5		4531.09	II	
30	c	4534.15	II	5079–27128
30		4535.92	II	0–22040
5	h	4539.29	II	
6		4542.54	II	
2.5		4543.97	II	
7		4548.54	II	
3.5		4549.84	II	
2.5		4550.06	II	5226–27198
3.0		4550.88	II	1649–23617
6		4552.26	I	
18		4563.13	II	
2.0	h	4568.55	II	5079–26962
6	h	4570.57	II	1744–23616
2.5		4571.61	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		4572.13	I	
6	h	4576.32	II	3403–25249
5	h	4578.14	II	2998–24835
2.0		4592.15	II	
2.5		4593.93	II	
2.5		4595.87	II	5108–26860
6		4596.95	II	
2.0		4598.95	I	
3.0		4600.39	II	
2.0		4603.81	I	
3.5	h	4606.45	II	
12		4612.07	II	0–21676
2.0		4617.73	I	
2.0		4618.01	II	
3.0		4627.05	II	3893–25500
24	c	4628.75	II	442–22040
12		4632.28	I	
12		4635.69	I	
18		4639.56	I	
7		4640.21	I	
10	c	4643.51	II	
12		4646.06	II	1744–23261
5		4646.99	I	
18	c	4651.52	II	1649–23141
2.5		4658.09	II	
3.0		4658.73	I	
5	h	4660.92	I	
12		4664.65	II	3403–24835
24	c	4672.08	II	1744–23141
5		4678.17	II	4098–25468
3.5		4679.11	II	5079–26445
5	c	4684.94	II	
16		4687.81	I	
26		4695.77	I	
5		4707.54	II	1649–22886
6		4707.94	II	442–21676
6		4708.16	II	
12		4709.52	I	
8		4713.10	I	
8		4714.15	I	
5		4728.63	II	1744–22886
16		4730.69	I	
2.0		4733.75	I	
4	c	4734.18	II	2998–24115
22		4736.69	I	
2.5		4741.50	I	
9		4744.16	I	
8		4744.93	II	1649–22718
13		4746.93	II	5226–26287
6	d	4755.98		
		4756.13	II	
7	c	4757.94	II	6414–27425
9		4762.73	II	3403–24394
6	c	4765.22	II	2998–23978
1.8	c	4775.17	I	
2.5	c	4779.20	II	7660–28578
10		4783.35	II	2998–23898
1.4		4788.28	I	
1.2		4799.94	II	1744–22571
8		4801.15	II	3893–24716
2.5		4808.19	I	
4		4814.34	II	8958–29724
8		4822.98	II	
3.0		4827.25	I	
3.5	c	4832.07	II	
4	c	4837.04	II	
3.5		4839.54	II	4098–24755
2.5		4840.74	I	
1.0		4845.97	I	
3.5	c	4848.55	II	
3.0		4853.68	I	
2.0		4857.37	I	
1.4		4858.59	I	
2.5		4859.04	II	3403–23978
5		4865.24	II	6414–26962
2.0		4869.33	I	
3.0		4876.26	II	5108–25610
8	c	4877.82	II	3403–23898
1.0	c	4879.12	II	5079–25569
2.5		4882.25	I	
1.2		4884.46	I	
2.5		4886.05	II	5108–25569
5		4890.26	II	
4		4896.14	I	
2.5		4901.48	II	7806–28202
10		4906.98	I	
5		4912.63	II	7660–28010
12		4914.03	I	
2.0		4915.42	I	
18		4924.59	I	
2.0		4925.32	I	
2.5		4925.63	II	1744–22040
2.5		4932.17	I	
12		4936.00	I	
3.5		4938.90	I	
28		4939.74	I	
14		4940.30	I	
2.5		4943.74	II	3893–24115
34		4951.36	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.5	4956.06	I	
7 c	4956.65	II	5079–25249
5	4960.26	I	
2.5	4967.89	I	
2.5	4970.92	I	
7	4974.92	I	
10	4975.75	I	
7	4976.40	I	
8	4989.27	II	
8	5002.45	II	6414–26398
4	5004.58	II	7806–27782
2.5	5015.54	II	1744–21676
11	5018.58	I	
18	5019.76	I	
18	5026.97	I	
3.0	5031.98	II	
9	5033.38	I	
24	5034.42	II	8958–28816
6 c	5037.46	II	
10	5043.83	I	
28	5045.53	I	
14	5053.40	I	
3.5	5063.39	I	
2.5 c	5064.84	II	3403–23141
2.5 c	5070.01	I	
4 c	5075.68	II	
16	5087.11	I	
32	5110.38	II	4098–23660
50	5110.77	II	9255–28816
3.5	5117.27	I	
2.0 c	5118.02	II	4437–23970
36	5129.52	II	5226–24716
24	5133.42	I	
24	5135.13	II	7660–27128
9	5139.80	I	
2.5	5147.46	I	
2.5	5149.87	I	
9 c	5152.21	II	
7	5156.49	II	
18	5161.74	II	3893–23261
2.5	5168.31	I	
55	5173.90	II	7806–27128
7	5175.19	II	
4 c	5175.83	II	3403–22718
4	5177.37	I	
4	5183.85	II	5108–24394
2.0	5188.24	II	
18	5191.34	II	
11	5194.41	I	
13	5195.11	II	8958–28202
18	5195.31	II	6414–25657
7	5195.48	I	
32	5206.56	II	7660–26861
13	5207.90	II	6414–25610
4	5216.76	II	4098–23261
32	5219.05	II	6414–25569
50	5220.11	II	6418–25569
10	5228.01	I	
2.0 c	5230.27	I	
2.0 c	5242.67	I	
1.8	5243.69	II	
2.0	5249.84	I	
6 c	5251.74	II	5079–24115
60	5259.74	II	5108–24115
16	5263.88	II	3893–22886
1.4	5272.72	II	
2.0 c	5277.32	II	
8	5285.63	I	
4	5289.35	I	
30 c	5292.10	II	5079–23970
30	5292.63	II	5226–24115
20	5298.11	II	5108–23978
2.0	5308.96	II	6418–25249
8	5311.12	II	8958–27782
6 cw	5312.33	II	5079–23898
2.5	5313.39	II	
1.4	5316.61	I	
8	5321.09	II	4098–22886
3.5	5321.81	II	7660–26445
38	5322.78	II	3893–22675
6	5331.48	II	5226–23978
1.4 cw	5341.6	I	
1.8	5342.55	II	
5	5343.86	II	
18	5352.40	II	3893–22571
3.0	5358.99	I	
1.6	5372.37	I	
1.6	5374.24	I	
1.2	5377.44	II	
1.6	5381.26	II	4098–22675
1.6	5381.70	II	
2.5 c	5395.89	I	
1.2	5400.95	I	
2.5	5402.59	I	
1.6	5404.81	II	
4 cw	5410.60	II	
5	5411.56	II	4098–22571
7 cw	5413.19	II	
2.5	5422.42		
1.6	5427.27	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.6	5428.00	II	
2.5	5432.07	II	
1.6	5432.64	II	
1.6	5432.91	I	
2.5 c	5437.37	I	
1.4 h	5445.43	I	
1.6	5457.06	I	
2.5	5460.25	I	
1.0	5469.71	I	
2.0	5469.92	I	
3.0 c	5475.67	II	
3.5	5479.73	I	
1.4	5481.76	I	
1.4	5485.53	I	
1.4	5486.61	I	
4 d	5487.41	I	
	5487.58	I	
1.4	5488.93	I	
1.4	5490.56	I	
2.5	5492.37	II	
1.4 c	5497.24	I	
1.4	5501.47	I	
3.5	5508.79	II	
6	5509.15	II	3893–22040
1.4 c	5511.66		
5	5513.58	II	
2.5	5515.11	II	
1.2	5519.38	II	11611–29724
1.8 c	5519.84		
4 c	5522.80	I	
2.5 c	5524.14	I	
2.5 c	5525.90	II	
1.4 c	5527.88		
1.2	5530.19	I	
4	5531.15	I	
13	5535.18	II	
2.5	5538.37	I	
1.8	5538.77	II	
5	5545.01	II	
1.8	5548.31	II	
1.0	5553.40	II	
2.0	5561.46	II	
4 c	5562.06	I	
1.2	5565.54	I	
1.2	5566.92	II	
4	5571.84	II	4098–22040
1.0	5574.60	II	
1.0	5578.81	I	
1.2	5582.40	II	8490–26398
1.0	5584.01	II	
2.0	5594.92	I	
2.0	5597.29	II	
1.2	5601.31	II	
8	5605.64	II	
1.2	5606.68		
2.5	5608.98	II	
5	5610.22	II	9379–27198
1.0	5620.07	II	
1.8	5620.25	I	
4 c	5621.85	II	3893–21676
10	5623.05	II	
8	5624.43	II	
1.0 h	5633.02	I	
2.0	5636.46	II	
5 c	5638.79	II	
1.4	5640.34	I	
1.4 cw	5643.20	I	
2.0	5645.39	II	
3.0	5654.25	II	
5	5659.84	II	
3.0 h	5661.56	I	
1.4	5662.19	II	8490–26146
6 c	5668.45	I	
4	5669.55	II	
3.0	5670.02	II	
1.4	5674.13	II	
1.4	5677.04	II	5108–22718
5	5681.90	II	9379–26974
1.2	5685.61	II	9379–26962
1.4	5686.50	I	
2.0 h	5687.19	II	4098–21676
6	5688.46	II	
2.0	5689.18	II	11005–28578
5 d	5690.95	PrO	
	5691.04	II	
2.0	5695.93	II	9647–27198
2.0	5704.39	I	
6	5707.61	I	
3.5	5711.65	II	11005–28509
2.0	5713.83	I	
1.4	5716.08		
4	5719.09	II	6418–23898
4 d	5719.63		
	5719.81		
1.0	5728.36	I	
3.5	5731.87	II	
1.8	5747.14	II	
2.0 c	5747.88		
2.0	5753.02	II	
8	5756.17	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.4		5759.39	II	
2.0		5760.21	I	
2.0		5769.15	II	
1.4		5769.78	II	
4		5773.11	II	
1.4		5773.95		
1.0		5775.92	II	7447–24755
1.4		5777.29	II	
8		5779.29	I	
6	c	5785.30	II	
6		5786.18	II	
1.4	h	5788.30	I	
1.4		5788.92	II	
1.4		5790.87	II	
4		5791.38	II	9379–26641
2.0		5792.96	I	
3.5		5810.62	II	11611–28816
1.4		5813.59	II	11005–28202
14	d	5815.18	II	
		5815.37	I	
5		5818.57	II	
3.5		5820.62	I	
1.4	h	5821.35	I	
5		5822.63	II	
8		5823.72	II	8490–25657
4		5830.97	II	
3.5		5835.13	I	
3.0	c	5844.64	II	
3.5		5845.00	II	
6		5847.13	II	
6	c	5850.65	II	
4		5852.63	II	
1.0	c	5854.43	I	
4		5856.08		
5		5856.92	II	
8		5859.69	II	
7		5868.83	II	
2.0		5873.87	II	
3.0		5874.73	I	
3.0		5878.11	I	
3.0		5879.07	I	
7		5879.25	II	11005–28010
3.0	c	5884.70	I	
5		5892.23	II	11611–28578
2.0		5894.29	I	
3.5		5903.13	II	
4		5904.45	II	
3.5		5908.67	II	
1.0		5915.31	I	
1.0		5915.98	I	
3.5		5920.76	I	
3.5		5930.67	I	
1.4		5936.31	I	
14		5939.91	II	
6		5940.73	II	
2.0		5941.65	I	
3.0		5947.20		
2.0	c	5949.79	I	
5		5951.28	II	
1.8		5951.78	II	
8		5956.62	II	
1.2		5959.31	I	
1.8		5962.21	I	
2.5		5963.02	I	
10		5967.84	II	9647–26398
1.2	c	5976.96	I	
1.2		5978.88	I	
6		5981.21	II	
3.5		5986.14	I	
4	c	5987.15	I	
1.2		5991.26	I	
1.2	c	5994.92	I	
1.0		5996.05	I	
2.6		6002.45	II	
8		6006.35	II	
1.2		6008.61	I	
5		6016.49	II	
13		6017.80	II	
2.5	c	6019.90	I	
13		6025.72	II	11611–28202
3.0		6042.87	II	
5		6046.68	II	
3.0		6049.26	I	
2.5		6050.03	II	
1.0		6050.88	I	
12		6055.13	I	
1.2		6067.24	II	
1.2		6085.85		
2.5		6086.15	II	
6		6087.51	II	
1.8		6090.37	II	
2.5		6093.04	I	
1.6		6096.35	I	
2.0		6106.76	II	
1.6		6109.06	I	
6		6114.40	II	
2.0	c	6118.02	I	
2.0	c	6122.24	I	
3.0		6141.51	II	9379–25657
6		6148.25	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		6157.80	II	
1.2		6159.09	II	9379–25610
17		6161.19	II	8490–24716
1.6		6165.26	I	
24		6165.95	II	7447–23660
5		6182.34	II	11611–27782
1.2		6187.98	I	
3.0		6197.46	II	
3.0		6200.79	II	11005–27128
1.2		6205.65	II	
1.2		6210.59	I	
2.0		6212.73	I	
1.6		6218.08	I	
1.8	h	6236.83	I	
1.8	h	6241.11	I	
4		6244.34	II	9647–25657
3.0		6255.10	II	
3.5		6262.54	II	9647–25610
1.6		6264.60		
2.0	c	6274.74		
3.5		6278.68	II	9647–25569
10		6281.31	II	
1.6	c	6289.03	I	
1.0	c	6297.99		
1.0		6302.02		
3.0		6302.36	I	
1.4		6304.03	I	
3.0		6305.26	II	11005–26861
1.0	h	6318.12	I	
4	c	6322.37	I	
2.0	h	6343.94	I	
2.5		6347.13	II	
1.6	c	6350.98	I	
2.0	c	6357.24	I	
5	c	6359.04	I	
1.0	h	6363.59	II	
1.4		6377.62	I	
1.4		6378.62	I	
1.0		6389.59	I	
1.6	c	6392.10	I	
3.5		6393.19	I	
4		6398.00	II	8490–24115
0.9	h	6410.66	I	
5		6411.30	I	
3.5		6413.70	II	
0.9		6415.53	I	
4		6429.65	II	
4		6431.86	II	
0.6	h	6442.81	I	
0.8	h	6443.94	II	
1.4	c	6453.44	I	
0.8		6454.87	II	8490–23978
0.8		6456.20	I	
0.8	h	6460.30	I	
1.6		6467.76		
0.8	h	6475.29	II	7447–22886
3.0	cw	6478.03	II	
4		6486.56	I	
0.8	h	6486.95	II	
3.5	h	6491.76	I	
0.8		6493.49	I	
1.0		6494.90	I	
2.0	c	6497.18	I	
1.6		6498.94	II	
2.0		6500.73	I	
0.8		6504.10	I	
0.7		6517.15	I	
1.4		6518.81	II	
0.7		6534.64	I	
1.4		6540.48	I	
0.6	h	6553.30	I	
2.0		6564.63	II	7447–22675
4		6566.75	II	
0.6		6571.04	I	
0.5		6578.00	I	
0.5		6584.59	II	
0.8	h	6593.69	I	
1.2		6595.47	I	
1.6		6609.85	I	
6		6616.65	I	
1.2		6618.42		
0.7	h	6631.1	I	
1.4	h	6632.04	I	
1.5		6647.12	I	
8		6656.83	II	
6		6673.41	II	
8		6673.78	II	
0.5	h	6687.6	II	
0.4	h	6699.32	I	
1.4		6736.89	I	
4	c	6747.17	I	
2.0	c	6749.28	I	
0.8	c	6785.12		
6	cw	6798.68	I	
1.2		6811.88	II	
1.8	cw	6812.91		
1.4		6814.10	II	
1.0		6817.70	I	
3.5	cw	6827.70	II	
2.0		6830.57	II	

Praseodymium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.0	6844.48	I	
1.0 h	6845.54	II	
1.0	6846.72		
1.8 c	6850.55	II	7447–22040
1.2	6852.90	I	
1.2 c	6870.55	I	
0.9	6884.72	I	
1.0	6892.76	I	
1.0 h	6970.38		
1.0 c	6980.18	I	
5	7021.54	II	9379–23617
1.2	7024.59	I	
1.6	7042.54	I	
1.0	7044.60	II	
0.9	7051.06	I	
1.2	7080.02	I	
1.4 c	7095.28		
2.5	7114.55	I	
1.2 h	7116.88	I	
1.4	7118.19		
0.9	7137.28	II	
1.2 h	7159.87	I	
0.9	7167.75	II	
0.9 h	7189.96	I	
1.2 c	7208.81	II	
3.0	7227.71	I	
1.6	7231.49	I	
0.9 c	7243.24	I	
0.9 c	7259.22	I	
0.9 c	7287.71	I	
0.9 h	7289.14	I	
0.9 cw	7324.36	I	
0.9	7328.47		
0.9	7344.86		
2.0	7407.60		
2.5 c	7451.71		
1.4 h	7495.62		
0.8 h	7499.45	II	
1.8	7541.02	II	
0.7	7574.92	I	
2.5	7645.67	II	
0.9	7704.96	II	
2.0	7721.81	I	
0.7 h	7786.11	I	
0.8 cw	7841.02		
1.8	7871.65	II	
0.7	7880.95		
0.7 cw	7888.40		
0.7	7915.07	II	
0.7	8031.80	II	
0.7	8055.32	I	
1.8	8067.31		
1.2 cw	8122.67		
1.4	8141.05	I	
0.6	8181.21	II	
0.6 c	8211.90	I	
0.7	8289.84	I	
0.7	8379.77		
0.7 h	8427.79	I	
0.7 h	8605.20	II	
1.2	8714.43		

609065 O - 62 - 18

RHENIUM

Re, $Z=75$, $M=186.22$, Ratio $\frac{Re}{Cu}=2.931$

Re I Normal state of valence electrons $5d^5\,6s^2\,{}^6S_{2\frac{1}{2}}=0$. I.P.=63530 K
Re II Normal state of valence electrons $5d^5\,6s^1\,{}^7S_3=0$.

References

Wavelengths:
W. F. Meggers, J. Research NBS **49,** 187 (1952).

Classification:
Re I, P. F. A. Klinkenberg, W. F. Meggers, R. Velasco, and M. A. Catalán, J. Research NBS **59,** 319 (1957).
Re II, W. F. Meggers, M. A. Catalán, and M. Sales, J. Research NBS **61,** 441 (1958).

Relative intensity of rhenium lines observed in an arc of copper containing 0.1 atomic percent of rhenium

Strong lines of rhenium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
5500 c	3460. 46	I	0–28890	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^56s^16p^1$ $z\ {}^6P^0_{3\frac{1}{2}}$
4000 c	3464. 73	I	0–28854	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^56s^16p^1$ $z\ {}^6P^0_{2\frac{1}{2}}$
1600 c	3451. 88	I	0–28962	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^56s^16p^1$ $z\ {}^6P^0_{1\frac{1}{2}}$
800	3424. 62	I	11754–40946	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$—$5d^56s^16p^1$ $y\ {}^6D^0_{3\frac{1}{2}}$
500	2999. 60	I	11754–45083	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$—$5d^66p^1$ $y\ {}^6F^0_{5\frac{1}{2}}$
400	3399. 30	I	11754–41164	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$— $41164^0_{3\frac{1}{2}}$
400	3725. 76	I	23632–50464	$5d^56s^16p^1$ $z\ {}^8P^0_{4\frac{1}{2}}$—$5d^56s^16d^1$ $e\ {}^8D_{5\frac{1}{2}}$
360 c	4227. 46	I	18950–42598	$5d^56s^16p^1$ $z\ {}^8P^0_{2\frac{1}{2}}$—$5d^56s^17s^1$ $e\ {}^8S_{3\frac{1}{2}}$
260	2887. 68	I	11754–46374	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$—$5d^66p^1$ $y\ {}^6F^0_{4\frac{1}{2}}$
260	4513. 31	I	20448–42598	$5d^56s^16p^1$ $z\ {}^8P^0_{3\frac{1}{2}}$—$5d^56s^17s^1$ $e\ {}^8S_{3\frac{1}{2}}$
220 cw	4889. 14	I	0–20448	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^56s^16p^1$ $z\ {}^8P^0_{3\frac{1}{2}}$
200	3338. 18	I	20448–50396	$5d^56s^16p^1$ $z\ {}^8P^0_{3\frac{1}{2}}$—$5d^56s^16d^1$ $e\ {}^8D_{4\frac{1}{2}}$
180	4136. 45	I	11754–35923	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$—$5d^46s^26p^1$ $z\ {}^6D^0_{4\frac{1}{2}}$
160	2428. 58	I	0–41164	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$— $41164^0_{3\frac{1}{2}}$
160	2992. 36	I	0–33409	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^46s^26p^1$ $z\ {}^6D^0_{2\frac{1}{2}}$
160	3067. 40	I	0–32592	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^46s^26p^1$ $z\ {}^6D^0_{1\frac{1}{2}}$
160	3342. 24	I	20448–50359	$5d^56s^16p^1$ $z\ {}^8P^0_{3\frac{1}{2}}$—$5d^56s^16d^1$ $e\ {}^8D_{3\frac{1}{2}}$
160 cw	5275. 56	I	0–18950	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^56s^16p^1$ $z\ {}^8P^0_{2\frac{1}{2}}$
150 c	2508. 99	I	0–39845	$5d^56s^2$ $a\ {}^6S_{2\frac{1}{2}}$—$5d^56s^16p^1$ $x\ {}^6P^0_{3\frac{1}{2}}$
150 c	3691. 48	I	16327–43409	$5d^66s^1$ $a\ {}^6D_{1\frac{1}{2}}$— $43409^0_{1\frac{1}{2}}$
140	2965. 76	I	11754–45463	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$— $45463^0_{3\frac{1}{2}}$
130	5270. 95	I	23632–42598	$5d^56s^16p^1$ $z\ {}^8P^0_{4\frac{1}{2}}$—$5d^56s^17s^1$ $e\ {}^8S_{3\frac{1}{2}}$
120	2715. 47	I	11754–48570	$5d^66s^1$ $a\ {}^6D_{4\frac{1}{2}}$— $48570^0_{3\frac{1}{2}}$
110	3184. 76	I	18950–50341	$5d^56s^16p^1$ $z\ {}^8P^0_{2\frac{1}{2}}$—$5d^56s^16d^1$ $e\ {}^8D_{2\frac{1}{2}}$
110	3185. 57	I	18950–50333	$5d^56s^16p^1$ $z\ {}^8P^0_{2\frac{1}{2}}$—$5d^56s^16d^1$ $e\ {}^8D_{1\frac{1}{2}}$
110 c	3204. 25	I	16307–47507	$5d^56s^2$ $a\ {}^4G_{5\frac{1}{2}}$— $47507^0_{6\frac{1}{2}}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
13	2003.53	I	0–49895
10	2017.87	I	0–49541
24	2049.08	I	0–48786
5	2074.70	I	0–48184
5	2083.92	I	0–47971
14	2085.59	I	0–47932
7	2092.41	II	
14	2097.12	I	0–47669
5	2109.22	I	
9	2139.04	II	
4	2142.74	II	
	2142.97	I	0–46649
11	2156.67	I	0–46353
17	2167.94	I	0–46112
13	2176.21	I	0–45937
24 c	2214.26	II	0–45148
13	2214.58	I	
12	2226.42	I	0–44901
7	2235.44	I	0–44720
4	2255.73	I	11584–55902
8	2256.19	I	0–44309
20	2264.39	I	0–44148
24	2274.62	I	0–43950
60 c	2275.25	II	0–43938
20	2281.62	I	0–43815
40	2287.51	I	0–43702
40	2294.49	I	0–43569
6	2298.09	II	27628–71128
6	2299.77	I	11755–55224
10	2302.99	I	0–43408
11	2306.54	I	0–43342
4	2312.97	I	15058–58280
4	2313.34	I	
4	2319.19	I	16307–59412
7	2320.16	I	16307–59394
15	2322.49	I	0–43044
6	2328.66	I	11584–54514
6	2334.33	I	11584–54410
6	2335.73	I	11754–54554
5	2336.10	I	16619–59412
6	2337.95	I	11754–54514
22	2344.78	I	
3.5	2345.28	I	13826–56452
3.5	2347.06	I	11584–54177
6	2349.39	I	14621–57173
6 d	2350.46	I	
18	2352.07	I	11584–54087
6 d	2353.95	I	
	2354.08	I	11754–54221
7	2356.50	I	11754–54177
6	2365.32	I	
36	2365.90	I	0–42254
18	2367.68	I	15058–57281
6	2368.53	II	14930–57139
17	2369.27	I	11755–53949
7	2370.76	II	14883–57050
7	2371.52	I	11584–53738
5	2373.48	II	14930–57050
11	2375.07	I	14217–56308
5	2375.82	I	11584–53662
3.5	2377.33	I	
2.5	2378.53	II	27746–69776
14	2379.77	I	
7	2380.22	I	16619–58619
2.5	2380.89	I	16307–58295
7	2381.14	I	11754–53738
7	2383.46	I	14217–56160
7	2386.90	II	20976–62859
3.5	2387.46	I	16307–58180
14	2388.57	I	
7	2389.11	I	0–41844
7	2390.43	I	
3.5	2391.28	I	11584–53390
10	2393.65	I	13826–55590
14	2394.37	I	11584–53336
15	2396.79	I	11584–53294
9	2397.31	I	15166–56866
3.5	2398.71	I	16619–58295
3.5	2398.89	I	
10 d	2400.72	I	15058–56699
	2400.89	I	
10	2401.68	I	11754–53379
7	2402.60	I	
3.5	2403.04	II	23341–64942
7	2404.34	I	
70	2405.06	I	11754–53321
36	2405.60	I	0–41557
16	2406.70	I	
14	2410.37	I	11584–53059
6	2410.99	I	
10	2413.22	I	
7	2414.59	I	15770–57173
7	2416.30	I	
7	2416.44	I	11584–52954
7	2417.66	I	16307–57657
3.5	2418.20	II	25988–67328
10	2419.40	I	15770–57090
70	2419.81	I	0–41313
10	2421.38	I	15166–56452
17	2421.73	I	14621–55901

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
17		2421.88	I	
3.5		2423.50	I	15058–56308
3.5		2423.84	II	
3.5		2425.38	I	
6		2426.64	I	16328–57524
160		2428.58	I	0–41164
7		2429.65	I	16307–57453
34		2431.54	I	
28		2432.18	I	11754–52857
10		2432.70	I	15166–56260
12		2433.28	I	16307–57391
7		2433.61	I	
7		2436.05	I	16619–57657
14		2438.46	I	13826–54823
10		2439.06	I	11754–52741
5		2440.41	I	
5		2440.58	I	
25	c	2441.47	I	0–40946
17		2442.51	I	15770–56699
7		2444.09	I	
20		2444.94	I	11584–52472
50		2446.98	I	15058–55912
10		2448.20	I	
7		2449.03	II	18846–59666
7		2449.52	II	26237–67049
50		2449.71	I	0–40809
7		2450.89	I	11584–52373
7		2453.14	I	16619–57372
16		2455.83	II	14352–55059
5		2455.99	I	
7		2460.24	I	11584–52218
32		2461.20	I	11754–52373
65	c	2461.84	II	
7		2462.54	I	
9		2463.31	I	13826–54410
10		2465.13	I	16619–57173
16		2467.57	II	14930–55444
10		2467.85	II	26768–67276
12	c	2469.36	II	18846–59330
5	h	2470.05	I	
10		2470.61	II	20463–60927
6		2471.05	II	19140–59596
12		2473.72	II	
13		2474.73	I	15058–55454
13		2475.17	II	23894–64282
6		2476.28	I	11584–51955
6		2477.43	II	
16		2479.02	I	17331–57657
15		2480.82	I	14217–54514
100		2483.92	I	11754–52001
32		2485.81	I	16307–56523
10		2486.78	I	11754–51955
5		2486.97	I	
80		2487.33	I	11755–51946
6		2490.16	II	30982–71128
16		2492.84	I	13826–53929
12		2495.26	I	11584–51648
30		2496.04	I	14217–54268
3.0		2496.70	I	17331–57372
16		2498.22	I	13826–53843
9		2498.86	I	11584–51590
6		2500.31	I	22160–62143
11		2500.57	I	23956–63935
30		2501.72	I	14217–54177
46		2502.35	II	20976–60927
19		2504.60	II	17224–57139
6		2505.43	I	
22		2505.94	I	11754–51648
12		2507.40	I	14217–54087
150	c	2508.99	I	0–39845
6		2512.55	I	14621–54410
6	c	2514.51	I	
5		2515.47	I	
10		2516.12	I	11754–51486
4		2517.08	I	
46		2520.01	I	0–39670
44		2521.50	I	14621–54268
9		2525.55	I	
5		2526.81	I	13826–53390
11		2529.50	I	14217–53738
12		2533.31	I	13826–53288
12		2534.10	II	14352–53802
30		2534.80	I	11754–51193
9		2539.33	I	17331–56699
46		2540.51	I	11584–50934
9		2543.67	I	15166–54467
5		2543.84	I	13826–53125
9		2544.22	I	16619–55912
60	d	2544.74	I	11584–50869
		2544.88		
30		2545.48	I	11754–51028
9		2548.14	I	13826–53059
12		2548.88	I	14621–53842
5		2549.37	I	17238–56452
13		2550.09	II	20463–59666
24		2552.02	I	14217–53390
3.0		2552.73	I	14217–53379
12	c	2553.59	II	17224–56372
6		2554.18	I	
30		2554.63	II	20463–59596

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		2554.93	I	13826–52954
85		2556.51	I	14217–53321
12		2558.06	I	17331–56411
20		2559.08	I	0–39065
6		2559.71	I	13826–52881
6		2559.88	I	15770–54823
12		2561.46	I	15058–54087
12		2563.01	I	
28		2564.19	I	11584–50571
6		2565.84	I	21775–60737
3.0		2566.57	I	
44		2568.64	II	14883–53802
12		2571.26	I	11584–50464
30		2571.81	II	14930–53802
12		2573.76	I	14217–53059
4		2574.21	I	16619–55454
6		2576.32	I	17331–56134
4		2578.12	I	
12		2579.01	I	15166–53929
8		2580.31	I	15770–54514
12		2581.44	I	11584–50311
9		2582.77		
6		2584.77	I	15166–53842
34		2586.79	I	11754–50401
6		2587.00	I	13826–52469
6		2591.13	I	17331–55912
16		2591.59	I	11584–50159
8	h	2592.84	I	11755–50311
14	c	2594.85	I	11584–50110
16		2595.23	I	0–38521
10		2596.40	I	
14		2596.78	I	15770–54268
10		2596.95	I	16327–54823
6		2597.96	I	
26		2599.86	I	13826–52278
6		2600.87	I	14621–53059
8		2601.87	I	16307–54730
5		2602.55	I	
8		2602.93	I	15770–54177
12		2603.46	I	
26		2603.89	I	
5		2607.32	I	
60		2608.50	II	14352–52677
55	d	2611.54	I	
		2611.60	I	11584–49863
10		2613.74	I	15770–54018
14		2614.56	I	14621–52857
5		2615.68	I	
14	c	2616.72	II	18846–57050
9		2617.11	I	
8		2617.44	I	16619–54813
15		2620.03	I	14217–52373
15		2620.34	I	21775–59927
18		2622.76	I	
8		2623.28	I	11754–49863
4		2625.04	I	11584–49667
5	c	2630.75	I	15058–53059
8		2631.57	I	11584–49573
4		2633.01	I	15770–53738
12		2633.61	I	15166–53125
28		2635.83	II	17224–55151
50		2636.64	I	0–37916
17		2637.01	II	19140–57050
8		2641.02	II	14824–52677
24		2642.75	I	11754–49583
14		2647.13	I	0–37766
6		2648.46	II	14930–52677
24		2649.05	I	14217–51955
4		2649.58	I	17238–54969
60		2651.90	I	0–37698
12		2652.91	I	15058–52741
36		2654.12	I	11584–49250
4		2655.18	I	13826–51477
4		2655.84	I	16307–53949
6		2659.02	I	14621–52218
6		2659.79	I	26349–63935
4		2660.54	I	
20		2663.63	I	11755–49286
6		2664.22	I	15770–53294
6		2664.81	I	16327–53842
6		2667.13	I	17331–54813
6		2670.24	I	11584–49023
10		2670.79	I	14217–51648
14		2671.84	I	11754–49171
7		2672.77	I	
85		2674.34	I	0–37381
14		2677.03	I	
12		2677.76	I	14621–51955
12		2679.10	I	15058–52373
14		2679.91	I	22160–59464
12		2683.56	I	22160–59412
6		2685.31	I	
20		2688.53	I	15770–52954
10	h	2690.25	I	16307–53467
4	h	2690.79	I	
7		2694.39	I	11754–48858
14		2695.56	I	15770–52857
8		2697.26	I	0–37064
4		2698.79	I	16619–53662
3.0		2699.58	I	11754–48786

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	2702.67	I	
12	2704.37	I	16327–53294
4	2706.06	I	15058–52001
3.0	2707.40	I	
4	2710.22	I	
6	2712.48	I	14621–51477
8	2713.02	I	16619–53467
6	2713.16	I	17331–54177
120	2715.47	I	11754–48570
16	2715.77	I	14217–51028
6	2716.75	I	16327–53125
4	2719.54	I	16619–53379
16	2722.21	I	
17	2722.70	I	14217–50934
9	2723.84	I	15770–52472
10	2727.55	I	14217–50869
4	2728.63	I	13826–50464
6	2729.64	I	16327–52952
4	2730.83	I	14621–51230
18	2731.56	II	18846–55444
20	2732.21	I	15058–51648
55	2733.04	II	17224–53802
5	2734.31	I	14621–51183
8	2738.32	I	15770–52278
11	2739.94	I	
6	2741.97	I	22160–58619
6 d	2742.74	I	
	2742.86	I	15770–52218
8	2743.87	I	16307–52741
13	2747.44	I	11584–47971
7	2752.85	I	11584–47899
12	2753.05	I	14621–50934
10 h	2753.64	II	19140–55444
5	2755.21	I	13826–50110
5	2757.49	I	
20	2758.00	I	14621–50869
5	2758.71	I	16619–52857
10	2761.93	I	11584–47780
8	2763.30	I	11754–47932
19	2763.79	I	15058–51230
18	2766.39	I	27130–63268
28	2767.74	I	11584–47704
20	2768.85	I	11754–47860
20	2769.32	I	
32	2770.42	I	11584–47669
15	2773.11	I	17238–53288
7	2777.71	I	17331–53321
8	2778.09	I	
7	2778.50	I	14218–50197
16	2781.43	I	14217–50159
50	2783.57	I	11754–47669
14	2785.21	I	14217–50110
5	2786.14	I	21775–57657
11	2786.56	I	15058–50934
8 c	2789.27	I	13826–49667
13	2790.94	I	15770–51590
20	2791.29	I	16307–52122
4	2793.66	I	
9	2798.10	I	17331–53059
13 h	2800.75	I	
5 h	2802.25	I	
11	2803.28	II	13777–49439
9	2807.86	I	11754–47358
5	2812.07	I	17331–52881
7	2812.36	I	16328–51874
5	2813.11	I	14621–50159
15	2813.96	I	17331–52857
20	2814.68	I	11584–47102
15	2816.32	I	22160–57657
9	2816.96	I	14621–50110
7	2819.78	II	17224–52677
80	2819.95	I	11754–47206
10	2822.12	I	13826–49250
10	2824.25	I	21775–57173
9	2825.46	I	16619–52001
10	2827.52	I	14217–49573
5	2830.35	I	
28	2834.08	I	14621–49896
18	2837.55	I	22160–57391
18	2840.35	I	13826–49023
20	2843.00	I	15770–50934
9	2844.16	I	11584–46133
9	2846.97	I	
24	2850.98	I	11584–46649
8	2852.84	I	17331–52373
5	2860.07	I	14217–49171
5	2860.25	I	14621–49573
5	2864.56	I	27244–62143
22	2867.19	I	16619–51486
14	2871.82	I	14217–49028
5	2872.30	I	15058–49863
4	2872.67	I	15770–50571
18	2875.28	I	11584–46353
6	2879.27	I	16307–51028
18	2883.44	I	17331–52001
6	2884.04	I	23956–58619
10	2884.64	I	
6	2887.31	I	17331–51955
260	2887.68	I	11754–46374
12 c	2888.06	II	14824–49439

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	2889.45	I	11754–46353	20	2982.19	I	
9	2891.48	I	16619–51193	6	2984.75	I	19458–52952
16	2891.88	I	14217–48786	20	2988.47	I	14217–47669
14	2892.63	I	19458–54018	160	2992.36	I	0–33409
10	2894.32	I	15770–50311	6	2992.82	I	
4	2895.65	I	15058–49583	15	2995.40	I	30560–63935
44	2896.01	I	0–34520	500	2999.60	I	11754–45083
3.0	2898.79	I	20482–54969	32	3001.14	I	14621–47932
75 c	2902.48	I	18950–53392	20	3004.14	I	14621–47899
19	2905.58	I	14621–49028	6	3004.34	I	13826–47102
16	2906.02	I	14621–49023	18	3006.42	I	15770–49023
9	2908.34	I		13	3011.92	I	11754–44946
50	2909.82	I	16307–50663	19	3013.14	I	13826–47004
5	2910.08	I	11584–45937	50	3016.02	I	11754–44901
6	2913.15	I	17331–51648	30	3016.49	I	14217–47358
6 h	2916.73	II	25321–59596	4	3016.97	I	11584–44720
6	2918.88	I	16619–50869	12	3021.88	I	14621–47704
9	2919.41	I	16327–50571	6	3022.99	I	17331–50401
14	2924.60	I	11754–45937	38	3030.45	I	14217–47206
11	2925.20	I	26661–60837	6	3031.27	I	23155–56134
6	2926.93	I	17331–51486	6	3032.79	I	16619–49583
75 c	2927.42	I	11754–45904	13	3034.55	I	20448–53392
16	2929.53	I	15770–49895	6	3036.55	I	16327–49250
24	2930.61	I	15058–49171	10	3037.96	I	13826–46733
6	2932.31	I	15770–49863	13	3040.03	I	14217–47102
12	2936.50	I	16619–50663	10	3041.00	I	15058–47932
4	2941.56	I	20482–54467	6	3041.99	I	16307–49171
40	2943.14	I	14217–48184	6	3042.29		
6	2944.32	I	13826–47780	10	3044.08	I	15058–47899
6	2946.57	I	20482–54410	24	3047.25	I	28030–60837
11	2949.09	I	17331–51230	10	3053.63	I	21775–54514
6	2949.88	I	16307–50197	13	3054.90	I	11584–44309
12	2950.83	I	11584–45463	9	3057.66	I	16327–49023
11	2954.34	I	13826–47665	20	3058.78	I	13826–46509
12 h	2957.91	II	23341–57139	13	3060.32	I	16619–49286
13	2961.74	I	14217–47971	10	3061.61	I	22160–54813
24	2962.27	I	11584–45332	7	3064.60	I	17238–49860
6	2962.87	I	22160–55901	160	3067.40	I	0–32592
65	2965.11	I	14217–47932	32	3069.94	I	11584–44148
140	2965.76	I	11754–45463	26	3071.16	I	16619–49171
8	2967.25	I	16619–50311	20	3072.96	I	17331–49863
16	2968.04	I	14217–47899	9	3076.14	I	15166–47665
8	2968.98	II		10	3078.86	I	11754–44225
7	2975.02	I	17331–50934	55	3082.43	I	14217–46649
11	2975.25	I	19458–53059	18	3084.21	I	15770–48184
28	2976.29	I	0–33589	9	3087.15	I	14621–47004
6	2977.30	I	16619–50197	34	3088.76	I	11584–43950
19	2978.15	I	16327–49895	11	3089.94	I	22160–54514
20	2980.82	I	11584–45122	20	3093.64	I	13826–46141
6	2981.01	I	19758–53294	20	3095.06	I	15058–47358

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	3095.79	I	14217–46509
10	3096.41	I	13826–46112
70	3100.67	I	16327–48569
14	3103.06	II	17224–49439
14	3103.26		
14	3104.65	I	15770–47971
70	3108.81	I	14217–46374
34	3110.86	I	14217–46353
14	3111.56	I	15770–47899
34 c	3118.19	I	11754–43815
34	3121.36	I	14621–46649
7	3123.16	I	15770–47780
7	3125.52	I	11584–43569
42	3128.94	I	16619–48569
26	3134.02	I	15770–47669
7	3139.79	I	17331–49171
7	3139.94	I	15166–47004
25	3141.38	I	11584–43408
14	3142.65	I	
7	3151.16	I	19458–51183
44	3151.64	I	14217–45937
33	3153.79	I	11754–43453
36 c	3158.31	I	11754–43408
22	3164.52	I	15058–46649
5	3167.16	I	16619–48184
70	3168.37	I	16307–47860
14	3173.09	I	13826–45332
22	3174.61	I	14621–46112
14	3174.78	I	27130–58619
44	3177.71	I	11584–43044
26	3178.61	I	15058–46509
7	3182.66	I	19458–50869
60	3182.87	I	18950–50359
110	3184.76	I	18950–50341
110	3185.57	I	18950–50333
12	3186.29	I	27244–58619
15	3190.17	I	16328–47665
26	3190.78	I	17238–48569
26	3192.36	I	14621–45937
14	3193.20	I	22160–53467
20	3194.50	I	15058–46353
22	3198.58	I	14621–45876
7	3199.49	I	14217–45463
15	3200.04	I	16619–47860
10	3200.72	I	15770–47004
110 c	3204.25	I	16307–47507
7	3205.42	I	24724–55912
14	3211.75	I	14217–45343
12	3212.94	I	14217–45332
7	3213.49		
12	3214.11	I	26349–57453
15	3227.46	I	15166–46141
7	3228.73	I	15770–46733
38	3235.94	I	13826–44720
15	3237.51	I	15058–45937
8	3241.47	I	14621–45463
8	3248.55	I	16327–47102
15	3252.26	I	15770–46509
60	3258.85	I	16327–47004
60	3259.55	I	11584–42254
20	3261.56	I	15166–45817
12	3262.77	I	17331–47971
12	3266.85	I	17331–47932
15	3268.48	I	16619–47206
30	3268.89	I	15770–46353
16	3277.71	I	14621–45122
16	3285.64	I	17238–47665
8	3287.13	I	27244–57657
20	3294.83	I	15770–46112
28	3296.70	I	18950–49275
28	3296.99	I	16327–46649
8	3300.97	I	15058–45343
28	3301.60	I	14621–44901
24	3302.23	I	15058–45332
32	3303.21	II	14883–45148
28	3303.75	I	11584–41844
8	3307.01	I	27161–57391
8	3308.25	I	
8	3312.29	I	16327–46509
24	3313.95	I	15770–45937
16	3318.67	I	13826–43950
60	3322.48	I	11754–41844
7	3324.93	I	16307–46374
20	3331.52	I	14217–44225
16	3335.36	I	11584–41557
200	3338.18	I	20448–50396
14	3339.68	I	17238–47173
160	3342.24	I	20448–50359
80	3344.32	I	20448–50341
32	3346.20	I	13826–43702
13	3353.21	I	16327–46141
16	3355.29	I	22423–52218
24 d	3356.33	I	22160–51946
	3356.46	I	16327–46112
20	3358.02	I	17331–47102
16	3359.22	I	23632–53392
16	3361.14	I	13826–43569
20	3362.74	I	11584–41313
16 d	3365.73	I	23155–52857
	3365.84	I	21775–51477

Rhenium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
24	3377.74	I	16307–45904
32	3379.06	II	14352–43938
32	3379.70	I	11584–41164
16	3384.45	I	27161–56699
20	3385.76	I	14621–44148
24	3389.43	I	17238–46733
20	3390.25	I	22160–51648
8	3394.12	I	21775–51230
8	3397.21	I	26349–55777
400	3399.30	I	11754–41164
8	3401.17		
65	3404.72	I	11584–40946
65	3405.89	I	14217–43569
24	3408.67	I	14621–43950
32	3409.83	I	17331–46649
8	3413.74	I	16619–45904
32	3417.77	I	15058–44309
80	3419.41	I	14217–43453
16	3420.75	I	11584–40809
800	3424.62	I	11754–40946
40	3426.19	I	17331–46509
30	3427.61	I	15058–44225
32	3437.71	I	14621–43702
8	3441.25	I	
6	3442.97	I	16307–45343
40	3449.37	I	15166–44148
1600 c	3451.88	I	0–28962
8	3453.28	I	15770–44720
24	3453.50	I	14621–43569
16	3458.88	I	17238–46141
5500 c	3460.46	I	0–28890
4000 c	3464.73	I	0–28854
40	3467.96	I	20448–49275
16	3472.72	I	14621–43409
24	3476.44	I	15058–43815
8	3477.14	I	27161–55912
40	3480.38	I	16619–45343
32	3480.85	I	14621–43342
24	3482.23	I	22160–50869
11	3490.86	I	17238–45876
8	3494.72	I	17331–45937
13 c	3495.90	I	
8	3502.73	I	20482–49023
56	3503.06	I	15770–44309
10 c	3512.28	I	16619–45083
32	3516.65	I	13826–42254
32	3517.33	I	14621–43044
8 c	3520.72	I	15058–43453
8	3524.54	I	
6	3529.21	I	16619–44946
12	3534.82	I	16619–44901
32	3537.46	I	11584–39845
16	3539.33	I	19458–47704
6	3539.94	I	22160–50401
24	3549.89	I	11754–39916
16	3551.29	I	22160–50311
16	3553.65	I	17331–45463
16	3558.94	I	11754–39845
8	3564.73	I	15770–43815
16	3568.23	I	24724–52741
24	3570.26	I	17331–45332
36	3579.12	I	15770–43702
80 c	3580.15	II	17224–45148
65	3580.97	I	16307–44225
80	3583.02	I	11754–39656
7	3590.88	I	22423–50263
8	3595.16	I	21775–49583
16	3596.39	I	11754–39552
8	3598.77	I	23155–50934
8	3604.39	I	22423–50159
16	3610.49	I	16307–43996
32	3617.08	I	15770–43409
8	3617.25	I	15770–43408
16	3621.46	I	16619–44225
16	3625.91	I	15770–43342
6	3629.20	I	19458–47004
14	3637.06	I	13826–41313
80	3637.84	I	11584–39065
3.5	3642.99	I	11754–39197
8	3651.66	I	16619–43996
44	3651.97	I	16327–43702
8	3653.62	I	23632–50994
6	3660.52	I	27244–54554
4	3662.13	I	27514–54813
12	3669.78	I	16327–43569
8	3670.36	I	23956–51193
32	3670.53	I	14217–41453
8	3672.41	I	14621–41844
6	3676.00	I	16619–43815
3.5	3680.21	I	24425–51590
3.5	3681.28	I	26132–53288
85 c	3689.50	I	14217–41313
150 c	3691.48	I	16327–43409
10	3697.71	I	27141–54177
3.5	3700.37	I	
52	3703.24	I	13826–40822
7	3704.45	I	
6	3704.84	I	13826–40810
10	3705.02	I	13826–40809
24	3709.93	I	14217–41164

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	3715.02	I	17238–44148
36 c	3717.28	I	17331–44225
400	3725.76	I	23632–50464
14	3731.87	I	16619–43408
14	3732.28	I	15058–41844
24 c	3735.01	I	11754–38521
80	3735.31	I	23632–50396
4	3736.84	I	24724–51477
90	3740.10	I	14217–40946
14	3740.41	I	23632–50359
13	3742.26	II	17224–43938
30 cw	3745.44	I	14621–41313
8	3755.62	I	17331–43950
14	3766.48	I	14621–41164
12	3768.26	I	
14	3777.66	I	17238–43702
70	3787.52	I	15058–41453
16	3796.59	I	11584–37916
16	3797.59	I	14621–40946
19	3807.74	I	15058–41313
12	3815.66	I	14621–40822
12	3836.30	I	14434–40494
24	3869.94	I	16307–42140
24	3875.26	I	11584–37381
24	3876.86	I	15770–41557
8	3887.49	I	27141–52857
8	3887.95	I	17331–43044
7	3889.96	I	22160–47860
8	3896.11	I	20482–46141
8	3900.91	I	14217–39845
4	3901.09	I	11754–37381
10	3908.21	I	27161–52741
13	3913.92	I	15770–41313
38 c	3917.27	I	16619–42140
6 c	3920.85	I	27244–52741
7 c	3927.59	I	14217–39670
55	3929.85	I	14217–39656
6	3931.20	I	21775–47206
14	3936.90	I	15770–41164
6	3941.54	I	19758–45122
11	3944.72	I	27514–52857
18	3945.91	I	14217–39552
7	3950.64	I	14621–39927
3.5	3954.43	I	22423–47704
28	3961.04	I	13826–39065
35 c	3962.48	I	16327–41557
6	3963.27	I	16619–41844
3.0	3964.81	I	23956–49171
7	3967.39	I	22160–47358
3.5	3975.65	I	16307–41453
3.5	3983.91	I	
4	3984.25	I	
3.5	3991.03	I	14621–39670
10	4004.93	I	19758–44720
6	4012.26	I	26661–51578
3.5	4018.40	I	27244–52122
14	4022.96	I	18950–43801
10	4023.31	I	14217–39065
6	4028.53	I	23155–47971
11 c	4029.63	I	13826–38635
22	4033.31	I	15058–39845
11	4037.49	I	15166–39927
20	4048.99	I	16307–40998
5	4061.86	I	15058–39670
24	4081.43	I	16327–40822
5	4083.36	I	16327–40810
5	4083.58	I	16327–40809
4	4089.92	I	14621–39065
14	4104.42	I	19458–43815
24 c	4110.89	I	17238–41557
5	4113.40	I	14217–38521
19	4121.64	I	20448–44703
5	4132.28	I	13826–38019
24 cw	4133.42	I	16307–40494
180	4136.45	I	11754–35923
5	4137.60	I	21775–45937
70	4144.36	I	17331–41453
14	4149.96	I	13826–37916
7	4152.29	I	33589–57665
5	4152.63	I	15770–39845
9	4159.92	I	27161–51193
16	4170.40	I	27514–51486
22	4182.90	I	15770–39670
22	4183.06	I	14621–38521
9	4194.67	I	17331–41164
9	4204.52	I	22160–45937
7	4213.27	I	27141–50869
65	4221.08	I	11584–35268
3.5	4223.18	I	
360 c	4227.46	I	18950–42598
3.5	4232.96	I	17695–41313
4	4236.24	I	16327–39927
3.0	4238.59	I	18950–42536
9	4241.16	I	17238–40810
15	4241.39	I	17238–40809
7	4246.82	I	34520–58061
4	4255.75	I	17331–40822
26 c	4257.60	I	14217–37698
12 c	4291.17	I	16619–39916
8	4291.65	I	14621–37916

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	4299.92	I	23956–47206
20	4304.40	I	16619–39845
3.0	4314.58	I	21775–44946
8	4318.58	I	27514–50663
4	4319.53	I	14621–37766
20	4332.25	I	14621–37698
4	4357.98	II	
38	4358.69	I	11584–34520
19	4367.58	I	16307–39197
14	4391.34	I	11754–34520
7 cw	4392.45	I	14621–37381
36 cw	4394.38	I	15770–38521
6	4396.80	I	16327–39065
8	4402.60	I	15058–37766
11 cw	4406.40	I	16307–38995
18	4415.82	I	15058–37698
6	4440.44	I	17331–39845
3.0 c	4453.92	I	35923–58369
3.0	4454.62	I	14621–37064
3.0	4463.53	I	35268–57665
3.0	4467.54	I	24724–47102
8	4467.92	I	16619–38995
15	4475.08	I	17331–39670
8	4477.99	I	17331–39656
12	4478.39	I	15058–37381
2.5	4496.43	I	19758–41991
12 c	4507.04	I	28854–51035
5	4508.01	I	28854–51031
260	4513.31	I	20448–42598
26	4516.64	I	28854–50988
8	4519.76	I	28854–50973
50	4522.73	I	28890–50994
12	4523.88	I	28890–50988
8	4526.01	I	20448–42536
7	4528.97	I	28962–51035
12	4529.95	I	28962–51031
5	4530.89	I	22160–44225
4	4541.80	I	28962–50973
10	4545.17	I	15770–37766
5	4559.27	I	15770–37698
7	4559.68	I	13826–35751
5 c	4565.30	I	15166–37064
12	4580.68	I	11584–33409
2.5	4591.68	I	20482–42254
12	4605.73	I	14217–35923
2.5 cw	4614.66	I	17331–38995
10	4621.38	I	21775–43408
2.5 h	4625.96	I	15770–37381
8 c	4630.82	I	16327–37916
9	4652.33	I	14434–35923
4	4662.49	I	13826–35268
5	4682.32	I	19458–40809
2.5	4687.86	I	27244–48570
2.5 c	4694.99	I	15770–37064
4	4700.44	I	21775–43044
6	4705.04	I	22160–43408
2.5	4725.93	I	23155–44309
6	4727.60	I	16619–37766
6	4748.38	I	16327–37381
2.5	4749.03	I	14217–35268
4	4758.83	I	11584–32592
2.0	4763.67	I	17238–38225
19 c	4791.42	I	15058–35923
220 cw	4889.14	I	0–20448
5	4915.02	I	12251–32592
22	4923.90	I	14217–34520
8	4946.72	I	15058–35268
5	4956.76	I	23632–43801
8	4985.98	I	17331–37381
4	5058.56	I	13826–33589
7	5096.50	I	16307–35923
2.0	5120.32	I	24425–43950
2.5	5161.65	I	17695–37064
4 c	5178.89	I	16619–35923
2.0	5181.74	I	22160–41453
3.5	5234.31	I	23155–42254
5	5248.86	I	21775–40822
130	5270.95	I	23632–42598
160 cw	5275.56	I	0–18950
10	5278.24	I	16327–35268
3.0	5305.56	I	
2.0	5317.28	I	26661–45463
3.5	5321.28	I	14621–33409
5	5327.46	I	13826–32592
2.0	5331.90	I	15770–34520
2.0	5332.76	I	
2.0	5333.85	I	27161–45904
3.5	5369.48	I	24425–43044
5 c	5369.80	I	13826–32444
10 c	5377.10	I	17331–35923
2.5	5431.90	I	39656–58061
1.4	5437.03	I	22423–40810
1.4	5447.92	I	15058–33409
2.5	5460.64	I	19458–37766
1.4 h	5520.05	I	28030–46141
2.5	5521.10	I	28542–46649
5 c	5532.68	I	21775–39845
5 c	5563.24	I	14621–32592
2.5	5573.47	I	17331–35268
2.5	5584.72	I	16619–34520

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.0	h	5607.21	I	27514–45343
1.2	h	5612.27	I	
10		5667.88	I	15770–33409
2.5		5711.43	I	22423–39927
1.8		5716.95	I	26661–44148
11	c	5752.93	I	11584–28962
11	cw	5776.83	I	11584–28890
1.8		5791.60	I	16327–33589
1.0	c	5815.92	I	17331–34520
55		5834.31	I	11754–28890
1.0		5919.86	I	24425–41313
6		5943.24	I	15770–32592
1.0		5950.21	I	28542–45343
1.8	h	5969.77	I	26661–43408
1.0		5989.99	I	23155–39845
1.8	h	5995.73	I	27141–43815
3.0		6114.22	I	17238–33589
3.5	c	6145.81	I	27141–43408
5		6146.82	I	16327–32592
1.8		6203.24	I	16327–32444
2.5		6217.97	I	17331–33409
3.0	cw	6229.42	I	28854–44903
3.5	cw	6243.24	I	28890–44903
3.5	d	6260.02	I	
		6260.24	I	
1.8	c	6271.37	I	28962–44903
1.8		6278.76	I	21775–37698
1.0		6286.41	I	27141–43044
1.0		6303.42	I	26132–41992
20		6307.70	I	28854–44703
20		6321.90	I	28890–44703
8	d	6350.75	I	28962–44703
1.6	h	6382.94	I	29800–45463
1.4		6411.47	I	26661–42254
5		6511.47	I	17238–32592
1.4		6515.25	I	30560–45904
1.2		6544.91	I	22423–37698
3.5	c	6577.11	I	28854–44054
4	cw	6592.52	I	28890–44054
10	cw	6605.19	I	13826–28962
3.0	c	6623.91	I	28962–44054
1.0	c	6637.25	I	19458–34520
3.0	cw	6652.39	I	13826–28854
1.6	h	6683.28	I	22423–37381
1.0	c	6711.30	I	17695–32592
3.5		6751.22	I	
0.6	c	6761.19	I	20482–35268
20	c	6813.41	I	14217–28890
28		6829.90	I	14217–28854
10		6971.53	I	14621–28962
4	cw	7006.63	I	14621–28890
8	cw	7024.15	I	14621–28854
8	cw	7246.67	I	15058–28854
1.6	cw	7292.72	I	28890–42598
5	cw	7578.73	I	15770–28962
1.6		7611.89	I	19458–32592
0.8	cw	7620.25	I	15770–28890
6	cw	7640.94	I	15770–28854
8	cw	7912.94	I	16327–28962
4	cw	7980.77	I	16327–28854
5		8417.13	I	11754–23632
3.5	cw	8527.73	I	17238–28962

RHODIUM

Rh, $Z=45$, $M=102.91$, Ratio $\frac{\text{Rh}}{\text{Cu}}=1.620$

Rh I Normal state of valence electrons $4d^8\ 5s^1\ {}^4F_{4½}=0$. I.P.= 60197 K
Rh II Normal state of valence electrons $4d^8\quad {}^3F_4=0$. I.P.=145800 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

H. Kayser and R. Ritschl, Tabelle der Hauptlinien der Linienspektren aller Elemente (Julius Springer, Berlin, 1939).

Classification:

Rh I, J. P. Molnar and W. J. Hitchcock, J. Opt. Soc. Am. **30,** 523 (1940).

Rh II, F. J. Sancho, Anales Real. Soc. Esp. Fis. y Quim. **54A,** 41 (1958).

Relative intensity of rhodium lines observed in an arc of copper containing 0.1 atomic percent of rhodium

Strong lines of rhodium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
800	3692. 36	I	0–27075	$5s\ a\ {}^4F_{4½}$—$5p\ z\ {}^4D^3_{3½}$
750	3528. 02	I	1530–29866	$5s\ a\ {}^4F_{3½}$—$5p\ z\ {}^4F^3_{3½}$
700	3434. 89	I	0–29105	$5s\ a\ {}^4F_{4½}$—$5p\ z\ {}^4G^5_{5½}$
700	3657. 99	I	1530–28860	$5s\ a\ {}^4F_{3½}$—$5p\ z\ {}^4D^2_{2½}$
650	3700. 91	I	1530–28543	$5s\ a\ {}^4F_{3½}$—$5p\ z\ {}^4G^4_{4½}$
500	3462. 04	I	2598–31474	$5s\ a\ {}^4F_{2½}$—$5p\ z\ {}^4F^3_{3½}$
500	3502. 52	I	0–28543	$5s\ a\ {}^4F_{4½}$—$5p\ z\ {}^4G^4_{4½}$
500	3597. 15	I	3310–31102	$4d^9\ a\ {}^2D_{2½}$—$5p\ z\ {}^4G^3_{3½}$
500	3856. 52	I	5691–31614	$5s\ a\ {}^2F_{3½}$—$5p\ z\ {}^2G^4_{4½}$
480	3396. 85	I	0–29431	$5s\ a\ {}^4F_{4½}$—$5p\ z\ {}^4F^4_{4½}$
420	3799. 31	I	5691–32004	$5s\ a\ {}^2F_{3½}$—$5p\ z\ {}^2F^3_{3½}$
400	3470. 66	I	3473–32277	$5s\ a\ {}^4F_{1½}$—$5p\ z\ {}^4F^1_{1½}$
400	3474. 78	I	3473–32243	$5s\ a\ {}^4F_{1½}$—$5p\ z\ {}^4G^2_{2½}$
400	3583. 10	I	1530–29431	$5s\ a\ {}^4F_{3½}$—$5p\ z\ {}^4F^4_{4½}$
400	3596. 19	I	2598–30397	$5s\ a\ {}^4F_{2½}$—$5p\ z\ {}^4D^1_{1½}$
360	3323. 09	I	1530–31614	$5s\ a\ {}^4F_{3½}$—$5p\ z\ {}^2G^4_{4½}$
360	4374. 80	I	5691–28543	$5s\ a\ {}^2F_{3½}$—$5p\ z\ {}^4G^4_{4½}$

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.6		2276.21	II	28835–71359
1.6		2288.57	I	2598–46280
1.6		2309.82	I	3473–46753
1.0		2318.36	I	5691–48811
1.6		2319.10	I	5691–48798
1.6		2321.73	I	1530–44588
6		2322.58	I	0–43042
2.5		2326.47	I	3310–46280
1.4		2328.64	I	7791–50721
4		2334.77	II	16885–59702
1.2		2345.41		
1.4		2352.47	I	0–42495
1.4		2359.18	I	1530–43905
8		2361.92	I	0–42325
3.0		2368.34	I	3473–45683
10		2382.89	I	0–41953
8		2383.40		
1.4		2384.65	I	7791–49713
10		2386.14		
4		2407.88	I	1530–43048
1.2		2408.19	I	1530–43042
1.2		2410.25	I	3310–44787
4		2415.84	II	19793–61173
3.0		2418.64		
2.5		2419.75	I	3473–44787
2.5		2420.18	II	33845–75152
3.5		2420.98	II	20647–61940
5		2423.94		
4		2427.11	II	18540–59729
8		2427.68	I	2598–43777
14		2429.52	I	3473–44621
2.5		2431.85	II	21180–62288
2.5		2432.66	I	5658–46753
1.2		2437.08	I	7791–48811
8		2437.80		
24		2440.34	I	1530–42495
4	h	2444.27		
5		2448.84	I	2598–43421
4		2449.04	I	5691–46511
6		2450.56		
2.5		2455.70	II	20647–61356
5		2458.90	II	19792–60448
7		2461.04	II	18540–59161
2.5		2463.61		
6		2470.39	I	3310–43777
7		2471.47	I	2598–43048
2.5		2472.51		
10		2473.09	I	1530–41953
1.2		2475.64	II	31730–72112
1.2		2477.54		
2.0		2482.04		
4		2483.33	I	3473–43729
12		2487.47		
8		2490.77	II	16885–57021
2.5		2492.30	I	3310–43421
6	h	2494.51		
1.2		2499.02		
3.0		2500.58		
10		2502.46	I	3473–43421
1.2		2503.84	II	20647–60573
24		2504.29		
3.0		2505.10	II	19792–59699
12		2505.67	I	2598–42495
28		2509.70	I	2598–42431
4		2510.66	II	18540–58358
24		2511.03		
6		2513.36		
16		2515.75	I	3310–43048
10		2520.53	II	16885–56547
1.0		2525.99	I	9221–48798
1.0		2531.74	I	5691–45178
4		2532.66		
1.0		2533.59		
4		2534.07		
9		2536.71		
9		2537.04	II	34243–73646
2.5		2539.72		
3.0		2544.22		
28		2545.70		
1.0		2548.60		
44		2555.36	I	3310–42431
2.0		2558.62		
4		2565.79	I	5658–44621
3.5		2566.04	I	3473–42431
2.0		2566.92	II	38687–77633
4		2567.28		
2.0		2574.66		
2.0		2575.75	I	14788–53600
1.0		2576.23		
3.0		2587.29	II	27439–66078
2.5		2598.07		
2.5		2603.32	II	32605–71006
6		2606.44	II	41045–79399
6		2613.60		
12		2622.58	I	5658–43777
18		2625.88	I	5658–43729
8		2630.42	I	2598–40603
3.0		2634.99		
2.5		2638.74	II	34243–72128
6		2643.00		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	2647.28	I	5658–43421
32	2652.66	I	2598–40285
2.5	2659.01	I	1530–39127
2.5	2671.06	I	3473–40900
5	2676.11	I	5691–43048
2.0	2680.28		
8	2680.63	I	3310–40603
2.5	2681.78	I	14788–52065
2.5 h	2686.50		
2.5 h	2686.91		
4	2694.31	I	3473–40577
32	2703.73	I	3310–40285
3.0	2705.63	II	25377–62326
3.0	2707.23	I	2598–39525
6	2714.41	I	11968–48798
8	2715.31	II	25377–62194
6	2717.51	I	0–36787
14	2718.54	I	5658–42431
5	2720.14		
2.5	2720.52	I	13975–50721
13	2728.94	I	2598–39231
3.0	2736.76	I	2598–39127
6	2741.75	I	9221–45683
4	2767.73	I	2598–38718
8	2771.51	I	2598–38669
4	2778.06	I	7791–43777
6	2779.54	I	10313–46280
10	2783.03	I	3310–39231
2.0	2791.16	I	3310–39127
6	2796.63	I	11006–46753
12	2826.43	I	10313–45683
14	2826.68	I	9221–44588
2.5	2827.31	I	3310–38669
6	2834.12	I	11006–46280
3.5	2835.44	I	1530–36787
6	2836.69	I	5658–40900
4	2856.16	I	3473–38474
4 d	2860.68	I	5658–40605
	2860.76	I	5658–40603
22	2862.94	I	5658–40577
5	2864.40	I	3310–38211
4	2871.35		
2.5	2873.62		
9	2878.66	I	3310–38038
6	2880.76	I	3310–38013
11	2882.37	I	9221–43905
6	2885.97	I	7791–42431
6	2889.11	I	1530–36133
6	2889.84	I	5691–40285
5	2899.96	I	10313–44787
2.0	2904.81	I	14382–48798
13	2907.21	I	2598–36985
5	2910.17	II	25377–59729
6	2912.62	I	5658–39981
7	2915.42	I	5691–39981
2.5	2923.10	I	9221–43421
14	2924.02	I	2598–36787
10	2929.11	I	5658–39788
10	2931.94	I	5691–39788
2.5	2955.41	I	9221–43048
18	2968.66	I	3310–36985
2.0	2974.03	I	11006–44621
13	2977.68	I	5658–39231
36	2986.20	I	3310–36787
7	2986.99	I	5658–39127
4	2987.45	I	10313–43777
9	3004.46	I	9221–42495
4	3019.54	I	10313–43421
10	3023.91	I	5658–38718
4	3028.43	I	5658–38669
2.5	3045.77	I	3310–36133
2.5	3046.76	I	7791–40603
2.0	3057.89	I	16119–48811
5	3067.30	I	12723–45316
14	3083.96	I	1530–33946
2.5	3087.42	I	5658–38038
6	3114.91	I	3310–35404
12	3121.76	I	3310–35334
20	3123.70	I	0–32004
3.0	3130.79	I	3473–35404
8	3137.71	I	3473–35334
4	3151.36	I	14788–46511
4	3152.60	I	5658–37369
11	3155.78	I	9221–40900
6	3179.73	I	7791–39231
7	3185.59	I	9221–40603
12	3189.05	I	2598–33946
40	3191.19	I	5658–36985
16	3197.13	I	2598–33867
6	3214.32	I	0–31102
7	3237.66	I	7791–38669
44	3263.14	I	3310–33946
44	3271.61	I	3310–33867
200	3280.55	I	1530–32004
9	3281.70	I	11968–42431
200	3283.57	I	2598–33044
24	3289.14	I	3473–33867
4	3289.64	I	14788–45178
18	3294.28	I	12723–43070
4	3296.72	I	12723–43048

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22	3300.46	I	10313–40603
360	3323.09	I	1530–31614
5	3331.09	I	5658–35670
4	3331.24	I	9221–39231
28	3338.54	I	1530–31474
6	3342.90	I	9221–39127
7	3344.20	I	11006–40900
5	3359.90	I	13975–43729
24	3360.80	I	5658–35404
5	3362.18	I	3310–33044
36	3368.38	I	2598–32277
4	3369.68	I	10313–39981
95	3372.25	I	2598–32243
9	3377.14	I	12723–42325
7	3377.71	I	11006–40603
9	3385.78	I	13521–43048
480	3396.85	I	0–29431
70	3399.70	I	2598–32004
14	3406.55	I	14382–43729
70	3412.27	I	16018–45316
5	3420.16	I	12723–41953
28	3421.20		
10 d	3424.38	I	7791–36985
700	3434.89	I	0–29105
120	3440.53	I	16121–45178
3	3442.63	I	14382–43421
10	3447.74	I	7791–36787
5	3448.58	I	14788–43777
10	3450.29	I	13521–42495
5	3451.15	I	3310–32277
34	3455.22	I	3310–32243
5	3455.42	I	11968–40900
15	3457.07	I	10313–39231
19	3457.93	I	13521–42431
500	3462.04	I	2598–31474
15	3469.62	I	10313–39127
400	3470.66	I	3473–32277
10	3472.25	I	9221–38013
400	3474.78	I	3473–32243
180	3478.91	I	3310–32046
8	3484.04	I	3310–32004
7	3491.07	I	11968–40605
9	3494.44	I	11968–40577
100	3498.73	I	3473–32046
500	3502.52	I	0–28543
5	3505.41	I	11006–39525
240	3507.32	I	2598–31102
5	3511.78	I	16121–44588
5	3513.10	I	13975–42431
5	3519.54	I	10313–38718
750	3528.02	I	1530–29866
75 d	3538.14	I	5691–33946
	3538.26	I	14788–43042
24	3541.91	I	11006–39231
100	3543.95	I	5658–33867
150	3549.54	I	3310–31474
20	3564.13	I	14382–42431
100	3570.18	I	3473–31474
400	3583.10	I	1530–29431
10	3583.53	I	10313–38211
400	3596.19	I	2598–30397
500	3597.15	I	3310–31102
26	3605.86	I	10313–38038
260	3612.47	I	3473–31147
20	3614.78	I	16121–43777
17	3620.46	I	7791–35404
150	3626.59	I	9221–36787
8	3627.80	I	11968–39525
26	3639.51	I	11006–38474
30	3654.87	I	5691–33044
700	3657.99	I	1530–28860
24	3661.86	I	16121–43421
110	3666.22	I	2598–29866
15	3666.91	I	11968–39231
12	3674.76	I	11006–38211
48	3681.04	I	11968–39127
160	3690.70	I	3310–30397
800	3692.36	I	0–27075
5	3694.95	I	13521–40577
80	3695.52	I	16018–43070
24	3698.26	I	11006–38038
32	3698.60	I	16018–43048
650	3700.91	I	1530–28543
80	3713.02	I	3473–30397
5	3713.43	I	16121–43042
4	3714.83	I	9221–36133
1.4	3724.94	I	11968–38807
55	3735.28	I	13521–40285
36	3737.27	I	11968–38718
36	3744.17	I	11968–38669
100	3748.22	I	10313–36985
20	3754.12	I	13975–40605
32	3754.27	I	13975–40603
42	3755.58	I	5658–32277
85	3760.40	I	5658–32243
200	3765.08	I	5691–32243
42	3769.97	I	14382–40900
6	3775.72	I	16018–42495
32	3778.13	I	13521–39981
85	3788.47	I	5658–32046

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
110	3792.18	I	11006-37369	180	4135.27	I	5691-29866
320	3793.22	I	5691-32046	20	4154.37	I	12723-36787
420	3799.31	I	5691-32004	28	4196.50	I	9221-33044
65	3805.92	I	13521-39788	6	4206.62	I	3310-27075
110	3806.76	I	2598-28860	280	4211.14	I	5691-29431
4	3809.50	I	11968-38211	2.5	4230.20	I	10313-33946
8	3812.45	I	14382-40605	3.5	4244.44	I	10313-33867
40	3815.01	I	16121-42325	5	4273.43	I	13975-37369
65	3816.47	I	14382-40577	5	4278.60	I	11968-35334
110	3818.19	I	9221-35404	70	4288.71	I	7791-31102
320	3822.26	I	7791-33946	6	4296.77	I	13521-36787
200	3828.48	I	9221-35334	2.0	4342.44	I	9221-32243
170	3833.89	I	7791-33867	4	4373.04	I	11006-33867
4	3834.75	I	11968-38038	360	4374.80	I	5691-28543
500	3856.52	I	5691-31614	8	4379.92	I	9221-32046
42	3870.01	I	16121-41953	2.0	4433.32	I	16119-38669
6	3872.39	I	5658-31474	3.0	4492.47	I	9221-31474
32	3877.34	I	5691-31474	2.5	4503.78	I	14788-36985
6	3888.34	I	13521-39231	2.0	4528.72	I	7791-29866
2.5	3904.22	I	13521-39127	1.4	4544.27	I	14788-36787
2.0	3912.83	I	3310-28860	3.0	4548.73	I	11968-33946
10	3913.51	I	1530-27075	3.5	4551.64	I	10313-32277
20	3922.19	I	5658-31147	1.6	4560.89	I	16119-38038
170	3934.23	I	5691-31102	1.4	4565.19	I	11968-33867
4	3934.98	I	14382-39788	11	4569.00	I	9221-31102
42	3935.84	I	11968-37369	1.2	4571.31		
50	3942.72	I	10313-35670	2.5	4608.12	I	13975-35670
8	3958.24	I	13975-39231	1.2	4619.91		
320	3958.86	I	7791-33044	2.0	4643.18	I	16944-38474
4	3964.54			13	4675.03	I	5691-27075
32	3975.31	I	13521-38669	1.6	4721.00	I	9221-30397
20	3984.40	I	10313-35404	6	4745.11	I	7791-28860
20	3995.61	I	10313-35334	1.0	4755.58	I	14382-35404
32	3996.15	I	11968-36985	2.0	4810.49	I	27075-47857
10	4023.14	I	14382-39231	1.8	4842.43	I	9221-29866
5	4048.41	I	13975-38669	4	4843.99	I	27075-47714
2	4049.04	I	13521-38211	5	4851.63		
3.5	4053.44	I	11006-35670	5	4963.71	I	11006-31147
2.0	4056.34	I	9221-33867	5	4977.75	I	10313-30397
6	4077.57	I	13521-38038	3.5	4979.18	I	11968-32046
48	4082.78	I	7791-32277	1.2	5085.52		
1.6	4084.28	I	2598-27075	6	5090.63	I	9221-28860
4	4087.79	I	16121-40577	2.0	5120.69	I	13521-33044
5	4088.50	I	7791-32243	1.6	5130.76	I	14382-33867
12	4097.52	I	11006-35404	5	5155.54	I	11006-30397
4	4107.49	I	14788-39127	1.2	5157.09	I	28543-47928
6	4116.33	I	14382-38669	3.5	5158.69	I	28860-48239
10	4119.68	I	16018-40285	5	5175.97	I	28543-47857
90	4121.68	I	7791-32046	1.0	5177.27	I	32046-51356
130	4128.87	I	7791-32004	3.0	5184.19	I	7791-27075

609065 O - 62 - 19

Rhodium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
8		5193.14	I	28543–47793
1.4		5206.95		
1.4		5211.52	I	31102–50285
1.6		5212.73	I	11968–31147
1.4		5214.79	I	28543–47714
1.6		5222.66	I	32277–51419
1.6		5230.62	I	32243–51356
4		5237.16	I	31102–50191
0.8		5237.80		
1.2		5269.27	I	28860–47832
0.9	h	5280.12	I	31474–50408
1.2		5292.14	I	12723–31614
1.2		5314.79	I	31474–50285
3.5	h	5329.74	I	29105–47862
1.2	h	5331.08	I	29105–47857
0.8		5349.31	I	29105–47794
11		5354.40	I	31614–50285
2.0		5356.47	I	31614–50278
4		5379.10	I	31614–50199
8		5390.44	I	10313–28860
2.0	h	5404.73	I	29431–47928
5	h	5424.07	I	29431–47862
1.6		5424.72	I	11968–30397
1.6	h	5425.45	I	29431–47857
1.0		5439.52	I	12723–31102
1.0	h	5441.36	I	29866–48239
0.8	h	5444.32	I	29431–47794
3.0	h	5445.23		
2.0	h	5468.11	I	29431–47714
3.0	h	5470.85	I	32004–50278
1.0		5476.12	I	14788–33044
1.0		5481.42	I	32046–50285
1.4		5484.23	I	32004–50233
0.8		5504.65	I	32046–50208
2.5		5535.04	I	29866–47928
1.8	l	5544.58	I	29866–47897
14		5599.42	I	9221–27075
0.6		5607.71	I	33946–16119
1.4		5608.35	I	16121–33946
0.4		5632.77	I	16119–33867
0.8		5659.62	I	14382–32046
3.5		5686.38	I	13521–31102
0.8	h	5702.47	I	33946–51478
0.5		5727.30	I	14788–32243
2.5		5792.77	I	14788–32046
0.8		5795.79		
0.8		5803.34		
3.5		5806.91	I	14788–32004
0.5		5821.84	I	13975–31147
3.0		5831.58	I	12723–29866
0.6		5907.31	I	16121–33044
0.8		5918.54	I	11968–28860
0.6		5941.46	I	31102–47928
11		5983.60	I	12723–29431
0.8		5991.19	I	14788–31474
3.0		6102.72	I	12723–29105
0.5		6116.15	I	13521–29866
0.7		6128.06	I	14788–31102
0.7		6186.89	I	16119–32277
1.2		6199.99	I	16119–32243
1.4		6253.72	I	16018–32004
0.4		6276.66	I	16119–32046
0.7		6277.46	I	16121–32046
0.5		6293.38	I	16119–32004
2.5		6319.53	I	12723–28543
1.0		6414.72	I	28860–44445
1.4		6510.41	I	16119–31474
1.6		6519.70	I	16944–32277
0.8		6627.80	I	16018–31102
1.6		6630.16	I	14788–29866
5		6752.35	I	27075–41881
1.2		6796.65	I	35334–50043
1.6		6827.33	I	14788–29431
1.4		6857.68	I	29866–44445
2.5		6879.94	I	16944–31474
8		6965.67	I	12723–27075
1.0		6972.91	I	31474–45812
2.0		6979.15	I	31147–45471
2.0		7001.58	I	16119–30397
1.8		7038.76	I	16944–31147
3.0		7101.64	I	30397–44475
2.5		7104.45	I	14788–28860
1.0		7142.55	I	31474–45471
1.6		7219.06	I	16018–29866
3.0		7268.18	I	14788–28543
6		7270.82	I	28543–42293
2.0		7271.94	I	16119–29866
0.8		7273.03	I	16121–29866
1.6		7375.57	I	13521–27075
0.8	h	7386.64	I	32277–45812
1.6		7430.80	I	16944–30397
3.0	h	7442.39	I	28860–42293
1.2		7446.77	I	32046–45471
2.0		7475.74	I	31102–44475
2.0		7495.24	I	28543–41881
1.4		7542.02	I	36787–50043
1.8		7557.67	I	32243–45471
1.4		7577.22	I	32277–45471
1.8		7690.05	I	31474–44475
3.0		7772.90	I	29431–42293

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	7791.61	I	31614–44445
9	7824.91	I	29105–41881
2.5	7830.05	I	
2.5	7846.50	I	16119–28860
3.5	8029.91	I	29431–41881
1.8 h	8036.11	I	32004–44445
5	8045.40	I	29866–42293
1.2	8063.50	I	32046–44445
2.5	8136.20	I	14788–27075
1.2 h	8193.63	I	32243–44445
0.8 h	8369.55	I	33867–45812
1.4	8425.51	I	33946–45812

RUBIDIUM

Rb, $Z=37$, $M=85.48$, Ratio $\frac{\text{Rb}}{\text{Cu}}=1.345$

Rb I Normal state of valence electrons $4p^6\ 5s^1\ {}^2S_{0\frac{1}{2}}=0$. I.P.= 33691 K
Rb II Normal state of valence electrons $4p^6\quad {}^1S_0=0$. I.P.=221852 K

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:

Rb I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

Intensities:

L. S. Ornstein and J. Key, Physica **1,** 945 (1934).
G. Stephenson, Proc. Phys. Soc. (London) **A44,** 458 (1951).

Relative intensity of rubidium lines observed in an arc of copper containing 0.1 atomic percent of rubidium

Strong lines of rubidium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
3000	7800. 23	I	0–12817	$4p^65s^1\ {}^2S_{0\frac{1}{2}}$—$4p^65p^1\ {}^2P^0_{1\frac{1}{2}}$
1500	7947. 60	I	0–12579	$4p^65s^1\ {}^2S_{0\frac{1}{2}}$—$4p^65p^1\ {}^2P^0_{0\frac{1}{2}}$

Rubidium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
32	4201. 85	I	0–23793	5	7408. 17	I	12817–26311
16	4215. 56	I	0–23715	7	7618. 93	I	12579–25701
1. 2 h	5648. 10	I	12579–30280	11 hl	7757. 65	I	12817–25704
2. 0 l	5724. 45	I	12817–30282	2. 0	7759. 43	I	12817–25701
2. 5	6206. 31	I	12579–28687	3000	7800. 23	I	0–12817
4 h	6298. 33	I	12817–28689	1500	7947. 60	I	0–12579
3. 5 hl	7280. 00	I	12579–26311				

RUTHENIUM

Ru, $Z=44$, $M=101.1$, Ratio $\frac{\text{Ru}}{\text{Cu}}=1.591$

Ru I Normal state of valence electrons $4d^7\ 5s^1\ {}^5F_5 = 0$. I.P.= 59410 K
Ru II Normal state of valence electrons $4d^7\ {}^4F_{4½} = 0$. I.P.=135200 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
Supplemented by K. G. Kessler and W. F. Meggers, J. Research NBS **55,** 97 (1955).

Classification:
Ru I, K. G. Kessler, J. Research NBS **63A,** 213 (1959).
Ru II, A. G. Shenstone and W. F. Meggers, J. Research NBS **61,** 373 (1959).

Relative intensity of ruthenium lines observed in an arc of copper containing 0.1 atomic percent of ruthenium

Strong lines of ruthenium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1000	3728. 03	I	0–26816	$5s^1\ a\ {}^5F_5$—$5p^1\ z\ {}^5F^\circ_5$
850	3498. 94	I	0–28572	$5s^1\ a\ {}^5F_5$—$5p^1\ z\ {}^5G^\circ_6$
800	3726. 93	I	1191–28015	$5s^1\ a\ {}^5F_4$—$5p^1\ z\ {}^5F^\circ_4$
700	3593. 02	I	2713–30537	$5s^1\ a\ {}^5F_2$—$5p^1\ z\ {}^5G^\circ_3$
700	3798. 90	I	1191–27507	$5s^1\ a\ {}^5F_4$—$5p^1\ z\ {}^5D^\circ_3$
700	3799. 35	I	0–26313	$5s^1\ a\ {}^5F_5$—$5p^1\ z\ {}^5D^\circ_4$
700	4199. 90	I	6545–30348	$5s^1\ a\ {}^3F_4$—$5p^1\ z\ {}^3F^\circ_4$
650	3436. 74	I	1191–30280	$5s^1\ a\ {}^5F_4$—$5p^1\ z\ {}^5G^\circ_5$
650	3589. 22	I	3105–30959	$5s^1\ a\ {}^5F_1$—$5p^1\ z\ {}^5G^\circ_2$
650	3596. 18	I	2092–29891	$5s^1\ a\ {}^5F_3$—$5p^1\ z\ {}^5G^\circ_4$
650	3730. 43	I	2092–28891	$5s^1\ a\ {}^5F_3$—$5p^1\ z\ {}^5F^\circ_3$
600	3661. 35	I	1191–28495	$5s^1\ a\ {}^5F_4$—$5p^1\ z\ {}^3G^\circ_5$
550	3790. 51	I	2092–28466	$5s^1\ a\ {}^5F_3$—$5p^1\ z\ {}^5D^\circ_2$
550	4080. 60	I	6545–31044	$5s^1\ a\ {}^3F_4$—$5p^1\ y\ {}^5F^\circ_3$
500	3428. 31	I	0–29161	$5s^1\ a\ {}^5F_5$—$5p^1\ z\ {}^7F^\circ_6$
500	4212. 06	I	6545–30280	$5s^1\ a\ {}^3F_4$—$5p^1\ z\ {}^5G^\circ_5$
500	4554. 51	I	6545–28495	$5s^1\ a\ {}^3F_4$—$5p^1\ z\ {}^3G^\circ_5$
360	3786. 06	I	2713–29118	$5s^1\ a\ {}^5F_2$—$5p^1\ z\ {}^5D^\circ_1$
340	4297. 71	I	8084–31346	$5s^1\ a\ {}^3F_3$—$5p^1\ z\ {}^3G^\circ_4$
320	3417. 35	I	2092–31346	$5s^1\ a\ {}^5F_3$—$5p^1\ z\ {}^3G^\circ_4$
320	3742. 28	I	2713–29427	$5s^1\ a\ {}^5F_2$—$5p^1\ z\ {}^5F^\circ_2$
300	3634. 93	I	2092–29595	$5s^1\ a\ {}^5F_3$—$5p^1\ z\ {}^7F^\circ_4$
300	3925. 92	I	0–25465	$5s^1\ a\ {}^5F_5$—$5p^1\ z\ {}^7D^\circ_4$
260	3745. 59	I	12207–38898	$5s^1\ a\ {}^3G_5$—$5p^1\ z\ {}^3H^\circ_6$
220	4372. 21	I	7483–30348	$5s^2\ a\ {}^5D_4$—$5p^1\ z\ {}^3F^\circ_4$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	2076.43	I	0–48144
5	2083.77	I	1191–49165
5	2090.89	I	
9	2255.52	I	0–44322
4	2259.53	I	0–44243
12	2272.09	I	0–43999
4	2278.19	I	1191–45071
14	2279.57	I	
3.0	2285.38	I	0–43743
7	2302.54	I	1191–44608
13	2317.80	I	1191–44322
4	2322.01	I	1191–44243
4	2334.96	II	10151–52964
8	2340.69	I	2092–44801
7 h	2342.85	II	10151–52820
7	2349.34	I	1191–43743
12	2351.33	I	2092–44608
7	2357.91	II	9152–51549
6	2360.56	I	2092–44442
8	2370.17	I	2713–44891
12	2375.27	I	2713–44801
4	2375.63	II	11604–53685
10	2392.42	I	3105–44891
6	2396.71	II	9152–50863
50	2402.72	II	9152–50758
10	2407.92	II	11304–52820
4	2410.89	I	
4	2414.82	II	10151–51549
10	2420.82	I	
4	2422.92	I	
4	2429.60	I	8575–49722
6	2432.93	I	6545–47635
3.5	2447.45	I	9492–50339
3.5	2450.58	I	6545–47339
7	2454.92	I	8044–48766
20	2455.53	II	10151–50863
16	2456.44	II	10852–51549
40	2456.57	II	10151–50845
7 h	2458.62	I	7483–48144
6	2462.94	I	8575–49165
9	2464.70	I	8044–48604
3.5	2474.04	I	9620–50028
12	2475.41	I	7483–47868
11	2476.88	I	8044–48405
30	2478.93	II	10852–51179
3.0	2481.11	II	29019–69311
3.5	2489.91	I	6545–46695
2.0	2491.78	I	9184–49304
7	2493.69	II	26109–66199
9	2494.02	I	9058–49141
5	2494.48	II	11304–51380
9	2495.69	II	27545–67602
7	2496.56	I	7483–47526
15	2498.42	II	11304–51317
15	2498.57	II	10852–50863
9	2499.78	I	
3.5	2500.84	I	9073–49048
8	2501.48	I	9073–49037
6	2501.89	I	9184–49141
28	2507.01	II	11304–51179
14	2508.27	I	7483–47339
12	2509.07	I	9121–48964
3.5	2511.56	I	
12	2512.81	I	8084–47868
12	2513.32	II	11604–51380
7	2515.28	I	8044–47789
12	2517.32	II	11604–51317
6	2517.62	I	9058–48766
3.5	2519.95	I	
6	2521.61	I	9121–48766
3.0	2525.17	I	8575–48165
8	2526.83	I	7483–47047
6	2528.88	I	9073–48604
6	2530.64	I	8044–47547
5	2533.24	I	7483–46947
16	2535.59	II	26911–66338
5	2541.28	I	8771–48109
7	2543.25	II	25952–65260
30	2544.22	I	8575–47868
13	2546.67	I	8084–47339
30	2549.48	I	7483–46695
60	2549.58	I	6545–45756
2.5	2555.86	I	
3.5	2556.00	I	9492–48604
4	2556.31	I	9058–48165
5	2558.54	I	8084–47157
14	2560.26	I	8771–47818
13	2560.83	I	
12	2563.15	I	8044–47047
3.0	2564.58	I	9184–48165
6	2566.59	I	8575–47526
17	2568.77	I	7483–46401
3.0	2569.74	I	8044–46947
11	2570.97	I	
3.0	2572.28	I	8771–47635
6	2572.41	I	8084–46947
3.0 h	2575.24	I	6545–45365
11	2578.57	I	8575–47345
6	2578.95	I	8575–47339
5	2579.22	I	8044–46804

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
11	2579.53	I	8771–47526
10	2580.80	I	9073–47809
8	2581.14	I	9058–47789
7	2581.91	I	8084–46804
6	2583.04	I	8044–46746
8	2584.14	I	8575–47262
5	2585.74	I	8084–46746
11	2589.57	I	9184–47789
7	2590.97	I	7483–46067
18	2591.12	I	8575–47157
4	2591.64	I	8771–47345
13	2592.02	I	8771–47339
11	2593.70	I	12817–51360
12	2594.85	I	6545–45071
5	2597.33	I	9058–47547
9	2601.46	I	
8	2605.35	I	8575–46947
7	2605.86	I	9184–47547
40	2609.06	I	8084–46401
5	2609.48	I	10624–48934
9	2611.05	I	9058–47345
90	2612.07	I	7483–45756
10	2614.07	I	1191–39434
6	2614.59	I	2713–40949
11	2615.09	I	8575–46804
8	2617.79	I	9620–47809
10	2619.67	I	9184–47345
9	2620.61	I	8044–46191
3.0	2623.83	I	16191–54292
6	2627.65	I	7483–45529
24	2631.30	I	7483–45476
6	2631.57	I	9058–47047
5	2632.13	I	10624–48604
5	2632.50	I	8771–46746
3.0	2633.46	I	11447–49409
24	2635.86	I	9620–47547
18	2636.67	I	12207–50122
10	2638.51	I	9058–46947
8	2639.12	I	9620–47501
12	2640.33	I	9184–47047
50	2642.96	I	8575–46401
3.0	2646.02	I	10624–48405
12	2647.32	I	9184–46947
3.5	2648.45	I	8044–45790
3.0	2648.78	I	12207–49949
7	2649.51	I	9058–46789
12	2651.29	I	8084–45790
36	2651.84	I	6545–44243
3.0	2656.25	II	25952–63588
1.4	2656.56	I	
1.4	2656.69	I	8771–46401
5	2658.40	I	9184–46789
44	2659.62	I	7483–45071
2.5	2661.17	II	25952–63518
36	2661.61	II	9152–46711
22	2664.76	I	1191–38706
3.5	2667.40	II	26109–63588
4	2667.97	I	9058–46528
6	2673.48	I	9073–46466
5	2673.60	I	8084–45476
75	2678.76	II	9152–46471
24	2686.29	I	8575–45790
3.0	2687.50	II	26109–63308
3.5	2688.11	I	26118–63308
	2688.16	II	
2.0	2689.90	I	10624–47789
36	2692.06	II	10151–47285
4	2693.29	I	9073–46191
10	2699.88	I	8044–45071
12	2701.34	I	9184–46191
12	2702.83	I	8084–45071
4	2707.97	I	2092–39009
18	2709.20	I	8575–45476
22	2712.41	II	10852–47708
8	2713.19	I	9620–46466
5	2717.40	I	3105–39895
2.5	2718.83	I	
75	2719.52	I	7483–44243
10	2721.56	I	9058–45790
14	2722.65	I	9073–45790
8	2724.06	I	9492–46191
15	2725.47	II	11304–47984
6	2728.83	I	9121–45756
2.5	2729.46	I	8575–45202
6	2730.33	I	2092–38706
10	2730.93	I	9183–45790
5	2733.59	I	9620–46191
34	2734.35	II	10151–46711
200	2735.72	I	0–36543
18	2739.22	I	8575–45071
8	2743.94	I	6545–42978
14	2744.45	I	8771–45197
4	2747.97	II	11604–47984
8	2752.45	II	10151–46471
8	2752.77	II	19379–55695
10	2753.44	I	
4	2762.31	I	8044–44235
28	2763.42	I	1191–37367
4	2765.44	II	20515–56665
10	2768.93	II	11604–47708

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	2774.48	I	
11	2778.38	II	11304–47285
6	2785.65	I	9184–45071
12	2787.83	II	10852–46711
4	2792.64	I	8044–43842
15	2802.81	I	8575–44243
4	2806.74	II	21646–57263
38	2810.03	I	2092–37668
190	2810.55	I	1191–36760
6	2812.82	I	
8	2817.09	I	2713–38200
38	2818.36	I	0–35471
4	2818.95	I	8771–44235
12	2822.03	I	8084–43509
22	2827.87	I	1191–36543
44	2829.16	I	6545–41881
14	2834.00	I	2092–37367
4	2836.57	I	9058–44301
16	2840.54	I	6545–41739
4	2841.68	II	20515–55695
8	2843.17	I	9073–44235
4	2846.32	I	9121–44244
9	2848.58	I	3105–38200
70	2854.07	I	2092–37119
20	2860.02	I	2713–37668
46	2861.41	I	6545–41483
60	2866.64	I	2092–36965
9	2868.19	I	9121–43976
12	2868.31	I	
10	2871.64	I	
200	2874.98	I	0–34773
24	2879.76	I	6545–41260
5	2881.28	I	3105–37802
6	2882.12	II	19379–54065
14	2883.60	I	2092–36760
7	2884.51	I	9184–43842
80	2886.54	I	2713–37347
8	2888.00	I	1191–35807
4	2891.65	I	15550–50122
20	2892.56	I	
8	2896.53	I	3105–37620
6	2898.54	I	8044–42534
12	2901.94	I	8084–42534
6	2902.10	I	10624–45071
2.0	2903.08	I	9073–43509
15	2905.65	I	2713–37119
7	2905.83	I	6545–40949
8	2906.32	I	7483–41881
40	2908.88	I	3105–37473
3.5	2909.22	I	8575–42939
4	2913.17	I	11786–46103
4	2914.30	I	11753–46056
120	2916.26	I	1191–35471
3.0	2917.77	I	8084–42347
16	2919.61	I	3105–37347
3.0	2927.12	I	14700–48854
4	2927.54	II	20515–54663
4	2939.94	I	11786–45790
6	2940.36	I	7483–41483
8	2943.92	I	8575–42534
20	2945.67	II	19379–53317
20	2946.99	I	8084–42007
40	2949.50	I	6545–40439
4	2952.50	I	3105–36965
16	2954.49	I	8043–41881
8	2958.00	I	8084–41881
3.0	2959.74	I	7483–41260
8	2961.69	I	11447–45202
2.0	2963.40	II	21246–54981
6	2963.72	I	6545–40277
60	2965.16	I	2092–35807
18	2965.55	II	20515–54225
6	2968.48	I	10624–44301
9	2968.95	I	8084–41756
4	2973.99	I	9492–43108
3.0	2974.34	I	10624–44235
15	2976.59	II	19379–52964
60	2976.92	I	1191–34773
5	2977.23	II	21646–55224
8	2979.72	I	15054–48604
		II	20515–54065
8	2979.96	II	21246–54794
6	2981.94	I	2713–36239
150	2988.95	I	0–33447
4	2989.66	I	8044–41483
4	2991.62	II	21246–54663
12	2993.27	I	8084–41483
50	2994.96	I	2092–35471
6	2996.90	I	9058–42416
3.0	2997.43	I	10624–43976
10	2998.35	I	
6	3001.64	I	8575–41881
48	3006.59	I	2713–35964
4	3008.26	I	9184–42416
6	3008.80	I	9121–42347
6	3012.92	I	8575–41756
6	3013.36	I	8084–41260
36	3017.24	I	3105–36239
2.0	3019.37	I	8771–41881
34	3020.88	I	2713–35807

Ruthenium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
26	3033.45	I	7483–40439
7	3034.06	I	9058–42007
6	3035.47	I	9073–42007
6	3038.18	I	8044–40949
20	3040.31	I	1191–34072
22	3042.48	I	3105–35964
6	3042.83	I	10655–43510
11	3045.71	I	9184–42007
6	3048.50	I	7483–40277
11	3048.78	I	2092–34882
15	3054.94	I	8044–40768
40	3064.84	I	9121–41739
9	3068.26	I	
9	3073.34	I	11447–43976
9	3080.90	I	11786–44235
6	3086.07	I	11447–43842
17	3089.14	I	9121–41483
12	3089.80	I	8084–40439
6	3090.23	I	17097–49448
6	3091.87	I	2713–35047
34	3096.57	I	12207–44492
12	3097.60	I	10624–42897
85	3099.28	I	1191–33447
75	3100.84	I	1191–33431
9	3110.55	I	9121–41260
6	3124.17	I	2092–34091
12	3125.96	I	2092–34072
9	3132.88	I	10624–42534
9	3136.56	I	8044–39917
9	3140.97	I	9121–40949
9	3144.26	I	14700–46495
6	3150.69	I	8044–39774
12	3153.82	I	8044–39742
6	3158.89	I	9121–40768
30	3159.92	I	2092–33729
20	3168.52	I	11447–42998
6	3177.05	II	19379–50845
18	3186.04	I	2713–34091
24	3188.34	I	2092–33447
24	3189.98	I	2092–33431
18	3196.59	I	3105–34380
6	3212.97	I	9121–40235
6	3216.52	I	2092–33172
18	3223.27	I	2713–33729
11	3226.37	I	3105–34091
10	3227.88	I	8771–39742
22	3228.53	I	8044–39009
22	3238.53	I	15054–45923
12	3241.24	I	9073–39917
12	3243.50	I	6545–37367
8	3254.54	I	2713–33431
6	3254.71	I	9058–39774
28	3260.35	I	1191–31853
12 d	3264.55	I	3105–33729
	3264.66	I	8084–38706
12	3266.44	I	10655–41260
20	3268.21	I	13646–44235
20	3273.08	I	8044–38587
20	3274.71	I	10655–41183
10	3277.57	I	14700–45202
50	3294.11	I	0–30348
6	3296.11	I	13646–43976
6	3297.96	I	9121–39434
38	3301.59	I	0–30280
22	3306.17	I	8771–39009
6	3315.05	I	8044–38200
30	3315.23	I	1191–31346
30	3316.39	I	10624–40768
6	3317.89	I	8575–38706
6	3318.82	I	14700–44823
	3318.91	I	9620–39742
10	3325.00	I	3105–33172
4	3332.05	I	31385–61388
12	3335.69	I	11786–41756
95	3339.55	I	8771–38706
24	3341.66	I	9121–39037
6	3344.53	I	0–29891
20	3361.15	I	17046–46789
6	3362.00	I	11447–41183
38	3368.45	I	2713–32392
10	3371.86	I	9058–38706
13	3374.65	I	8044–37668
12	3378.02	I	0–29595
10	3379.60	I	10655–40235
13	3380.18	I	8044–37620
13	3385.14	I	12207–41739
13	3388.71	I	11447–40949
10	3389.50	I	2713–32208
6	3391.89	I	14828–44301
38	3392.54	I	0–29468
32	3401.74	I	9620–39009
32	3409.28	I	8044–37367
19	3411.64	I	8044–37347
320	3417.35	I	2092–31346
7	3420.08	I	11786–41017
500	3428.31	I	0–29161
13	3428.63	I	1191–30348
19	3429.54	I	10624–39774
50	3430.77	I	2713–31853
10	3432.21	I	9073–38200

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
32	3432.74	I	9121–38243	17	3631.71	I	6545–34072
19	3433.26	I	10624–39742	8	3633.92	I	17097–44608
16	3435.19	I	3105–32208	300	3634.93	I	2092–29595
650	3436.74	I	1191–30280	12	3635.52	I	9620–37119
26	3438.37	I	8044–37119	20	3637.47	I	13699–41183
22	3440.20	I	7483–36543	4	3638.02	I	15054–42534
16	3448.95	I	11447–40433	19	3640.64	I	12817–40277
10	3452.90	I	2092–31044	16	3646.11	I	12817–40235
7	3456.62	I	15054–43976	28	3650.32	I	8084–35471
7	3463.14	I	2092–30959	6	3652.32	I	2713–30085
26	3473.75	I	10655–39434	30	3654.40	I	16240–43597
24	3481.30	I	8044–36760	5	3660.81	I	16240–43549
13	3483.16	I	1191–29892	600	3661.35	I	1191–28495
13	3483.29	I	1191–29891	80	3663.37	I	7483–34773
13	3494.25	I	9058–37668	60	3669.49	I	12207–39451
13	3495.97	I	8771–37367	22	3678.32	I	2713–29892
850	3498.94	I	0–28572	4	3685.95	I	13646–40768
7	3502.42	I	8575–37119	24	3696.59	I	10624–37668
65	3514.49	I	2092–30537	10	3697.76	I	8771–35807
34	3519.64	I	1191–29595	12	3700.99	I	17097–44109
20	3528.68	I	2713–31044	2.5	3702.24	I	8044–35047
13	3531.39	I	9058–37367	10	3712.30	I	17046–43976
24	3532.81	I	14700–42998	5	3715.56	I	9058–35964
10	3535.37	I	1191–29468	10	3716.18	I	6545–33447
13	3535.83	I	9073–37347	38	3717.00	I	8575–35471
40	3537.95	I	2092–30348	24	3719.33	I	17097–43976
80	3539.37	I	2713–30959	16	3724.97	I	8044–34882
20	3541.63	I	6545–34773	5	3725.49	I	11753–38587
13	3550.27	I	2092–30250	50	3726.10	I	12207–39037
13	3553.85	I	11786–39917	800	3726.93	I	1191–28015
10	3556.63	I	11786–39895	1000	3728.03	I	0–26816
13	3564.56	I	9073–37119	650	3730.43	I	2092–28891
13	3567.16	I	13982–42007	8	3732.03	I	13646–40433
70	3570.59	I	15550–43549	8	3733.05	I	9184–35964
20	3574.58	I	8575–36543	26	3737.40	I	9058–35807
7	3579.77	I	2092–30018	5	3737.74	I	9492–36239
40	3587.20	I	16240–44109	4	3738.63	I	13699–40439
650	3589.22	I	3105–30959	10	3738.91	I	16240–42978
700	3593.02	I	2713–30537	38	3739.46	I	13699–40433
650	3596.18	I	2092–29891	320	3742.28	I	2713–29427
130	3599.76	I	8771–36543	80	3742.78	I	15550–42261
13	3605.64	I	9620–37347	26	3744.22	I	8771–35471
10	3608.73	I	9058–36760	38	3744.40	I	16240–42939
6	3616.95	I	9121–36760	260	3745.59	I	12207–38898
10	3619.20	I	12817–40439	70	3753.54	I	12817–39451
6	3620.28	I	13646–41260	28	3755.09	I	9184–35807
6	3623.64	I	10655–38243	80	3755.93	I	12817–39434
34	3625.20	I	10624–38200	110	3759.84	I	7483–34072
36	3626.74	I	17097–44662	34	3760.03	I	3105–29694
4	3627.29	I	13699–41260	55	3761.51	I	13699–40277

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
55	3767.35	I	13699–40235
5	3773.17	I	10624–37119
140	3777.59	I	3105–29570
14	3778.70	I	12817–39273
42	3781.18	I	20056–46495
55	3782.74	I	27289–53718
360	3786.06	I	2713–29119
550	3790.51	I	2092–28466
22	3794.92	I	16191–42534
		I	9620–35964
8	3795.18	I	10624–36965
70	3798.05	I	3105–29427
700	3798.90	I	1191–27507
700	3799.35	I	0–26313
28	3800.26	I	8575–34882
8	3803.20	I	20242–46528
28	3808.68	I	14700–40949
55	3812.72	I	12817–39037
14	3814.86	I	15054–41260
70	3817.27	I	15550–41739
70	3819.03	I	2713–28891
5	3819.77	I	11447–37620
60	3822.09	I	16191–42347
50	3824.93	I	10624–36760
12	3828.71	I	8771–34882
70	3831.80	I	12207–38297
20	3835.05	I	14700–40768
28	3838.07	I	8044–34091
85	3839.70	I	12207–38243
14	3840.82	I	8044–34072
8	3843.16	I	3105–29119
44	3846.68	I	9058–35047
70	3850.43	I	7483–33447
12	3852.14	I	17046–42998
44	3856.46	I	2092–28015
120	3857.55	I	14700–40616
20	3860.72	I	15054–40949
60	3862.69	I	17097–42978
12	3865.40	I	9184–35047
120	3867.84	I	6545–32392
24	3873.52	I	9073–34882
3	3876.08	I	13982–39774
9	3882.01	I	2713–28466
12	3884.02	I	14700–40439
9	3884.68	I	13699–39434
9	3887.77	I	15054–40768
14	3890.20	I	9184–34882
6	3891.41	I	16191–41881
60	3892.21	I	8044–33729
3	3892.77	I	20242–45923
3	3894.24	I	11447–37119
9	3897.24	I	9121–34773
9	3898.36	I	8084–33729
14	3901.24	I	1191–26816
12	3908.76	I	14700–40277
70	3909.08	I	13699–39273
9	3912.11	I	9492–35047
14	3914.85	I	8044–33580
24	3920.92	I	8575–34072
140	3923.47	I	12817–38297
6	3924.63	I	20056–45529
300	3925.92	I	0–25465
55	3931.76	I	9620–35047
		I	12817–38243
28	3933.55	I	2092–27507
11	3937.90	I	8044–33431
6	3941.65	I	8084–33447
8	3942.06	I	3105–28466
6	3944.19	I	8084–33431
70	3945.57	I	16240–41578
3.5	3946.31	I	11786–37119
6	3949.42	I	11447–36760
11	3950.04	I	20056–45365
42	3950.21	I	6545–31853
14	3950.41	I	9073–34380
6	3951.21	I	8771–34072
28	3952.68	I	16191–41483
3.5	3957.45	I	9620–34882
42	3964.90	I	0–25214
3.0	3969.79	I	10624–35807
8	3974.50	I	8575–33729
55	3978.44	I	8044–33172
55	3979.42	I	1191–26313
80	3984.86	I	8084–33172
2.5	3987.80	I	16191–41260
5	3993.53	I	9058–34091
26	3995.98	I	9073–34091
2.5	3996.51	I	9058–34072
13	4005.64	I	8771–33729
8	4006.60	I	9120–34073
5	4007.54	I	14827–39774
8	4008.27	I	13646–38587
8	4013.50	I	7483–32392
5	4021.00	I	15054–39917
140	4022.16	I	8575–33431
55	4023.83	I	1191–26036
8	4031.00	I	6545–31346
14	4032.20	I	2713–27507
3.5	4037.74	I	9620–34380
28	4039.21	I	14700–39451

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	4040.48	I	22519–47262
16	4045.76	I	17046–41756
6	4049.41	I	15054–39742
130	4051.40	I	8771–33447
16	4052.20	I	9058–33729
65	4054.05	I	8771–33431
5	4062.85	I	20056–44662
11	4062.99	I	13982–38587
10	4064.10	I	9492–34091
34	4064.46	I	8575–33172
18	4067.61	I	16191–40768
70	4068.37	I	14700–39273
14	4071.40	I	13646–38200
18	4073.00	I	9184–33729
90	4076.73	I	9058–33580
550	4080.60	I	6545–31044
7	4082.79	I	11753–36239
28	4085.43	I	16713–41183
10	4091.06	I	17046–41483
10	4097.03	I	8771–33172
85	4097.79	I	9184–33580
7	4100.37	I	2092–26473
32	4101.74	I	9058–33431
7	4102.28	I	7483–31853
12	4107.84	I	14700–39037
2.5	4109.65	I	9120–33447
170	4112.74	I	8084–32392
15	4113.38	I	16713–41017
3.0	4114.13	I	8044–32343
6	4118.50	I	1191–25464
15	4120.99	I	8084–32343
15	4123.06	I	9184–33431
6	4123.81	I	16191–40433
11	4127.44	I	2092–26313
11	4127.87	I	13982–38200
9	4137.23	I	8044–32208
180	4144.16	I	8084–32208
60	4145.74	I	9058–33172
24	4146.77	I	9620–33729
8	4148.38	I	9073–33172
5	4150.30	I	9492–33580
3.0	4159.17	I	16240–40277
12	4161.66	I	13646–37668
10	4166.88	I	6545–30537
80	4167.51	I	9184–33172
10	4170.05	I	13646–37620
5	4175.43	I	20056–43999
10	4182.46	I	17046–40949
6	4182.64	I	7483–31385
3.0	4189.46	I	7483–31346
14	4196.87	I	13982–37802
50	4197.58	I	8575–32392
50	4198.88	I	8044–31853
700	4199.90	I	6545–30348
140	4206.02	I	8084–31853
17	4207.64	I	14828–38587
500	4212.06	I	6545–30280
70	4214.44	I	13646–37367
85	4217.27	I	6545–30250
34	4220.68	I	13982–37668
10	4225.09	I	20242–43903
7	4226.66	I	15054–38706
17	4229.31	I	13982–37620
50	4230.31	I	8575–32208
14	4232.32	I	8771–32392
10	4236.67	I	14700–38297
70	4241.05	I	8771–32343
70	4243.06	I	7483–31044
10	4244.83	I	9620–33172
17	4246.33	I	14700–38243
34	4246.73	I	20056–43597
3.5	4248.14	I	15054–38587
28	4258.99	I	13646–37119
7	4260.00	I	10624–34091
3.0	4263.40	I	10624–34072
7	4265.61	I	10655–34091
3.0	4277.26	I	14827–38200
3.5	4278.69	I	13982–37347
4.0	4281.93	I	15550–38898
7	4282.22	I	6545–29891
70	4284.33	I	9058–32392
17	4287.05	I	13646–36965
20	4293.28	I	9058–32343
24	4294.79	I	8575–31853
50	4295.93	I	9121–32392
340	4297.71	I	8084–31346
85	4307.60	I	9183–32392
3.5	4309.21	I	26036–49235
10	4314.30	I	25214–48386
7	4316.64	I	9184–32343
34	4318.43	I	9058–32208
50	4319.87	I	8044–31186
3.5	4320.58	I	17097–40235
3.0	4321.30	I	9073–32208
3.0	4322.96	I	25201–48327
16	4325.05	I	13646–36760
16	4326.82	I	10624–33729
10	4327.43	I	8084–31186
9	4331.16	I	8771–31853
3.5	4332.50	I	23453–46528

Ruthenium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	4336.42	I	7483–30537
16	4337.27	I	6545–29595
3.0	4338.68	I	20934–43976
4.0	4340.34	I	16240–39273
3.5	4341.04	I	16713–39742
50	4342.07	I	9184–32208
10	4346.48	I	8044–31044
32	4349.70	I	13982–36965
65	4354.13	I	8084–31044
13	4354.80	I	10624–33580
80	4361.21	I	6545–29468
3.0	4370.42	I	8084–30959
6	4371.20	I	17046–39917
220	4372.21	I	7483–30348
3.0	4381.27	I	16191–39009
9	4383.36	I	10624–33431
80	4385.39	I	7483–30280
120	4385.65	I	9058–31853
9	4386.27	I	14827–37620
2.5	4388.99	I	22419–45197
160	4390.44	I	8575–31346
8	4391.03	I	7483–30250
3.0	4394.96	I	15550–38297
16	4397.80	I	9121–31853
3.5	4399.59	I	9620–32343
3.0	4404.82	I	17046–39742
150	4410.03	I	9184–31853
6	4420.84	I	8771–31385
15	4421.46	I	8575–31186
3.5	4424.78	I	11786–34380
30	4428.46	I	8771–31346
42	4439.76	I	10655–33172
8	4444.51	I	8044–30537
40	4449.34	I	8575–31044
100	4460.04	I	8771–31186
2.0	4467.26	I	20242–42621
17	4473.93	I	6545–28891
2.5	4479.41	I	13646–35964
14	4480.45	I	15054–37367
3.0	4482.03	I	11786–34091
8	4488.39	I	8771–31044
5	4490.24	I	8084–30348
4	4491.68	I	13982–36239
32	4498.14	I	9121–31346
11	4510.10	I	8084–30250
8	4511.20	I	13646–35807
20	4516.89	I	11447–33580
20	4517.82	I	9058–31186
10	4520.95	I	9073–31186
6	4530.85	I	15054–37119
		I	20934–42998
2.5	4543.69	I	9184–31186
16	4547.33	I	7483–29468
10	4547.85	I	13982–35964
2.5	4549.43	I	8044–30018
4	4549.96	I	23393–45365
4	4552.11	I	8575–30537
500	4554.51	I	6545–28495
10	4559.98	I	9121–31044
2.0	4562.60	I	15054–36965
3.5	4564.69	I	9058–30959
6	4580.07	I	11753–33580
160	4584.44	I	8084–29891
4	4587.10	I	11786–33580
10	4591.10	I	9184–30959
14	4592.52	I	10624–32392
6	4596.71	I	23453–45022
30	4599.08	I	10655–32392
5	4601.76	I	11447–33172
3.5	4605.66	I	15054–36760
2.0	4612.32	I	8575–30250
14	4635.69	I	9620–31186
17	4645.09	I	20056–41578
60	4647.61	I	8084–29595
24	4654.32	I	9058–30537
2.0	4669.14	I	14827–36239
6	4669.98	I	7483–28891
8	4674.65	I	11786–33172
24	4681.79	I	9184–30537
16	4684.02	I	8084–29427
24	4690.11	I	8575–29891
120	4709.48	I	9121–30348
2.5	4720.92	I	16191–37367
12	4731.33	I	9121–30250
10	4733.52	I	8771–29891
2.5	4738.40	I	
3.0	4743.02	I	22519–43597
6	4756.23	I	8575–29595
42	4757.84	I	7483–28495
1.8	4764.40	I	27507–48490
8	4769.30	I	6545–27507
1.8	4773.15	I	11447–32392
3.0	4774.00	I	20242–41183
4	4784.27	I	11447–32343
3.0	4794.38	I	8575–29427
3.0	4795.57	I	8044–28891
4	4798.44	I	9058–29892
5	4804.88	I	8084–28891
1.6	4806.19	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22	4815.52	I	11447–32208
1.6	4817.34	I	15054–35807
6	4833.00	I	
4	4839.01	I	26313–46972
1.6	4839.77	I	8771–29427
10	4844.56	I	9058–29694
2.0	4854.56	I	26313–46906
7	4861.87	I	10624–31186
46	4869.15	I	7483–28015
6	4895.32	I	8044–28466
12	4895.60	I	10624–31044
6	4899.25	I	11447–31853
36	4903.05	I	10655–31044
3.0	4905.02	I	8084–28466
9	4907.89	I	9058–29427
20	4921.07	I	8575–28891
14	4938.43	I	9184–29427
7	4955.26	I	26816–46991
3.5	4959.86	I	26816–46972
12	4968.90	I	8771–28891
2.5	4974.12	I	22162–42261
7	4976.20	I	26816–46906
12	4980.35	I	9620–29694
4	4983.45	I	9058–29119
4	4987.26	I	9073–29119
9	4992.74	I	7483–27507
12	5011.23	I	9620–29570
7	5014.95	I	9184–29119
7	5026.18	I	8575–28466
5	5028.16	I	10655–30537
2.5	5040.35	I	20934–40768
2.5	5040.74	I	9058–28891
5	5047.31	I	9620–29427
34	5057.33	I	6545–26313
1.6	5062.64	I	13982–33729
7	5072.97	I	9184–28891
9	5076.32	I	10655–30348
15	5093.83	I	9492–29119
6	5107.07	I	12817–32392
1.8	5123.73	I	11447–30959
4	5127.26	I	9620–29119
5	5133.89	I	13699–33172
40	5136.55	I	8044–27507
13	5142.76	I	8575–28015
19	5147.24	I	8084–27507
8	5151.07	I	9058–28466
4	5153.20	I	11786–31186
38	5155.14	I	9073–28466
4	5160.00	I	9121–28495
70	5171.03	I	7483–26816
14	5195.02	I	8771–28015
6	5199.87	I	29160–48386
3.5	5202.12	I	20056–39273
3.5	5213.43	I	28495–47671
5	5223.55	I	12207–31346
3.0	5242.38	I	10624–29694
4	5251.67	I	12817–31853
3.0	5257.07	I	30537–49554
3.0	5266.47	I	20934–39917
3.0	5266.83	I	20056–39037
3.0	5280.82	I	8575–27507
10	5284.08	I	6545–25465
3.0	5291.16	I	9121–28015
6	5304.86	I	9620–28466
20	5309.27	I	7483–26313
1.0	5315.33	I	20934–39742
3.0	5332.93	I	13646–32392
3.5 h	5334.70	I	
8	5335.93	I	8771–27507
10	5361.77	I	
5	5377.84	I	28495–47085
5	5385.88	I	13646–32208
8 h	5401.04	I	
3.0	5401.39	I	13699–32208
3.0	5418.86	I	9058–27507
4	5427.59	I	28572–46991
2.0 l	5439.21	I	
1.0	5452.71	I	28572–46906
6 h	5454.82	I	31186–49513
7	5456.13	I	9184–27507
1.0 h	5475.18	I	31346–49605
4	5479.40	I	31346–49591
2.0	5480.30	I	30280–48522
6	5484.32	I	8084–26313
1.4	5484.64	I	12817–31044
2.0	5496.69	I	20056–38243
1.0	5501.02	I	30348–48522
10	5510.71	I	12207–30348
1.5	5512.37	I	30250–48386
0.6	5517.86	I	15054–33172
0.9	5521.78	I	31186–49291
0.9	5530.99	I	20934–39009
1.8	5540.66	I	12207–30250
0.9	5556.52	I	8044–26036
7	5559.75	I	7483–25465
0.8	5569.03	I	8084–26036
1.6	5578.40	I	
1.6	5603.14	I	10624–28466
0.6	5603.55	I	
1.0	5606.73	I	29160–46991

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.8		5629.79	I	22519–40277
22		5636.24	I	8575–26313
0.8		5641.66	I	12817–30537
0.5		5649.56	I	9121–26816
0.5		5653.30	I	12207–29891
0.8		5665.20	I	13699–31346
1.2		5679.63	I	22293–39894
14		5699.05	I	8771–26313
1.0		5724.82	I	12817–30280
1.0		5725.73	I	8575–26036
1.2		5745.99	I	13646–31044
1.2		5747.47	I	21643–39037
0.8		5752.02	I	8084–25465
0.8		5756.83	I	11753–29119
0.8		5767.92	I	11786–29119
1.2		5804.39	I	23393–40616
5		5814.98	I	9121–26313
0.6		5828.06	I	15054–32208
1.2	h	5833.21	I	30348–47487
4		5919.34	I	8575–25465
6		5921.45	I	10624–27507
1.6		5926.87	I	16713–33580
2.0		5932.38	I	9184–26036
0.6		5936.65	I	30348–47188
0.6		5951.15	I	15054–31853
1.6	h	5973.38	I	30348–47085
0.6		5974.17	I	20934–37668
1.2		5988.67	I	8771–25465
2.5		5993.65	I	11786–28466
1.4		6116.77	I	9121–25465
2.0		6199.42	I	17046–33172
2.0		6225.20	I	11447–27507
0.7		6284.49	I	22293–38200
1.4		6295.22	I	23393–39273
1.0		6330.62	I	25465–41256
0.7		6336.12	I	22519–38297
0.7	h	6363.41	I	28466–44176
0.7		6376.45	I	12817–28495
1.2		6390.23	I	23393–39037
0.6		6417.57	I	34773–50351
2.0	h	6444.84	I	27507–43019
0.6		6496.44	I	27507–42895
0.8		6528.74	I	
0.3		6560.45	I	23005–38243
0.3		6593.74	I	17046–32208
0.7		6618.20	I	16240–31346
2.0		6663.14	I	28015–43019
5		6690.00	I	26313–41256
1.0		6707.52	I	23393–38297
1.4		6718.30	I	28015–42895
1.4		6730.45	I	16191–31044
0.7		6756.54	I	32392–47188
2.0		6766.95	I	29119–43892
3.0		6775.02	I	17097–31853
1.2		6787.23	I	15550–30280
0.8		6813.51	I	22293–36965
1.4		6823.88	I	29694–44344
2.0		6824.17	I	28466–43116
0.7		6831.52	I	25643–40277
3.0		6911.48	I	29427–43892
12		6923.23	I	26816–41256
3.0		6982.01	I	27507–41825
3.0		7027.98	I	28891–43116
1.0		7086.06	I	16240–30348
1.4		7087.35	I	12207–26313
0.4		7141.72	I	17046–31044
0.7		7219.26	I	25603–39451
4.0		7238.92	I	28015–41825
0.8		7266.96	I	
0.9		7323.56	I	16240–29891
1.8		7393.93	I	29595–43116
2.0		7468.91	I	30959–44344
1.4		7475.40	I	
3.0		7485.79	I	30537–43892
8		7499.75	I	28495–41825
0.8		7532.07	I	24927–38200
3.0		7559.61	I	29891–43116
0.6		7612.94	I	31044–44176
2.0		7621.50	I	31853–44970
2.0		7722.87	I	15550–28495
0.6		7729.91	I	30959–43892
2.5		7791.86	I	31346–44176
0.5		7797.89	I	
0.5		7806.82	I	37367–50173
0.3		7813.43	I	20934–33729
0.5		7829.81	I	30250–43019
0.6	h	7833.39	I	32208–44970
0.7	h	7841.90	I	36543–49291
3.5		7847.80	I	30280–43019
9		7881.49	I	28572–41256
1.8		7890.37	I	30348–43019
1.8		7924.43	I	30280–42896
0.6		7948.15	I	32392–44970
1.0		7967.84	I	30348–42895
1.0		8112.47	I	31853–44176
2.0		8264.96	I	29161–41256
1.2		8348.98	I	31044–43019
0.7		8352.94	I	32208–44176
0.4		8435.77	I	31044–42895
1.2		8473.64	I	33172–44970

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.2	8483.56	I	32392–44176	1.6	8724.98	I	20934–32392
2.5	8710.84	I	30348–41825	1.0	8777.36	I	33580–44970

SAMARIUM

Sm, $Z=62$, $M=150.35$, Ratio $\frac{\text{Sm}}{\text{Cu}}$ 2.366

Sm I Normal state of valence electrons $4f^6\,6s^2\,{}^7F_0 = 0$. I.P.=45000 K
Sm II Normal state of valence electrons $4f^6\,6s^1\,{}^8F_{0\frac{1}{2}} = 0$. I.P.=92000 K

References

Wavelengths:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945), below 2900 A.

A. S. King, Astrophys. J. **82,** 140 (1935), above 2900 A.

Classification:

Sm I, W. Albertson, Phys. Rev. **47,** 370 (1935).
F. W. Paul, Phys. Rev. **49,** 156 (1936) (Spectrum assignment only).
W. Albertson, Phys. Rev. **52,** 644 (1937).

Sm II, W. Albertson, Astrophys. J. **84,** 26 (1936).

Relative intensity of samarium lines observed in an arc of copper containing 0.1 atomic percent of samarium

Strong lines of samarium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
350	3568. 27	II	3910–31926	$4f^6 6s\ a\ {}^8F_{6\frac{1}{2}}$— $\quad {}^8G^\circ_{7\frac{1}{2}}$
350	3592. 60	II	3053–30880	$4f^6 6s\ a\ {}^8F_{5\frac{1}{2}}$— $\quad {}^8G^\circ_{6\frac{1}{2}}$
280	3609. 49	II	2238–29935	$4f^6 6s\ a\ {}^8F_{4\frac{1}{2}}$— $\quad {}^8G^\circ_{5\frac{1}{2}}$
280	3634. 29	II	1489–28997	$4f^6 6s\ a\ {}^8F_{3\frac{1}{2}}$— $\quad {}^8G^\circ_{4\frac{1}{2}}$
280	3885. 29	II	3910–29641	$4f^6 6s\ a\ {}^8F_{6\frac{1}{2}}$—$4f^6 6p$ $\quad 115^\circ_{6\frac{1}{2}}$
220	3739. 12	II		
	3739. 20	II	327–27063	$4f^6 6s\ a\ {}^8F_{1\frac{1}{2}}$— $\quad {}^8G^\circ_{1\frac{1}{2}}$
200	3854. 21	II		
200	4424. 34	II	3910–26506	$4f^6 6s\ a\ {}^8F_{6\frac{1}{2}}$—$4f^6 6p$ $\quad 56^\circ_{5\frac{1}{2}}$
180	3661. 36	II	327–27631	$4f^6 6s\ a\ {}^8F_{1\frac{1}{2}}$— $\quad {}^8G^\circ_{2\frac{1}{2}}$
180	3670. 84	II	838–28073	$4f^6 6s\ a\ {}^8F_{2\frac{1}{2}}$— $\quad {}^8G^\circ_{3\frac{1}{2}}$
170	3922. 40	II	3053–28540	$4f^6 6s\ a\ {}^8F_{5\frac{1}{2}}$—$4f^6 6p$ $\quad 98^\circ_{5\frac{1}{2}}$
160	3731. 26	II	838–27631	$4f^6 6s\ a\ {}^8F_{2\frac{1}{2}}$— $\quad {}^8G^\circ_{2\frac{1}{2}}$
150	4280. 79	II	3910–27263	$4f^6 6s\ a\ {}^8F_{6\frac{1}{2}}$—$4f^6 6p$ $\quad 75^\circ_{7\frac{1}{2}}$
150	4467. 34	II	5318–27696	$4f^6 6s\ a\ {}^6F_{5\frac{1}{2}}$—$4f^6 6p$ $\quad 84^\circ_{6\frac{1}{2}}$
140	3306. 39	II	3910–34145	$4f^6 6s\ a\ {}^8F_{6\frac{1}{2}}$— $\quad 162^\circ_{6\frac{1}{2}}$
140	3604. 28	II	3910–31646	$4f^6 6s\ a\ {}^8F_{6\frac{1}{2}}$— $\quad 128^\circ_{7\frac{1}{2}}$
140	3621. 23	II	838–28445	$4f^6 6s\ a\ {}^8F_{2\frac{1}{2}}$— $\quad 97^\circ_{3\frac{1}{2}}$
140	3760. 69	II	1489–28072	$4f^6 6s\ a\ {}^8F_{3\frac{1}{2}}$— $\quad {}^8G^\circ_{3\frac{1}{2}}$
130	3928. 28	II	1489–26938	$4f^6 6s\ a\ {}^8F_{3\frac{1}{2}}$— $\quad 66^\circ_{3\frac{1}{2}}$
130	4118. 55	II	5318–29591	$4f^6 6s\ a\ {}^6F_{5\frac{1}{2}}$— $\quad 114^\circ_{4\frac{1}{2}}$
130	4318. 94	II	2238–25385	$4f^6 6s\ a\ {}^8F_{4\frac{1}{2}}$—$4f^6 6p$ $\quad 38^\circ_{5\frac{1}{2}}$
120	3728. 47	II	5318–32131	$4f^6 6s\ a\ {}^6F_{5\frac{1}{2}}$— $\quad 143^\circ_{6\frac{1}{2}}$
120	3735. 98	II	2238–28997	$4f^6 6s\ a\ {}^8F_{4\frac{1}{2}}$— $\quad {}^8G^\circ_{4\frac{1}{2}}$
120	3793. 97	II	838–27188	$4f^6 6s\ a\ {}^8F_{2\frac{1}{2}}$—$4f^6 6p$ $\quad 73^\circ_{3\frac{1}{2}}$
120	3797. 73	II		
120	3826. 20	II	4386–30514	$4f^6 6s\ a\ {}^6F_{4\frac{1}{2}}$— $\quad 127^\circ_{4\frac{1}{2}}$
120	3843. 50	II	3499–29510	$4f^2 6s\ a\ {}^6F_{3\frac{1}{2}}$— $\quad 113^\circ_{3\frac{1}{2}}$
120	3896. 98	II	327–25980	$4f^6 6s\ a\ {}^8F_{1\frac{1}{2}}$—$4f^6 6p$ $\quad 47^\circ_{2\frac{1}{2}}$
120	4329. 02	II	1489–24583	$4f^6 6s\ a\ {}^8F_{3\frac{1}{2}}$—$4f^6 6p$ $\quad 24^\circ_{2\frac{1}{2}}$
120	4434. 32	II	3053–25598	$4f^6 6s\ a\ {}^8F_{5\frac{1}{2}}$—$4f^6 6p$ $\quad 43^\circ_{4\frac{1}{2}}$
110	3788. 12	II	2003–28394	$4f^6 6s\ a\ {}^6F_{1\frac{1}{2}}$— $\quad 95^\circ_{2\frac{1}{2}}$
110	4296. 74	I	4021–27288	$4f^6 6s^2\ a\ {}^7F_6$ —$4f^6 6s 6p\ z\ {}^7G^\circ_7$
110	4390. 86	II	1489–24257	$4f^6 6s\ a\ {}^8F_{3\frac{1}{2}}$—$4f^6 6p$ $\quad 21^\circ_{4\frac{1}{2}}$
110	4433. 88	II	3499–26046	$4f^6 6s\ a\ {}^6F_{3\frac{1}{2}}$—$4f^6 6p$ $\quad 49^\circ_{4\frac{1}{2}}$
110	4674. 60	II	1489–22875	$4f^6 6s\ a\ {}^8F_{3\frac{1}{2}}$—$4f^6 6p$ $\quad 12^\circ_{3\frac{1}{2}}$

609065 O - 62 - 20

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.5	2610.07	I	
5	2640.27		
2.0	2649.17		
3.0	2657.68		
5	2662.42	I	
8	2675.15		
7	2688.60		
3.0	2690.90		
9	2693.34		
3.0	2693.74	I	
4	2696.08		
6	2707.96		
3.5	2732.42	I	
2.5	2739.87		
2.0	2762.28		
2.5	2764.18		
6	2767.85		
4	2774.77	I	
6	2776.11		
6	2779.23		
6	2786.64		
10	2789.38		
9 h	2796.70		
6	2807.36		
10	2809.50		
8	2810.86		
6	2817.20		
2.0	2820.96		
15	2830.94		
4	2840.30		
4	2847.49		
4	2851.35		
8	2866.09	I	
5	2868.40		
5	2881.34		
6	2881.68	I	
4	2883.09		
3.0	2889.06		
4	2891.34		
6 d	2907.88		
	2907.99		
9	2910.28	II	
6	2937.48	II	
5	2943.49	II	
10	2953.19	II	
6	2962.74	II	
11	2969.02	II	
7	2983.43	II	
4	2991.57	II	
7	3021.01		
10	3034.84	II	
7	3039.13	II	
8	3046.93	II	
3.0	3050.80	II	
6	3065.78	II	327–32935
10	3067.54		
8	3071.29	II	
7	3086.45	II	
6	3096.68	II	1489–33773
8	3096.88	II	
7 h	3102.30	II	
17	3106.52	II	2238–34419
15	3110.20	II	
4	3115.05	II	2238–34331
14	3117.72	II	
7	3134.18	II	
22	3136.30	II	
12	3139.97	II	
7	3143.30	II	
12	3147.19	II	2689–34454
15	3152.10	II	3053–34768
34	3152.52	II	
7	3162.15	II	2238–33853
12	3162.30	II	
30	3169.88	II	2238–33776
7	3170.21	II	2238–33773
15	3178.12	II	1489–32945
60	3183.92	II	
7	3186.02	II	
26	3187.01	II	1489–32858
36	3187.22	II	3053–34419
30	3187.79	II	2238–33599
7	3188.72	II	2689–34040
30	3193.01	II	
30	3196.18	II	3053–34331
12	3201.80	II	
12	3204.90	II	2689–33882
30	3207.18	II	0–31171
15	3208.17	II	
50	3211.73	II	
12	3214.12	II	2003–33107
22	3215.26	II	3053–34145
44	3216.85	II	838–31916
50	3218.61	II	
12	3219.43	II	
22	3226.86	II	
15	3228.50	II	
22	3228.78	II	4386–35349
60	3230.56	II	1489–32435
30	3231.53	II	838–31775

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
12		3231.95	II	2003–32935
36		3233.68	II	
60		3236.64	II	
12		3237.89	II	3499–34375
60		3239.66	II	3910–34768
44		3241.16	II	327–31171
15		3241.59	II	1518–32359
15		3242.04	II	
12		3244.69	II	
7		3245.80	I	1490–32290
20		3249.75	II	
60		3250.37	II	0–30757
30		3253.40	II	
22		3253.94	II	3053–33776
70		3254.38	II	327–31045
9		3255.63	II	2238–32945
7		3258.25	II	2003–32686
30		3262.28	II	2689–33333
36		3264.94	II	2238–32858
15		3270.49	II	
15		3270.68	II	
36	d	3272.48	II	
		3272.60	II	
36		3272.81	II	3052–33599
7		3273.32	II	3499–34040
36		3273.48	II	
7		3275.87	II	1489–32007
36		3276.75	II	3910–34419
22		3280.84	II	
15		3285.66	II	1489–31916
36		3286.23	II	3910–34331
7		3286.54	II	2689–33107
60	d	3290.28	II	
		3290.39	II	3499–33882
15		3290.65	II	
20		3293.37	II	2003–32359
30		3295.44	II	
36		3295.81	II	838–31171
60		3298.10	II	
14		3300.98	II	1489–31775
28		3301.68	II	3910–34189
28		3304.52	II	0–30253
28		3305.18	II	2689–32935
140		3306.39	II	3910–34145
14		3306.61	II	
70		3307.02	II	
28		3309.52	II	838–31045
70		3310.66	II	2238–32435
50		3312.42	II	1489–31670
34		3316.58	II	
7		3319.56	II	
36		3320.16	II	1489–31600
9		3320.59	II	
100		3321.18	II	3053–33154
28		3323.77	II	
28		3325.26	II	
14		3325.48	II	
28		3327.88	II	
7		3329.62	II	3910–33935
7		3332.70	II	2689–32686
14		3333.64	II	4386–34375
7		3335.03	II	
14		3336.12	II	2238–32204
70		3340.58	II	327–30253
7		3341.43	II	838–30757
20		3343.49	II	
9		3343.64	II	
20		3344.35	II	3053–32945
7		3346.35	II	5318–35192
7		3346.91	II	
14		3347.30	II	3910–33776
20		3348.68	II	
18		3350.88	II	
34	d	3354.18	II	3053–32858
		3354.30	II	
14		3354.72	II	
7		3361.43	II	
7		3364.80	II	
100		3365.86	II	
12		3367.27	II	3910–33599
28		3368.57	II	2238–31916
7		3369.04	II	
28		3369.46	II	2689–32359
14		3370.59	II	327–29986
28		3371.21	II	4386–34040
12		3376.48	II	3499–33107
6		3377.81	II	2003–31600
100		3382.40	II	1489–31045
42		3384.66	II	3053–32589
12		3384.86		
5		3385.39	II	2238–31768
12		3387.66	II	
34		3389.32	II	4386–33882
12		3391.11	II	1489–30969
34		3396.19	II	3499–32935
12		3397.76	II	
12		3399.84	II	
50		3402.46	II	3053–32435
17		3403.09	II	
70		3408.68	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
7		3411.30	II	
7		3413.90	II	2238–31522
22		3418.15	II	
36		3418.51	II	3910–33154
14		3419.77	II	
10		3424.78	II	
14		3426.20	II	
7		3427.97	II	
8		3429.75	II	838–29986
14		3433.68	II	
5		3435.27	II	5318–34419
12		3437.10	II	2689–31775
14		3438.06	II	3053–32131
20		3440.50	II	5318–34375
7		3444.62	II	
6		3449.56	II	2689–31670
7		3452.78	II	3053–32007
14		3453.56	II	
7		3454.97	II	3499–32435
14		3459.20	II	
10		3459.42	II	
20		3461.14	II	
7		3462.69	II	5318–34189
10		3464.07	II	
6		3464.43	II	1489–30346
14		3467.87	II	5318–34145
11		3473.96	II	3053–31830
11		3479.53	II	2238–30969
11		3480.26	II	
14		3480.56	II	
14		3487.41	II	
7		3492.62	II	1489–30113
14		3493.61	II	
5		3495.92	II	
18		3499.84	II	
14		3500.54	II	4386–32945
10		3506.85	II	3499–32007
10		3507.09	II	
11		3509.10	II	
28		3511.23	II	838–29310
14	d	3512.93	II	5318–33776
		3513.06	II	
7		3516.30		
11		3523.12	II	
7		3525.51	II	2689–31045
26		3530.60	II	1489–29805
18		3532.57	II	
22		3535.65	II	3499–31775
7		3536.77	II	
7		3542.46	II	3910–32131
10		3552.30	II	0–28143
20		3554.15	II	2689–30817
14		3556.74	II	2238–30346
14		3557.38	II	327–28429
42		3559.10	II	
7		3560.27	II	
14		3561.59	II	
18		3566.84	II	
350		3568.27	II	3910–31926
22		3577.79	II	0–27942
7		3579.67		
32		3580.94	II	
7		3582.67	II	
26		3583.39	II	1489–29388
14		3584.26	II	838–28730
14		3585.83		
11		3587.46	II	
7		3589.50		
7		3591.74	II	838–28672
350		3592.60	II	3053–30880
7		3593.73	II	4386–32204
28		3601.69	II	1489–29246
140		3604.28	II	3910–31646
280		3609.49	II	2238–29935
9		3612.43	II	
14		3613.58	II	
11		3615.24	II	2003–29656
14		3620.10	II	327–27942
20		3620.58	II	3910–31522
140		3621.23	II	838–28445
14		3622.50	II	327–27924
20		3623.32	II	838–28429
70		3627.01	II	2238–29801
14		3627.97	II	838–28394
14		3630.67	II	
70		3631.13	II	
280		3634.29	II	1489–28997
20		3634.93	II	327–27830
10		3636.06	II	
34		3638.77	II	
14		3642.76	II	4386–31830
30		3645.29	II	1489–28914
25		3645.39	II	2689–30113
14		3645.90	II	1518–28939
7		3647.29	II	
55		3649.53	II	3053–30446
28		3650.19	II	2003–29391
14		3651.00	II	4386–31768
11		3654.86	II	2238–29591
28		3656.22	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
14	3659.62	II	3499–30817
180	3661.36	II	327–27631
14	3662.27	II	2689–29986
18	3662.69	II	
14	3662.90	II	3053–30346
28	3667.93	II	2238–29494
28	3670.68	II	
180	3670.84	II	838–28073
14	3674.07	II	0–27210
28	3677.79	II	
11	3680.98	I	3125–30284
22	3681.73	II	
7	3687.10	II	
22	3688.42	II	838–27942
7	3690.08	I	2273–29365
7	3690.93	II	838–27924
22	3692.22	II	2238–29314
10	3692.76	II	
85	3693.99	II	0–27063
14	3694.30	II	
22	3700.60	II	3499–30514
22	3700.92	II	
8	3701.56	II	2238–29246
36	3706.75	II	3910–30880
36	3706.98	II	
8	3707.17	II	2689–29656
36	3708.41	II	327–27285
70	3708.65	II	1489–28445
10	3709.52	II	
12	3710.87	II	1489–28429
36	3711.54	II	2003–28939
18	3712.11	II	
26	3712.76	II	2003–28930
70	3718.88	II	3053–29935
10	3720.57	II	
7	3721.03	I	1490–28356
70	3721.85	II	
3.0	3724.02	II	
32	3724.90	II	327–27165
1.4	3726.24	II	
14	3726.80	II	1489–28314
4	3727.38	II	2689–29510
120	3728.47	II	5318–32131
7	3728.93	II	
16	3729.75	II	
4	3730.74	I	2273–29070
160	3731.26	II	838–27631
120	3735.98	II	2238–28997
60	3737.14	II	
24	3737.48	II	3053–29801
14	3738.27	II	
220	3739.12	II	
	3739.20	II	327–27063
60	3741.29	II	
90	3743.87	II	2689–29391
70	3745.46	I	1490–28181
	3745.60	II	0–26690
36	3747.62	II	2238–28914
12 d	3748.52	I	293–26962
	3748.63	II	2003–28672
6	3750.66	II	
12	3751.57	II	327–26974
1.6	3753.09	II	
12	3754.86	II	1518–28143
60	3755.28	II	2689–29310
60	3756.41	I	812–27426
		II	3499–30113
22	3756.53	II	
90	3757.53	II	
34	3758.45	II	0–26599
50	3758.97	II	
26	3760.04	II	3053–29641
140	3760.69	II	1489–28072
50	3762.59	II	2003–28513
85	3764.37	II	2689–29246
10	3765.43	II	
36	3767.36	II	3910–30446
36	3767.76	II	
10	3770.73	II	5318–31830
6	3771.35	II	
16	3772.64	II	
28 d	3773.33	I	
	3773.42	II	1518–28012
22	3774.29	II	2238–28726
14	3774.68	II	0–26485
7	3777.08	II	
10	3777.84	II	
85	3778.14	II	
10	3779.56	II	5318–31768
50	3780.76	II	
32	3780.93	II	3053–29494
7	3782.42	II	4386–30817
3.5	3782.68	I	
7	3783.06	II	2003–28429
10	3783.36	II	1518–27942
14	3785.35	II	
24	3787.20	II	327–26724
110	3788.12	II	2003–28394
20	3791.28	II	
20	3792.02	II	327–26690

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
120	3793.97	II	838–27188
32	3797.28	II	838–27165
120	3797.73	II	
38	3799.54	II	1518–27830
20	3800.37	II	3499–29805
60	3800.89	II	2238–28540
12	3803.94	I	0–26281
24	3805.63	II	838–27108
2.0	3806.04	II	
14	3806.47	I	4021–30284
10	3806.77	II	3053–29314
14	3807.92	II	0–26254
32	3808.46	II	2689–28939
24	3809.75	II	2689–28930
24	3809.88	II	838–27078
32	3810.43	II	
38	3812.07	II	838–27063
36	3813.63	II	
8	3813.83	I	4021–30234
32	3814.63	II	2238–28445
3.5	3818.36	I	1490–27671
70 d	3820.82		
40	3824.18	II	1489–27631
120	3826.20	II	4386–30514
10	3826.56	II	
18	3828.05	II	
40	3830.29	II	838–26938
85	3831.50	II	3499–29591
8	3832.81	I	2273–28356
40	3833.83	II	2238–28314
42	3834.48	I	4021–30093
42	3834.60	II	
28	3835.72	II	1489–27553
38	3838.94	II	2689–28730
30	3840.45	II	327–26358
6	3840.61	II	
20	3842.36	II	2238–28256
120	3843.50	II	3499–29510
20	3843.77	II	2003–28012
8 h	3844.50	II	1489–27493
5	3846.28	I	
12	3846.76	I	293–26281
40	3847.51	II	2689–28672
48	3848.78	II	
32	3851.88	II	2238–28192
40	3853.30	I	3125–29070
200	3854.21	II	
36	3854.56	I	1490–27426
60	3855.90	II	327–26254
36	3857.91	II	2238–28151
14	3858.52	I	1490–27399
30	3858.74	I	2273–28181
50	3862.05	II	838–26724
26	3862.23	II	2689–28573
14 h	3863.42	II	
11	3864.05	II	
24	3865.24	II	327–26191
6	3865.69	II	3053–28914
60	3871.78	II	1489–27310
10	3873.22	II	3499–29310
14	3873.47	II	
2.0	3874.39	II	
30	3875.19	II	
42	3875.54	II	1489–27285
12	3877.20	II	
18	3877.49	I	4021–29803
60	3880.77	II	838–26599
34	3881.38	II	2689–28445
34	3881.79	II	
24	3882.50	II	
2.0	3883.80	II	2689–28429
280	3885.29	II	3910–29641
18	3885.91	II	4386–30113
5	3887.11	II	
50	3889.16	II	2689–28394
	3889.22	II	
46	3890.08	II	1489–27188
24	3891.21	II	1518–27210
30	3894.05	II	3053–28726
3.5	3895.09	II	
3.5	3895.42	II	
120	3896.98	II	327–25980
3.5	3897.26	II	5318–30969
20	3900.89	II	2003–27631
5	3902.32	II	1489–27108
100	3903.42	II	
4	3906.81	II	1489–27078
6	3909.95	I	3125–28694
6	3910.09	II	2689–28256
3.5	3910.92	II	5318–30880
8	3912.98	II	4386–29935
8	3913.37	II	
6	3913.62	II	
4	3916.36	II	
42	3917.44	II	838–26358
13	3918.62	II	1489–27001
3.5	3920.10	II	
13	3922.05	II	2003–27493
170	3922.40	II	3053–28540
6	3922.70	II	1489–26974

Samarium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
20	3925.22	I	812–26281
130	3928.28	II	1489–26938
2.5	3931.16	II	3499–28930
6	3932.97	II	4386–29805
20	3933.58	II	4386–29801
3.5	3935.18	II	3910–29314
32	3935.76	II	2238–27638
20	3937.06	II	
2.0	3938.43	II	2689–28073
3.5	3939.64	II	838–26214
85	3941.87	II	0–25361
42	3943.24	II	838–26191
34	3946.51	II	1489–26821
20	3947.84	II	2689–28012
50	3948.11	II	838–26160
3.5	3949.85	I	2273–27583
32	3951.89	I	
8	3954.20	II	1489–26772
2.0	3954.97		
3.5	3957.52	II	
8	3958.72	II	2689–27942
25	3959.53	II	
13	3961.80	II	
6	3962.13	I	
6	3962.24	II	3499–28730
100	3963.00	II	
42	3966.04	II	2003–27210
6	3966.34	II	4386–29591
32	3967.68	II	5318–30514
50	3970.53	II	0–25178
100	3971.40	II	3499–28672
13	3974.45	II	
42	3974.66	I	2273–27426
11	3975.22	II	2238–27387
65	3976.27	II	838–25980
70	3976.43	II	2689–27830
65	3979.20	II	4386–29510
3.5	3980.88	II	
50	3983.14	II	3053–28151
10	3986.00	II	1518–26599
2.0	3986.21	II	
50	3986.68	II	1489–26566
10	3986.90	II	
25	3987.43	II	2238–27310
100	3990.00	II	0–25056
	3990.02	I	3125–28181
10	3991.02	I	
50	3993.31	II	327–25361
6	3995.59	II	
13	3998.35	I	
19	4003.46	II	2003–26974
6	4003.72	II	
3.5	4004.26	II	1518–26485
13	4006.60	II	838–25790
6	4006.82	II	2238–27188
32	4007.48	II	3499–28445
10	4008.10	II	2689–27631
10	4008.33	II	
6	4011.73	II	0–24920
4	4015.77	II	3499–28394
8	4019.84	II	2238–27108
19	4019.98	II	1489–26358
6	4022.73	II	327–25178
60	4023.23	II	327–25175
10	4032.98	II	
50	4035.11	II	2689–27464
12	4037.10	II	2238–27001
10	4038.10	II	3499–28256
40	4041.68	II	1518–26254
50	4042.72	II	327–25056
60	4042.90	II	838–25566
16	4044.11	II	
38	4045.05	II	838–25553
30	4046.16	II	838–25546
50	4047.16	II	1489–26191
7	4047.35	II	2238–26938
14	4048.62	II	3499–28192
5	4049.58	II	2003–26690
40	4049.81	II	0–24686
30	4058.87	II	3910–28540
38	4063.54	II	327–24929
19	4064.32	II	
95	4064.58	II	2689–27285
55	4066.74	II	2238–26821
48	4068.33	II	3499–28073
55	4075.84	II	4386–28914
19	4076.65	II	838–25361
6	4076.86	II	327–24848
7	4079.83	I	2273–26777
16	4080.56	II	2689–27188
9	4081.97	II	1489–25980
28	4082.60	II	5318–29805
6	4083.24	II	5318–29801
19	4083.58	II	2003–26485
15	4084.40	II	2689–27165
3.0	4086.16		
2.0	4089.48		
70	4092.27	II	0–24430
3.5	4093.04	II	3499–27924
20	4094.05	II	2689–27108

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	4098.97	II	2689–27078
4	4099.96	I	
16	4104.13	II	327–24686
6	4106.62	II	4386–28730
55	4107.28	II	838–25178
	4107.39	II	4386–28726
4	4107.80	II	838–25175
9	4108.32	II	3053–27387
28	4109.40	II	2238–26566
19	4110.19	II	5318–29641
28	4113.90	II	1489–25790
13	4116.46	II	2689–26974
130	4118.55	II	5318–29591
10	4119.57	II	2238–26506
28	4121.36	II	3053–27310
8	4121.54	II	327–24583
19	4122.51	II	2003–26254
48	4123.96	II	3910–28151
4	4125.23	I	
6	4125.85	II	
2.0	4128.12		
19	4129.23	II	2003–26214
7	4133.19	II	2003–26191
17	4135.14	II	5318–29494
3.0	4135.50	I	1490–25664
3.5	4138.97	II	4386–28540
5	4142.81	II	
5	4145.24	I	
11	4146.75	II	1489–25598
22	4147.71	II	327–24430
55	4149.83	II	838–24929
80	4152.21	II	1489–25566
36	4153.33	II	5318–29388
38	4155.22	II	4386–28445
9	4156.25	II	3499–27553
7	4159.40	II	1518–25553
7	4159.51	II	2689–26724
11	4163.14	II	
7	4163.72	II	838–24848
3.0	4165.54	II	
3.5	4166.34	II	
55	4169.48	II	2003–25980
28	4171.57	II	3499–27464
13	4174.43	II	3053–27001
30	4178.02	II	4386–28314
36	4181.10	II	2689–26599
14	4183.33	I	1490–25387
36	4183.76	II	327–24222
70	4188.13	II	4386–28256
28	4191.93	II	
11	4192.16	II	838–24686
3.0	4197.90	II	1489–25304
18	4199.45	II	4386–28192
1.8	4201.22	II	2689–26485
44	4202.92	II	3910–27696
75	4203.05	II	3499–27285
3.5	4204.82	II	3053–26828
11	4205.78	I	
45	4206.13	II	3053–26821
18	4206.62	II	4386–28151
45	4210.35	II	838–24583
7	4213.05	II	3910–27639
1.8	4213.94	II	
7	4218.63	I	
3.5	4219.31	I	293–23986
12	4220.14	II	3499–27188
50	4220.66	II	4386–28072
10	4223.70	II	2689–26358
3.5	4224.23	II	3499–27165
70	4225.33	II	1518–25178
10	4226.18	I	812–24467
50	4229.70	II	327–23962
3.5	4230.73	I	0–23630
42	4234.57	II	3499–27108
80	4236.74	II	5318–28914
34	4237.66	II	838–24430
3.0	4240.45	I	1490–25065
42	4244.70	II	2238–25790
8	4245.18	II	2003–25553
3.5	4247.39	II	1518–25056
14	4249.55	II	2689–26214
17	4251.78	II	3053–26566
4	4253.72	II	3499–27001
140	4256.39	II	3053–26540
14	4258.58	II	3499–26974
3.5	4259.39	II	2689–26160
85	4262.68	II	3053–26506
34	4265.08	II	1489–24930
8	4266.31	I	812–24245
2.5	4269.77	II	2003–25417
3.5	4270.73	II	1489–24898
10	4270.84	II	5318–28726
3.5	4271.86	I	2273–25676
3.5	4272.01	II	1518–24920
80	4279.68	II	2238–25598
	4279.75	II	1489–24848
16	4279.94	II	2003–25361
6	4280.32	II	838–24194
150	4280.79	II	3910–27263
13	4281.01	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
48	4282.21	I	3125–26471
32	4282.83	I	2273–25616
16	4283.50	I	812–24151
2.5	4284.53	II	
3.5	4285.50	II	2238–25566
24	4286.64	II	3499–26821
2.5	4291.62	II	
24	4292.18	II	2689–25980
4	4295.74	II	3499–26772
110	4296.74	I	4021–27288
6	4299.14	I	293–23547
6	4299.34	II	4386–27639
3.0	4301.28	I	812–24054
22	4304.94	II	5318–28540
60	4309.01	II	1489–24690
16	4312.85	I	2273–25453
12	4313.73	II	2003–25178
5 d	4315.35	II	
	4315.38	II	4386–27553
130	4318.94	II	2238–25385
32	4319.53	I	1490–24634
40	4323.28	II	838–23962
16	4324.46	I	2273–25391
3.0	4327.51	II	2689–25790
120	4329.02	II	1489–24583
30	4330.02	I	293–23381
8	4331.45	I	
90	4334.15	II	2238–25304
60	4336.14	I	3125–26182
3.0	4336.78		
6	4338.96	I	812–23852
2.5	4339.92	I	812–23847
2.5 h	4342.38	II	
38	4345.86	II	838–23842
6	4346.49	II	4386–27387
75	4347.80	II	3053–26046
38	4350.46	II	3910–26889
1.6	4350.82	I	1490–24467
38	4352.10	II	
1.6	4357.90	I	3125–26066
38	4360.72	II	2003–24929
15	4361.07	II	4386–27310
55	4362.04	II	3910–26828
30	4362.91	I	0–22914
15	4363.45	II	1518–24430
1.6	4364.05	II	
3.0	4365.95	I	812–23710
34	4368.03	II	3053–25940
14	4369.92	II	2689–25566
3.0	4370.48	II	5318–28192
30	4373.46	II	3499–26358
22	4374.98	II	327–23177
60	4378.24	II	5318–28151
36	4380.42	I	1490–24312
20	4384.29	II	4386–27188
8	4386.22	I	2273–25065
1.4	4388.99	II	
110	4390.86	II	1489–24257
1.4	4392.60	II	0–22759
14	4393.35	I	1490–24245
20	4397.34	I	812–23547
6	4399.88	II	4386–27108
28	4401.17	I	3125–25840
55 d	4403.06	II	1489–24194
	4403.13	I	2273–24978
28	4403.36	II	1518–24222
2.5	4405.67	II	3499–26191
4	4407.52	II	2003–24686
35	4409.33	II	2689–25361
20	4411.58	I	1490–24151
8	4411.83	I	2238–24898
26	4417.58	II	3910–26540
32	4419.33	I	293–22914
100	4420.53	II	2689–25304
65	4421.14	II	3053–25665
5	4423.38	I	293–22893
200	4424.34	II	3910–26506
2.5	4426.01	II	
12	4427.58	II	2003–24583
5	4427.81	II	2238–24816
32	4429.66	I	812–23381
8	4433.08	I	293–22844
110	4433.88	II	3499–26046
120	4434.32	II	3053–25598
36	4441.81	I	1490–23997
30	4442.28	I	812–23317
7	4442.51	II	
3.5	4443.27	I	2273–24773
48	4444.26	II	
48	4445.15	I	3125–25616
2.5	4445.88		
3.0	4446.96	II	3499–25980
90	4452.73	II	2238–24690
17	4452.95	I	4021–26471
80	4454.63	II	4386–26828
6	4456.11	II	4386–26821
70	4458.52	II	838–23261
17	4459.29	I	812–23231
2.0	4463.90	I	2273–24669
150	4467.34	II	5318–27696

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4469.66	II	
55	4470.89	I	2273–24634
32	4472.43	II	1489–23842
42	4473.02	II	2238–24588
5	4475.18	II	838–23177
3.5	4477.50	I	3125–25453
50	4478.66	II	
8	4480.32	I	0–22314
2.0	4485.57	II	
1.8	4490.02	I	3125–25391
1.6	4495.14	II	2689–24929
25	4499.11	I	1490–23710
25	4499.48	II	2003–24222
4	4501.38	II	2689–24898
16	4503.38	I	293–22492
12	4505.05	II	2003–24194
8	4511.33	I	4021–26182
38	4511.83	II	1489–23647
30	4515.09	II	
2.0	4517.27	II	
60	4519.63	II	4386–26506
4	4522.55	I	1490–23595
30	4523.04	II	327–22429
	4523.18	I	812–22914
44	4523.91	II	3499–25598
4	4527.42	I	812–22893
5	4532.44	I	1490–23547
20	4533.80	I	2273–24324
18	4536.51	II	838–22875
48	4537.95	II	3910–25940
10	4538.53	II	
20	4540.19	II	2238–24257
26	4542.06	II	
55	4543.95	II	2689–24690
7	4544.83	II	2689–24686
2.0	4545.81	II	5318–27310
3.0	4550.03	I	2273–24245
28	4552.66	II	2003–23962
18	4554.45	II	838–22789
6 d	4556.54	II	
	4556.63	I	3125–25065
16	4560.43	II	327–22248
1.2	4561.19	II	3499–25417
4	4564.10	II	0–21904
32	4566.21	II	2689–24583
4	4566.77	I	1490–23381
2.5	4569.58	I	2273–24151
40	4577.69	II	2003–23842
3.0	4578.72	II	
5	4579.09	II	
20	4581.58	I	812–22632
30	4581.73	I	4021–25840
38	4584.83	II	3499–25304
3.0	4589.43	II	
20	4591.82	II	1489–23261
26	4593.54	II	3053–24816
2.5	4594.59	II	
38	4595.29	II	3910–25665
16	4596.74	I	
6	4598.35	II	2689–24430
4	4603.12	II	
15	4604.18	II	327–22040
20	4606.51	II	0–21702
3.0	4606.88	II	
5	4611.25	I	812–22492
5	4613.50	II	2689–24358
20	4615.44	II	4386–26046
32	4615.69	II	1518–23177
2.0	4616.49	II	0–21655
1.0	4620.25	II	
1.6	4624.97	II	10214–31830
2.0	4629.43	I	4021–25616
10	4630.21	II	838–22429
6	4636.26	II	
60	4642.24	II	3053–24588
20	4645.40	I	293–21813
20	4646.68	II	2238–23753
6	4647.53	II	5318–26828
16	4648.16	II	0–21508
26	4649.49	I	812–22314
10	4655.13	II	3910–25385
20	4663.56	I	2273–23710
5	4665.13	II	3499–24929
50	4669.40	II	838–22248
42	4669.65	II	2238–23647
32 d	4670.75	I	1490–22894
	4670.83	I	1490–22893
110	4674.60	II	1489–22875
70	4676.91	II	327–21702
22	4681.55	I	1490–22844
8	4682.69	II	3499–24848
38	4687.18	II	327–21655
38	4688.73	I	2273–23595
4	4689.57	II	327–21645
13	4693.63	II	1489–22789
12	4699.34	II	2689–23962
55	4704.40	II	0–21251
6	4710.64	II	5318–26540
28	4713.06	II	4386–25598
8	4714.62	II	3053–24257

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
13	4715.26	II	838–22040
75	4716.10	I	3125–24324
28	4717.07	I	0–21194
22	4717.72	II	3499–24690
20	4718.33	II	5318–26506
3.0	4718.64	I	3125–24312
28	4719.84	II	327–21508
3.5	4720.12	II	4386–25566
3.0	4721.39	II	2003–23177
13	4726.02	II	2689–23842
80	4728.42	I	1490–22632
5	4741.72	II	3499–24583
48	4745.68	II	838–21904
15	4750.72	I	2273–23317
4	4755.37	II	2238–23261
75	4760.27	I	812–21813
11	4770.20	I	2273–23231
11	4774.15	II	1489–22429
20	4777.85	II	327–21251
7	4781.84	II	3910–24816
60	4783.10	I	293–21194
36	4785.86	I	812–21701
16	4789.96	I	3125–23997
24	4791.58	II	838–21702
1.6 h	4804.90	II	838–21645
44	4815.81	II	1489–22248
9	4816.01	II	3499–24257
13	4829.57	II	3053–23753
4	4833.32	II	8046–28730
8	4834.62	II	3910–24588
3.5	4836.67	II	838–21508
4	4837.65	II	10214–30880
100	4841.70	I	4021–24669
32	4844.21	II	2238–22875
14	4847.76	II	5318–25940
28	4848.32	I	2273–22893
12	4854.36	II	3053–23647
9	4859.55	II	2689–23261
8	4869.98	II	9407–29935
0.8	4873.19	II	
22	4883.77	I	293–20763
75	4883.97	I	3125–23595
1.2	4891.94	II	
8	4893.35	II	4386–24816
3.5	4894.30	II	2003–22429
4	4900.73	II	8046–28445
2.5	4901.90	II	9407–29801
18	4904.97	I	812–21194
65	4910.40	I	2273–22632
36	4913.25	II	5318–25665
1.4	4914.30	II	3499–23842
44	4918.99	I	1490–21813
8	4920.38	II	8679–28997
6	4923.83	II	4386–24690
11	4924.04	I	4021–24324
3.0	4929.56	II	5318–25598
6	4936.03	II	3499–23753
16	4938.10	II	2003–22248
13	4946.32	I	1490–21701
24	4948.63	II	4386–24588
16	4952.37	II	2689–22875
6	4953.03	II	1518–21702
4 d	4955.95	II	
	4956.13	II	13604–33776
24	4961.94	II	3499–23647
6	4964.56	II	1518–21655
8	4972.16	II	7525–27631
5	4973.74	II	2689–22789
24	4975.98	I	0–20091
6	4981.73	II	5318–25385
4	4983.38	II	
5	4989.44	II	2003–22040
10	4992.02	II	8046–28072
6	5001.22	II	1518–21508
6	5016.61	II	7135–27063
8	5023.50	II	2003–21904
20	5028.44	II	12045–31926
4	5031.18	II	12045–31916
55	5044.28	I	1490–21308
6	5049.51	I	293–20091
28	5052.76	II	11094–30880
9	5057.74	II	8679–28445
8	5059.85		
10	5060.93	I	1490–21243
4	5064.24	II	2689–22429
3.0	5066.86	II	11791–31522
24	5069.46	II	10214–29935
75	5071.20	I	
9	5076.69		
8	5079.86	I	
4	5087.08	II	2003–21655
4	5087.65	II	
8	5088.32	I	812–20459
3.0	5088.97	II	12790–32435
24	5100.22	II	12045–31646
	5100.39	I	
36	5103.09	II	9407–28997
20	5104.48	II	8046–27631
19	5116.70	II	7525–27063
70	5117.16	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
48	5122.14	I	3125–22643
7	5124.86	II	
5	5132.21	I	
5	5135.86	I	
8	5154.23	II	
50	5155.03	II	8679–28072
8	5155.86	I	
9	5157.07	II	10960–30346
	5157.23	I	293–19677
4	5162.86		
3.0	5164.62		
11	5166.06	II	11094–30446
7	5168.35	I	
7	5169.57	II	
34	5172.74	I	2273–21600
65	5175.42	I	
10 h	5178.01	II	
6	5187.09	I	1490–20763
6	5194.73	I	
34	5200.59	I	1490–20713
4	5201.45	I	
8	5202.73	II	2689–21904
8	5209.92	I	
8	5218.40	I	
4	5221.12	I	
8 h	5228.80	I	
6 h	5234.18	II	
4 h	5237.58	I	
36	5251.92	I	2273–21308
5	5252.77	II	8046–27078
3.0	5253.80	I	
3.5	5265.67	I	0–18986
55	5271.40	I	812–19777
3.5	5272.82	II	
34	5282.91	I	1490–20413
3.5 h	5289.94	I	
5	5294.65	I	
5	5303.23	I	
3.0	5309.50	I	
5	5312.23	II	2689–21508
3.0	5313.76	I	
26	5320.60	I	2273–21063
2.5 h	5321.82	I	
3.0 hd	5324.99	I	
2.5	5332.09	I	
15	5341.29	I	293–19010
4	5348.08	I	293–18986
6	5348.74	I	
5	5349.14	I	812–19501
6	5350.62	I	
5 h	5355.88	I	
3.0	5364.39	II	
20	5368.36	I	4021–22643
2.0	5369.18	II	
3.0	5370.06	I	
2.0 h	5378.09	I	
5	5387.97	I	
3.0	5389.85	I	
3.0	5392.69	I	
4	5394.48	II	
13	5403.70	I	1490–19990
18	5405.23	I	293–18788
8	5411.39	I	3125–21600
5	5415.98	II	
1.2	5419.07	I	
6	5421.57	I	2273–20713
2.5	5425.63	I	
2.5	5433.55	I	
2.5	5433.82	I	812–19210
4	5436.33	I	
30	5453.00	I	3125–21459
2.5	5461.55	I	
19	5466.72	I	1490–19777
3.5	5478.29	II	10181–28429
9	5485.42	I	0–18225
32	5493.72	I	812–19010
11	5498.21	I	293–18475
4	5511.09	I	2273–20413
11	5512.10	I	812–18949
32	5516.09	I	2273–20397
1.4	5525.61	I	
4	5537.07	II	13466–31522
7	5548.95	I	
20	5550.40	I	1490–19501
2.0	5561.37	I	812–18788
6	5573.42	I	3125–21063
4	5574.89	I	293–18225
5	5588.20	I	2273–20163
7	5600.86	II	11791–29641
7	5621.79	I	293–18076
10	5626.01	I	0–17770
2.0	5637.30	II	
12	5644.10	I	
3.0	5656.34	I	
20	5659.86	I	812–18475
1.2	5661.54	II	
3.0	5663.91	I	
4	5686.84		
2.0	5686.98	I	4021–21600
1.2	5692.05	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.0		5696.24		
16		5696.73	I	
12		5706.20	I	1490–19010
3.0		5706.75	I	
3.0		5709.73	I	
5		5710.93	I	
2.0		5711.45	I	2273–19777
4		5717.92	I	
2.0		5719.16		
4		5720.19	I	293–17770
3.0		5721.38		
1.6		5724.45	I	
2.0		5729.30	I	
1.4		5730.13		
7		5732.95	I	4021–21459
3.0		5736.84	I	
4		5738.01	II	14504–31926
3.0		5740.89	I	
1.4		5741.19	I	812–18225
7		5743.35	II	14115–31522
1.2		5745.50	I	
4		5748.09	I	
3.0		5757.97	I	
6		5759.52	II	12988–30346
4		5763.91	I	
10		5773.77	I	
8		5778.33	I	
6		5779.24	I	1490–18788
6		5781.93	II	
10	d	5786.98	II	13604–30880
		5787.15	I	
2.0		5787.53	I	
8		5788.38	I	3125–20397
8		5800.52	I	
2.0		5801.24	I	
1.2	h	5801.66	II	10960–28192
9		5802.84	I	2273–19501
2.0		5806.77	I	
6		5814.89	I	
1.6		5816.34	I	
1.8		5818.32	I	
2.5		5820.68	II	
4		5830.51	I	
6		5831.02	II	12790–29935
3.0	h	5831.74	II	14504–31646
6		5836.37	II	8046–25175
3.0		5842.60	II	8679–25790
3.0		5843.76	I	
3.0		5848.67	II	12842–29935
2.0		5860.42	II	7135–24194
5		5860.78	I	3125–20183
9		5867.79	I	3125–20163
6		5868.61	I	4021–21056
5		5871.06	I	3125–20153
7		5874.21	I	812–17831
1.2		5875.10	I	
1.8		5875.92	I	1490–18503
1.8		5878.11	II	10181–27188
3.5		5891.41	I	
3.0		5895.16	I	
6		5897.39	II	12045–28997
7		5898.96	I	
4		5902.60	I	2273–19210
4		5903.50	II	
2.5		5906.05	I	1490–18417
3.0		5909.04	I	
1.2		5910.83	I	
4		5912.61	I	
3.0		5913.56	I	
2.0		5915.56	I	
2.0		5916.36	I	293–17190
3.0		5919.33	II	
3.0		5921.01	I	
3.0		5923.34	I	
3.0		5924.66	I	
3.5		5932.18	I	
3.5		5932.90	II	12790–29641
5		5938.90	II	7525–24358
3.0		5942.33	I	
3.5		5946.37	I	
3.5	h	5955.82	II	
3.5		5956.76	I	
3.0		5957.52	II	9410–26191
3.5		5960.09	I	
3.5		5963.22	II	12232–28997
9		5965.71	II	10874–27631
5	h	5968.82	II	11791–28540
1.8		5969.49	I	
3.5		5979.38	I	1490–18210
5		5984.29	I	
1.8	h	5993.85		
3.5		5994.64	II	11395–28072
4.0		5995.09	I	2273–18949
3.0		6001.94	I	
3.0		6004.18	I	812–17462
3.5		6011.22	II	11799–28429
1.6		6016.80	I	
2.5		6017.39	II	10214–26828
3.5		6027.16	I	3125–19712
		6027.52	I	1490–18076

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.5		6033.23	II	9410–25980
4		6041.40	I	
2.5		6042.84	I	
7		6045.00	I	2273–18811
6		6045.39	I	
1.2	h	6053.88	I	
1.6		6067.78	II	
7		6070.06	I	1490–17959
1.6	h	6075.72	I	
6		6084.12	I	812–17244
1.6		6088.62	I	
5	h	6091.40	I	
2.0		6096.78	I	
2.0	h	6099.90	I	293–16682
2.5		6101.96		
3.0		6103.37		
6		6110.66	II	11791–28151
1.6	h	6112.98	I	
2.5		6114.58	II	10960–27310
3.0		6114.73	I	
2.5		6122.75	I	
3.0		6123.60	II	10214–26540
2.0		6124.88	II	12988–29310
2.0		6126.33	I	
1.6		6130.62	I	
3.0		6135.85	I	
2.5		6138.05	I	
2.5		6139.33	I	
3.0		6140.60	I	
2.5		6143.09	I	
1.6		6143.59	I	
4		6149.10	II	12988–29246
2.0		6156.90	II	
2.0	h	6157.55	II	11395–27631
6	h	6159.56	I	2273–18503
3.0		6160.42	II	10960–27188
1.6		6164.51	II	
2.5		6165.84	I	
1.6	h	6168.33	II	12790–28997
2.5		6173.95	I	
2.5		6174.45	I	812–17003
2.5		6174.96	II	
2.5		6179.41	I	
3.0	h	6179.82	II	10181–26358
2.5		6181.05	II	13466–29641
4	h	6182.89	II	11094–27263
3.0		6188.00	II	9410–25566
4		6192.64		
2.5		6194.39	I	3125–19265
1.4		6198.14	II	
2.5		6201.13	I	
3.5		6203.86	I	
3.0		6206.87	I	
1.4		6207.13	I	
2.5		6217.17		
1.4		6225.48		
2.5		6226.70	I	2273–18329
4		6237.66	II	12045–28072
2.5		6238.30	I	
3.5	h	6244.21	II	8679–24690
6		6246.76	II	8579–24583
2.0		6248.11	I	
6		6256.54	I	
6		6256.66	II	9407–25385
14		6267.28	II	9410–25361
1.4		6279.49		
3.5		6289.90	II	9410–25304
7		6291.82	II	11395–27285
2.0		6292.94	I	
4		6294.68	II	
3.0		6301.12	II	10181–26046
2.5		6302.40	II	12567–28429
4		6303.15	II	
1.8		6305.19	II	
5		6307.06	II	8579–24430
1.8		6315.78	II	
3.5		6321.75	II	
1.8		6322.51	I	
2.5		6325.54	II	
10		6327.47	II	10181–25980
1.8		6328.01	I	
3.5		6340.10	I	
3.0		6353.54		
1.8		6355.35	I	
4		6357.18		
2.0		6367.41	I	1490–17190
3.0		6368.28	II	12842–28540
0.8		6371.01	I	4021–19712
0.7		6380.05	I	
2.0	h	6386.77	I	
4		6389.85	II	9410–25056
3.5		6390.81	II	8579–24222
1.2	h	6403.98		
1.6	h	6406.24	II	10960–26566
4		6417.50	II	8679–24257
6		6426.64	II	14085–29641
3.0		6428.32	II	
1.4		6428.94	I	
3.0		6431.00	II	10960–26506
1.4		6431.96	II	11395–26938

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.4		6435.34	I	
1.0		6447.56		
1.6		6452.08	I	
2.0		6455.60	II	11799–27285
1.4		6456.25	II	
1.4		6457.55	I	
0.6		6459.36	I	
2.5	h	6470.46	II	10214–25665
1.4		6471.59	I	
6		6472.34	II	11094–26540
5		6484.52	II	10181–25598
4		6487.62	II	9407–24816
4		6490.82	II	12790–28192
5		6498.67	II	8579–23962
1.2		6502.00	II	12567–27942
1.8	h	6507.70		
4	hl	6509.44	I	o 293–15651
1.8	h	6526.64	II	
2.5	h	6528.02	I	2273–17587
2.5	h	6529.70	I	
2.5	h	6532.25	I	812–16116
		6533.96	I	812–16112
7		6542.76	II	11799–27078
2.5		6544.57	II	9410–24686
2.5	h	6549.77	II	8579–23842
1.8	h	6551.80	I	1490–16748
20		6569.31	II	12045–27263
5	h	6570.67	II	8046–23261
4		6574.38	II	
6	h	6585.21	II	9407–24588
1.0	h	6587.54	I	
4		6588.91	I	3125–18298
16		6589.72	II	10214–25385
1.8		6591.50		
6		6601.83	II	12045–27188
14		6604.56	II	14504–29640
1.6		6617.61	II	
0.9		6625.28	II	
3.0	h	6628.88	II	
2.0	h	6630.61	II	12232–27310
6	h	6632.28	II	8679–23753
1.8	h	6646.22	I	
3.0	h	6649.02	II	
3.0		6651.61	II	11791–26821
4		6656.19	II	9410–24430
2.5	h	6667.22	II	10181–25175
7		6671.51	I	4021–19006
10		6679.21	II	8679–23647
2.5	h	6681.53	II	11395–26358
2.5	h	6687.79	II	
10		6693.55	II	13604–28540
1.6	h	6694.69	II	12232–27165
2.0		6703.61	I	17655–32568
3.0	h	6707.45	II	7525–22429
2.0		6712.62	II	12045–26938
6	d	6723.07	I	
		6723.26	I	
4		6724.73	I	16859–31726
3.0		6725.88	I	0–14864
17	d	6731.84	II	9407–24257
10	d	6734.06	II	11094–25940
6	d	6734.81	II	12045–26889
8		6741.47	II	8046–22875
2.5	h	6754.68	II	11799–26599
		6754.85	I	
2.5		6759.25	I	4021–18811
2.0		6766.52	II	11791–26566
3.0		6778.19	II	11791–26540
6	h	6778.61	II	10181–24929
2.0	h	6780.03	II	
2.5	h	6781.17	II	8046–22789
3.0		6782.95	II	
9		6790.00	II	7525–22248
2.0	h	6792.55	II	12567–27285
14		6794.20	II	11791–26506
3.0	h	6802.96	I	812–15507
		6803.1	I	
1.4		6807.50	I	
3.0	h	6808.31	I	15507–30191
1.2		6813.4	II	
2.0	h	6820.91	I	14380–29037
4		6829.86	II	10960–25598
2.5		6830.54	I	14916–29552
1.8	h	6837.20		
2.5		6838.33	I	
1.4	h	6839.64	II	
3.0	h	6841.75	I	15579–30191
8		6844.71	II	10960–25566
4	d	6846.54	II	10214–24816
2.0		6848.16	II	12567–27165
		6848.31	I	
1.4	h	6853.54	I	
2.0	h	6854.50	II	11395–25980
11		6856.03	II	8679–23261
1.4	h	6858.12	I	16345–30922
17		6860.93	I	293–14864
		6861.10	II	11094–25665
6		6862.82	II	7135–21702
1.2		6867.11	I	
4	h	6872.43	II	13604–28151

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.4	h	6875.27	II	12567–27108
1.8	h	6877.10	II	
2.0		6879.50	I	17194–31726
4	h	6885.16	II	12790–27310
2.5	h	6887.42	II	
1.4		6900.28	II	10874–25361
1.4		6904.51	II	
2.5		6906.22	I	
2.0		6909.81	II	12842–27310
2.0	d	6918.78	I	
		6919.03	I	18119–32568
2.5		6927.03	II	9410–23842
1.8		6929.60	II	
2.5		6930.41	II	10960–25385
2.5		6941.56	II	10181–24583
1.8		6949.23	II	
5		6950.51	II	8046–22429
18		6955.29	II	10214–24588
1.4		6958.97	II	
2.5		6968.65	II	9407–23753
2.0		6984.16	II	
2.0		6988.36	I	
2.0		6993.40	II	
14		7020.44	II	9407–23647
2.0		7036.73	II	
14		7039.22	II	8046–22248
14		7042.24	II	8679–22875
2.0		7049.15	II	
14		7051.52	II	7525–21702
2.5		7054.97	II	11395–25566
3.0		7074.67	I	
14		7082.37	II	7135–21251
6	d	7085.52	II	8679–22789
4		7088.30	I	812–14916
2.5		7091.16	I	4021–18119
5		7095.50	I	1490–15579
2.5		7096.33	I	293–14380
5		7104.54	I	2273–16345
3.0		7106.23	I	3125–17194
4		7115.96	I	
3.5		7117.51	II	
4	h	7119.81	II	
1.8		7122.40	II	14115–28151
3.5	h	7125.11	II	12790–26821
2.0		7131.80	I	1490–15507
1.6		7136.01	I	
1.8		7139.39	II	
6	d	7143.98	II	8046–22040
13	d	7149.60	II	7525–21508
1.6		7172.67	I	2273–16211
1.6		7189.57	II	
1.4		7210.95	I	
3.5		7213.82	I	2273–16132
4	d	7218.09	II	8579–22429
2.0		7220.07	I	16345–30191
2.0		7237.02	II	12232–26046
9		7240.90	II	11791–25598
1.4		7257.11	II	12790–26566
1.4	d	7261.45	II	9410–23177
2.0		7279.25	I	3125–16859
4		7281.47	II	10960–24690
1.2		7282.21	I	17194–30922
3.0		7283.33	II	
2.5		7288.92	II	12790–26506
2.0		7290.23	I	
4	h	7300.72	II	
2.0		7327.08	II	
2.0		7332.65	I	4021–17655
1.2		7338.04	I	
4		7347.30	I	18119–31726
4		7376.69	II	12045–25598
2.0		7393.98	II	
5		7444.56	I	
4		7445.41	I	
4	d	7453.03	II	12567–25980
2.0		7470.76	I	
4		7481.99	II	13466–26828
3.5	h	7502.39	II	8579–21904
1.6	h	7517.00	II	
3.5	h	7541.42	II	12790–26046
1.4		7544.74	I	
1.6		7546.57	I	
1.8	h	7560.15	II	13604–26828
3.0		7562.94	II	
3.5		7570.95	II	12842–26046
3.5		7572.29	II	
3.0		7578.09	II	14504–27696
5		7585.77	II	14085–27263
3.5		7588.31	II	
1.6		7598.01	I	
3.5	d	7607.48	II	
		7607.74	I	15567–28708
1.8		7613.94	II	11799–24929
1.6	h	7631.77	II	11799–24898
3.5		7637.94	II	10874–23962
7		7645.09	II	8579–21655
1.8		7645.82	I	
3.0		7648.02	II	12232–25304
1.6		7655.78	II	12988–26046
3.0		7667.20	II	13466–26506

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.2		7672.49	II	
1.6	h	7678.79	II	9410–22429
1.6	h	7695.78	I	
3.5		7712.04	II	14115–27078
5		7728.56	II	13604–26540
5		7736.26	II	
5		7749.30	II	13604–26506
3.5		7755.20	II	11799–24690
1.6		7794.50	I	16211–29037
1.6		7801.54	I	19753–32568
1.2	h	7812.75	II	
2.5		7820.15	II	11799–24583
1.6		7831.40	II	
6	w	7835.08	II	14504–27263
4		7837.27	II	12842–25598
1.6		7844.82	II	14085–26828
1.0		7859.53	I	19006–31726
3.0		7863.65	II	14115–26828
1.6	h	7880.07	II	10960–23647
2.5		7895.96	I	16891–29552
4		7914.96	II	11799–24430
14		7928.14	II	12988–25598
1.4		7931.92	I	17587–30191
3.0		7937.09	II	12790–25385
2.5		7948.12	II	12988–25566
3.0	w	8001.61	II	9410–21904
3.0	w	8014.92	II	13466–25940
3.5		8025.12	II	12232–24690
3.5	w	8026.32	II	14085–26540
2.5		8032.03	II	11395–23842
6		8048.70	II	14085–26506
2.5		8065.16	I	
7		8068.46	II	14115–26506
1.4	w	8117.16	II	12988–25304
1.4		8125.12	II	10874–23177
4		8161.90	II	10181–22429
3.0	w	8195.50	II	13466–25665
1.0		8206.30	II	
4	w	8218.76	II	11799–23962
1.4		8230.33	I	
2.5		8240.98	II	13466–25598
3.0	w	8289.26	II	13604–25665
1.6		8300.88	II	11799–23842
6	w	8305.79	II	14504–26540
1.6		8315.45	I	
3.0	w	8348.68	II	12842–24816
3.0		8383.71	I	
3.0		8387.77	II	13466–25385
5	w	8432.64	II	14085–25940
3.0	w	8473.54	II	12790–24588
7	w	8485.99	II	13604–25385
5	w	8510.90	II	12842–24588
3.5		8543.22	II	12988–24690
3.5	w	8617.03	II	12045–23647
3.5	w	8632.82	II	14085–25665
1.8	w	8677.93	II	
2.0		8706.32	II	14115–25598
7	w	8708.43	II	11395–22875
5	w	8717.89	II	12790–24257
5	w	8758.28	II	12232–23647
2.5	w	8780.59		
3.5	w	8788.83	II	10874–22248
4		8859.76		
15		8913.66	II	12045–23261

609065 O - 62 - 21

SCANDIUM

Sc, $Z=21$, $M=44.96$, Ratio $\frac{Sc}{Cu}=0.708$

Sc I Normal state of valence electrons $3d^1\,4s^2\,{}^2D_{1½}=0$. I.P.= 52920 K
Sc II Normal state of valence electrons $3d^1\,4s^1\,{}^3D_1=0$. I.P.=103240 K

References

Wavelengths:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden, (Specola Vaticana, Vatican, 1945), below 7000 A.

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), above 7000 A.

The last five lines in the table are new.

Classification:

Sc I and Sc II, H. N. Russell and W. F. Meggers, Sci. Papers NBS **22,** 329 (1927).

Molecular Spectra:

ScO, W. F. Meggers and J. A. Wheeler, J. Research NBS **6,** 239 (1931).

Intensities:

Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroskopiya **3,** 391 (1957).

Relative intensity of scandium lines observed in an arc of copper containing 0.1 atomic percent of scandium

Strong lines of scandium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2500	3613. 84	II	178–27841	$3d^14s^1\ a\ {}^3D_3 - 3d^14p^1\ z\ {}^3F^0_4$
2100	3911. 81	I	168–25725	$3d^14s^2\ a\ {}^2D_{2½} - 3d^14s^14p^1\ y\ {}^2F^0_{3½}$
1800	3630. 75	II	68–27602	$3d^14s^1\ a\ {}^3D_2 - 3d^14p^1\ z\ {}^3F^0_3$
1800	3907. 49	I	0–25585	$3d^14s^2\ a\ {}^2D_{1½} - 3d^14s^14p^1\ y\ {}^2F^0_{2½}$
1800	4020. 40	I	0–24866	$3d^14s^2\ a\ {}^2D_{1½} - 3d^14s^14p^1\ y\ {}^2D^0_{1½}$
1800	4023. 69	I	168–25014	$3d^14s^2\ a\ {}^2D_{2½} - 3d^14s^14p^1\ y\ {}^2D^0_{2½}$
1400	4246. 83	II	2541–26081	$3d^14s^1\ a\ {}^1D_2 - 3d^14p^1\ z\ {}^1D^0_2$
1200	3572. 53	II	178–28161	$3d^14s^1\ a\ {}^3D_3 - 3d^14p^1\ z\ {}^3D^0_3$
1200	3642. 79	II	0–27444	$3d^14s^1\ a\ {}^3D_1 - 3d^14p^1\ z\ {}^3F^0_2$
900	3353. 73	II	2541–32350	$3d^14s^1\ a\ {}^1D_2 - 3d^14p^1\ z\ {}^1F^0_3$
900	3576. 35	II	68–28021	$3d^14s^1\ a\ {}^3D_2 - 3d^14p^1\ z\ {}^3D^0_2$
700	3580. 94	II	0–27918	$3d^14s^1\ a\ {}^3D_1 - 3d^14p^1\ z\ {}^3D^0_1$
600	3372. 15	II	178–29824	$3d^14s^1\ a\ {}^3D_3 - 3d^14p^1\ z\ {}^3P^0_2$
600	3558. 55	II	68–28161	$3d^14s^1\ a\ {}^3D_2 - 3d^14p^1\ z\ {}^3D^0_3$
600	3645. 31	II	178–27602	$3d^14s^1\ a\ {}^3D_3 - 3d^14p^1\ z\ {}^3F^0_3$

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
4		2429.16		
7		2438.62		
42		2545.22	II	68–39345
220		2552.37	II	178–39345
42		2555.82	II	0–39114
170		2560.25	II	68–39114
85		2563.21	II	0–39002
3.0		2611.22	II	26081–64366
1.4		2684.23	II	39345–76588
10		2692.78	I	0–37126
5		2699.11	III	25537–62576
30		2706.77	I	0–36934
17		2707.95	I	168–37086
48		2711.35	I	168–37040
2.5		2819.54	II	27918–63374
3.0		2822.15	II	28021–63444
5		2826.68	II	28161–63528
28		2965.86	I	0–33707
100		2974.01	I	0–33615
120		2980.75	I	168–33707
28		2988.95	I	168–33615
180		3015.36	I	0–33154
220		3019.34	I	168–33279
30		3030.76	I	168–33154
2.5		3039.93	II	32350–65236
6		3045.72	II	27444–60267
7		3052.93	II	27602–60348
10	h	3056.31		
11		3065.11	II	27841–60457
4		3139.75	II	28161–60002
90		3251.32	II	68–30816
140		3255.69	I	0–30707
400		3269.91	I	0–30573
500		3273.63	I	168–30707
10	d	3343.28	II	27841–57743
24		3352.05	II	0–29824
900		3353.73	II	2541–32350
6	d	3357.30		
180		3359.68	II	68–29824
150		3361.27	II	0–29742
150		3361.94	II	0–29736
360		3368.95	II	68–29742
600		3372.15	II	178–29824
8		3416.68	I	15757–45016
12		3418.51	I	15882–45126
6		3419.36	I	15673–44910
18		3429.21	I	15757–44910
18		3429.48	I	15673–44823
24		3431.36	I	15882–45016
48		3435.56	I	16027–45126
8		3439.41	I	15757–44823
6		3440.18		
6		3448.49	I	16027–45016
24		3457.45	I	16211–45126
16		3462.19	I	16141–45016
12	d	3469.65	I	16010–44823
10		3471.13	I	16022–44823
18		3498.91	I	16027–44599
240		3535.73	II	2541–30816
600		3558.55	II	68–28161
550		3567.70	II	0–28021
1200		3572.53	II	178–28161
900		3576.35	II	68–28021
700		3580.94	II	0–27918
360		3589.64	II	68–27918
360		3590.48	II	178–28021
2500		3613.84	II	178–27841
10		3617.43		
1800		3630.75	II	68–27602
1200		3642.79	II	0–27444
600		3645.31	II	178–27602
10		3646.90		
480		3651.80	II	68–27444
10		3664.25	II	2541–29824
26		3666.54	II	178–27444
5		3675.26	II	2541–29742
3.5		3678.35	II	32350–59528
7	h	3717.10		
24		3833.07	II	0–26081
55		3843.03	II	68–26081
8		3894.97		
1800		3907.49	I	0–25585
2100		3911.81	I	168–25725
4		3923.51	II	2541–28021
400		3933.38	I	168–25585
4		3952.27		
4		3989.06	II	2541–27602
500		3996.61	I	0–25014
48		4014.49	II	2541–27444
1800		4020.40	I	0–24866
1800		4023.69	I	168–25014
20		4030.67	I	16023–40826
13		4031.39	I	15757–40555
9		4034.23	I	16022–40803
20		4043.80	I	15882–40604
18		4046.48	I	16097–40803
240		4047.79	I	168–24866
11		4049.95	I	16141–40826
500		4054.55	I	0–24657
20		4056.59	I	16027–40671

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
14 h	4074.97	I	16022–40555
14	4078.57	I	16010–40521
550	4082.40	I	168–24657
18	4086.67	I	16141–40604
36	4087.16	I	16211–40671
3.5 h	4093.13	I	16097–40521
6	4094.85	I	16141–40555
5 h	4098.35	I	16211–40604
6	4100.33	I	15042–39424
40 h	4133.00	I	15673–39861
48 h	4140.30	I	15757–39903
6 h	4147.40	I	15757–39861
65	4152.36	I	15882–39958
5 h	4154.72		
8 hd	4161.88	I	15882–39903
100 h	4165.19	I	16027–40028
6 h	4171.56	I	15757–39722
4 h	4186.45		
6 h	4187.62	I	15882–39755
7	4205.20	I	16027–39800
6	4212.34	I	16022–39755
4	4212.49	I	16023–39755
7 h	4216.10	I	16010–39722
10 h	4218.26	I	16022–39722
10 h	4219.73	I	16010–39701
3.5	4221.88	I	16022–39701
8 d	4225.59	I	16141–39800
16	4231.93		
18	4233.61	I	16141–39755
9	4237.82		
36	4238.05	I	16211–39800
8	4239.57	I	16141–39722
9	4246.12	I	16211–39755
1400	4246.83	II	2541–26081
5	4283.56		
26	4294.77	II	4883–28161
32	4305.71	II	4803–28021
380	4314.09	II	4988–28161
300	4320.74	II	4883–28021
220	4325.01	II	4803–27918
2.5	4348.53	I	15882–38872
16	4354.61	II	4883–27841
10	4358.64	I	16023–38959
5	4359.08		
2.5	4364.92		
180	4374.46	II	4988–27841
12	4384.81	II	4803–27602
4 h	4389.60	I	16097–38872
100	4400.37	II	4883–27602
80	4415.56	II	4803–27444
2.5	4420.66	II	4988–27602
4	4431.36	II	4883–27444
6	4542.55	I	14926–36934
8	4544.68	I	15042–37040
11 h	4557.24	I	21400–43337
14 h	4573.99	I	21480–43337
6 h	4592.94	I	21400–43167
6 h	4598.45	I	21480–43221
5 h	4604.72		
4	4609.53		
4	4609.95	I	21480–43167
36	4670.40	II	10945–32350
4 h	4680.49		
5	4698.29	II	4803–26081
12	4706.97	I	18516–39755
12	4709.34	I	18571–39800
20	4728.77	I	11610–32752
50	4729.23	I	11558–32697
4 h	4732.30	I	16023–37148
60	4734.10	I	11520–32637
6	4735.08		
70	4737.65	I	11558–32659
80	4741.02	I	11610–32697
120	4743.81	I	11677–32752
20	4753.16	I	0–21033
22	4779.35	I	168–21086
9	4791.50	I	168–21033
10	4827.28	I	17948–38658
10	4833.67	I	17919–38602
17	4839.44	I	18000–38658
4	4840.47	I	17948–38602
8	4847.68	I	17948–38571
8	4852.68	I	18000–38602
14 ld	4857.79	ScO	
	4858.09	ScO	
8	4906.67	I	16141–36516
9	4909.76	I	16211–36573
10	4922.84	I	16023–36330
10	4934.25	I	17919–38180
5	4935.74	I	16022–36277
8	4941.33	I	17948–38180
19	4954.06	I	18000–38180
14	4973.66	I	17025–37126
17	4980.37	I	17013–37086
9	4983.45	I	17025–37086
16	4991.92	I	17013–37040
9	5018.39	I	17013–36934
8	5020.14		
9	5021.51	I	17025–36934
60	5031.02	II	10945–30816

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		5032.74		
28		5064.32	I	11610–31351
9		5068.86	II	16023–35746
60		5070.23	I	11558–31275
28		5075.81	I	11520–31216
240		5081.56	I	11677–31351
140		5083.72	I	11610–31275
120		5085.55	I	11558–31216
85		5086.95	I	11520–31173
44		5087.14	I	20237–39889
30		5089.89	I	20240–39881
5		5092.46		
44		5096.73	I	11558–31173
70		5099.23	I	11610–31216
42		5101.12	I	11677–31275
20		5109.06		
17		5112.86		
36		5116.69		
8	b	5133.68	ScO	
5	b	5171.06	ScO	
44		5210.52	I	20237–39424
5		5211.28		
32		5219.67	I	20240–39392
40		5239.82	II	11736–30816
32		5258.33	I	20237–39249
4		5284.97	I	20237–39153
24		5285.76	I	20240–39153
4		5301.94	I	0–18856
2.5		5318.35	II	10945–29742
8		5331.77	I	15673–34423
1.6		5334.23	II	12074–30816
11		5339.41	I	15757–34480
14		5341.05	I	15673–34390
11		5342.96	I	0–18711
40		5349.30	I	14926–33615
13		5349.71	I	168–18856
7		5350.30	I	15882–34567
24		5355.75	I	15757–34423
60		5356.10	I	15042–33707
1.6		5357.19	II	12154–30816
30		5375.35	I	15882–34480
42		5392.08	I	16027–34567
5		5416.12	I	16022–34480
5		5425.57	I	16141–34567
5		5429.41	I	16010–34423
4		5432.94	I	16022–34423
6		5433.23	I	16023–34423
5		5438.22	I	16097–34480
6		5439.03	I	16010–34390
6	h	5442.60	I	16022–34390
30		5446.20	I	16211–34567
2.0		5447.39	I	14926–33279
13		5451.34	I	16141–34480
3.5		5455.21	I	16097–34423
2.0		5465.20	I	18856–37148
6		5468.40	I	16141–34423
7		5472.19	I	16211–34480
2.0		5474.64		
85		5481.99	I	15042–33279
60		5484.62	I	14926–33154
65		5514.22	I	14926–33056
1.8		5515.39	I	15673–33799
75		5520.50	I	15042–33151
5		5526.06	I	15673–33764
75		5526.82	II	14261–32350
6		5541.04	I	15757–33799
3.5		5546.40	I	15882–33906
2.0		5550.40	I	18504–36516
0.6		5552.25	II	11736–29742
4		5553.59	I	18571–36573
1.8		5561.10	I	18516–36493
8		5564.86	I	15882–33847
2.0		5571.24	I	18571–36516
1.6		5579.76	I	15882–33799
12		5591.33	I	16027–33906
4	h	5593.38	I	21086–38959
2.5		5604.19	I	21033–38872
2.5		5631.02	I	16010–33764
9		5640.98	II	12101–29824
5.0		5646.36	I	16141–33847
1.8		5647.60	I	16097–33799
6		5649.56	I	16211–33906
28		5657.88	II	12154–29824
7		5658.34	II	12074–29742
6		5667.16	II	12101–29742
8		5669.04	II	12101–29736
170		5671.81	I	11677–29304
11		5684.20	II	12154–29742
140		5686.84	I	11610–29190
120		5700.21	I	11558–29096
22		5708.61	I	11677–29190
100		5711.75	I	11520–29023
26		5717.28	I	11610–29096
20		5724.08	I	11558–29023
6	bl	5736.85	ScO	
6	bl	5764.45	ScO	
11	bl	5772.74	ScO	
6	bl	5775.32	ScO	
8	bl	5809.84	ScO	
8	bl	5811.60	ScO	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
11 bl	5847.73	ScO	
8 bl	5849.07	ScO	
8 b	5887.38	ScO	
4 bl	5918.04	ScO	
3.5	5919.11	I	18856-35746
7 bl	5928.10	ScO	
4	5961.49	I	21086-37856
7 bl	5968.25	ScO	
4	5969.19	I	21033-37781
10	5988.42	I	17013-33707
18 bl	6017.07	ScO	
7	6026.18	I	17025-33615
70 bl	6036.17	ScO	
55 bl	6064.31	ScO	
50 bl	6072.65	ScO	
70 bl	6079.30	ScO	
36 bl	6101.87	ScO	
42 bl	6109.93	ScO	
42 bl	6115.97	ScO	
20 b	6148.70	ScO	
17 b	6153.93	ScO	
17 b	6188.09	ScO	
17 b	6192.90	ScO	
70	6210.68	I	0-16097
10	6239.41	I	0-16023
36	6239.78	I	0-16022
14	6245.63	II	12154-28161
12	6249.96	I	18571-34567
28	6258.96	I	168-16141
7	6262.25	I	18516-34480
6	6276.31	I	168-16097
5	6279.76	II	12101-28021
2.0	6300.70	II	12154-28021
85	6305.67	I	168-16023
3.0	6309.90	II	12074-27918
1.8	6320.85	II	12101-27918
3.0	6344.83	I	0-15757
7	6378.82	I	0-15673
6 bl	6408.41	ScO	
10	6413.35	I	168-15757
3.0 b	6437.08	ScO	
6 bl	6446.24	ScO	
3.0 b	6457.78	ScO	
4 b	6485.40	ScO	
3.0 b	6495.90	ScO	
6 b	6525.62	ScO	
2.5 b	6535.30	ScO	
5 b	6557.84	ScO	
4 b	6566.88	ScO	
2 b	6575.85	ScO	
7	6604.60	II	10945-26081
3.0 bl	6609.99	ScO	
2.0 bl	6617.94	ScO	
2.0 bl	6645.08	ScO	
2.5 bl	6654.42	ScO	
3.0 bl	6661.01	ScO	
2.0 b	6700.48	ScO	
2.0 b	6705.93	ScO	
8	6737.87	I	
4	6739.40		
4	6817.08	I	
6	6819.52	I	21086-35746
3.5	6829.54	I	21033-35671
6	6835.03	I	
0.7 b	6963.12	ScO	
0.7 bl	6990.68	ScO	
0.6 bl	7025.72	ScO	
1.0 b	7035.77	ScO	
0.6 b	7072.37	ScO	
0.6 b	7094.38	ScO	
1.6 h	7138.14	I	24866-38872
1.8	7169.13	I	25014-38959
1.6	7257.57	I	31351-45126
1.0	7275.57	I	31275-45016
0.4 h	7300.62	I	31216-44910
1.6 h	7524.13	I	25585-38872
1.8 h	7553.96	I	25725-38959
2.0 h	7574.44	I	24657-37856
1.4	7617.45	I	24657-37781
1.8 h	7665.72	I	20237-33279
4.0	7697.73	I	25585-38572
2.4	7729.72	I	25725-38658
7 h	7741.17	I	20237-33151
0.7 h	7750.37	I	29023-41922
0.7	7752.72	I	29190-42085
0.8 h	7771.06	I	29096-41961
2.0	7785.17	I	25014-37856
1.0	7794.68	I	29190-42016
4	7800.44	I	20240-33056
1.4	7821.64	I	29304-42085
1.4 h	8196.98	I	25585-37781
2.0	8241.13	I	25725-37856
2.5 h	8761.40	I	24866-36277
1.4 h	8774.8		
2.0 h	8794.72	I	29304-40671
2.0 h	8823.8		
4 h	8834.45	I	25014-36330

SELENIUM

Se, $Z=34$, $M=78.96$, Ratio $\frac{\text{Se}}{\text{Cu}}=1.243$

Se I Normal state of valence electrons $4s^2 4p^4\ {}^3P_2 = 0$. I.P.= 78658 K
Se II Normal state of valence electrons $4s^2 4p^3\ {}^4S^\circ_{1\frac{1}{2}} = 0$. I.P.=173557 K

References

Wavelengths and Classification:
Se I, J. E. Ruedy and R. C. Gibbs, Phys. Rev. **46,** 880 (1934).

Relative intensity of selenium lines observed in an arc of copper containing 0.1 atomic percent of selenium

Strong line of selenium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
40	2039. 85	I	1989–50997	$4s^2 4p^4\ {}^3P_1$—$4s^2 4p^3 5s^1\ {}^3S^\circ_1$

Selenium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
34	1960. 26	I	0–50997	3. 0	2074. 79	I	0–48182
40	2039. 85	I	1989–50997	5	8918. 80	I	48182–59391
15	2062. 79	I	2534–50997				

SILICON

Si, $Z=14$, $M=28.09$, Ratio $\frac{\text{Si}}{\text{Cu}}=0.442$

Si I Normal state of valence electrons $3s^2 3p^2\ {}^3P_0$ =0. I.P.= 65743 K
Si II Normal state of valence electrons $3s^2 3p^1\ {}^2P^o_{0\frac{1}{2}}$=0. I.P.=131818 K

References

Wavelengths:
C. C. Kiess, J. Research, NBS **21,** 185 (1938).

Classification:
Si I, C. C. Kiess, ibid.

Intensities:
P. Hey, Z. Physik **157,** 79 (1959).

Relative intensity of silicon lines observed in an arc of copper containing 0.1 atomic percent of silicon

Strong lines of silicon

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
360	2516. 11	I	223–39955	$3s^2 3p^2\ {}^3P_2$—$3s^2 3p^1 4s^1\ {}^3P^o_2$
260	2881. 60	I	6299–40992	$3s^2 3p^2\ {}^1D_2$—$3s^2 3p^1 4s^1\ {}^1P^o_1$

Silicon — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	2124. 11	I	6299–53362	120	2519. 21	I	77–39760
2. 0	2207. 97	I	0–45276	240	2524. 11	I	77–39683
2. 0	2210. 88	I	77–45294	200	2528. 51	I	223–39760
3. 5	2216. 67	I	223–45322	24	2631. 28	I	15394–53387
26	2435. 16	I	6299–47352	260	2881. 60	I	6299–40992
170	2506. 90	I	77–39955	15	2987. 65	I	6299–39760
160	2514. 32	I	0–39760	11	3905. 53	I	15394–40992
360	2516. 11	I	223–39955				

SILVER

Ag, $Z=47$, $M=107.880$, Ratio $\frac{Ag}{Cu}=1.698$

Ag I Normal state of valence electrons $4d^{10}5s^1\ ^2S_{0\frac{1}{2}}=0$. I.P.= 61106 K
Ag II Normal state of valence electrons $4d^{10}\ \ ^1S_0=0$. I.P.=173300 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Ag I, A. G. Shenstone, Phys. Rev. **57,** 894 (1940).
Ag II, A. G. Shenstone, Phys. Rev. **31,** 317 (1928).

Intensities:
A. Filippov and I. Islamov, Z. Physik **85,** 409 (1933).
J. Terpstra and J. A. Smit, Physica **24,** 937 (1958).

Relative intensity of silver lines observed in an arc of copper containing 0.1 atomic percent of silver

Strong lines of silver

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
5500	3280. 68	I	0–30473	$4d^{10}5s^1\ ^2S_{0\frac{1}{2}}$—$4d^{10}5p^1\ ^2P^\circ_{1\frac{1}{2}}$
2800	3382. 89	I	0–29552	$4d^{10}5s^1\ ^2S_{0\frac{1}{2}}$—$4d^{10}5p^1\ ^2P^\circ_{0\frac{1}{2}}$

Silver — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2. 0	2331. 37	II	40741 – 83621	5 hl	4476. 08	I	29552 – 51887
10	2413. 18	II	40741 – 82168	6 hl	4668. 48	I	30473 – 51887
8	2437. 79	II	39164 – 80172	100	5209. 07	I	29552 – 48744
3. 0	2447. 93	II	46046 – 86884	100	5465. 49	I	30473 – 48764
6	2721. 77	I	30242 – 66972	10	5471. 55	I	30473 – 48744
5500	3280. 68	I	0 – 30473	32	7687. 78	I	29552 – 42556
2800	3382. 89	I	0 – 29552	50	8273. 52	I	30473 – 42556
9 hs	4210. 94	I	30473 – 54214				

SODIUM

Na, $Z=11$, $M=22.991$, Ratio $\frac{\text{Na}}{\text{Cu}}=0.3618$

Na I Normal state of valence electrons $2p^6 3s^1\ ^2S_{0\frac{1}{2}}=0$. I.P.= 41450 K
Na II Normal state of valence electrons $2p^6\ \ ^1S_0=0$. I.P.=381528 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Na I, A. Fowler, Report on Series in Line Spectra (Fleetway Press, London, 1922).

Intensities:
R. Minkowski, Z. Physik **36,** 839 (1926).
A. Filippov and W. Prokofiev, Z. Physik **56,** 458 (1929).

Relative intensity of sodium lines observed in an arc of copper containing 0.1 atomic percent of sodium

Strong lines of sodium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	5889. 95	I	0–16973	$2p^6 3s^1\ ^2S_{0\frac{1}{2}}—2p^6 3p^1\ ^2P^\circ_{1\frac{1}{2}}$
1000	5895. 92	I	0–16956	$2p^6 3s^1\ ^2S_{0\frac{1}{2}}—2p^6 3p^1\ ^2P^\circ_{0\frac{1}{2}}$

Sodium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
30	3302. 32	I	0–30273	2000	5889. 95	I	0–16973
15	3302. 99	I	0–30267	1000	5895. 92	I	0–16956
1. 0 l	5149. 09	I	16956–36373	3. 0 l	6154. 23	I	16956–33201
2. 0 l	5153. 64	I	16973–36373	6 l	6160. 76	I	16973–33201
7 l	5682. 66	I	16956–34549	110	8183. 27	I	16956–29173
14 l	5688. 22	I	16973–34549	220	8194. 81	I	16973–29173

STRONTIUM

Sr, $Z=38$, $M=87.63$, Ratio $\frac{\text{Sr}}{\text{Cu}}=1.379$

Sr I Normal state of valence electrons $4p^6 5s^2\ {}^1S_0 = 0$. I.P.= 45926 K
Sr II Normal state of valence electrons $4p^6 5s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.= 88964 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Sr I, F. J. Sullivan, Univ. of Pittsburgh Bull. **35,** 1 (1938).
Sr II, F. A. Saunders, E. G. Schneider and E. Buckingham, Proc. Nat. Acad. Sci. U.S. **20,** 291 (1934).

Intensities:
J. W. Schuttevaer, M. J. de Bont, and T. H. van den Broek, Physica **10,** 544 (1943).
A. Eberhagen, Z. Physik **143,** 392 (1955).
Y. I. Ostrovskii, N. P. Penkin, and L. N. Shabanova, Doklady Akad. Nauk S.S.S.R. **120,** 66 (1958).

Relative intensity of strontium lines observed in an arc of copper containing 0.1 atomic percent of strontium

Strong lines of strontium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
4600	4077. 71	II	0–24517	$4p^6 5s^1\ {}^2S_{0\frac{1}{2}}$—$4p^6 5p^1\ {}^2P^\circ_{1\frac{1}{2}}$
3200	4215. 52	II	0–23715	$4p^6 5s^1\ {}^2S_{0\frac{1}{2}}$—$4p^6 5p^1\ {}^2P^\circ_{0\frac{1}{2}}$
650	4607. 33	I	0–21698	$4p^6 5s^2\ {}^1S_0$ —$4p^6 5s^1 5p^1\ {}^1P^\circ_1$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2152.84	II	14556–60992
6	2165.96	II	14836–60992
1.2	2428.10	I	0–41172
1.2	2569.47	I	0–38907
2.0	2931.83	I	0–34098
3.0	3301.73	I	14318–44596
3.0	3329.99	I	14504–44526
4	3351.25	I	14899–44730
3.0	3366.33	I	14899–44596
65	3380.71	II	23715–53286
95	3464.46	II	24517–53373
12	3474.89	II	24517–53286
3.0 h	3940.80	I	14318–39686
6	3969.26	I	14504–39691
3.0	3970.04	I	14504–39686
13	4030.38	I	14899–39703
3.0	4032.38	I	14899–39691
4600	4077.71	II	0–24517
20	4161.80	II	23715–47737
3200	4215.52	II	0–23715
34	4305.45	II	24517–47737
3.5 h	4438.04	I	14899–37425
650	4607.33	I	0–21698
32	4722.28	I	14504–35675
22	4741.92	I	14318–35400
14	4784.32	I	14504–35400
48	4811.88	I	14899–35675
36	4832.08	I	14504–35194
		I	14318–35007
5	4855.04	I	18159–38750
6	4868.70	I	18219–38752
30	4872.49	I	14504–35022
6	4876.06	I	14504–35007
20	4876.32	I	14899–35400
10	4891.98	I	18319–38755
80	4962.26	I	14899–35045
13	4967.94	I	14899–35022
8 h	5156.07	I	20150–39539
14	5222.20	I	18159–37302
20	5225.11	I	18159–37292
20	5229.27	I	18219–37336
28	5238.55	I	18219–37302
48	5256.90	I	18319–37336
3.5 h	5329.82	I	20150–38907
15	5450.84	I	18219–36560
70	5480.84	I	18319–36560
11	5486.12	I	18159–36382
35	5504.17	I	18219–36382
26	5521.83	I	18159–36264
20	5534.81	I	18319–36382
20	5540.05	I	18219–36264
2.5 h	5543.36	I	21698–39733
2.0 h	5970.10	I	21698–38444
2.5 h	6345.75	I	18219–33973
2.5 h	6363.94	I	18159–33868
3.5 h	6369.96	I	18159–33853
10	6380.75	I	18159–33827
9 h	6386.50	I	18319–33973
6 h	6388.24	I	18219–33868
90	6408.47	I	18319–33919
2.5	6446.68	I	18319–33827
2.5 h	6465.79	I	21698–37160
55	6504.00	I	18219–33590
10	6546.79	I	18319–33590
17	6550.26	I	21698–36961
30	6617.26	I	18159–33267
8	6643.54	I	18219–33267
18	6791.05	I	14318–29039
48	6878.38	I	14504–29039
12	6892.59	I	0–14503
55	7070.10	I	14899–29039
0.6	7153.09	I	21698–35675
2.5 h	7167.24	I	20150–34098
2.0	7232.27	I	20150–33973
25	7309.41	I	20150–33827
5	7621.50	I	20150–33267
4 h	7673.06	I	21698–34727

TANTALUM

Ta, $Z=73$, $M=180.95$, Ratio $\frac{\text{Ta}}{\text{Cu}}=2.848$

Ta I Normal state of valence electrons $5d^3 6s^2\ {}^4F_{1\frac{1}{2}}=0$. I.P.=63600 K
Ta II Normal state of valence electrons $5d^3 6s^1\ {}^5F_1=0$.

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
C. C. Kiess, unpublished material.

Classification:

Ta I, P. F. A. Klinkenberg, G. J. van den Berg, and J. C. van den Bosch, Physica **16,** 861 (1950).
G. J. van den Berg, P. F. A. Klinkenberg, and J. C. van den Bosch, Physica **18,** 221 (1952).
C. C. Kiess and H. K. Kiess, unpublished material.
Ta II, C. C. Kiess, G. R. Harrison, and W. J. Hitchcock, J. Research NBS **44,** 245 (1950).
C. C. Kiess, J. Research NBS **66A,** No. 2 (Mar.–Apr. 1962).

Relative intensity of tantalum lines observed in an arc of copper containing 0.1 atomic percent of tantalum

Strong lines of tantalum

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
300	2653. 27	I	2010–39688	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $39688^{3}_{3\frac{1}{2}}$
300	2714. 67	I	0–36826	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$—$5d^3 6s6p\ y\ {}^4G^{2}_{2\frac{1}{2}}$
280	2647. 47	I	0–37761	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$— $37761^{1}_{1\frac{1}{2}}$
240	3012. 54	II	5331–38516	$5d^2 6s^2\ a\ {}^3P_1$ — $^5F^{2}_{2}$
220	2656. 61	I	0–37630	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$— $37630^{2}_{2\frac{1}{2}}$
220	2850. 98	I	5621–40686	$5d^3 6s^2\ a\ {}^4F_{4\frac{1}{2}}$—$5d^3 6s6p\ y\ {}^4G^{3}_{4\frac{1}{2}}$
		II	14581–49647	$5d^3 6s^1\ b\ {}^3F_3$ — 49647^{3}_{3}
200	2933. 55	I	0–34078	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$— $34078^{1}_{1\frac{1}{2}}$
180	2661. 34	I	5621–43185	$5d^3 6s^2\ a\ {}^4F_{4\frac{1}{2}}$— $43185^{5}_{4\frac{1}{2}}$
180	2685. 17	II	4125–41355	$5d^2 6s^2\ a\ {}^3P_0$— 41355^{1}_{1}
180	2963. 32	I	2010–35746	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $35746^{3}_{3\frac{1}{2}}$
170	2850. 49	I		
160	2608. 63	I	2010–40333	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $40333^{3}_{3\frac{1}{2}}$
140	2400. 63	II	6187–47830	$5d^3 6s^1\ a\ {}^5F_5$ — $z\ {}^5G^{6}_{6}$
140	2635. 58	II	1031–38962	$5d^3 6s^1\ a\ {}^5F_2$ — $^5G^{3}_{3}$
140	2710. 13	I	3964–40851	$5d^3 6s^2\ a\ {}^4F_{3\frac{1}{2}}$— $40851^{2}_{3\frac{1}{2}}$
140	2748. 78	I	3964–40333	$5d^3 6s^2\ a\ {}^4F_{3\frac{1}{2}}$— $40333^{3}_{3\frac{1}{2}}$
140	2940. 22	I	0–34001	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$— $34001^{2}_{1\frac{1}{2}}$
140	3311. 16	I	5621–35813	$5d^3 6s^2\ a\ {}^4F_{4\frac{1}{2}}$— $35813^{5}_{4\frac{1}{2}}$
130	3626. 62	I	3964–31530	$5d^3 6s^2\ a\ {}^4F_{3\frac{1}{2}}$— $31530^{4}_{3\frac{1}{2}}$
120d	2526. 35	I	2010–41581	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$—$5d^4 6p\ \ y\ {}^6F^{3}_{2\frac{1}{2}}$
	2526. 45	I	3964–43533	$5d^3 6s^2\ a\ {}^4F_{3\frac{1}{2}}$— $43533^{3}_{3\frac{1}{2}}$
120	2559. 43	I	0–39060	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$— $39060^{2}_{1\frac{1}{2}}$
120	2698. 30	I	2010–39060	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $39060^{2}_{2\frac{1}{2}}$
120	2758. 31	I	2010–38253	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $38253^{3}_{3\frac{1}{2}}$
100	2636. 90	I	5621–43533	$5d^3 6s^2\ a\ {}^4F_{4\frac{1}{2}}$— $43533^{3}_{3\frac{1}{2}}$
100	2749. 83	I	9705–46061	$5d^3 6s^2\ a\ {}^2G_{3\frac{1}{2}}$— $46061^{3}_{3\frac{1}{2}}$
100	3607. 41	I	2010–29723	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $29723^{3}_{3\frac{1}{2}}$
90	2675. 90	II	4416–41775	$5d^3 6s^1\ a\ {}^5F_4$ — 41775^{4}_{4}
90	2775. 88	I	0–36014	$5d^3 6s^2\ a\ {}^4F_{1\frac{1}{2}}$—$5d^3 6s6p\ z\ {}^4G^{2}_{2\frac{1}{2}}$
90	2891. 84	I	2010–36580	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$—$5d^3 6s6p\ y\ {}^4F^{1}_{1\frac{1}{2}}$
90	2965. 13	II	0–33715	$5d^3 6s^1\ a\ {}^5F_1$ — 33715^{2}_{2}
90	2965. 54	I	2010–35721	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $35721^{1}_{1\frac{1}{2}}$
90	3318. 84	I	2010–32132	$5d^3 6s^2\ a\ {}^4F_{2\frac{1}{2}}$— $32132^{3}_{3\frac{1}{2}}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	2140.13	II	
5	2146.87	II	1031–47596
2.5	2150.62	II	1031–47515
2.5	2165.01	II	0–46175
3.5	2178.03	II	3180–49080
6	2182.71	II	1031–46831
3.0	2193.20	II	2642–48223
6	2193.88	II	6187–51754
9	2196.03	II	4416–49938
9	2199.67	II	0–45447
3.5	2207.14	II	
9 d	2210.03	II	0–45234
	2210.19	II	4416–49647
3.0	2215.60	II	4416–49536
13	2239.48	II	2642–47281
2.5	2248.48	II	9746–54207
5	2249.79	II	0–44435
13	2250.76	II	1031–45447
3.0	2254.86	II	3180–47515
5	2255.77	II	12436–56753
4	2256.51	II	9746–54048
6	2258.71	II	0–44259
10	2261.42	II	0–44206
3.0	2261.62	II	1031–45234
13	2262.30	II	2642–46831
3.0	2269.56	II	12705–56753
10	2271.85	II	2642–46646
13	2272.59	II	3180–47169
3.0	2279.85	I	
5	2282.19	II	1031–44835
2.0	2285.02	II	5331–49080
12	2285.25	II	2642–46387
9	2286.59	II	9746–53466
4	2287.27	II	12436–56142
16	2289.16	II	3180–46851
3.0	2292.54	II	0–43606
3.0	2295.18		
3.0	2301.47	II	12705–56142
9	2302.24	II	5658–49080
9	2302.93	II	4416–47825
6	2303.49	II	1031–44430
2.0	2308.46	II	5658–48963
9	2312.60	II	1031–44259
9	2315.46	II	1031–44206
6	2319.16	II	12436–55543
2.5	2331.29	II	11767–54649
18	2331.98	II	
15	2332.19	II	4416–47281
3.0	2334.13	II	
5	2334.88	II	6831–49647
4	2335.75	II	12705–55505
9	2338.28	II	6988–49741
6	2340.94	II	6831–49536
6	2341.61	II	12436–55128
4	2343.64	II	
3.0	2346.42	II	
3.0	2351.99	II	
6	2353.86	II	5331–47801
4	2355.22	II	
6	2356.05	II	9690–52121
5	2356.90	II	4416–46831
9	2357.30	I	0–42408
6	2359.16	II	9746–52121
10	2361.09	I	2010–44350
6	2362.78	II	
5	2363.32	II	
24	2364.24	II	6187–48470
2.0	2367.24	II	4416–46646
6	2369.32	II	2642–44835
12	2370.76	II	5658–47825
13	2371.58	I	3964–46117
		II	0–42153
3.0	2372.80	II	6831–48963
4	2373.94	II	10713–52825
3.0	2375.91	I	
7	2378.31	II	1031–43065
20	2381.13	II	2642–44626
11	2381.52	II	0–41977
8	2383.72	II	5658–47596
11	2384.28	II	1031–42960
6	2385.73	I	
70	2387.06	II	4416–46295
4	2388.37	II	5658–47515
8	2389.11	II	9690–51534
4	2396.30	I	5621–47340
6	2399.15	I	
3.0	2399.92	II	3180–44835
140	2400.63	II	6187–47830
8	2402.13	II	2642–44259
6	2403.68	II	11875–53466
8	2406.55	I	2010–43551
2.5	2407.57	I	2010–43553
8	2408.26	II	5658–47169
2.5 d	2412.53	II	14581–56019
	2412.67	I	
8	2414.32	I	9253–50660
16	2415.21	II	6831–48223
22	2416.89	II	2642–44005
5	2417.33	II	0–41355
16	2417.86	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
11		2418.77	II	
10		2421.03	I	3964–45256
11		2421.85	II	14581–55859
13		2423.48	II	3180–44430
10		2425.91	II	12436–53645
28		2427.64	I	0–41180
5		2428.00	II	5658–46831
28		2429.71	II	0–41145
14		2431.06	II	1031–42153
5		2431.66	I	
40		2432.70	II	6187–47281
11		2433.59	II	3180–44259
11		2436.51	II	12436–53466
9		2437.07	I	
8		2437.67	I	0–41010
10		2438.64	II	6831–47825
18		2439.91	I	2010–42983
12		2442.39	I	5621–46552
10		2444.13	II	2642–43544
9		2444.67	II	
5		2445.53	II	
10		2447.17	I	0–40852
8		2449.44	II	6988–47801
8		2454.21	I	
10		2454.48	I	3964–44693
5		2454.70	II	11767–52493
10		2458.68	I	
10		2460.55	I	9253–49882
8	d	2461.06	II	10713–51334
16		2463.82	II	12436–53011
8		2465.26	I	5621–46172
13		2466.99	II	1031–41555
13		2467.37	II	5658–46175
5		2468.41	II	15851–56351
38		2470.90	II	6187–46646
12		2471.38	I	
12		2472.13	I	3964–44403
15		2473.13	I	3964–44386
12		2473.31	II	4416–44835
60		2474.62	I	2010–42408
12		2475.33	I	9759–50146
20		2476.67	II	3180–43544
15		2478.22	I	0–40339
8		2479.58	II	2642–42960
12		2481.86	II	11875–52156
10		2482.10	I	
10		2482.58	II	
8		2483.46	II	
10		2484.04	II	
8		2484.72	II	0–40234
50		2484.95	I	0–40230
12		2486.70	I	3964–44166
60		2488.70	II	4416–44585
50		2490.46	I	
5		2496.24	I	6069–46117
7		2496.64	I	
5		2497.77	II	0–40024
9		2498.33	II	4416–44430
14		2501.98	II	9690–49647
10		2503.01	II	
60		2504.45	I	3964–43881
10		2505.32	II	5331–45234
60		2507.45	I	2010–41879
10		2508.92	II	9690–49536
10		2510.71	II	15726–55544
5	d	2511.69	II	
24		2512.65	I	0–39787
10		2513.10	II	3180–42960
7		2513.88	II	11767–51534
10		2519.78	I	6049–45724
14		2526.02	II	5658–45234
120	d	2526.35	I	2010–41581
		2526.45	I	3964–43533
5		2531.29	I	5621–45115
60		2532.12	II	2642–42123
12		2533.00	I	
7		2534.16	I	
5		2534.47	I	9705–49149
12		2534.97	I	5621–45058
16		2537.94	II	9690–49080
9	d	2542.23	I	
		2542.35	II	11875–51197
5		2544.27	I	
		2544.37	II	12831–52121
24		2545.49	II	1031–40305
24		2546.80	I	0–39253
14		2549.38	I	3964–43177
46	d	2551.07	I	2010–41198
		2551.19	I	5621–44807
14		2551.73	II	5658–44835
7		2553.18	II	
46		2554.62	II	2642–41775
12		2554.91	II	4416–43544
24		2555.05	I	3964–43090
14		2556.51	II	5331–44435
18		2557.71	II	9690–48776
120		2559.43	I	0–39060
18		2560.68	I	
46		2562.10	I	3964–42983
8		2563.33	I	2010–41010

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
14		2563.70	I	0–38994
14		2569.13	II	2642–41555
40		2571.51	II	5331–44206
50		2573.54	I	0–38845
46		2573.79	I	2010–40852
18		2574.38	I	9976–48809
18		2575.47	I	9253–48070
70		2577.37	II	11099–49887
40		2577.78	I	5621–44403
8		2578.24	II	12705–51480
12		2579.62	I	0–38754
24		2580.16	I	2010–40756
4		2581.60	II	9746–48470
40		2584.03	II	
16		2584.49	II	13475–52156
17		2584.69	I	9253–47931
12		2585.61	I	9705–48369
4		2588.88	II	6831–45447
9		2589.81	II	5658–44259
2.5		2590.20	II	13560–52156
8	d	2592.44	I	
		2592.53	II	13560–52121
50		2593.08	I	5621–44174
48		2593.66	II	4416–42960
36		2594.25	II	0–38535
65		2595.26	I	5621–44141
14		2595.59	II	0–38516
10		2596.12	I	0–38508
36	l	2596.45	II	2642–41145
7		2596.61	I	2010–40510
12		2598.21	II	
5		2598.75	I	6049–44518
26		2600.14	I	0–38448
8		2600.73	II	6187–44626
16		2601.06	I	6049–44484
10		2602.38	I	6069–44484
70		2603.49	II	6187–44585
7		2603.82	I	9976–48369
7		2605.32	I	9253–47625
8		2606.43	II	15851–54206
14		2607.84	II	
6		2608.20	I	2010–40339
160		2608.63	I	2010–40333
24		2609.00	I	6069–44386
4		2610.13	I	6049–44350
36	d	2611.34	I	3964–42247
		2611.46	I	
13		2612.61	II	1031–39296
8		2615.25	I	9705–47931
40		2615.46	I	9705–47928
36		2615.66	I	2010–40230
6		2620.18	I	
20		2624.12	I	6049–44146
10		2625.46	I	6069–44146
5		2627.43	I	
8		2628.85	II	18494–56522
9		2630.53	II	6831–44835
12		2632.27	II	
10		2633.79	II	18494–56451
140		2635.58	II	1031–38962
8		2635.93	I	2010–39936
6		2636.37	I	9705–47625
55		2636.67	I	3964–41879
100		2636.90	I	5621–43533
6		2637.93	II	0–37897
10		2638.67	II	5658–43544
6		2639.19	II	11767–49647
20		2643.89	I	6069–43880
14		2644.60	II	2642–40444
14		2645.10	II	6831–44626
60		2646.22	I	
70		2646.37	I	2010–39787
18	d	2646.74	II	11875–49647
		2646.89	II	11767–49536
280		2647.47	I	0–37761
6		2650.02	I	
8		2650.28	I	9253–46974
32		2651.22	II	4416–42123
5		2652.32	I	9705–47397
300		2653.27	I	2010–39688
2.5		2654.01	I	
4		2655.68	I	
5		2656.08	I	
220		2656.61	I	0–37630
8		2657.30	I	3964–41585
6		2658.14	II	
14		2658.86	II	6831–44430
10		2659.41	II	2642–40234
4		2659.66	I	
180		2661.34	I	5621–43185
18		2661.89	I	5621–43177
15		2662.10	I	
3.0		2663.88	II	14628–52156
6		2664.24	II	17982–55505
26		2665.60	II	1031–38535
4		2665.94	I	
5		2667.00	II	1031–38516
6		2667.17	I	6069–43551
26		2668.07	I	5621–43090
70		2668.62	I	0–37461

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	2669.58	II	24870–62318
12	2671.63	I	10950–48369
12	2672.50	II	5658–43065
6	2674.18	II	15851–53235
4	2674.49	I	10690–48070
90	2675.90	II	4416–41775
6	2676.48	II	10713–48064
8	2678.80	II	18186–55505
32	2680.06	II	5658–42960
26	2680.66	II	4416–41709
3.0	2681.63	I	
13	2681.87	I	
70	2684.28	I	2010–39253
180	2685.17	II	4125–41355
4	2686.29	I	9759–46974
12	2689.24	II	6831–44005
4	2690.54	I	9253–46410
40	2691.31	I	0–37146
6	2691.80	II	4416–41555
30	2692.40	I	5621–42752
5	2692.83	II	3180–40305
11	2693.34	I	6049–43167
6	2693.50	I	5621–42737
55	2694.52	II	2642–39744
17	2694.76	I	6069–43167
5	2695.54	II	10713–47801
3.0	2695.71	II	9746–46831
28	2696.81	I	9253–46323
120	2698.30	I	2010–39060
6	2700.70	I	12866–49882
14	2702.80	II	0–36988
10	2703.06	I	2010–38994
10	2704.31	I	
55	2706.69	I	10690–47625
3.5	2706.92	I	
36	2709.27	II	9746–46646
140	2710.13	I	3964–40851
3.0	2710.72	II	24226–61106
300	2714.67	I	0–36826
28	2717.18	I	3964–40756
17	2718.38	I	6069–42845
55	2720.76	I	2010–38754
20	2721.83	I	6049–42779
13	2725.42	II	
3.0	2726.32	I	2010–38679
55	2727.44	II	5331–41984
48	2727.78	I	10690–47340
6	2730.73	II	28044–64653
10	2732.06	I	
8	2732.92	I	0–36580
3.5	2733.34	II	18554–55128
12	2735.26	II	9746–46295
36	2736.25	II	
24	2739.26	II	5658–42153
3.5	2740.70	II	17168–53645
17	2741.17	I	9253–45724
3.0	2742.92	I	
24	2743.59	I	2010–38448
60	2746.68	I	5621–42018
14	2746.83	II	15726–52121
10	2747.25	I	
3.5	2747.85	I	11244–47625
140	2748.78	I	3964–40333
100	2749.83	I	9705–46061
8	2750.41	II	11875–48223
18	2752.30	I	10690–47013
48	2752.49	II	2642–38962
8 h	2757.26	II	12705–48963
120	2758.31	I	2010–38253
8	2759.06	II	6831–43065
50	2761.68	II	1031–37231
7	2762.05	II	
13	2763.37	II	0–36177
6	2768.09	II	3180–39296
8	2771.83	II	
12	2774.88	I	15391–51418
15	2775.11	II	5331–41355
4	2775.35	II	18186–54207
90	2775.88	I	0–36014
3.0	2776.71	II	17231–53235
6	2778.82	II	13560–49536
12	2779.10	I	3964–39936
6	2779.70	I	9759–45724
12	2780.34	II	1031–36988
3.5	2780.89		
12	2781.37	I	9705–45648
3.0	2781.79	I	10950–46888
18	2784.97	II	5658–41555
7	2786.77	II	2642–38516
46	2787.69	I	9253–45115
15	2788.30	I	
6	2789.15	II	17168–53011
6	2789.77	I	12235–48070
12	2790.71	I	3964–39787
16	2791.37	II	5331–41145
14	2791.67	I	6069–41879
6	2793.86	II	3180–38962
6	2795.20	II	12705–48470
80	2796.34	I	2010–37761
9	2796.56	I	9976–45724

609065 O - 62 - 22

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
80		2797.76	II	1031–36764
22		2798.40	I	
6		2800.57	I	12235–47931
44		2802.07	I	3964–39641
6		2804.76	I	6049–41693
50		2806.30	I	6069–41693
60		2806.58	I	2010–37630
16		2810.92	I	12235–47800
8		2811.72	II	
12		2814.31	II	6187–41709
11		2814.80	I	6069–41585
11		2815.01	I	2010–37524
11		2815.12	I	6069–41581
30		2817.10	II	5658–41145
6		2817.50	I	10690–46172
5		2819.14	II	10713–46175
11		2819.37	I	3964–39422
6		2821.99	I	
5		2824.81	I	12235–47625
8		2826.18	I	10950–46323
4		2826.42	I	10690–46061
11		2827.18	I	5621–40982
11	d	2827.48	II	14581–49938
		2827.60	II	3180–38535
18		2828.58	II	31267–66610
4		2829.79	II	4416–39744
8		2832.70	II	6831–42123
20		2833.64	I	9976–45256
8		2834.41	I	9976–45246
4		2836.62	I	0–35243
6		2837.94	I	10950–46177
10		2838.24	II	15851–51074
9		2840.39	II	
30		2842.82	I	11244–46410
8		2843.51	II	18186–53344
75		2844.25	I	6049–41198
34		2844.46	II	1031–36177
20		2844.76	I	
34	c	2845.35	I	5621–40756
4		2845.84	I	6069–41198
8		2846.75	I	
17		2848.05	I	9705–44807
65		2848.52	I	3964–39060
12		2849.82	I	11244–46323
170		2850.49	I	
220		2850.98	I	5621–40686
			II	14581–49647
7		2852.36	II	18186–53235
8		2856.69	II	12601–47596
12		2857.28	II	9705–44693
26		2858.44	II	5331–40305
7		2860.88	II	6831–41775
6		2861.12	I	6069–41010
42		2861.98	I	9759–44689
18		2864.50	I	
9		2865.32	II	17231–52121
8		2866.14	I	
12		2867.41	II	17982–52846
36		2868.65	I	3964–38813
55		2871.42	I	2010–36826
32		2873.36	I	0–34792
30		2873.56	I	3964–38754
24		2874.17	I	6069–40852
16		2876.11	I	9759–44518
10		2877.05	II	13475–48223
12		2877.69	II	9690–44430
8		2879.05	II	6831–41555
4		2879.52	I	13352–48070
14		2879.74	I	3964–38679
44		2880.02	I	5621–40333
4		2881.23	I	9705–44403
4		2882.33	II	9746–44430
10		2885.40	II	5658–40305
11		2889.38	I	
9		2890.25	II	2642–37231
10		2891.04	I	13352–47931
90		2891.84	I	2010–36580
12		2894.15	I	9976–44518
16		2895.10	I	12866–47397
4		2896.41	I	
4		2898.42	I	15391–49882
30		2899.04	I	3964–38448
20		2900.36	I	9705–44174
7		2900.75	II	12705–47169
5		2901.05	I	9705–44166
65		2902.05	I	13352–47800
18		2904.07	I	10690–45115
20		2905.24	II	4125–38535
20		2908.91	I	10690–45058
4		2913.32	I	5621–39936
4		2913.45	II	6831–41145
24		2914.12	I	10950–45256
3.0		2914.94	I	10950–45246
20		2915.34	I	
36		2915.49	I	3964–38253
4		2917.12	I	6069–40339
4		2917.56	II	13560–47825
11		2918.96	II	17231–51480
4		2922.11	II	15726–49938
8		2922.84	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
48	2925.19	I	6069–40245
4	2925.66	I	9976–44146
12	2926.46	I	6069–40230
4	2930.99	I	12866–46974
36	2932.70	I	12235–46323
200	2933.55	I	0–34078
8	2934.85	I	9705–43769
4	2938.00	II	18554–52580
4	2938.43	I	12866–46888
18	2939.28	I	11244–45256
55	2940.06	I	10690–44693
140	2940.22	I	0–34001
18	2941.37	I	13352–47340
7	2941.58		
28	2942.14	I	3964–37943
4	2943.77	I	
4	2945.69	I	12235–46172
18	2946.91	I	9253–43177
4	2949.92	II	14581–48470
60	2951.92	I	2010–35877
		II	15726–49593
12	2952.99	II	9690–43544
40	2953.56	I	
12 c	2955.32	II	
14 c	2956.84	II	15726–49536
20	2957.60	I	5621–39422
4	2957.88	II	9746–43544
4	2963.06	I	10950–44689
180	2963.32	I	2010–35746
14	2963.91	I	9253–42983
90	2965.13	II	0–33715
90	2965.54	I	2010–35721
11	2965.92	II	0–33706
4	2968.28	II	11767–45447
40	2969.47	I	3964–37630
8	2969.90	I	13352–47013
50	2975.56	I	3964–37561
10	2976.10	I	9253–42845
10	2976.26	II	12705–46295
7	2976.76	I	
12	2978.18	II	18554–52121
20	2978.75	I	
7	2981.19	I	9705–43239
7	2984.36	I	9253–42752
14	2986.81	II	2642–36113
22	2988.58	I	10690–44141
7	2989.05	I	
22	2989.50	I	6049–39490
12	2991.25	I	6069–39490
8	2999.37	II	14495–47825
6	3001.54	I	12866–46172
4	3002.98	II	13560–46851
8	3004.15	I	9705–42983
9	3004.92	II	9690–42960
5	3006.56	I	
14	3010.84	II	5331–38535
24	3011.12	I	13352–46552
28	3011.88	I	5621–38813
240	3012.54	II	5331–38516
9	3016.37	I	11244–44386
8	3019.67	I	11244–44350
12	3024.09	I	5621–38679
24	3025.16	I	9705–42752
38 d	3027.51	I	12235–45256
	3027.61	II	14495–47515
12	3028.78	I	9976–42983
14	3030.29	I	6069–39059
14	3037.50	II	6831–39744
5	3040.70	II	5658–38535
10	3040.98	I	
38	3042.06	II	4125–36988
14	3042.44	II	11767–44626
10	3043.92	I	10690–43533
14	3045.96	I	13352–46172
24	3048.86	I	2010–34800
70	3049.56	I	2010–34792
14	3050.10	I	6069–38845
10	3056.62	II	17231–49938
14	3057.22	II	14581–47281
19	3058.64	I	6069–38754
19	3060.29	I	3964–36631
24	3063.56	I	5621–38253
5	3063.88	I	
70	3069.24	I	12235–44807
8	3073.39	I	
5	3076.38	I	6049–38546
48	3077.24	I	10690–43177
19	3078.23	I	6069–38546
14	3079.96	I	12235–44693
24	3081.85	I	6069–38508
22	3085.54	I	10690–43090
19	3087.53	I	6069–38448
8	3087.76	II	9746–42123
4	3092.06	I	9253–41585
24	3092.44	I	9253–41581
5	3092.99	I	5621–37943
20	3093.87	I	9705–42018
24	3095.39	I	13352–45648
10	3101.03	II	11767–44005
5	3101.72	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
75	3103.25	I	0–32215
5	3104.42	I	
10	3107.21	I	9705–41879
5	3110.82	II	
13	3113.90	I	
10	3115.86	I	2010–34095
20	3117.44	I	2010–34078
10	3119.59	I	10690–42737
5	3120.92	I	10950–42983
50	3124.97	I	2010–34001
20	3127.76	II	9746–41709
8	3129.55	I	9253–41198
15	3129.95	I	5621–37561
50	3130.58	I	11244–43177
36	3132.64	I	3964–35877
5	3133.55	I	9976–41879
10	3133.89	II	5331–37231
24	3135.89	I	9705–41585
		II	12705–44585
8	3137.44	II	9690–41555
8	3142.96	II	9746–41555
10 c	3147.37	I	13352–45115
18	3148.04	I	9253–41010
5	3150.85	I	9253–40982
5	3155.25	II	6831–38516
5	3156.76	II	11875–43544
10	3157.96	II	5331–36988
5	3159.05	I	12235–43881
10	3162.72	I	9976–41585
19	3163.13	I	9976–41581
9	3163.82	I	9253–40852
10	3167.53	I	6068–37630
9	3168.18	II	15726–47281
42	3170.29	I	12235–43769
10	3172.87	I	11244–42752
36	3173.59	I	0–31501
26	3176.29	I	6049–37524
19	3178.16	I	5621–37077
	3178.27	I	6069–37524
80	3180.95	I	0–31428
14	3181.69	I	9759–41180
15	3182.57	I	6049–37461
32	3184.55	I	6069–37461
16	3191.16	I	10690–42018
10	3192.25	I	
26	3198.67	I	3964–35218
5	3201.98	I	9976–41198
10	3205.00		
20	3206.39	I	5621–36800
6	3207.85	I	11244–42408
26	3213.91	II	5658–36764
20	3216.93	I	6069–37146
10	3221.32	I	9976–41010
40	3223.83	I	5621–36631
24	3227.32	I	9253–40230
30	3229.24	I	
11	3229.88	II	14495–45447
16	3230.86	I	12235–43177
11	3234.69	I	
5	3236.40	I	
9	3239.99	I	12235–43090
16	3240.94	II	5331–36177
26	3242.05	I	3964–34800
26	3242.83	I	3964–34792
5	3248.52	I	11244–42018
5	3250.36	I	6069–36826
9	3260.18	I	0–30665
28	3274.95	II	3180–33706
11	3275.68	II	5658–36177
9	3279.29	I	9759–40245
9	3280.87	I	9759–40230
4	3292.48	I	9976–40339
5	3293.93	I	
18	3295.33	I	11244–41581
16	3299.77	I	6049–36346
9	3304.38	I	9976–40230
10	3309.78	I	2010–32215
140	3311.16	I	5621–35813
28	3317.93	I	3964–34095
9	3318.53	I	5621–35746
90	3318.84	I	2010–32132
44 d	3331.00		
	3331.01	I	12235–42247
11	3332.41	I	9253–39253
9	3337.80	I	2010–31961
11	3338.49	I	6069–36014
17	3339.91	II	6831–36764
4	3343.47	I	11792–41693
17 c	3349.21	II	14581–44430
12	3350.96	I	13352–43185
17	3351.51	I	9759–39588
30	3358.47	I	11244–41010
23	3361.64	I	13352–43090
5	3362.53	I	9759–39490
6	3366.66	I	
15	3369.28	I	6049–35721
85	3371.54	I	3964–33615
17	3376.05	I	9976–39588
6	3376.49	II	
18	3379.52	II	4125–33706

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
48	3385.05	I	3964–33497
5	3387.46	I	11244–40756
5	3388.82	I	9253–38754
30	3398.33	I	2010–31428
22	3406.66	II	6831–36177
60	3406.94	I	0–29344
12	3412.89	I	9253–38546
18	3414.14	II	6831–36113
6	3417.03	II	0–29257
10	3419.75	I	3964–33198
19	3424.45	I	6049–35243
12	3426.73	I	6069–35243
24	3430.94	I	
10	3434.50	I	9705–38813
19	3436.00	I	11244–40339
6	3438.40		
12	3440.24	II	14495–43554
6	3445.15	I	9976–38994
9	3445.91	I	
10 c	3446.91	II	12705–41709
12	3447.29	I	9253–38253
31	3463.97	I	0–28862
6	3472.52	I	17383–46172
6	3473.90	I	9976–38754
6	3477.22	I	15391–44141
13	3477.45	I	9759–38508
65	3480.52	I	6069–34792
6	3484.62	I	0–28689
10	3490.93	I	10950–39588
50	3497.85	I	2010–30591
10	3502.50	I	11244–39787
17	3502.87	I	10950–39490
32	3503.87	I	9976–38508
17	3504.98	I	3964–32487
10	3505.18	I	12235–40756
65	3511.04	I	5621–34095
26	3513.61	I	11792–40245
7	3527.06	I	11244–39588
10	3528.61	I	12866–41198
20	3531.58	I	9253–37561
5	3532.21	I	10950–39253
10	3536.30	I	9253–37524
7	3540.82	I	
13	3541.88	II	1031–29257
16	3549.05	I	3964–32132
7	3553.42	I	0–28134
7	3557.98	I	12235–40333
7	3564.79	I	10950–38994
24	3566.72	I	6049–34078
20	3571.85	I	10690–38679
20 c	3573.44	II	11767–39744
14	3584.21	I	9253–37146
11	3584.51	I	12866–40756
20	3586.29	I	5621–33497
20	3595.64	I	10950–38754
7	3602.48	I	11244–38994
100	3607.41	I	2010–29723
7	3625.24	I	5621–33198
130	3626.62	I	3964–31530
7	3633.79	I	
60	3642.06	I	5621–33070
5	3653.39	I	12866–40230
2.5	3653.83	I	15391–42752
5	3656.89	I	
7	3657.27	I	13352–40686
7	3657.49	I	2010–29344
10	3658.78	I	19658–46982
8	3661.69	I	11244–38546
8	3662.34	II	9690–36988
4	3667.82	I	
8	3674.83	I	11244–38448
4	3675.12	I	11792–38994
5	3681.04	I	13352–40510
5	3681.24		
7	3683.06	I	
12	3686.18	I	9705–36826
12	3689.73	I	9705–36800
9	3693.05	I	12866–39936
7	3694.52	II	14495–41555
7	3695.38	I	11792–38845
2.5	3701.34	I	11244–38253
2.0	3710.79	I	
5	3723.07	I	2010–28862
16	3731.02	I	0–26795
17	3736.76	I	11792–38546
16	3746.36	I	
13	3754.52	I	3964–30591
9	3755.11	I	9253–35877
2.5	3757.75	I	9976–36580
5	3759.75	I	0–26590
2.5	3760.21	I	9759–36346
5	3762.11	I	10950–37524
4	3770.52	I	
5	3770.93	I	5621–32132
12	3777.10	I	9253–35721
2	3784.25	I	6069–32487
12	3792.02	I	0–26364
10	3823.60	I	6069–32215
4	3826.17	I	12866–38994
9	3826.85	I	2010–28134

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	3828.95	I	10690–36800
3.5	3830.00	II	5658–31760
22	3833.74	II	3180–29257
7	3836.60	I	3964–30021
9	3839.03	I	9705–35746
4	3844.04	I	
4	3846.64	I	9253–35243
11	3848.05	I	5621–31601
4	3849.42	I	
4	3859.80	I	9976–35877
11	3885.20	I	11792–37524
2.0	3893.03	I	12866–38546
2.0 bl	3896.43	TaO	
3.5	3898.78	I	
7	3909.33	I	
4	3912.13	I	17224–42779
4	3912.44	I	
22	3918.51	I	0–25513
4	3919.47	I	
6	3922.42	II	6831–32318
15	3922.78	I	6069–31554
15	3922.92	I	9759–35243
7	3930.94	I	6069–31501
4	3936.55	I	12235–37630
9	3937.84	I	12866–38253
2.0	3942.24	I	6069–31428
7	3952.16	I	15391–40686
4	3954.29	I	
7	3956.57	I	9976–35243
2.0	3956.82	I	
3.0	3959.73	I	
22	3970.10	I	0–25181
7	3979.28	I	10690–35813
2.0	3981.01	II	11875–36988
9	3981.95	I	15904–41010
2.0	3983.82	I	9705–34800
1.8	3984.98	I	9705–34792
9	3988.70	I	10950–36014
4	3990.40	I	
22	3996.17	I	6049–31066
11	3999.28	I	6069–31066
7	4003.70	I	5621–30591
20	4006.84	I	2010–26960
3.5	4007.23	I	15904–40852
7	4012.11	I	
7	4013.19	I	12235–37146
20	4026.94	I	6069–30895
15	4029.94	I	
9	4033.07	I	11792–36580
2.0	4033.38	I	
1.8	4033.63	I	2010–26795
7	4035.89	I	10950–35721
3.5	4039.63	I	
13	4040.87	I	5621–30361
9	4041.06	I	0–24739
7	4058.46	I	11244–35876
44	4061.40	I	6049–30665
22	4064.63	I	6069–30665
11	4067.24	I	2010–26590
33	4067.91	I	2010–26586
4	4073.00	I	15391–39936
7	4079.19	I	
2.0	4081.13	I	
4	4085.80	I	17224–41693
4	4091.26	I	15904–40339
2.0 h	4095.55	II	11767–36177
4	4097.19	I	5621–30021
13	4105.02	I	2010–26364
2.0	4114.77	I	9705–34001
2.0	4118.07	I	
6	4123.17	I	
9	4127.88	I	3964–28183
22	4129.38	I	2010–26220
24	4136.20	I	3964–28134
24	4147.89	I	5621–29723
8 h	4161.00	I	
22	4175.21	I	9253–33198
8	4176.90	II	14581–38516
	4176.99	I	12866–36800
11	4177.92	I	11792–35721
14	4181.15	I	9705–33615
9	4191.16	I	
6	4193.10	I	10950–34792
32	4205.88	I	3964–27734
13	4206.40	I	
10	4228.61	I	12235–35877
3.5	4232.94	I	
6	4235.94	II	24870–46470
3.0	4243.99	I	11244–34800
14	4245.35	I	11244–34792
14	4268.26	I	15391–38813
7	4271.51	I	10690–34095
10	4279.06	I	0–23363
7	4286.38	I	19178–42502
6	4294.36	I	13352–36631
17 c	4302.98	I	9253–32487
10	4314.52	I	2010–25181
7	4318.81	I	12866–36014
7	4322.68	I	17383–40510
9	4329.57	I	15904–38994

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	4336.20	I	23927–46982
9	4344.31	I	
12	4355.14	I	22682–45637
5	4360.83	I	10690–33615
5	4364.84	I	
6	4369.35	I	12866–35746
3.0	4374.21	I	12866–35721
5	4375.14	I	15904–38754
3.0	4376.31	I	
3.0	4377.98	I	24982–47817
11	4378.82	I	3964–26795
2.5	4381.88	I	21168–43982
16	4386.07	I	6069–28862
12	4398.45	I	2010–24739
19	4402.50	I	9253–31961
14	4415.74	I	6049–28689
5	4419.55	I	6069–28689
3.5	4424.96	I	20647–43239
7	4430.41	I	12235–34800
3.5	4431.09	I	5621–28183
4	4432.98	I	15391–37943
6	4441.03	I	9976–32487
8	4441.68	I	10690–33198
8	4450.72	I	13352–35813
2.0 h	4451.87	I	9759–32215
10	4459.76	I	19178–41595
10	4473.52	I	9253–31601
5	4480.93	I	25009–47319
4	4494.97	I	
4	4496.50	I	2010–24243
38 c	4510.98	I	5621–27783
8	4511.50	I	5621–27781
6	4521.09	I	5621–27734
3.5	4521.71	I	
7	4527.50	I	
20	4530.85	I	6069–28134
3.0	4547.15	I	9976–31961
14	4551.95	I	3964–25926
5	4553.69	I	11244–33198
9	4556.35	I	11244–33185
5	4559.46	I	12866–34792
1.8	4561.48	I	2010–23927
18	4565.85	I	9705–31601
3.0	4566.86	I	25926–47817
5	4573.29	I	12235–34095
36	4574.31	I	0–21855
3.0	4580.69	I	9705–31530
2	4583.17	I	9253–31066
4	4601.42	I	15904–37630
5	4602.19	I	9705–31428
1.8 h	4604.28	I	22429–44141
3.5 h	4604.85	I	23927–45637
28	4619.51	I	9253–30895
3.0	4622.96	I	9976–31601
1.6	4624.84	I	
4	4633.06	I	9976–31554
8	4661.12	I	13352–34800
12	4669.14	I	9253–30665
42	4681.88	I	2010–23363
4	4684.87	I	5621–26960
3.5	4685.27	I	9253–30591
1.8	4688.84	I	17224–38546
12	4691.90	I	9759–31066
8	4693.35	I	22682–43982
6	4701.32	I	10950–32215
6	4706.09	I	11244–32487
4	4722.88	I	0–21168
8	4730.12	I	12866–34001
2.5 h	4738.35	I	
14	4740.16	I	9976–31066
3.5	4745.93	I	17383–38448
20	4756.51	I	3964–24982
4	4758.03	I	10950–31961
11	4768.98	I	12235–33198
8	4780.94	I	10690–31601
2.0	4786.64	I	9705–30591
20	4812.75	I	0–20772
8	4819.53	I	13352–34095
8	4825.43	I	11244–31961
5	4832.18	I	9976–30665
6	4846.45	I	25009–45637
3.0	4852.17	I	10950–31554
1.8	4871.70	I	6069–26590
1.2	4879.14	I	23913–44403
1.0	4881.94	I	10950–31428
7	4883.95	I	9253–29723
5	4904.59	I	
3.0	4907.73	I	2010–22380
2.5	4914.96	I	0–20340
9	4920.11	I	12866–33185
8	4921.27	I	6049–26364
1.6	4923.47	I	5621–25926
2.0	4924.96	I	17224–37524
9	4926.00	I	6069–26364
12	4936.42	I	12235–32487
4	4937.63	I	17383–37630
1.4	4958.11	I	
2.0	4968.53	I	22380–42502
3.5	4969.69	I	10950–31066
1.4	4972.06	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		4976.20	I	9253–29344
6		5012.52	I	10950–30895
16		5037.37	I	13352–33198
7		5037.66	I	2010–21855
7		5043.32	I	11244–31066
1.4		5044.42	I	
2.0	h	5058.70	I	17383–37146
8		5067.87	I	12235–31961
3.5		5076.37	I	17383–37077
2.5		5082.25	I	10690–30361
5		5087.37	I	11244–30895
7		5090.71	I	9705–29344
3.0		5095.27	I	12866–32487
2.0	c	5109.37	II	9690–29257
1.6		5109.77	I	5621–25186
9		5115.84	I	
3.0		5117.25	I	27783–47319
3.5		5132.12	I	
2.5		5136.47	I	6049–25513
8		5141.62	I	6069–25513
8		5143.69	I	9253–28689
6		5147.62	I	11244–30665
2.0		5148.78	I	17383–36800
2.0		5150.85	I	15391–34800
6		5153.42	I	3964–23363
26		5156.56	I	5621–25009
6		5161.81	I	9976–29344
5		5163.65	I	5621–24982
2.0		5166.79	I	12866–32215
1.6		5171.63	I	10690–30021
3.0	c	5180.98	I	21855–41151
1.6		5188.93	I	12866–32132
1.6	c	5193.99	I	17383–36631
1.6		5206.26	I	
9		5212.74	I	0–19178
9	d	5218.45	I	2010–21168
		5218.66	I	9705–28862
3.0		5230.80	I	6069–25181
2.5		5235.39	I	12866–31961
2.5		5237.53	II	14628–33715
1.4		5244.78	I	9705–28767
2.5		5275.02	I	
1.4		5279.82	I	
1.4		5281.02	I	9759–28689
7		5295.01	I	9253–28134
3.0	c	5318.67	I	25186–43983
6		5328.38	I	2010–20772
2.5		5336.13	I	12866–31601
11		5341.05	I	3964–22682
2.0		5342.25	I	9976–28689
4		5349.09	I	6049–24739
4		5349.57	I	12866–31554
5		5354.68	I	6069–24739
1.2		5365.95	I	17383–36014
1.6		5373.01	I	
2.0	c	5388.51	I	28767–47319
7		5389.30	I	
3.0		5395.99	I	9253–27781
2.0		5397.56	I	17224–35746
16		5402.51	I	0–18505
1.0		5403.54	I	15114–33615
3.5		5404.96	I	17224–35721
1.0		5405.80	I	17383–35877
2.5		5408.78	I	
1.4		5410.55	I	9705–28183
2.0	c	5413.48	I	6049–24517
10		5419.13	I	6069–24517
1.8		5431.66	I	
5		5435.27	I	10950–29344
2.0		5458.41	I	
7		5461.29	I	5621–23927
1.0		5471.56	I	
2.5		5475.54	I	24243–42502
1.2		5481.16	I	23355–41595
1.6		5483.43	I	23363–41595
3.0		5490.11	I	
1.6		5494.78	I	6049–24243
4		5499.44	I	13352–31530
1.4		5500.68	I	6069–24243
1.6		5505.66	I	9976–28134
1.2	c	5516.27	I	
7		5518.91	I	17383–35498
0.7		5521.15	I	20647–38754
0.8		5523.98	I	
1.0		5528.36	I	3964–22047
0.8	l	5545.14	I	12866–30895
1.6		5548.32	I	17224–35243
2.5		5584.02	I	27734–45637
1.2		5598.75	I	27781–45637
2.5		5599.52	I	27783–45637
0.7	c	5605.50	I	17383–35218
0.7	c	5617.71	I	23355–41151
3.0		5620.68	I	12235–30021
1.0		5628.20	I	
1.6		5635.71	I	10950–28689
3.0		5640.18	I	12866–30591
12		5645.91	I	9253–26960
10		5664.90	I	2010–19658
2.5		5688.25	I	17224–34800
3.0		5699.24	I	9253–26795

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.2		5704.31	I	21153–38679
2.0		5706.28	I	24982–42502
2.5		5715.24	I	10690–28183
0.6		5716.53	I	12235–29723
1.8		5746.71	I	26586–43983
2.5		5755.81	I	
1.2	h	5761.61	I	24243–41595
2.0		5766.56	I	9253–26590
2.5	c	5767.91	I	9253–26586
0.8		5771.93	I	25181–42502
10		5776.77	I	6049–23355
2.0		5780.02	I	20647–37943
7		5780.71	I	6069–23363
10		5811.10	I	3964–21168
2.0		5816.51	I	26795–43983
3.5	c	5843.94	I	9759–26866
1.0		5849.68	I	10690–27781
1.2		5866.61	I	
19		5877.36	I	13352–30361
10		5882.30	I	23515–40510
7		5901.91	I	11244–28183
2.5		5916.51	I	11792–28689
7		5918.95	I	9976–26866
1.2		5925.90	I	17224–34095
1.2		5930.62	I	12866–29723
1.8		5931.05	I	24739–41595
1.6		5931.68	I	17224–34078
1.4		5935.54	I	23913–40756
10		5939.76	I	9759–26590
19		5944.02	I	9976–26795
2.0		5951.78	I	
1.4		5960.13	I	23913–40686
15	c	5997.23	I	13352–30021
2.0	h	6009.89	I	24517–41151
2.0		6015.90	I	17383–34001
8		6020.72	I	9759–26364
20		6045.39	I	11244–27781
8		6047.25	I	12235–28767
2.0		6053.64	I	9705–26220
2.5		6090.82	I	25181–41595
1.4		6092.06	I	
8		6101.58	I	22429–38813
2.0		6140.07	I	26220–42502
5		6144.56	I	10690–26960
2.5		6152.54	I	27734–43983
10		6154.50	I	9976–26220
3.0		6158.84	I	17383–33615
1.2		6170.46	I	27781–43983
1.2		6189.66	I	
1.2		6193.11	I	
2.0		6208.37	I	25478–41581
3.0		6249.79	I	12866–28862
12		6256.68	I	6069–22047
12		6268.70	I	12235–28183
4		6278.34	I	
5		6281.33	I	10950–26866
1.2		6287.36	I	
3.0		6287.91	I	12235–28134
3.0		6289.34	I	10690–26586
4		6309.06	I	
12		6309.58	I	10950–26795
2.0	c	6312.24	I	
6		6325.08	I	6049–21855
4		6332.91	I	6069–21855
5		6341.17	I	
2.5		6346.02	I	9759–25513
6		6356.14	I	9253–24982
5		6360.84	I	11244–26960
3.0		6373.06	I	22761–38448
1.2		6379.07	I	
7		6389.45	I	21153–36800
1.8	h	6392.21	I	10950–26590
5		6428.60	I	11244–26795
20		6430.79	I	12235–27781
1.0		6437.36	I	
3.0		6444.61	I	
2.5		6445.87	I	
16		6450.36	I	12235–27734
1.6		6455.83	I	9253–24739
2.5		6459.92	I	9705–25181
30		6485.37	I	13352–28767
1.4	h	6502.43	I	
5		6505.52	I	
8		6514.39	I	11244–26590
8		6516.10	I	11244–26586
2.0	h	6561.60	I	10690–25926
2.0	cw	6564.26	I	
8		6574.84	I	9976–25181
0.8		6585.13	I	22761–37943
1.2	c	6587.16	I	
9		6611.95	I	11244–26364
6		6621.30	I	6069–21168
1.2	cw	6662.24	I	
8		6673.73	I	9759–24739
14		6675.53	I	11244–26220
2.5		6684.00	I	
1.2		6693.61	I	
1.2		6706.46	I	15114–30021
2.0		6709.39	I	23913–38813
0.8		6714.44	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6	c	6740.73	I	13352–28183
3.0		6754.91	I	26795–41595
1.0	c	6755.85	I	11792–26590
1.0		6770.37	I	23913–38679
6		6771.74	I	9976–24739
3.0	cw	6774.25	I	9759–24517
3.0	cw	6788.99	I	12235–26960
1.0	c	6790.06	I	6049–20772
1.0		6799.27	I	6069–20772
3.0	c	6810.46	I	
13	c	6813.25	I	9253–23927
1.6		6819.36	I	
1.4	c	6824.96	I	
1.0		6832.00	I	
1.2		6850.83	I	
1.2		6865.13	I	10950–25513
17		6866.23	I	12235–26795
14		6875.27	I	9976–24517
3.0		6877.49	I	
1.2		6896.77	I	10690–25186
3.0		6900.55	I	26022–40510
12		6902.10	I	9759–24243
11		6927.38	I	13352–27783
11		6928.54	I	13352–27781
0.6	h	6939.33	I	
1.6	c	6946.87	I	
5		6951.26	I	13352–27734
3.5		6953.88	I	17224–31601
14		6966.13	I	12235–26586
0.6		6969.49	I	
0.6	c	6971.31	I	
0.7		6971.53	I	23913–38253
1.8		6983.52	I	22761–37077
9	d	6995.22	I	10690–24982
		6995.49	I	6049–20340
1.6		7000.21	I	
3.0		7005.07	I	6069–20340
6		7006.96	I	9976–24243
4		7025.03	I	10950–25181
1.0		7031.51	I	17383–31601
3.0		7039.07	I	22429–36631
1.2	h	7081.30	I	
1.6		7085.40	I	9253–23363
1.8		7093.02	I	12866–26960
0.6		7108.05	I	22761–36826
1.2	c	7117.52	I	
1.6		7121.27	I	22761–36800
3.0		7125.72	I	
12		7148.63	I	12235–26220
9		7172.90	I	11244–25181
1.0	c	7174.91	I	
1.0		7191.35	I	
0.6		7233.45	I	
2.5	h	7250.27	I	10950–24739
0.9	h	7264.82	I	
0.5		7272.29	I	
2.5		7276.96	I	11244–24982
0.4		7277.54	I	
0.7		7286.36	I	11792–25513
1.0	c	7296.32	I	
11		7301.74	I	12235–25926
1.6		7319.84	I	9705–23363
0.9	c	7322.72	I	15114–28767
1.0		7325.95	I	
0.9	cw	7340.19	I	
13		7346.41	I	6049–19658
11	c	7352.86	I	9759–23355
8		7356.96	I	6069–19658
7	cw	7369.09	I	10950–24517
13		7407.89	I	11244–24739
0.9	c	7435.19	I	
1.8		7440.17	I	
2.5		7467.75	I	9976–23363
1.8		7486.01	I	
2.5		7520.56	I	10950–24243
0.5		7569.23	I	17383–30591
0.7		7590.22	I	
0.5		7649.62	I	
0.9	h	7722.02	I	12235–25181
0.9		7763.11	I	
0.7	c	7779.67	I	
1.6	c	7842.76	I	12235–24982
8		7882.37	I	11244–23927
2.5		7950.19	I	13352–25926
0.4		7952.07	I	
0.5		7998.75	I	17224–29723
0.5		8022.09	I	28689–41151
6		8026.50	I	6049–18505
0.4		8029.04	I	11792–24243
1.2		8039.08	I	6069–18505
0.6		8053.93	I	10950–23363
1.2		8068.98	I	15391–27781
0.4		8100.11	I	9705–22047
1.0		8128.76	I	
0.7		8158.54	I	
0.4	c	8180.74	I	
1.0	c	8248.95	I	11244–23363
1.6	d	8264.85	I	9759–21855
6		8281.62	I	9976–22047
0.9		8389.06	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.4	8415.73	I	9976–21855
2.0 cw	8447.62	I	13352–25186
0.9 h	8550.49	I	12235–23927
1.2	8575.92	I	13352–25009
0.8 cw	8595.84	I	13352–24982

TELLURIUM

Te, $Z=52$, $M=127.61$, Ratio $\frac{\text{Te}}{\text{Cu}}=2.008$

Te I Normal state of valence electrons $5s^2 5p^4\ {}^3P_2 = 0$. I.P.= 72667 K
Te II Normal state of valence electrons $5s^2 5p^3\ {}^4S^\circ_{1\frac{1}{2}} = 0$. I.P.=150000 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939), above 2000 A.
J. C. McLennan, A. B. McLay, and J. H. McLeod, Phil. Mag. **4,** 486 (1927), below 2000 A

Classification:
Te I, O. Bartelt, Z. Physik **88,** 522 (1934).

Relative intensity of tellurium lines observed in an arc of copper containing 0.1 atomic percent of tellurium

Strong line of tellurium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
70	2385.76	I	4751–46653	$5p^4\ {}^3P_1 — 5p^3 6s^1\ {}^3S_1^\circ$

Tellurium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	1994.2	I	4751–54877	6	2259.04	I	0–44253
16	2002.0	I	4751–54685	55	2383.25	I	4707–46653
10	2081.03	I	10559–58596	70	2385.76	I	4751–46653
55	2142.75	I	0–46653	12	2530.70	I	4751–44253
11	2147.19	I	10559–57116	11	2677.16	I	
1.4	2159.79	I	10559–56845	10	3175.11	I	23199–54685

TERBIUM

Tb, $Z=65$, $M=158.93$, Ratio $\frac{Tb}{Cu}=2.501$

References

Wavelengths:
A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945).
Supplemented by:
J. M. Eder, Sitzber. Akad. Wiss. Wien, Math. naturw. Kl. **131,** 199 (1922).
A. S. King, Astrophys. J. **72,** 221 (1930).
About 70 lines above 7000 A were measured on our plates.

Classification:
J. Sugar, unpublished material (1961).

Spectrum Assignments:
From 3837 to 4677 A the assignment of spectrum is from A. S. King, Astrophys. J. **72,** 221 (1930).
The rest of the assignments are from our plates.

Relative intensity of terbium lines observed in an arc of copper containing 0.1 atomic percent of terbium

Strong lines of terbium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
600	3509. 17	II		
460	3702. 85	II		
440	3568. 51	II		
400	3324. 40	II		
380	3676. 35	II		
340	3561. 74	II		
340	3848. 76	II		
320 w	3874. 19	II		
280	4326. 47	I	0–23107	
240	3650. 40	II		
240	3703. 92	II		
220	3899. 20	II		
200	3658. 88	II		
200 d	3976. 84	II		
200	4318. 85	I	0–23148	
190	3776. 49	II		
190	4033. 06	II		
180	4005. 57	II		
170	3568. 98	II		
170	3600. 44	II		
170	3981. 89	II		
160	3293. 07	II		
160	3765. 14	I		
160	4338. 45	I	0–23043	
150	3901. 35	I		
140	3523. 66	II		
140	3830. 29	II		
130	3219. 95	II		
120	3218. 93	II		
120	3540. 24	II		
120	3579. 20	II		
120	4061. 59	I		
110	3285. 04	II		
100 d	3711. 74	II		
100	3755. 24	II		
100	4144. 46	II		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2577.73	II	
12	2584.61	II	
3.0	2590.31	II	
3.0	2591.42	II	
2.5	2592.64	II	
6	2597.71	II	
4	2602.93	II	
11	2608.57	II	
4	2616.90		
14	2628.69	II	
6	2655.96	II	
5	2661.40	II	
2.5	2661.64	II	
6	2667.64	II	
5	2668.86	II	
15	2669.29	II	
4	2674.13	II	
4	2674.69	II	
3.0	2678.15	II	
4	2683.97	II	
3.5	2687.84	II	
5	2691.90	II	
3.5	2693.05	II	
6	2693.41	II	
3.5	2695.46	II	
5	2696.83	II	
3.5	2701.52	II	
20	2704.07	II	
10	2706.28	II	
5	2713.22	II	
3.5	2720.89	II	
3.5	2724.29	II	
3.5	2726.49	II	
7 d	2730.21	II	
3.5	2733.90	II	
3.5	2735.45	II	
3.5	2735.99	II	
14	2736.24	II	
7	2742.26	II	
9	2743.50	II	
3.5	2757.41	II	
17	2759.47	II	
7	2760.96	II	
3.5	2766.57	II	
3.5	2767.02	II	
28	2769.53	II	
3.5	2782.35	II	
3.5	2783.00	II	
14	2784.49	II	
3.5	2785.50	II	
4	2796.95	II	
19	2800.51	II	
8	2800.63	II	
26	2802.75	II	
26	2809.32	II	
19	2812.64	II	
4	2818.48	II	
4	2819.78	II	
9	2827.40	II	
8	2833.03	II	
9	2838.72	II	
4	2842.00	II	
8	2843.96	II	
8	2845.93	II	
6	2851.04	II	
20	2852.14	II	
8	2854.17	II	
8	2854.96	II	
8	2855.69	II	
12	2857.68	II	
10	2861.34	II	
4	2864.48	II	
5	2867.42	II	
5	2872.32	II	
4	2872.55	II	
8	2881.25	II	
10	2884.70	II	
8	2885.90	II	
24	2886.29	II	
8	2887.44	II	
5	2888.10	II	
4	2888.31	II	
4	2888.82	II	
8	2889.66	II	
4	2892.49	II	
17	2894.48	II	
6	2896.03	II	
34	2897.46	II	
17	2898.84	II	
11	2901.54	II	
7	2903.25	II	
4	2907.10	II	
11	2910.30	II	
8	2911.80	II	
4	2912.65	II	
4	2913.41	II	
17	2914.80	II	
17	2915.33	II	
20	2915.60	II	
13	2916.27	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
13	2918.89	II	
7	2919.00	II	
13	2924.16	II	
13	2924.53	II	
7	2925.94	II	
8	2931.41	II	
17	2932.91	II	
8	2933.79	II	
6	2934.82	II	
6	2936.39	II	
16	2940.05	II	
9	2941.70	II	
9	2944.91	II	
10	2945.70	II	
8	2946.85	II	
6	2949.04	II	
6	2950.06	II	
26	2956.21	II	
4	2957.32		
4	2957.70	II	
7	2960.58	II	
6	2962.78	II	
10	2963.97	II	
9	2964.76	II	
6	2965.32	II	
18	2968.87	II	
4	2974.15	II	
18	2977.78	II	
4	2981.99	II	
12	2987.03	II	
12	2988.57	II	
4	2989.84	II	
9	2991.96	II	
5	2992.56	II	
14	2996.01	II	
12	2999.03	II	
8	3002.45	II	
9	3004.58	II	
14	3005.52	II	
6	3007.11	II	
18	3009.30	II	
6	3010.12	II	
24	3010.55	II	
7	3013.61	II	
24	3016.18	II	
14	3019.17	II	
18	3020.29	II	
6	3021.95	II	
11	3023.43	II	
8	3023.70	II	
18	3027.33	II	
5	3027.58	II	
9	3029.23	II	
24	3031.60	II	
9	3032.83	II	
8	3034.12	II	
9	3034.91	II	
5	3037.04	II	
9	3038.66	II	
5	3042.07	II	
5	3042.50	II	
4	3042.83	II	
10	3043.65	II	
24	3044.97	II	
5	3047.00	II	
5	3050.57	II	
20	3051.12	II	
10	3052.18	II	
14	3053.24	II	
48	3053.55	II	
5	3061.80	II	
14	3062.78	II	
24	3064.09	II	
5	3064.51	II	
5 h	3065.17	II	
11	3065.69	II	
8	3065.87	II	
24	3067.20	II	
28	3069.02	II	
48	3070.05	II	
28	3072.60	II	
6	3074.71	II	
10	3076.04	II	
70	3078.86	II	
7	3080.11	II	
10	3081.55	II	
7	3082.01	II	
50	3082.36	II	
8	3083.83	II	
7	3085.99	II	
13	3086.78	II	
7	3087.54	II	
26	3088.43	II	
5	3089.10	II	
50	3089.58	II	
10 d	3091.62	II	
10	3092.96	II	
7	3093.20	II	
10	3096.86	II	
5	3097.40	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
24	3102.54	II		5	3168.59	II	
50	3102.97	II		24	3169.84	II	
10	3108.41	II		10	3171.19	II	
7	3109.15	II		20	3173.76	II	
7	3109.82	II		40	3174.66	II	
7	3112.43	II		8	3175.45	II	
5	3112.53	II		5	3179.84	II	
8	3113.62	II		40	3180.54	II	
5	3116.66	II		5	3181.22	II	
8	3117.26	II		10	3183.29	II	
30	3117.89	II		10	3183.64	II	
30	3119.62	II		15	3183.88	II	
10	3121.43	II		10	3186.23	II	
24	3121.94	II		50	3187.25	II	
8	3122.83	II		30	3188.03	II	
24	3123.05	II		10	3188.55	II	
5	3124.02	II		5	3188.83	II	
17	3124.54	II		10	3189.97	II	
10	3126.16	II		5	3190.72	II	
5	3128.88	II		7	3192.76	II	
12	3131.35	II		5	3194.18	II	
26	3134.26	II		20	3194.71	II	
10	3135.35	II		40	3195.60	II	
10	3137.22	II		5	3198.02	II	
5	3138.63	II		50	3199.56	II	
46	3139.64	II		16	3200.73	II	
20	3140.04	II		10	3202.70	II	
9	3143.38	II		7	3202.95	II	
24	3145.22	II		8	3207.09	II	
16	3146.67	II		14	3207.53	II	
32	3147.04	II		10	3207.96	II	
32	3147.13	II		7	3209.54	II	
7	3148.21	II		5	3210.01	II	
32	3148.71	II		16	3210.22	II	
7	3154.69	II		10	3215.01	II	
7	3155.10	II		120	3218.93	II	
13	3155.62	II		130	3219.95	II	
5	3156.52	II		10	3220.17	II	
5	3157.49	II		5	3222.37	II	
8	3158.66	II		10	3222.97	II	
10	3159.22	II		5	3227.48	II	
10	3159.39	II		16	3229.19	II	
14	3162.42	II		26	3230.03	II	
30	3162.93	II		26	3231.06	II	
10	3163.85	II		10	3231.46	II	
8	3164.10	II		9	3232.00	II	
10	3164.77	II		5	3232.73	II	
20	3165.74	II		10	3234.50	II	
40	3167.52	II		12	3235.79	II	
15	3168.32	II		10	3236.20	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22 d	3239.66	II	
26	3240.00	II	
20	3240.65	II	
8	3243.20	II	
5	3244.60	II	
10	3245.17	II	
5	3245.42	II	
5	3247.18	II	
7	3249.61	II	
5	3250.75	II	
5	3250.95	II	
16	3251.25	II	
50	3252.34	II	
7	3253.54	II	
7	3255.22	II	
10	3259.38	II	
20	3260.05	II	
5	3260.66	II	
10	3260.83	II	
20	3261.74	II	
10	3262.68	II	
26	3262.97	II	
5	3263.65	II	
24 d	3263.89	II	
5	3264.06	II	
24	3264.90	II	
8	3265.93	II	
42	3266.40	II	
20	3268.10	II	
16	3268.52	II	
8	3270.63	II	
16	3272.35	II	
26	3274.19	II	
26	3274.33	II	
7	3275.66	II	
22	3277.32	II	
11	3277.73	II	
80	3280.28	II	
80	3281.40	II	
55	3283.10	II	
5	3283.81	II	
110	3285.04	II	
16	3285.21	II	
5	3286.98	II	
32	3287.55	II	
32	3291.56	II	
160	3293.07	II	
11	3294.04	II	
22	3295.33	II	
11	3298.20	II	
32	3298.66	II	
11	3304.10	II	
11	3304.26	II	
22	3304.95	II	
11	3305.37	II	
8	3306.41	II	
44 d	3307.44	II	
9	3307.80	II	
22	3308.51	II	
11	3309.17	II	
5	3310.10	II	
8	3310.37	II	
11	3310.80	II	
16	3312.53	II	
16	3312.80	II	
22	3314.38	II	
5	3314.70	II	
11	3315.07	II	
5	3317.58	II	
11	3319.16	I	
36 d	3321.15	II	
44	3322.28	II	
22	3323.38	II	
22	3323.89	II	
400	3324.40	II	
16	3325.52	II	
11	3327.11	II	
55	3329.08	II	
11	3333.21	II	
13	3333.93	II	
11	3334.25	II	
22	3334.48	II	
12	3335.42	II	
26	3336.70	II	
32	3338.03	II	
26	3339.00	II	
13	3339.61	II	
5	3342.98	II	
13	3343.77	II	
5	3343.93	II	
5	3346.32	II	
22	3347.27	II	
22	3348.07	II	
9	3348.23	II	
16	3348.54	II	
80	3349.42	II	
19	3351.44	II	
19	3352.89	II	
5	3356.18	II	
13	3357.37	II	

609065 O - 62 - 23

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		3358.46	II	
11		3359.86	II	
5		3360.05	II	
5		3360.29	II	
34		3362.25	II	
11		3364.24	II	
9		3364.36	II	
80		3364.93	II	
11		3365.29	II	
16		3367.18	II	
24	d	3370.61	II	
34		3371.50	II	
55		3372.36	II	
48	d	3372.72	II	
20		3374.41	II	
55		3375.03	II	
11		3376.36	II	
17		3376.66	II	
20		3377.66	II	
11		3378.40	II	
34		3378.73	II	
55		3378.86	II	
9		3379.15	II	
17		3380.60	II	
9		3380.89	II	
34		3382.80	II	
11	d	3386.49	II	
9		3388.37	II	
6		3388.63	II	
11		3390.02	II	
22		3390.60	II	
40		3391.28	II	
8		3391.72	II	
17		3392.01	II	
6		3393.01	II	
17		3393.58	II	
11		3394.77	II	
17		3395.02	II	
6		3397.60	II	
28		3398.35	II	
9		3398.58	II	
34		3399.10	II	
9		3399.30	II	
11		3399.97	II	
28		3400.53	II	
22	d	3400.86	II	
44		3402.33	II	
6		3402.78	II	
6		3404.24	II	
17		3404.71	II	
20		3406.01	II	
4		3407.10	II	
9		3408.86	II	
17	d	3409.94	II	
22		3410.40	II	
22		3410.71	II	
55		3413.76	II	
28		3416.24	II	
9		3417.72	II	
6		3417.91	II	
6		3418.86	II	
6		3418.95	II	
9		3419.54	II	
42	d	3420.34	II	
20		3422.44	II	
8		3423.05	II	
11		3423.96	II	
20	d	3424.35	II	
11		3424.66	II	
6		3425.92	II	
11	d	3428.16	II	
6		3428.71	II	
6		3429.09	II	
22		3430.61	II	
6		3431.86	II	
11		3432.35	II	
11		3432.90	II	
34		3433.26	II	
6		3434.54	II	
8		3434.92	II	
8		3435.53	II	
9		3436.97	II	
20		3438.57	II	
8		3439.05	II	
28		3439.72	II	
55		3440.37	II	
8		3441.68	II	
34		3444.58	II	
22		3446.40	II	
28		3449.46	II	
11		3450.30	II	
11		3452.37	II	
8		3453.46	II	
85		3454.06	II	
11		3455.35	II	
6		3455.99	II	
11		3456.55	II	
17	h	3457.03	II	
20		3458.71	II	
40		3460.38	II	

Terbium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
20		3461.00	II	
24	d	3462.97	II	
6		3464.63	II	
11		3465.98	II	
8		3466.92	II	
65		3468.03	II	
11		3469.70	II	
8		3469.85	II	
17		3470.36	II	
28		3471.73	II	
28		3472.37	II	
85	d	3472.82	II	
22		3473.00	II	
6		3473.28	II	
8		3473.79	II	
6		3475.72	II	
11		3476.12	II	
11		3476.29	II	
6		3479.29	II	
40		3480.17	II	
9		3481.50	II	
8		3482.80	II	
24		3483.04	II	
24		3483.69	II	
12		3487.28	II	
9		3487.62	II	
30	d	3489.51	II	
12		3489.78	II	
8		3491.24	II	
22	d	3492.00	II	
17		3492.56	II	
12		3492.99	II	
28		3494.21	II	
17		3494.93	I	
28		3495.36	II	
6		3496.20	II	
17		3499.34	I	
17		3500.27	II	
85		3500.84	II	
10		3504.04	II	
15		3504.75	II	
12		3505.09	II	
28	d	3505.90	II	
8		3506.56	II	
60		3507.45	II	
600		3509.17	II	
40		3510.10	II	
10		3511.04	II	
17		3512.60	II	
34		3513.10	II	
30		3513.86	II	
30		3515.04	II	
12		3515.44	II	
22		3516.14	II	
17		3516.64	I	
17		3518.96	I	
60		3519.76	II	
17		3520.79	II	
6		3522.92	II	
6		3523.20	II	
140		3523.66	II	
40		3525.14	II	
46		3525.61	II	
17		3525.79	II	
9		3526.73	II	
12		3529.76	II	
22		3531.70	II	
17		3532.70	II	
15		3533.86	II	
46		3536.32	II	
9		3536.62		
24		3537.11	II	
12		3537.69		
60		3537.94	II	
15		3538.90		
15		3539.81		
120		3540.24	II	
12		3541.75		
30		3543.23	II	
85		3543.86	II	
10		3544.36	II	
6		3545.40	II	
8		3546.05	II	
30		3546.52		
12		3548.82		
6		3549.21		
16		3549.36	II	
32	d	3551.03		
34		3551.96	II	
17		3555.29		
6		3556.05		
12		3556.25		
8		3558.09		
48	d	3558.77		
6		3559.14		
30		3559.39	I	
24		3559.76	II	
340		3561.74	II	
50		3562.90	II	
17		3565.34		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
60	3565.74			30	3630.28	II	
85	3567.35	II		12	3631.46	II	
440	3568.51	II		70	3633.29	II	
170	3568.98	II		20	3635.42	II	
34	3572.07	II		70	3638.46	II	
17	3575.90			17	3638.95	I	
17	3576.64			30	3639.82	II	
24	3576.83			70	3641.66	II	
24	3577.08			30	3642.68	II	
12	3578.70			8	3643.26	II	
120	3579.20	II		8	3643.76	II	
75	3585.03			10	3644.13	II	
60	3587.44	II		24	3645.38	II	
12	3587.76			12	3645.82	II	
12	3589.53			10	3646.46	II	
6	3591.39			46	3647.06	II	
12	3591.66	II		60	3647.75	II	
24	cw 3593.10			10	3649.41	II	
12	3593.75			240	3650.40	II	
8	3594.65			30	3650.93	II	
12	3594.98	II		24	3651.86	II	
85	3596.38	II		24	3652.26	II	
46	3598.06	II		20	3652.97	II	
20	3600.04			17	3653.87	II	
170	3600.44	II		85	3654.88	II	
12	3601.75	II		24	3658.22	II	
34	3604.90	II		200	3658.88	II	
30	3606.04	II		12	3659.45	II	
30	3606.16	II		10	3660.44	II	
6	3608.25	II		20	3660.75	II	
34	3611.33	II		44	3663.12	II	
28	3611.41	II		9	3665.60	II	
17	3613.06	II		4	3668.00	II	
10	3613.36	II		8	3668.50	II	
24	3613.68	II		26	3669.62	I	
34	3614.63	II		10	3674.05	II	
34	d 3615.66	II		22	3675.78	II	
34	3616.58	II		380	3676.35	II	
40	3617.88	II		30	3677.89	II	
17	3618.18	II		10	3678.78	II	
12	3618.90	II		80	3682.26	II	
40	3619.73	II		22	3684.81	II	
14	3622.11	II		32	3688.15	II	
30	3623.92	II		24	3689.12	II	
12	3624.80	II		12	3689.72	II	
85	3625.54	II		60	3691.15	II	
60	3626.50	II		30	3692.95	II	
17	3626.87	II		44	3693.56	I	
30	d 3628.20	II		14	3694.75	II	
40	3629.43	II		17	3696.30	II	

Terbium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
32		3696.85	II	
20		3699.33	II	
44		3700.12	I	
20		3701.14	I	
15		3701.33	I	
8		3701.50	II	
460		3702.85	II	
30		3703.07	I	
8		3703.50	II	
240		3703.92	II	
24		3705.06	I	
28		3706.34	II	
10		3706.80	I	
10		3708.45	I	
18		3708.75	II	
36		3709.30	II	
100	d	3711.74	II	
8		3714.37	II	
14		3716.08	II	
20		3716.43	II	
10		3717.47	II	
8		3717.88	I	
4		3718.24	II	
18		3718.44	II	
30		3719.45	II	
13		3723.04	II	
4		3723.84	II	
13		3724.92	I	
8		3725.32	II	
7		3728.65		
12		3728.96		
60		3729.91	II	
8		3731.00	I	
14		3731.51	I	
40		3732.39	II	
8		3732.65	I	
12	d	3734.80		
		3735.04		
4		3738.45		
16		3740.32		
20		3741.24		
20		3741.58	II	
24		3741.89		
16	d	3742.43		
40		3743.09		
16		3743.65	I	
60		3745.07	I	
7		3746.30		
20		3746.54		
80		3747.17	II	
80		3747.34	II	
8		3748.80	II	
12		3749.70		
7	d	3750.24		
4		3751.35		
4		3751.62		
8		3752.99		
8		3753.52		
100		3755.24	II	
4		3757.04		
40		3757.44	II	
40	d	3757.90	II	
60		3759.35	I	
19	d	3760.13		
32		3761.12	I	
6		3762.51	I	
6		3762.74		
8		3763.96	I	
160		3765.14	I	
18		3767.50	II	
8		3769.43	I	
4		3771.03		
15		3775.26		
190		3776.49	II	
11		3777.48		
30		3779.22		
6		3782.18		
5		3782.62	I	
55		3783.54		
5		3784.15	I	
11		3785.38		
38	d	3787.22		
11		3787.60		
8		3787.71	I	
15		3789.00		
11		3789.68		
38		3789.92		
11		3791.07		
36		3792.18		
7		3793.30		
55		3793.55		
12		3796.20		
7		3796.98		
15		3798.59		
18		3798.95	II	
7	h	3801.36		
30		3801.80	II	
15		3802.17	II	
11		3804.42		
9		3806.26		

Terbium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
70	d	3806.85		
3.5	d	3810.57		
22		3811.65	I	
22		3812.73		
22		3813.16		
14	d	3814.97		
11		3816.27		
22		3816.90		
14		3820.11	II	
7		3821.00		
11		3823.12		
6		3824.14		
7	h	3826.74		
140		3830.29	II	
7		3832.65		
50		3833.40	I	
17		3834.02	I	
7		3837.18	I	
14		3837.83		
85	d	3842.50	II	
17		3842.98		
34	d	3845.61	II	
17		3847.88	I	
340		3848.76	II	
4		3849.59	I	
10	w	3851.37		
24		3851.86	II	
7		3855.38	I	
16		3855.58	II	
13		3868.90	II	
42	d	3869.75	II	
8		3873.00	I	
19		3873.78	II	
320	w	3874.19	II	
22		3875.22	II	
6		3876.67	I	
12		3878.21	II	
9		3879.99	I	
9		3880.35	I	
9		3881.29	I	
24		3881.76	II	
18		3885.10	I	
24		3886.82	II	
15	d	3887.64	II	
15		3887.88	I	
44		3888.23	I	
9		3889.84	II	
6		3890.95	I	
15		3893.38	II	
6		3893.69	I	
15		3894.46	II	
45		3894.60	I	
6		3895.08	I	
6		3895.39	I	
30		3895.99	II	
30		3896.58	II	
4		3897.26	I	
30		3897.89	I	
220		3899.20	II	
15		3899.57	II	
12		3900.74	I	
150		3901.35	I	
9		3901.68	II	
9	d	3902.00	II	
3.0		3903.08	I	
7		3904.14	I	
5		3906.54	II	
44		3908.08	I	
6		3908.68	I	
35		3909.16	I	
30		3909.54	I	
9		3910.14	II	
15		3910.43	I	
15		3910.85	I	
10		3912.30	I	
7		3912.77	II	
26		3913.48	I	
14		3914.63	I	
60		3915.43	I	
6		3916.67	I	
4		3916.90	I	
7		3917.30	I	
9		3918.78	II	
7		3919.00	I	
44		3919.52	II	
14		3920.72	II	
28		3922.10	II	
44		3922.74	II	
14		3923.31	II	
6	d	3924.42	II	
10		3924.81	II	
70		3925.45	II	
6		3929.75	I	
7		3929.89	I	
5		3930.76	II	
20		3932.37	I	
12		3934.41	I	
60		3935.24	II	
6		3937.17	I	
15		3937.64	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	3938.07	I	
75 d	3939.52	II	
24	3941.21	II	
20	3942.21	II	
10	3942.95	I	
9	3943.68	I	
15	3944.88	II	
60	3946.89	II	
4	3947.25	I	
24	3948.35	II	
6	3949.51	II	
19	3950.14	I	
19	3950.44	I	
6	3951.88	I	
19	3954.05	I	
4	3955.65	I	
6	3956.18	II	
16	3957.35	I	
26	3957.97	II	
32 d	3958.36	II	
3.0 h	3960.12	II	
6	3960.30	I	
9	3960.70	I	
3	3962.61	I	
16	3965.10	I	
16	3965.95	II	
9	3967.22	I	
20	3967.66	I	
5	3969.94	I	
16 d	3970.19	II	
20	3971.79	I	
16	3972.06	II	
16	3974.29	II	
16	3974.68	I	
200 d	3976.84	II	
24	3981.16	II	
170	3981.89	II	
28	3983.85	II	
24	3984.05	II	
14	3984.84	II	
14	3985.08	II	
24	3986.35	II	
14	3987.67	I	
7	3989.54	I	
5	3990.22	I	
20	3990.63	I	
7 d	3991.58	I	
17 d	3993.54	I	
8	3995.15	I	
7 d	3995.80	II	
14	3997.43	II	
14	3998.40	II	
10	3998.90	I	
6	3999.24	II	
32	3999.40	II	
14	4000.01	II	
17	4001.28	I	
32 d	4002.19	II	
90	4002.59	II	
10	4003.78	II	
6	4003.91	II	
7	4004.52	II	
180	4005.57	II	
10	4005.97	II	
14	4009.26	I	
14	4009.56	II	
28	4010.06	I	
14	4010.85	I	
70	4012.75	II	
14	4012.86	II	
30	4013.27	I	
7	4017.85	II	
10	4018.42	I	
34	4019.14	II	
50	4020.47	II	
20	4022.89	I	
17 d	4024.10	II	
34	4024.79	I	
16	4025.73	II	
16 d	4028.31	II	
8	4028.59	I	
48	4031.66	II	
80	4032.34	I	
13 d	4032.72	I	
190	4033.06	II	
32	4036.24	I	
4	4036.46	II	
19	4038.86	I	
3	4039.21	II	
14	4039.48	I	
14	4040.11	I	
12	4040.41	II	
6	4041.85	I	
9	4042.34	II	
4	4043.67	II	
6	4045.36	I	
14	4047.14	I	
6	4048.82	I	
5	4049.87	II	
6	4051.49	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
28	4051.86	II	
28	4052.87	II	
14	4054.00	I	
40	4054.12	I	
38	4060.40	I	
20	4060.87	II	
120	4061.59	I	
20	4063.89	II	
36	4066.22	II	
14	4070.13	I	
10 d	4070.54	II	
5	4070.72	I	
10	4071.22	I	
12 d	4072.69	I	
10	4073.75	II	
7	4073.94	I	
12	4074.16	I	
24	4075.22	I	
9	4078.47	II	
5 d	4078.79	I	
36	4081.24	I	
2.5 h	4082.24	II	
12	4082.80	I	
10	4083.21	I	
10	4084.27	I	
10	4084.84	I	
19	4086.62	I	
4	4087.70	II	
11	4089.35	II	
5	4089.51	II	
6 d	4091.35	I	
19	4092.20	I	
12	4094.05	I	
24	4094.37	II	
24	4094.50	I	
11	4095.93	I	
9	4097.36	II	
10	4097.48	II	
5	4098.62	II	
4	4099.15		
7 d	4099.48	II	
12 d	4100.90	I	
12	4101.65	I	
8	4102.53	II	
7	4103.21	I	
16	4103.36	I	
8	4103.46	I	
24	4103.90	II	
60	4105.37	I	
4	4106.35	I	
5	4107.79	I	
5	4110.09	I	
5	4110.86	I	
28	4112.50	I	
12	4112.88	I	
5 h	4114.13	II	
5 d	4115.36	II	
10	4117.23	I	
5	4118.43	I	
24	4119.96	I	
10	4120.51	II	
8	4121.03	I	
10	4122.47	I	
8	4126.71	I	
13	4127.29	I	
13	4130.14	I	
5	4131.11	I	
13	4131.45	I	
4	4132.23		
13	4132.48	I	
8	4132.83	I	
5	4133.51	I	
5 d	4134.32		
12	4135.37	I	
3.5	4136.47	I	
3.5	4137.03		
5	4139.06	I	
13	4139.79	I	
13	4141.55	I	
5	4142.45	I	
5	4143.24	I	
26	4143.49	I	
13	4143.57	I	
100	4144.46	II	
10	4146.96	I	
4	4148.21	II	
10	4149.17	II	
5	4150.54		
5	4150.86	I	
8	4152.24	I	
8	4156.28	I	
5	4158.28	II	
32	4158.53	I	
11 cw	4161.36	I	
5	4166.51		
22	4169.11	I	
22	4169.31	I	
11	4169.92	I	
8	4170.49	I	
22	4171.05	I	

Terbium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
14	4171.80	I	
22	4172.60	I	
22	4172.82	I	
24	4173.47	I	
6	4175.08	I	
8	4175.84	I	
14 d	4178.98	II	
6	4179.79	II	
17	4180.40	I	
8	4181.33	II	
17	4184.29	I	
6	4185.89	I	
22	4186.24	I	
28	4187.16	I	
17	4188.09	I	
7	4188.51	II	
14	4191.08	I	
17	4191.59	I	
5	4193.35	I	
7	4194.01	I	
36	4196.73	I	
8	4198.41	I	
11 d	4199.06	I	
42	4201.00	II	
60	4203.72	I	
55	4206.49	I	
6	4206.80	I	
11	4207.53	I	
11 d	4208.70	I	
28 cw	4213.50	I	
28	4214.42	II	
44	4215.13	I	
9 h	4216.67	I	
28	4217.56	I	
9	4218.86	I	
24	4219.17	I	
8	4220.10	II	
5	4221.41	I	
9	4222.71	I	
7	4223.32	II	
24	4224.28	I	
44 cw	4226.45	II	
8	4230.62	I	
6	4231.34	I	
24	4231.89	I	
17	4232.19	II	
44	4232.82	I	
6	4234.22	I	
28	4235.35	I	
15	4239.28	I	
9	4239.91	I	
9	4242.56	II	
9	4245.14	I	
12	4246.59	I	
6	4248.57	II	
5	4250.26	II	
12	4251.33	I	
12	4251.72	II	
9	4252.70	I	
6	4254.04	I	
34	4255.25	I	
9	4256.12	I	
44	4258.23	I	
5	4261.84	I	
24	4263.66	I	
6	4264.72	I	
7	4264.98	I	
60	4266.34	I	
30	4269.69	I	
9	4271.63	I	
9	4272.21	I	
20	4275.21	I	
10 d	4276.75	II	
9	4277.77	I	
70 cw	4278.52	II	
28	4285.13	II	
6	4285.75	II	
6	4286.13	II	
11	4286.91	II	
14	4287.11	I	
28	4289.72	I	
6 h	4293.13	I	
6 h	4294.04	I	
14	4295.34	I	
8	4296.34	I	
34	4298.37	I	
28	4299.90	I	
6	4301.15	I	
22	4302.94	I	
11	4304.00	I	
6	4304.27	I	
22	4307.21	I	
14 d	4308.68	II	
42	4310.44	I	
7	4310.96	II	
8	4311.29	I	
28	4311.56	I	
10	4312.08	II	
34	4313.25	I	
11 h	4313.43	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
14	4315.73	I	
200	4318.85	I	
14	4320.26	I	
5	4321.49	I	
55	4322.24	I	
16	4322.87	I	
8 d	4323.66	II	
11	4325.50	I	
55	4325.83	II	
8	4326.14	I	
280	4326.47	I	
22	4328.95	I	
8	4330.31	I	
55	4332.12	I	
5	4333.73	I	
14	4334.68	I	
80	4336.50	I	
55	4337.64	I	
160	4338.45	I	
14	4339.62	I	
8	4339.87	I	
65	4340.62	I	
10	4341.00	I	
40 cw	4342.53	I	
5 h	4343.85	I	
4	4344.21	II	
5	4346.49	I	
10	4349.61	I	
5 h	4350.75	I	
5	4351.60	II	
40 d	4353.20	II	
26	4356.09	I	
80	4356.84	I	
4	4357.47	I	
26	4360.16	I	
5 w	4362.44	I	
4	4366.00	II	
20	4367.30	I	
20	4372.05	I	
5	4374.43	I	
5	4376.43	II	
8	4381.31	I	
30	4382.46	I	
4	4384.06	II	
12	4385.68	I	
12	4386.08	II	
28	4388.25	I	
5 h	4389.81	I	
24	4390.91	I	
4	4392.96	I	
5	4394.03	I	
4	4394.92	II	
17	4396.56	I	
4	4401.54	II	
7	4403.18	I	
7	4405.40	II	
5	4406.76	I	
9 d	4409.52	II	
5	4411.14	I	
5	4411.93	I	
5	4413.63	I	
18	4416.27	II	
13	4420.20	I	
32	4423.11	I	
4	4427.34	I	
4 d	4430.13	II	
9	4430.66	I	
10	4432.70	I	
9	4434.47	II	
7	4435.01	I	
7	4435.55	II	
22	4436.12	I	
9	4438.97	II	
10	4439.38	I	
4	4441.27	II	
7 h	4441.48	I	
22	4448.04	I	
8	4451.64	I	
8 d	4452.82	I	
4 h	4459.38	II	
4	4461.27	I	
10	4467.70	I	
6	4469.12	I	
4	4471.72	II	
3.5	4485.68	I	
8	4488.16	I	
6	4491.01	I	
40	4493.08	I	
4	4499.47	I	
4 d	4509.04	II	
14 h	4511.52	I	
4	4512.96	II	
7	4514.31	II	
4	4519.72	II	
4	4525.01	II	
4	4529.76		
4 h	4531.83	II	
4	4534.13	I	
8 d	4537.14	I	
	4537.23	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10	4549.07	I	
4	4549.72	II	
10	4550.45	I	
10	4556.46	I	
5	4562.24	II	
10	4563.69	II	
3.0	4564.85	II	
5	4573.19	II	
19	4578.69	II	
6	4584.84	II	
6	4591.56	II	
4	4592.38	I	
4 h	4604.10	II	
3.0	4611.96	I	
4 h	4615.92	II	
2.5	4617.49	I	
3.0	4619.36	II	
7 d	4626.32	II	
9	4626.94	II	
6	4632.07	I	
6 h	4636.59	I	
3.0	4636.99	II	
8	4641.00	II	
19	4641.98	II	
24 cw	4645.28	II	
8	4647.23	I	
6	4658.38	I	
2.0	4658.73		
8	4662.80	I	
5 c	4665.45	I	
4	4669.40	I	
8	4676.90	I	
7 c	4681.87	I	
5	4682.52	I	
2.5 c	4682.79	II	
8	4688.63	II	
8	4693.11	II	
3.0 h	4693.39	II	
20	4702.41	II	
11	4707.94	II	
4 w	4716.07	II	
4	4728.16	II	
6 cw	4734.20	II	
8	4739.93	I	
7	4747.80	I	
40 cw	4752.51	II	
4	4758.44	II	
4	4760.19	II	
3.0	4762.37	II	
2.5	4764.47	II	
3.5	4778.36	II	
3.5	4778.80	II	
18	4786.78	I	
4 cw	4789.91	II	
3.0	4801.87	II	
10	4813.77	I	
6	4837.59	II	
2.5	4840.39	I	
3.0 c	4842.69	II	
3.0	4844.89	II	
3.0	4854.81	I	
2.0	4856.54	II	
3.0	4858.87	II	
8	4875.58	II	
2.5	4876.12	II	
8	4881.15	II	
3.0	4894.33		
10	4915.90	I	
3.5	4924.09	I	
3.5	4926.83	I	
5	4928.93	I	
7	4931.79	I	
2.0	4940.72	II	
2.0	4959.93	II	
2.0	4962.28	II	
3.0	4970.99	II	
3.0	4971.42	I	
3.0	4973.04	I	
3.0	4980.16	II	
3.0	4980.56	I	
9	4993.85	II	
5	4995.84	II	
6	4997.95	I	
2.0	5004.84	I	
3.0	5006.10	II	
5	5022.16	I	
3.0	5024.24	II	
3.0	5024.65	I	
5	5033.12	I	
5 w	5042.06	II	
6	5054.30	I	
6	5065.79	I	
11	5078.25	I	
2.5	5080.05	II	
2.5	5081.11	I	
2.0	5081.80	I	
8	5089.12	II	
2.5	5089.66	I	
2.5	5101.09	I	
2.5	5108.56	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	5118.39	I	
2.5	5120.18	I	
2.0	5121.61	II	
5 w	5131.69	I	
5 w	5141.08	II	
5	5147.58	I	
2.5	5164.27	I	
3.0	5170.13	I	
2.5	5170.61	I	
5	5176.51	I	
5	5179.97	I	
5	5184.59	I	
9	5186.16	I	
5	5188.48	I	
5	5198.86	I	
3.5 w	5202.77	I	
4	5204.55	I	
4	5207.97	I	
2.0	5209.34	II	
4	5214.28	I	
4	5221.99	I	
12	5228.12	I	
4	5235.11	I	
8	5248.71	I	
8 w	5262.11	II	
1.4	5264.92		
2.0 w	5272.07	II	
2.5	5275.03	I	
8	5281.05	I	
1.4	5287.30		
7	5304.72	I	
3.0	5308.19	I	
3.0	5309.46	I	
11	5319.23	I	
1.6	5322.11	II	
1.6	5323.92	II	
1.6	5329.05	I	
3.5	5331.04	I	
1.2	5332.58	I	
7 w	5337.90	I	
3.5 d	5338.59	I	
1.6	5346.14	I	
2.5	5347.93		
17	5354.88	I	
1.0	5363.62	I	
8	5369.72	I	
8	5375.98	I	
2.0 w	5377.88	II	
1.6	5397.90		
3.0 d	5402.06	II	
1.6	5403.82	II	
3.0	5413.65	I	
3.0	5416.20	I	
5	5424.10	II	
2.0	5425.00	I	
3.0 c	5426.43	I	
1.4	5427.47	I	
1.4	5432.45	II	
1.4	5437.10	I	
1.4	5438.12	I	
3.5	5443.38	I	
3.0	5457.00	I	
6	5459.81	I	
2.0	5464.39	I	
3.0 w	5470.34	II	
1.2	5476.96	I	
2.5	5481.45	I	
1.2	5488.26	II	
1.2	5500.10	II	
6	5509.61	I	
5	5514.54	I	
7	5524.12	I	
2.5 c	5525.62	II	
1.2	5536.26	II	
1.2	5556.30	II	
3.5	5565.93	I	
1.2	5572.82	I	
2.0	5586.96	I	
2.0	5589.56	I	
1.2	5591.62	II	
1.2	5621.55	II	
2.0	5636.56	I	
3.0 c	5638.80	I	
2.0 c	5645.75	I	
2.0	5671.84	I	
3.0 c	5685.74	II	
4 c	5686.48	I	
1.8	5712.45	II	
9 c	5747.58	I	
0.9	5761.62	II	
2.5	5762.66	I	
2.5	5785.18	II	
8	5795.64	I	
8	5803.13	I	
7	5815.36	I	
3.0	5842.97	I	
7	5851.07	I	
7	5870.62	I	
3.5	5898.84	I	
2.5	5902.40	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	5904.71	I	
1.6	5910.10	I	
7 c	5920.78	I	
1.6	5937.09	I	
5 c	5939.38	I	
3.5	5940.17	I	
2.5	5951.17	I	
1.6	5951.78	I	
2.0	5961.00	II	
8	5967.34	II	
1.6 c	5979.83	I	
1.2	6010.65	II	
1.6	6019.24	II	
3.0	6038.97	I	
3.0	6039.38	I	
1.6	6061.83	I	
1.6	6077.84	II	
1.6	6084.34	II	
1.6	6093.99	II	
2.5	6104.29	II	
1.4	6106.06	II	
1.4	6134.39	II	
1.4	6137.00	II	
1.4 c	6156.29	I	
1.2	6171.88		
1.2	6193.64	II	
1.2	6194.52	II	
1.2 c	6195.14	II	
1.0	6218.4	II	
1.4	6222.25	II	
1.0	6225.95	II	
1.2 h	6272.36	I	
2.5 c	6292.43	II	
2.0	6303.78	II	
1.0	6317.82	II	
2.0	6321.59	II	
2.0	6322.33	II	
3.5	6331.68	II	
2.5	6334.91	II	
1.0	6336.74	II	
1.2	6337.85	II	
0.9	6356.40	II	
0.9	6359.88	II	
1.8 c	6405.97	II	
1.4	6424.43	II	
1.0 c	6441.03	II	
2.5	6446.87	II	
1.0 c	6461.74	II	
1.4	6470.86	II	
0.8 c	6501.33	II	
0.9	6512.19	II	
3.5 cw	6518.68	I	
1.8	6527.63	II	
2.5 c	6574.04	II	
3.5	6581.82	II	
1.4	6593.66	II	
3.0	6607.17	II	
1.6	6640.14	II	
0.8 c	6642.27	II	
1.8	6645.41	II	
0.6	6665.94	II	
9	6677.94	II	
0.8	6689.51	II	
1.8	6693.38	II	
4 cw	6702.61	II	
2.0 c	6706.79	II	
1.2 c	6714.98	II	
0.7	6727.21	II	
0.7 c	6734.86	II	
0.7	6754.29	I	
1.4	6755.01	II	
1.4	6769.81	II	
3.0	6785.12	II	
1.2 c	6792.48	II	
12	6794.58	II	
3.5	6874.18	II	
5	6896.37	II	
4 h	6899.95	II	
3.5	6902.08	II	
1.2	6916.69	II	
1.2 h	6923.09	II	
1.0	6989.60	II	
0.8	7005.99	II	
1.6	7082.85	II	
1.0	7089.22	II	
1.0	7112.69	II	
0.9	7187.48	II	
0.9 h	7195.89	II	
6	7204.28	II	
1.8 h	7234.98	I	
3.5	7257.73	I	
1.6	7311.57	II	
4	7348.88	II	
0.9	7398.27	II	
1.4 h	7424.24	II	
0.9 h	7429.62	II	
0.8	7472.15	I	
2.0	7484.54	II	
0.8	7495.45	I	
4	7496.12	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.6		7499.69	II	
2.5		7511.40	II	
0.8		7519.77	II	
0.6		7557.59	II	
2.5	h	7582.03	II	
2.5		7587.49	II	
4		7590.24	I	
6		7596.44	I	
1.6	h	7601.18	II	
1.6		7616.01	II	
2.0	h	7624.05	I	
3.0		7627.81	I	
0.8	h	7639.05	II	
0.7		7672.72	II	
0.7	h	7694.74	II	
2.0	h	7706.16	I	
2.0	h	7726.97	I	
3.0		7737.63	I	
2.0		7793.20	II	
0.7		7807.33	II	
1.5		7832.91	II	
3.0		7855.79	II	
1.4		7864.99	II	
0.6	h	7885.70	II	
0.6		7913.11		
2.5		7927.90	II	
1.2		7955.31	I	
1.0		7998.03	I	
1.2		7998.93	I	
1.6		8001.04	I	
1.2	h	8010.16	II	
3.0		8025.42	II	
0.6		8046.06	I	
0.6		8053.80	I	
1.8		8067.35	II	
3.0		8085.06	II	
2.5		8164.17	II	
1.2		8171.70		
6		8194.82	II	
9		8212.57	II	
1.0		8214.33	I	
3.0		8220.37	I	
0.7		8259.08	I	
3.5		8327.00	I	
4		8387.77	I	
3.5		8450.06	II	
0.7	h	8465.80	II	
1.4		8468.59	I	
1.2		8502.70	II	
3.0	h	8512.01		
4		8583.45	II	
3.0		8603.40	I	
3.5		8661.91	I	
0.8		8678.25	I	
4		8688.61	I	
6		8765.74	II	

THALLIUM

Tl, $Z=81$, $M=204.39$, Ratio $\frac{Tl}{Cu}=3.217$

Tl I Normal state of valence electrons $6s^2 6p^1\ ^2P^\circ_{0\frac{1}{2}}=0$. I.P.= 49264 K
Tl II Normal state of valence electrons $6s^2\ \ ^1S_0=0$. I.P.=164765 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
A. Fowler, Report on Series in Line Spectra, (Fleetway Press, London, 1922).

Classification:
Tl I, A. Fowler, Report on Series in Line Spectra, (Fleetway Press, London, 1922).

Intensities:
W. Kuhn, Naturwiss. **13,** 724 (1925).
W. Prokoviev and W. Soloviev, Z. Physik **48,** 276 (1928).
A. Filippov and W. Prokoviev, Z. Physik **85,** 647 (1933).

Relative intensity of thallium lines observed in an arc of copper containing 0.1 atomic percent of thallium

Strong lines of thallium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
2000	3519.24	I	7793–36200	$6s^2 6p^1\ ^2P^i_{1\frac{1}{2}}$—$6s^2 6d^1\ ^2D_{2\frac{1}{2}}$
1800	5350.46	I	7793–26478	$6s^2 6p^1\ ^2P^i_{1\frac{1}{2}}$—$6s^2 7s^1\ ^2S_{0\frac{1}{2}}$
1200 cw	3775.72	I	0–26478	$6s^2 6p^1\ ^2P^i_{0\frac{1}{2}}$—$6s^2 7s^1\ ^2S_{0\frac{1}{2}}$
500	3529.43	I	7793–36118	$6s^2 6p^1\ ^2P^i_{1\frac{1}{2}}$—$6s^2 6d^1\ ^2D_{1\frac{1}{2}}$
440 d	2767.87	I	0–36118	$6s^2 6p^1\ ^2P^i_{0\frac{1}{2}}$—$6s^2 6d^1\ ^2D_{1\frac{1}{2}}$

Thallium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2315.98	I	0–43166	280	2918.32	I	7793–42049
40 h	2379.69	I	0–42011	44	2921.52	I	7793–42011
70	2580.14	I	0–38746	120	3229.75	I	7793–38746
6	2608.99	I	7793–46110	2000	3519.24	I	7793–36200
8	2665.57	I	7793–45296	500	3529.43	I	7793–36118
42	2709.23	I	7793–44693	1200 cw	3775.72	I	0–26478
5 h	2710.67	I	7793–44673	1800	5350.46	I	7793–26478
440 d	2767.87	I	0–36118	1.6 h	6549.77	I	26478–41741
28	2826.16	I	7793–43166	0.6 h	6713.69	I	26478–41368

THORIUM

Th, $Z=90$, $M=232.05$, Ratio $\frac{\text{Th}}{\text{Cu}}=3.652$

Th I Normal state of valence electrons $6d^2\,7s^2\ {}^3F_2\ =0$. I. P. ≈ 50000 K
Th II Normal state of valence electrons $6d^1\,7s^2\ {}^2D_{1½}=0$.

References

Wavelengths and Spectrum Assignments:
R. Zalubas, NBS Monograph 17 (1960).
Classification:
Th I, R. Zalubas, unpublished material.
Th II, J. R. McNally, G. R. Harrison, and H. B. Park, J. Opt. Soc. Am. **32,** 334 (1942).
J. R. McNally, J. Opt. Soc. Am. **35,** 390 (1945).

Relative intensity of thorium lines observed in an arc of copper containing 0.1 atomic percent of thorium

Strong lines of thorium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
300	4019. 13	II	0–24874	$6d^17s^2$ $a\ {}^2D_{1½}$— $57^{\circ}_{2½}$
110	2837. 30	II		
95	3469. 92	II	4147–32957	$6d^27s^1$ $a\ {}^4F_{3½}$— $81^{\circ}_{3½}$
90	3392. 03	II	1522–30994	$6d^27s^1$ $a\ {}^4F_{2½}$— $73^{\circ}_{3½}$
90	3741. 19	II	1522–28244	$6d^27s^1$ $a\ {}^4F_{2½}$— $67^{\circ}_{2½}$
90	4381. 86	II	6700–29515	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{4½}$— $111_{4½}$
80	4391. 11	II	4490–27257	$5f^17s^2$ $a\ {}^2F^{\circ}_{2½}$—$5f^17s^17p^1$ ${}^4G_{3½}$
75	3180. 20	II	1522–32957	$6d^27s^1$ $a\ {}^4F_{2½}$— $81^{\circ}_{3½}$
75	4116. 71	II	6168–30453	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{3½}$— $112_{4½}$
70	2832. 31	II	4147–39443	$6d^27s^1$ $a\ {}^4F_{3½}$— $106^{\circ}_{4½}$
70	3351. 23	II	1522–31353	$6d^27s^1$ $a\ {}^4F_{2½}$—$6d^17s^17p^1$ ${}^4F^{\circ}_{1½}$
70	3402. 70	II		
70	3434. 00	II	1860–30972	$6d^27s^1$ $a\ {}^4F_{1½}$— ${}^2P^{\circ}_{2½}$
70	3609. 44	II	4113–31811	$6d^17s^2$ $a\ {}^2D_{2½}$— $77^{\circ}_{2½}$
65	3256. 28	II		
65	3262. 67	II	6168–36809	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{3½}$— $143_{3½}$
65	3291. 74	II	6214–36584	$6d^27s^1$ $a\ {}^4F_{4½}$—$6d^27p^1$ ${}^4G^{\circ}_{3½}$
65	4069. 20	II	6691–31259	$5f^16d^17s^1$ $a\ {}^4F^{\circ}_{1½}$— $114_{2½}$
60	3325. 12	II	4147–34212	$6d^27s^1$ $a\ {}^4F_{3½}$— $84^{\circ}_{3½}$
60	3839. 74	II	6700–32736	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{4½}$— $119_{3½}$
60	4108. 42	II	4490–28824	$5f^17s^2$ $a\ {}^2F^{\circ}_{2½}$—$5f^17s^17p^1$ ${}^4F_{2½}$
55	3188. 23	II	1860–33216	$6d^27s^1$ $a\ {}^4F_{1½}$— $82^{\circ}_{1½}$
55	3435. 98	II	0–29095	$6d^17s^2$ $a\ {}^2D_{1½}$— $69^{\circ}_{2½}$
55	3721. 82	II	1860–28721	$6d^27s^1$ $a\ {}^4F_{1½}$— ${}^4D^{\circ}_{1½}$
50	3675. 57	II	1522–28721	$6d^27s^1$ $a\ {}^4F_{2½}$— ${}^4D^{\circ}_{1½}$
50	4085. 04	II	10189–34662	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{5½}$— $130_{5½}$
50	4086. 52	II	0–24464	$6d^17s^2$ $a\ {}^2D_{1½}$— $55^{\circ}_{2½}$
50	4094. 75	II	0–24415	$6d^17s^2$ $a\ {}^2D_{1½}$— $54^{\circ}_{1½}$
50	4282. 04	II	6168–29515	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{3½}$— $111_{4½}$
48	2870. 40	II	1860–36688	$6d^27s^1$ $a\ {}^4F_{1½}$—$6d^27p^1$ ${}^4G^{\circ}_{2½}$
48	3078. 82	II	4113–36584	$6d^17s^2$ $a\ {}^2D_{2½}$—$6d^17s^17p^1$ ${}^4F^{\circ}_{3½}$
48 d	3511. 56	II	4490–32960	$5f^17s^2$ $a\ {}^2F^{\circ}_{2½}$— $120_{1½}$
	3511. 67	II		
48	3539. 59	II	0–28244	$6d^17s^2$ $a\ {}^2D_{1½}$— $67^{\circ}_{2½}$
48 d	3617. 02	II	15305–42944	$6d^3$ $a\ {}^2H_{4½}$—$6d^17s^17p^1$ ${}^4D^{\circ}_{3½}$
	3617. 12	II		
46	2747. 16	II	0–36390	$6d^17s^2$ $a\ {}^2D_{1½}$—$6d^27p^1$ ${}^4F^{\circ}_{1½}$
46	3752. 57	II	9238–35879	$5f^16d^17s^1$ $a\ {}^2G^{\circ}_{4½}$—$5f^17s^17p^1$ ${}^2G_{3½}$
44	2565. 60	II	1860–40826	$6d^27s^1$ $a\ {}^4F_{1½}$—$6d^27p^1$ ${}^4D^{\circ}_{0½}$
44	3287. 79	II	1522–31929	$6d^27s^1$ $a\ {}^4F_{2½}$—$6d^17s^17p^1$ ${}^2D^{\circ}_{1½}$
44	3292. 52	II	6700–37063	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{4½}$— $145_{4½}$
44	3334. 61	II	6214–36194	$6d^27s^1$ $a\ {}^4F_{4½}$—$6d^17s^17p^1$ ${}^4F^{\circ}_{4½}$
44	3337. 87	II	1860–31811	$6d^27s^1$ $a\ {}^4F_{1½}$— $77^{\circ}_{2½}$
44	3358. 60	II	1860–31626	$6d^27s^1$ $a\ {}^4F_{1½}$—$6d^17s^17p^1$ ${}^4D^{\circ}_{0½}$
44	4178. 06	II	7332–31259	$5f^16d^17s^1$ $a\ {}^4F^{\circ}_{2½}$— $114_{2½}$
44	4208. 89	II	6700–30453	$5f^16d^17s^1$ $a\ {}^4H^{\circ}_{4½}$— $112_{4½}$
42	2692. 42	II	0–37130	$6d^17s^2$ $a\ {}^2D_{1½}$—$6d^27p^1$ ${}^4D^{\circ}_{0½}$
42	3238. 12	II		
42	3719. 44	I	0–26878	$6d^27s^2$ $a\ {}^3F_2$ — 26878°_{3}
42	3803. 07	I	0–26287	$6d^27s^2$ $a\ {}^3F_2$ — 26287°_{1}
42	3929. 67	II	0–25440	$6d^17s^2$ $a\ {}^2D_{1½}$— $61^{\circ}_{2½}$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2326.93	II	1860–44822
3.0	2354.02	II	
3.0	2356.75	II	0–42418
1.6	2366.04	II	
4	2366.98	II	
1.8	2368.05	II	4490–46706
6	2373.84	II	0–42113
4	2375.07	II	
9	2377.84	II	4113–46156
3.0	2384.36	II	
3.0	2388.14	II	1522–43383
3.0	2393.11	II	4490–46264
5	2404.17	II	
5	2404.51	II	4113–45689
2.5	2411.30	II	
6	2413.41	II	1522–42944
3.0	2423.00	II	
6	2423.68	II	
2.0	2431.15	II	4490–45611
4	2432.85	II	
3.5	2437.54	II	
3.0	2443.96	II	
2.5	2444.46	II	1522–42418
2.5	2450.78	II	
8	2456.30	II	4490–45190
2.0	2456.86	II	
2.5	2459.01	II	0–40655
8	2466.13	II	4113–44651
5	2468.15	II	4147–44651
4	2470.59	II	
3.0	2476.95	II	1860–42220
1.2	2485.05	II	9061–49289
6	2489.62	II	6214–46368
3.0	2494.61	II	
6	2495.35	II	4490–44553
1.8	2497.56	II	
5	2498.40	II	4490–44504
5	2498.86	II	6700–46706
3.0	2502.87	II	
9	2504.28	II	
3.5	2505.60	II	4490–44389
5	2507.91	II	0–39862
2.5	2509.96	II	9585–49415
2.5	2516.42	II	
7	2520.66	II	
1.2	2525.93	II	9712–49289
2.5 d	2526.22	II	
	2526.34	II	7331–46903
4	2532.43	II	6214–45689
4	2535.87	II	7001–46424
3.0	2542.65	II	4490–43808
5	2545.34	II	6214–45489
3.0	2545.74	II	4113–43383
13	2547.90	II	4147–43383
3.0	2548.14	II	9585–48818
1.0	2549.99		
1.2	2551.24	II	1522–40707
1.0	2554.65	I	
1.8	2555.17	II	
0.7	2560.93	II	
7	2561.94	II	6168–45190
44	2565.60	II	1860–40826
24	2566.59	II	1522–40472
2.5	2567.94	I	
6	2574.48	II	4113–42944
1.0	2576.32	I	
18	2576.69	II	4147–42944
9	2579.43	II	
2.0	2580.35	II	
5	2580.70	II	4490–43228
3.0	2583.45	I	
1.2	2586.15	II	
1.0	2587.25	II	
20	2589.06	II	1860–40472
5	2595.03	II	8379–46903
20	2597.05	II	0–38494
20	2600.89	II	6214–44651
2.5	2607.48	II	1522–39862
2.0	2608.32	II	8379–46706
9	2609.86	II	4113–42418
2.0	2611.62	I	
20	2618.90	II	4147–42319
24	2623.45	II	4113–42220
24	2625.74	II	4147–42220
2.5	2626.40	II	
5	2628.81	II	4490–42519
1.6	2630.02	II	
4	2633.33	II	8460–46424
3.5	2639.51	II	1522–39397
1.2	2639.88	II	
1.2	2640.27	II	
1.2	2640.40	II	4490–42352
24	2641.49	II	0–37846
1.2	2642.61	II	
1.2	2643.27	II	7001–44822
4	2649.48	II	
4	2649.87	II	
15	2650.58	II	0–37716
13	2658.66	II	0–37602
3.0	2661.39	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2662.34	II	8606–46156
3.5	2662.86	II	
2.0	2664.06	II	
1.6	2665.89	II	6244–43744
1.0	2667.54	II	
1.6	2669.45	II	
1.6	2671.47	II	
1.6	2672.94		
3.0	2675.67	II	9061–46424
1.6	2678.93	II	9585–46903
32	2684.29	II	
11	2687.13	II	8018–45221
1.6	2688.34	II	4490–41677
2.0	2691.03	I	
4	2691.18	II	
42	2692.42	II	0–37130
1.6	2693.97	II	
1.6	2695.02	II	
7	2695.21	II	11726–48818
10	2695.56	II	
2.5	2695.81	II	8606–45689
3.5	2696.83	II	12220–49289
4	2697.54	II	1522–38582
6	2698.74	II	6244–43288
1.6	2700.60	II	9585–46603
2.5	2701.82	II	
24	2703.96	II	1522–38494
15	2708.18	II	1522–38436
1.0	2710.48	II	
3.0	2711.46	II	
3.0	2714.61	II	
3.5	2715.09	II	
8	2716.32	II	8018–44822
3.0	2719.45	II	8460–45221
5	2719.93	II	9401–46156
20	2721.70	II	6214–42944
15	2722.38	II	1860–38582
1.6	2723.32	II	
6	2724.89	II	0–36688
3.5	2726.49	II	
2.5	2727.25	II	9712–46368
4	2728.91	II	1860–38494
22	2729.33	II	9061–45689
9	2730.27	II	8606–45221
3.5	2731.58	II	
3.0	2731.92	II	
22	2732.82	II	0–36582
1.0	2733.20	II	
14	2734.42	II	4147–40707
2.5	2735.83	II	4113–40655
2.0	2736.44		
6	2737.43	II	8379–44899
4	2738.33	II	4147–40655
2.0	2738.82	II	
1.6	2740.48	II	
16	2743.07	II	0–36445
46	2747.16	II	0–36390
1.6	2747.58	II	
4	2747.85	II	7001–43383
3.5	2748.81	II	
9	2749.53	II	4113–40472
1.6	2749.71	II	
36	2752.17	II	1522–37846
1.6	2753.09	II	
1.6	2755.96	II	
1.6	2758.96	II	
4	2759.41	II	
11	2760.40	II	8606–44822
13	2763.62	II	6244–42418
9	2764.64	II	9061–45221
9	2765.12	II	4490–40644
24	2768.85	II	6214–42319
18	2770.82	II	1522–37602
18	2771.49	II	
1.6	2772.01	II	
1.6	2773.02	II	
12 d	2773.96	II	13251–49289
	2774.07	II	
4	2774.85	II	
1.8	2775.08	II	
6	2777.80	II	
3.5	2778.04	II	1860–37846
6	2778.71	II	9712–45689
4	2780.70	II	
1.6	2782.37	II	
10	2783.06	II	4490–40412
6	2783.49	II	7829–43744
4	2784.06	II	
6	2784.98	II	7332–43228
3.0	2785.59	II	
1.6	2786.24	II	
6	2786.92	II	
9	2787.13	II	6244–42113
3.0	2787.67	II	
3.0	2788.68	II	
4	2790.42	II	
6	2791.01	II	6700–42519
3.0	2791.43	II	
8	2794.26	II	9712–45489
6	2797.02	II	1860–37602

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		2797.74	II	4490–40223
5		2798.27	II	8018–43744
2.5		2798.66	II	
5		2799.11	II	4147–39862
6		2800.57	II	9202–44899
3.0		2803.37	II	6691–42352
5		2807.71		
10		2807.83	II	9585–45190
16		2808.99	II	9061–44651
1.8		2812.42	II	
6		2814.32	II	
4		2814.57	II	
4		2816.07	II	
1.6		2817.14	II	11117–46603
9		2819.33	II	7829–43288
4		2820.34	II	
3.5		2821.61	II	
9		2822.02	II	8379–43804
3.0		2822.38	II	9401–44822
1.8		2822.57	II	
1.8		2822.69	II	
1.8		2823.55	II	
15		2826.86	II	8018–43383
1.8		2827.76	II	
4		2827.99	II	9202–44553
1.8		2829.94	II	11576–46903
6		2830.45	II	6168–41488
70		2832.31	II	4147–39443
5		2833.33	II	8460–43744
14		2834.49	II	8018–43288
11		2836.05	II	4147–39397
4		2836.44	I	
110		2837.30	II	
8	d	2839.24	II	4490–39701
		2839.34		
6		2840.15	II	0–35199
8		2841.16	II	9202–44389
1.8		2841.81	II	9720–44899
28		2842.82	II	1522–36688
1.8		2843.30	II	
1.8		2845.19	II	
1.8		2845.83	II	
8		2847.36	II	9712–44822
1.8		2848.02	II	
24		2851.26	II	1522–36584
7		2851.43	II	1522–36582
2.0		2852.50	II	
4		2854.14	II	
2.0		2854.92	II	
5		2855.90	II	
5		2857.49	II	6691–41677
28	d	2861.34	II	9712–44651
		2861.42	II	10673–45611
5		2862.61	II	
6		2864.65	II	
3.0		2866.40	II	4490–39367
3.0		2866.65	II	
3.0		2868.45	II	12472–47324
4		2868.68	II	8379–43228
6		2869.92	II	
48		2870.40	II	1860–36688
2.5		2870.81	II	
6		2876.41	II	6168–40924
3.5		2879.19	II	1860–36582
2.0		2879.53	II	8379–43097
4		2881.13	II	
4		2882.00	II	11576–46264
3.5		2882.51	II	8606–43288
2.0		2883.61	II	9720–44389
28		2884.29	II	4490–39151
32		2885.04	II	
4		2886.23	II	6691–41328
4		2886.50	II	
32		2887.81	II	
14		2891.25	I	
14	d	2891.73	II	
		2891.81	II	
3.5		2892.17	II	9238–43804
2.0		2894.48	II	
11		2895.13	II	1860–36390
6		2897.07	I	
3.0		2898.25	II	
4		2899.37	I	
22		2899.72	II	6168–40644
4		2903.16	II	4147–38582
2.0		2904.26	II	12902–47324
4		2905.93	II	
2.5		2906.12	II	8018–42418
7		2908.36	II	4490–38864
2.0		2909.77	II	7332–41688
18		2910.59	II	4147–38494
8		2911.32	II	8606–42944
8		2912.01	II	0–34330
8	d	2912.66	II	4113–38436
		2912.75	II	9061–43383
3.5		2916.37	I	
4		2917.03	II	
14		2917.41	II	4490–38758
5		2917.78	II	
4		2917.90	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	2919.83	II	4490–38729
4	2920.36	II	6691–40924
4	2920.94	II	10673–44899
2.0	2921.36	II	
14	2921.56	II	
	2921.62	II	
6	2922.59	II	
4	2922.79	II	12220–46424
2.0	2922.99	II	8018–42220
2.0	2924.10	II	
22	2925.05	II	
22	2928.25	II	8379–42519
3.5	2928.70	II	
3.5	2929.28	II	
4	2930.90	II	
2.5	2932.64	II	
5	2933.09	II	9720–43804
5	2934.13	II	
11	2936.19	II	
15	2936.46	II	
6	2937.43	II	12902–46936
2.5	2938.10	II	9202–43228
9	2939.57	II	
	2939.62	II	
6 h	2940.58	II	7332–41328
	2940.68	II	
2.5	2941.34	II	
2.0	2941.89	II	9401–43383
11	2942.62	II	8379–42352
30	2942.85	II	
2.0	2945.95	II	
2.5	2946.25	II	10572–44504
13	2949.06	II	4490–38389
8	2949.94	II	
7	2950.43	II	9061–42944
6	2951.21	II	
4	2954.88	II	
5	2955.03	II	10673–44504
5	2955.60	II	7001–40826
3.0	2955.85	II	
15	2957.58	II	4490–38292
8	2957.92	II	
6	2958.14	II	
2.5	2959.87	II	
2.5	2963.61	II	4113–37846
2.5	2963.87	II	
2.5	2964.00	II	
5	2964.11	II	6168–39895
10	2964.92	II	
10	2965.49	II	6700–40412
24	2968.69	II	4490–38165
2.5	2969.38	II	
4	2969.82	II	
10	2971.48	II	4113–37757
7	2972.22	II	1522–35157
10	2973.53	II	
19	2974.01	II	4490–38105
10	2976.02	II	7332–40924
2.5	2976.64	II	
2.5	2980.10	I	
5	2980.32	II	9401–42944
14	2981.33	II	6168–39701
14	2981.47	II	
2.5	2981.84	II	
2.5	2982.02	I	
2.5	2983.02	II	
5	2983.56	I	
	2983.66		
12	2983.80	II	
14	2985.24	II	4113–37602
7	2986.77	II	7001–40472
2.5	2987.68	I	3688–37149
32	2988.23	II	4490–37945
13	2991.05	II	
8	2991.68	II	
6	2993.65	II	
14	2993.82	II	6214–39606
2.5	2995.27	II	9720–43097
10	2996.99	II	9061–42418
2.5	2997.19	II	0–33355
16	2999.10	II	
2.5	2999.28	II	
4	2999.80	II	
5	3000.95	II	
13	3001.27	II	8379–41688
16	3002.39	II	1860–35157
2.5	3006.00	II	6691–39949
8	3006.93	II	
9	3007.62	II	
8	3007.80	II	
5	3007.95	II	
5	3008.27	II	9712–42944
13	3008.50	II	6214–39443
5	3009.76	II	0–33216
4	3011.59	II	6700–39895
6	3012.70	II	6214–39397
5	3013.60	II	
3.0	3014.92	II	9061–42220
6	3015.73	II	
6	3017.13	II	10673–43808

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	3018.49	II	13249–46368
8	3019.41	II	8379–41488
3.0	3021.47	II	
8	3022.09	II	7332–40412
3.0	3024.68	II	9061–42113
3.0	3025.43	II	
11	3026.57	II	
9	3028.57	II	6691–39701
3.0	3030.48	I	
3.0	3030.86	II	
6 d	3031.19	II	
	3031.28	I	
3.0	3031.70	II	4490–37465
5	3032.00	I	
26	3034.06	II	8379–41328
12	3035.11	II	
3.0	3035.53	II	0–32933
6	3038.60	II	6168–39069
5	3040.05	II	
9	3043.06	II	2210–35062
9	3045.55	II	10189–43014
12	3046.95	II	
30	3049.09	II	4490–37277
6	3049.64	II	
3.0	3049.86	II	
6	3050.98	II	9585–42352
6	3051.78	II	6700–39458
3.0	3057.63	II	6168–38864
2.0	3057.89	II	
6	3058.42	II	
13	3060.18	II	
6	3060.44	I	0–32666
16	3061.69	II	
16 d	3063.03	II	
	3063.10	II	
6	3065.93	II	9712–42319
3.0	3066.41	II	12220–44822
32	3067.72	II	
16 d	3068.90	II	
	3068.96	II	4113–36688
3.0	3069.26	II	
19	3070.82	II	
26	3072.11	II	4147–36688
6	3072.82	II	
2.0	3075.83	II	
6	3077.34	II	9202–41688
5	3077.93	II	
48	3078.82	II	4113–36584
3.5	3079.88	II	
34	3080.21	II	
3.5	3081.65	II	13249–45689
14	3081.98	II	4147–36584
10	3082.17	II	
10	3083.00	II	12472–44899
10	3083.29	II	10673–43097
17	3088.47	II	7332–39701
9	3090.08	II	1860–34212
6	3093.05	II	
3.5	3096.26	II	
7	3096.43	II	9202–41488
10	3097.27	II	4113–36390
7 d	3099.74	II	
	3099.87	II	9238–41488
14 d	3100.79	II	
	3100.93	II	
3.5	3101.68	II	11576–43808
14	3102.66	II	6168–38389
6 d	3104.96		
	3105.05	II	
20	3105.74	II	
3.5	3106.68	II	
14	3107.03	II	6691–38867
36	3108.29	II	
18	3110.02	II	6691–38836
3.5	3112.08	II	6168–38292
3.5	3114.06	II	9585–41688
3.5	3114.26	II	8606–40707
18	3116.28	II	
7	3116.48	II	
10	3117.68	II	6691–38758
7	3119.36	II	
36	3119.51	II	4147–36194
3.5	3120.88	I	2558–34591
36	3122.96	II	6168–38180
26	3124.38	II	6168–38165
16	3125.21	II	
34	3125.51	II	
10	3125.74	II	
6	3127.21	II	9720–41688
3.5	3129.98	II	
11	3131.07	II	0–31929
6	3133.62	II	9585–41488
11	3134.42	II	
7	3136.22	I	4962–36838
3.5	3136.83	I	0–31870
30	3139.30	II	
7	3139.89	II	
7	3140.27	I	2869–34704
15	3141.84	II	7332–39151
30	3142.84	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	3145.63	I	0–31781
22	3146.04	II	6168–37945
11	3150.46	II	
7	3151.64	II	
22	3154.30	II	1522–33216
22	3154.77	II	6700–38389
7	3155.83	II	
7	3156.39	II	
3.5	3158.62	II	
3.5	3159.07	II	9061–40707
5	3161.68	II	
8	3162.83	II	9720–41328
8	3164.48	II	6700–38292
4	3165.62	II	7001–38582
8	3165.82	II	
10	3166.09	II	4490–36066
6	3167.55	II	
8	3169.32	II	6214–37757
4	3170.42	II	7331–38864
4	3171.26	I	0–31524
3.0	3171.68	II	11576–43097
4	3173.43	I	2869–34372
8	3174.19	II	1860–33355
30	3175.72	II	6700–38180
4	3176.50	II	6244–37716
4	3177.17	II	6700–38165
6	3178.24	I	
19	3179.05	II	
75	3180.20	II	1522–32957
8	3181.18	II	7332–38758
4	3181.66	II	
6	3182.40	II	6691–38105
8	3182.64	II	9061–40472
4	3183.13	II	
4	3183.79	II	13251–44651
22	3184.94	II	4490–35879
4	3187.00	II	
4	3187.40	II	
55	3188.23	II	1860–33216
19 d	3190.07	II	9585–40924
	3190.17	II	
8	3191.08	II	1522–32850
6	3191.21	II	
4	3192.57	I	2869–34183
4	3193.16	II	
4	3195.69	I	0–31283
8	3198.23	II	
8	3198.48	II	
8	3198.71	II	6691–37945
6	3198.96	II	
4	3203.23	II	9202–40412
3.0	3203.61	II	
4	3203.88	II	9720–40924
4	3205.28	II	
4	3206.94	II	8379–39552
4	3207.78	II	
4	3208.03	II	12220–43383
12	3210.31	II	
4	3211.20	I	2869–34001
12	3213.57	II	6168–37277
4	3214.08	I	2558–33662
4	3214.38	I	4962–36063
4	3215.78	II	
12	3217.45	II	9401–40472
4	3217.73	II	
12	3220.35	II	4113–35157
40	3221.28	II	
20	3225.42	II	9712–40707
4	3225.66	II	
4	3225.90	II	
4	3226.12	II	8379–39367
4	3226.41	II	
8	3227.78	II	0–30972
40	3229.01	II	7332–38292
8	3230.86	II	9712–40655
8	3232.13	II	
3.0	3232.31	I	0–30929
4	3235.00	I	3688–34591
34	3235.85	II	6168–37063
42	3238.12	II	
4	3238.94	I	
7	3239.29	II	
8	3240.48	II	6691–37542
4	3240.64	II	
17	3241.12	II	7001–37846
8	3244.46	I	0–30813
20	3245.78	II	9061–39862
8	3247.59	II	
8	3248.53	II	6691–37465
7	3249.87	I	0–30762
20	3251.92	I	
10	3252.74	II	
10	3254.82	II	7001–37716
10	3255.51	II	
65	3256.28	II	
13	3257.16	II	9585–40278
13	3257.38	I	
8	3259.06	I	
8	3259.61	II	
8	3260.92	II	9238–39895

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
8		3261.54	II	
65		3262.67	II	6168–36809
8		3263.03	II	9585–40223
8		3264.44	II	12472–43097
8		3265.58	II	7332–37945
13		3267.00	II	7001–37602
8		3269.48	II	6700–37277
8		3270.83	II	0–30565
8		3272.05	I	0–30553
22		3273.89	II	
22		3275.06	II	
22		3280.37	II	8018–38494
4		3282.96	II	
9		3285.75	I	
22		3286.58	II	8018–38436
44		3287.79	II	1522–31929
9		3290.12		
65		3291.74	II	6214–36584
44		3292.52	II	6700–37063
9		3293.58	II	
17		3293.94	II	9202–39552
9		3294.99	II	
13		3295.32	II	6244–36582
9		3295.52	II	9061–39397
11		3296.60	II	12902–43228
9		3297.36	II	
17		3297.83	II	9238–39552
4		3298.04		
4		3300.61	II	1522–31811
17		3301.26	II	
		3301.35		
17		3301.63	II	
9		3303.48	II	
34		3304.24	I	0–30255
4		3305.30	I	
9		3309.14	II	7332–37542
9		3309.36	I	0–30209
13		3310.24	II	6244–36445
4		3313.06	I	
13		3313.64	II	
17		3314.80	II	
4		3317.73	II	13251–43383
4		3318.97	II	6691–36813
20		3320.29	II	6700–36809
36		3321.44	II	4113–34212
4		3322.09	I	2558–32651
28		3324.75	II	1860–31929
60		3325.12	II	4147–34212
7		3326.45	II	4490–34544
9		3327.18	II	12472–42519
4		3328.25	II	13251–43288
4		3329.72		
18		3330.48	I	0–30017
7		3332.40	II	12220–42220
12		3333.13	I	2869–32863
44		3334.61	II	6214–36194
9		3335.06	II	8606–38582
44		3337.87	II	1860–31811
9		3338.39	II	7332–37277
4	bl	3341.31	ThO	
4		3343.26	II	
9		3343.61	I	
9		3344.87	II	7829–37716
7	bl	3345.89	ThO	
13		3346.55	II	9585–39458
22		3348.77	I	0–29853
9		3348.96	II	
70		3351.23	II	1522–31353
9		3353.95	II	11117–40924
22		3354.18	II	
14		3354.61	II	8379–38180
9		3355.25	II	
7		3356.82	II	
44		3358.60	II	1860–31626
9		3360.15	II	11576–41328
9		3360.37	II	
22	d	3361.61	II	
		3361.73	II	9720–39458
7		3362.18	II	
9		3362.50	II	9712–39443
5		3362.67		
9		3363.06	II	8379–38105
9		3363.70	II	0–29720
18		3364.69	II	
9		3365.33	I	2869–32575
18		3366.52	II	13249–42944
28		3367.81	II	4490–34175
18		3371.79	II	
9		3373.49	I	
18		3374.58	II	
18		3374.98	I	
5		3376.84	II	10673–40278
28		3378.58	II	8018–37608
9		3380.86	I	2869–32439
9		3381.35	II	9585–39151
9		3383.14	II	
22		3385.53	II	4490–34019
22		3386.50	II	9061–38582
8		3387.91	I	
8		3388.58	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	3389.46	I	8111–37606
22	3389.65	II	1860–31353
8	3390.36	II	
90	3392.03	II	1522–30994
5	3393.23	II	
8	3394.13	II	
9	3394.79	II	
8	3395.37	II	7001–36445
9	3396.41	II	
14	3396.73	I	3865–33297
16	3397.52	I	
18	3398.53	I	
14	3401.68	II	7001–36390
14	3402.02	I	8460–37846
70	3402.70	II	
14	3403.28	II	9061–38436
12	3404.63	II	10189–39552
14	3405.56	I	3688–33043
9	3406.23	II	6691–36041
5	3407.82	I	
18 d	3408.63	II	
	3408.75	I	2869–32197
14	3409.26	II	10572–39895
12	3411.77	II	7829–37130
18	3413.01	I	
9	3414.51	II	9585–38864
5	3415.88	II	
14	3418.77	II	4113–33355
14	3418.94	II	4490–33731
19	3419.17	II	
28	3421.21	I	2869–32090
14	3422.65	II	4147–33355
9	3423.11	II	12472–41677
19	3423.99	I	0–29197
9	3425.15	II	9202–38389
9	3425.94	II	9401–38582
14	3429.00	I	2558–31713
8	3429.39	II	9238–38389
9	3429.88	II	4490–33637
9	3431.80	II	
70	3434.00	II	1860–30972
9	3434.74		
55	3435.98	II	0–29095
19	3436.71	II	9202–38292
9	3437.02	II	8379–37465
24	3437.31	I	2869–31953
24	3438.95	II	13249–42319
5	3439.40	I	
38	3439.72	II	
9	3441.01	II	
9	3441.36	II	6691–35741
8	3442.58	I	4962–34001
5	3443.11	II	9401–38436
5	3444.00	II	10673–39701
14	3445.21	II	
5	3445.38	II	12472–41488
14	3445.73	II	14791–43804
5	3449.28	II	
12	3449.65	II	10572–39552
8	3450.94	II	13251–42220
9	3451.70	II	9202–38165
19	3452.68	II	6244–35199
8	3453.51	I	
7	3454.20	II	9238–38180
14	3461.02	I	0–28885
19	3461.22	I	4962–33845
24	3462.85	II	9712–38582
19	3463.72	II	13251–42113
5	3465.03		
32	3465.77	II	6700–35546
9	3465.92	II	4113–32957
19 d	3466.52	I	4962–33801
	3466.64	I	4962–33800
28	3468.22	II	
12	3469.34		
95	3469.92	II	4147–32957
12	3471.21	I	3865–32666
5	3471.95	I	7280–36074
9	3473.03	II	9061–37846
7	3473.41	II	9712–38494
12	3476.53	II	6700–35456
5	3477.70		
9	3478.12	II	9202–37945
9	3478.46	II	
18	3479.17	II	6691–35426
5	3480.05	I	8111–36838
9	3482.55	II	9585–38292
9	3482.76	II	1860–30565
14	3485.20	II	8379–37063
28	3486.50	II	
	3486.54	I	
5	3490.26	II	
5	3490.45	II	
5	3491.57	II	
19	3493.52	II	7829–36445
9	3495.70	I	
5	3496.81	I	0–28589
5	3497.01	II	
5	3497.26		
14	3498.00	II	

Thorium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
9		3498.62	I	
9		3498.95	I	7502–36074
		3498.99	II	9720–38292
14		3499.98	II	8018–36582
10		3501.46	II	
5		3501.94	II	7332–35879
14		3502.77	II	9061–37602
10		3503.61	II	
5		3503.78	I	
10		3505.48	II	
5		3506.85	II	15237–43744
5		3509.09	I	
8		3511.16	I	
48	d	3511.56	II	4490–32960
		3511.67	II	
10		3512.74	II	9720–38180
14		3514.52	II	9401–37846
5		3514.96	II	
10		3516.36	II	8379–36809
10		3516.83	II	8018–36445
10		3518.40	I	2869–31283
5		3518.89	II	7332–35741
5		3521.06	I	
24		3521.92	II	
5		3523.53	II	8018–36390
5		3526.64	I	0–28348
10		3528.82	II	
19		3528.95	II	
8		3530.52	I	
10		3531.44	I	4962–33271
10		3531.92	II	
14		3537.15	II	9202–37465
24		3539.32	II	4490–32736
48		3539.59	II	0–28244
10		3541.62	II	8460–36688
5		3542.50	I	
13		3544.02	I	8800–37009
5		3545.00	I	
18	d	3545.18	II	
		3545.29	II	1522–29720
5		3545.96	I	
10		3547.34	I	3688–31870
12		3549.60	I	8111–36275
5		3550.29	II	
10		3551.40	I	
14		3553.11	II	
5		3553.38	II	9712–37846
14	d	3555.02	I	2869–30991
		3555.10	II	
5		3555.71	I	
12		3557.47	II	6168–34270
38		3559.45	II	6244–34330
19		3559.95	II	8606–36688
5		3561.78	I	
8		3563.37	I	
5		3564.72	II	
10		3565.39	I	
5		3567.06	II	6700–34727
12		3567.26	I	0–28025
5		3567.69	II	12902–40924
5		3569.62	II	6168–34175
10		3569.82	I	3865–31870
8		3571.57	II	10189–38180
24		3572.39	II	8460–36445
14		3573.22	II	8606–36584
38		3575.32	II	6700–34662
14		3576.56	II	15145–43097
24		3579.35	II	8460–36390
10		3580.23		
14		3582.01		
10	d	3583.04	II	
		3583.11	I	4962–32863
8		3584.18	I	2869–30762
9		3585.06	II	
19	d	3585.76	II	9585–37465
		3585.89	II	
12		3588.22	II	1860–29720
8		3589.15	II	6700–34554
14		3589.36	II	6691–34544
12		3589.75	I	7502–35351
8		3591.06	II	8606–36445
10		3591.46	I	3688–31524
19		3592.78	I	
10		3593.88	II	10572–38389
5		3595.33	II	12472–40278
5		3595.61	I	
19		3598.12	I	0–27784
28		3601.04	II	
24		3603.21	II	9720–37465
5		3603.36	II	
5		3604.05	II	
8		3604.68	I	5563–33297
5		3605.20	I	
8		3605.65	II	
12		3608.38	I	
14		3609.22	II	
70		3609.44	II	4113–31811
17	d	3610.04	II	
		3610.13	II	
12		3610.40	II	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
14		3610.79	II	4113–31800
14		3612.43	I	0–27674
5		3612.87	I	0–27671
10		3613.78	II	4147–31811
10		3614.01	II	
5		3614.21	I	
5		3614.35	I	
34		3615.13	II	4147–31800
48	d	3617.02	II	15305–42944
		3617.12	II	
8		3618.36	I	7502–35131
3		3619.71	II	10673–38292
14		3620.37	II	
19		3621.12	II	10572–38180
10		3622.33	I	5563–33162
8		3622.80	I	3688–31283
19		3624.90	II	6700–34279
28		3625.63	II	1522–29095
14		3625.89	II	
		3625.93	II	9238–36809
8		3632.62	II	9061–36582
10		3632.83	I	
17		3634.58	I	
10		3635.24	II	
14		3635.42	II	
19		3635.94	I	
8		3637.57	II	6691–34175
4		3638.32		
5		3638.64	I	8800–36275
24		3639.45	II	6168–33637
22		3642.25	I	0–27448
8		3643.51	I	6362–33801
5		3644.35	II	10673–38105
7		3647.30	II	
		3647.38	II	
11		3647.65	II	
8		3648.17	II	0–27403
10		3648.42	II	
22		3649.25	II	7332–34727
12		3649.73	I	5563–32955
12		3650.77	II	9061–36445
26		3652.17	II	
10		3652.54	II	7829–35199
7		3656.20	II	9720–37063
30		3658.06	II	7001–34330
40		3659.51	II	
14		3661.62	II	
16		3663.20	II	11576–38867
24		3663.70	II	9401–36688
9		3666.98	I	8800–36063
10		3668.14	I	
20		3669.96	I	8111–35351
		3670.06	II	4113–31353
7		3671.54	I	6362–33591
10		3673.26	II	
14		3673.79	II	7332–34544
50		3675.57	II	1522–28721
28		3678.04	II	8018–35199
20		3679.72	II	
6		3681.88	II	11576–38729
17		3688.76	II	
15		3690.49	II	9720–36809
13		3691.88	I	
12		3692.57	I	3688–30762
20		3693.90	II	
11		3695.98	II	11117–38165
5		3696.65	II	9401–36445
5		3697.03	II	6168–33209
13		3698.11	I	9805–36838
4		3698.30	II	11726–38758
8		3700.77	II	15305–42319
3.0		3700.98	I	5563–32575
3.0		3702.87	II	
6		3703.78	I	4962–31953
18	d	3703.92	II	
		3704.00	II	
6	d	3704.87	I	2869–29853
		3704.97	II	15237–42220
24		3706.77	I	8111–35081
3.0		3707.00	I	
3.0		3707.43	II	
2.5		3708.76	II	
20		3711.30	II	6700–33637
6		3711.62	I	6362–33297
4		3712.54	II	
3.0		3717.83	II	
3.0		3718.17	II	9238–36125
42		3719.44	I	0–26878
32		3719.96	II	10189–37063
19		3720.31	II	9712–36584
55		3721.82	II	1860–28721
24		3722.11	II	4113–30972
3.5		3723.29	II	
4		3723.66	II	4147–30994
6		3724.74	II	
5		3725.39	I	
16		3726.72	II	4147–30972
8		3727.90	I	2869–29686
9		3730.37	I	6362–33162
12		3730.75	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.6	3731.26	I	
3.0	3731.42	II	
3.5	3732.98	I	
3.5	3733.66	I	
7	3734.59	II	4490–31259
7	3737.51	I	
12	3738.84	II	8460–35199
8	3740.87	II	
90	3741.19	II	1522–28244
11	3742.92	I	
3.0	3743.51	II	10572–37277
4	3744.74	II	8460–35157
3.5	3745.66	I	
24	3745.98	II	7332–34019
22	3747.54	II	9202–35879
3.0	3751.02	I	
	3751.12	I	
46	3752.57	II	9238–35879
2.5	3753.24	I	
4	3754.03	I	
9	3754.59	II	0–26626
9	3755.21	I	
3.5	3756.29	I	
10	3757.70	I	
9	3758.46	I	2558–29157
9	3759.31		
3.5	3760.28	II	
5	3761.11		
3.5	3761.47	I	
36	3762.88	II	6168–32736
	3762.94	I	3688–30255
3.5	3763.32	II	
8	3765.24	I	8800–35351
3.5	3766.35		
14	3767.90	I	
13	3770.05	I	5563–32080
14	3771.37	I	0–26508
7	3772.24	II	7829–34330
12	3773.74	II	10572–37063
3.5	3774.19	II	
5	3775.91	II	14349–40826
6	3776.27	I	
1.8	3777.41	I	
3.5	3780.97	I	
1.8	3781.31	I	
12	3783.01	II	
10	3783.29	II	0–26425
24	3785.60	II	6168–32577
3.5	3785.91	II	
5	3786.88	II	7332–33731
3.5	3788.35	II	
22	3789.11	II	1860–28244
6 h	3790.35	I	
14	3790.79	I	
5	3791.29	II	11576–37945
8	3792.38	I	
7	3794.15	II	11117–37465
4	3794.69	I	
6	3795.38		
4	3796.72	I	8800–35131
3.0	3797.45	II	
4	3798.10	I	4962–31283
9	3801.44	I	7502–33801
2.0	3802.14	II	9585–35879
42	3803.07	I	0–26287
6	3803.98	I	8800–35081
8	3805.81	II	6691–32960
26	3807.87	II	9202–35456
4	3808.61	I	
4	3809.83	II	
7	3810.99	I	
2.0	3812.40	I	
24	3813.07	II	9238–35456
3.0	3815.02	II	
8	3817.47	I	
3.5	3818.68	I	
12	3821.42	II	11117–37277
12	3822.15	II	9585–35741
6	3823.58	II	13251–39397
2.0	3826.36	I	
8	3826.94	II	14349–40472
32	3828.38	I	0–26113
11	3829.33	II	
4	3830.06	I	
8	3830.77	I	0–26097
19	3831.74	II	
3.5	3832.97	II	
9	3836.54	I	
	3836.58	I	
18	3837.87	I	2869–28918
60	3839.74	II	6700–32736
6	3840.80	I	4962–30991
20	3841.96	II	9720–35741
6	3842.90	II	
	3843.02	I	
2.0	3846.25	II	
6	3852.14	I	3688–29640
28	3854.50	II	10189–36125
10	3859.85	II	8379–34279
32	3863.41	II	6700–32577

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
24		3872.72	II	
26		3873.82	I	
18		3874.86	I	4962–30762
15		3875.37	I	2869–28666
2.0		3875.64	I	7502–33297
10		3879.64	I	7502–33271
4		3884.52	II	9720–35456
10		3884.82	II	
4		3885.77	I	6362–32090
7		3886.91	I	2869–28589
7		3887.01	I	
6		3891.05	II	11117–36809
2.0		3891.72	I	
3.5		3892.30	II	6244–31929
4		3893.11	II	
2.0		3893.41	II	
24		3895.42	I	
6		3898.43	I	
		3898.50	I	
2.0		3900.12	II	12472–38105
4		3900.57	I	
24		3900.88	II	7332–32960
4		3901.14	II	12220–37846
3.5		3902.12	II	14276–39895
		3902.17	I	
8		3903.10	I	
10		3904.08	II	4113–29720
12		3905.19	II	
3.5		3908.74	I	
2.0		3909.13	I	
6		3911.91	I	
8		3912.28	II	10572–36125
7		3913.01	II	
		3913.08	I	11601–37149
4		3913.82	II	1860–27403
3.5		3916.42	I	0–25526
10		3916.79	II	9202–34727
4		3917.26	I	
6		3918.07	I	
4		3918.51	II	
8		3919.02	I	3688–29197
4		3922.22	II	9238–34727
2.0		3923.80	I	2869–28347
10		3925.09	I	3688–29158
2.0		3926.70	II	
8		3927.17	II	
8		3927.42	II	
42		3929.67	II	0–25440
4		3932.00	II	
6		3932.23	II	9238–34662
14		3932.91	I	
10	d	3935.54	II	
		3935.63	II	
10		3937.04	II	10673–36066
8		3937.92	II	7828–33216
8	d	3938.69	I	
		3938.73	II	12220–37602
8	h	3941.23		
3.5		3942.07	II	
5		3942.64	II	10189–35546
11		3943.39	II	8379–33731
6		3943.69	II	
16		3945.51	II	
6		3945.82	II	
16		3946.15	II	
8		3947.33	I	9805–35131
5		3948.03	I	0–25322
		3948.13	I	
14	h	3948.96	II	
14		3950.39	II	10572–35879
2.0		3951.11	II	
16		3951.52	II	
3.5		3952.76	I	3865–29157
8		3955.17	I	9805–35081
3.5		3955.89		
28	d	3956.59	II	10189–35456
		3956.68	II	0–25267
4		3957.16	ThO	
8		3959.30	I	5563–30813
5		3960.33	II	13251–38494
4		3962.42	I	3688–28918
3.5		3963.22	II	
2.0		3963.48	II	
3.5	d	3964.74	I	
		3964.87	II	
28		3967.39	I	
5		3969.00	II	0–25188
14		3972.15	I	
5		3972.63	I	
11		3973.20	I	6362–31524
4		3974.22	II	
15		3976.42	II	9585–34727
4		3979.04		
11		3980.09	I	
4		3980.75	II	
14		3981.11	II	
4		3981.82	I	
6		3987.22	I	7502–32575
14		3988.01	II	9202–34270
4		3988.60	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	3988.85	II	6691–31754
8	3990.49	I	3865–28918
8	3991.73	I	8800–33845
4	3992.28	II	9238–34279
38	3994.55		
18	3996.06	II	
4	3997.47	II	11117–36125
11	3997.87	II	9720–34727
4	4000.28		
8	4001.06	I	
4	4001.73	II	4113–29095
8	4003.11	II	10572–35546
17	4003.31	II	9202–34175
4	4005.09	I	3688–28649
10	4005.53	II	9585–34544
7	4006.38	II	
18	4007.02	II	11117–36066
16	4008.21	I	
16	4009.05	I	7502–32439
4	4009.72	I	8111–33043
	4009.81	I	
4	4011.59	I	6362–31283
8	4011.75	I	
20	4012.50	I	2869–27784
4	4014.51	II	1522–26425
4	4018.10	I	
300	4019.13	II	0–24874
8	4019.77	ThO	
15	4022.08		
15	4025.66	II	9720–34554
12	4026.16	II	8379–33209
10	4027.01	I	
18	4030.84	I	2869–27671
8	4032.46	II	
8	4032.60	II	
10	4034.25	II	6214–30994
5	4034.90		
	4034.93	I	
18	4036.05	I	0–24770
17	4036.56	II	1860–26626
8	4039.86	I	
17	4041.20	II	
5	4043.12	II	
8	4043.40	I	4962–29686
3.5	4045.61	II	
4	4048.29	II	
4	4048.43	II	9585–34279
6 d	4049.83	II	
	4049.95	I	3688–28373
8	4050.89	I	
10	4053.52	I	
10	4059.25	I	6362–30991
18	4063.40	II	11726–36329
4	4064.32	I	
4	4065.62	I	
	4065.68	II	9585–34175
4	4067.45	I	2869–27448
65	4069.20	II	6691–31259
4	4071.74	I	
4	4075.50	I	2558–27088
4	4080.70	I	
8	4081.37	I	
8	4082.26	II	11576–36066
5	4083.47	I	3865–28348
50	4085.04	II	10189–34662
6	4085.43	I	8800–33271
50	4086.52	II	0–24464
3.5	4087.28	I	
5	4088.72	I	6362–30813
4	4089.14	I	2869–27317
3.5	4091.34	II	9202–33637
6	4093.39	II	7332–31754
50	4094.75	II	0–24415
4	4097.33	II	9238–33637
8	4097.74	I	2869–27266
12	4098.94	II	8460–32850
11	4100.34	I	0–24381
10	4100.84	II	
4	4102.62	I	7502–31870
3.5 d	4103.65	II	12220–36582
	4103.68	I	6362–30724
10	4104.38	II	8379–32736
19	4105.34	II	7001–31353
5	4105.91	II	
4	4107.37	II	11117–35456
4	4107.86	I	3688–28025
60	4108.42	II	4490–28824
4	4109.32	I	8111–32439
8 d	4110.51	II	
	4110.64	II	6244–30565
6	4110.86	II	
17	4112.75	I	0–24308
20 bl	4115.76	ThO	
75	4116.71	II	6168–30453
3.5	4118.48	I	
4	4122.67	II	
8	4123.53	II	8606–32850
14	4127.41	I	
4	4130.33	I	
8	4131.00	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	4131.42	II	8379–32577
24	4132.75	II	
10 h	4133.46		
14	4134.06	I	0–24182
	4134.11	II	
10 d	4136.28	I	
	4136.40	II	
5 b	4139.19	ThO	
16	4140.23	II	
11	4141.63	II	15305–39443
12	4142.48	II	
18	4142.70	II	0–24132
4	4145.84	I	
16	4148.18	II	7829–31929
3.5	4148.65	I	
	4148.72	I	7502–31599
32	4149.99	II	10572–34662
4 d	4152.20	I	
	4152.34	I	
8	4155.30	II	
5	4155.47	II	
9	4156.23	II	10673–34727
24	4156.52	II	9585–33637
4 d	4157.27	I	
	4157.39	I	
8	4158.54	I	9805–33845
6	4159.66	II	
4 d	4161.59	II	
	4161.74	I	7502–31524
4	4162.51	I	
10	4162.68	II	14276–38292
12	4163.64	II	9720–33731
8	4164.25	II	9202–33209
4	4165.07	II	
10	4165.77	I	
4 h	4168.05	I	
12	4168.63	II	
16	4170.47	II	9238–33209
	4170.54	I	4962–28933
4	4170.78	II	
8	4171.34	II	
3.5 d	4176.33	II	14791–38729
	4176.48	I	
44	4178.06	II	7332–31259
18	4179.71	II	1522–25440
11	4179.96	II	9720–33637
4	4180.88	I	
8	4182.16	II	14276–38180
4	4183.56	II	9061–32957
3.5	4184.71	II	14276–38165
3.5	4189.56	I	
4	4191.82	II	11576–35426
2.0	4192.36	I	6362–30209
9	4193.02	I	8111–31953
3.5	4194.93	I	
5	4195.56	II	
6	4195.83	II	
	4195.95	II	
4	4199.02	II	
12	4201.85	II	8018–31811
3.5	4206.66	II	
44	4208.89	II	6700–30453
4	4210.77	I	
9	4210.92	II	
4	4213.07	I	2558–26287
2.0	4214.54	II	
2.0	4214.83	I	
4	4217.23	II	
4	4218.19	II	11726–35426
4	4218.54	II	10572–34270
4	4220.08	II	
4	4224.25	II	1522–25188
4	4227.39	I	7280–30929
7	4229.45	II	
6	4230.43	I	
4	4233.29	I	
6	4235.46	I	0–23604
3.5	4240.59	II	
6	4243.93	II	9401–32957
2.0	4247.60	II	
10	4248.00	II	9202–32736
4	4249.68	II	7829–31353
12	4250.31	II	4490–28011
8	4253.53	I	
5	4256.09	II	9720–33209
5	4256.25	I	7502–30991
7	4257.50	I	0–23481
8	4260.34	I	9805–33271
2.0	4262.61	I	
4	4263.36	II	9401–32850
2.0	4269.94	I	8111–31524
4	4270.33	II	
3.5	4271.09	II	1860–25267
4	4272.86	I	8800–32197
20	4273.36	II	8379–31773
8	4274.02	II	
7	4276.81	II	8379–31754
4	4276.96	II	9202–32577
34	4277.31	II	0–23373
5	4278.32	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		4280.57	I	5563–28918
9		4281.07	II	1522–24874
8		4281.41	II	8460–31811
50		4282.04	II	6168–29515
8		4283.52	II	9238–32577
5		4284.97	II	
3.5		4286.21		
4		4288.05	II	14791–38105
2.0		4288.48	I	
2.0		4288.66	I	7502–30813
4		4291.81	I	
6		4295.04	II	
4		4297.30	I	
5		4298.84	II	
6		4299.84	I	
4		4306.37	II	
7		4307.18	I	
2.0		4308.12	I	
14		4309.99	II	
2.0		4311.58	I	
2.0		4311.80	I	
10		4312.99	I	2869–26049
4		4315.25	I	2869–26036
8	d	4318.29	II	9585–32736
		4318.42	I	
2.0		4319.09		
10		4320.12	II	4490–27631
6		4320.58	II	12902–36041
6	d	4327.14		
4		4328.68	II	
4		4329.49	II	
2.0		4330.84	I	8111–31195
4		4331.92	II	
2.0		4333.93	II	
2.0		4335.32	I	
12		4335.70	II	11117–34175
9		4337.28	I	0–23049
3.5		4338.10	I	
4	d	4340.89	I	
		4341.02	II	
6		4342.26	II	
5		4342.44	I	
7		4343.94	II	1860–24874
9		4344.32	II	0–23012
12		4344.60		
5		4346.43	I	
3.5		4347.22	II	
4		4348.59	I	
4		4349.07	I	4962–27949
10	h	4350.82	II	
6		4352.67	I	
6		4353.39	II	10673–33637
4		4354.48	I	
8		4355.32	II	8018–30972
4		4357.61	II	1522–24464
4		4358.31	I	
6		4359.37	I	
6		4361.30	II	
6		4365.93	I	
6		4369.30	II	8379–31259
6		4373.90	II	9720–32577
6		4374.13	I	0–22855
9		4374.78		
4		4378.18	I	2869–25703
5		4381.41	I	
90		4381.86	II	6700–29515
2.0		4384.65	II	15145–37945
80		4391.11	II	4490–27257
4		4392.98	I	
2.0		4393.76	I	7502–30255
6		4394.90	II	8606–31353
5		4396.48	II	9061–31800
6		4397.92	II	
3.5		4399.10	II	
4		4401.58	I	4962–27674
4		4402.93	I	
6		4408.88	I	3688–26363
2.0		4410.47	II	
6		4412.56	I	
15		4412.74	II	6168–28824
4		4414.52	I	
6		4416.23	II	10572–33209
2.0		4416.84	I	9805–32439
2.0		4418.66	II	
3.5		4421.54	II	1522–24132
3.5		4422.06	I	
4		4427.64	II	
2.0		4432.25	I	6362–28918
18		4432.96	II	
1.6		4436.06	II	10673–33209
2.0		4436.28	II	9238–31773
3.0		4436.55	II	14276–36809
10		4439.12	II	11117–33637
3.0		4440.58		
10		4440.86	II	8460–30972
3.5		4443.07		
2.0		4445.01	I	
2.0		4445.89	II	14791–37277
8		4447.83	II	6244–28721
1.8		4452.56	I	2869–25322

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.8		4454.51	II	11576–34019
6		4458.00	I	3688–26113
6	d	4461.08	II	9401–31811
		4461.24	I	3688–26097
3.0		4461.51		
3.0		4461.72	II	
16		4465.34	II	8606–30994
4		4469.53	I	
2.5		4472.25		
3.0		4474.07	II	
6		4480.82	II	4113–26425
3.0		4482.17	I	4962–27266
3.0		4485.78	II	10673–32960
1.8		4486.65	II	
1.8		4486.90	I	2558–24839
8		4487.50	II	4147–26425
10		4488.68	II	1860–24132
3.0		4492.24	II	12472–34727
12		4493.33	I	0–22249
3.0		4496.32	II	
1.7		4497.92	I	
8		4498.96	I	5563–27784
5		4499.99	I	
4		4505.22	I	8800–30991
1.7		4506.49	I	7502–29686
20		4510.53	II	10572–32736
3.0		4512.50	II	11576–33731
4		4513.69	I	9805–31953
3.0		4515.12	I	0–22142
3.0		4515.98	II	
1.6		4517.04	II	6691–28824
1.6		4518.64	II	
1.6		4519.26	I	3688–25809
1.6		4519.75	I	
5	h	4521.22	I	2869–24981
1.6		4522.78	II	
3.0		4524.85	II	7001–29095
2.0		4525.10	II	11117–33209
1.4		4529.50	II	12472–34544
1.6		4530.32	I	
5		4531.71	II	
6		4532.26	II	
12		4533.29	II	9720–31773
5		4534.12	II	10572–32621
3.0		4535.25	I	
5		4537.08	II	14276–36310
4		4540.41	II	14791–36809
5		4544.52	II	4490–26489
2.5		4545.84	II	
		4545.92	I	
1.6		4551.49	I	
2.5		4552.16	I	8800–30762
5		4555.81	I	3865–25809
5		4561.36	I	7280–29197
7		4563.28	II	
3.0		4563.66	I	8111–30017
1.6		4564.19	II	10673–32577
2.5		4566.66	II	7829–29720
1.6		4567.25	I	
5		4570.97	I	
2.0		4573.71	I	
1.6		4575.27	II	1522–23373
1.6		4575.43	II	14276–36125
1.6		4581.20	I	
3.0		4581.58	II	
2.5		4584.37	II	12472–34279
2.5		4588.22	II	
4		4588.43	I	
3.0		4589.12	II	
2.5		4589.66	I	
4		4592.67	I	
1.5		4593.65	I	
6		4595.42	I	3688–25443
3.5		4602.90	II	7001–28721
2.0		4606.52	II	8018–29720
4		4609.38	II	
5		4611.87		
2.0		4612.56	II	9585–31259
8		4619.51	II	
2.5		4623.90	II	
2.0		4624.14	II	11117–32736
2.0		4625.04	II	
11		4631.76	II	10189–31773
3.5		4633.77	I	
5		4639.71	II	12472–34019
5		4640.05	II	
2.5		4641.23	I	
11		4651.56	II	7332–28824
2.5		4651.99	II	1522–23012
1.8		4663.20	I	2869–24308
5		4666.01	II	
4		4666.79	I	6362–27784
7		4668.17	I	7502–28918
4	h	4669.98	I	
6		4673.66	I	
5		4676.06	II	
2.5		4680.65	I	
1.2		4686.19	I	2869–24203
8		4689.20	II	6691–28011
1.2		4690.64		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	4691.07	II	
1.2	4691.64	I	6362–27671
11	4694.09	II	0–21297
4 d	4694.90	II	4147–25440
	4695.04	I	3688–24981
4	4700.14	II	14276–35546
1.2	4702.32	II	9712–30972
4	4703.99	I	0–21253
10	4705.76	II	
3.0	4706.25	II	7001–28244
1.2	4708.10	II	11726–32960
5	4712.44	II	9238–30453
2.0	4715.43	II	10572–31773
5	4718.61	II	
3.0	4719.98	II	14276–35456
2.5	4722.09	I	
7	4723.44	II	12472–33637
9	4723.78	I	7502–28666
4	4724.76	I	
2.5 d	4726.32	II	1860–23012
	4726.47		
2.5	4729.11	I	
3.5	4729.87	II	8379–29515
1.0	4732.66	II	
15	4740.53	II	6168–27257
1.0	4741.31	I	6362–27448
2.0	4742.26	II	10673–31754
3.5	4743.68	II	4113–25188
2.0	4749.19	I	
1.6	4749.95	I	8111–29158
11	4752.41	II	
3.5 h	4758.12	I	
5	4761.11	II	
3.0	4764.35	I	
1.0	4766.60	I	3865–24839
5	4774.27	II	6691–27631
2.0	4777.19	I	
2.0	4778.30	I	0–20922
1.0	4779.60		
1.8	4782.76	II	
1.2	4784.04	I	
3.0	4789.39	I	3688–24562
1.0	4800.18	II	
1.6	4803.49	II	
0.9	4803.96	II	
3.5	4808.13	I	
2.0 d	4813.73	I	
	4813.89	I	
3.5	4818.65	II	
1.4	4820.90	II	
0.9	4821.29	II	
2.0	4822.86	I	
1.8	4823.20	II	4147–24874
2.5	4823.61	I	6362–27088
3.0	4826.71	I	13088–33801
3.5	4831.12	I	3688–24381
1.0	4831.60	I	
5	4832.80	II	
3.5	4840.48	II	
4	4840.84	I	2869–23521
3.5	4844.17	II	11117–31754
1.4	4844.57	II	
2.5	4848.36	I	3688–24308
3.0	4849.04	II	
6	4850.44	II	
1.2	4852.86	I	
0.9	4858.09	II	
3.0	4858.33		
1.0	4861.22	I	
22	4863.17	II	6700–27257
3.5	4865.48	I	13297–33845
0.9	4868.27	II	
0.9	4868.87	I	
3.0	4872.91	I	6362–26878
1.0	4874.37	I	
4	4877.00	II	
2.0	4878.73	I	2558–23049
3.5	4894.95	I	0–20424
2.5	4898.45	II	
1.0	4898.80	II	
2.0	4899.23	I	
1.4	4911.39	I	
3.0	4912.52	II	4113–24464
1.2	4914.12	II	
19	4919.82	II	6168–26489
2.0	4920.53	I	
5	4921.62	II	9202–29515
1.4	4922.94	II	
2.0	4924.42	II	4113–24415
1.4	4927.78	I	
1.4	4929.98	II	
1.4	4933.85	I	
3.0	4936.77	I	8800–29051
3.5	4939.64	I	
1.4	4943.07	I	2869–23094
1.4	4945.47	I	0–20215
1.4	4946.67		
5	4947.58	I	
4	4950.64	II	
8	4954.57	II	11576–31754

609065 O - 62 - 25

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.6	4960.46	I	
2.0	4963.20	II	11117–31259
4	4964.12	II	
2.0	4968.76	I	
3.5	4970.06	I	
3.0	4972.18	II	
3.0	4973.40	II	
3.0	4975.96		
1.6	4976.60		
1.6	4980.96	I	
2.0	4985.38	I	3688–23741
9	4987.15	II	
1.6	4989.31	I	7280–27317
2.0	4997.82		
1.6	4999.95	II	14276–34270
4	5002.10	I	
1.6	5008.19	II	
4	5015.90	II	
22	5017.26	II	7332–27257
3.5	5019.34	II	
1.4	5020.55	II	
11	5028.66	II	10572–30453
1.4	5029.63	II	
2.0	5039.24	I	2558–22397
3.5 h	5040.15		
4 d	5040.57	I	
	5040.69	I	3688–23521
4	5044.73	I	0–19817
1.6	5045.25	I	7502–27317
1.6	5047.05	I	4962–24770
2.0	5047.43	II	
20	5049.80	II	6691–26489
2.0	5050.80	I	3688–23481
7	5055.36	II	1522–21297
6	5058.57	II	
2.0	5059.86	I	7502–27260
3.5	5061.23	II	14791–34544
1.6	5064.61	I	4962–24701
2.0	5066.79	I	
9	5067.97	I	
2.0	5075.47	II	
2.0	5090.75	II	8606–28244
1.8	5094.12		
3.5	5095.06	II	9202–28824
4	5098.05		
1.8	5100.62	I	4962–24562
2.0	5107.24	II	7829–27403
4	5110.86	II	
2.5	5115.04	I	
3.5	5131.06	II	
2.0	5140.77	I	6362–25809
8	5143.28	II	1860–21297
2.0	5143.92	I	
2.0	5145.04	I	
10	5148.22	II	
4	5151.62	II	12220–31626
2.0	5151.87	II	
4	5154.24	I	
7	5158.60	I	2869–22249
6	5160.72	I	
2.0	5163.46	I	3688–23049
4	5164.98	I	
2.0	5170.23	II	11117–30453
4	5176.96	I	
3.0	5182.53	II	
3.0	5183.99	II	
1.2	5187.46	I	
1.8	5189.68	II	
4	5190.88	II	4113–23373
3.5	5193.84	II	0–19248
4 h	5195.82	I	4962–24203
4	5198.81		
8	5199.16	I	3865–23094
2.0	5205.77	II	
5	5206.49	II	
	5206.65	II	
4	5211.23	I	3865–23049
2.0	5213.35	I	
8	5216.58	II	
4	5218.52	II	7332–26489
3.0	5219.10	I	8111–27266
9	5231.16	I	2558–21669
2.0	5232.02		
7	5233.21	II	9720–28824
3.5	5237.90	II	
3.5	5240.18	II	
8	5247.65	II	0–19051
1.6	5253.45	I	
3.0	5258.36	I	3865–22878
1.0	5266.70	I	3688–22670
6	5277.50	II	10572–29515
1.0	5280.08	II	14276–33209
2.5	5297.74	I	8800–27671
3.0	5301.40	II	
1.0	5303.04	II	12902–31754
1.0	5304.63	II	14791–33637
1.4	5305.57	II	9401–28244
2.5	5307.46	II	
3.5	5310.25	II	
3.0	5312.00	I	3688–22508

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	5312.53	I	5563–24381
5	5325.14	II	
4	5326.98	I	8111–26878
2.0	5329.38	II	
5	5343.58	I	3688–22397
2.5	5345.31	II	
1.2	5347.04	II	
1.2	5351.13	I	
3.5	5375.35	II	
2.0	5375.77	II	
1.0	5378.84	I	
3.0	5382.93	II	
1.0	5384.04	I	
3.0	5386.62	I	4962–23521
6	5390.46	II	
4	5392.58	II	
1.0	5394.76	I	3865–22397
2.0	5398.91	I	8800–27318
2.0	5407.65	I	
1.8	5410.76	I	6362–24839
6	5415.46	II	14276–32736
2.0	5417.49	I	3688–22142
1.6	5421.84	II	7001–25440
1.8	5424.04	I	
5	5425.68	II	9585–28011
1.0	5431.11	I	6362–24770
0.8	5433.69	II	11117–29515
1.0	5435.12	II	
4	5435.88	II	
2.0	5437.38	II	
3.0	5443.11	I	
3.5	5449.47	II	14276–32621
2.5	5452.22	I	
2.0	5461.74	II	
2.5	5462.61	II	14276–32577
1.6	5474.86	II	
2.0	5484.12	II	
2.0	5488.63	II	0–18214
0.6	5495.82	II	
0.8	5496.13	I	5563–23753
2.5	5499.26	I	2558–20737
1.0	5501.93	II	6244–24415
1.6	5504.30	I	7280–25443
3.0	5509.99	I	9805–27949
1.0	5510.67	II	
1.6	5514.87	I	
1.6	5518.99	I	
1.0	5521.75	I	
2.0	5524.22	II	
1.0	5524.58	I	
1.0 h	5528.00	II	
1.0	5537.12	II	9202–27257
4	5539.26	I	9805–27853
6	5539.90	II	9585–27631
1.6	5542.88	I	
0.8	5546.10		
3.0	5548.18	I	6362–24381
2.0	5551.36	II	
2.0	5557.04	I	8800–26790
1.0	5557.30	II	
4	5558.35	I	8111–26097
0.6	5559.88	I	3688–21669
5	5564.19	II	
3.0	5568.00	II	
3.0	5571.20	I	
1.4	5572.47	I	7502–25443
3.5	5573.35	I	8111–26049
2.0 d	5575.98	I	
	5576.21	I	
3.0	5579.36	I	5563–23481
1.8	5583.76	II	
5	5587.03	I	4962–22855
2.0	5587.72	II	
2.0	5588.87	I	
2.0	5593.62	II	7001–24874
2.0	5595.07	I	
0.6	5601.60	I	
4	5604.51	II	
0.6	5605.28	I	
1.0	5610.25	I	7502–25322
1.6	5610.67	I	11601–29419
1.0	5612.07	I	
3.0	5615.32	I	3865–21669
2.0	5615.68	II	
0.6	5626.73	II	
0.6	5630.30	I	
6	5639.75	II	1522–19248
4	5645.88	II	11117–28824
1.0	5652.90	II	
1.0	5654.01	II	
1.0	5657.93	I	
1.4	5665.18	I	
2.5	5665.62	II	
1.2	5674.98	I	11803–29419
0.6	5678.97		
2.0	5700.45	II	
8	5700.69	II	9720–27257
	5700.90	II	
8	5707.10	II	6214–23731
1.6	5719.63	I	7502–24981

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	5720.20	I	3688–21165
2.5	5725.39	I	
2.5	5732.99	II	
0.6	5738.29	II	8018–25440
1.6	5741.18	II	7001–24415
2.0	5742.09	I	
0.8	5745.68	II	
0.8	5748.76	I	6362–23753
2.5	5749.40	II	1860–19248
0.8	5753.04	I	4962–22339
6	5760.55	I	0–17355
0.8	5763.54	I	2869–20215
0.8	5784.86	II	
1.8	5796.42	II	11576–28824
3.0	5804.14	I	0–17224
1.4	5806.25	II	
1.6	5815.43	II	1860–19051
0.8	5838.94	II	0–17122
0.6	5852.68	I	
1.4	5859.67	II	
1.4	5870.54	II	
1.2	5885.70	I	9805–26790
0.7	5891.45	I	
3.5	5914.39	II	9585–26489
1.4	5914.68	I	7280–24182
1.6	5925.89	II	
1.4	5938.83	I	5563–22397
0.8	5944.66	I	
2.5	5973.67	I	3688–20424
2.5	5975.06	I	6362–23094
7	5989.07	II	1522–18214
1.2	5991.03	I	6362–23049
2.0	5994.16	I	
0.6	6001.22	I	8111–24770
1.8	6007.07	I	8800–25443
0.9	6010.18	I	2869–19503
2.5	6015.43	II	
1.0	6019.00	II	15145–31754
1.4	6021.04	I	
1.4	6037.70	I	3865–20424
2.0	6044.42	II	
1.0	6066.49	II	
2.5	6073.09	II	
1.0	6085.26	II	6214–22642
2.5	6087.25	II	
2.0	6099.08	II	
0.9	6102.60	I	
2.5	6104.57	II	8606–24982
3.5	6112.83	II	1860–18214
2.5	6120.55	II	
1.2	6151.99	I	7502–23753
5	6169.82	I	4962–21165
4	6182.62	I	2869–19039
1.0	6184.77	I	13089–29253
1.6	6188.12	I	
1.0	6191.89	I	6362–22508
2.0	6193.86	II	11117–27257
0.8	6198.24	I	3688–19817
1.0	6200.43	II	
1.0	6203.50	I	
1.6	6207.22	I	5563–21669
1.0	6224.53	I	2869–18930
1.0	6232.98	II	9401–25440
2.0 h	6234.85	I	6362–22396
1.0 h	6258.60	II	
1.8	6261.06	II	4113–20081
1.8	6261.42	I	
0.9	6266.17	II	8460–24415
4	6274.13	II	4147–20081
0.9	6277.23	II	6214–22140
2.5	6279.16	II	12902–28824
1.4	6285.28	II	11726–27631
0.9 h	6289.49	II	
0.9	6301.41	I	
0.9 h	6304.25	II	8606–24464
0.6	6326.37	I	
1.8	6327.28	I	
3.0	6342.86	I	8800–24562
0.9 h	6348.57	II	
0.6	6358.61	II	
1.2	6369.13	I	
3.5	6376.93	I	
3.5 bl	6406.2	ThO	
1.6	6408.60	II	1522–17122
2.5	6411.90	I	7502–23094
2.0	6413.61	I	13297–28885
1.4	6416.10	II	9401–24982
1.2	6424.80	II	
5	6457.28	I	
4	6462.62	I	
0.7	6471.22	II	
1.2	6490.74	I	8800–24203
1.0	6503.50	II	11117–26489
0.6 h	6511.35	II	9061–24415
4 h	6531.34	I	6362–21669
0.5	6554.16	I	4962–20215
1.2	6560.07	II	14276–29515
0.8	6569.61	II	
0.4	6572.88	II	
1.6	6577.65	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	6583.91	I	
2.0	6588.54	I	3865–19039
1.0	6591.48	I	0–15167
2.0	6593.94	I	
2.0	6605.42	II	4113–19248
0.8	6617.06	II	12902–28011
2.0	6619.95	II	4147–19248
1.8	6644.66	II	
0.7	6646.54	II	
0.5	6648.50	II	
0.3	6648.95	I	
0.5 h	6658.68	II	9401–24415
2.5	6662.27	I	7502–22508
0.3	6678.71	I	7280–22249
1.0	6692.71	II	4113–19051
1.0	6704.04	II	8460–23373
1.0	6713.98	I	6362–21253
1.0	6719.19	I	
2.0	6727.46	I	5563–20424
1.0	6733.76	I	
0.8	6742.87	I	12848–27674
2.5	6756.45	I	2558–17355
0.8	6765.69	I	
1.2	6770.10	II	
1.0	6772.17	I	15493–30255
0.8	6778.31	I	3865–18614
0.9	6780.12	I	
1.4	6780.41	I	8111–22855
0.8	6787.73	I	
0.8	6788.84	I	
0.8	6791.23	I	8800–23521
0.7	6804.73	II	
1.0	6810.54	II	
0.8	6812.77	II	
1.0	6824.68	I	
1.4	6829.04	I	7502–22142
1.8	6834.92	I	
0.9	6854.11	I	13089–27674
0.7	6868.45	I	13297–27853
1.0	6874.75	I	2869–17411
2.5	6889.30		
1.4 bl	6894.5	ThO	
2.5	6909.85	II	
4	6911.23	I	
6	6943.61	I	9805–24203
1.0	6952.95	II	
9	6989.66	I	
4	6993.04	II	7001–21297
3.0	7000.80	I	
1.6	7018.57	I	
0.8	7021.27	I	
1.2	7036.28	I	11601–25809
5	7045.80	II	
2.5	7053.62	II	
1.0	7060.66	II	
1.0	7064.45	I	
1.0	7072.39	I	
4	7075.33	II	
5	7084.17	I	
4	7089.34	II	
1.6	7100.52	II	
1.8	7124.56	I	0–14032
0.6	7130.29	I	
0.9	7131.36	I	
0.8	7140.45	II	
0.8	7148.55	I	
0.9	7150.28	I	3865–17847
1.6 hw	7154.94	I	7280–21253
2.5 hs	7155.38		
0.8	7156.94	I	4962–18930
1.4 hs	7158.56		
3.0 hs	7159.10		
0.9	7159.93	I	13297–27260
1.2 hs	7164.88		
5	7168.90	I	
1.2	7173.37	I	
0.9	7176.72	II	
7	7191.14	II	
1.2	7200.04	I	7280–21165
0.8	7206.48	I	
6	7208.01	I	8800–22670
1.8	7212.69	I	
1.6	7217.75	II	
1.8	7218.05	I	9805–23655
0.7	7219.15	I	
0.8	7230.86	I	
0.8	7244.69	I	
1.2	7284.90	I	3688–17411
0.8	7285.62		
1.2	7287.05	I	
1.8 hs	7288.97		
1.8	7305.40	II	
1.2	7324.81	I	
1.2	7328.28	I	7280–20922
1.2	7335.57	II	
1.4	7341.15	I	
0.8	7342.58	I	
0.9	7346.34	II	
1.0 h	7358.35	II	
1.4	7376.88	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.2	7383.71	I	
3.0	7385.50	I	3688–17224
0.5	7393.44	I	
0.9	7402.24	I	
3.5	7428.94	I	7280–20737
1.6	7430.25	I	6362–19817
0.7	7447.84	I	
1.6	7481.35	I	
1.2	7511.34	II	
8	7525.51	II	
0.7	7528.48		
0.8	7536.41	II	
1.2	7549.31	I	7280–20523
1.2	7566.53		
3.0	7567.74	I	
4	7585.73	I	
0.6	7598.20	II	
1.2	7625.70	I	8800–21910
0.8	7627.16	I	
0.7 h	7630.30	I	
5	7647.38	I	
1.2	7653.83		
0.6	7658.32	I	8111–21165
1.2	7676.22	II	
0.6	7678.12	I	7502–20523
3.5	7685.30	II	
0.6	7693.80	II	
1.4 h	7701.11	II	
0.9	7709.57	II	
0.6	7710.27	I	
1.6	7731.74	II	
0.6	7742.57	I	
0.5	7743.95	II	
1.2	7782.32	I	
2.5	7787.80	II	
2.5	7788.93	II	
0.9	7798.36	I	
3.5	7817.77	I	
1.4	7834.46	II	
1.0 d	7840.31	I	
	7840.45	I	
0.9	7841.79	I	
2.5	7847.54	I	
0.6	7848.45	I	8800–21540
0.7	7849.62	II	
2.0	7865.97	I	
1.6 bl	7868.40		
1.0	7886.28	I	6362–19039
1.2	7897.99	I	
1.8	7900.32	II	12220–24874
1.8	7941.73	I	
1.2 h	7972.59	I	
4	7978.97	I	3688–16218
0.8	7981.23	II	
0.6	7981.68	II	
1.8	7987.98	I	
1.8	8032.43	I	7502–19948
0.6	8054.52	II	
1.8	8062.63	I	
0.9	8075.65	I	11803–24182
0.9	8085.22	I	8800–21165
0.8	8093.60	I	3865–16218
1.2	8122.73	I	
1.8	8138.46	I	5563–17847
0.9 h	8139.92	II	
3.0	8143.16	II	14349–26626
0.8	8152.40		
2.0	8159.75	I	6362–18614
1.6	8163.15	II	
1.2	8166.47	I	
1.2	8169.81	I	7280–19517
2.5	8186.92	I	
2.0	8203.21	I	
1.2	8217.23	II	
0.8	8252.39	I	
0.6	8261.02	I	
0.8	8263.93		
3.0	8275.63	I	
2.5	8320.86	I	7502–19517
5	8330.47	I	7502–19503
0.7	8358.72	I	
0.7	8369.34	I	
1.0	8387.10	II	
3.0	8403.79	II	
2.5	8416.72	I	
0.9	8418.00	I	
2.0	8421.22	II	
1.4	8445.49	I	8111–19948
3.5	8446.51	I	
0.9	8450.67	II	
3.0	8478.37	I	5563–17355
0.9	8500.67	I	
1.0 h	8516.55	I	
0.7	8543.69	I	
0.6	8544.58	I	
0.6 h	8556.32	I	
0.7	8568.22	II	
1.8	8573.14	I	5563–17224
0.8 h	8587.64	II	
2.0	8591.85	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.6	8639.44	I	
0.6	8645.31	I	13962–25526
1.6	8665.50	I	7502–19039
0.7	8668.11	I	12848–24381
0.7	8686.12	II	
0.9	8709.24	I	3688–15167
0.8	8719.63	I	
0.8	8721.67	I	
1.4	8732.42	II	
3.0	8748.03	I	7502–18930
1.0	8749.16	I	
2.5	8758.24	I	8800–20215
1.4 h	8775.58	I	8111–19503
1.4 h	8784.57	II	1522–12902
1.4	8816.16	II	4113–15453
1.0	8841.16	I	
3.0	8842.08	II	4147–15453
2.5	8868.81	I	
2.5	8957.97	II	
7	8967.61	I	8800–19948
2.5 bl	8971.96	ThO	

THULIUM

Tm, $Z=69$, $M=168.94$, Ratio $\frac{\text{Tm}}{\text{Cu}}=2.659$

Tm I Normal state of valence electrons $4f^{13}\ 6s^2\ {}^2F^\circ_{3½}=0$. I. P. ≈ 50000 K
Tm II Normal state of valence electrons $4f^{13}\ 6s^1\ {}^3F^\circ_4=0$.

References

Wavelengths and Spectrum Assignments:
W. F. Meggers, unpublished material (1940).

Classification:
Tm I, Tm II, W. F. Meggers, Rev. Mod. Phys. **14,** 96 (1942), and unpublished material (1961).

Relative intensity of thulium lines observed in an arc of copper containing 0.1 atomic percent of thulium

Strong lines of thulium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
800	3462. 20	II	0–28875	$4f^{13}6s^1\ {}^3F^\circ_4 - 28875_5$
750	3848. 02	II	0–25980	$4f^{13}6s^1\ {}^3F^\circ_4 - 25980_3$
750	4094. 19	I	0–24418	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 24418_{4½}$
700	3131. 26	II	0–31927	$4f^{13}6s^1\ {}^3F^\circ_4 - 31927_5$
700	4105. 84	I	0–24349	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 24349_{4½}$
650	3717. 92	I	0–26889	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 26889_{4½}$
650	4187. 62	I	0–23873	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 23873_{4½}$
600	3425. 08	II	237–29425	$4f^{13}6s^1\ {}^3F^\circ_3 - 29425_3$
600	3795. 76	II	237–26575	$4f^{13}6s^1\ {}^3F^\circ_3 - 26575_4$
500	3761. 33	II	0–26579	$4f^{13}6s^1\ {}^3F^\circ_4 - 26579_3$
500	3883. 13	I	0–25745	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 25745_{4½}$
460	3441. 50	II	237–29286	$4f^{13}6s^1\ {}^3F^\circ_3 - 29286_2$
460	3453. 67	II	237–29183	$4f^{13}6s^1\ {}^3F^\circ_3 - 29183_4$
440	4203. 73	I	0–23782	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 23782_{4½}$
420	3744. 07	I	0–26701	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 26701_{4½}$
400	3700. 26	II	237–27254	$4f^{13}6s^1\ {}^3F^\circ_3 - 27254_4$
400	3761. 91	II	0–26575	$4f^{13}6s^1\ {}^3F^\circ_4 - 26575_4$
400	3887. 35	I	0–25717	$4f^{13}6s^2\ {}^2F^\circ_{3½} - 25717_{3½}$
380	3362. 62	II	237–29967	$4f^{13}6s^1\ {}^3F^\circ_3 - 29967_2$
320	3701. 36	II	0–27009	$4f^{13}6s^1\ {}^3F^\circ_4 - 27009_4$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	2284.80	II	
3.5	2329.78	II	
7	2331.78	III	
7	2338.36	III	
2.5	2340.93	II	
12	2357.05	III	
5	2361.23	III	
5	2363.93	III	
2.0	2365.95	II	
7	2367.11	II	237−42470
8	2383.68	II	
6	2388.95	II	
4	2408.23	II	
32	2409.03	II	
7	2412.44	II	
5	2419.37	II	
2.5	2420.21	II	
9	2421.64	II	
2.0	2423.28	II	
40	2426.16	II	
5	2428.42	II	
3.0	2430.75	II	
5	2434.74	II	
4	2436.19	II	
6	2437.66	II	
9	2440.69	II	
14	2445.46	II	
4	2445.94	II	
7	2447.40	II	
9	2451.20	II	
4	2454.90	II	
9	2458.57	II	
9	2464.94	II	
2.0	2471.36	II	
9	2476.96	II	
85	2480.13	II	237−40545
17	2481.15	II	
14	2487.52	II	
4	2490.93	II	
28	2491.59	II	
10	2499.20	II	
11	2499.52	II	
6	2502.69	II	
7	2504.74	III	
3.0	2505.89	II	0−39894
3.0	2506.45	II	
14	2507.14	II	
140	2509.08	II	0−39843
5	2511.82	II	
10 d	2513.77	I	
	2513.85	II	
2.5	2518.46	II	
11	2519.80	III	
22	2520.87	II	
	2520.94	II	
28	2522.16	II	
20	2524.09	II	237−39843
14	2527.03	I	
12	2527.42	II	0−39554
4	2527.86	II	
2.0	2531.43	II	
13	2542.66	II	237−39554
3.5	2544.02	II	
3.5	2551.51	II	
13	2552.49	III	
40	2552.75	II	
60	2561.65	II	
17	2563.86	II	
7	2565.98	II	237−39197
4	2568.26	II	
4	2569.34	II	
5	2574.56	III	
4	2583.42	II	
48	2588.27	II	
4	2594.97	II	
19 h	2596.49	I	
12	2601.08	I	
24	2606.01	II	0−38361
90	2607.05	II	237−38583
6	2609.46	II	
8	2613.59	II	
4	2615.99	II	
8	2616.31	II	
4	2616.99		
4	2620.93	II	
8	2622.21	II	237−38361
75	2624.34	II	0−38094
7	2629.78	II	
4	2632.23	II	
6	2637.23	II	
7	2638.41	II	
22	2640.77	II	237−38094
4	2642.83	II	
4	2643.50	II	
13	2646.45	II	
7	2648.14	II	
16	2650.27	II	237−37958
3.5	2653.41	II	
19	2658.48	II	237−37841

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
26	2660.09	II	
5	2664.46	II	
14	2668.20	II	
4	2674.98	II	
6	2677.12	II	
5	2678.09	II	
32	2679.56	II	
10	2682.31	III	
10	2684.08	II	237−37483
3.5 d	2686.20	II	
	2686.32	II	
3.5	2689.99	II	
3.5	2693.47	II	
17	2697.50	II	
4 h	2698.26	III	
4	2699.47	III	
4	2699.82	III	
5	2700.17	II	
4	2701.95	II	
8	2707.01	III	
2.0	2708.19	II	237−37151
10	2709.72	III	
11	2711.51	II	0−36869
4	2717.55	III	
20	2719.46	III	
55	2721.19	II	
3.0	2721.90	II	
20	2727.55	III	
15	2729.04	II	237−36869
3.5	2730.72	II	
7	2731.42	III	
5	2735.33	II	0−36548
10	2742.95	II	
20	2744.08	II	
11	2750.77	II	
11	2753.18	II	237−36548
15	2756.69	II	8770−45034
9	2758.97	II	
4	2759.56	II	
7	2766.81	II	0−36132
5	2767.09	II	
11	2771.04	II	8957−45034
9	2773.80	II	0−36041
7	2774.78	II	
18	2774.98	II	
5	2776.69	II	
12	2777.04	II	
9	2777.50	II	
5	2778.40	II	
28	2779.55	II	0−35966
11	2780.87	II	
36	2785.07	II	237−36132
10	2786.17	II	
5	2787.96	II	
3.0	2791.43	II	
12	2791.62	II	
18	2792.15	II	237−36041
70	2794.60	II	
10 h	2796.09	II	0−35754
75	2797.26	II	
6	2797.98	II	237−35966
10	2800.40	II	
7	2803.10	II	
4	2806.79	III	
18	2807.98	II	
17	2808.42	II	237−35834
10	2812.26	II	
4	2813.02	II	
3.0	2813.82	II	
14	2814.42	II	
14	2814.51	II	
3.0	2814.74	II	237−35754
4	2816.55	II	
9	2817.31	II	
11	2818.14	II	
26	2818.47	II	
7	2819.08	II	
2.5	2820.22	II	
4	2823.54	II	
6	2824.77	II	
10	2826.43	II	
26	2827.02	II	
8	2827.76	II	
60	2827.92	II	
5	2830.15	II	
20	2831.55	II	
7	2833.82	II	8770−44047
5	2836.17	II	
4	2838.63	II	
16	2838.93	II	
10	2839.10	II	
7	2839.85	II	
12	2841.34	II	
4	2842.42	II	
3.0	2842.76	II	
32	2844.66	II	237−35380
6	2845.35	II	
10	2848.86	II	
3.0	2848.98	II	8957−44047
3.0	2852.59	II	

Thulium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2853.25	II	237–35274
9	2854.02	II	
20	2854.16	I	
6	2854.89	II	
20	2860.12	II	
5	2860.36	II	
7	2860.55	II	237–35185
20	2861.74	II	
10	2863.35	II	0–34914
15	2863.75	II	
3.0	2864.75	I	
16	2868.01	II	
160	2869.22	II	
8	2873.00	II	
4	2878.20	II	
6	2878.36	II	
1.8	2883.04	II	
14	2886.46	II	237–34871
6 h	2887.96	II	
10	2889.64	II	8770–43366
3.0	2889.93	II	
3.5	2890.74	II	
65	2890.93	II	
5	2893.60	II	
17	2894.47	II	
13	2903.08	II	
3.0	2904.09	II	
10	2905.41	II	8957–43366
7	2907.17	II	
6	2908.69	II	
3.0	2910.36	II	
5	2911.87	II	
13	2913.96	II	0–34308
17	2914.83	I	0–34297
13	2916.52	II	
22	2918.27	II	
7	2920.98	II	
6	2921.27	II	
7	2922.09	II	
7	2922.83	II	
28	2925.65	II	
7	2925.92	II	237–34404
70	2926.74	II	
3.0	2927.31	II	
5	2927.65	II	
11	2928.22	II	
3.0	2928.64	II	
5	2930.56	II	
4	2931.09	I	
7	2932.58	II	
8	2932.96	I	0–34085
3.0	2933.78	II	
4	2933.89	II	
3.0	2935.49	II	
65	2935.99	II	
3.0	2936.59	II	
7	2943.36	II	
10	2946.83	II	
14	2948.00	II	
10	2948.15	II	
3.5	2950.08	II	
36	2951.26	II	
5	2951.80	II	
5	2952.48	II	
6	2953.58	II	
5	2955.06	II	
3.0	2957.05	II	
6	2957.55	II	
3.0	2957.67	II	
18	2959.64	II	
5	2961.40	II	
44	2965.86	II	
12	2967.75	II	
12	2969.50	II	0–33666
50	2973.22	I	0–33624
16	2973.39	II	
11	2974.29	II	
3.0	2974.60	II	
15	2978.42	II	0–33565
3.5	2979.43	II	
55	2981.48	II	
7	2983.13	II	8957–42470
7	2985.08	II	0–33490
13	2985.37	II	
36	2986.52	II	
65	2990.54	II	237–33666
3.5	2992.88	II	
20	2993.26	II	0–33399
12	2993.90	II	0–33392
3.0	2994.33	II	
13	2999.60	II	237–33565
3.5	3001.16	II	
3.0	3004.17	II	
6	3006.36	II	237–33490
12	3008.91	II	
3.0	3009.20	II	
7	3013.59	II	
24	3013.71	II	
44	3014.65	II	237–33399
150	3015.30	II	237–33392

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
7	d	3016.09	II	
		3016.18	II	
3.5		3016.79	II	
28		3017.10	II	
7		3017.26	II	
3.0		3018.27	II	
10		3018.59	II	
6		3019.79	II	
3.5		3022.08	II	
34		3026.06	II	
5		3028.73	II	
7		3031.67	II	
7		3034.08	II	
8		3035.98	II	
26		3042.35	II	237–33097
32	d	3046.76	II	237–33049
		3046.87	I	0–32811
16		3048.81	II	
30		3050.73	II	
7		3053.71	II	
14		3054.04	II	
32		3056.07	II	
7		3058.35	II	
7		3058.98	II	
7		3061.14	II	
7		3062.06	II	
7		3064.01	II	
5		3068.11	II	
55		3073.08	II	
14		3073.49	II	
7		3073.84	II	
34		3081.12	I	0–32446
14		3087.01	II	
17		3093.11	II	
11		3096.96	II	
70		3098.60	II	237–32500
7		3099.60	II	
5		3101.85	II	
7		3102.87	II	
5		3113.31	II	
14		3122.53	I	
4		3123.29	II	
7		3124.90	II	
7		3125.73	II	
14		3126.01	II	
700		3131.26	II	0–31927
220		3133.89	II	0–31900
22		3144.89	II	
22		3146.16	II	8770–40545
7		3149.15	II	0–31745
7		3150.07	II	8770–40506
180		3151.04	II	
140		3157.35	II	237–31900
7		3162.44	II	
7		3164.87	II	8957–40545
18		3168.19	II	
7		3168.82	II	8957–40506
42		3172.66	I	0–31510
220		3172.83	II	237–31745
36		3173.58	II	
12		3177.46	II	8770–40232
7		3178.20	II	
14		3180.56	I	0–31432
14		3185.47	II	
22		3195.33	II	8770–40056
12		3196.54	II	8957–40232
12		3200.00	II	
30		3210.57	II	
30		3210.83	II	0–31136
30		3212.02	II	8770–39894
12		3214.63	II	8957–40056
7		3216.12	II	
7		3226.81	II	
7		3228.90	II	
22		3231.51	II	8957–39894
7		3233.75	I	0–30915
44		3235.45	II	237–31136
110		3236.81	II	8957–39843
150		3240.23	II	
220		3241.53	II	0–30841
12		3245.86	II	237–31037
40		3247.46	II	8770–39554
7		3249.83	II	
7		3251.33	II	
15		3251.63	II	
180		3258.05	II	0–30684
38		3261.65	II	
30		3264.09	II	
150		3266.63	II	237–30841
110		3267.40	II	8957–39554
75		3268.99	II	
100		3276.81	II	0–30509
110		3283.40	II	237–30684
8		3284.67	II	
110		3285.61	II	8770–39197
220		3291.00	II	0–30377
190		3302.45	II	237–30509
20		3306.01	II	8957–39197
20		3306.91	II	8770–39001
20		3308.01	II	

Thulium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
110		3309.80	II	
60		3310.60	II	
8		3316.17	II	
38		3316.88	II	237–30377
15		3323.21	II	
8		3327.58	II	8957–39001
8		3335.06	II	
22		3349.99	I	0–29842
22		3354.86	II	
380		3362.62	II	237–29967
12		3368.33	II	
12		3368.60	I	
15		3369.64	II	
8		3372.78	I	
46		3374.51	II	8957–38583
5		3380.04	II	
16		3380.53	I	
40	d	3384.98	II	
		3385.09	I	
16		3393.19	I	
160		3397.50	II	0–29425
6		3397.87	I	
16		3398.02	II	
40		3399.95	II	8957–38361
80		3410.05	I	0–29317
5		3411.57	II	
32		3412.59	I	0–29295
32		3416.59	I	0–29260
16		3421.80	I	
6		3424.50	I	
600		3425.08	II	237–29425
90		3425.63	II	0–29183
16		3428.62	II	
32		3429.33	I	0–29152
80		3429.97	II	
40		3431.20	II	8957–38094
5		3434.91	II	
18		3435.35	I	
8		3437.64	II	
13		3438.81	II	8770–37841
460		3441.50	II	237–29286
16		3443.00	I	
8		3444.16	I	
8		3446.55	I	
16	d	3447.26	II	8957–37958
		3447.35	I	
16		3449.76	II	
8	h	3453.02	I	
460		3453.67	II	237–29183
5		3456.36	I	
13		3458.55	I	
13		3461.16	II	8957–37841
800		3462.20	II	0–28875
20		3467.51	I	
32		3476.69	I	
32		3480.98	I	
32		3481.75	II	8770–37483
16		3487.08	II	
40		3487.38	I	0–28666
12		3489.52	I	
5		3491.72	I	
20		3492.58	II	
8		3495.19	II	
32		3499.95	I	0–28564
12		3503.36	I	
24		3513.02	II	
8		3514.12	I	0–28449
8		3514.86	I	
24		3517.60	I	0–28420
13		3517.72	I	
16		3522.43	II	8770–37151
8		3525.03	I	
6		3525.28	I	
24		3534.85	II	
160		3535.52	II	
46		3536.21	II	
80		3536.58	II	0–28268
40		3537.91	I	
5		3542.08	I	
13		3548.48	II	
8		3550.16	II	
8		3550.83	II	
8		3551.68	I	
20		3555.82	I	
8		3556.58	I	
8		3557.34	I	
40		3557.80	II	8770–36869
32		3560.92	I	
40		3563.88	I	0–28051
46		3565.91	II	
120		3566.47	II	237–28268
40		3567.36	I	0–28024
12		3569.80	I	
26		3574.06	II	
8		3575.29	I	
8		3583.43	I	
26		3586.07	I	
12		3590.73	I	
16		3598.62	I	
8		3599.16	II	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	3607.35	II	
200	3608.77	II	0–27702
24	3609.54	II	
6	3611.61	II	
8	3612.39	II	
7	3613.03	II	
15	3619.97	II	
2.5	3623.42	II	8957–36548
7	3624.20	I	0–27584
32	3638.41	I	0–27477
3.0	3639.89	II	237–27702
7	3642.94	I	
80	3643.66	II	
15	3646.70	I	0–27414
12	3647.23	II	
20	3647.73	II	
50	3653.61	II	8770–36132
7	3660.88	II	
42	3665.81	II	8770–36041
90	3668.09	II	0–27254
10	3673.14	II	
34	3677.98	II	
38 d	3678.86	II	8957–36132
	3678.95	II	
12	3683.20	II	
34	3694.73	II	
	3694.82	II	
7	3697.57	II	
14	3699.87	II	
400	3700.26	II	237–27254
320	3701.36	II	0–27009
28	3704.85	II	8770–35754
650	3717.92	I	0–26889
6	3719.71	II	8957–35834
75	3725.06	II	
10	3730.81	II	8957–35754
200	3734.12	II	237–27009
420	3744.07	I	0–26701
140	3751.81	I	0–26646
26	3756.86	II	8770–35380
500	3761.33	II	0–26579
400	3761.91	II	0–26575
6	3765.85	II	
7	3781.15	I	0–26440
22	3783.56	II	8957–35380
4	3787.01	I	
32	3795.17	II	237–26579
600	3795.76	II	237–26575
65	3798.54	I	
20	3798.75	II	8957–35274
6	3802.07	I	
50	3807.72	I	0–26255
32	3810.72	II	8770–35004
46	3817.40	II	
5	3821.62	I	
24	3826.38	I	0–26127
110	3838.20	II	8957–35004
24	3840.87	I	
750	3848.02	II	0–25980
5	3853.10	II	
10	3857.84	II	8957–34871
500	3883.13	I	0–25745
130	3883.44	II	237–25980
400	3887.35	I	0–25717
32	3890.53	II	0–25696
32	3896.62	I	0–25656
50	3900.79	II	8770–34398
260	3916.48	I	8771–34297
9	3928.66	II	8957–34404
42	3929.58	II	8957–34398
110	3949.28	I	8771–34085
4	3957.42	II	
110	3958.10	II	0–25258
7	3976.68	I	
32	3995.59	II	237–25258
130	3996.52	II	
16	4024.23	I	
6	4034.76	II	
28	4044.47	I	0–24718
6	4055.80	I	
6	4090.30	II	8957–33399
6	4091.49	II	8957–33392
750	4094.19	I	0–24418
700	4105.84	I	0–24349
5	4107.93	I	
9	4132.69	II	
80	4138.34	I	0–24157
9	4149.14	I	
4	4150.11	I	
9	4158.60	I	8771–32811
5	4159.55	II	
5	4170.45	I	
650	4187.62	I	0–23873
38	4199.92	II	0–23803
440	4203.73	I	0–23782
16	4206.00	I	
4	4212.79	II	8770–32500
28	4222.67	I	8771–32446
7	4236.94	II	
220	4242.15	II	237–23803

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	4246.40	II	8957–32500
5	4268.56	I	
20	4271.71	I	8771–32174
11	4298.37	I	
7	4318.40	I	
5	4344.48	I	
5	4346.48	I	
4	4351.00	II	
7	4351.18	II	8770–31745
200	4359.93	I	0–22930
7	4363.66	II	
4	4367.89	II	
100	4386.43	I	0–22791
15	4394.42	I	0–22750
9	4395.96	I	
10	4396.49	I	8771–31510
4	4399.73	I	
4	4437.40	II	
6	4442.74	I	
3.5	4447.59	I	
9	4454.04	I	
6	4459.98	I	
3.5	4467.98	II	
40	4481.27	II	0–22309
6	4489.71	II	8770–31037
11	4519.61	I	
19	4522.57	II	
13	4529.38	II	237–22309
6	4532.15	I	
8	4548.60	I	
3.0	4556.69	II	
3.0	4561.86	II	8770–30684
6	4564.69	I	
3.0	4567.11	II	
7	4596.63	I	
20	4599.02	I	0–21738
2.5	4601.29	II	8957–30684
4	4603.44	II	
3.0	4604.86	I	
3.5	4613.98	I	
3.0	4614.47	II	
22	4615.95	II	
2.5	4619.06	II	
3.0	4621.72	I	
6	4626.33	II	
7	4626.56	II	0–21608
3.0	4626.97	I	
8	4634.26	II	
3.0	4642.96	II	
7	4643.12	I	8771–30302
2.5	4644.58	I	
9	4655.09	I	
2.5	4666.70	II	
2.5	4671.99	II	
2.5	4675.10	I	
6	4675.32	I	
3.0	4677.86	II	237–21608
12	4681.92	I	
5	4685.12	I	
9	4691.11	I	
8	4724.26	I	0–21161
50	4733.34	I	0–21121
2.5	4750.75	II	
5	4759.90	I	
2.0	4789.92	II	
2.0	4807.48	I	
2.5	4808.68	I	
2.5	4813.50	I	
2.0	4826.99	II	
2.0	4828.97	I	
6	4831.20	II	
2.5	4835.76	I	
2.0 d	4851.75	I	
	4851.90	II	
1.4	4872.28	II	
2.0	4879.20	I	
2.0	4891.59	I	
1.8	4909.74	I	
4	4923.83	I	
10	4957.18	I	
3.0	4970.87	II	
2.0	4971.26	I	
3.0	4975.12	II	
3.5	4978.90	I	
3.0	4980.68	II	
4	4989.32	II	
2.0	4993.78	II	
1.4	4994.72	II	
2.5	5001.03	I	
2.0	5001.57	I	
12	5009.78	II	
2.5	5014.56	II	
2.0	5017.88	II	
12	5034.24	II	
2.0 h	5041.00	II	
1.6	5043.51	I	
2.5	5045.41	I	
2.0	5060.43	II	
11	5060.90	I	0–19754
2.0	5062.26	I	

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	5065.87	I	
6	5066.68	I	
2.0	5072.43	I	
2.0	5076.37	I	
2.0	5077.20	I	
2.5	5085.10	I	
3.0	5107.54	I	
7	5113.99	I	0−19549
3.5	5114.55	II	
1.6	5120.68	I	
1.6	5140.28	II	
3.0	5149.40	II	
1.4	5182.68	I	
3.0	5185.25	I	8771−28051
1.0	5204.52	II	
6	5213.38	I	
1.6	5228.24	II	
1.0	5260.93	II	
1.8	5267.34	II	
3.0	5291.15	I	
3.0	5294.32	I	
2.5	5300.21	I	
2.5	5302.70	I	
4	5305.88	II	
48	5307.12	I	0−18837
1.2	5323.00	II	
2.5	5338.92	I	
	5339.03	I	
6	5346.50	II	
2.0	5373.01	II	
1.0	5391.97	II	
2.0	5400.46	II	
2.0	5402.24	I	
1.0	5405.99	II	
1.0	5461.96	II	
1.0	5464.15	I	
1.0	5465.54	II	
1.2	5500.32	II	
1.0	5526.82	II	
1.8	5528.32	I	
1.0	5539.03	II	
2.0	5566.01	I	
1.6	5581.36	I	
1.0	5586.66	II	
1.0	5589.95	II	
1.0	5606.64	I	
20	5631.40	I	0−17753
3.0	5642.60	I	
2.0	5645.40	I	
5	5658.30	I	8771−26440
38	5675.85	I	0−17614
1.0	5683.60	I	
3.0	5684.77	II	
1.0	5696.44	II	
2.5	5709.98	II	
1.6	5715.79	I	
1.0	5733.82	II	
0.8 h	5737.22	II	
1.0 h	5738.93	II	
2.0	5758.02	I	
4	5760.21	I	8771−26127
14	5764.30	I	0−17343
0.4	5778.83	II	
1.4	5782.36	II	
1.6	5784.44	I	
0.8	5799.98	II	
1.0	5811.18	II	
1.0 h	5816.48	I	
2.5	5838.78	II	
18	5895.65	I	0−16957
2.5	5899.48	I	8771−25717
1.8	5901.58	I	
0.6	5912.59	I	
0.8	5931.72	I	
2.0	5935.90	I	
10	5971.28	I	0−16742
2.0	5975.03	I	
0.8	5984.87	I	
1.4	6025.45	I	
0.8	6067.78	II	
1.2	6131.54	I	
1.0	6175.30	I	
1.0	6181.42	II	
1.0	6299.45	II	
2.0	6352.66	I	
1.6	6401.45	I	
0.6	6430.95	II	
1.0	6440.55	I	
15	6460.27	I	
1.0	6490.72	I	
1.0	6519.79	I	
0.6	6575.54	I	
7	6604.97	I	
0.6	6627.25	I	
2.5	6657.73	I	
0.8	6658.64	I	
1.2	6692.93	I	
3.5	6721.37	I	
1.0	6726.35		
1.0	6728.01		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.0		6739.23		
1.0	h	6767.50		
1.0		6777.94		
12		6779.77	I	
1.6	h	6782.01	I	
2.0		6788.52	I	
1.4	h	6820.27		
1.6		6826.96		
1.6		6829.14		
2.5		6831.11		
13		6844.28	I	
9		6845.77	I	
2.0		6854.16		
0.9		6898.58		
0.9		6915.87		
1.4		6937.40		
0.8		6949.55		
0.8	h	6976.71		
0.7		7010.81		
0.9	h	7014.33		
1.4		7017.90		
0.9	h	7029.38		
1.8		7034.32		
1.4		7056.44		
0.7		7060.99	I	8771 – 22930
0.9		7079.80		
1.4		7106.14		
0.7	h	7231.32		
0.8		7233.74		
0.6		7257.71		
2.5		7272.62		
1.2		7284.31		
1.6	h	7286.15		
2.0		7310.51		
1.6		7336.73		
2.0		7432.19		
0.8		7434.51		
0.7		7439.96		
11		7481.09	I	
11		7490.22	I	
1.4	h	7507.31		
2.0		7545.78		
20		7558.35	I	
2.5	h	7580.61		
3.0	h	7593.74		
2.5		7595.07		
0.7		7629.86		
0.7	h	7648.78		
2.5		7655.01		
0.6		7660.32		
1.0	h	7666.25		
1.2		7676.04		
1.2	h	7701.46		
12		7731.54	I	
0.6	h	7778.29		
1.8	h	7782.36		
1.2	h	7785.66		
2.5		7803.93	I	
0.6		7829.22		
6		7856.11	I	
0.5		7861.76		
0.7		7918.10		
8		7927.52		
16		7930.88		
0.9		7971.56		
1.6	h	7985.94		
2.0	h	8014.79		
14		8017.92	I	
0.5	h	8021.31		
2.0		8194.20		
0.8		8294.53		
1.0		8365.74		
1.0		8460.77		
4		8472.02		
1.0	h	8546.09		
1.6		8565.73		

609065 O - 62 - 26

TIN

Sn, $Z=50$, $M=118.70$, Ratio $\frac{Sn}{Cu}=1.868$

Sn I Normal state of valence electrons $5s^2\ 5p^2\ {}^3P_0 = 0$. I.P.= 59232 K
Sn II Normal state of valence electrons $5s^2\ 5p^1\ {}^2P^o_{0\frac{1}{2}} = 0$. I.P.=118017 K

References

Wavelengths and Classification:
Sn I, W. F. Meggers, J. Research NBS **24,** 153 (1940).

Relative intensity of tin lines observed in an arc of copper containing 0.1 atomic percent of tin

Strong lines of tin

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1400	2839.99	I	3428–38629	$5s^25p^2\ {}^3P_2 - 5s^25p^16s^1\ {}^3P^o_2$
1000	2863.33	I	0–34914	$5s^25p^2\ {}^3P_0 - 5s^25p^16s^1\ {}^3P^o_1$
850	3034.12	I	1692–34641	$5s^25p^2\ {}^3P_1 - 5s^25p^16s^1\ {}^3P^o_0$
700	2706.51	I	1692–38629	$5s^25p^2\ {}^3P_1 - 5s^25p^16s^1\ {}^3P^o_2$
700	3009.14	I	1692–34914	$5s^25p^2\ {}^3P_1 - 5s^25p^16s^1\ {}^3P^o_1$

Tin — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
11	1970.80	I	1692–52416
8 h	1983.55	I	3428–53826
8	2040.66	I	3428–52416
7	2073.08	I	0–48222
10	2091.58	I	1692–49487
2.5 h	2096.39	I	8613–56299
3.0	2100.93	I	3428–51010
12	2113.93	I	1692–48982
2.0	2148.73	I	1692–48216
5	2151.43	I	3428–49894
9	2194.49	I	3428–48982
13	2199.34	I	1692–47146
22	2209.65	I	3428–48670
2.0	2211.05	I	8613–53826
4	2231.72	I	3428–48222
42	2246.05	I	0–44509
2.0	2251.17	I	8613–53021
6	2267.19	I	8613–52707
42	2268.91	I	3428–47488
10	2286.68	I	3428–47146
50	2317.23	I	8613–51754
38	2334.80	I	1692–44509
190	2354.84	I	1692–44145
2.0	2357.90	I	8613–51010
9	2380.72	I	1692–43683
16	2408.15	I	8613–50126
260	2421.70	I	8613–49894
420	2429.49	I	3428–44576
3.0	2433.47	I	3428–44509
5	2455.24	I	3428–44145
110	2483.39	I	3428–43683
110	2495.70	I	8613–48670
15	2523.92	I	8613–48222
240	2546.55	I	0–39257
100	2571.58	I	8613–47488
55	2594.42	I	8613–47146
140	2661.24	I	1692–39257
700	2706.51	I	1692–38629
11	2761.78	I	3428–39626
100	2779.81	I	8613–44576
32	2785.03	I	8613–44509
12	2812.59	I	17163–52707
60	2813.58	I	8613–44145
1400	2839.99	I	3428–38629
170	2850.62	I	8613–43683
1000	2863.33	I	0–34914
24 h	2913.54	I	17163–51475
700	3009.14	I	1692–34914
40	3032.80	I	17163–50126
850	3034.12	I	1692–34641
4	3141.84	I	17163–48982
550	3175.05	I	3428–34914
550	3262.34	I	8613–39257
110	3330.62	I	8613–38629
40	3655.78	I	17163–44509
280	3801.02	I	8613–34914
40	4524.74	I	17163–39257
4	5631.71	I	17163–34914
0.8 h	8552.60	I	34914–46603

TITANIUM

Ti, $Z=22$, $M=47.90$, Ratio $\frac{\text{Ti}}{\text{Cu}}=0.754$

Ti I Normal state of valence electrons $3d^2\,4s^2\,{}^3F_2$ =0. I.P.= 55138 K
Ti II Normal state of valence electrons $3d^2\,4s^1\,{}^4F_{1½}$=0. I.P.=109506 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
Supplemented by the following:
A. S. King, Astrophys. J. **39,** 139 (1914).
C. C. Kiess and W. F. Meggers, Sci. Papers BS **16,** 51 (1920).
H. Crew, Astrophys. J. **60,** 108 (1924).
A. S. King, Astrophys. J. **59,** 155 (1924).
W. F. Meggers and C. C. Kiess, J. Research NBS **9,** 309 (1932).

Classification:
Ti I, H. N. Russell, Astrophys. J. **66,** 347 (1927).
W. F. Meggers and C. C. Kiess, J. Research NBS **9,** 309 (1932).
Ti II, H. N. Russell, Astrophys. J. **66,** 283 (1927).

Molecular Spectra:
TiO, F. Lowater, Proc. Phys. Soc. (London) **41,** 557 (1929).

Intensities:
R. Frerichs, Ann. Physik **81,** 807 (1926).
G. R. Harrison, J. Opt. Soc. Am. **17,** 389 (1928).
G. R. Harrison and H. Engwicht, J. Opt. Soc. Am. **18,** 287 (1929).
G. R. Harrison, J. Opt. Soc. Am. **19,** 109 (1929).
R. B. King and A. S. King, Astrophys. J. **87,** 24 (1938).
R. B. King, Astrophys. J. **94,** 27 (1941).
L. H. M. van Stekelenburg and J. A. Smit, Physica **14,** 185 (1948).
Y. I. Ostrovskii, G. F. Parchevskii, and N. P. Penkin, Optika i Spektroscopiya **1,** 821 (1956).

Relative intensity of titanium lines observed in an arc of copper containing 0.1 atomic percent of titanium

Strong lines of titanium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1000	3349. 41	II	393–30241	$3d^2\,4s^1\,a\,{}^4F_{4½}$—$3d^2\,4p^1$ $z\,{}^4G^\circ_{5½}$
650	3998. 64	I	387–25388	$3d^2\,4s^2\,a\,{}^3F_4$ —$3d^2\,4s^1\,4p^1\,y\,{}^3F^\circ_4$
600	3361. 21	II	225–29968	$3d^2\,4s^1\,a\,{}^4F_{3½}$—$3d^2\,4p^1$ $z\,{}^4G^\circ_{4½}$
	3361. 26	I	170–29912	$3d^2\,4s^2\,a\,{}^3F_3$ —$3d^2\,4s^1\,4p^1\,w\,{}^3D^\circ_3$
600	3653. 50	I	387–27750	$3d^2\,4s^2\,a\,{}^3F_4$ —$3d^3\,4p^1$ $y\,{}^3G^\circ_5$
550	3234. 52	II	393–31301	$3d^2\,4s^1\,a\,{}^4F_{4½}$—$3d^2\,4p^1$ $z\,{}^4F^\circ_{4½}$
550	3642. 68	I	170–27615	$3d^2\,4s^2\,a\,{}^3F_3$ —$3d^3\,4p^1$ $y\,{}^3G^\circ_4$
550	4981. 73	I	6843–26911	$3d^3\,4s^1\,a\,{}^5F_5$ —$3d^3\,4p^1$ $y\,{}^5G^\circ_6$
500	4305. 92	I	6843–30060	$3d^3\,4s^1\,a\,{}^5F_5$ —$3d^3\,4p^1$ $x\,{}^5D^\circ_4$
500	4533. 24	I	6843–28896	$3d^3\,4s^1\,a\,{}^5F_5$ —$3d^3\,4p^1$ $y\,{}^5F^\circ_5$
480	3341. 88	I	0–29915	$3d^2\,4s^2\,a\,{}^3F_2$ —$3d^2\,4s^1\,4p^1\,x\,{}^3G^\circ_3$
		II	4629–34543	$3d^2\,4s^1\,a\,{}^2F_{2½}$—$3d^2\,4p^1$ $z\,{}^2G^\circ_{3½}$
480	3372. 80	II	94–29734	$3d^2\,4s^1\,a\,{}^4F_{2½}$—$3d^2\,4p^1$ $z\,{}^4G^\circ_{3½}$
480	3383. 76	II	0–29544	$3d^2\,4s^1\,a\,{}^4F_{1½}$—$3d^2\,4p^1$ $z\,{}^4G^\circ_{2½}$
480	3989. 76	I	170–25227	$3d^2\,4s^2\,a\,{}^3F_3$ —$3d^2\,4s^1\,4p^1\,y\,{}^3F^\circ_3$
440	3236. 57	II	225–31114	$3d^2\,4s^1\,a\,{}^4F_{3½}$—$3d^2\,4p^1$ $z\,{}^4F^\circ_{3½}$
440	3752. 86	I	387–27026	$3d^2\,4s^2\,a\,{}^3F_4$ —$3d^3\,4p^1$ $x\,{}^3F^\circ_4$
440	3958. 21	I	387–25644	$3d^2\,4s^2\,a\,{}^3F_4$ —$3d^2\,4s^1\,4p^1\,y\,{}^3D^\circ_3$
440	4991. 07	I	6743–26773	$3d^3\,4s^1\,a\,{}^5F_4$ —$3d^3\,4p^1$ $y\,{}^5G^\circ_5$
400	3635. 46	I	0–27499	$3d^2\,4s^2\,a\,{}^3F_2$ —$3d^3\,4p^1$ $y\,{}^3G^\circ_3$
400	3981. 76	I	0–25107	$3d^2\,4s^2\,a\,{}^3F_2$ —$3d^2\,4s^1\,4p^1\,y\,{}^3F^\circ_2$
380	3948. 67	I	0–25318	$3d^2\,4s^2\,a\,{}^3F_2$ —$3d^2\,4s^1\,4p^1\,y\,{}^3D^\circ_1$
380	3956. 34	I	170–25439	$3d^2\,4s^2\,a\,{}^3F_3$ —$3d^2\,4s^1\,4p^1\,y\,{}^3D^\circ_2$
380	4999. 51	I	6661–26657	$3d^3\,4s^1\,a\,{}^5F_3$ —$3d^3\,4p^1$ $y\,{}^5G^\circ_4$
360	3349. 04	II	4898–34748	$3d^2\,4s^1\,a\,{}^2F_{3½}$—$3d^2\,4p^1$ $z\,{}^2G^\circ_{4½}$
360	3371. 45	I	387–30039	$3d^2\,4s^2\,a\,{}^3F_4$ —$3d^2\,4s^1\,4p^1\,x\,{}^3G^\circ_5$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	2272.61	I	387–44376
2.5	2273.28	I	0–43976
2.0	2276.70	I	170–44079
3.0	2279.96	I	387–44233
3.0	2299.85	I	0–43468
3.0	2302.73	I	170 43583
4	2305.67	I	387–43745
3.0	2380.81	I	387–42377
1.6	2384.52	I	387–42311
4	2418.36	I	0–41337
6	2421.30	I	170–41458
8	2424.24	I	387–41624
3.0	2428.23	I	0–41170
3.0	2433.22	I	170–41255
1.6	2434.10	I	387–41458
3.0	2440.21	II	12629–53597
6	2440.98	I	387–41342
2.5	2450.44	II	12758–53555
2.5	2504.54	I	
8	2517.43	II	1087–40798
4	2519.04	I	0–39686
15	2520.54	I	0–39662
8	2524.64	II	984–40582
38	2525.60	II	1216–40798
3.0	2527.98	I	170–39716
22	2529.85	I	170–39686
20	2531.25	II	1087–40582
20	2534.62	II	984–40426
14	2535.87	II	908–40330
20	2541.92	I	387–39716
7	2555.99	II	4629–43741
12	2571.03	II	4898–43781
5	2572.65	II	
5	2580.82	I	
3.5	2590.26	I	170–38765
20	2593.64	I	0–38544
7	2596.58	I	170–38671
28	2599.92	I	0–38451
36	2605.15	I	170–38544
48	2611.28	I	387–38671
7	2611.48	I	170–38451
28	2619.94	I	387–38544
16	2631.54	I	170–38160
16	2632.42	I	0–37977
60	2641.10	I	0–37852
75	2644.26	I	170–37977
90	2646.64	I	387–38160
3.0	2649.30	I	
1.4	2654.93	I	0–37655
3.5	2657.19	I	0–37623
8	2661.97	I	0–37555
9	2669.60	I	170–37618
12	2679.93	I	387–37690
2.5	2684.80	I	
3.0	2685.14	I	387–37618
6	2688.82	I	
2.5	2716.25	II	8744–45549
8	2725.07	I	8492–45178
7	2727.42	I	8437–45091
2.0	2731.13	I	8602–45206
4	2731.58	I	8492–45091
16	2733.26	I	8602–45178
5	2735.29	I	8492–45041
4	2735.61	I	7255–43800
8	2739.81	I	8602–45091
24	2742.32	I	7255–43710
4	2749.06	I	8492–44858
6	2757.40	I	8602–44858
9	2758.08	I	12118–48365
1.4	2761.29	II	8710–44915
24	2802.50	I	7255–42928
5	2805.70	I	8602–44233
3.0	2806.50	II	9851–45473
4	2809.17	I	8492–44079
7	2810.30	II	29734–65307
3.0	2812.98	I	8437–43976
3.0	2817.40	I	8492–43976
6	2817.84	I	8602–44079
	2817.87	II	29968–65446
6	2828.07	I	6557–41907
	2828.15	II	30241–65589
12	2832.16	II	4629–39927
18	2841.94	II	4898–40075
10	2851.10	II	9851–44915
4	2853.93	II	4898–39927
9	2862.32	II	9976–44902
5	2868.74	II	4629–39477
17	2877.44	II	8998–43741
26	2884.11	II	9118–43781
6	2888.93	II	4629–39233
5	2891.07	II	4898–39477
5	2905.66	I	
3.0	2909.92	II	393–34749
42	2912.08	I	7255–41585
32	2928.34	I	12118–46258
17	2933.55	I	0–34079
14	2937.32	I	170–34205
100	2942.00	I	0–33981
120	2948.26	I	170–34079
3.0	2954.58		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
150	2956.13	I	387–34205
16	2956.80	I	170–33981
2.5	2959.71	I	8492–42270
3.5	2959.99	I	8602–42377
16	2965.71	I	8602–42311
18	2967.22	I	387–34079
2.5	2968.23	I	0–33680
7	2970.38	I	0–33656
3.0	2974.93	I	8602–42207
16	2983.31	I	170–33680
3.0	3000.87	I	387–33701
10	3017.19	II	12775–45909
12	3029.73	II	12677–45674
9	3046.68	II	9396–42209
11	3056.74	II	9364–42069
11	3057.40	II	0–32698
14	3058.09	II	9518–42209
7	3059.74	II	9396–42069
110 d	3066.22	II	94–32698
	3066.35	II	0–32603
6	3071.24	II	9518–42069
50	3072.11	II	225–32767
95	3072.97	II	0–32532
130	3075.22	II	94–32603
190	3078.64	II	225–32698
300	3088.02	II	393–32767
15	3089.40	II	15266–47625
15	3097.19	II	9931–42209
15	3100.67	I	8602–40844
19	3103.80	II	15258–47467
19	3105.08	II	9873–42069
22	3106.23	II	10025–42209
6	3106.81	I	8492–40671
4	3110.67	II	9931–42069
4	3112.48	I	8437–40556
12	3117.67	II	9931–41997
60	3119.72	I	12118–44163
	3119.80	II	10025–42069
16	3123.07	I	7255–39266
20	3130.80	II	94–32026
12	3141.54	I	7255–39078
8	3141.67	I	17215–49036
18	3143.76	II	225–32026
20	3148.04	II	0–31757
20	3152.25	II	984–32698
20	3154.20	II	908–32603
20	3155.67	II	1087–32767
42	3161.20	II	908–32532
65	3161.77	II	984–32603
85	3162.57	II	1087–32698
130	3168.52	II	1216–32767
200	3186.45	I	0–31374
85	3190.87	II	8744–40075
260	3191.99	I	170–31489
4	3197.52	II	225–31491
320	3199.92	I	387–31629
65	3202.54	II	8710–39927
4	3203.44	II	0–31207
20	3203.83	I	170–31374
4	3204.87	I	8492–39686
9	3213.14	II	94–31207
22	3214.24	I	387–31489
16	3214.75	II	393–31491
90	3217.06	II	225–31301
9	3217.94	I	15877–46944
22	3218.27	II	12677–43741
9	3219.21	I	15976–47030
9	3221.38	I	16106–47140
110	3222.84	II	94–31114
18	3223.52	I	16268–47281
20	3224.24	II	12775–43781
12	3226.13	I	16459–47447
44	3228.60	II	8710–39675
65	3229.19	II	0–30959
44	3229.42	II	9118–40075
9	3231.32	II	1087–32026
20	3232.28	II	8998–39927
550	3234.52	II	393–31301
18	3236.12	II	8710–39603
440	3236.57	II	225–31114
340	3239.04	II	94–30959
18	3239.66	II	8744–39603
220	3241.99	II	0–30837
100	3248.60	II	10025–40798
80	3251.91	II	94–30837
100	3252.91	II	225–30959
100	3254.25	II	393–31114
100	3261.60	II	15258–45909
26	3271.65	II	10025–40582
26	3272.08	II	9873–40426
17	3278.29	II	9931–40426
22	3278.92	II	8744–39233
18	3282.33	II	9873–40330
44	3287.66	II	15266–45674
24	3292.08	I	7255–37623
14	3299.41	I	7255–37555
14	3306.88	I	17215–47447
18	3308.39	I	8437–38654
18	3308.81	II	1087–31301
22	3309.50	I	8492–38700

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		3309.73	I	17075–47281
9		3312.69	I	16961–47140
70		3314.42	I	8602–38765
		3314.52	I	8492–38654
24		3315.32	II	9873–40027
28		3318.02	II	984–31114
46		3321.70	II	9931–40027
240		3322.94	II	1216–31301
32		3326.76	II	908–30959
180		3329.46	II	1087–31114
46		3332.11	II	10025–40027
150		3335.20	II	984–30959
95		3340.34	II	908–30837
480		3341.88	I	0–29915
			II	4629–34543
10		3342.15	I	0–29912
22		3343.77	II	1216–31114
28		3346.73	II	1087–30959
360		3349.04	II	4898–34748
1000		3349.41	II	393–30241
10		3352.94	I	170–29986
340		3354.64	I	170–29971
24		3358.28	I	0–29769
24		3360.99	I	170–29915
600		3361.21	II	225–29968
		3361.26	I	170–29912
10		3361.84	I	170–29907
95		3370.44	I	0–29661
360		3371.45	I	387–30039
12		3372.21	II	4898–34543
480		3372.80	II	94–29734
5		3374.35	II	9976–39603
240	d	3377.48	I	387–29986
		3377.58	I	170–29769
24		3379.22	I	387–29971
120		3380.28	II	393–29968
14		3382.31	I	8602–38160
480		3383.76	II	0–29544
14		3385.66	I	387–29915
120		3385.95	I	387–29912
120		3387.84	II	225–29734
5		3388.76	II	9976–39477
12		3390.68	I	8492–37977
12		3392.71	I	12118–41585
95		3394.58	II	94–29544
5		3398.63	I	8437–37852
5		3402.42	II	9851–39233
5		3407.20	II	393–29734
8		3409.81	II	225–29544
5		3439.30	I	11777–40844
75		3444.31	II	1216–30241
5		3452.47	II	16516–45473
15		3456.39	II	16625–45549
50		3461.50	II	1087–29968
8		3467.26	I	8492–37325
50		3477.18	II	984–29734
5		3478.92	I	8437–37173
20		3480.53	I	8602–37325
5		3485.69	I	8492–37173
5		3489.74	II	1087–29734
40		3491.05	II	908–29544
5		3495.75	I	8492–37091
8		3499.10	I	8602–37173
75		3504.89	II	15258–43781
10		3506.64	I	387–28896
50		3510.84	II	15266–43741
5		3520.25	II	16516–44915
26		3535.41	II	16625–44902
16		3547.03	I	12118–40303
10		3573.74	II	4629–32603
5		3574.24	I	18288–46258
5		3587.13	II	4898–32767
20		3596.05	II	4898–32698
16		3598.72	I	7255–35035
50		3610.16	I	7255–34947
16		3624.82	II	9851–37431
8		3635.20	I	387–27888
400		3635.46	I	0–27499
10		3637.97	I	0–27480
16		3641.33	II	9976–37431
550		3642.68	I	170–27615
15		3646.20	I	0–27418
600		3653.50	I	387–27750
24		3654.59	I	0–27355
55		3658.10	I	170–27499
10		3659.76	II	12758–40075
32		3660.63	I	170–27480
16		3662.24	II	12629–39927
32		3668.97	I	170–27418
50		3671.67	I	387–27615
260		3685.20	II	4898–32026
10		3685.96	I	11532–38654
8		3687.35	I	387–27499
50		3689.91	I	387–27480
12		3694.45	I	11640–38700
2.5		3698.18	I	18145–48178
5		3698.43	I	11640–38671
5		3700.08	I	
10		3702.29	I	8437–35439
16		3704.30	I	11777–38765

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	3706.23	II	12629–39603
4	3707.53	I	16268–43232
24	3709.96	I	8492–35439
2.5	3715.40	I	
38	3717.40	I	0–26893
12	3721.64	II	4629–31491
28	3722.57	I	170–27026
50	3724.57	I	12118–38960
32	3725.16	I	8602–35439
240	3729.82	I	0–26803
4	3735.67	I	
5	3738.90	I	15157–41895
280	3741.06	I	170–26893
28	3741.64	II	12758–39477
13	3748.10	I	15108–41781
440	3752.86	I	387–27026
50	3753.64	I	170–26803
12	3757.69	II	12629–39233
280	3759.30	II	4898–31491
240	3761.32	II	4629–31207
4	3761.89	II	20892–47467
5	3766.45	I	8492–35035
50	3771.66	I	387–26893
2.5	3776.06	II	12758–39233
70	3786.04	I	7255–33661
10	3789.30	I	11777–38160
6	3795.90	I	11640–37977
5	3798.31	I	11532–37852
6	3818.22	I	18193–44376
5	3822.03	I	17075–43232
20	3828.19	I	17215–43330
8	3833.68	I	
8	3836.78	I	
5	3846.45	I	
11	3853.05	I	15877–41823
11	3853.73	I	15976–41917
14	3858.14	I	16106–42018
20	3866.44	I	16268–42124
14	3868.40	I	15976–41819
10	3873.21	I	16106–41917
22	3875.26	I	0–25798
		I	16106–41903
14	3882.15	I	16268–42019
14	3882.33	I	16268–42018
42	3882.89	I	16459–42206
5 h	3888.02	I	16106–41819
6	3889.95	I	0–25700
17 h	3895.25	I	16459–42124
7	3898.49	I	0–25644
44	3900.54	II	9118–34748
15	3900.96	I	170–25798
220	3904.78	I	7255–32858
9 h	3911.19	I	16459–42019
42	3913.46	II	8998–34543
42	3914.34	I	387–25927
2.0	3914.74	I	0–25537
3.0	3919.82	I	12118–37623
24	3921.42	I	0–25494
90	3924.53	I	170–25644
9	3926.32	I	20796–46258
75	3929.88	I	0–25439
3.0	3932.02	II	9118–34543
6	3934.24	I	387–25798
90	3947.78	I	170–25494
380	3948.67	I	0–25318
380	3956.34	I	170–25439
440	3958.21	I	387–25644
80	3962.85	I	0–25227
80	3964.27	I	170–25388
400	3981.76	I	0–25107
48	3982.48	I	0–25103
5	3984.33	I	16961–42053
3.0	3985.25	I	
5	3985.59	I	
480	3989.76	I	170–25227
3.0	3994.70	I	16875–41901
650	3998.64	I	387–25388
6	3999.36	I	16961–41959
6	4002.49	I	17075–42053
6	4003.81	I	17215–42185
3.0	4005.97	I	16961–41917
6	4008.06	I	17075–42018
80	4008.93	I	170–25107
16	4009.66	I	170–25103
6	4012.39	II	4629–29544
15	4013.58	I	17215–42124
6	4015.38	I	16817–41714
3.0	4016.28	I	17215–42107
10 h	4017.77	I	16875–41757
12	4021.83	I	16961–41819
100	4024.57	I	387–25227
3.5	4025.14	II	4898–29734
16 h	4026.54	I	17075–41903
3.5	4027.48	I	
3.5	4028.34	II	15258–40075
16 h	4030.51	I	17215–42019
3.5	4033.91	I	17424–42207
2.5	4034.91	I	17370–42146
9	4035.83	I	17540–42311
3.0 h	4040.32	I	17075–41819

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
24	4055.02	I	8437–33091
7	4057.62	I	18594–43232
7	4058.14	I	18695–43330
34	4060.26	I	8492–33114
17	4064.22	I	8492–33091
17	4065.10	I	8492–33085
70	4078.47	I	8602–33114
3.5	4079.72	I	17424–41929
24	4082.46	I	8602–33091
7	4099.17	I	17540–41929
18	4112.71	I	387–24695
7	4122.17	I	21470–45722
3.5	4123.31	I	22405–46650
7	4123.57	I	21588–48832
11	4127.54	I	21740–45960
3.5	4129.17	I	
3.5	4131.25	I	18525–42724
12	4137.29	I	18695–42859
7	4143.05	I	18594–42724
14	4150.96	I	17540–41624
7	4159.64	I	17424–41458
6	4163.65	II	20892–44902
3.0	4164.14	I	15108–39116
3.5	4166.32	I	15157–39152
7	4169.35	I	15220–39198
10	4171.03	I	17370–41337
3.5	4171.90	II	20952–44915
3.0	4183.30	I	18062–41959
30	4186.12	I	12118–36000
3.5	4188.69	I	18062–41929
6	4200.75	I	18145–41944
7	4203.46	I	18145–41929
3.0	4211.73	I	20063–43800
3.5	4224.79	I	22405–46068
3.5	4227.65	I	20063–43710
11	4237.89	I	20210–43800
7	4249.12	I	18525–42053
11	4256.04	I	18695–42185
6	4258.54	I	18483–41959
6	4261.60	I	18594–42053
28	4263.13	I	15220–38671
3.0	4265.71	I	15108–38544
3.5	4266.22	I	18525–41959
6	4270.14	I	18695–42107
7	4272.43	I	6661–30060
20	4274.58	I	6599–29986
		I	15157–38544
10	4276.43	I	13982–37359
10	4278.23	I	20796–44163
2.5	4278.81	I	18594–41959
9	4281.38	I	6557–29907
18	4282.71	I	15108–38451
13	4284.99	I	14028–37359
75	4286.01	I	6661–29986
70	4287.40	I	6743–30060
2.5	4288.16	I	6599–29912
		I	8492–31806
80	4289.07	I	6599–29907
10	4290.23	II	9396–32698
70	4290.94	I	6557–29855
10	4291.14	I	
12	4294.12	II	8744–32026
70	4295.76	I	6557–29829
170	4298.66	I	6599–29855
17	4299.23	I	14106–37359
17	4299.64	I	6661–29912
17	4300.05	II	9518–32767
240	4300.56	I	6661–29907
340	4301.09	I	6743–29986
7	4301.93	II	9364–32603
500	4305.92	I	6843–30060
15	4307.90	II	9396–32603
3.0	4308.50	I	8602–31806
3.5	4311.65	I	17370–40556
7	4312.87	II	9518–32698
7	4314.35	I	6743–29915
100	4314.80	I	6743–29912
		I	6599–29769
30	4318.64	I	18193–41342
15	4321.66	I	18037–41170
16	4325.13	I	18141–41255
13	4326.36	I	6661–29769
2.5	4334.84	I	6599–29661
13	4337.92	II	8710–31756
2.0	4344.29	II	8744–31756
6	4346.11	I	18037–41040
3.0	4354.06	I	17424–40385
8	4360.49	I	17540–40467
2.0	4368.94	I	18288–41170
8	4369.68	I	20796–43674
5	4372.38	I	20063–42928
2.5	4388.08	I	18062–40844
14	4393.92	I	18288–41040
28	4395.04	II	8744–31491
5	4399.77	II	9976–32698
20	4404.28	I	18145–40844
5	4404.90	I	15157–37852
2.5	4405.68	I	8492–31184
5	4416.54	I	15108–37744
18	4417.28	I	15220–37852

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	4417.72	II	9396–32026
10	4421.76	I	18062–40671
10	4422.82	I	8602–31206
2.0	4424.39	I	18288–40883
2.5	4425.83	I	8602–31191
10	4426.06	I	15157–37744
75	4427.10	I	12118–34700
1.8	4430.02	I	19422–41988
7	4430.37	I	11640–34205
4	4431.28	I	17996–40556
2.5	4432.60	I	
2.0	4433.58	I	19323–41872
14	4434.00	I	11532–34079
		I	15108–37655
6	4436.59	I	15157–37690
2.5	4438.23	I	18145–40671
11	4440.35	I	15108–37623
4	4441.27	I	15108–37618
19	4443.80	II	8710–31207
2.0	4444.27	I	18062–40556
70	4449.15	I	15220–37690
2.5	4450.49	II	8744–31207
46	4450.90	I	15157–37618
70	4453.32	I	11532–33981
24	4453.71	I	15108–37555
80	4455.33	I	11640–34079
90	4457.43	I	11777–34205
1.8	4462.09	I	0–22405
6	4463.38	I	15157–37555
8	4463.54	I	15220–37618
24	4465.81	I	14028–36415
20	4468.50	II	9118–31491
20	4471.24	I	13982–36341
8	4474.85	I	11640–33981
8	4479.70	I	13982–36298
4	4480.59	I	14028–36341
44	4481.26	I	14106–36415
8	4482.69	I	11777–34079
1.6	4488.32	II	25193–47467
22	4489.09	I	14028–36298
2.0	4492.55	I	16961–39214
3.5	4495.01	I	
20	4496.15	I	14106–36341
2.0	4497.73	I	17075–39302
17	4501.27	II	8998–31207
3.5	4503.78	I	17215–39413
1.8	4506.36	I	
4	4511.17	I	
65	4512.74	I	6743–28896
1.6	4515.62	I	17075–39214
85	4518.03	I	6661–28788
8	4518.70	I	11532–33656
85	4522.80	I	6599–28703
65	4527.31	I	6557–28639
500	4533.24	I	6843–28896
20	4533.97	II	9976–32026
300	4534.78	I	6743–28788
200	4535.58	I	6661–28703
100	4535.92	I	6599–28639
100	4536.05	I	6557–28596
2.0	4537.23	I	
2.0	4539.10	I	
60	4544.69	I	6599–28596
80	4548.77	I	6661–28639
20	4549.63	II	12775–34748
80	4552.46	I	6743–28703
2.0	4555.08	I	19422–41369
60	4555.49	I	6843–28788
1.6	4557.86	I	19938–41872
1.6	4558.11	I	18912–40844
5	4559.92	I	11777–33701
4	4562.63	I	170–22081
3.0	4563.43	I	19574–41481
9	4563.77	II	9851–31756
3.0	4570.91	I	19323–41194
20	4571.98	II	12677–34543
2.0	4589.95	II	9976–31756
5	4599.23	I	
1.8	4609.37	I	
80	4617.27	I	14106–35758
2.0	4619.52	I	18826–40467
40	4623.09	I	14028–35653
16	4629.34	I	13982–35577
4	d 4634.87		
5	4637.88	I	18912–40467
20	4639.37	I	14028–35577
18	4639.67	I	14106–35653
16	4639.95	I	13982–35528
12	4645.19	I	13982–35503
10	4650.02	I	14028–35528
2.0	4656.04	I	14106–35577
60	4656.47	I	0–21470
70	4667.59	I	170–21588
6	4675.12	I	8602–29986
80	4681.92	I	387–21740
1.8	4686.92	I	17370–38700
2.0	4690.80	I	8602–29915
16	4691.34	I	8602–29912
3.5	4693.68	I	170–21470
2.0	4696.94	I	17370–38654

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
16	4698.76	I	8492–29769
10	4710.19	I	8437–29661
2.0	4715.30	I	387–21588
6	4722.62	I	8492–29661
6	4723.17	I	8602–29769
5	4731.17	I	17540–38671
4	4733.43	I	17424–38544
1.6	4734.68	I	18037–39152
2.0	4742.11	I	17370–38451
15	4742.79	I	18037–39116
2.0	4747.68	I	18141–39198
28	4758.12	I	18141–39152
28	4759.28	I	18193–39198
4	4766.33	I	18141–39116
2.5	4769.77	I	18193–39152
6	4778.26	I	18037–38960
4	4781.72	I	6843–27750
10	4792.49	I	18826–39686
4	4796.22	I	18818–39662
3.0	4797.98	I	18826–39662
10	4799.80	I	18288–39116
2.5	4805.10	II	16625–37431
10	4805.43	I	18912–39716
4	4808.53	I	24695–45485
2.0	4811.08	I	15220–36000
3.5	4812.25	I	18912–39686
18	4820.42	I	12118–32858
2.0	4825.46	I	18695–39413
3.5	4836.13	I	18288–38960
42	4840.87	I	7255–27907
6	4848.47	I	17540–38160
26	4856.01	I	18193–38780
3.0	4864.18	I	17424–37977
18	4868.26	I	18037–38573
22	4870.14	I	18141–38669
2.5	4880.91	I	17370–37852
4	4882.35	I	18193–38669
36	4885.08	I	15220–35685
36	4899.91	I	15157–35560
30	4913.62	I	15108–35454
5	4915.24	I	15220–35560
12	4919.87	I	17424–37744
17	4921.77	I	17540–37852
5	4925.41	I	15157–35454
3.0	4926.16	I	6599–26893
14	4928.34	I	17370–37655
3.0	4937.74	I	6557–26803
9	4938.29	I	20796–41040
3.0	4941.58	I	17424–37655
2.0	4948.19	I	17540–37744
2.0	4958.25	I	7255–27418
5	4964.75	I	15877–36014
6	4968.58	I	15976–36096
7	4973.05	I	16106–36209
11	4975.35	I	20210–40303
6	4977.74	I	16268–36351
11	4978.20	I	15877–35959
550	4981.73	I	6843–26911
14	4989.15	I	15976–36014
440	4991.07	I	6743–26773
3.0	4995.08	I	18145–38160
13	4997.10	I	0–20006
380	4999.51	I	6661–26657
22	5001.01	I	16106–36096
340	5007.21	I	6599–26564
11	5009.65	I	170–20126
22	5013.30	I	16268–36209
300 d	5014.19	I	0–19938
	5014.24	I	6557–26494
55	5016.17	I	6843–26773
80	5020.03	I	6743–26657
80	5022.87	I	6661–26564
55	5024.84	I	6599–26494
28	5025.58	I	16459–36351
110	5035.91	I	11777–31629
80	5036.47	I	11640–31489
70	5038.40	I	11532–31374
110	5039.95	I	170–20006
7	5040.62	I	6661–26494
8	5043.59	I	6743–26564
3.5	5044.27	I	17540–37359
5.0	5045.41	I	6843–26657
2.5	5048.21	I	17370–37173
10	5052.87	I	17540–37325
2.0	5054.08	I	21588–41369
10	5062.11	I	17424–37173
3.5	5064.07	I	21740–41481
130	5064.66	I	387–20126
9	5065.99	I	11640–31374
3.5 h	5068.33	I	21470–41194
6	5069.35	I	17370–37091
12	5071.48	I	11777–31489
4	5085.34	I	11532–31191
12	5087.07	I	11532–31184
2.0	5103.15	I	
5	5109.44	I	11640–31206
18	5113.44	I	11640–31191
26	5120.42	I	20796–40320
3	5129.15	II	15258–34748
26	5145.47	I	11777–31206

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
22	5147.48	I	0–19422
20	5152.20	I	170–19574
2.0 bl	5166.86	TiO	
100	5173.75	I	0–19323
4	5186.34	I	17075–36351
8	5188.70	II	12758–32026
120	5192.98	I	170–19422
8 h	5194.04	I	16961–36209
6	5201.10	I	16875–36096
11	5206.08	I	20063–39266
7	5207.87	I	16817–36014
130	5210.39	I	387–19574
6	5212.29	I	
14	5219.71	I	170–19323
9	5222.69	I	16817–35959
8	5223.64	I	16875–36014
24	5224.32	I	17215–36351
9	5224.56	I	16961–36096
18	5224.95	I	17075–36209
6	5226.56	II	12629–31756
11	5238.58	I	6843–25927
2.0	5246.15	I	20210–39266
5	5246.57	I	6743–25798
7	5247.31	I	16961–36014
2.0	5250.95	I	6661–25700
10	5252.11	I	387–19422
7	5255.83	I	17075–36096
5	5259.99	I	22081–41087
5	5263.50	I	17215–36209
14	5265.98	I	15220–34205
4	5282.39	I	8492–27418
13	5283.45	I	15157–34079
3.5	5284.39	I	8437–27355
2.5	5288.81		
6	5295.79	I	8602–27480
11	5297.26	I	15108–33981
6	5298.44	I	20210–39078
2.5	5336.81	II	12758–31491
1.6	5341.50	I	34947–53663
7	5351.08	I	22405–41087
2.5	5366.65	I	6599–25227
5	5369.64	I	
4	5389.18	I	6557–25107
5	5389.99	I	15108–33656
1.6	5396.60	I	170–18695
8	5397.09	I	15157–33680
3.5	5404.02	I	18826–37325
10	5409.61	I	15220–33701
4	5426.26	I	170–18594
7	5429.15	I	18912–37325
2.5	5436.73	I	7255–25644
1.6	5438.32	I	11532–29915
4	5446.64	I	18818–37173
1.0 bl	5448.34	TiO	
3.0	5448.90	I	18826–37173
2.0	5449.16	I	11640–29986
3.5	5453.65	I	11640–29971
5	5460.51	I	387–18695
7	5471.21	I	11640–29912
3.5	5472.70	I	11640–29907
4 h	5473.55	I	18826–37091
8	5474.23	I	11777–30039
3.0	5474.46	I	18912–37173
11 h	5477.71	I	19574–37825
10	5481.43	I	19422–37660
7	5481.87	I	11532–29769
8 h	5488.20	I	19323–37539
14	5490.15	I	11777–29986
2.5	5490.84	I	387–18594
10	5503.90	I	20796–38960
4	5511.78	I	20063–38201
32	5512.53	I	11777–29912
26	5514.35	I	11532–29661
30	5514.54	I	11640–29769
2.5	5530.49		
10	5565.49	I	18037–36000
1.2	5579.16		
2.0 h	5582.98		
3.0 h	5585.68		
6 bl	5597.85	TiO	
5 bl	5629.28	TiO	
1.6	5635.84		
24	5644.14	I	18288–36000
7	5648.58	I	20126–37825
2.5 bl	5661.55	TiO	
18	5662.16	I	18695–36351
7	5662.91	I	20006–37660
2.0	5673.42	I	25103–42724
12	5675.44	I	18594–36209
3.0 h	5679.94	I	19938–37539
9	5689.47	I	18525–36096
7	5702.68	I	18483–36014
3.5	5708.23	I	18695–36209
6	5711.88	I	18594–36096
4 h	5713.92	I	18463–35959
9	5715.13	I	18193–35685
5	5716.48	I	18525–36014
3.5	5720.48	I	18483–35959
8	5739.51	I	18141–35560
4	5740.02	I	18037–35454

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.8	5741.22	I	20210–37623
2.0	5752.84	I	18062–35439
1.8	5756.86	I	
4 h	5762.27	I	26494–43844
5 h	5766.35	I	26564–43902
7 h	5774.05	I	26657–43972
3.0	5780.78	I	18145–35439
7 h	5785.98	I	26773–44051
6 hl	5804.26	I	26911–44135
2.0 bl	5814.96	TiO	
4	5823.71	I	18288–35454
2.0	5852.34		
38	5866.46	I	8602–25644
6	5880.31	I	8492–25494
2.0 h	5888.68		
22	5899.32	I	8492–25439
5	5903.33	I	8602–25537
11	5918.55	I	8602–25494
14	5922.12	I	8437–25318
7	5937.82	I	8602–25439
11	5941.76	I	8492–25318
28	5953.17	I	15220–32014
19	5965.84	I	15157–31914
26	5978.56	I	15108–31830
32	5999.04	I	17540–34205
6	5999.68	I	18037–34700
2.0	6012.73		
10	6064.63	I	8437–24921
11	6085.23	I	8492–24921
11	6091.17	I	18288–34700
4	6092.81	I	15220–31629
4 h	6098.67	I	24695–41087
3.5 h	6121.01	I	15157–31489
11	6126.22	I	8602–24921
1.8	6138.38	I	17370–33656
3.0	6146.22	I	15108–31374
2.0	6149.74	I	17424–33680
3.0 bl	6162.23	TiO	
3.5	6186.15	I	17540–33701
9 h	6215.28	I	21740–37825
7 h	6220.49	I	21588–37660
6 h	6221.41	I	21470–37539
36	6258.10	I	11640–27615
36	6258.70	I	11777–27750
28	6261.10	I	11532–27499
6	6303.75	I	11640–27499
5	6312.24	I	11777–27615
2.5	6318.03	I	11532–27355
3.0	6336.10	I	11640–27418
3.5	6366.35	I	11777–27480
1.0	6419.10	I	17540–33114
1.6	6497.69	I	11640–27026
1.8	6508.14	I	11532–26893
5	6546.28	I	11532–26803
6	6554.23	I	11640–26893
7	6556.07	I	11777–27026
1.8 h	6565.62	I	
1.6 h	6575.18	I	20796–36000
4	6599.11	I	7255–22405
2.0 bl	6651.46	TiO	
2.0 h	6666.55	I	11777–26773
2.0	6677.18	I	20063–35035
2.5 b	6691.21	TiO	
3.0	6716.68	I	20063–34947
1.8 bl	6723.95	TiO	
9	6743.12	I	7255–22081
2.0	6844.64		
2.0	6860.39		
4	6861.47	I	18288–32858
1.0	6873.92	I	21588–36132
1.4	6913.19	I	21740–36201
1.6 h	6933.15	I	25107–39527
1.6 h	6943.70	I	25388–39786
3.0	6996.63	I	18826–33114
2.0	7004.66	I	18818–33091
1.8	7008.35	I	18826–33091
1.8	7010.94	I	18826–33085
1.8 h	7035.86	I	25318–39527
5	7038.80	I	18912–33114
1.8	7050.65	I	18912–33091
5 bl	7054.51	TiO	
3.0	7069.11	I	25644–39786
3.0	7072.05		
6 bl	7087.89	TiO	
4 b	7124.9	TiO	
5 bl	7125.61	TiO	
3.5	7138.91	I	11640–25644
3.5	7167.13		
3.0	7171.53		
7	7189.89	I	20796–34700
3.5 b	7203.64	TiO	
34	7209.44	I	11777–25644
8	7216.20	I	11640–25494
17	7244.86	I	11640–25439
17	7251.72	I	11532–25318
2.5	7263.40		
2.5	7266.29	I	13982–27740
2.5 b	7269.05	TiO	
2.0	7315.56	I	17540–31206
3.5	7318.39	I	18145–31806

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
16		7344.72	I	11777–25388
1.4		7352.16	I	20063–33661
12		7357.74	I	11640–25227
8		7364.11	I	11532–25107
3.5		7440.60	I	18193–31629
1.2		7474.94	I	14106–27480
3.5		7489.61	I	18141–31489
2.5		7496.12	I	18037–31374
1.6		7580.55	I	17996–31184
1.2	bl	7589.62	TiO	
2.0		7614.50	I	18062–31191
3.0		7654.44	I	18145–31206
1.4	bl	7705.21	TiO	
4		7949.17	I	12118–24695
3.5	h	7961.58	I	26657–39214
8		7978.88	I	15220–27750
1.2		7979.07	I	26773–39302
4		7996.53	I	26911–39413
0.9	h	8003.55		
7		8024.84	I	15157–27615
4		8068.24	I	15108–27499
1.0		8267.62		
1.8	h	8306.31	I	27750–39786
1.2	h	8307.41	I	6661–18695
1.2	h	8311.76	I	27499–39527
1.0	h	8312.85	I	27615–39641
1.6		8334.37	I	6599–18594
1.8		8353.15	I	6557–18525
10		8364.24	I	6743–18695
13		8377.85	I	6661–18594
13		8382.54	I	6599–18525
7		8382.82	I	6557–18483
10		8396.87	I	6557–18463
16		8412.36	I	6599–18483
2.5		8416.98	I	18037–29915
2.0		8424.41	I	16961–28829
22		8426.52	I	6661–18525
65		8434.94	I	6843–18695
32		8435.70	I	6743–18594
5		8438.93	I	18193–30039
5		8450.89	I	18141–29971
1.2	h	8457.10	I	14106–25927
2.5	h	8467.15	I	17075–28882
6		8468.50	I	15220–27026
2.0		8496.04	I	18145–29912
2.5	h	8518.05	I	17215–28952
5		8518.32	I	15157–26893
1.8		8539.38	I	18062–29769
5		8548.12	I	15108–26803
1.2		8569.77	I	17996–29661
1.2	h	8598.18	I	18288–29915
12		8675.39	I	8602–20126
6		8682.99	I	8492–20006
3.0		8692.33	I	8437–19938
2.5		8734.69	I	8492–19938
3.0		8766.64	I	8602–20006
2.0	h	8778.71	I	14106–25494

TUNGSTEN

W, $Z=74$, $M=183.86$, Ratio $\frac{W}{Cu}=2.894$

W I Normal state of valence electrons $5d^4 6s^2\ {}^5D_0 = 0$. I.P.=64400 K
W II Normal state of valence electrons $5d^4 6s^1\ {}^6D_{0\frac{1}{2}} = 0$.

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
C. C. Kiess and W. F. Meggers, Sci. Papers BS **16,** 51 (1920).
D. D. Laun, unpublished material.

Classification:

W I, O. Laporte and J. E. Mack, Phys. Rev. **63,** 246 (1943).
D. D. Laun, unpublished material (1955).
W II, D. D. Laun, J. Research NBS **21,** 207 (1938) and unpublished material (1955).

Relative intensity of tungsten lines observed in an arc of copper containing 0.1 atomic percent of tungsten

Strong lines of tungsten

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
950	4008.75	I	2951–27890	$5d^5 6s^1\ a\ {}^7S_3$—$5d^5\ 6p^1\ z\ {}^7P_4^\circ$
550	4074.36	I	2951–27488	$5d^5 6s^1\ a\ {}^7S_3$—$5d^5\ 6p^1\ z\ {}^7P_3^\circ$
450	4294.61	I	2951–26230	$5d^5 6s^1\ a\ {}^7S_3$—$5d^5\ 6p^1\ z\ {}^7P_2^\circ$
320	2724.35	I	2951–39646	$5d^5 6s^1\ a\ {}^7S_3$—39646$_3^\circ$
300	2944.40	I	2951–36904	$5d^5 6s^1\ a\ {}^7S_3$—36904$_2^\circ$
300	2946.98	I	2951–36874	$5d^5 6s^1\ a\ {}^7S_3$—36874$_3^\circ$
280	2551.35	I	0–39183	$5d^4 6s^2\ a\ {}^5D_0$—39183$_1^\circ$
260	2681.41	I	2951–40234	$5d^5 6s^1\ a\ {}^7S_3$—40234$_4^\circ$
260	2718.90	I	2951–39720	$5d^5 6s^1\ a\ {}^7S_3$—39720$_4^\circ$
240	3617.52	I	2951–30587	$5d^5 6s^1\ a\ {}^7S_3$—$5d^4 6s^1 6p^1\ z\ {}^5P_3^\circ$
240	4302.11	I	2951–26189	$5d^5 6s^1\ a\ {}^7S_3$—$5d^4 6s^1 6p^1\ z\ {}^7D_3^\circ$
200	2656.54	I	2951–40583	$5d^5 6s^1\ a\ {}^7S_3$—40583$_4^\circ$
200	2831.38	I	2951–38259	$5d^5 6s^1\ a\ {}^7S_3$—38259$_4^\circ$
200	3867.98	I	2951–28797	$5d^5 6s^1\ a\ {}^7S_3$—$5d^4 6s^1 6p^1\ z\ {}^7D_4^\circ$
190	2896.45	I	2951–37466	$5d^5 6s^1\ a\ {}^7S_3$—37466$_2^\circ$
160	2435.96	I	4830–45869	$5d^4 6s^2\ a\ {}^5D_3$—45869$_4^\circ$
160	2481.44	I	6219–46506	$5d^4 6s^2\ a\ {}^5D_4$—46506$_5^\circ$
160	3817.48	I	2951–29139	$5d^5 6s^1\ a\ {}^7S_3$—$5d^4 6s^1 6p^1\ z\ {}^5F_3^\circ$
150	4269.39	I	2951–26367	$5d^5 6s^1\ a\ {}^7S_3$—26367$_2^\circ$
140	2466.85	I	3326–43851	$5d^4 6s^2\ a\ {}^5D_2$—43851$_3^\circ$
130	3215.56	I	6219–37309	$5d^4 6s^2\ a\ {}^5D_4$—37309$_5^\circ$
120	2474.15	I	6219–46625	$5d^4 6s^2\ a\ {}^5D_4$—46625$_4^\circ$
120	2547.14	I	3326–42573	$5d^4 6s^2\ a\ {}^5D_2$—42573$_1^\circ$
120	3768.45	I	1670–28199	$5d^4 6s^2\ a\ {}^5D_1$—$5d^4 6s^1 6p^1\ z\ {}^5P_1^\circ$
120	3780.77	I	2951–29393	$5d^5 6s^1\ a\ {}^7S_3$—$5d^4 6s^1 6p^1\ z\ {}^5P_2^\circ$
120	3835.05	I	3326–29393	$5d^4 6s^2\ a\ {}^5D_2$—$5d^4 6s^1 6p^1\ z\ {}^5P_2^\circ$
110	2459.30	I	3326–43975	$5d^4 6s^2\ a\ {}^5D_2$—43975$_2^\circ$
110	4102.70	I	6219–30587	$5d^4 6s^2\ a\ {}^5D_4$—$5d^4 6s^1 6p^1\ z\ {}^5P_3^\circ$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	2001.71	II	3173–53114
8	2008.07	II	4716–54499
3.0	2009.98	II	1518–51254
2.5	2010.23	II	3173–52902
2.5	2014.23	II	
5	2026.08	II	4716–54057
10	2029.98	II	6147–55393
2.0	2035.03	II	
5	2049.63	II	1519–50292
2.5	2065.57	II	4716–53114
4	2071.21	II	3173–51438
2.5	2075.59	II	8711–56875
12	2079.11	II	6147–54229
5	2088.19		
3.0	2089.14	II	4716–52567
2.5	2090.48		
9	2094.75	II	1519–49242
4	2098.60		
3.5	2100.67	II	0–47589
2.5	2101.54		
2.5	2106.18	II	1519–48983
2.5	2110.34	II	8711–56084
4	2118.87	II	0–47180
5	2121.59	II	3173–50292
2.5	2153.56	II	6147–52567
2.5	2157.80	II	4716–51045
5	2166.32	II	4716–50863
2.0	2182.90	I	6219–52015
2.0	2194.52	II	0–45554
7	2204.48	II	6147–51495
4	2248.75	II	0–44455
4	2249.84	I	1670–46105
2.0	2270.24	II	1519–45554
1.0	2271.37	I	3326–47338
6	2277.58	I	0–43893
2.0	2284.90	I	1670–45422
4	2285.17	I	6219–49966
8 d	2294.49	I	6219–49789
	2294.54	II	4716–48285
4	2298.28	I	4830–48326
4	2303.83	II	1519–44912
4	2306.60	I	2951–46292
6	2309.04	I	6219–49514
8	2313.19	I	0–43217
4	2314.18	I	6219–49418
3.5	2315.02	II	3173–46355
2.0	2318.94	I	15070–58179
9	2321.63	I	3326–46385
6	2326.09	II	6147–49125
8 d	2326.56	I	6219–49188
	2326.71	I	3326–46292
1.4	2328.31	II	1519–44455
4	2331.30	I	12162–55043
1.6	2331.92	I	
1.6	2332.76		
3.0	2333.77	II	1519–44355
5	2341.37	I	1670–44367
1.6	2343.13	I	17008–59673
1.8	2347.97	I	3326–45902
1.8	2349.26	II	
	2349.32	I	13307–55859
3.5 d	2350.37	II	
	2350.46	I	4830–47362
9	2354.61	I	6219–48676
1.8	2358.07	I	12162–54557
1.8	2358.81	II	3173–45554
18	2360.43	I	3326–45678
26	2363.06	I	1670–43975
1.8	2364.22	II	
3.5	2365.45	I	0–42262
3.5	2365.85	I	17008–59264
3.5	2366.18	I	4830–47079
3.0	2366.95	I	9528–51763
5	2367.68	I	1670–43893
3.5	2370.88	I	2951–45117
1.2	2371.39	I	17107–59264
1.8	2374.14	I	6219–48326
18	2374.46	I	4830–46932
3.0	2374.76	I	3326–45422
3.5	2376.07	I	15070–57143
1.8	2376.56	I	17107–59172
1.8	2377.03	I	
8	2382.99	I	6219–48171
26	2384.82	I	6219–48138
3.5	2386.17	I	17008–58904
10	2389.07	I	1670–43515
5	2390.37	II	7421–49242
5	2392.93	II	4716–46493
5	2395.47	I	
34	2397.09	II	3173–44877
26	2397.72	I	3326–45019
26	2397.98	I	3326–45015
3.0	2399.04	I	17107–58778
1.6	2401.29	I	6219–47851
5	2402.44	I	13778–55389
3.5	2404.24	II	8711–50292
2.5	2405.26	I	13349–54912
85 d	2405.58	I	1670–43228
	2405.69	I	4830–46385
5	2409.03	I	4830–46328
3.0	2410.63	I	6219–47689

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	2411.54	II	17437–58892
17	2414.04	I	3326–44737
34	2415.68	I	1670–43054
3.0	2416.23	I	6219–47593
3.0	2419.34	II	20040–61361
3.5	2420.20	I	13778–55084
3.0	2421.01	II	13412–54705
8	2422.28	I	3326–44596
2.5	2422.66	I	6219–47484
70	2424.22	I	4830–46068
16 d	2425.98	I	13349–54557
	2426.07	I	19535–60741
10	2427.29	I	15070–56256
15	2427.49	II	3173–44355
14	2429.39	II	
13	2429.84	I	6219–47362
10	2430.44	I	14976–56109
50	2431.08	I	3326–44447
55	2433.98	I	4830–45902
5	2435.01	II	20534–61590
160	2435.96	I	4830–45869
2.5	2436.26	I	2951–43985
22	2436.62	I	3326–44353
2.5	2437.96	I	9528–50534
6	2442.97	I	
2.5	2443.33	I	19826–60741
10	2443.62	I	17008–57919
55	2444.06	I	1670–42573
15	2446.39	II	7421–48285
28	2448.39	I	12162–52993
28	2451.34	I	12162–52943
80	2451.48	II	1519–42298
90	2452.00	I	0–40771
44	2454.71	I	15070–55796
65	2454.97	I	4830–45551
80	2455.50	I	6219–46932
80	2456.53	I	3326–44020
110	2459.30	I	3326–43975
28	2460.16	I	6219–46855
20	2461.57	I	12162–52774
50	2462.79	I	1670–42262
28	2464.31	I	3326–43893
10	2465.20	I	17008–57561
24	2466.52	II	1519–42049
140	2466.85	I	3326–43851
8	2470.80	II	20781–61241
8	2471.21	I	17107–57561
50	2472.51	I	4830–45263
10 d	2473.69	I	14976–55389
	2473.82	I	0–40411
120	2474.15	I	6219–46625
30	2477.80	II	6147–46493
90	2480.13	I	1670–41979
4	2480.65	I	2951–43251
40	2480.95	I	1670–41965
160	2481.44	I	6219–46506
50 d	2482.10	I	2951–43228
	2482.21	I	12162–52436
3.0	2484.40	II	20040–60279
60	2484.74	I	12162–52395
13	2486.30	I	
40	2487.49	I	4830–45019
28	2488.77	II	7420–47589
12	2488.91	I	6219–46385
40	2489.23	II	4716–44877
7	2489.72	I	3326–43479
8	2490.84	I	17008–57143
8	2492.93	II	14857–54959
7	2493.39	I	12162–52256
65	2495.26	I	1670–41734
24	2496.64	II	4716–44758
5	2496.97	I	17107–57143
10	2497.48	II	6147–46175
10	2499.44	I	13349–53346
14	2499.69	II	7420–47413
4	2500.11	II	
16 d	2501.78	I	2951–42911
	2501.90	II	13412–53370
1.4	2503.04	I	15070–55009
4	2503.96	I	
7	2504.53	I	9528–49444
70	2504.70	I	1670–41583
4	2505.38	I	3326–43228
10	2505.65	I	12162–52060
28	2506.03	I	3326–43217
2.5	2508.00	II	
10	2508.44	I	12162–52015
20	2508.74	I	6219–46068
26	2510.16	I	15070–54896
8	2510.47	II	19071–58892
3.0	2512.93		
14	2513.93	I	4830–44596
9	2516.58	I	17107–56832
6	2518.14	II	10593–50292
3.0	2518.50	I	12162–51856
10	2519.88	I	
32	2520.45	I	15070–54733
6	2520.98	I	
80	2521.32	I	2951–42601
28	2522.04	II	4716–44355

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
80	2523.41	I	4830–44447
6	2523.59	I	
8	2524.81	I	13349–52943
14	2525.68	I	
10	2526.42	I	6219–45790
44	2527.77	I	
20	2529.72	I	17008–56527
2.5	2530.99	I	2951–42450
80	2533.63	I	1670–41127
3.0	2533.98	I	15460–54912
5	2534.68	I	
5	2534.82	II	20781–60219
9	2535.10	I	1670–41104
7	2539.31	I	19535–58904
8	2541.69	I	6219–45551
12	2543.44	I	
3.0	2544.17	I	
60	2545.34	I	3326–42601
120	2547.14	I	3326–42573
3.5	2548.15	I	6219–45452
3.5	2548.57	I	
5	2549.09	II	3173–42390
4	2550.10	II	
80	2550.37	I	1670–40868
14	2551.00	I	3326–42514
280	2551.35	I	0–39183
3.0	2551.98	I	17107–56280
18	2553.16	I	4830–43985
46	2553.82	I	4830–43975
42	2554.86	II	0–39129
60	2555.09	II	3173–42298
	2555.20	I	3326–42450
4	2556.27	I	
32	2556.74	I	1670–40771
8	2557.56	I	13349–52436
3.0	2558.48	I	
30	2560.12	I	15070–54119
3.0	2560.75	I	
9	2561.51	I	2951–41979
75	2561.96	I	4830–43851
24	2563.16	II	17437–56440
11	2563.91	II	11301–50292
15	2564.68	I	17008–55988
14	2567.50	I	3326–42262
13	2568.21	I	3326–42251
10	2568.56	I	2951–41872
8	2568.98	I	19648–58563
20	2569.25	I	12162–51072
	2569.30	II	15147–54057
16	2570.09	I	6219–45117
55	2571.44	II	3173–42049
18 d	2572.24	II	20534–59399
	2572.35	II	13412–52276
20	2573.53	I	13307–52153
8	2573.95	II	16553–55393
5	2575.46	I	19828–58644
14	2577.02	I	15070–53863
20	2579.26	II	
20	2579.40	I	13307–52064
	2579.54	II	7420–46175
30	2580.33	I	2951–41694
90	2580.49	I	1670–40411
14	2581.06	I	12162–50894
4	2581.20	II	6147–44877
8	2583.22	I	
40	2584.38	I	17008–55691
4	2585.22	I	
11	2585.43	I	13349–52015
4	2586.34	I	3326–41979
5	2586.64	I	4830–43479
12	2586.94	I	12162–50806
10	2587.76	I	2951–41583
40	2589.17	II	6147–44758
18	2591.49	II	0–38576
7	2593.38	I	2951–41499
5	2596.34		
7	2596.67	I	15460–53959
8	2597.73	I	17008–55492
7	2598.42	I	17701–56175
11	2598.74	II	8711–47180
8	2600.74	I	17107–55546
38	2601.96	I	4830–43251
8	2602.51	II	
13	2602.80	I	3326–41734
8	2603.02	II	16553–54959
28	2603.54	I	4830–43228
15	2604.38	I	17107–55492
18	2605.51	I	3326–41694
70	2606.39	I	0–38356
8	2606.90	I	17107–55455
	2606.98	II	8833–47180
33	2607.38	I	1670–40011
38	2608.32	I	6219–44547
5	2610.74	I	
19	2612.19	I	19648–57919
100	2613.07	I	3326–41583
50	2613.82	I	2951–41198
24	2615.12	I	6219–44447
7	2615.44	II	15147–55370
20	2618.81	I	3326–41499

609065 O - 62 - 27

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
26		2619.18	I	15070–53238
50		2620.23	I	2951–41104
50		2622.21	I	15070–53194
50		2625.22	I	4830–42911
10		2626.24	I	14976–53042
26		2628.25	I	1670–39707
20	d	2628.89	I	
		2629.00	II	13412–51438
50		2632.49	I	12162–50137
50		2632.70	I	2951–40924
100		2633.13	I	1670–39637
36		2636.55	I	2951–40868
50	d	2638.61	I	19256–57143
		2638.75	I	15460–53346
20		2643.12	I	13778–51600
10		2644.60	I	6219–44020
26		2645.69	I	15070–52856
80		2646.19	I	3326–41104
50		2646.74	I	4830–42601
20		2647.10	I	6219–43985
9		2647.74	II	
10		2649.98	I	17008–54733
20		2652.61	I	16431–54119
5		2653.42	II	16553–54229
10		2653.57	II	4716–42390
16		2654.67	I	15460–53118
10	d	2655.55		
		2655.67	II	8711–46355
200		2656.54	I	2951–40583
50		2657.38	I	4830–42450
50	d	2658.04	II	1519–39129
		2658.19	I	19535–57143
10		2660.52	I	19256–56832
10		2661.56	I	13349–50909
100		2662.84	I	3326–40868
10		2663.94	I	14976–52503
20		2664.32	I	6219–43741
		2664.34	II	17437–54959
32		2664.96	I	1670–39183
20		2665.77	I	6219–43721
9		2666.49	II	7421–44912
26		2669.30	I	13349–50800
5		2669.77	I	3326–40771
100		2671.47	I	4830–42251
10		2673.59	II	
8		2674.70	I	
5		2675.13	I	13349–50719
5		2675.40	I	15070–52436
16		2675.87	I	1670–39030
80		2677.28	I	3326–40666
20	d	2677.79	II	4716–42049
		2677.91	I	17701–55033
5		2678.52	I	19826–57149
50		2678.88	I	2951–40269
16		2680.04	I	17008–54310
260		2681.41	I	2951–40234
36		2683.34	I	12162–49418
10		2687.37	I	18974–56175
26		2691.09	I	4830–41979
5		2692.16	I	18974–56108
80		2695.67	I	3326–40411
16		2697.51	I	2951–40011
26		2697.71	II	1519–38576
20		2698.84	I	4830–41872
80		2699.59	I	6219–43251
50		2700.01	I	12162–49188
5		2701.48	II	14857–51863
20		2702.11	II	13434–50431
26		2702.52	I	19535–56527
10		2706.01	I	3326–40269
50		2706.58	I	13349–50285
5		2707.02		
8		2707.88	I	19256–56175
5		2708.18	I	16431–53346
50		2708.58	I	15070–51979
50	d	2708.79	I	1670–38576
		2708.92	I	4830–41734
10		2709.58	II	14968–51863
5		2710.78	II	16235–53114
50		2715.50	I	6219–43034
10		2716.32	II	14634–51438
10		2717.53	I	14976–51763
		2717.61	I	15070–51856
10		2718.04	II	16590–53370
260		2718.90	I	2951–39720
40		2719.33	I	16431–53194
26		2719.86	I	2951–39707
20	d	2722.68	I	14976–51694
		2722.81	II	15147–51863
320		2724.35	I	2951–39646
26		2724.63	I	6219–42911
50		2725.03	I	3326–40011
		2725.06	I	1670–38356
16		2727.95	I	6219–42866
10		2729.62	II	8833–45457
10		2733.18	I	9528–46105
5		2735.97	I	19256–55796
5		2738.00	I	16431–52943
9		2740.79	II	23804–60279
20		2743.42	I	13349–49789

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
10		2744.34	I	19828–56256
5		2746.21	I	
10		2746.74	I	15460–51856
80		2748.85	I	4830–41198
20		2753.05		
10		2754.92	I	13349–49637
5		2755.26	I	17107–53390
10		2755.94	I	4830–41104
5		2760.03	I	15070–51291
5	d	2760.74	II	19277–55488
		2760.84	I	13307–49517
10		2761.59	II	8711–44912
50		2762.34	I	0–36190
50		2764.27	II	0–36165
26		2768.98	I	1670–37774
50		2769.74	I	4830–40924
100		2770.88	I	2951–39030
26		2773.70	I	
100		2774.00	I	4830–40868
100		2774.48	I	6219–42251
20		2776.50	II	14857–50863
5		2778.69	II	16590–52567
20		2779.72	I	16431–52395
10		2780.28	I	19535–55492
20		2783.12	I	19535–55455
5		2785.88	I	18974–54859
26		2787.98	I	3326–39183
16		2789.07	I	19648–55492
5		2789.68	I	4830–40666
42		2791.95	I	12162–47969
100		2792.70	I	2951–38748
10		2796.15	I	4830–40583
5		2797.20	I	13778–49517
10		2799.03	II	15147–50863
50		2799.92	I	3326–39030
20	d	2801.05	II	13434–49125
		2801.17	I	12162–47851
10		2802.95	I	13778–49444
10		2804.01	I	6219–41872
16		2804.24	I	16431–52081
10		2804.67	I	17701–53346
16		2805.63	I	18117–53749
16		2805.92	II	16235–51863
10		2807.72	I	19254–54859
8		2808.57	I	
5		2812.25	II	13434–48983
5		2813.13	I	17701–53238
10		2815.45	I	19535–55043
100		2818.06	I	6219–41694
20		2822.57	II	13412–48831
16	d	2827.15	I	19648–55009
		2827.28	I	
32		2829.82	I	13349–48676
5		2830.29	I	12162–47484
200		2831.38	I	2951–38259
100		2833.63	I	6219–41499
26		2835.64	I	2951–38206
10		2836.25	I	19648–54896
14		2837.34	I	1670–36904
5		2837.76	I	18117–53345
5		2838.89	I	15070–50285
16		2839.34	I	9528–44737
50		2841.57	I	4830–40011
5		2842.56	I	16431–51600
10		2843.78	I	
20		2847.82	I	3326–38430
100		2848.03	I	2951–38053
20	d	2849.46	I	19828–54912
		2849.56	I	13307–48390
16		2850.80	I	15070–50138
5		2852.91	I	
10		2853.49	I	15460–50495
5		2853.84	I	3326–38356
10		2855.35	I	13307–48319
80		2856.03	I	1670–36674
10		2857.13	I	14976–49966
20		2858.04	I	6219–41198
16		2863.01	I	1670–36588
16		2863.88	I	19826–54733
80		2866.06	I	3326–38206
5		2866.37	I	4830–39707
5		2870.90	I	13349–48171
16		2871.37	I	4830–39646
16		2875.21	I	12162–46932
28		2878.72	I	3326–38053
75		2879.11	I	2951–37674
75		2879.39	I	0–34719
5		2880.63	I	6219–40924
11		2884.18	I	19648–54310
11		2887.66	I	13349–47969
5		2893.12	I	17701–52256
5		2894.25	I	13778–48319
55		2896.01	I	1670–36190
190		2896.45	I	2951–37466
6		2900.52	I	13778–48244
6		2901.78	I	17701–52153
6		2907.26	I	18117–52503
11	d	2908.26	I	16431–50806
		2908.40	I	
11		2909.12	I	9528–43893

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
28		2910.48	I	3326–37674
34		2911.00	I	0–34342
11		2915.11	I	14976–49270
11		2915.59	I	
6		2917.67	I	18974–53238
44		2918.25	I	6219–40476
6		2918.63	II	11301–45554
44		2923.10	I	4830–39030
28		2923.54	I	2951–37146
28		2925.12	I	15460–49637
11		2926.98	I	17701–51856
6		2927.93	I	18974–53118
11		2928.19	I	3326–37466
6		2928.66	I	13349–47484
10		2930.15	I	15070–49188
85		2934.99	I	1670–35732
6		2935.62	I	15460–49514
12		2936.00	I	6219–40269
6		2936.67		
12		2937.14	I	19826–53863
17		2939.04	I	6219–40234
6		2941.24	I	13349–47338
300		2944.40	I	2951–36904
300		2946.98	I	2951–36874
60		2947.38	I	4830–38748
26		2952.29	II	14968–48831
12		2954.90	I	
12		2960.14	I	13307–47079
55		2964.52	I	2951–36674
12		2966.57	I	17107–50806
6		2967.07	I	17107–50800
6		2967.55	I	15460–49148
10		2969.62	I	13778–47443
18		2971.67	I	1670–35311
18		2972.92	I	12162–45790
12		2976.79	I	13349–46932
60		2977.10	I	19648–53228
		2977.21	I	3326–36904
90	d	2979.72	I	
		2979.86	I	3326–36874
18		2982.61	I	19256–52774
12		2984.14	I	6219–39720
19		2990.51	I	4830–38259
6		2990.71	I	6219–39646
50		2993.61	I	6219–39614
30		2995.26	I	4830–38206
24		2997.79	I	3326–36674
6		3000.24	I	19535–52856
10		3001.98	I	13778–47079
6		3002.82	I	19826–53118
24		3009.08	I	4830–38053
44		3013.79	I	4830–38001
65		3016.47	I	6219–39361
95		3017.44	I	2951–36082
13		3024.50	II	11301–44355
26		3024.92	I	1670–34719
38	d	3026.68	I	19826–52856
		3026.78	I	13778–46806
20		3033.58	I	12162–45117
20		3034.20	I	19826–52774
20		3039.31	I	
55	d	3041.74	I	15460–48326
		3041.87	I	3326–36190
34		3043.81	I	4830–37674
55		3046.45	I	1670–34486
14		3048.66	I	18280–51072
10		3049.00	I	
100		3049.69	I	2951–35732
7		3054.01	I	9528–42262
14		3064.94	I	3326–35943
22		3073.28	I	6219–38748
14		3077.52	II	
22	d	3084.82	I	17107–49514
		3084.91	I	3326–35732
		3089.06	I	
12	c	3089.18	I	14976–47338
		3089.31	I	2951–35311
8		3090.58	I	19254–51600
46		3093.51	I	4830–37146
8		3105.88	I	19828–52015
30		3107.23	I	3326–35499
30		3108.02	I	2951–35117
8		3111.12	I	15460–47593
28		3117.58	I	13307–45374
32		3120.18	I	6219–38259
20		3133.89	I	13778–45678
16		3141.42	I	12162–43985
8		3149.85	II	13173–44912
8		3152.96	I	16431–48138
8		3155.10	I	18280–49966
12		3159.18	I	13778–45422
36		3163.42	I	15070–46672
16		3164.44	I	13349–44940
16		3165.38	I	18117–49700
8		3167.58	I	
12		3170.20	I	2951–34486
40		3176.59	I	1670–33141
16		3179.06	I	17701–49148
8		3180.74	I	13307–44737
24		3181.81	I	16431–47851

Tungsten — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
16	3184.04	I	18117–49514
16	3184.42	I	3326–34719
8	3189.24	II	15147–46493
48	3191.57	I	0–31323
48	3198.84	I	4830–36082
65	3207.25	I	2951–34122
17	3208.28	I	3326–34486
130	3215.56	I	6219–37309
17	3221.21	I	18117–49152
17	3221.91	I	3326–34354
24	3232.49	I	6219–37146
10	3232.65	I	15460–46385
17	3237.09	I	9528–40411
17	3242.02	I	21449–52285
17	3252.29	I	
26	3254.36	I	15070–45789
17	3259.44	I	18117–48788
26	3259.66	I	4830–35499
26 d	3266.62	I	
	3266.76	I	19535–50138
18	3281.94	I	
18	3293.71	I	12162–42514
90	3300.82	I	4830–35117
55	3311.38	I	2951–33141
9	3316.09	I	1670–31818
9	3320.37	I	9528–39637
55	3326.19	I	6219–36275
55	3331.67	I	2951–32958
9	3345.09	I	
9	3345.86	I	13349–43228
18	3354.45	I	4830–34633
9	3363.34	I	6219–35943
19	3371.05	I	4830–34486
10	3371.35	I	1670–31323
48	3373.75	I	3326–32958
10	3388.83	I	21449–50949
10	3391.10	I	15460–44940
10	3391.53	I	15070–44547
10	3398.10	I	19256–48676
10 h	3408.38	I	
19	3412.96	I	4830–34122
19	3413.54	I	2951–32238
19	3422.43	I	
19	3427.72	I	13349–42514
28	3429.60	I	19535–48685
30	3443.01	I	12162–41198
10	3448.83	I	15460–44447
10	3463.25	I	2951–31818
10	3468.40	I	13778–42601
10	3475.84	I	12162–40924
20	3477.95	I	
10	3481.82	I	19256–47969
50	3495.25	I	19648–48251
20	3508.74	I	3326–31818
20	3510.03	I	2951–31433
10	3521.91	I	13349–41734
20	3526.85	I	13349–41694
20	3535.55	I	13307–41583
20	3537.45	I	15070–43331
80	3545.23	I	0–28199
10	3554.21	I	4830–32958
20	3568.04	I	15460–43479
30	3570.66	I	3326–31323
10	3572.48	II	10593–38576
20	3575.23	I	17008–44971
10	3575.98	I	13778–41734
10	3590.83	I	15070–42911
10	3592.42	II	11301–39129
30	3606.07	I	1670–29393
10	3607.07	I	19826–47541
10	3613.79	II	14634–42298
240	3617.52	I	2951–30587
20	3622.34	I	19256–46855
16	3627.24	I	13307–40868
40	3631.95	I	1670–29196
30	3641.41	II	8711–36165
10	3646.52	II	14634–42049
10	3651.00	I	17008–44390
10	3657.59	II	8833–36165
12	3663.36	I	16431–43721
10	3667.72	I	18117–45374
10	3668.66	I	19256–46506
12	3674.58	I	19648–46855
20	3675.56	I	12162–39361
10	3679.61	I	15070–42239
80	3682.09	I	6219–33370
50	3683.31	I	18280–45422
	3683.39	I	15460–42601
20	3683.94	I	19535–46672
10	3684.66	I	19254–46385
70	3688.07	I	19648–46755
10	3699.42	I	19648–46672
10	3702.32	I	14976–41979
10	3703.36	I	
95	3707.93	I	2951–29913
7	3714.24	I	17008–43924
7	3714.86	I	
7	3715.05	I	20428–47338
7	3716.08	II	15147–42049
10	3717.10	I	17701–44596

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
12	3719.40	I	17107–43985
10	3722.25	I	19648–46506
10	3730.43	I	19826–46625
6	3736.22	II	18001–44758
3.5	3739.48	I	18280–45015
14	3741.71	I	14976–41694
9	3742.68	I	22477–49188
8	3749.66		
4	3751.43	I	19254–45902
4	3757.09	I	6219–32828
60	3757.92	I	4830–31433
80	3760.13	I	3326–29913
3.0	3761.61	I	18974–45551
8	3764.31	I	19828–46385
8	3767.85	I	19256–45790
120	3768.45	I	1670–28199
14	3769.21	I	14976–41499
14	3769.87	I	15460–41979
8	3772.42	I	20983–47484
40	3773.70	I	13778–40269
9	3778.59	I	19648–46106
9	3778.68	I	18280–44737
120	3780.77	I	2951–29393
6	3783.73	I	19256–45678
4	3786.38	I	17008–43411
20	3792.77	I	13349–39707
10	3794.34	I	15070–41417
4	3796.28	I	19535–45869
8	3801.52	I	13349–39646
10	3801.92	I	19256–45551
3.0	3804.08	I	19826–46106
34	3809.23	I	2951–29196
22	3810.38	I	18117–44353
30	3810.80	I	13778–40011
4	3815.78	I	
8	3816.39	I	19256–45452
160	3817.48	I	2951–29139
4	3820.11	I	16431–42601
4	3824.15	I	18974–45117
11	3824.39	I	19648–45790
11	3826.19	I	15070–41198
12	3829.13	I	1670–27778
4	3834.04	I	19828–45902
120	3835.05	I	3326–29393
32	3838.50	I	12162–38206
10	3842.30	I	6219–32238
80	3846.21	I	1670–27662
28	3847.49	I	0–25984
3.0	3851.57	II	13173–39129
16	3855.54	I	13778–39707
16	3859.29	I	18117–44020
8	3861.06	I	14976–40868
4	3861.24	I	12162–38053
20	3864.34	I	3326–29196
7	3866.05	I	13778–39637
200	3867.98	I	2951–28797
28	3872.83	I	3326–29139
12	3874.41	I	19648–45452
8	3875.68	I	14976–40771
80	3881.39	I	4830–30587
4	3883.83	I	18280–44020
4	3890.74	I	18280–43975
12	3892.72	I	13349–39030
15 h	3897.91	I	
4	3901.83	I	18974–44596
4	3903.98	I	29773–55381
8	3905.97	I	19828–45422
8	3918.60	I	12162–37674
4	3924.37	I	20428–45902
4	3924.70	I	18974–44447
4	3926.03	I	15460–40924
7	3930.25	I	19826–45263
9	3930.48	I	14976–40411
4	3930.97	I	18083–43515
16	3935.04	I	13778–39183
4	3936.23	I	18117–43515
13	3936.98	I	18974–44367
4	3937.63	I	19535–44924
4	3939.44		
13	3947.98	I	19648–44971
13	3952.52	I	14976–40269
13	3952.90	I	19256–44547
18	3953.16	I	19828–45117
22	3955.31	I	19648–44924
8	3958.88	I	13778–39030
9	3962.33	I	17008–42239
9	3964.99	I	6219–31433
18	3965.14	I	22477–47689
14	3968.59	I	19256–44447
9	3969.20	I	19828–45015
17 h	3970.80	I	
9	3975.46	I	12162–37309
5	3975.89	I	17107–42251
14	3979.29	I	13307–38430
14	3980.64	I	19826–44940
4	3982.87	I	18117–43217
10	3982.96	I	19254–44353
28	3983.29	I	19826–44924
9	3991.22	I	21449–46497
8	3992.75	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		3993.90	I	23047–48078
5		3997.13	I	18974–43985
5		3998.16	I	21454–46458
8		3998.76	I	18974–43975
9	h	4000.69	I	
9		4001.37	I	12162–37146
8		4005.40	I	1670–26630
950		4008.75	I	2951–27890
5		4010.38	I	23047–47975
60		4015.22	I	19648–44547
19	h	4016.53	I	
24		4019.23	I	3326–28199
14		4022.12	I	19535–44390
20		4028.79	I	9528–34342
5		4035.36	I	15460–40234
20		4036.86	I	19256–44020
15		4039.86	I	18974–43721
5		4040.59	I	19648–44390
5		4043.89	I	19254–43975
15	h	4044.29	I	26230–50949
100		4045.60	I	2951–27662
10		4046.70	I	13349–38053
5		4047.94	I	1670–26367
10		4053.94	I	14976–39637
5		4060.71	I	19828–44447
20		4064.79	I	19256–43851
16		4069.80	I	19826–44390
80		4069.95	I	4830–29393
38		4070.61	I	1670–26230
11		4071.93	I	15460–40011
9		4073.15	I	15070–39614
550		4074.36	I	2951–27488
16		4082.97	I	19256–43741
14		4088.33	I	3326–27778
5		4088.77	I	19535–43985
11		4095.70	I	17008–41417
5		4097.67	I	18117–42514
4		4099.03	I	19535–43924
5		4101.85	I	
110		4102.70	I	6219–30587
6		4108.53	I	18117–42450
16		4109.76	I	13349–37674
6		4110.57	I	18280–42601
11		4111.81	I	1670–25984
6		4115.59	I	15070–39361
17		4118.05	I	18974–43251
11		4118.18	I	13778–38053
11		4120.86	I	15460–39720
6		4122.02	I	18974–43228
6		4123.06	I	15460–39707
11		4125.18	I	16431–40666
17		4126.80	I	19254–43479
6		4132.21	I	19828–44020
11		4133.48	I	19535–43721
6		4136.35	I	18280–42450
60		4137.46	I	3326–27488
17		4138.02	I	13307–37466
10		4138.30	I	19828–43985
6		4139.32	I	16431–40583
12		4142.26	I	18117–42251
15		4145.16	I	13349–37466
12		4145.95	I	12162–36275
6		4149.44	I	19648–43741
18		4154.68	I	19389–43452
6		4160.04	I	20983–45015
5		4160.35	I	22477–46506
10		4168.66	I	18280–42262
18		4170.54	I	18280–42251
50		4171.18	I	4830–28797
6		4180.24	I	19826–43741
6		4183.67	I	18083–41979
10		4183.83	I	19826–43721
5		4186.02	I	17701–41583
5		4199.63	I	17107–40912
6		4200.03	I	16431–40234
10		4203.82	I	12162–35943
18		4204.41	I	19256–43034
24		4207.05	I	19648–43411
12		4215.38	I	19535–43251
6		4218.56	I	18280–41979
28		4219.38	I	6219–29913
12		4222.06	I	15070–38748
6		4224.76	I	23930–47593
5		4226.34	I	19256–42911
6		4226.92	I	18083–41734
6		4233.00	I	18117–41734
16		4234.35	I	19256–42866
32		4241.45	I	15460–39030
6		4243.64	I	
60		4244.37	I	6219–29773
6		4249.46	I	13349–36874
6		4258.53	I	17107–40583
32		4259.36	I	21449–44920
6		4259.94	I	17008–40476
22		4260.29	I	18117–41583
22		4263.32	I	23047–46497
6		4266.54	I	23930–47362
150		4269.39	I	2951–26367
12		4269.78	I	18280–41694
6		4273.69	I	22477–45869

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
24	4274.55	I	20064–43452
18	4275.49	I	18117–41499
18	4276.75	I	19535–42911
12	4282.34	I	19256–42601
5	4284.96	I	19535–42866
12	4286.01	I	13349–36674
12	4294.10	I	13307–36588
450	4294.61	I	2951–26230
240	4302.11	I	2951–26189
18	4306.88	I	24763–47975
12	4307.64	I	19826–43034
6	4316.81	I	
6	4327.41	I	
9	4330.66	I	19826–42911
9	4330.97	I	19828–42911
12	4332.13	I	14976–38053
5	4345.84	I	18974–41979
11	4347.00	I	19254–42251
5	4347.51	I	19256–42251
6	4348.12	I	20983–43975
17	4355.16	I	12162–35117
11	4361.82	I	6219–29139
17	4364.79	I	3326–26230
11 d	4365.96	I	28393–51291
	4366.07	I	18974–41872
17	4372.53	I	3326–26189
22	4378.49	I	4830–27662
20	4384.86	I	15460–38259
6	4389.84	I	19828–42601
9	4394.08	I	18117–40868
11	4403.95	I	
22	4408.28	I	26676–49355
14	4412.20	I	3326–25984
5	4415.08	I	18280–40924
5	4418.45	I	20428–43054
10	4420.47	I	19256–41872
9	4423.78	I	22853–45452
5	4425.91	I	18280–40868
18	4436.90	I	20983–43515
5	4438.30	I	18974–41499
8	4441.81	I	17107–39614
10	4445.15	I	14976–37466
10	4449.01	I	12162–34633
5	4450.36	I	22477–44940
4	4455.46	I	19256–41694
4	4456.11	I	
5	4458.09	I	13307–35732
4	4458.30	I	19828–42251
15	4460.50	I	13778–36190
8	4463.50	I	23930–46328
15	4466.35	I	13349–35732
15	4466.73	I	
5	4474.04	I	
5	4481.28	I	
70	4484.19	I	1670–23965
5	4489.02	I	
5	4492.33	I	17107–39361
8	4493.97	I	19254–41499
9	4494.51	I	19256–41499
5	4495.30	I	15070–37309
3.5	4498.47	I	18974–41198
4	4504.17	I	
18	4504.86	I	12162–34354
14	4512.91	I	18117–40269
13	4513.30	I	13349–35499
4	4519.17	I	
4	4529.76	I	22477–44547
4	4530.47	I	12162–34229
7	4534.71	I	19826–41872
9	4535.05	I	19828–41872
7	4536.66	I	21856–43893
4	4542.89	I	15460–37466
17	4543.51	I	21449–43452
17	4546.49	I	18280–40269
16	4551.85	I	13349–35311
4	4556.87	I	23930–45869
4	4558.97	I	18083–40011
4	4559.11	I	14976–36904
8	4563.59	I	19828–41734
4	4565.32	I	14976–36874
15	4570.66	I	23047–44920
4	4578.34	I	
4	4579.70	I	
7	4586.85	I	9528–31323
19	4588.75	I	26189–47975
8	4592.42	I	19648–41417
6	4592.58	I	13349–35117
15	4599.96	I	24763–46497
3.5	4600.44	I	18280–40011
15	4609.92	I	15460–37146
18	4613.32	I	6219–27890
2.5	4614.86	I	19535–41198
3.5	4620.55	I	19535–41171
3.0	4623.69	I	16431–38053
6	4634.81	I	16431–38001
3.5	4641.80	I	4830–26367
10	4642.56	I	13778–35311
3.5	4643.15	I	20983–42514
3.5	4646.15	I	19254–40771
13	4657.44	I	27890–49355

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
65	4659.87	I	0–21454
2.5	4661.23	I	22477–43924
3.5	4661.97	I	15460–36904
4	4668.46	I	15460–36874
5	4676.63	I	19535–40912
6	4677.69	I	19826–41198
3.0	4679.04	I	18280–39646
65	4680.52	I	4830–26189
4	4683.54	I	19826–41171
10	4693.73	I	26676–47975
3.0	4698.63	I	19828–41104
5	4700.41	I	6219–27488
3.0	4702.47	I	18974–40234
2.0	4706.17	I	16431–37674
2.5	4710.34	I	
2.5	4711.19	I	19256–40476
4	4712.49	I	14976–36190
2.5	4716.86	I	17008–38203
2.5	4718.63	I	23930–45117
2.5	4720.40	I	13307–34486
5	4725.14	I	19254–40411
8	4729.65	I	13349–34486
2.0	4745.57	I	18117–39183
3.0	4752.21	I	18974–40011
3.0	4752.58	I	13307–34342
2.0	4753.39	I	
14	4757.55	I	2951–23965
2.5	4757.78	I	15070–36082
2.0	4758.21	I	23930–44940
1.8	4767.78	I	
3.5	4773.91	I	13778–34719
1.6	4780.52	I	
2.5	4787.94	I	13349–34229
2.0	4788.43	I	16431–37309
2.5	4797.55	I	19828–40666
8	4799.92	I	19648–40476
5	4807.37	I	12162–32958
2.0	4816.11	I	19254–40011
2.0	4816.82	I	28600–49355
2.5	4835.02	I	20428–41104
80	4843.83	I	3326–23965
4	4854.09	I	13349–33944
2.5	4863.08	I	22477–43034
2.5	4878.28	I	18083–38576
38	4886.91	I	6219–26676
1.6	4888.39	I	13778–34229
1.6	4890.29	I	16431–36874
1.6	4890.89	I	20428–40868
3.0	4892.44	I	22477–42911
3.0	4902.32	I	19254–39646
1.6	4902.97	I	19256–39646
2.5	4910.74	I	19256–39614
3.0	4916.18	I	14976–35311
4	4931.56	I	15460–35732
3.0	4953.09	I	19828–40011
3.5	4957.37	I	13778–33944
1.4	4972.57	I	19256–39361
5	4979.85	I	18280–38356
20	4982.60	I	0–20064
3.0	4983.54	I	
2.0	4984.72	I	18974–39030
6	4986.94	I	15070–35117
2.0	4989.09	I	
1.4	4994.10	I	
1.4	4995.32	I	22853–42866
1.4	5002.80	I	20428–40411
30	5006.16	I	6219–26189
20	5015.32	I	4830–24763
5	5040.36	I	13307–33141
2.0	5052.23	I	20983–40771
75	5053.30	I	1670–21454
19	5054.61	I	1670–21449
2.5	5055.53	I	22477–42251
19	5069.15	I	3326–23047
11	5071.73	I	
3.5	5110.36	I	15070–34633
3.5	5124.24	I	14976–34486
3.0	5130.11	I	23965–43452
3.5	5138.40	I	28233–47689
4	5145.77	I	20983–40411
1.6	5153.53	I	
3.0	5183.97	I	18974–38259
4	5192.72	I	14976–34229
2.0	5195.63	I	25984–45225
4	5203.26	I	19535–38748
5	5204.51	I	20428–39637
5	5206.19	I	19828–39030
4	5212.79	I	28797–47975
70	5224.67	I	4830–23965
3.0	5233.54	I	19254–38356
7	5242.99	I	16431–35499
3.0	5254.54	I	15460–34486
4	5255.42	I	22477–41499
6	5259.36	I	27488–46497
1.2	5263.21	I	
4	5275.55	I	19256–38206
2.5	5318.87	I	27662–46458
2.5	5337.37	I	26189–44920
4	5348.95	I	26230–44920
3.0	5350.44	I	29393–48078

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.0	5351.90	I	27778–46458
2.0	5354.46	I	9528–28199
1.2	5355.26	I	19535–38203
1.2	5357.12	I	15460–34122
1.2	5368.70	I	28233–46855
2.0	5374.16	I	20428–39030
2.0	5388.02	I	19648–38203
1.4	5397.97	I	19254–37774
1.0	5419.40	I	22477–40924
0.6	5422.89	I	22477–40912
0.6	5423.93	I	19828–38259
5	5435.06	I	1670–20064
1.0	5435.61	I	17107–35499
0.8	5440.08	I	19826–38203
2.0	5456.59	I	23930–42251
0.6	5457.94		
1.0	5475.11	I	28199–46458
3.5	5477.80	I	9528–27778
1.4	5486.01	I	31433–49656
0.9	5487.78	I	4830–23047
6	5492.32	I	29773–47975
0.9	5496.24	I	22477–40666
2.5	5500.51	I	19826–38001
2.5	5503.45	I	14976–33141
0.9	5508.63	I	20428–38576
20	5514.70	I	3326–21454
0.8	5521.01	I	18083–36190
1.4	5531.38	I	18117–36190
1.4	5537.74	I	19256–37309
0.8	5539.49	I	20983–39030
1.2	5568.07		
0.6	5576.34	I	20428–38356
1.2	5604.33	I	31818–49656
0.8	5616.19		
0.8	5617.08	I	17701–35499
0.5	5624.58	I	19535–37309
0.8	5629.65	I	15070–32828
1.0	5631.26	I	33370–51123
2.5	5631.97	I	12162–29913
0.5	5635.50		
0.7	5642.04	I	1670–19389
0.4	5644.48		
6	5648.38	I	18974–36674
0.7	5660.07	I	18280–35943
3	5660.75	I	19648–37309
0.7	5664.34	I	18083–35732
0.7	5673.56	I	19254–36874
2.5	5674.42	I	19256–36874
0.6	5675.38	I	18117–35732
1.2	5676.61	I	12162–29773
1.4	5676.93	I	17701–35311
1.4	5697.82	I	13778–31323
0.6	5723.06	I	25984–43452
5	5735.09	I	27488–44920
0.5	5739.60	I	32238–49656
0.6	5747.26	I	30683–48078
1.2	5749.22	I	30587–47975
0.5	5754.57		
1.0	5756.09	I	15460–32828
0.6	5759.65	I	29139–46497
1.2	5793.07	I	27662–44920
1.2	5796.51	I	17107–34354
0.4	5799.53	I	13349–30587
4	5804.87	I	26230–43452
1.2 d	5806.07	I	18280–35499
	5806.27	I	28233–45452
0.6	5822.60	I	22477–39646
1.2	5833.59	I	22477–39614
1.2	5838.99	I	17107–34229
1.6	5845.26	I	29393–46497
2.6	5851.56	I	26367–43452
1.0	5856.62	I	20983–38053
2.0	5864.63	I	19828–36874
1.0	5874.23	I	19256–36275
0.8	5875.66	I	17107–34122
1.2	5880.22	I	34122–51123
1.2	5891.61	I	18974–35943
1.2	5901.23		
3.5	5902.66	I	19254–36190
1.2	5928.58		
5	5947.58	I	13778–30587
1.2	5953.97	I	20983–37774
1.2	5956.18	I	17701–34486
2.5	5960.82		
5	5965.86	I	18974–35732
2.5	5972.52	I	3326–20064
1.8	5978.89	I	28199–44920
1.8	5983.84	I	28233–44940
1.2	6009.04	I	18083–34719
5	6012.81	I	19648–36275
3.5	6021.54	I	18117–34719
1.8	6028.35	I	29913–46497
1.8	6043.33	I	31433–47975
1.2	6049.92	I	18974–35499
1.2	6065.09	I	20983–37466
2.0	6081.48	I	18280–34719
1.2	6111.68	I	15460–31818
1.2	6115.55	I	14976–31323
2.0	6128.27	I	28233–44547
1.2	6143.94	I	22477–38748

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.8	6153.73	I	19254–35499
1.8	6154.86	I	17701–33944
1.8	6203.51	I	19828–35943
1.8	6254.29	I	33370–49355
2.5	6285.90	I	19828–35732
4	6292.03	I	13307–29196
1.8	6303.24	I	19256–35117
1.2	6386.47		
3.0	6404.20	I	14976–30587
3.5	6445.13	I	18974–34486
1.0	6508.02	I	13778–29139
1.4	6532.42	I	20428–35732
1.2	6538.14	I	19826–35117
1.2	6563.22	I	19254–34486
1.8	6573.95	I	20983–36190
1.0	6607.15	I	17107–32238
1.0	6609.04	I	15460–30587
1.6	6611.64	I	32958–48078
1.0	6621.68	I	19256–34354
1.2	6678.41	I	18974–33944
1.4	6693.12	I	14976–29913
0.5	6746.56	I	23930–38748
0.5	6764.43	I	
0.6	6805.28	I	19254–33944
0.8	6814.95	I	22477–37146
0.8	6820.28	I	19828–34486
0.7	6828.42	I	31818–46458
0.4	6853.73	I	19535–34122
0.4	6876.02	I	35117–49656
0.5	6908.29	I	13307–27778
0.8	6934.27	I	14976–29393
0.7	6964.12	I	13307–27662
1.2	6984.30	I	13349–27662
0.7	6993.26	I	19826–34122
0.4	6994.08	I	19828–34122
0.7	7017.91		
0.3	7028.68		
0.3	7098.22	I	44547–58631
0.4 h	7111.18	I	20428–34486
1.4	7140.54	I	13778–27778
0.8	7162.66	I	18280–32238
0.5 h	7191.37	I	31323–45225
0.5	7198.62	I	19254–33141
1.0	7200.18	I	13778–27662
0.5	7216.31	I	18974–32828
0.4	7226.05	I	19535–33370
0.7	7237.08	I	37309–51123
0.5	7274.49		
0.9	7278.23	I	15460–29196
1.4	7285.80	I	19648–33370
1.4	7296.58	I	19256–32958
0.3	7298.23		
0.6	7385.08	I	18280–31818
0.4	7451.40		
0.3	7456.34		
0.7	7483.35	I	20983–34342
0.6	7504.16	I	13307–26630
0.9	7508.99	I	19828–33141
0.3	7520.66	I	19535–32828
0.8	7537.43	I	18974–32238
0.8	7550.46	I	18083–31323
1.6	7569.91	I	18117–31323
0.5	7582.88	I	28233–41417
0.3	7612.13		
1.6	7614.11	I	19828–32958
0.3	7631.29		
0.3	7654.78		
1.2	7688.94	I	19826–32828
0.4	7701.00	I	19256–32238
0.5	7761.14	I	13349–26230
0.3	7776.71		
1.0	7784.12	I	18974–31818
0.6	7808.94	I	14976–27778
0.2	7823.78		
0.4	7863.46	I	20428–33141
0.2	7867.03	I	16431–29139
0.4	7880.34	I	14976–27662
0.5	7886.47	I	13307–25984
0.8	7940.93	I	13778–26367
0.3	7957.06	I	19254–31818
2.0	8017.18	I	18117–30587
0.6	8054.86	I	13778–26189
2.0	8055.60	I	19828–32238
0.5	8060.36	I	18280–30683
1.2	8123.79	I	18280–30587
0.5	8143.12		
0.3	8165.70	I	28233–40476
0.5	8210.20	I	19256–31433
0.4	8322.00	I	23930–35943
0.9	8338.01	I	19828–31818
0.4	8348.76	I	20983–32958
0.6	8358.67		
0.3	8382.87	I	9528–21454
0.4	8402.55	I	19535–31433
0.4	8475.16	I	18117–29913
2.5	8585.06	I	22477–34122
0.9	8594.37	I	18280–29913
0.7	8613.26	I	19826–31433
0.3	8614.48	I	19828–31433
1.2	8865.50	I	18117–29393

URANIUM

U, $Z=92$, $M=238.07$, Ratio $\frac{U}{Cu}=3.747$

U I Normal state of valence electrons $5f^3 6d^1 7s^2\ {}^5L_6^\circ = 0$. I.P. ≈ 50000 K
U II Normal state of valence electrons $5f^3\ \ 7s^2\ {}^4I^\circ_{4\frac{1}{2}} = 0$ (assumed)

References

Wavelengths:

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

C. C. Kiess, C. J. Humphreys, and D. D. Laun, unpublished material.

Classification:

U I, C. C. Kiess, C. J. Humphreys, and D. D. Laun, J. Research NBS **37,** 1 (1946).

U II, J. C. van den Bosch, Physica **15,** 503 (1949). In using this reference, we have assumed that the energy levels of "group B" start at the ground state of the atom.

Relative intensity of uranium lines observed in an arc of copper containing 0.1 atomic percent of uranium

Strong lines of uranium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
360	3859. 58	II	289–26191	$5f^3 6d^1 7s^1\ \ L^\circ_{5\frac{1}{2}}—261_{6\frac{1}{2}}$
180	3854. 66	II		
160	3670. 07	II	915–28154	$5f^3 6d^1 7s^1\ \ K^\circ_{4\frac{1}{2}}—281_{5\frac{1}{2}}$
160	3890. 36	II	289–25986	$5f^3 6d^1 7s^1\ \ L^\circ_{5\frac{1}{2}}—260_{6\frac{1}{2}}$
160	4090. 14	II	1749–26191	$5f^3 6d^1 7s^1\ \ L^\circ_{6\frac{1}{2}}—261_{6\frac{1}{2}}$
150	3831. 46	II		
140	3782. 84	II	289–26717	$5f^3 6d^1 7s^1\ \ L^\circ_{5\frac{1}{2}}—267_{6\frac{1}{2}}$
140	3812. 00	I	0–26226	$5f^3 6d^1 7s^2\ \ {}^5L^\circ\ —262_6$
140	3865. 92	II	2295–28154	$5f^3 6d^1 7s^1\ \ K^\circ_{5\frac{1}{2}}—281_{5\frac{1}{2}}$
130	3584. 88	I	0–27887	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —278_7$
120	4050. 04	II	0–24684	$5f^3\ \ 7s^2\ \ {}^4I^\circ_{4\frac{1}{2}}\ —247_{4\frac{1}{2}}$
110	3871. 04	I	0–25826	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —258_6$
100	4171. 59	II	1749–25714	$5f^3 6d^1 7s^1\ \ L^\circ_{6\frac{1}{2}}—257_{6\frac{1}{2}}$
95	3566. 60	I	620–28650	$5f^3 6d^1 7s^2\ \ {}^5K^\circ_5\ —287_5$
90	3839. 62	I	3801–29838	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_7\ —299_7$
90	3943. 82	I	0–25349	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —253_6$
85	3985. 80	II	5260–30342	$5f^3 6d^1 7s^1\ \ L^\circ_{7\frac{1}{2}}—303_{7\frac{1}{2}}$
80	3701. 52	II	5527–32535	$5f^3 6d^1 7s^1\ \ K^\circ_{6\frac{1}{2}}—325_{6\frac{1}{2}}$
75	3881. 46	II	4585–30342	$5f^3 6d^2\ \ {}^6M^\circ_{6\frac{1}{2}}—303_{7\frac{1}{2}}$
75	4042. 76	I	620–25349	$5f^3 6d^1 7s^2\ \ {}^5K^\circ_5\ —253_6$
75	4241. 67	II	4585–28154	$5f^3 6d^2\ \ {}^6M^\circ_{6\frac{1}{2}}—281_{5\frac{1}{2}}$
70	3748. 68	II		
65	3489. 37	I	0–28650	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —287_5$
65	3514. 61	I	0–28444	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —284_5$
65	4062. 55	II	0–24608	$5f^3\ \ 7s^2\ \ {}^4I^\circ_{4\frac{1}{2}}—246_{5\frac{1}{2}}$
65	4153. 97	I	0–24067	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —240_7$
60	4116. 10	II	0–24288	$5f^3\ \ 7s^2\ \ {}^4I^\circ_{4\frac{1}{2}}—243_{5\frac{1}{2}}$
55	2941. 92	II	5527–39508	$5f^3 6d^1 7s^1\ \ K^\circ_{6\frac{1}{2}}—395_{6\frac{1}{2},\ 7\frac{1}{2}}$
55	3659. 16	I	620–27941	$5f^3 6d^1 7s^2\ \ {}^5K^\circ_5\ —278_6$
55	3826. 51	II	289–26415	$5f^3 6d^1 7s^1\ \ L^\circ_{5\frac{1}{2}}—264_{6\frac{1}{2}}$
50	2889. 63	II	289–34886	$5f^3 6d^1 7s^1\ \ L^\circ_{5\frac{1}{2}}—349_{5\frac{1}{2}}$
50	3746. 41	II	5527–32211	$5f^3 6d^1 7s^1\ \ K^\circ_{6\frac{1}{2}}—322_{6\frac{1}{2}}$
50	4341. 69	II	289–23315	$5f^3 6d^1 7s^1\ \ L^\circ_{5\frac{1}{2}}—233_{4\frac{1}{2}}$
48	3550. 82	II	0–28154	$5f^3\ \ 7s^2\ \ {}^4I^\circ_{4\frac{1}{2}}—281_{5\frac{1}{2}}$
48	3561. 80			
48	3638. 20	I	3801–31279	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_7\ —312_8$
46	3854. 22	I	0–25938	$5f^3 6d^1 7s^2\ \ {}^5L^\circ_6\ —259_6$
46	3874. 04			
46	3878. 09			
46	3892. 68	II	5260–30942	$5f^3 6d^1 7s^1\ \ L^\circ_{7\frac{1}{2}}—309_{7\frac{1}{2}}$
46	3899. 78	II	2295–27930	$5f^3 6d^1 7s^1\ \ K^\circ_{5\frac{1}{2}}—279_{5\frac{1}{2}}$
46	4543. 63	II	915–22917	$5f^3 6d^1 7s^1\ \ K^\circ_{4\frac{1}{2}}—229_{5\frac{1}{2}}$

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		2419.57		
3.0		2423.70		
4		2427.45		
2.5		2432.4		
4		2448.93		
4		2450.44		
3.5		2454.37		
2.0		2455.68		
3.0		2468.26		
5		2470.64		
2.5		2477.18		
3.0		2484.01		
1.2		2490.93		
1.6		2498.83		
10		2500.86		
1.2		2503.9		
5		2514.77		
5		2518.97		
2.5		2528.10		
3.0		2533.23		
3.0		2534.95		
5		2537.30		
9		2538.43		
2.5		2538.73		
2.5		2541.37		
2.0		2544.36		
5		2549.30		
16		2556.19	II	0−39109
3.0		2559.49		
12		2562.94		
26		2565.41		
1.8		2567.11		
5		2567.96		
5		2568.87		
1.8		2568.98		
20		2569.71		
9		2570.67		
8		2577.32		
5		2579.16		
5		2579.44		
5		2579.57		
2.5		2582.11		
2.5		2583.48		
8		2584.42		
5		2584.90		
5		2586.20		
6	d	2587.07		
3.0		2589.59		
20		2591.25		
8		2592.57		
9		2593.57		
14		2597.69		
7		2598.86		
11		2601.54		
1.6		2603.55	II	
5		2604.31		
8		2606.52		
8		2606.73		
8		2608.20		
4		2609.26		
5		2612.46		
9		2613.95		
3.0		2615.95		
6		2616.07		
4		2621.81		
5		2623.54		
8		2624.92		
8		2625.26		
4		2625.86		
5		2628.50		
12		2628.93		
2.0		2629.15		
5		2631.26		
10		2632.66		
14		2632.98		
36		2635.53		
3.0		2636.25		
6		2637.70		
1.6		2638.6		
3.0		2639.01		
8		2639.84		
4		2639.89		
4		2641.55		
6		2641.93		
1.4		2643.24		
1.4		2643.54		
8		2644.12		
2.5		2644.48		
28		2645.47		
2.0		2647.02		
1.4		2647.53		
4		2648.79		
15		2649.07	II	
12		2652.83		
6		2654.58		
4	d	2656.46		
1.4	d	2657.86		
1.4	d	2658.36		
4		2659.02		
5		2659.46		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
8		2660.14		
4		2661.17		
10		2664.15		
6		2665.70		
6		2665.87		
8		2666.54		
3.0		2668.02		
20		2669.17		
8		2670.52		
3.0		2670.89		
6		2672.21		
3.0		2672.69		
1.4		2673.58		
8		2675.12		
8		2675.88	II	1749–39109
13		2676.41		
2.0		2676.69		
1.4		2678.86		
2.0	d	2681.73		
28		2683.28		
9		2684.04		
1.4		2684.29		
4		2685.61		
16		2685.98		
1.4		2689.13		
8		2690.51		
19		2691.04		
6		2691.80		
12		2692.36		
10		2693.77		
3.0		2694.22		
12		2695.49		
3.0		2695.91		
2.5		2696.30		
6		2697.40		
16		2698.06		
6		2698.45		
1.4		2699.37		
4		2700.96		
5		2701.55		
2.0		2704.80		
12	d	2705.19		
1.6		2705.77		
22		2706.95		
1.6		2708.50		
3.0	d	2709.03		
6		2709.51		
4		2711.10		
4		2711.76		
8		2712.06		
4		2713.91		
6		2714.58		
6		2715.54	II	2295–39109
5		2716.39		
3.0		2717.56		
8		2719.33		
12		2723.03		
2.0		2725.07		
6		2725.52		
8		2725.94		
6		2727.34		
7		2728.55		
7		2728.7		
3.0		2729.26		
10		2730.31		
6		2731.27		
3.0	d	2732.95		
3.0		2733.77		
22		2733.97		
7		2734.96		
5		2735.58		
5	d	2737.07		
6		2738.13		
3.0		2738.41		
6		2738.98		
10		2739.39	II	289–36783
4		2740.86		
2.0		2741.06		
8		2741.75		
5	d	2742.60		
6		2743.22		
6		2743.66		
2.0		2744.27		
10		2744.40		
8		2746.16		
3.5		2746.3		
3.0		2747.15		
6		2747.36		
10		2748.45		
6		2749.96		
3.0		2750.13		
28		2754.16		
8		2755.13		
3.5		2757.55		
4	d	2757.92		
		2758.18		
8		2758.50		
9		2758.96		
8		2759.79		
2.0		2760.33		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.6		2761.18		
20		2762.85		
6		2764.25		
12		2765.40		
8		2766.88		
16		2770.04		
4	d	2772.18		
8		2772.59		
6		2773.61		
5		2774.74		
5		2775.02		
3.5		2775.22		
3.5		2775.78		
3.5	d	2776.29		
3.0		2778.45		
7		2779.41		
8		2780.04		
9		2780.77		
9		2781.04		
8		2781.62		
5		2782.07		
7	d	2783.29		
17		2784.45	II	
7		2784.67		
3.0		2784.92		
2.5		2785.17		
7	d	2787.33		
6		2788.13		
7		2790.66		
5		2791.07		
3.0		2791.26		
34		2793.94	II	
8		2795.23		
12		2797.14		
3.5		2797.30		
3.5		2797.77		
5		2799.12		
36		2802.56		
5		2803.83		
7		2805.24		
26		2807.05	II	
18		2808.98		
9		2809.95		
5	d	2810.35		
12		2811.34		
7		2813.04		
5		2815.76		
7		2815.98	II	289–35790
2.5		2816.74		
26		2817.96	II	
5		2818.98		
9		2819.84		
8		2820.27		
36		2821.12	II	
16		2824.37	II	289–35685
5		2824.86		
8		2825.35		
9		2826.19		
4		2827.00		
28		2828.90		
8		2829.37		
38		2832.06		
9		2833.82		
4		2834.55		
6		2835.80		
15		2837.19		
9		2837.33		
4		2837.73		
3.0		2838.62	II	915–36133
19		2839.89	II	
4		2840.47		
8	d	2840.62		
15		2842.09		
4		2842.24		
4		2842.48		
6		2844.99		
8		2845.60		
6		2845.96		
4		2846.09		
4		2847.34		
2.0		2847.72		
2.5		2848.05		
15		2849.48		
6		2849.7		
4		2849.98		
8		2850.49		
4		2850.82		
5		2851.81		
6		2852.09		
8		2852.75		
2.0		2852.94		
8		2853.42		
8		2853.57	II	1749–36783
4		2854.92		
6		2855.96		
4		2857.47		
12		2858.90	II	
5		2859.74		
16		2860.47		
7		2860.80		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
7	2861.13		
5	2862.41		
4	2862.62	II	4585–39508
3.0	2862.80		
4	2863.44		
4	2863.54		
6	2864.10		
6	2864.28		
12	2865.14		
40	2865.68	II	0–34886
6	2866.16		
4	2867.80		
8	2868.19		
8 d	2869.37		
14	2870.97		
4	2873.00		
9	2874.08		
9	2875.20	II	915–35685
8 d	2876.43		
4	2877.05		
2.0	2877.83		
4	2878.87		
10 d	2879.59		
8	2880.59		
4	2882.34		
20	2882.74		
10	2882.93	II	
3.5 h	2883.75		
6 d	2884.92		
4	2885.19		
4	2886.05		
8 d	2886.45	II	289–34924
19	2887.25		
6	2887.59		
4	2887.91		
17	2888.26		
8	2888.74		
50	2889.63	II	289–34886
6 d	2891.80		
4	2893.76		
13	2894.14		
17	2894.51		
4	2894.84		
4	2894.89		
8 d	2895.54		
10	2896.68		
3.5	2896.96		
6	2898.01		
6	2898.1		
4	2898.37		
4	2898.56		
6	2898.71	II	2295–36783
8	2901.22		
6	2902.41		
4	2902.81	II	0–34439
4	2903.05		
6	2903.55		
5	2904.02		
6	2904.41		
10	2904.51	II	289–34708
32	2906.80		
8	2906.91		
32	2908.28		
8	2908.41		
8	2909.25		
7	2910.82		
4	2911.55		
6	2912.58		
4	2912.75		
6	2913.44		
13	2914.25	II	289–34593
15	2914.63	II	
4	2914.84		
9 d	2915.54		
9	2916.46		
4	2918.37		
4	2918.68		
7	2918.97	II	5260–39508
18 d	2921.68		
	2921.72		
4	2922.06		
4	2923.17	II	0–34199
11	2923.50		
7	2924.58		
4	2925.22		
11	2925.57		
7	2925.98		
4	2926.10		
4	2926.39		
9	2926.59		
13	2927.38	II	289–34439
20	2928.60		
7	2929.12		
9	2929.64		
7	2929.78		
8	2930.43		
5	2930.59		
24	2931.41		
9	2931.89		
5	2932.18		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	2932.61		
14	2933.86		
7	2935.62		
11	2936.45		
4	2936.78	II	1749–35790
5	2937.35		
9	2939.04		
5	2939.49		
4	2940.04		
22 d	2940.37		
9	2941.34		
55	2941.92	II	5527–39508
9	2942.12	II	289–34268
11	2942.85	II	915–34886
5	2943.18		
5	2943.40		
34	2943.90		
7	2944.19		
9	2945.89	II	1749–35685
11	2947.43		
14	2948.09	II	289–34199
4	2948.44		
12	2948.94		
9	2949.61		
4	2949.97		
5	2951.92		
9	2954.39	II	2295–36133
16	2954.77		
10	2955.65		
24	2956.06		
7	2956.78		
7 d	2957.74		
5	2958.10		
10	2959.85		
10 d	2962.78		
10	2964.25		
19	2965.03		
7	2966.12		
10	2966.66	II	1749–35447
24	2967.89	II	
7	2968.40	II	915–34593
5	2970.48		
24	2971.06		
10	2973.08		
12	2973.26		
10	2975.22		
7	2975.64		
12	2975.88		
17	2976.31		
12	2977.27		
10	2978.14		
5	2980.28		
5	2980.69		
5	2981.04		
13	2982.74	II	
22	2984.61	II	2295–35790
4	2985.08		
7 d	2985.80		
7	2987.80	II	289–33749
4	2987.95		
12	2988.42		
10	2988.71		
12	2989.88		
4	2990.21		
17	2992.72		
7	2993.70		
5	2994.45		
5	2996.10		
5	2996.39		
5	2998.36		
7	2999.03		
7	2999.22		
7	3000.09		
5	3001.21		
5	3002.64		
10	3003.07		
12	3003.32		
5	3003.85		
10	3004.15		
9	3005.10		
8	3005.52		
15	3007.91		
12	3009.42		
5	3010.37		
7	3010.75		
5	3011.48		
4	3012.45	II	289–33475
7	3012.71		
10	3013.37		
7	3013.44		
5	3014.88		
5	3015.68		
4	3016.05		
12	3016.96	II	1749–34886
7	3017.35		
6	3018.10		
5	3018.59		
5	3020.24		
5	3020.57		
5	3020.92		

609065 O - 62 - 28

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
13	3021.22		
26	3022.21	II	
7	3024.38		
13	3024.51		
8	3026.15		
5	3026.43		
8	3026.70		
10	3027.66	I	620–33640
13	3028.19		
9	3029.13		
5	3029.42		
5	3030.83		
26	3031.99	II	
20	3033.19	II	1749–34708
9	3035.51		
5	3035.96		
8	3036.45		
5	3036.61		
8	3038.05		
8	3039.14		
10	3039.26		
4	3039.93		
5	3040.5		
5	3041.25		
4	3041.86		
4	3041.9		
4	3042.73		
8	3043.79		
20	3044.16		
4	3045.46		
8	3046.46	II	289–33104
8	3046.57		
8	3046.84		
10	3047.57		
12	3048.64	I	620–33412
4	3049.84		
24	3050.20		
10	3051.14		
10	3052.91		
5	3054.73		
10	3055.59	II	0–32717
8	3056.72		
26	3057.91		
5	3060.06		
19	3061.62		
26	3062.54		
4	3063.88	II	2295–34924
4	3064.18		
5	3066.87		
11	3068.65		
4	3072.34		
3.5	3072.45		
24	3072.78		
8	3073.50		
11	3075.04		
5	3075.45		
5	3077.33		
11	3079.95		
12	3080.74	II	1749–34199
7	3081.19		
11	3082.02		
8	3083.61		
5	3084.24	II	2295–34708
8 d	3086.73		
5	3087.11		
10	3088.99		
8	3090.36		
4	3090.55		
5	3091.25		
24	3093.01		
5	3094.83		
12	3095.04	II	1749–34049
8	3095.23	II	2295–34593
13	3095.75		
5	3096.88		
13	3098.01	II	915–33184
24	3102.39		
6	3102.61		
3.5	3102.90		
5	3103.77		
19	3104.16		
6	3105.10		
5	3105.65		
4	3110.52		
6	3110.83		
40	3111.62		
10	3112.25		
7 d	3114.54	I	0–32098
	3114.59		
6	3115.93		
6	3119.24		
22	3119.35	II	5260–37308
6	3120.87		
5	3121.09		
6	3121.33		
8	3124.43		
28	3124.90	II	
6	3126.17		
7	3126.70	II	2295–34268
8	3129.73		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
4		3130.73		
8		3131.99		
4		3133.42	II	2295–34199
4		3133.63		
6		3133.92		
6		3136.89		
5		3138.51		
5		3138.83		
22		3139.56	II	4706–36549
6		3141.95		
17		3144.96		
20		3145.56	II	5527–37308
8		3146.26		
6		3146.75		
11		3147.09		
6		3148.56		
28		3149.21		
4		3150.36		
6	h	3151.08	II	1749–33475
6		3152.31		
22		3153.12		
4		3155.26		
6		3155.41	II	1749–33432
11		3155.86		
8		3156.07		
6		3157.45		
8		3157.86		
6		3159.82		
8		3160.77		
4		3163.73		
4		3165.28		
9		3165.50		
9		3167.10		
6		3170.86		
6		3171.37	II	5260–36783
4		3173.71		
6		3175.36		
14		3176.21		
14		3177.33		
9		3179.04		
9		3179.83		
9		3180.20		
3.0		3182.55		
3.0		3182.83		
5		3185.14		
11		3185.71		
9		3188.34	II	1749–33104
6		3189.02		
3.0		3189.42		
6		3190.70		
3.0		3190.89		
3.0		3191.76		
9		3193.23		
5		3196.74		
10		3200.14		
14		3206.05		
6		3206.23	II	2295–33475
3.0		3211.77		
3.0		3213.09	II	8394–39508
3.0		3214.70		
9		3218.34		
6		3219.17		
10		3224.26		
10		3226.17		
30		3229.50		
28		3232.16	II	289–31219
6		3233.34		
3.0		3235.23		
3.0		3238.42		
3.0		3240.35		
9		3241.99	II	
18		3244.17		
6		3244.79	II	2295–33104
9		3246.11		
9		3246.39	II	289–31084
3.0		3247.49		
4		3248.07		
4		3249.14		
6		3250.28		
6		3253.80		
9		3254.84		
3.0		3257.26		
12		3261.72		
5		3263.12	I	0–30637
14		3265.81		
3.0		3269.78	II	289–30863
18		3270.12	II	289–30860
3.0		3271.45		
3.0		3279.55		
6		3280.00		
6		3282.54		
8		3283.10		
12		3285.22		
9		3287.45		
18		3288.21		
30		3291.34		
3.0		3293.59		
5		3294.44		
4		3297.89		
11		3299.06		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	3299.70		
12	3303.60	II	289–30550
44	3305.93	II	0–30240
3.0	3307.55		
3.0	3310.50		
12	3311.72	II	5260–35447
12	3313.94		
3.0	3318.85	II	
6	3319.21	II	
6	3319.32		
9	3322.12	II	
3.0	3322.46		
6	3325.66	II	0–30061
6	3327.50		
12	3329.92		
3.0	3332.42	II	5791–35790
6	3336.68		
16	3337.79	II	289–30240
6	3338.48	II	915–30860
18	3341.66	II	2295–32211
12	3342.68		
6	3344.87		
4	3345.54		
6	3345.89	I	620–30499
11	3354.50		
3.0	3355.11	II	289–30086
11	3357.93	II	289–30061
6	3360.08		
6	3361.73		
6	3367.56		
5	3367.90		
9	3368.83		
3.0	3368.98	I	620–30294
5	3370.13	II	5260–34924
12	3371.29		
9	3372.01	II	289–29936
9	3375.78		
5	3376.55		
6	3377.39	II	
3.0	3378.20		
6	3380.70		
6	3381.95		
3.0	3382.68	II	915–30469
9	3384.45	II	289–29828
9	3386.13		
30	3390.39		
5	3390.97		
3.0	3392.99	II	4585–34049
12 d	3393.91		
14	3394.78	II	5260–34708
12	3395.32		
12 d	3395.58		
3.0	3397.20		
6	3398.26		
3.0	3399.00		
12	3401.01		
6	3401.21		
3.0	3401.87		
12	3403.55		
4	3405.75		
9	3406.28	II	915–30264
6 d	3407.91		
12	3411.53		
12	3412.10		
6	3412.36		
5	3413.81		
3.0	3414.36		
3.0	3416.12		
3.0	3418.39	I	620–29866
9	3421.69		
3.0	3422.35		
9	3423.05		
24	3424.56	II	1749–30942
6	3424.81		
7	3426.39		
2.0	3430.18		
3.0	3430.48		
6	3431.14	I	4276–33412
6	3431.54	II	5791–34924
3.0	3433.71	II	289–29404
6	3433.90	II	289–29402
11	3434.15	II	1749–30860
5	3434.61		
6	3435.20		
24	3435.49	I	620–29720
6	3436.78		
3.0	3437.93		
6	3440.98		
11	3442.95		
3.0	3447.32		
6	3448.78		
6	3451.21	II	1749–30716
15	3453.57		
6	3453.78		
13	3454.23		
10	3455.74		
13	3457.05	II	
13	3457.71		
10	3458.17		
3.0	3458.68		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
15	3459.92		
13	3462.21	I	0–28875
19	3463.54		
26	3466.30	I	3801–32642
6	3469.49		
5	3469.78	II	
16	3472.51		
6	3472.56	II	2295–31084
13	3473.43		
6	3474.54		
6	3474.99		
6	3476.44		
3.0	3477.50		
11	3477.84		
5	3479.16		
15	3480.36		
28	3482.54		
5	3486.30		
6	3488.82		
65	3489.37	I	0–28650
9	3489.57	II	5791–34439
12	3490.24		
5	3491.34		
16	3493.33		
14	3493.99	I	620–29233
13	3494.84		
3.0	3495.60	II	
3.0	3495.75		
22	3496.42	II	1749–30342
6	3497.26		
6	3497.62		
10	3499.33	II	2295–30863
26	3500.07	I	0–28563
3.0	3500.33		
3.0	3501.00		
10 d	3502.24		
13	3504.00		
6	3504.93		
13	3505.07		
6	3505.45		
10	3507.05	I	620–29126
32	3507.34	I	0–28504
13	3508.85	II	1749–30240
16	3509.67		
10	3511.44	I	0–28470
6	3511.58	II	289–28758
6	3513.37		
13	3513.68		
65	3514.61	I	0–28444
5	3515.24		
6	3516.3		
6	3516.85		
6	3517.05	II	6283–34708
16	3519.96		
8	3520.79		
5	3521.48		
6	3522.58		
6	3522.67		
3.0	3523.35		
10	3523.57		
10	3525.14		
10	3525.65		
3.0	3525.73		
10	3526.60		
10	3528.69		
3.0	3529.77		
16	3531.11	II	1749–30061
10	3531.64		
26	3533.57	II	915–29207
13	3534.33	I	0–28286
3.0	3535.84		
3.0	3537.06		
10	3537.28		
6	3537.44		
5	3538.23	I	620–28875
10	3539.65		
22	3540.46	II	
3.0	3541.89		
13	3542.57	I	4276–32496
10	3543.16	II	5260–33475
5	3543.73		
6	3544.21		
6	3544.99		
10	3545.44		
10	3545.67		
10	3546.13		
10	3546.68	II	1749–29936
16	3547.19	II	1749–29932
6	3548.62	II	5260–33432
13	3549.20	I	3801–31968
6	3550.17		
48	3550.82	II	0–28154
6	3551.04		
13	3552.17		
6	3552.67		
3.0	3552.92		
6	3553.44		
28	3555.32	I	0–28119
16	3557.84	I	0–28099
6	3560.31		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6		3560.44	II	1749–29828
13		3561.41		
48		3561.80		
16		3563.66	I	0–28053
5		3564.18		
10		3564.59		
6		3564.88		
6		3565.05	I	4276–32318
95		3566.60	I	620–28650
6		3568.82		
22		3569.06		
3.0		3570.65		
3.0		3570.93	II	4421–32417
6		3571.18		
5		3571.56		
6		3571.69	II	
8		3574.11		
13		3574.76	I	0–27966
10		3576.22		
6		3577.08		
15		3577.92	I	0–27941
10		3578.33	II	
26		3578.72		
8		3580.25	I	620–28543
15		3581.84		
12		3582.02		
8		3582.62		
130		3584.88	I	0–27887
10		3585.84		
5	d	3587.78	I	4453–32318
		3587.84		
10		3589.66	I	620–28470
10		3589.79	II	5667–33516
12		3590.32	II	5260–33104
13		3590.50	II	915–28758
6		3591.56		
16		3591.74	I	620–28454
5		3592.97	I	620–28444
10		3593.20	I	4276–32098
19		3593.52		
5		3593.68		
12		3594.95		
6	d	3596.76		
		3596.88		
6		3599.84		
6		3600.29		
3.0		3601.19		
6		3602.48	I	3801–31552
6		3603.36	I	0–27744
5		3603.74	I	4276–32017
19		3605.28		
5		3605.48	II	1749–29477
15		3606.32	II	
6		3608.96		
10		3609.68		
6		3610.49		
6		3610.69		
3.0		3611.24		
3.0		3611.40	I	0–27682
8		3612.67	II	915–28587
6		3615.54		
13		3616.33	I	3801–31445
13		3616.76	II	
3.0		3616.89		
3.0		3617.49		
3.0		3617.62		
6		3618.49		
3.0		3619.13	II	289–27912
13		3920.08	I	0–27616
3.0		3622.04		
13		3622.70		
16		3623.06	II	915–28508
5		3625.98		
3.0		3628.38		
19		3630.73		
3.0		3632.95		
8		3633.29		
5		3634.56		
6		3635.30	I	3801–31301
6		3635.40	II	0–27499
7		3637.51		
48		3638.20	I	3801–31279
7		3638.65		
18		3640.76		
14		3640.95	II	1749–29207
9		3642.44		
24		3644.24	I	620–28053
3.0		3644.85		
18		3645.03		
10	d	3649.41		
		3649.58		
38		3651.53		
28		3652.07		
8		3653.21	I	3801–31166
8		3654.89	I	3868–31221
7		3657.32		
10		3659.01		
55		3659.16	I	620–27941
10		3659.59		
9		3662.33		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
10 d	3666.10		
	3666.21		
6	3667.13		
6	3667.98		
7	3669.15		
160	3670.07	II	915–28154
14	3670.53		
11	3672.58		
10	3673.06		
11	3673.39		
11 d	3674.13		
11 d	3674.99		
	3675.08	II	
15	3676.56	II	6283–33475
15	3677.39	I	3801–30986
11	3677.67		
22	3678.75		
14	3679.38	I	620–27791
16	3679.81		
14	3680.88		
13	3682.04		
8	3682.46	II	6283–33432
13	3683.59		
13	3684.62		
11	3685.78	I	620–27744
40	3691.92		
24	3693.70		
14	3697.13		
16	3697.93		
40	3700.58	II	915–27930
80	3701.52	II	5527–32535
17	3702.62	I	4276–31276
17	3703.27	I	620–27616
17	3704.10		
13	3705.04		
8	3705.98		
17 d	3707.29		
	3707.39		
8	3707.65		
8	3707.95	I	7104–34065
8	3709.88		
26 d	3713.56	I	0–26921
	3713.65		
17	3714.76	II	2295–29207
17	3715.47		
8	3716.14		
22	3717.42		
26	3718.11		
12	3718.61		
8	3719.29	I	620–27499
17 h	3720.39		
17	3722.68		
8	3724.23		
26 d	3724.99	II	1749–28587
	3725.07		
9	3725.65		
26	3729.82		
9	3730.13		
7	3731.45	I	0–26792
17 d	3731.58		
	3731.77		
17	3732.26	I	3801–30587
26	3732.62		
26	3733.07		
17	3733.58		
17	3737.25		
44	3738.05	II	5791–32535
14	3742.35		
22	3744.24		
50	3746.41	II	5527–32211
26	3747.12		
70	3748.68	II	
44	3751.18	I	3801–30451
18	3751.72		
26	3752.66		
14	3754.31		
26	3755.48		
18	3756.66		
18	3756.92		
36	3758.36	I	4276–30876
26	3759.23		
9	3759.88		
18	3760.88		
12	3761.96		
12	3762.11		
24	3763.27	I	7006–33571
36	3764.57		
20	3765.35	I	0–26550
32	3766.89	I	4453–30993
18	3768.80		
24	3769.54		
14	3772.82		
40	3773.44	I	3801–30294
18	3775.99	II	915–27390
22	3776.48		
9	3779.05		
28	3780.72	II	915–27357
9	3781.75	I	3868–30304
140	3782.84	II	289–26717
32	3783.84	II	5791–32211

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	3786.57		
18	3786.84		
14	3787.23		
14	3788.16		
9	3790.22		
9	3790.33		
9	3792.41	II	
42	3793.10	II	4585–30942
28	3793.28		
28	3793.57		
16	3795.13		
18	3796.20		
18	3796.54		
18	3796.84		
14	3797.77		
18	3798.84		
18	3799.20	II	8394–34708
18	3799.55		
18	3801.15	I	620–26921
18	3802.27		
9	3803.35		
28	3808.93	I	6249–32496
28	3809.22	II	
7	3810.10		
140	3812.00	I	0–26226
9	3812.58		
28	3813.79	II	2295–28508
28	3814.07	II	915–27126
9	3816.61		
9	3817.16		
12	3818.06		
9	3818.48	II	1749–27930
9	3818.76	II	
9	3819.25	I	4276–30451
9	3821.22		
18	3821.95	I	3801–29958
9	3822.35		
9	3822.56		
55	3826.51	II	289–26415
18	3829.03		
14	3829.39		
9	3829.79	I	0–26104
150	3831.46	II	
18	3831.86		
15	3833.02		
18	3835.14		
9	3835.22		
15	h 3835.92		
9	3837.27		
15	3838.15		
90	3839.62	I	3801–29838
9	3842.99		
9	3844.00		
9	3844.23		
9	h 3845.12		
28	3845.32		
9	3846.24		
18	3846.55	I	3801–29791
15	3847.84		
36	d 3848.62	II	4585–30562
	3848.72		
9	3849.71		
15	3849.85	II	0–25968
9	3851.72	I	5991–31946
46	3854.22	I	0–25938
180	3854.66	II	
360	3859.58	II	289–26191
36	3861.16		
9	3863.09		
18	3864.30		
18	3864.48		
140	3865.92	II	2295–28154
28	3866.80		
18	3867.17	I	3868–29720
9	3868.42	II	4421–30264
18	3870.05		
110	3871.04	I	0–25826
7	3871.88		
46	3874.04		
18	3876.13	I	0–25792
9	3876.59		
46	3878.09		
18	3879.53	I	4453–30222
18	3879.71		
75	3881.46	II	4585–30342
36	3882.36	II	1749–27499
18	3883.10		
28	3883.33		
18	3884.68		
13	3887.45		
13	3887.70		
160	3890.36	II	289–25986
9	3891.68		
18	3891.82		
18	3892.41		
46	3892.68	II	5260–30942
36	3894.12	I	0–25672
15	3895.27	II	4421–30086
36	3896.78	II	8394–34049
18	3897.06		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
14	3897.26		
9	3897.71		
14	3899.10	II	4421–30061
18	3899.27		
18	3899.42		
46	3899.78	II	2295–27930
30	3902.49	II	2295–27912
34	3904.30	II	
18	3904.56	II	5260–30863
9	3904.85		
28	3906.46		
9	3908.33		
9	3908.47		
9	3909.06		
18	3910.89		
24	3911.67		
14	3914.20		
14	3914.27		
28	3915.88	II	
9	3916.53		
18	3917.25	I	8119–33640
9	3917.82		
6	3918.06	II	4421–29936
14	3921.55		
9	3923.05		
14	3924.27	II	4585–30061
24	3926.22	I	0–25463
24	3926.73	I	5762–31221
18	3927.76		
9	3928.83		
12	3930.43		
32	3930.98		
15	3932.03	II	289–25714
9	3933.03	II	0–25419
36	3935.38		
24	3940.49		
14	3942.55	II	0–25357
18	3942.83		
90	3943.82	I	0–25349
18	3944.13	II	4585–29932
22	3948.45	I	0–25319
7	3951.48		
7	3951.55	II	
22	3953.58	II	4421–29707
40	3954.66	II	
18	3955.38		
9	3959.20		
14	3962.79	II	4706–29934
26	3964.22	I	6249–31469
18	3964.67		
12	3964.96		
18	3966.40	II	2295–27499
44	3966.57	II	
9	3967.48		
9	3969.02		
9 h	3974.98		
14	3978.80		
9 h	3980.80	I	5762–30876
17	3983.91	II	
7	3984.18		
85	3985.80	II	5260–30342
6	3988.64		
14	3988.89	II	2295–27357
34	3990.42	II	915–25968
28	3992.54	II	
9	3994.29		
17	3994.98		
14	3995.97	II	
9	3997.09	I	7008–32017
26	3998.24		
9	3999.18	I	3801–28799
9 d	4001.25		
9	4002.34		
9	4003.20		
26	4004.06	II	1749–26717
32	4005.21	I	4453–29414
14	4005.70		
9	4009.17	II	6283–31219
8	4011.45		
6	4014.16		
42	4017.72	II	
22	4018.99	II	289–25164
6	4026.02	II	2295–27126
12	4031.31		
12	4033.43	II	4421–29207
14	4033.73		
16	4034.50	I	4453–29233
16	4039.78		
75	4042.76	I	620–25349
38	4044.42		
30	4047.62	I	620–25319
120	4050.04	II	0–24684
40	4051.91	II	5260–29932
13	4053.03	II	1749–26415
22	4054.31	II	6283–30942
32	4058.16		
6	4060.10		
6	4061.35		
8	4061.74		
65	4062.55	II	0–24608

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	4064.16		
8	4066.80		
38	4067.76	II	6283–30860
30	4071.11		
22	4074.49	II	
24	4076.72		
16	4077.79		
24	4080.61		
14 h	4084.93	II	5791–30264
20	4088.25	II	0–24453
160	4090.14	II	1749–26191
16	4091.52		
8	4091.64	I	0–24433
6	4094.62		
6	4094.89		
16	4095.75		
16	4096.35		
34	4098.03	II	289–24684
15	4101.91	I	8119–32491
14	4103.12		
28	4106.28		
15	4106.93	II	0–24342
5	4108.36	I	0–24334
8	4113.11	II	0–24306
60	4116.10	II	0–24288
4	4116.89		
30	4124.73	II	1749–25986
30	4128.34		
10	4132.02		
10	4133.20		
15	4133.50	I	0–24186
7	4135.76	II	4585–28758
10	4136.81	II	4421–28587
7	4138.66		
14	4139.14	II	0–24153
34	4141.23	II	8394–32535
5	4141.86	I	620–24757
11	4144.70	II	2295–26415
4	4145.39	II	6445–30562
4	4146.61		
65	4153.97	I	0–24067
20	4155.41	II	6283–30342
28	4156.66	I	620–24671
5	4160.95	I	0–24026
18	4162.43	I	3801–27818
26	4163.68	II	0–24010
5	4164.79		
20	4165.68	II	289–24288
5	4166.64		
12	4169.06	I	8119–32098
100	4171.59	II	1749–25714
10	4172.97	II	6283–30240
16	4174.19	II	5527–29477
10	4179.00	II	4585–28508
6 h	4184.89		
14	4186.96	I	4276–28153
14	4188.07	II	289–24160
22	4189.28	II	289–24153
4	4191.94	I	0–23849
13	4197.52	II	8394–32211
10	4198.22	I	620–24433
4	4200.10	II	6283–30086
7	4201.13		
13	4204.37	II	0–23778
6	4210.45		
18	4211.68	II	
10	4212.26	II	4421–28154
10	4213.88		
6	4214.28		
6	4214.42	II	289–24010
5	4219.98		
26	4222.36	I	3801–27478
5	4227.33	II	6283–29932
6	4228.76		
16	4231.67	I	7646–31270
5	4232.04	II	289–23912
12	4236.04		
4	4240.59	II	6283–29858
75	4241.67	II	4585–28154
38	4244.37	II	0–23554
19	4246.26	I	0–23544
12	4252.43		
4	4266.32	I	0–23433
10	4267.30	II	915–24342
4	4267.94		
6	4268.85		
12	4269.61	II	1749–25164
6	4273.98	II	915–24306
6	4276.47		
15	4282.03	II	289–23636
12	4282.45	II	4585–27930
15	4287.87	II	0–23315
15	4288.84	I	6249–29559
11	4297.11	II	289–23554
9	4301.47	II	0–23241
4	4306.78		
4	4310.39	II	6283–29477
11	4313.13	I	3801–26979
9	4313.88		
3	4319.78		

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		4325.90		
9		4335.73	I	0–23058
50		4341.69	II	289–23315
11		4347.19	II	915–23912
10		4354.55		
32	h	4355.75	I	620–23572
32		4362.05	I	0–22919
14		4362.26	II	0–22917
5		4362.93	II	4585–27499
7		4371.76	I	8119–30986
12		4372.57	II	915–23778
5		4372.76	I	0–22862
8		4373.41	II	1749–24608
4		4383.27	I	3801–26608
24		4393.60	I	0–22754
5	d	4402.30		
		4402.44		
10		4415.24	II	0–22642
5		4426.68	II	4706–27290
5		4426.94	I	0–22583
8		4427.65	II	289–22868
5		4433.89	II	8394–30942
8		4434.53	II	
3.0		4440.74	I	3801–26313
11		4462.97	II	915–23315
5		4465.13	II	2295–24684
4		4469.32	I	0–22368
44		4472.34	II	289–22642
5		4477.71	II	915–23241
8		4490.84	II	1749–24010
5		4510.32	II	0–22165
18		4515.28	II	289–22430
5		4516.73	I	620–22754
14		4538.19	II	1749–23778
46		4543.63	II	915–22917
11		4545.58	II	2295–24288
3.5		4551.98	I	620–22583
3.0		4553.86	II	915–22868
6		4555.10	II	8394–30342
4		4563.96		
7		4567.69	II	1749–23636
10		4569.91	II	289–22165
3.0		4570.99	II	6283–28154
12		4573.69	II	2295–24153
4		4576.64	I	620–22464
4		4584.85	II	1749–23554
4		4601.13	II	915–22642
10		4603.66	II	2295–24010
4		4605.15	II	5791–27499
3.0		4609.86		
3.0		4611.44		
22		4620.23	I	6249–27887
3.0		4622.43	II	5260–26887
19		4627.08	II	4585–26191
17		4631.62	I	0–21585
5		4641.66	II	8394–29931
18		4646.60	II	915–22430
4		4663.75	I	620–22056
11		4666.86	II	289–21711
8		4671.41	II	4585–25986
14		4689.07	II	0–21320
3.5		4700.98		
4		4702.05	II	4706–25968
8		4702.52	II	2295–23554
3.5		4715.68	I	4453–25653
13		4722.73	II	1749–22917
10		4731.60	II	4585–25714
3.0		4743.53	I	6249–27324
8		4755.73	II	0–21021
12		4756.80	I	620–21637
3.0		4768.66	I	620–21585
6		4769.26	II	0–20962
8		4772.70	II	2295–23241
3.0		4778.10		
4		4779.63	II	6445–27361
3.0		4780.19	II	
3.0		4785.91		
3.5		4790.06	I	3801–24671
3.0		4810.90	I	3801–24581
4		4819.54	II	4421–25164
4		4842.48	I	620–21265
6		4847.66	II	2295–22917
7		4858.08	II	4585–25164
6		4859.68	II	0–20572
8		4861.02	II	5402–25968
3.0		4868.86	I	3801–24334
3.5		4883.78		
3.5		4885.15	I	0–20464
2.5		4886.33	II	5527–25986
8		4899.29	II	915–21320
4		4910.35	I	6249–26608
6		4913.16	II	2295–22642
3.5		4924.64	II	5667–25968
3.5		4928.44	I	4276–24560
2.0		4933.06	I	3801–24067
2.5		4933.66	II	4421–24684
2.5		4950.17	II	5791–25986
3.5		4955.78	I	7646–27818
3.5		4967.33	I	3801–23927
3.5		4972.10	II	915–21021

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	4986.90	II	915–20962
10	5008.22	II	1749–21711
2.0	5011.42	I	620–20569
15	5027.38	I	0–19885
2.0	5047.42	II	2295–22101
3.0	5063.77	I	3801–23544
2.0	5077.82		
3.0	5085.86	II	915–20572
1.8	5088.29	I	0–19648
6	5117.25		
1.6	5137.05		
2.0	5145.10	II	6283–25714
2.5	5154.04		
7	5160.33	II	5791–25164
5	5164.14	I	8119–27478
5	5184.59	II	5402–24684
4	5204.32		
2.0	5225.12	II	4421–23554
1.6	5238.61		
1.6	5247.35	II	5402–24453
4	5247.75	II	4585–23636
4	5257.04	II	5667–24684
1.4	5272.00	I	7646–26608
2.0	5278.18	II	5402–24342
6	5280.38	I	0–18933
1.6	5288.40	II	5402–24306
3.5	5308.54	I	3801–22633
1.8	5310.04		
3.5	5311.88	II	4421–23241
1.4	5312.73	II	5791–24608
1.6	5315.27	I	7646–26454
1.8	5319.38		
1.4	5321.60	II	5667–24453
3.0	5327.71		
3.5	5329.26	I	0–18759
1.8	5349.92		
1.6	5362.40		
1.6	5363.82	II	5667–24306
2.5	5368.43		
1.0	5373.45		
1.0	5382.94	I	620–19192
1.0	5385.54	I	7646–26209
5	5386.21	II	
1.6	5389.80		
3.0	5400.95	II	5402–23912
2.0	5403.20		
2.0	5406.00	II	8394–26887
1.2	5410.24	I	4276–22754
1.0	5423.35		
3.0	5444.48	II	5791–24153
1.6	5449.86		
	5449.93		
1.6	5459.27	I	620–18933
3.0	5465.69		
7	5475.72		
6	5480.28	II	
6	5481.22	II	6445–24684
4	5482.55	II	
1.0	5484.52		
3.0	5487.02	II	5791–24010
2.5	5488.91		
3.0	5491.24		
14	5492.97	II	0–18200
2.5	5494.67		
3.0	5496.43	I	4276–22464
1.4	5500.69	I	11545–29720
1.4	5501.49		
3.5	5504.15	II	6445–24608
3.0	5510.44		
4	5511.49	I	620–18759
1.4	5513.39		
6	5527.85	II	
1.4	5531.26	I	8119–26192
1.4	5535.80		
2.0	5538.53		
2.5	5544.82		
1.4	5548.06		
2.5	5551.44	II	6445–24453
1.6	5552.62	II	6283–24288
1.4 h	5555.77		
2.0	5557.90	II	5791–23778
6	5564.17	I	3801–21768
3.5	5570.68		
1.2	5573.07	I	10347–28286
1.0	5573.59	I	6249–24186
1.8	5580.82	II	5402–23315
2.5	5581.23		
4	5581.61	II	289–18200
1.0	5587.19		
2.5	5597.38	II	6445–24306
2.0	5602.91	II	6445–24288
1.2	5603.99		
1.2	5608.86		
5	5610.89	I	6249–24067
1.2	5616.58	I	8119–25918
5	5620.78	I	620–18406
2.5	5621.51	I	3801–21585
1.2	5628.02	II	5791–23554
1.2	5629.46		
1.2	5632.47		

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.5	5634.38	I	7646–25389
0.8	5636.80		
1.2 h	5638.00		
1.2	5640.33		
0.8	5644.25		
0.8	5648.38		
2.0	5653.79		
2.0	5654.41	II	4421–22101
1.6	5658.26	I	5762–23430
1.2 h	5664.86		
2.5	5669.42	I	620–18254
0.8	5674.88		
1.2	5680.37	I	6249–23849
1.6	5683.33		
1.2	5685.19	I	4453–22038
3.5	5691.39	II	6445–24010
2.0	5704.07		
1.0	5705.66		
1.8	5706.99		
1.0	5709.49		
1.8	5716.87	I	4453–21941
1.0	5722.23		
3.5	5723.63	II	6445–23912
2.0	5733.26		
2.0	5736.38	I	7006–24433
2.0	5737.27	I	5762–23187
1.8	5748.13		
1.0	5748.47		
1.8	5750.54		
2.0	5758.14	I	0–17362
1.0	5758.35	I	4276–21637
0.8	5761.88		
1.0 h	5763.63	I	7326–24671
1.0 h	5765.41		
1.0	5767.43	I	5991–23325
1.0	5771.05	I	6249–23572
1.0	5776.90		
1.0	5777.81		
6	5780.59	I	6249–23544
2.0	5788.59	II	6283–23554
2.0	5791.77		
1.0	5796.54		
6	5798.55		
3.5	5802.11	I	8119–25349
1.0	5805.20		
1.8	5811.29		
1.0	5813.83	I	5991–23187
0.8	5814.41	I	3868–21062
1.0	5816.79		
0.8	5819.01	I	7006–24186
1.6	5828.02		
1.6	5832.39		
4	5836.08	I	10347–27478
5	5837.71	II	4585–21711
1.0	5839.05		
1.6	5841.84		
2.0	5843.29	II	6445–23554
1.0	5843.92		
3.0	5845.27		
1.0	5852.03		
2.5	5853.93		
1.0	5859.19		
0.6	5863.43		
3.0	5870.95	II	5402–22430
1.0	5886.95		
2.0	5895.33		
1.8	5898.78	I	6249–23197
2.0	5902.50		
20	5915.40	I	0–16900
2.0 h	5925.47	I	7646–24517
1.8	5929.33	I	3801–20662
1.4	5932.44	II	5791–22642
1.4	5933.85	I	620–17468
0.9	5934.46		
0.9	5942.77	I	5762–22584
1.2	5948.57	I	7646–24452
1.8	5952.05	II	6445–23241
1.8	5956.86	I	5991–22774
5	5971.50	I	620–17362
9	5976.32	I	3801–20529
2.5	5986.10	I	3868–20569
4	5997.31	I	6249–22919
1.4	5997.96	I	4276–20943
2.0	5999.41	I	3801–20464
1.8	6000.20		
1.8	6004.83		
1.8	6008.87		
1.8	6010.86	I	10347–26979
1.8	6014.07		
0.9	6016.73	I	5762–22378
2.5	6017.39	II	4706–21320
1.8	6017.57	I	6249–22862
1.4	6019.19	I	4453–21062
2.0	6028.13		
0.6	6035.54		
1.8	6039.60	I	8119–24671
0.8	6050.48	I	3868–20392
0.8	6050.67	I	7326–23849
5	6051.74		
1.4	6056.80	I	0–16506

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.4	6057.07	I	6249–22754
1.6	6059.73	II	5667–22165
1.6	6062.30	I	4276–20766
4	6067.23		
8	6077.29	I	620–17070
2.5	6087.34	II	6445–22868
1.4	6089.19	I	3801–20219
1.6	6101.77	I	6249–22633
0.8	6110.91		
1.4	6127.77	I	8119–24433
2.5	6129.72	I	620–16930
1.8	6132.61		
0.8	6138.54		
0.8	6152.25	I	10347–26597
0.7	6164.50	I	7326–23544
1.4	6164.77		
3.5	6171.85	I	7646–23844
3.0	6175.38	I	4276–20464
0.7	6181.37	II	
1.4	6215.37	I	3801–19885
1.4	6234.30	I	4276–20312
1.4	6246.53	I	5762–21766
1.4	6254.22	II	6445–22430
1.2	6268.66	I	8119–24067
1.0	6279.64	II	5791–21711
2.5	6280.20	II	5402–21320
0.6	6291.48		
1.2	6292.03		
1.8	6293.32	I	620–16506
1.6	6298.53	I	3868–19741
1.2	6322.37		
0.8	6330.77		
0.6	6336.55		
0.6	6346.27		
2.5	6359.28	I	0–15721
5	6372.47	I	3801–19489
0.5	6373.01		
1.0	6374.78		
0.5	6375.98		
2.5	6378.56		
2.0	6379.64		
0.7	6383.59	I	4453–20114
1.0	6386.8		
2.0	6389.80	I	5991–21637
0.5	6391.32		
2.5	6392.78	I	0–15638
8	6395.45	I	0–15632
1.6	6397.18	I	7006–22633
0.7	6400.36	II	5402–21021
0.8	6411.59	I	7326–22919
1.0	6424.89	II	5402–20962
0.7	6430.93		
0.4	6448.04		
10	6449.17	I	620–16122
3.0	6465.00	I	7326–22790
0.4	6470.55		
0.4	6481.72		
0.4	6485.38		
0.8	6488.35		
0.4	6495.35		
1.4	6503.62	I	4276–19648
0.4	6506.32		
1.4	6518.94	I	6249–21585
0.4	6520.98		
0.6	6526.08		
0.4	6527.04	I	5762–21079
0.4	6534.60		
1.0	6535.46		
0.6	6536.58	II	5667–20962
0.8	6542.97	I	7104–22383
0.6	6549.88		
0.3	6552.75	I	7326–22583
1.2	6555.01		
0.6	6557.58		
0.3	6582.78		
0.6	6587.83		
0.9	6590.05	II	5402–20572
0.4	6601.46	I	7646–22790
0.2	6602.68		
0.5	6603.34		
0.9	6603.98	I	7326–22464
2.5	6620.52	I	620–15721
2.5	6621.77		
1.0	6622.82		
1.0	6625.29	I	5762–20852
0.6	6628.65		
0.8	6647.79		
0.8	6656.81	I	620–15638
0.4	6671.29		
1.4	6676.92		
0.4	6681.15		
1.8	6683.38	I	3801–18759
0.4	6691.21	I	10686–25627
0.4	6700.83		
0.6	6701.68		
0.8	6707.59		
0.8	6710.57		
1.2	6717.51		
0.8	6720.84	II	6445–21320
0.8	6726.89		

Uranium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.4		6727.96	I	5762–20621
1.4		6736.80		
0.4		6742.47		
0.6		6754.93	I	8119–22919
0.4		6768.64		
0.6		6771.03		
0.8		6776.89		
0.4		6780.62		
0.4		6782.70		
0.4		6782.85	I	4453–19192
2.0		6790.30	I	7646–22368
0.4		6796.46		
0.4	d	6808.76		
0.2		6812.98	I	4453–19127
0.4	d	6813.75		
		6813.81		
1.0		6818.29	I	3868–18531
3.5		6820.76	I	4276–18933
1.2		6824.56		
14		6826.93	I	0–14644
0.6		6832.71	I	7006–21637
1.0		6846.25	I	6249–20852
2.5	h	6869.07		
5		6876.75		
1.2		6887.74	I	8119–22633
1.0		6902.55	I	4276–18759
1.2		6915.31	I	5762–20219
2.5		6917.05	I	3801–18254
2.5		6948.58	II	
1.2		6987.72		
1.2		7015.72	I	8119–22368
3.0		7020.71		
1.2		7030.69		
2.5		7033.84	I	10347–24560
1.2		7073.61		
5		7074.81	I	4276–18406
2.5		7082.11		
6		7101.63	I	4453–18531
7		7128.91	I	620–14644
1.0	h	7130.09	I	5762–19783
3.5		7147.89	I	10347–24334
2.0		7164.87	I	4453–18406
1.0		7172.10	I	7326–21265
2.0		7183.47		
2.0		7194.63		
1.0		7196.66		
1.0		7205.45	I	10686–24560
1.6		7210.29	I	6249–20114
1.6		7218.04		
3.5		7254.47		
1.0		7371.95	I	5991–19552
3.0		7379.70	II	
1.0		7390.99		
1.0		7392.11		
3.0		7396.99	I	4453–17969
1.0		7416.57		
5		7425.50	I	0–13463
2.5		7454.03		
1.0		7510.08		
1.0		7517.41		
2.0		7528.70		
10		7533.91	I	3801–17070
2.5		7550.23		
1.6		7580.91		
0.7		7587.55		
1.0		7590.54	I	5762–18933
1.0		7595.07	I	10686–23849
0.8		7600.27		
2.0		7609.16	I	7326–20464
3.5		7619.35	I	7646–20766
1.6		7621.95		
2.5		7631.71	I	3801–16900
1.6		7634.73	I	7326–20420
3.0		7639.54	I	4276–17362
0.8		7653.61		
0.8		7668.73		
0.8		7669.69		
1.6		7748.19	I	11545–24448
1.6		7754.19	I	7326–20219
1.6		7759.87	I	7646–20529
2.5		7761.86	I	7006–19885
3.0		7784.13	I	620–13463
1.6	h	7802.40		
1.6		7816.32	I	13128–25918
0.7		7832.05		
0.5		7835.71		
2.0		7837.71		
2.0		7844.71		
3.0		7868.75	I	3801–16506
3.0		7875.38		
11		7881.94	I	6249–18933
2.0		7900.43	I	4276–16930
1.4		7904.29	I	8119–20766
1.4	h	7908.00	I	7006–19648
2.0		7918.80	I	4276–16900
1.4		7959.96	I	7326–19885
3.0		7963.97		
4		7970.46	I	8119–20662
0.7		7974.66		
2.0		7975.09	I	5991–18527

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.7	7975.47		
2.0	7976.88	II	
1.4	7991.30	I	6249–18759
2.0	7998.60	I	13128–25627
0.7	8012.96	I	4453–16930
1.2	8019.38	I	7006–19472
2.0	8034.79	I	10347–22790
0.7	8040.10		
1.4	8055.60	I	8119–20529
2.0	8065.47		
0.7	8065.84		
2.0	8074.03		
2.0	8097.62		
1.2	8126.23		
1.4	8137.21	I	10347–22633
1.4	8153.71	I	13128–25389
3.5	8174.30	I	4276–16506
1.4	8175.85	I	0–12228
2.0	8188.20		
1.4	8210.27		
1.4	8230.83	I	5762–17908
0.7	8240.51	I	5762–17894
4	8262.05	I	8119–20219
0.8	8307.56		
1.6	8310.61		
3.5	8318.34		
1.4	8329.73		
3.5	8337.46		
2.5	8346.74	I	5991–17969
1.4	8357.07		
4	8381.86	I	7006–18933
1.6	8387.16		
2.5	8389.17	I	5991–17908
1.6	8396.76		
0.8	8402.58		
3.5	8441.20	I	7646–19489
8	8445.35	I	3801–15638
4	8450.03	I	3801–15632
1.6	8496.09	I	8119–19885
1.6	8504.70	II	6445–18200
2.5	8540.20	I	5762–17468
0.8	8542.32		
1.6	8557.34	I	10686–22368
1.6	8567.73	I	4453–16122
3.5	8570.51	I	8119–19783
1.6	8574.61	I	6249–17908
17	8607.94	I	0–11614
0.8	8618.96		
2.0	8641.12		
1.6	8659.52		
5	8691.28		
1.0	8702.08		
4	8710.77	I	5991–17468
4	8753.69	I	10347–21768
7	8757.75		
1.8	8787.37		
2.0	8816.56		

VANADIUM

V, $Z=23$, $M=50.95$, Ratio $\frac{V}{Cu}=0.802$

V I Normal state of valence electrons $3d^3\,4s^2\,{}^4F_{1\frac{1}{2}}=0$. I.P.= 54361 K
V II Normal state of valence electrons $3d^4\quad {}^5D_0=0$. I.P.=118200 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).
Supplemented above 6700 A by the following:
W. F. Meggers and C. C. Kiess, Sci. Papers BS **16,** 51 (1920).
W. F. Meggers and H. N. Russell, J. Research NBS **17,** 125 (1936).

Classification:
V I, W. F. Meggers and H. N. Russell, J. Research, NBS **17,** 125 (1936).
C. E. Moore, Phys. Rev. **55,** 710 (1939).
V II, W. F. Meggers and C. E. Moore, J. Research NBS **25,** 83 (1940).

Intensities:
R. Frerichs, Ann. Physik **81,** 807 (1926).
R. B. King, Astrophys. J. **105,** 376 (1947).
G. Righini, Mem. Soc. Astron. Ital. **20,** 303 (1949).
G. Righini, Osservazioni e Memorie dell Osservatorio Astrofisico di Arcetri **66,** 1 (1950).
Y. I. Ostrovskii and N. P. Penkin, Optika i Spektroscopiya **5,** 345 (1958).

Relative intensity of vanadium lines observed in an arc of copper containing 0.1 atomic percent vanadium

Strong lines of vanadium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
950	4379. 24	I	2425–25254	$3d^4\,4s^1\,a\,{}^6D_{4\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{5\frac{1}{2}}$
700	3183. 98	I	323–31722	$3d^3\,4s^2\,a\,{}^4F_{3\frac{1}{2}}$—$3d^3\,4s^1\,4p^1\,x\,{}^4G^\circ_{4\frac{1}{2}}$
		I	0–31398	$3d^3\,4s^2\,a\,{}^4F_{1\frac{1}{2}}$—$3d^3\,4s^1\,4p^1\,x\,{}^4G^\circ_{2\frac{1}{2}}$
700	4111. 78	I	2425–26738	$3d^4\,4s^1\,a\,{}^6D_{4\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6D^\circ_{4\frac{1}{2}}$
550	4384. 72	I	2311–25112	$3d^4\,4s^1\,a\,{}^6D_{3\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{4\frac{1}{2}}$
500	3093. 11	II	3163–35483	$3d^3\,4s^1\,a\,{}^5F_5$ —$3d^3\,4p^1\quad z\,{}^5G^\circ_6$
500	3185. 40	I	553–31937	$3d^3\,4s^2\,a\,{}^4F_{4\frac{1}{2}}$—$3d^3\,4s^1\,4p^1\,x\,{}^4G^\circ_{5\frac{1}{2}}$
420	3183. 41	I	137–31541	$3d^3\,4s^2\,a\,{}^4F_{2\frac{1}{2}}$—$3d^3\,4s^1\,4p^1\,x\,{}^4G^\circ_{3\frac{1}{2}}$
400	3102. 30	II	2968–35193	$3d^3\,4s^1\,a\,{}^5F_4$ —$3d^3\,4p^1\quad z\,{}^5G^\circ_5$
400	3703. 58	I	2425–29418	$3d^4\,4s^1\,a\,{}^6D_{4\frac{1}{2}}$—$3d^3\,4s^1\,4p^1\,y\,{}^6P^\circ_{3\frac{1}{2}}$
380	4389. 97	I	2220–24993	$3d^4\,4s^1\,a\,{}^6D_{2\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{3\frac{1}{2}}$
360	4408. 51	I	2153–24830	$3d^4\,4s^1\,a\,{}^6D_{1\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{1\frac{1}{2}}$
		I	2112–24789	$3d^4\,4s^1\,a\,{}^6D_{0\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{0\frac{1}{2}}$
340	3110. 71	II	2809–34947	$3d^3\,4s^1\,a\,{}^5F_3$ —$3d^3\,4p^1\quad z\,{}^5G^\circ_4$
340	4115. 18	I	2311–26605	$3d^4\,4s^1\,a\,{}^6D_{3\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6D^\circ_{3\frac{1}{2}}$
320	2908. 82	II	3163–37531	$3d^3\,4s^1\,a\,{}^5F_5$ —$3d^3\,4p^1\quad z\,{}^5D^\circ_4$
320	2924. 02	II	3163–37352	$3d^3\,4s^1\,a\,{}^5F_5$ —$3d^3\,4p^1\quad z\,{}^5F^\circ_5$
320	3066. 38	I	553–33155	$3d^3\,4s^2\,a\,{}^4F_{4\frac{1}{2}}$—$3d^3\,4s^1\,4p^1\,w\,{}^4F^\circ_{4\frac{1}{2}}$
320	3855. 84	I	553–26480	$3d^3\,4s^2\,a\,{}^4F_{4\frac{1}{2}}$—$3d^4\quad 4p^1\,y\,{}^4D^\circ_{3\frac{1}{2}}$
280	3840. 75	I	323–26353	$3d^3\,4s^2\,a\,{}^4F_{3\frac{1}{2}}$—$3d^4\quad 4p^1\,y\,{}^4D^\circ_{2\frac{1}{2}}$
280	4395. 23	I	2153–24899	$3d^4\,4s^1\,a\,{}^6D_{1\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{2\frac{1}{2}}$
280	4408. 20	I	2220–24899	$3d^4\,4s^1\,a\,{}^6D_{2\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{2\frac{1}{2}}$
260	3118. 38	II	2687–34746	$3d^3\,4s^1\,a\,{}^5F_2$ —$3d^3\,4p^1\quad z\,{}^5G^\circ_3$
240	4128. 07	I	2220–26438	$3d^4\,4s^1\,a\,{}^6D_{2\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6D^\circ_{1\frac{1}{2}}$
240	4132. 02	I	2311–26506	$3d^4\,4s^1\,a\,{}^6D_{3\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6D^\circ_{2\frac{1}{2}}$
220	2924. 64	II	2968–37151	$3d^3\,4s^1\,a\,{}^5F_4$ —$3d^3\,4p^1\quad z\,{}^5F^\circ_4$
220	4099. 80	I	2220–26605	$3d^4\,4s^1\,a\,{}^6D_{2\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6D^\circ_{3\frac{1}{2}}$
220	4105. 17	I	2153–26506	$3d^4\,4s^1\,a\,{}^6D_{1\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6D^\circ_{3\frac{1}{2}}$
220	4407. 64	I	2311–24993	$3d^4\,4s^1\,a\,{}^6D_{3\frac{1}{2}}$—$3d^4\,4p^1\quad y\,{}^6F^\circ_{3\frac{1}{2}}$

609065 O - 62 - 29

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	2092.44	I	553–48329
2.5	2384.00	II	8842–50775
2.5	2384.28	I	0–41928
4	2386.96	I	10892–52774
4	2388.92	I	11101–52948
5	2390.87	I	137–41950
5	2391.26	I	2220–44026
6	2392.90	I	2425–44203
5	2397.78	I	553–42246
5	2398.27	I	553–42237
5	2399.96	I	0–41655
10	2406.75	I	323–41861
9	2407.90	I	137–41655
8	2412.69	I	323–41758
6	2413.03	I	0–41429
11	2415.33	I	0–41389
11	2416.75	I	553–41918
8	2417.35	I	137–41492
9	2420.12	I	553–41861
9	2421.06	I	137–41429
9	2421.98	I	323–41599
4	2423.38	I	137–41389
11	2428.28	I	323–41492
8	2432.02	I	323–41429
12	2435.52	I	553–41599
6	2439.10	I	553–41539
4	2441.89	I	553–41492
9	2479.05	II	13543–53869
6	2479.52	II	13609–53927
6	2482.31	II	11908–52181
18	2501.61	I	0–39962
8	2503.02	II	8640–48580
10	2503.30	I	0–39935
9	2506.22	II	8842–48731
20	2506.90	I	0–39878
32	2507.78	I	137–40001
24	2511.65	I	323–40126
24	2511.95	I	137–39935
10	2514.64	II	9098–48853
9	2515.15	I	137–39884
24	2517.14	I	323–40039
32	2519.62	I	323–40000
55	2526.22	I	553–40126
28	2527.90	II	12706–52253
16	2528.47	II	12545–52083
20	2528.84	II	12622–52154
32	2530.18	I	553–40064
4	2534.52	II	11296–50739
8	2545.98	I	0–39267
8	2548.69	II	11515–50739
14	2549.28	II	11908–51123
16	2552.65	I	137–39300
12	2552.96	II	13609–52767
5	2553.67	II	11515–50662
7	2554.86	I	137–39267
5	2558.90	I	323–39391
28	2562.13	I	323–39342
10 h	2564.23	I	15265–54251
15	2564.82	I	323–39300
5	2568.39	I	
30	2574.02	I	553–39391
6	2577.29	I	553–39342
12	2620.29	I	8716–46868
19	2630.67	II	14656–52658
5	2640.69	I	9825–47683
17	2642.21	II	14556–52392
6	2643.16	I	137–37960
6	2644.36	II	34746–72551
20	2645.26	I	323–38116
11	2645.84	II	14462–52246
12	2647.71	I	0–37757
19	2651.90	I	137–37835
6	2652.92	I	15265–52948
6	2653.83	I	15104–52774
7	2655.68	II	35193–72837
20	2656.22	I	323–37960
4	2658.98	II	14656–52253
4	2659.61	II	17911–55499
24	2661.42	I	553–38116
4	2665.96	I	0–37499
4	2671.67	I	137–37556
38	2672.00	II	107–37521
5	2673.23	II	
50	2677.80	II	36–37369
36	2678.57	II	209–37531
50	2679.32	II	209–37521
24	2682.87	II	107–37369
24	2683.09	II	0–37259
6	2685.14	I	9637–46868
9	2685.69	II	36–37259
6	2686.36	I	9637–46851
	2686.51	I	553–37765
140	2687.96	II	339–37531
22	2688.72	II	339–37521
20	2689.88	II	36–37201
30	2690.24	II	209–37369
32	2690.79	II	107–37259
16	2696.99	I	10893–47960
16	2697.74	I	11101–48158
6	2698.73	I	9825–46868

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	2699.11	I	9825–46863
90	2700.94	II	339–37352
50	2702.19	II	209–37205
6	2705.22	II	0–36955
70	2706.17	II	209–37151
20	2706.70	II	107–37041
14	2707.86	II	36–36955
22	2711.74	II	339–37205
8	2713.05	II	107–36955
16	2714.20	II	209–37041
85	2715.69	II	107–36919
20	2722.56	I	10893–47612
4	2723.22	II	209–36919
32	2728.64	II	36–36674
24	2731.35	I	11101–47702
5	2733.90	II	107–36674
13	2739.71	II	0–36489
12	2742.41	II	36–36489
4	2742.67	II	3163–39613
8	2747.48	II	19113–55499
19	2753.40	II	19192–55499
8	2760.12	II	13512–49731
12	2760.70	II	19192–55403
18	2765.67	II	12706–48853
8	2766.46	II	13595–49731
11	2768.56	II	12622–48731
6	2773.68	I	11101–47143
12	2774.28	II	12545–48580
6	2774.72	II	19113–55142
6	2775.76	II	19192–55207
18	2777.73	II	13742–49731
7	2783.78	I	13811–49723
3.5	2785.54	I	14515–50404
7	2785.69	I	13802–49689
9	2797.02	II	16341–52083
10	2797.80	II	16422–52154
11	2798.76	II	16533–52253
12	2799.45	II	13491–49202
12	2802.80	II	13543–49211
16	2803.47	II	13609–49269
4	2805.54	II	18294–53927
12	2810.16	II	18294–53869
12	2810.27	II	18354–53927
8	2817.50	II	18269–53751
8	2836.52	II	13609–48853
4	2838.06	I	0–35225
8	2841.04	II	13543–48731
4	2844.93	I	14549–49689
6	2845.24	II	20363–55499
16	2846.57	I	
14	2847.57	II	20242–55350
9	2848.77	I	0–35092
4	2849.05	II	13491–48580
9	2849.18	I	137–35225
10	2850.69	II	22274–57343
	2850.77	II	14656–49724
18	2852.87	I	13802–48845
18	2854.34	II	20280–55304
26	2855.22	I	0–35013
8 h	2857.94	I	9637–44617
24	2859.97	I	137–35092
32	2864.36	I	323–35225
10	2866.42	I	9825–44701
22	2866.59	I	15104–49978
28	2868.10	I	15265–50121
18	2869.13	II	20363–55207
4	2869.96	II	2687–37521
28	2870.55	I	553–35379
14	2877.69	II	14462–49202
14	2879.16	II	2809–37531
46	2880.03	II	2809–37521
50	2882.50	II	2687–37369
50	2884.78	II	2605–37259
19	2888.25	II	14656–49269
50	2889.62	II	2605–37201
120	2891.64	II	2687–37259
70	2892.44	II	2968–37531
120	2892.66	II	2809–37369
190	2893.32	II	2968–37521
8	2894.58	I	0–34537
48	2896.21	II	2687–37205
12	2899.20	I	137–34620
15	2899.60	I	0–34477
48	2903.08	II	2605–37041
8	2903.70	I	0–34429
11	2904.13	I	323–34747
20	2906.13	I	137–34537
120	2906.46	II	2809–37205
65	2907.47	II	2968–37352
6	2908.44	II	20343–54716
320	2908.82	II	3163–37531
95	2910.02	II	2687–37041
70	2910.39	II	2605–36955
75	2911.06	II	2809–37151
7	2914.30	I	16573–50876
50	2914.93	I	323–34620
		I	16729–51026
8	2915.33	I	137–34429
6 h	2916.02	I	10893–45176
16	2917.37	II	2687–36955

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
8		2917.93	I	11101–45361
28		2919.99	II	2968–37205
50		2920.38	II	2687–36919
95		2923.62	I	553–34747
320		2924.02	II	3163–37352
220		2924.64	II	2968–37151
8		2926.26	I	323–34487
7		2930.13	II	14462–48580
95		2930.81	II	2809–36919
9		2932.32	II	20623–54716
28		2934.40	II	2605–36674
15		2935.87	I	323–34375
12		2937.69	I	137–34168
4	h	2938.25	II	14556–48580
120		2941.37	II	3163–37151
60		2941.49	II	2687–36674
30	d	2942.33	I	553–34530
		2942.35	I	0–33976
30		2943.20	I	0–33967
140		2944.57	II	2968–36919
15		2946.53	I	137–34066
8		2949.17	II	22274–56171
30		2949.63	I	137–34030
40		2950.35	II	2605–36489
85		2952.08	II	2809–36674
16		2954.33	I	137–33976
12		2955.80	I	553–34375
11		2957.33	I	323–34128
34		2957.52	II	2687–36489
55		2962.77	I	323–34066
80		2968.38	II	13742–47420
16		2972.25	II	19133–52767
6		2974.22	I	9637–43249
12		2975.65	II	13512–47108
16		2976.20	II	13512–47102
50		2976.52	II	13595–47181
32		2977.54	I	553–34128
8		2981.20	II	19166–52700
12		2988.02	II	13595–47052
6		2989.60	II	13742–47181
10		2994.54	II	30673–64057
10		2996.00	II	13512–46880
6		2999.24	I	9637–42969
34		3001.20	II	13742–47052
12		3003.46	II	13595–46880
6		3008.61	II	13512–46740
12		3013.10	II	13512–46690
18		3014.82	II	13595–46755
10		3016.16	I	9825–42969
24		3016.78	II	13742–46880
9		3031.01	I	10893–43875
36		3033.45	II	20363–53320
38		3033.82	II	14656–47608
6		3041.42	II	16341–49211
12		3042.26	II	16341–49202
30		3043.12	I	137–32989
30		3043.56	I	0–32847
30		3044.94	I	323–33155
30		3048.22	II	20280–53077
12		3048.89	II	16422–49211
6		3050.40	I	11101–43874
22		3050.89	I	0–32768
9		3052.19	I	137–32891
24		3053.39	II	14556–47297
60		3053.65	I	0–32738
9		3053.89	II	16533–49269
160		3056.33	I	137–32847
190		3060.46	I	323–32989
19		3063.25	II	20242–52878
320		3066.38	I	553–33155
26		3067.12	II	14462–47056
18		3069.64	I	323–32891
22		3073.82	I	323–32847
13		3075.27	I	15104–47612
20		3082.11	I	553–32989
6		3087.06	I	9545–41928
12		3088.11	I	9637–42010
6		3089.13	I	9637–41999
500		3093.11	II	3163–35483
26		3094.20	II	16422–48731
7		3094.69	I	9545–41848
24		3100.94	II	16341–48580
400		3102.30	II	2968–35193
340		3110.71	II	2809–34947
12		3113.57	II	23391–55499
260		3118.38	II	2687–34746
10		3120.73	II	20623–52658
50		3121.14	II	3163–35193
20		3122.90	II	23391–55403
200		3125.28	II	2605–34593
34		3126.22	II	2968–34947
70		3130.27	II	2809–34746
55		3133.33	II	2687–34593
28		3134.93	II	20363–52253
20		3136.51	II	20280–52154
20		3139.74	II	20242–52083
26		3142.48	II	17911–49724
20		3145.34	II	3163–34947
7		3145.97	II	2968–34746
6		3146.23	II	20617–52392

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
5		3151.32	II	20522–52246
5		3164.83	II	8842–40430
7		3168.14	II	8640–40196
420		3183.41	I	137–31541
700		3183.98	I	323–31722
			I	0–31398
500		3185.40	I	553–31937
55		3187.71	II	8640–40002
70		3188.51	II	8842–40196
100		3190.68	II	9098–40430
7		3193.92	I	15063–46363
70		3198.01	I	137–31398
7		3199.82	I	15001–46244
100		3202.38	I	323–31541
60		3205.58	I	10893–42079
60		3207.41	I	553–31722
10		3208.35	II	8842–40002
55		3212.43	I	11101–42221
10		3214.75	II	9098–40196
28		3217.11	II	16533–47608
			I	323–31398
5		3218.87	I	10893–41950
7		3233.19	I	11101–42021
20		3237.87	II	16422–47297
7		3249.57	I	553–31318
7		3250.78	II	23391–54144
5		3251.87	II	20343–51086
18		3254.77	II	16340–47056
5		3255.65	I	8716–39423
18		3263.24	I	0–30636
140		3267.70	II	8640–39234
120		3271.12	II	8842–39404
12		3271.64	I	137–30694
10		3273.03	I	10893–41437
100		3276.12	II	9098–39613
14		3279.84	II	19113–49593
7		3282.53	II	19113–49568
12		3283.31	I	323–30771
7		3284.36	I	11101–41539
12		3289.39	II	8842–39234
19		3298.14	I	553–30864
12		3298.74	II	9098–39404
7		3309.18	I	9637–39847
7	d	3321.54	II	19113–49211
		3321.68	I	15265–45361
14		3329.86	I	9825–39847
12		3356.35	I	9637–39423
14		3365.55	I	9545–39249
7		3376.06	I	9637–39249
7		3377.39	I	9637–39237
14		3377.62	I	9825–39423
22		3400.40	I	8716–38116
7		3402.57	I	8579–37960
7		3417.06	I	8579–37835
6		3418.52	I	8716–37960
15		3425.07	I	
15		3485.92	II	8842–37521
6		3489.47	I	17242–45892
7		3493.17	II	8640–37259
12		3497.03	II	20981–49568
5		3500.82	I	19145–47702
28		3504.44	II	8842–37369
7		3505.69	I	13802–42318
75		3517.30	II	9098–37521
20		3520.02	II	8640–37041
15		3524.72	II	8842–37205
30		3529.74	I	9637–37960
30		3530.77	II	8640–36955
75		3533.68	I	9825–38116
15		3543.50	I	9545–37757
75		3545.20	II	8842–37041
15		3553.27	I	9825–37960
7		3556.25	I	17242–45354
75		3556.80	II	9098–37205
7		3560.60	II	8842–36919
15		3566.18	I	8579–36612
			II	8640–36674
7		3568.94	I	17055–45067
7		3571.04	I	17242–45237
12		3571.65	I	17117–45107
12		3573.52	I	17182–45158
7		3577.87	I	17117–45059
7		3582.81	I	17242–45145
75		3589.76	II	8640–36489
65		3592.02	II	8842–36674
75		3592.53	I	
36		3593.33	II	9098–36919
6		3605.59	I	
15		3606.69	I	10893–38611
7		3616.72	I	
6		3637.76	I	
15		3639.02	I	14549–42021
7		3643.86	I	14515–41950
15		3644.71	I	11101–38530
12		3648.97	I	16450–43847
12		3656.71	I	16573–43912
26		3663.59	I	16361–43649
8		3665.14	I	16729–44005
26		3667.74	I	16450–43707
12		3669.41	II	20363–47608

Vanadium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	3671.20	I	10893–38124
10	3672.40	I	16917–44140
30	3673.40	I	16573–43788
30	3675.70	I	2220–29418
18	3676.68	I	17136–44327
32	3680.11	I	16729–43894
60	3683.13	I	2153–29296
20	3686.26	I	11101–38221
50	3687.47	I	16917–44028
140	3688.07	I	2311–29418
110	3690.28	I	2112–29203
160	3692.22	I	2220–29296
48	3695.34	I	17136–44190
110	3695.86	I	2153–29203
400	3703.58	I	2425–29418
190	3704.70	I	2311–29296
60	3705.04	I	2220–29203
10	3706.04	I	15104–42079
14	3708.72	I	15265–42221
4	3713.96	I	553–27471
34	3715.47	II	12706–39613
5	3718.91	I	
5	3722.00	I	15001–41861
5	3722.20	I	18198–45057
26	3727.34	II	13609–40430
5	3728.34	II	20242–47056
6	3729.04	I	14949–41758
30	3732.76	II	12622–39404
16	3734.43	I	15078–41848
5	3737.99	I	14910–41655
9	3738.76	I	15270–42010
4	3740.24	I	15270–41999
10	3741.50	I	18438–45158
24	3745.80	II	12545–39234
4	3747.98	I	15572–42246
22	3750.87	II	13543–40196
4	3751.78	I	8579–35225
4	3753.27	I	13802–40437
4	3755.70	I	18302–44921
4	3759.32	I	20830–47423
5	3761.44	I	15270–41848
9	3763.14	I	15572–42138
4	3769.07	I	13802–40326
22	3770.97	II	13491–40002
4	3774.11	I	13811–40300
4	3775.19	I	15270–41752
4	3775.72	I	18680–45158
4	3776.16	I	15771–42246
28	3778.68	I	2311–28768
5	3779.65	I	10893–37343
4	3781.39	I	15572–42010
7	3787.14	I	15104–41501
55	3790.32	I	2220–28596
10	3793.61	I	0–26353
120	3794.96	I	2425–28768
60	3799.91	I	2153–28462
60	3803.47	I	2311–28596
9 d	3803.78	I	10893–37175
	3803.90	I	323–26605
20	3806.80	I	11101–37362
32	3807.50	I	2112–28369
55	3808.52	I	0–26249
24	3809.60	I	2220–28462
110	3813.49	I	137–26353
10	3815.51	I	2112–28314
15 d	3817.84	I	553–26738
	3817.98	I	11101–37285
140	3818.24	I	0–26183
24	3819.96	I	2425–28596
24	3821.49	I	2153–28314
60	3822.01	I	323–26480
48	3822.89	I	2311–28462
32	3823.21	I	2220–28369
7	3823.99	I	8476–34620
5	3826.77	I	8413–34537
180	3828.56	I	137–26249
5	3830.27	I	
3.0	3832.84	I	13802–39884
30	3834.22	I	13811–39884
8	3835.56	I	8413–34477
8	3836.05	I	8476–34537
17	3839.00	I	8579–34620
12	3839.38	I	14549–40587
8	3840.14	I	10893–36926
60	3840.44	I	8716–34747
280	3840.75	I	323–26353
12	3841.89	I	323–26345
40	3844.44	I	0–26004
34	3847.33	I	137–26122
12	3849.32	I	
8	3851.17	I	8579–34537
4	3852.10	I	8476–34429
130	3855.37	I	0–25931
320	3855.84	I	553–26480
7	3858.68	I	8579–34487
8	3859.34	I	8716–34620
16	3862.22	I	137–26022
14	3863.87	I	10893–36766
140	3864.86	I	137–26004
24	3867.60	I	323–26172

Vanadium — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
4		3870.58	I	15771–41599
18		3871.08	I	11101–36926
7		3873.64	I	10893–36701
160		3875.08	I	323–26122
44		3875.90	I	137–25931
60		3876.09	I	553–26345
14		3878.71	II	14656–40430
3.0		3883.89	I	15689–41429
7		3886.59	I	11101–36823
55		3890.18	I	323–26022
7	h	3891.12	I	
36		3892.86	I	323–26004
7		3894.04	I	18174–43847
7		3896.16	I	8716–34375
7		3897.08	I	18259–43912
22	h	3898.02	I	18680–44327
11		3899.13	II	14556–40196
11	h	3900.18	I	18372–44005
11	h	3901.15	I	18513–44140
190		3902.25	I	553–26172
4		3903.26	II	11908–37521
4		3904.47	I	14515–40119
8		3906.75	I	8579–34168
55		3909.89	I	553–26122
8		3910.79	I	8413–33976
17		3912.21	I	8413–33967
4		3912.89	I	8579–34128
11		3914.33	II	14462–40002
8		3916.41	II	11515–37041
8		3920.49	I	8476–33976
8		3921.90	I	8476–33967
18		3922.43	I	8579–34066
19		3924.66	I	15063–40536
12		3925.24	I	19026–44495
16		3927.93	I	15001–40452
20		3930.02	I	11101–36539
12		3931.34	I	14949–40379
20		3934.01	I	8716–34128
12		3935.14	I	14910–40315
8		3936.28	I	8579–33976
4		3937.53	I	15063–40452
4		3938.20	I	19078–44463
4		3939.33	I	15001–40379
3.0		3941.25	I	14949–40315
7		3942.01	I	11101–36461
12		3943.66	I	8716–34066
8		3950.23	I	
11		3951.97	II	11908–37205
7		3963.63	I	
4		3968.09	II	11296–36489
8		3973.64	II	11515–36674
4		3979.14	I	20768–45892
4		3979.42	I	19023–44146
4		3980.52	I	
4		3984.34	I	14910–40001
7		3984.60	I	14949–40039
7		3988.83	I	15001–40064
42		3990.57	I	14949–40001
20		3992.80	I	15001–40038
4		3997.12	II	11908–36919
34		3998.73	I	15063–40064
13		4005.71	II	14656–39613
4		4023.17	I	15270–40119
9		4023.39	II	14556–39404
9		4031.83	I	19078–43874
12		4035.63	II	14462–39234
9		4042.64	I	15270–40000
4		4048.62	I	137–24830
28		4050.96	I	17182–41861
28		4051.35	I	17242–41918
4		4053.26	I	15270–39935
22		4057.07	I	17117–41758
10		4057.82	I	15689–40326
18		4063.93	I	17055–41655
18		4071.54	I	15572–40126
5		4082.93	I	9545–34030
90		4090.58	I	8716–33155
4		4091.94	I	9545–33976
14		4092.41	I	9637–34066
140		4092.69	I	2311–26738
9		4093.50	I	9545–33967
5		4094.28	I	17242–41660
70		4095.49	I	8579–32989
220		4099.80	I	2220–26605
46		4102.16	I	8476–32847
18		4104.40	I	17242–41599
20		4104.78	I	15771–40126
220		4105.17	I	2153–26506
5		4107.49	I	9637–33976
9		4108.22	I	17055–41389
180		4109.79	I	2112–26438
700		4111.78	I	2425–26738
9		4112.33	I	17182–41492
18		4113.52	I	9825–34128
5		4114.53	I	15665–39962
340		4115.18	I	2311–26605
140		4116.47	I	2220–26506
14		4118.18	I	15724–40000
14		4118.64	I	8716–32989
18		4119.46	I	8579–32847

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
14		4120.54	I	8476–32738
14		4123.19	I	15689–39935
160		4123.57	I	2153–26397
9		4124.07	I	9825–34066
240		4128.07	I	2220–26438
9		4128.86	I	15665–39878
240		4132.02	I	2311–26506
180		4134.49	I	2425–26605
5		4136.11	I	15078–39249
5		4139.26	I	15270–39423
3.5		4150.67	I	
3.5		4152.66	I	
12		4159.69	I	2311–26345
5		4171.30	I	15270–39237
8		4174.01	I	13802–37753
18		4179.42	I	2425–26345
12		4182.59	I	2220–26122
14		4189.84	I	2311–26172
14		4191.56	I	2153–26004
5		4197.60	I	15265–39081
5		4198.61	I	2311–26122
4		4200.19	I	2220–26022
18		4209.86	I	2425–26172
5		4218.71	I	2425–26122
5		4224.14	I	15724–39391
9		4226.62	I	15689–39342
4		4227.74	I	13811–37458
4		4229.69	I	15665–39300
28		4232.46	I	15771–39391
14		4232.95	I	15724–39342
14		4234.00	I	15689–39300
4		4234.52	I	0–23609
9		4235.76	I	15665–39267
4		4240.36	I	15724–39300
8		4257.37	I	15001–38483
9		4259.31	I	137–23609
9		4262.16	I	14949–38405
4	h	4265.17	I	
44		4268.64	I	15063–38483
4		4269.76	I	14910–38324
4		4270.32	I	14549–37960
36		4271.55	I	15001–38405
36		4276.96	I	14949–38324
3.5		4282.91	I	15063–38405
34		4284.06	I	14910–38246
4		4286.42	I	15001–38324
3.5		4287.81	I	
3.0		4291.30	I	14949–38246
26		4291.82	I	17242–40536
17		4296.11	I	17182–40452
13		4297.68	I	17117–40379
13		4298.03	I	17055–40315
13		4306.21	I	137–23353
11		4307.18	I	0–23211
13		4309.80	I	323–23520
3.0		4313.89	I	14949–38124
36		4330.02	I	0–23088
40		4332.82	I	137–23211
3.0		4334.09	I	9825–32891
60		4341.01	I	323–23353
4		4342.83	I	15104–38124
80		4352.87	I	553–23520
10		4354.98	I	15265–38221
12		4355.94	I	137–23088
4		4363.52	I	2220–25131
4		4364.22	I	17055–39962
12		4368.04	I	323–23211
4		4368.60	I	17117–40001
11	d	4373.23	I	21603–44463
6		4373.83	I	17182–40039
8		4375.30	I	21646–44495
950		4379.24	I	2425–25254
8		4380.55	I	17242–40064
550		4384.72	I	2311–25112
380		4389.97	I	2220–24993
7		4392.07	I	2153–24915
3.5		4393.09	I	15078–37835
3.5		4393.84	I	8476–31229
280		4395.23	I	2153–24899
110		4400.58	I	2112–24830
6		4403.67	I	15063–37765
7	h	4406.15	I	8579–31268
180		4406.64	I	2425–25112
220		4407.64	I	2311–24993
280		4408.20	I	2220–24899
360		4408.51	I	2153–24830
			I	2112–24789
11		4412.14	I	2112–24771
3.5		4415.06	I	15001–37644
50		4416.47	I	2153–24789
9		4419.94	I	2220–24839
50		4421.57	I	2220–24830
7		4423.21	I	8716–31318
2.5		4423.91	I	20813–43411
3.5		4424.56	I	11101–33695
7		4425.71	I	14910–37499
36		4426.00	I	2311–24899
9		4427.31	I	21603–44184
24		4428.52	I	2153–24728
18		4429.80	I	2425–24993

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
2.5	4430.50	I	15270–37835
7	4434.60	I	15572–38116
34	4436.14	I	2112–24648
50	4437.84	I	2311–24839
65	4441.68	I	2220–24728
7	4443.34	I	21646–44146
50	4444.21	I	2153–24648
5	4449.57	I	10893–33360
5	4450.90	I	19078–41539
48	4452.01	I	15063–37518
2.0	4452.70	I	14910–37362
3.0 h	4456.50	I	
32	4457.48	I	2220–24648
9	4457.76	I	15104–37530
80	4459.76	I	2311–24728
160	4460.29	I	2425–24839
6	4460.99	I	19026–41437
48	4462.36	I	15001–37404
3.0	4464.27	I	19145–41539
3.0	4464.75	I	15724–38116
3.0	4465.50	I	15572–37960
9	4468.01	I	14910–37285
3.0	4468.76	I	15104–37475
30	4469.71	I	14949–37316
9	4474.04	I	15771–38116
16	4474.71	I	15265–37606
2.0	4475.89	I	14949–37285
6	4480.04	I	15001 37316
30	4488.89	I	14910–37181
6	4490.80	I	14949–37211
8	4496.06	I	15724–37960
5	4496.85	I	14949–37181
3.0	4497.40	I	21646–43875
9	4501.95	I	11101–33307
6	4514.19	I	15689–37835
11	4524.22	I	15265–37362
3.0	4525.16	I	15665–37757
3.0	4527.99	I	
3.0	4529.30	I	15270–37343
6	4529.59	I	15104–37175
3.0	4530.79	I	
3.0	4533.92	I	
3.0	4537.66	I	14549–36580
3.0	4540.01	I	15265–37285
28	4545.39	I	15771–37765
8	4549.65	I	
2.0	4551.84	I	14515–36478
7	4553.05	I	19023–40981
22	4560.71	I	15724–37644
5	4570.42	I	15771–37644
16	4571.78	I	15689–37556
40	4577.17	I	0–21841
11	4578.73	I	15665–37499
2.5	4579.19	I	15724–37556
50	4580.40	I	137–21964
4	4583.78	I	15689–37499
65	4586.36	I	323–22121
13	4591.22	I	19145–40920
100	4594.11	I	553–22314
8	4606.15	I	137–21841
2.5	4609.65	I	11101–32788
2.0	4611.74	I	15665–37343
18	4619.77	I	323–21964
5	4624.41	I	8476–30095
4	4626.48	I	8413–30022
8	4635.18	I	553–22121
5	4640.07	I	8476–30022
5	4640.74	I	8579–30121
10	4646.40	I	8579–30095
2.5	4648.89	I	19189–40694
2.5	4666.14	I	15270–36695
12	4670.49	I	8716–30121
1.8	4684.45	I	15270–36612
2.5	4686.92	I	15078–36408
4	4706.16	I	15572–36815
6	4706.57	I	17242–38483
6	4710.56	I	17182–38405
5	4714.12	I	17117–38324
2.5	4715.89	I	19026–40225
4	4717.69	I	17055–38246
3.0	4721.51	I	15724–36898
3.0	4722.86	I	15771–36938
3.0	4729.53	I	15270–36408
2.0	4730.38	I	15689–36823
2.0	4742.63	I	18805–39884
1.8	4746.63	I	16361–37423
3.0	4748.52	I	16450–37503
3.5	4750.98	I	16573–37615
2.5	4751.56	I	15572–36612
3.0	4753.93	I	16729–37758
5	4757.48	I	16361–37375
4	4766.63	I	16450–37423
10	4776.36	I	16573–37503
	4776.52	I	19189–40119
8	4786.51	I	16729–37615
10	4796.92	I	16917–37758
1.4	4799.77	I	0–20828
10	4807.53	I	17136–37931
10	4827.45	I	323–21033
11	4831.64	I	137–20828

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
9	4832.43	I	0–20688
1.4	4833.02	I	13802–34487
1.4	4848.81	I	21603–42221
24	4851.48	I	0–20606
2.5	4862.61	I	20830–41389
36	4864.74	I	137–20688
1.6	4871.26	I	17242–37765
46	4875.48	I	323–20828
4	4880.56	I	9637–30121
55	4881.56	I	553–21033
2.0	4891.60	I	
1.6	4894.21	I	17055–37481
4	4900.62	I	17117–37517
7 d	4904.29	I	9637–30022
	4904.34	I	17242–37626
6	4925.65	I	9825–30121
2.5	4932.03	I	9825–30095
1.6	4966.12	I	23935–44066
5	5002.33	I	19023–39009
6	5014.62	I	19145–39081
2.0	5051.63	I	21646–41437
2.5	5064.12	I	
2.5	5105.14	I	
8	5128.53	I	18438–37931
8	5138.42	I	18302–37758
1.8	5139.53	I	19078–38530
5	5148.72	I	18198–37615
3.0	5159.35	I	18126–37503
1.6	5169.94	I	18086–37423
5	5176.77	I	
1.4	5192.01	I	18120–37375
8	5192.99	I	18680–37931
1.6	5193.62	I	18174–37423
8	5194.83	I	18259–37503
4	5195.36	I	18372–37615
1.4	5206.61	I	18174–37375
3.0	5216.59	I	18259–37423
2.5	5225.77	I	18372–37503
2.5	5233.75	I	18513–37615
8	5234.07	I	19023–38124
1.4	5240.20	I	18680–37758
8	5240.87	I	19145–38221
1.2	5260.98	I	18438–37441
3.0	5353.41	I	19078–37753
2.5	5383.43	I	20828–39399
3.0	5385.14	I	21033–39597
1.0	5388.30	I	20688–39241
0.8	5397.87	I	20606–39127
7	5401.93	I	19023–37530
10	5415.26	I	19145–37606
2.0	5418.09	I	19023–37475
3.5	5424.08	I	19026–37458
3.0	5434.18	I	19078–37475
0.8	5437.66	I	19145–37530
1.2	5458.12	I	19026–37343
0.9	5471.33		
1.8	5487.22	I	14549–32768
6	5487.92	I	19145–37362
1.8	5489.94	I	14515–32725
2.0	5504.87	I	13802–31962
5	5507.75	I	19023–37175
1.0	5511.18	I	19145–37285
1.6	5545.93	I	8579–26605
5	5547.07	I	8716–26738
2.5	5558.75	I	13802–31786
2.0	5561.66	I	13811–31786
10	5584.50	I	8579–26480
1.6	5586.00	I	15001–32898
7	5592.42	I	8476–26353
2.0	5601.38	I	19078–36926
5	5604.94	I	8413–26249
0.9	5624.20	I	18805–36580
14	5624.60	I	8579–26353
5	5624.89	I	8476–26249
4	5626.01	I	8413–26183
28	5627.64	I	8716–26480
0.9	5632.46	I	553–18302
0.7	5633.90	I	19078–36823
0.9	5635.51	I	19026–36766
6	5646.11	I	8476–26183
8	5657.44	I	8579–26249
8	5668.36	I	8716–26353
22	5670.85	I	8716–26345
1.4	5683.22	I	
85	5698.52	I	8579–26122
65	5703.56	I	8476–26004
40	5706.98	I	8413–25931
0.8	5708.95	I	19189–36701
0.8 h	5716.21	I	
5	5725.64	I	19078–36539
60	5727.03	I	8716–26172
12	5727.66	I	8476–25931
16	5731.25	I	8579–26022
3.0	5734.01	I	19026–36461
16	5737.06	I	8579–26004
8	5743.45	I	8716–26122
1.2	5747.70	I	19145–36539
3.0	5748.87	I	15270–32660
1.2	5752.74	I	15078–32456
1.2	5761.41	I	8579–25931

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
5	5772.42	I	15572–32891
2.5	5776.64	I	8716–26022
0.8	5782.61	I	8716–26004
0.8	5783.50	I	21841–39127
3.0 h	5784.38	I	22314–39597
4 h	5786.16	I	21964–39241
1.6	5788.56	I	15078–32349
2.5 h	5807.14	I	24899–42114
1.6	5817.06	I	15270–32456
2.5 h	5817.53	I	24993–42177
4 h	5830.72	I	25112–42257
6 h	5846.30	I	25254–42353
0.8	5850.32	I	15572–32660
3.0	5924.57	I	15063–31937
2.0	5978.91	I	15001–31722
1.4	5980.78	I	9637–26353
2.0	6002.31	I	9825–26480
4	6002.63	I	8476–25131
2.0	6016.12	I	21603–38221
1.4	6025.41	I	14949–31541
32	6039.73	I	8579–25131
7	6058.14	I	8413–24915
1.4	6067.26	I	21646–38124
34	6081.44	I	8476–24915
90	6090.22	I	8716–25131
2.0	6106.98	I	11101–27471
20	6111.67	I	8413–24771
42	6119.52	I	8579–24915
1.4	6128.34	I	8476–24789
20	6135.38	I	8476–24771
13	6150.15	I	2425–18680
6	6170.36	I	2311–18513
1.6	6189.35	I	2220–18372
32	6199.19	I	2311–18438
9	6213.87	I	2425–18513
32	6216.37	I	2220–18302
2.0 h	6218.31	I	23520–39597
9	6224.50	I	2311–18372
30	6230.74	I	2153–18198
7	6233.20	I	2220–18259
4	6240.13	I	2153–18174
12	6242.81	I	2112–18126
50	6243.10	I	2425–18438
20	6251.82	I	2311–18302
6	6256.90	I	2220–18198
6	6258.57	I	2112–18086
4	6261.22	I	2153–18120
6	6266.32	I	2220–18174
9	6268.82	I	2425–18372
12	6274.65	I	2153–18086
1.2 h	6282.33	I	17242–33155
14	6285.16	I	2220–18126
14	6292.83	I	2311–18198
12	6296.49	I	2425–18302
2.0 h	6311.50	I	26738–42578
1.0	6324.66	I	17182–32989
5	6326.84	I	15063–30864
4	6339.09	I	15001–30771
3.5	6349.48	I	14949–30694
1.0	6355.58	I	17117–32847
3.5	6357.30	I	14910–30636
1.8	6358.82	I	17242–32964
2.5	6361.27	I	17182–32898
1.6	6379.36	I	17117–32788
1.0	6393.28	I	17055–32692
2.5	6430.47	I	15771–31318
1.6	6431.63	I	15724–31268
1.0	6433.18	I	15689–31229
0.8	6435.16	I	15665–31200
5	6452.34	I	9637–25131
0.8	6488.05	I	19078–34487
4	6504.17	I	9545–24915
8	6531.43	I	9825–25131
2.0	6543.51	I	9637–24915
1.2	6558.02	I	11101–26345
0.8	6565.88	I	9545–24771
4	6605.97	I	9637–24771
1.2	6607.83	I	10892–26022
0.8	6623.54	I	15771–30864
4	6624.85	I	9825–24915
1.0	6633.26	I	11101–26172
1.0	6643.79	I	15724–30771
0.6	6693.66	I	21603–36539
0.6	6708.07	I	9825–24728
5 c	6753.00	I	8716–23520
0.8	6760.12	I	
4 c	6766.49	I	8579–23353
3.0	6784.98	I	8476–23211
1.2	6786.32	I	
2.0	6812.40	I	8413–23088
0.7 c	6829.94	I	8716–23353
1.2	6832.44	I	8579–23211
0.9	6839.58	I	19023–33640
0.9	6841.90	I	8476–23088
0.8 c	6870.88	I	19145–33695
0.7	6871.56	I	15572–30121
0.6	6894.00	I	19026–33528
1.0	6974.50	I	19026–33360
1.8	7026.07	I	19078–33307
0.6	7063.69	I	11101–25254

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
0.9	h	7092.08	I	
0.5		7102.58	I	17242–31318
2.0		7148.15	I	
0.6		7151.36	I	20768–34747
0.6		7182.08	I	18805–32725
1.2		7264.29	I	20768–34530
0.7		7321.44	I	17117–30771
3.5		7338.92	I	17242–30864
3.0		7356.54	I	17182–30771
0.9		7358.66	I	20789–34375
2.0		7361.39	I	17054–30636
1.0		7362.49	I	19189–32768
2.0		7363.16	I	17117–30694
0.8		7385.95	I	19189–32725
0.5	h	7393.49		
1.0	h	7485.90	I	20813–34168
1.0	h	7488.08	I	15270–28621
1.0	h	7492.44		
1.0	h	7578.75	I	24915–38106
0.8	h	7591.24	I	24771–37940
1.2	h	7596.92	I	19189–32349
1.0	h	7598.28	I	18805–31962
2.0		7624.81	I	25131–38242
0.4		7701.37	I	18805–31786
0.7		7704.81	I	25131–38106
0.7	h	7851.18		
1.2	bl	7865.51	VO	
1.0		7896.40		
1.2	h	7898.81		
2.0		7937.92	I	24728–37322
2.5	c	8027.39	I	8579–21033
1.2		8028.13	I	
1.2	h	8035.38		
1.2	h	8045.71		
1.0		8051.89		
1.2		8093.48	I	8476–20828
0.7		8102.44	I	
1.0		8108.59	I	25112–37441
0.8	h	8109.07	I	24899–37227
10	cw	8116.80	I	8716–21033
0.9	h	8136.79	I	24830–37117
2.5		8144.59	I	8413–20688
0.8		8154.55	I	24899–37158
6	c	8161.07	I	8579–20828
1.2		8171.35	I	24993–37227
0.6		8180.21	I	20768–32989
3.0		8186.71	I	8476–20688
2.0		8187.33	I	25112–37322
2.5		8198.87	I	8413–20606
3.0		8203.07	I	25254–37441
2.0		8241.61	I	8476–20606
2.5	c	8253.51	I	8716–20828
2.5		8255.88	I	8579–20688
0.4	h	8280.39	I	25931–38004
1.6		8282.37	I	26172–38242
0.7		8324.42	I	25931–37940
1.2	h	8331.23	I	26004–38004
1.2		8342.03	I	26122–38106
0.6		8402.81	I	
1.0		8499.52	I	26480–38242
0.5		8534.49	I	21646–33360
0.5	bl	8624.86	VO	
5	c	8919.85	I	9824–21033
2.5	c	8932.93	I	9637–20828
1.0		8971.62	I	9545–20688

YTTERBIUM

Yb, $Z=70$, $M=173.04$, Ratio $\frac{\text{Yb}}{\text{Cu}}=2.723$

Yb I Normal state of valence electrons $6s^2\ {}^1S_0 = 0$. I.P.=50000 K
Yb II Normal state of valence electrons $6s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.=97000 K

References

Wavelengths:
W. F. Meggers and B. F. Scribner, J. Research NBS **19,** 651 (1937).
W. F. Meggers, unpublished material (1961).

Classification and Spectrum Assignments:
Yb I, W. F. Meggers, unpublished material (1961).
Yb II, W. F. Meggers and G. Racah, unpublished material (1953).
Yb III, W. F. Meggers and B. F. Scribner, J. Research NBS **19,** 651 (1937).

Relative intensity of ytterbium lines observed in an arc of copper containing 0.1 atomic percent of ytterbium

Strong lines of ytterbium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination		
3200	3694. 19	II	0–27062	$4f^{14}6s^1$	${}^2S_{0\frac{1}{2}}$—$4f^{14}6p^1$	${}^2P^\circ_{0\frac{1}{2}}$
2600	3289. 37	II	0–30392	$4f^{14}6s^1$	${}^2S_{0\frac{1}{2}}$—$4f^{14}6p^1$	${}^2P^\circ_{1\frac{1}{2}}$
1900	3987. 98	I	0–25068	$4f^{14}6s^2$	${}^1S_0$ —$4f^{14}6s^16p^1$	${}^1P^\circ_1$
500	2891. 38	II	0–34575	$4f^{14}6s^1$	${}^2S_{0\frac{1}{2}}$—$4f^{13}5d^16s^1$	$34575^\circ_{1\frac{1}{2}}$
340	3464. 36	I	0–28857	$4f^{14}6s^2$	${}^1S_0$ —$4f^{13}5d^16s^2$	28857°_1
280	2970. 56	II	0–33654	$4f^{14}6s^1$	${}^2S_{0\frac{1}{2}}$—$4f^{13}5d^16s^1$	$33654^\circ_{0\frac{1}{2}}$
180	2750. 48	II	21418–57765	$4f^{13}6s^2$	${}^2F^\circ_{3\frac{1}{2}}$—$4f^{13}6s^16p^1$	$57765^\circ_{4\frac{1}{2}}$
140	2653. 74	II	21418–59090	$4f^{13}6s^2$	${}^2F^\circ_{3\frac{1}{2}}$—$4f^{13}6s^16p^1$	$59090^\circ_{3\frac{1}{2}}$
140	5556. 48	I	0–17992	$4f^{14}6s^2$	${}^1S_0$ —$4f^{14}6s^16p^1$	${}^3P^\circ_1$
130	3031. 11	II	0–32982	$4f^{14}6s^1$	${}^2S_{0\frac{1}{2}}$—$4f^{13}5d^16s^1$	$32982^\circ_{1\frac{1}{2}}$
75	7699. 49	I	19710–32695	$4f^{14}6s^16p^1$	${}^3P^\circ_2$ —$4f^{14}6s^17s^1$	${}^3S_1$
70	3454. 07	II	26759–55702	$4f^{13}5d^16s^1$	$26759^\circ_{2\frac{1}{2}}$—$4f^{13}5d^16p^1$	$55702_{1\frac{1}{2}}$
70	3476. 31	II	0–28758	$4f^{14}6s^1$	${}^2S_{0\frac{1}{2}}$—$4f^{13}5d^16s^1$	$28758^\circ_{1\frac{1}{2}}$
70	3478. 84	II	30224–58961	$4f^{13}5d^16s^1$	$30224^\circ_{1\frac{1}{2}}$—$4f^{13}5d^16p^1$	$58961_{5\frac{1}{2}}$
65	2464. 49	I	0–40564	$4f^{14}6s^2$	${}^1S_0$ —$4f^{14}6s^17p^1$	40564°_1

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
8	2116.65	II	
11	2126.72	II	0–47006
2.0	2161.60	II	
6	2185.70	II	0–45737
7	2224.45	II	0–44941
5	2320.81	II	
2.5	2362.88	II	21418–63727
12	2390.73	II	21418–63234
1.4	2398.01	II	0–41688
3.0	2421.36	II	32371–73658
3.5	2447.25	II	28758–69608
4	2460.24	II	30224–70858
65	2464.49	I	0–40564
2.0	2484.87	II	30563–70794
10	2502.00	II	21418–61374
4	2505.46	II	31568–71469
1.6	2508.04	II	
20	2512.05	II	21418–61215
2.5	2516.36	II	33052–72780
7	2522.42	II	21418–61051
9	2537.64	II	30563–69957
38	2538.67	II	0–39379
2.0	2550.04	II	
10	2552.14	II	30224–69395
8	2552.69	II	31632–70794
3.0	2565.56	II	34785–73751
4	2571.35	II	31980–70858
1.8	2573.13	II	32371–71222
2.5	2596.14	II	
4	2596.29	II	31632–70136
3.0	2615.26	II	30224–68450
14	2617.00	II	21418–59619
8	2634.31	II	
6	2639.44	II	31568–69444
12	2641.90	II	21418–59259
11	2642.55	III	34656–72487
16	2644.30	II	33052–70858
4	2646.44	II	33494–71270
4	2647.46	II	35019–72780
4	2648.80	II	33052–70794
7	2649.79	II	33494–71222
4	2650.73	II	30224–67939
140	2653.74	II	21418–59090
5	2656.11	II	28758–66396
3.0	2659.26	II	28758–66351
28	2665.02	II	31568–69080
12	2666.11	III	34991–72486
12	2666.98	III	34656–72140
8	2668.74	II	33494–70954
55	2671.98	I	0–37415
55	2672.65	II	21418–58823
3.0	2680.40	II	26759–64056
2.0	2683.42	II	44438–81693
10	2684.75	II	32371–69608
3.5	2687.96	II	30224–67416
4	2695.43	II	31632–68720
2.0	2696.62	II	32371–69444
2.5	2700.80	II	
3.0	2708.84	II	33052–69957
9	2710.54	II	31568–68450
3.5	2711.79	II	21418–58284
8	2712.66	II	30563–67416
24	2718.35	II	31980–68756
3.0	2722.19	II	34390–71114
16	2732.72	II	31568–68150
3.0	2734.08	II	34390–70954
8	2741.71	II	33494–69957
8	2747.58	II	32371–68756
2.5	2748.03	II	34575–70954
32	2748.66	II	31568–67939
180	2750.48	II	21418–57765
12	2751.45	II	30224–66558
3.0	2759.00	II	37516–73751
9	2760.78	II	35059–71270
9	2761.38	II	35019–71222
5	2764.42	II	35059–71222
12	2771.33	II	34785–70858
24	2776.28	II	34785–70794
14	2784.66	II	33494–69395
2.5	2787.96	II	30224–66082
6	2793.28	II	33654–69444
3.5	2794.44	II	35019–70794
3.0	2795.08	II	37516–73283
2.5	2795.31	II	
5	2797.79	II	
14	2798.21	II	30224–65951
6	2799.38	II	
12	2800.05	II	28758–64461
2.0	2810.72	II	32371–67939
9	2814.53	II	30563–66082
4	2816.35	II	30392–65888
20	2821.15	II	31980–67416
14	2824.97	II	30563–65951
26	2830.98	II	30563–65876
2.5	2832.20	II	28758–64056
4	2834.98	II	37516–72780
2.0	2842.58	II	32982–68150
32 h	2847.17	II	27062–62174
14	2848.44	II	33052–68149
3.0	2849.33	II	44498–79583

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
50	2851.12	II	26759–61822
8	2851.86	II	33494–68549
3.0	2853.41	II	46170–81205
2.5	2853.68	II	34575–69608
8	2854.13	II	35832–70858
6	2854.49	II	40036–75058
6	2858.33	II	30224–65200
6	2858.46	II	32982–67955
14	2859.38	II	35832–70794
60	2859.80	II	21418–56376
8	2860.40	II	
20	2861.21	II	31632–66571
14	2861.33	II	35019–69957
28	2867.05	II	30224–65093
3.5	2870.06	II	
6	2873.50	I	
4	2885.97	II	33494–68135
10	2886.26	II	30563–65200
28	2888.03	II	26759–61374
500	2891.38	II	0–34575
6	2893.63	II	35059–69608
4	2896.90	II	46170–80679
12	2899.71	II	28758–63234
2.5	2902.40	II	33494–67939
3.0	2902.92	II	38342–72780
3.0	2906.88	II	37078–71469
4	2908.32	II	30224–64598
5	2909.19	II	33052–67416
8	2909.47	II	30563–64923
12	2911.52	II	35059–69395
2.5	2912.86	II	31568–65888
24	2914.21	II	35832–70136
20	2915.27	II	26759–61051
2.5	2916.43	II	39379–73658
40	2919.34	II	31632–65876
8	2921.12	II	32982–67205
6	2924.23	II	32371–66558
3.5	2927.85	II	37078–71222
5	2934.35	I	
8	2935.10	II	34390–68450
3.0	2937.18	II	37078–71114
6	2939.52	II	31568–65577
6	2940.51	II	
4	2942.04	II	32371–66351
20	2945.90	II	34785–68720
6	2946.30	II	40036–73967
2.5	2946.76	II	43956–77882
4	2950.32	II	35059–68944
6	2955.31	II	26759–60586
2.5	2957.63	II	
9	2962.52	II	34390–68135
3.0	2963.21	II	
6	2963.45	II	
18	2964.75	II	30224–63944
280	2970.56	II	0–33654
6	2982.49	II	33052–66571
3.0	2982.66	II	32371–65888
4	2983.70	II	33052–66558
28	2983.98	II	30224–63727
13	2985.08	II	35059–68549
5	2985.87	II	32982–66463
6	2990.36	II	35019–68450
9	2991.87	II	32982–66396
4	2993.93	II	35059–68450
24	2994.80	II	30563–63944
4	2995.86	II	32982–66351
10	3000.46	II	
3.5	3002.61	II	41679–74973
44	3005.76	II	31632–64891
14	3009.39	II	31980–65200
9	3010.62	II	32371–65577
8	3014.43	II	30563–63727
22	3017.55	II	35019–68149
22	3026.67	II	33052–66082
130	3031.11	II	0–32982
8	3034.64	II	31980–64923
3.5	3037.99	II	32982–65888
8	3039.67	II	35832–68720
11	3042.65	II	33494–66351
3.0	3044.01	II	30392–63234
6	3046.48	II	34390–67205
5	3047.06	II	33654–66463
6	3063.13	II	30224–62861
3.0	3063.67	II	34785–67416
16	3065.04	II	28758–61374
2.5	3076.02	II	26759–59259
14	3089.10	II	28758–61120
10	3093.87	II	31632–63944
4	3100.71	I	
6	3101.36	II	33654–65888
4	3102.07	II	32371–64598
8	3107.76	II	34390–66558
24	3107.90	II	40036–72202
12	3115.33	II	32371–64461
8	3116.70	II	31980–64056
26	3117.80	II	26759–58823
7	3136.75	II	33052–64923
32	3140.92	II	28758–60586
11	3141.72	II	34575–66396
11	3145.06	II	34785–66571

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
4		3145.55	II	
4		3153.17	II	33494–65200
13		3153.86	II	
7		3155.17	II	32371–64056
4		3162.31	I	
10		3163.79	II	33494–65093
7		3165.20	II	35832–67416
17		3169.06	II	33052–64598
17		3180.92	II	33494–64923
55		3192.88	II	30563–61874
10		3198.65	II	31980–63234
34		3201.16	II	31632–62861
11		3217.18	II	32982–64056
7		3218.33	II	35019–66082
7		3225.86	II	30224–61215
6		3239.20	II	32371–63234
5		3239.60	I	
5		3246.06	II	
18		3261.50	II	30563–61215
2600		3289.37	II	0–30392
18		3305.27	I	
20		3305.73	II	31632–61874
7		3315.11	II	
11		3319.43	I	
7		3333.06	II	33654–63648
34		3337.18	II	
40	h	3342.94	II	
11		3346.50	II	
7		3347.53	II	35059–64923
5		3351.08	II	
7		3351.24	II	
14		3352.49	II	
14		3362.43	II	
7		3363.64	II	
34		3375.48	II	26759–56376
7		3376.62	II	
4		3382.58	II	
20		3387.51	I	
7		3390.24	II	
4		3390.32	II	
7		3391.10	II	37078–66558
7	h	3394.44	II	32371–61822
7		3401.02	II	30224–59619
5		3404.11	II	35832–65200
7		3412.45	I	
20		3418.40	I	
50		3426.06	I	
11		3428.47	II	34785–63944
34		3431.14	I	
6		3434.62	II	
7		3438.71	II	34575–63648
14		3438.85	II	31980–61051
5		3443.59	II	
5		3446.89	II	32371–61374
12		3452.41	I	
70		3454.07	II	26759–55702
26	d	3458.28	II	40036–68944
		3458.36	I	
50		3460.27	I	
5		3462.36	II	
340		3464.36	I	0–28857
70		3476.31	II	0–28758
70		3478.84	II	30224–58961
7		3482.57	II	
12		3485.76	II	32371–61051
12		3488.42	II	
14	hw	3495.92	II	
12		3507.82	II	37078–65577
7		3517.02	I	19710–48136
32		3520.29	II	30563–58961
7		3545.71	II	
14		3549.82	II	33052–61215
5		3559.00	I	
28		3560.33	II	21418–49498
24		3560.71	II	34785–62861
7	h	3563.94	II	31568–59619
12		3570.56	II	33052–61051
7		3572.50	II	
7		3574.54	II	
50		3585.47	II	21418–49301
13		3606.48	II	33494–61215
5		3610.24	II	31568–59259
7		3611.30	II	37516–65200
20		3619.82	II	28758–56376
11		3634.54	II	
24		3637.76	II	21418–48900
7		3648.13	I	
9		3655.73	I	17992–45339
24		3669.70	II	27062–54304
5		3670.69	II	38342–65577
14		3675.08	II	30563–57765
5		3690.56	II	34785–61874
3200		3694.19	II	0–27062
7		3698.59	II	35832–62861
7		3700.57	I	
5		3710.33	II	28758–55702
6		3724.22	II	31980–58823
18		3734.70	I	17992–44760
55		3770.10	I	17288–43805
8		3774.32	I	

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6	h	3791.74	I	
10		3839.92	I	
20		3872.85	I	17992–43805
20		3900.86	I	19710–45339
3.0		3904.82	II	38342–63944
8		3911.28	I	
1900		3987.98	I	0–25068
55		3990.89	I	19710–44760
3.0		4007.36	I	
4		4052.28	I	
5		4077.28	II	38342–62861
26		4089.69	I	
7	h	4119.26	II	
4		4135.09	II	34785–58961
28		4149.07	I	19710–43805
7		4174.57	I	
20		4180.82	II	30392–54304
9	d	4218.56	II	37516–61215
		4218.64	I	24752–48449
7		4231.99	I	17992–41615
4		4277.73	I	
7		4305.96	I	
4		4316.96	II	30563–53721
3.5	h	4393.76	I	25068–47822
3.5	h	4430.22	I	24489–47055
26		4439.21	I	17288–39809
5	h	4482.44	I	24752–47055
5		4515.17	II	26759–48900
2.0		4553.59	II	30563–52517
5	h	4564.00	I	19710–41615
38		4576.21	I	17992–39838
12		4582.36	I	17992–39809
4		4589.22	I	25271–47055
8		4590.84	I	
2.5		4598.37	II	31980–53721
2.0		4683.83	II	32371–53715
2.5		4684.28	I	
11		4726.08	II	26759–47912
10	h	4781.89	I	
10		4786.61	II	31632–52517
2.0		4816.40	I	
2.5		4820.25	II	28758–49498
2.0		4836.95	II	33052–53721
2.5		4837.47	I	24489–45155
1.0		4851.16	II	24333–44941
2.5	h	4894.63	I	
1.6		4912.38	I	19710–40062
42		4935.51	I	19710–39966
1.4		4937.23	II	37516–57765
8		4966.91	I	19710–39838
1.4		5009.52	II	32982–52938
1.0		5067.31	II	34575–54304
1.8		5067.80	I	
4		5069.15	I	
13		5074.33	I	24752–44453
3.0		5076.75	I	25068–44760
1.2		5135.99	II	33052–52517
0.8		5147.03	II	38342–57765
1.2		5184.18	II	33654–52938
3.5		5196.09	I	
5		5211.59	I	25271–44453
2.0		5240.52	II	30224–49301
6		5244.11	I	24752–43816
2.5		5257.51	II	34390–53405
9	h	5277.08	I	24489–43434
2.0		5279.56	II	34785–53721
1.0		5300.95	II	37516–56376
10		5335.15	II	30563–49301
1.8	d	5345.67	II	35019–53721
		5345.85	II	40918–59619
3.5		5347.22	II	35019–53715
1.8	h	5351.33	I	24752–43434
9		5352.96	II	30224–48900
1.8		5358.66	II	35059–53715
1.8		5363.66	I	
1.0		5389.87	II	34390–52938
0.8		5432.74	II	47680–66082
2.5		5449.30	II	35059–53405
0.8		5478.52	II	40036–58284
3.5		5481.94	I	24489–42726
2.5		5505.50	I	24489–42648
1.0		5524.55	I	
5	h	5539.09	I	
140		5556.48	I	0–17992
2.0		5562.07	I	24752–42726
1.2		5568.11	I	
1.2		5586.35	I	24752–42648
2.5		5588.47	II	35832–53721
3.5		5652.00	II	30224–47912
0.4		5686.53	II	
13		5720.01	I	27678–45155
0.6		5749.92	II	49009–66396
0.6	h	5755.90	I	
1.6		5771.67	II	31980–49301
0.6		5803.45	I	
0.6		5819.43	II	46548–63727
2.0		5834.00	II	
2.0		5837.15	II	32371–49498
1.6		5854.52	I	
0.5		5897.23	II	48923–65876

609065 O - 62 - 30

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
1.2		5908.38	II	31980–48900
1.0		5989.32	I	
2.5		5991.51	II	35832–52517
0.6		6052.90	II	32982–49498
0.6		6054.56	I	
3.5		6152.58	II	33052–49301
1.8		6246.97	II	33494–49498
3.5		6274.80	II	31980–47912
0.8		6308.15	II	33052–48900
2.0	h	6400.40	I	27678–43298
2.0	h	6417.97	I	27678–43255
1.2		6432.73	II	32371–47912
1.0	h	6463.15	II	
20		6489.10	I	17288–32695
1.6		6643.54	I	27678–42726
14		6667.85	I	25068–40062
1.2		6678.17	I	27678–42648
2.0		6727.61	II	33052–47912
2.0		6768.70	I	25068–39838
55		6799.61	I	17992–32695
1.4		6934.04	II	33494–47912
2.0		6999.87	II	
1.0		7043.80	II	47680–61873
0.9	h	7244.47	I	24752–38552
0.8	h	7305.25	I	24489–38174
1.0	h	7313.10	I	24752–38422
1.6	h	7350.09	I	
2.5		7448.33	I	24752–38174
3.0	h	7527.56	I	25271–38552
75		7699.49	I	19710–32695
0.7		7895.12	I	24752–37415
7	h	8922.62	II	44498–55702

YTTRIUM

Y, $Z=39$, $M=88.91$, Ratio $\frac{Y}{Cu}=1.399$

Y I Normal state of valence electrons $5s^2\ 4d^1\ {}^2D_{1½}=0$. I.P.= 52650 K
Y II Normal state of valence electrons $5s^2\ \ {}^1S_0=0$. I.P.=100000 K

References

Wavelengths:

A. Gatterer and J. Junkes, Spektren der Seltenen Erden (Specola Vaticana, Vatican, 1945), below 7350 A.

G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York (1939), above 7350 A.

Classification:

Y I, Y II, and Y III, W. F. Meggers and H. N. Russell, J. Research NBS **2,** 733 (1929).

Molecular Spectra:

YO, W. F. Meggers and J. A. Wheeler, J. Research NBS **6,** 239 (1931).

Relative intensity of yttrium lines observed in an arc of copper containing 0.1 atomic percent of yttrium

Strong lines of yttrium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1500	3710. 30	II	1450–28394	$4d^15s^1\ a\ {}^3D_3$ —$4d^15p^1\ \ z\ {}^3F_4^\circ$
1300	3600. 73	II	1450–29214	$4d^15s^1\ a\ {}^3D_3$ —$4d^15p^1\ \ z\ {}^3D_3^\circ$
1200	3774. 33	II	1045–27532	$4d^15s^1\ a\ {}^3D_2$ —$4d^15p^1\ \ z\ {}^3F_3^\circ$
1200	4374. 94	II	3296–26147	$4d^15s^1\ a\ {}^1D_2$ —$4d^15p^1\ \ z\ {}^1D_2^\circ$
1000	3611. 05	II	1045–28730	$4d^15s^1\ a\ {}^3D_2$ —$4d^15p^1\ \ z\ {}^3D_2^\circ$
1000	3633. 12	II	0–27517	$5s^2\ a\ {}^1S_0$ —$4d^15p^1\ \ z\ {}^1P_1^\circ$
1000	4102. 38	I	530–24900	$4d^15s^2\ a\ {}^2D_{2½}$—$4d^15s^15p^1\ y\ {}^2F^\circ_{1½}$
950	4077. 38	I	0–24519	$4d^15s^2\ a\ {}^2D_{1½}$—$4d^15s^15p^1\ y\ {}^2F^\circ_{2½}$
900	4128. 31	I	530–24747	$4d^15s^2\ a\ {}^2D_{2½}$—$4d^15s^15p^1\ y\ {}^2D^\circ_{2½}$
850	3788. 70	II	840–27227	$4d^15s^1\ a\ {}^3D_1$ —$4d^15p^1\ \ z\ {}^3F_2^\circ$
800	3242. 28	II	1450–32284	$4d^15s^1\ a\ {}^3D_3$ —$4d^15p^1\ \ y\ {}^3P_2^\circ$
800	3601. 92	II	840–28595	$4d^15s^1\ a\ {}^3D_1$ —$4d^15p^1\ \ z\ {}^3D_1^\circ$
800	4177. 54	II	3296–27227	$4d^15s^1\ a\ {}^1D_2$ —$4d^15p^1\ \ z\ {}^3F_2^\circ$
750	4142. 85	I	0–24131	$4d^15s^2\ a\ {}^2D_{1½}$—$4d^15s^15p^1\ y\ {}^2D^\circ_{1½}$
600	3327. 89	II	3296–33337	$4d^15s^1\ a\ {}^1D_2$ —$4d^15p^1\ \ z\ {}^1F_3^\circ$
550	3620. 94	I	530–28140	$4d^15s^2\ a\ {}^2D_{2½}$—$4d^15s^15p^1\ x\ {}^2P^\circ_{1½}$
500	3216. 69	II	1045–32124	$4d^15s^1\ a\ {}^3D_2$ —$4d^15p^1\ \ y\ {}^3P_1^\circ$
500	3549. 01	II	1045–29214	$4d^15s^1\ a\ {}^3D_2$ —$4d^15p^1\ \ z\ {}^3D_3^\circ$

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.5	2243.06	II	0–44568
1.6	2354.20	I	530–42995
8	2367.25	III	725–42955
1.4	2373.83		
2.5	2385.24		
1.6	2413.93	II	23776–65189
16	2414.68	III	0–41401
38	2422.20	II	3296–44568
6	2460.61	II	24647–65275
2.5	2490.42	I	530–40672
1.2	2540.28		
1.4	2547.57		
1.0	2550.17		
2.0	2681.65	I	0–37279
7	2694.21		
3.0	2695.39	I	530–37620
11	2723.00	I	530–37244
2.5	2730.08	I	0–36618
2.5	2734.85	II	24647–61200
8	2742.53	I	0–36452
16	2760.10	I	530–36751
3.5	2785.21	II	23776–59670
1.4	2785.59	II	24647–60535
1.4	2791.20	I	0–35817
3.5	2800.11	II	23445–59147
3.0	2813.64	I	530–36061
44	2817.01	III	7466–42955
2.0	2818.86	I	10529–45994
5	2822.56	I	10529–45948
2.5	2825.37	II	29214–64597
5	2826.38	II	23776–59147
8	2854.43	II	24647–59670
3.0	2856.30	II	23776–58776
1.2	2857.87		
11	2886.48	I	11360–45994
2.0	2897.69	II	24647–59147
1.6	2898.82	II	23776–58262
18	2919.05	I	0–34248
2.0 h	2930.03	II	27532–61650
32 h	2945.94	III	7466–41401
44	2948.40	I	0–33907
40	2964.96	I	530–34248
2.0	2973.91	II	24647–58262
55	2974.59	I	0–33608
3.5	2980.55	II	28394–61934
85	2984.26	I	530–34030
8	2995.26	I	530–33907
16	2996.94	I	0–33358
8	3005.26	I	0–33265
6	3018.95	I	10529–43644
15	3021.73	I	530–33614
10	3022.28	I	530–33608
3.0	3026.49	II	26147–59179
3.5	3036.59	II	28730–61650
5	3044.84	I	
22	3045.37	I	530–33358
2.5	3047.11	I	
7	3055.22	II	29214–61934
7	3086.85	II	26147–58533
6 h	3091.70	I	
2.5	3093.76	II	32284–64597
11	3095.88	II	1045–33337
5	3111.81	I	10529–42656
6	3112.04	II	0–32124
2.5	3114.28	I	
7	3128.77	II	27227–59179
10	3129.93	II	27532–59472
12	3135.17	II	1450–33337
14	3173.06	II	28394–59900
28	3179.41	II	840–32284
9	3191.31	I	11360–42686
300	3195.62	II	840–32124
280	3200.27	II	1045–32284
280	3203.32	II	840–32049
500	3216.69	II	1045–32124
800	3242.28	II	1450–32284
40	3280.91	II	14098–44568
2.5	3308.47	II	28730–58947
600	3327.89	II	3296–33337
7	3340.38	I	16066–45994
20	3362.00	II	14833–44568
11	3388.59	I	15246–44748
6	3397.04	I	16234–45664
11	3412.47	I	15712–45008
26	3448.82	II	3296–32284
9	3450.95	I	16234–45204
14	3467.88	II	3296–32124
22	3485.73	I	17116–45796
220	3496.09	II	0–28595
10	3521.53	I	14949–43338
6	3546.01	II	
500	3549.01	II	1045–29214
17	3551.80	I	14949–43096
70	3552.69	I	0–28140
22	3558.76	I	15246–43338
24	3571.43	I	15712–43704
34	3576.05	I	16234–44190
420	3584.52	II	840–28730
38	3587.75	I	
13	3589.69	I	15246–43096

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
360		3592.92	I	0–27824
1300		3600.73	II	1450–29214
800		3601.92	II	840–28595
1000		3611.05	II	1045–28730
550		3620.94	I	530–28140
240		3628.71	II	1045–28595
1000		3633.12	II	0–27517
350		3664.61	II	1450–28730
5		3668.49	II	28394–55645
20		3692.53	I	17116–44190
1500		3710.30	II	1450–28394
7		3718.12	I	16817–43704
7		3738.61	I	16597–43338
140		3747.55	II	840–27517
6		3749.89	I	16436–43096
1200		3774.33	II	1045–27532
160		3776.56	II	1045–27517
6		3782.30	II	29214–55645
850		3788.70	II	840–27227
150		3818.35	II	1045–27227
460		3832.88	II	1450–27532
7		3847.87	II	
8		3876.82		
48		3878.28	II	1450–27227
3.0		3887.77	I	11360–37074
6	h	3904.59	I	
5	h	3918.25	I	10937–36452
6	h	3930.11	I	
24		3930.66	II	3296–28730
440		3950.36	II	840–26147
15		3951.60	II	3296–28595
6	h	3955.09	I	
360		3982.60	II	1045–26147
4		3987.50	I	11360–36431
95		4039.83	I	0–24747
240		4047.64	I	0–24699
950		4077.38	I	0–24519
9	h	4081.22	I	18499–42995
200		4083.71	I	0–24481
1000		4102.38	I	530–24900
6	h	4106.39	I	18512–42858
8		4110.81	I	15246–39565
32		4124.92	II	3296–27532
900		4128.31	I	530–24747
750		4142.85	I	0–24131
10	h	4157.63	I	15712–39758
240		4167.52	I	530–24519
200		4174.14	I	530–24481
800		4177.54	II	3296–27227
12		4199.28	II	840–24647
38		4204.70	II	0–23776
8		4213.02	I	16234–39964
4		4213.54	I	14949–38675
16		4217.80	I	10529–34231
28	h	4220.63	I	14949–38636
8		4224.25	I	
60		4235.73	II	1045–24647
220		4235.94	I	530–24131
30		4251.20	I	15246–38762
36	h	4302.30	I	15712–38949
280		4309.63	II	1450–24647
5		4316.30	I	11360–34521
11		4330.78	I	10529–33613
3.0		4337.29	I	15712–38762
6		4344.65	I	16436–39446
44	h	4348.79	I	16234–39223
6		4352.33	I	11278–34248
6		4352.70	I	16597–39565
12		4357.73	I	16817–39758
80		4358.73	II	840–23776
12		4366.03	I	11360–34257
1200		4374.94	II	3296–26147
15	h	4375.61	I	17116–39964
8		4379.33	I	11079–33907
3.0		4385.48	I	11360–34156
10		4387.74	I	
3.0		4394.01	I	11278–34030
3.0		4394.67	I	16817–39565
180		4398.02	II	1045–23776
90		4422.59	II	840–23445
8		4437.34	I	11079–33608
10		4443.66	I	11532–34030
13		4446.63	I	11360–33842
2.0		4465.27	I	
4		4473.89	I	
17		4475.72	I	11278–33614
18		4476.96	I	11278–33608
16		4477.45	I	10937–33265
11		4487.28	I	11079–33358
30		4487.47	I	10937–33215
3.0		4491.75	I	11532–33789
2.5		4492.42	I	11360–33613
50		4505.95	I	11079–33265
5		4513.58	I	15327–37476
8		4514.01	I	15329–37476
4	h	4522.05	I	16436–38544
90		4527.25	I	11532–33614
44		4527.80	I	11278–33358
10		4544.32	I	15477–37476
10		4559.37	I	15222–37148

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
3.0	4564.39	I	
6 h	4573.56	I	16817–38675
3.5	4581.32	I	15327–37148
3.0	4581.77	I	15329–37148
11	4596.55	I	17116–38866
8	4604.80	I	15329–37040
3.5	4613.00	I	15477–37148
170	4643.70	I	0–21529
17 h	4658.32	I	16159–37620
6	4658.89	I	
7	4667.47	I	15994–37413
5	4670.82	I	
170	4674.84	I	530–21915
5	4678.35	I	19148–40517
22	4682.32	II	3296–24647
7	4689.77	I	16159–37476
15	4696.81	I	15994–37279
3.0	4708.85	I	15222–36452
5	4725.85	I	15994–37148
14	4728.53	I	10529–31672
5 h	4732.37	I	15327–36452
7	4741.40	I	16159–37244
13	4752.79	I	15327–36361
34	4760.98	I	530–21529
1.4	4780.18	I	15222–36136
10	4781.04	I	11278–32188
13	4786.58	II	8328–29214
14	4786.89	I	15477–36361
15	4799.30	I	11079–31909
4	4804.31	I	15327–36136
6	4804.81	I	15329–36136
7 bl	4817.38	YO	
12 bl	4818.20	YO	
12	4819.64	I	10937–31680
10	4822.13	I	15329–36061
16	4823.31	II	8003–28730
5	4839.15	I	15477–36136
65	4839.87	I	11532–32188
46	4845.68	I	11278–31909
34	4852.69	I	11079–31680
10	4854.25	I	15222–35817
75	4854.87	II	8003–28595
4	4856.70	I	15477–36061
28	4859.84	I	10937–31508
4	4879.65	I	15329–35817
160	4883.69	II	8743–29214
4	4886.28	I	16159–36618
3.5	4886.65	I	15994–36452
8	4893.44	I	11079–31508
95	4900.12	II	8328–28730
7	4906.11	I	11532–31909
3.0	4909.00	I	16066–36431
10	4921.87	I	11360–31672
2.5	4930.93	I	16146–36420
3.0	4950.66	I	
8	4974.30	I	18499–38597
8	4982.13	II	8328–28394
7	5006.97	I	18512–38479
5	5070.21	I	19148–38866
5	5072.19	I	
75	5087.42	II	8743–28394
2.0	5088.18	I	19028–38675
14	5119.11	II	8003–27532
30	5123.21	II	8003–27517
12	5135.20	I	18499–37967
8	5196.43	II	14098–33337
65	5200.41	II	8003–27227
100	5205.72	II	8328–27532
12	5240.81	I	18512–37588
4	5289.82	II	8328–27227
3.0	5320.78	II	8743–27532
5	5380.62	I	15327–33907
15	5402.78	II	14833–33337
1.6	5417.03	I	16066–34521
6	5424.37	I	15477–33907
13	5438.24	I	15864–34248
48	5466.46	I	11532–29820
7	5468.47	I	15327–33608
6	5473.39	II	14018–32284
6	5480.74	II	13883–32124
4	5493.17	I	14949–33148
2.5	5495.59	I	16066–34257
16	5497.41	II	14098–32284
20	5503.45	I	15864–34030
17	5509.90	II	8003–26147
4	5513.64	I	15477–33608
8	5521.63	I	15327–33432
	5521.70	II	14018–32124
1.6	5526.76	I	16159–34248
50	5527.54	I	11278–29364
2.5	5541.63	I	15712–33753
8	5544.61	I	15327–33358
		II	14018–32049
6	5546.02	II	14098–32124
5	5556.43	I	15246–33238
4	5567.75	I	15477–33432
12	5577.42	I	15864–33789
1.6	5581.08	I	15994–33907
42	5581.87	I	11079–28989
1.4	5590.96	I	15477–33358

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.4	5594.12	I	16159–34030
8	5606.33	I	11532–29364
1.0	5623.91	I	16066–33842
38	5630.13	I	10937–28694
1.6	5632.25	I	15864–33614
1.4	5632.89	I	16159–33907
8	5644.69	I	11278–28989
8	5648.47	I	15712–33412
50	5662.94	II	15683–33337
6	5675.27	I	11079–28694
1.2	5693.63	I	16597–34156
11	5706.73	I	16234–33753
1.6	5720.61	I	16436–33912
5	5728.89	II	14833–32284
10 bl	5730.12	YO	
1.4	5732.09	I	16817–34257
6	5743.85	I	17116–34521
1.2 bl	5746.93	YO	
1.6 bl	5764.22	YO	
5	5765.64	I	16817–34156
2.5	5773.86	I	16597–33912
7	5781.69	II	14833–32124
1.0 bl	5800.00	YO	
1.0 bl	5818.58	YO	
2.0	5821.87	I	16066–33238
1.4	5832.27	I	17116–34257
0.6 b	5838.07	YO	
1.0	5858.83	YO	
1.0	5871.83	I	16817–33842
1.6	5876.14	YO	
1.6	5879.96	I	16146–33148
1.6 b	5893.94	YO	
2.5	5902.96	I	16817–33753
1.6 b	5912.19	YO	
1.6 b	5931.10	YO	
6 bl	5939.08	YO	
3.0	5945.72	I	16597–33412
1.6	5950.02	I	16436–33238
5 b	5956.41	YO	
85 bl	5972.04	YO	
3.5	5981.86	I	16436–33148
70 bl	5987.64	YO	
50 bl	6003.60	YO	
8	6004.65		
8	6009.19	I	17116–33753
42 bl	6019.87	YO	
8	6023.41	I	0–16597
34 bl	6036.60	YO	
28 bl	6053.81	YO	
9 bl	6072.78	YO	
3.5	6088.00	I	16817–33238
14 bl	6089.35	YO	
11 bl	6096.78	YO	
9 bl	6107.82	YO	
9 bl	6114.73	YO	
5 bl	6127.38	YO	
95 bl	6132.06	YO	
8	6135.04	I	17116–33412
10	6138.43	I	530–16817
75 bl	6148.36	YO	
8	6151.72	YO	
55 bl	6165.08	YO	
38 bl	6182.23	YO	
80	6191.73	I	0–16146
40 bl	6199.82	YO	
30 bl	6217.96	YO	
20	6222.59	I	0–16066
18 bl	6236.72	YO	
3	6251.05	I	
8 bl	6275.01	YO	
4 b	6295.46	YO	
1.6 b	6316.20	YO	
1.6 b	6338.10	YO	
1.0 b	6359.48	YO	
1.0	6369.87	YO	
5	6402.01	I	530–16146
70	6435.00	I	530–16066
1.6	6437.18	I	18499–34030
1.2 h	6501.23	YO	
1.2 h	6518.33	YO	
1.2 h	6535.84	YO	
6	6538.60	I	18499–33789
0.8 h	6553.84	YO	
6	6557.39	I	0–15246
1.0 h	6572.58		
3.0	6576.85	I	19238–34438
2.0	6584.87	I	530–15712
8	6613.75	II	14098–29214
1.2	6622.49	I	18512–33608
1.6 h	6636.49	I	28989–44053
3.5	6650.61	I	19406–34438
1.8	6664.40	I	29364–44366
13	6687.58	I	0–14949
1.2 h	6691.83	I	29820–44760
0.6	6694.75	I	18499–33432
1.4 h	6699.26	I	
6	6700.71	I	18512–33432
3.0	6713.20	I	21529–36420
3.5	6735.99	I	19406–34248
16	6793.71	I	530–15246

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
6	h	6795.41	II	14018–28730
1.0	h	6803.15	I	19148–33842
1.8		6815.16	I	19238–33907
1.2		6832.49	II	14098–28730
4		6845.24	I	19148–33753
1.2		6858.24	II	14018–28595
2.5		6887.22	I	21915–36431
1.8		6896.00	II	14098–28595
0.8		6908.26	I	14949–29420
1.2		6933.52	I	530–14949
2.5	h	6950.31	I	19028–33412
1.0		6951.68	II	14833–29214
1.0		6958.04	I	15246–29614
2.5		6979.88	I	14949–29272
1.4	h	7008.97	I	19148–33412
1.0		7009.93	I	18976–33238
2.0	h	7035.18	I	19028–33238
3.0		7052.94	I	15246–29420
1.4	h	7054.28	I	18976–33148
0.9		7075.13	I	15712–29843
1.2		7127.92	I	15246–29272
3.5		7191.66	I	15712–29614
1.0	h	7195.93	I	36361–50254
3.5		7264.17	II	14833–28595
0.9	h	7293.08	I	15712–29420
0.9	h	7330.62		
0.5		7332.96	II	13883–27517
5		7346.46	I	16234–29843
1.2	h	7398.77	I	15477–28989
3.0		7450.30	II	14098–27517
1.8		7494.88	I	19028–32366
0.7	h	7536.71	I	
3.5		7563.13	I	19148–32366
0.8	h	7617.72	I	
2.0	h	7622.94	I	18976–32091
0.7		7652.89	I	19028–32091
0.5		7689.49	I	18976–31978
0.8	h	7698.00	I	
2.0		7719.89	I	19028–31978
2.0		7724.08	I	19148–32091
1.4		7788.42	I	16436–29272
1.4		7796.32	I	16597–29420
0.6		7802.52	I	15327–28140
1.8		7812.16	I	16817–29614
3.0		7855.52	I	17116–29843
11		7881.90	II	14833–27517
1.0	h	7999.33	I	17116–29614
0.9		8329.61	I	32188–44190
2.5		8344.43	I	16159–28140
0.8	h	8365.64	I	24481–36431
1.8		8450.36	I	15994–27824
0.8	h	8528.94	I	24699–36420
10		8800.62	I	0–11360
2.0	h	8835.85	II	14833–26147

ZINC

Zn, $Z=30$, $M=65.38$, Ratio $\frac{Zn}{Cu}=1.029$

Zn I Normal state of valence electrons $3d^{10}\ 4s^2\ {}^1S_0 = 0$. I.P.= 75767 K
Zn II Normal state of valence electrons $3d^{10}\ 4s^1\ {}^2S_{0\frac{1}{2}} = 0$. I.P.=144891 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Zn I, C. W. Hetzler, R. W. Boreman, and K. Burns, Phys. Rev. **48,** 656 (1935).
Zn II, G. V. Salis, Ann. Physik **76,** 145 (1925).

Intensities:
A. Filippov, Phys. Z. Sowjetunion **1,** 289 (1932).
W. Billeter, Helv. Phys. Acta **7,** 841 (1934).
J. W. Schuttevaer and J. A. Smit, Physica **10,** 502 (1943).

Relative intensity of zinc lines observed in an arc of copper containing 0.1 atomic percent of zinc

Strong lines of zinc

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
1000	2138. 56	I	0–46745	$3d^{10}4s^2\ {}^1S_0$—$3d^{10}4s^14p^1\ {}^1P_1^\circ$
140	3345. 02	I	32890–62777	$3d^{10}4s^14p^1\ {}^3P_2^\circ$—$3d^{10}4s^14d^1\ {}^3D_3$
140	4810. 53	I	32890–53672	$3d^{10}4s^14p^1\ {}^3P_2^\circ$—$3d^{10}4s^15s^1\ {}^3S_1$

Zinc — All Observed Lines

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K	Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
2.5		2025.51	II	0−49354	20		3282.33	I	32311−62769
13		2061.91	II	0−48481	90		3302.59	I	32501−62772
1000		2138.56	I	0−46745	28		3302.94	I	32501−62769
3.5	h	2756.45	I	32311−68579	140		3345.02	I	32890−62777
6	d	2770.86	I	32501−68581	30		3345.57	I	32890−62772
		2770.98	I	32501−68579					
					6		3345.93	I	32890−62769
9	d	2800.87	I	32890−68583	40		4680.14	I	32311−53672
		2801.06	I	32890−68581	100		4722.16	I	32501−53672
10	h	3072.06	I	32890−65432	140		4810.53	I	32890−53672
26		3075.90	I	0−32502	12	hl	6362.35	I	46745−62458

ZIRCONIUM

Zr, $Z=40$, $M=91.22$, Ratio $\frac{Zr}{Cu}=1.436$

Zr I, Normal state of valence elections $4d^2\ 5s^2\ {}^3F_2\ =0$. I.P.= 56077 K
Zr II, Normal state of valence electrons $4d^2\ 5s^1\ {}^4F_{1½}=0$. I.P.=113175 K

References

Wavelengths:
G. R. Harrison, Massachusetts Institute of Technology Wavelength Tables (John Wiley & Sons, New York, 1939).

Classification:
Zr I, C. C. Kiess and H. K. Kiess, J. Research NBS **6,** 621 (1931).
Zr II, C. C. Kiess and H. K. Kiess, J. Research NBS **5,** 1205 (1930).

Molecular Spectra:
ZrO, C. C. Kiess, Sci. Papers BS **22,** 47 (1927).

Relative intensity of zirconium lines observed in an arc of copper containing 0.1 atomic percent of zirconium

Strong lines of zirconium

Intensity	Wavelength A	Spectrum	Energy levels K	Term combination
900	3391. 98	II	1323–30796	$4d^25s^1\ a\ {}^4F_{4½}—4d^2\ 5p^1\ z\ {}^4G^0_{5½}$
750	3438. 23	II	763–29840	$4d^25s^1\ a\ {}^4F_{3½}—4d^2\ 5p^1\ z\ {}^4G^0_{4½}$
650	3496. 21	II	315–28909	$4d^25s^1\ a\ {}^4F_{2½}—4d^2\ 5p^1\ z\ {}^4G^0_{3½}$
550	3601. 19	I	1241–29002	$4d^25s^2\ a\ {}^3F_4\ —4d^25s^15p^1\ x\ {}^3G^0_5$
340	3556. 60	II	3758–31866	$4d^3\ b\ {}^4F_{4½}—4d^2\ 5p^1\ z\ {}^4F^0_{4½}$
340	3572. 47	II	0–27984	$4d^25s^1\ a\ {}^4F_{1½}—4d^2\ 5p^1\ z\ {}^4G^0_{2½}$
320	3519. 60	I	0–28404	$4d^25s^2\ a\ {}^3F_2\ —4d^25s^15p^1\ x\ {}^3G^0_3$
280	3547. 68	I	570–28750	$4d^25s^2\ a\ {}^3F_3\ —4d^25s^15p^1\ x\ {}^3G^0_4$
280	3551. 95	II	763–28909	$4d^25s^1\ a\ {}^4F_{3½}—4d^2\ 5p^1\ z\ {}^4G^0_{3½}$
280	3835. 96	I	0–26062	$4d^25s^2\ a\ {}^3F_2\ —4d^25s^15p^1\ x\ {}^3F^0_2$
260	3863. 87	I	570–26444	$4d^25s^2\ a\ {}^3F_3\ —4d^25s^15p^1\ x\ {}^3F^0_3$
260	3890. 32	I	1241–26938	$4d^25s^2\ a\ {}^3F_4\ —4d^25s^15p^1\ x\ {}^3F^0_4$
200	2678. 63	II	1323–38644	$4d^25s^1\ a\ {}^4F_{4½}—4d^15s^15p^1\ y\ {}^4F^0_{4½}$
200	3279. 26	II	763–31249	$4d^25s^1\ a\ {}^4F_{3½}—4d^2\ 5p^1\ z\ {}^4F^0_{3½}$
200	3481. 15	II	6468–35186	$4d^25s^1\ a\ {}^2F_{3½}—4d^2\ 5p^1\ z\ {}^2G^0_{4½}$
200	3576. 85	II	3300–31249	$4d^3\ b\ {}^4F_{3½}—4d^2\ 5p^1\ z\ {}^4F^0_{3½}$
200	4687. 80	I	5889–27215	$4d^35s^1\ a\ {}^5F_5\ —4d^3\ 5p^1\ y\ {}^5G^0_6$
190	3479. 39	II	5753–34485	$4d^25s^1\ a\ {}^2F_{2½}—4d^2\ 5p^1\ z\ {}^2G^0_{3½}$
180	3613. 10	II	315–27984	$4d^25s^1\ a\ {}^4F_{2½}—4d^2\ 5p^1\ z\ {}^4G^0_{2½}$
180	3614. 77	II	2895–30551	$4d^3\ b\ {}^4F_{2½}—4d^2\ 5p^1\ z\ {}^4F^0_{2½}$
180	3623. 86	I	570–28157	$4d^25s^2\ a\ {}^3F_3\ —4d^25s^15p^1\ w\ {}^3F^0_3$
180	3891. 38	I	1241–26931	$4d^25s^2\ a\ {}^3F_4\ —4d^25s^15p^1\ z\ {}^1G^0_4$
180	4072. 70	I	5541–30087	$4d^35s^1\ a\ {}^5F_4\ —4d^3\ 5p^1\ x\ {}^5D^0_3$
180	4081. 22	I	5889–30385	$4d^35s^1\ a\ {}^5F_5\ —4d^3\ 5p^1\ x\ {}^5D^0_4$
180	4227. 76	I	5889–29535	$4d^35s^1\ a\ {}^5F_5\ —4d^3\ 5p^1\ y\ {}^5F^0_5$
180	4239. 31	I	5541–29123	$4d^35s^1\ a\ {}^5F_4\ —4d^3\ 5p^1\ y\ {}^5F^0_4$

Zirconium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
1.8	2374.42	I	0–42103
1.8	2384.17	I	
1.8	2388.01	I	570–42434
1.8	2389.21	I	
1.8	2405.52	I	1241–42799
3.0	2419.41	II	4248–45568
10	2449.85	II	4248–45055
1.4	2457.44	II	4506–45186
5	2487.29	II	8153–48345
3.0	2496.48	II	7838–47882
12	2532.46	II	763–40239
6	2539.65	I	570–39934
15	2542.10	II	315–39640
3.0	2550.51	I	570–39766
15	2550.74	II	0–39192
3.0	2556.43	I	1241–40346
4	2567.45	I	1241–40178
38	2567.64	II	0–38934
110	2568.87	II	1323–40239
140	2571.39	II	763–39640
5	2583.40	II	4506–43202
9	2589.07	II	4248–42861
1.5	2589.65	I	570–39174
5	2609.43	I	570–38882
17	2630.91	II	4506–42504
9	2635.42	I	1241–39174
24	2639.09	II	763–38644
8	2643.40	II	315–38134
6	2647.78	I	570–38327
12	2650.38	II	763–38483
8	2658.69	I	4186–41788
20	2667.80	II	315–37788
6	2669.49	II	5753–43202
		II	7736–45186
13	2670.96	II	4248–41677
200	2678.63	II	1323–38644
4	2681.76	II	763–38041
10	2687.75	I	1241–38436
10	2692.60	II	8058–45186
2.5	2692.92	I	0–37123
18	2693.53	II	315–37430
20	2694.06	II	5753–42861
8	2695.43	II	4248–41337
11	2699.60	II	315–37346
85	2700.13	II	763–37788
10	2706.17	I	0–36942
8	2709.33	I	570–37469
32	2711.51	II	0–36869
16	2712.42	II	315–37171
16	2714.26	II	4506–41337
1.4	2717.48	I	4186–40974
150	2722.61	II	1323–38041
16	2725.47	I	1241–37921
90	2726.49	II	763–37430
7	2727.02	I	570–37230
55	2732.72	II	763–37346
160	2734.86	II	315–36869
4	2737.89	I	
8	2740.35	II	3758–40239
12	2740.51	II	4248–40727
16	2741.55	II	1323–37788
120	2742.56	II	0–36452
75	2745.86	II	763–37171
75	2752.21	II	315–36639
60	2758.81	II	0–36237
1.4	2759.48	I	1241–37469
8	2761.91	II	0–36197
10	2763.03	I	4376–40558
22 d	2768.73	II	1323–37430
	2768.85	II	763–36869
19 d	2774.04	I	570–36608
	2774.16	II	6468–42504
9	2786.86	I	5102–40974
22	2790.14	I	5102–40932
14	2792.04	I	0–35806
10	2793.39	I	
3.5	2795.13	I	570–36336
18	2796.90	II	5724–41468
12	2799.15	II	5753–41468
10	2806.78	I	4186–39804
4	2808.16	II	315–35915
20	2810.91	II	6112–41677
70	2814.90	I	0–35515
44	2818.74	II	7736–43202
8	2819.56	I	5102–40558
6	2821.56	I	570–36001
60	2825.56	II	7513–42894
10	2827.50	II	6112–41468
	2827.54	I	1241–36597
7	2829.81	I	4376–39704
12	2833.91	II	7513–42789
9	2834.40	II	6468–41738
4	2836.49	I	5102–40346
80	2837.23	I	570–35806
6	2838.02	II	6112–41337
14	2839.34	II	6468–41677
15	2843.52	II	7736–42894
75	2844.58	II	8058–43202
24	2848.19	II	5753–40853
40	2848.52	I	1241–36336

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
40	2851.97	II	7736–42789
8	2854.43	II	7838–42861
3.0	2856.06	II	5724–40727
11	2860.85	I	570–35515
6	2865.10	II	2895–37788
10	2865.60	II	3758–38644
38	2869.81	II	8058–42894
4	2872.53	II	8058–42861
55	2875.98	I	1241–36001
10	2877.55	II	3300–38041
4	2880.83	I	5102–39804
4	2882.09	II	4248–38934
6	2883.80	II	7838–42504
10	2888.04	II	6112–40727
5	2889.43	II	2572–37171
14	2892.26	I	1241–35806
10	2898.71	II	3300–37788
7	2901.62	II	13428–47882
6	2901.82	II	2895–37346
18	2905.23	II	6468–40878
8	2907.38	II	6468–40853
10	2910.25	II	8153–42504
34	2915.99	II	3758–38041
3.0	2916.25	I	570–34851
12	2916.64	II	2895–37171
30	2918.24	II	8153–42410
8	2923.85	I	570–34762
5	2924.64	II	14163–48345
36	2926.99	II	14190–48345
18	2934.61	II	2572–36639
18	2936.31	II	3300–37346
10	2945.46	II	7736–41677
36	2948.94	II	7838–41738
24	2951.48	II	3300–37171
11	2952.24	II	1323–35186
36	2955.78	II	14060–47882
50	2960.87	I	0–33764
50	2962.68	II	2895–36639
50	2968.96	II	3758–37430
19	2969.19	I	570–34240
36	2969.63	II	2572–36237
20	2976.61	II	8153–41738
50	2978.05	II	3300–36869
36	2979.18	II	2895–36452
26	2981.02	II	4506–38041
130	2985.39	I	0–33487
4	2987.80	II	9743–43202
8	2991.41	II	0–33419
50	3003.74	II	4506–37788
16	3005.37	I	4186–37450
26	3005.50	I	8057–41320
130	3011.75	I	570–33764
16	3013.32	II	4506–37682
10	3014.44	I	0–33164
26	3019.84	II	315–33419
55	3020.47	II	4248–37346
80	3028.04	II	7838–40853
140	3029.52	I	1241–34240
28	3030.92	II	0–32984
55 d	3036.39	II	4506–37430
	3036.50	II	4248–37171
5	3043.25	I	570–33420
16	3045.83	I	4186–37008
11	3049.33	I	4186–36971
110	3054.84	II	8153–40878
11	3057.22	II	8153–40853
16	3060.11	II	315–32984
14	3061.35	II	763–33419
11	3063.57	I	4376–37008
16	3064.63	II	4248–36869
8	3065.21	II	0–32615
17	3085.34	I	570–32972
9	3090.44	I	5102–37450
17	3094.80	I	4186–36489
40	3095.07	II	315–32615
17	3095.82	I	4197–36489
44	3099.23	II	0–32257
110	3106.58	II	8058–40239
18	3108.37	I	4376–36538
34	3110.88	II	763–32899
55	3120.74	I	4186–36220
11	3125.19	II	4248–36237
50	3125.92	II	0–31981
80	3129.18	II	4248–36197
80	3129.76	II	315–32257
22	3131.11	I	4197–36125
55	3132.07	I	4376–36295
17	3133.23	I	5102–37008
55	3133.48	II	7736–39640
28	3136.96	I	5102–36971
110	3138.68	II	763–32615
22	3139.80	I	5102–36942
28	3148.82	I	4376–36125
46	3155.67	II	7513–39192
24	3157.00	II	4248–35915
50	3157.82	I	4376–36035
		I	5102–36760
85	3164.31	II	5753–37346
24	3165.45	II	8058–39640
140	3165.97	II	1323–32899

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
24		3166.26	II	6468–38041
30		3178.09	II	7736–39192
30		3181.58	II	7513–38934
24		3181.92	II	5753–37171
140		3182.86	II	4506–35915
85		3191.21	I	0–31327
34		3191.90	II	6468–37788
12		3197.04	I	4186–35456
4		3204.35	II	7736–38934
15		3204.90	I	5102–36295
85		3212.01	I	570–31695
7		3212.58	I	5102–36220
12		3212.85	II	5753–36869
120		3214.19	II	763–31866
17		3222.47	II	14163–45186
32		3228.81	II	6468–37430
100		3231.69	II	315–31249
100		3234.12	I	1241–32152
17		3236.58	II	14299–45186
120		3241.05	II	315–31160
50		3250.39	I	570–31327
		3250.46	II	14299–45055
32		3254.28	I	16978–47698
32		3260.11	I	4186–34851
6		3264.81	II	7513–38134
30		3269.66	I	4186–34762
24		3271.13	II	4248–34810
85		3272.22	II	0–30551
160		3273.05	II	1323–31866
200		3279.26	II	763–31249
50	d	3282.73	I	1241–31695
		3282.83	II	14733–45186
140		3284.71	II	0–30435
22		3285.88	II	8058–38483
24		3288.80	II	763–31160
			II	7736–38134
12		3296.40	II	7736–38063
12		3302.67	II	9969–40239
			II	17614–47882
85		3305.15	II	315–30562
140		3306.28	II	315–30551
6		3309.89	II	7838–38041
6		3311.34	II	5724–35915
24		3313.70	II	7513–37682
34		3314.50	II	5753–35915
12		3318.51	II	6112–36237
24		3319.02	II	315–30435
60		3322.99	II	6112–36197
6		3326.41	I	4186–34240
60		3326.80	II	12360–42410
60		3334.25	II	8058–38041
34		3334.62	II	4506–34485
30		3338.41	II	7736–37682
120		3340.56	II	1323–31249
60		3344.79	II	8153–38041
20		3353.66	I	1241–31050
28		3354.39	II	6112–35915
120		3356.09	II	763–30551
85		3357.26	II	0–29778
28		3359.96	II	11984–41738
24		3360.46	I	5102–34851
15		3362.68	II	8058–37788
24		3363.82	II	2895–32615
24		3367.82	II	2572–32257
4		3368.64	I	0–29677
6		3369.26	II	9969–39640
24		3370.59	I	5102–34762
28		3373.42	II	8153–37788
60		3374.73	II	8058–37682
17		3376.27	II	7736–37346
24		3377.46	II	3300–32899
9		3378.30	II	7838–37430
9		3379.92	I	17556–47135
90		3387.87	II	7838–37346
120		3388.30	II	0–29505
900		3391.98	II	1323–30796
90		3393.12	II	315–29778
26		3396.33	II	7736–37171
6		3396.66	II	13429–42861
6		3397.92	I	18277–47698
60		3399.35	II	2572–31981
24		3402.87	II	12360–41738
30		3403.68	II	8058–37430
90		3404.83	II	2895–32257
30		3408.08	II	7838–37171
6		3408.78		
120		3410.25	II	3300–32615
6	h	3411.79	I	17833–47135
60		3414.66	I	570–29847
			II	8153–37430
12		3419.11	II	1323–30562
18		3419.66	I	4186–33420
25		3424.82	II	315–29505
4		3426.93	I	8057–37230
10		3430.29	I	1241–30385
160		3430.53	II	3758–32899
18		3431.57	II	7736–36869
22		3432.41	II	7513–36639
18		3433.91	II	8058–37171
60		3437.14	II	5724–34810

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
750	3438.23	II	763–29840
28	3440.45	I	0–29058
19	3443.57	II	7838–36869
30	3446.61	I	4186–33192
95	3447.36	I	0–28999
32	3455.91	I	4186–33114
18	3457.18	I	4197–33114
65	3457.56	II	4506–33419
32	3458.93	II	7736–36639
26	3461.09	I	8057–36942
130	3463.02	II	11984–40853
15	3465.63	I	1241–30087
6	3469.94	II	8058–36869
95	3471.19	I	0–28801
4	3472.90	I	4186–32972
20	3478.30	II	763–29505
10	3478.50	II	9743–38483
32	3478.79	I	4376–33114
28	3479.02	II	4248–32984
190	3479.39	II	5753–34485
24	3480.41	II	7513–36237
200	3481.15	II	6468–35186
30	3482.81	I	570–29275
30	3483.01	I	8057–36760
120	3483.54	II	6112–34810
20	3485.32	II	7513–36197
7	3495.37	I	11956–40558
650	3496.21	II	315–28909
30	3499.58	II	3300–31866
20	3501.35	I	570–29123
13	3501.49	I	8057–36608
55	3505.48	II	12360–40878
130	3505.67	II	1323–29840
13	3506.05	II	9969–38483
7	3507.67	II	7736–36237
160	3509.32	I	570–29058
32	3510.46	II	4506–32984
320	3519.60	I	0–28404
20	3520.87	II	4506–32899
70	3525.81	II	2895–31249
14	3530.22	I	5102–33420
11	3530.85	II	14190–42504
70	3533.22	I	1241–29535
34	3535.16	I	8057–36336
18	3536.94	II	2895–31160
7	3539.01	II	13429–41677
100	3542.62	II	14190–42410
280	3547.68	I	570–28750
20	3549.51	II	9969–38134
34	3549.74	I	8057–36220
100	3550.46	I	0–28157
280	3551.95	II	763–28909
20	3554.07	II	9553–37682
340	3556.60	II	3758–31866
24	3558.96	I	5102–33192
170	3566.10	I	1241–29275
14	3568.14	II	6468–34485
34	3568.88	I	5102–33114
340	3572.47	II	0–27984
34	3573.08	II	2572–30551
170	3575.79	I	570–28528
200	3576.85	II	3300–31249
28	3577.55	I	8057–36001
24	3578.23	II	9743–37682
140	3586.29	I	0–27876
70	3587.98	II	2572–30435
28	3588.32	II	3300–31160
11	3591.72	I	570–28404
7 h	3593.13	I	17060–44882
14	3599.90	II	14733–42504
550	3601.19	I	1241–29002
26	3607.38	II	9969–37682
110	3611.89	II	14060–41738
180	3613.10	II	315–27984
22	3613.70	I	4186–31851
180	3614.77	II	2895–30551
180	3623.86	I	570–28157
28	3630.02	II	2895–30435
22	3633.49	II	14163–41677
50	3634.15	I	1241–28750
28	3636.45	II	3758–31249
5	3638.72	I	4376–31851
5	3655.56	II	7838–35186
32	3661.20	I	570–27876
12	3662.14	II	13429–40727
140	3663.65	I	1241–28528
20	3668.45	II	3300–30551
48	3671.27	II	5753–32984
100	3674.72	II	2572–29778
18	3678.90	II	14163–41337
7	3680.37	I	1241–28404
48	3697.46	II	3758–30796
120	3698.17	II	8153–35186
11	3706.63	I	1241–28212
90	3709.26	II	6468–33419
24	3714.13	I	1241–28157
24	3714.78	II	4248–31160
8	3718.84	II	2895–29778
34	3731.26	II	14060–40853
6	3737.39	I	5102–31851

Zirconium — All Observed Lines

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	3738.11	II	4506–31249
70	3745.98	II	14190–40878
10	3750.64	II	4506–31160
110	3751.60	II	7838–34485
6	3754.79	I	14349–40974
12	3757.79	II	14733–41337
60	3764.39	I	0–26557
60	3766.72	I	12342–38882
42	3766.82	II	3300–29840
3	3767.88	II	5724–32257
90	3780.54	I	0–26444
6	3782.22	II	6468–32899
12	3786.61		
70	3791.40	I	570–26938
11	3792.40	I	570–26931
16	3796.48	II	8153–34485
12	3808.20		
26	3817.58	II	4248–30435
70	3822.41	I	0–26154
		I	5541–31695
7	3827.27	II	
280	3835.96	I	0–26062
160	3836.76	II	4506–30562
14	3838.28	II	4506–30551
50	3843.02	II	2895–28909
50	3847.01	I	570–26557
50	3849.25	I	0–25972
10	3855.43	II	4506–30435
260	3863.87	I	570–26444
70	3864.34	I	1241–27111
90	3877.60	I	8057–33839
18	3879.05	I	570–26343
140	3885.42	I	0–25730
260	3890.32	I	1241–26938
180	3891.38	I	1241–26931
9 h	3892.03	I	15201–40888
7 h	3893.84	I	12761–38436
14	3896.53	I	570–26227
		I	17143–42799
7	3897.66	I	14697–40346
36	3900.52	I	0–25630
3.5	3914.34	II	19515–45055
28	3915.94	II	4248–29778
14	3916.64	I	1241–26766
55	3921.79	I	570–26062
7 h	3926.78	I	15720–41179
110	3929.53	I	570–26012
18	3934.12	II	2572–27984
18	3934.79	II	5753–31160
6	3936.06	II	6468–31866
9	3941.62	I	8057–33420
3.5	3951.33	I	11641–36942
3.5	3956.79		
85	3958.22	II	4248–29505
7 h	3963.80	I	16317–41538
44	3966.66	I	1241–26444
90	3968.26	I	1241–26434
3.5	3972.30	I	15720–40888
10	3973.39	I	12761–37921
60	3973.50	I	570–25730
18	3975.29	I	12773–37921
6	3977.34	I	5249–30385
14	3977.48	I	8057–33192
3.5	3978.25	I	
9	3978.74	I	12342–37469
18 h	3981.60	I	11017–36125
		I	16978–42087
9	3982.16	I	10885–35990
14	3984.75	I	4186–29275
6	3986.80	I	570–25646
9	3988.68	I	5023–30087
7	3989.29	I	570–25630
14	3989.50	I	15120–40178
70	3991.13	II	6112–31160
70	3998.97	II	4506–29505
3.5	4001.09	I	1241–26227
7	4002.55	I	4871–29847
13	4003.10	I	11017–35990
7	4004.40	I	12503–37469
7 h	4004.87	I	16978–41941
18	4007.60	I	14989–39934
18	4012.25	I	15720–40637
14	4016.98	I	12342–37230
11	4018.38	II	7736–32615
36	4023.98	I	5541–30385
11	4024.44	II	8058–32899
70	4024.92	I	5249–30087
90	4027.20	I	5023–29847
22	4028.95	I	4186–28999
36	4029.68	II	5753–30562
44	4030.04	I	4871–29677
3.5	4034.09	II	6468–31249
36	4035.89	I	1241–26012
3.5	4040.24	II	7513–32257
9	4041.64	I	15201–39937
22	4042.22	I	11258–35990
55	4043.58	I	4186–28910
44	4044.56	I	4871–29588
36	4045.61	II	5724–30435
55	4048.67	II	6468–31160

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
18	4050.33	II	5753–30435
18	4050.48	I	4376–29058
11	4054.43	I	1241–25898
70	4055.03	I	5023–29677
54	4055.71	I	12773–37422
30	4061.53	I	4186–28801
140	4064.16	I	5249–29847
7	4068.72	I	10885–35456
180	4072.70	I	5541–30087
28	4074.93	I	4376–28910
18	4076.53	I	4186–28710
22	4078.31	I	4197–28710
180	4081.22	I	5889–30385
6	4082.30	I	1241–25730
11	4083.08	I	11641–36125
14	4084.30	I	14697–39174
14	4085.66	I	12761–37230
7	4087.69	I	12773–37230
14	4090.51	II	6112–30551
14	4090.79	I	12503–36942
5	4093.16	I	4376–28801
11	4094.27	I	12342–36760
6	4096.63	II	4506–28909
10	4099.31	I	0–24388
14	4107.50	I	11956–36295
18	4108.40	I	4376–28710
10	4119.83	I	12342–36608
36	4121.46	I	4376–28633
7 h	4127.96	I	4186–28404
		I	4376–28595
7	4134.31	I	12761–36942
14	4135.68	I	5102–29275
3.5	4140.01	I	14123–38271
6	4147.37	I	12503–36608
110	4149.20	II	6468–30562
14	4150.97	II	6468–30551
18	4152.64	I	11017–35091
7	4153.75	I	12773–36841
26	4156.24	II	5724–29778
36	4161.21	II	5753–29778
36	4166.36	I	5541–29535
7	4169.36	I	14349–38327
11	4171.48	I	10885–34851
7	4179.81	II	13429–37346
18	4183.32	I	5102–28999
9	4186.69	II	14163–38041
60	4187.56	I	11641–35515
11	4191.79	I	11956–35806
3.5	4192.10	I	12761–36608
3.5	4194.01	I	12761–36597
36	4194.76	I	11258–35091
7	4196.13	I	12773–36597
55	4199.09	I	5102–28910
55	4201.46	I	5023–28818
55	4208.98	II	5753–29505
7	4211.34	I	14697–38436
18	4211.88	II	4248–27984
7	4212.62	I	10885–34617
36	4213.86	I	4871–28595
11	4218.45	I	5102–28801
3.5	4220.65	I	5023–28710
6	4225.46	I	12342–36001
180	4227.76	I	5889–29535
3.5	4231.63	II	14163–37788
14	4234.63	I	5102–28710
18	4236.06	I	11017–34617
6	4236.55	I	0–23597
9	4237.43	I	11258–34851
180	4239.31	I	5541–29123
70	4240.34	I	4871–28447
70	4241.20	I	5023–28595
110	4241.69	I	5249–28818
7	4253.57	I	11258–34762
7	4256.44	I	4186–27673
16	4258.04	II	4506–27984
7	4261.21	I	5541–29002
7	4261.42	I	12761–36220
28	4268.02	I	5023–28447
7	4273.52	II	6112–29506
8	4274.77	I	4186–27573
11	4276.72	I	4197–27573
7	4282.03	I	17833–41179
50	4282.20	I	5249–28595
3.5	4286.51	II	7838–31160
10	4291.20	I	4376–27673
10	4291.35	I	4186–27482
50	4294.79	I	5541–28818
3.5	4296.74	II	14163–37430
28	4302.89	I	5889–29123
17	4304.68	I	14697–37921
3.5	4309.82	I	4376–27573
7	4317.31	II	5753–28909
7	4319.05	I	1241–24388
7	4321.17	I	1241–24376
10	4324.03	I	14349–37469
16	4325.44	I	5889–29002
3.5	4329.56	I	570–23661
3.5	4333.26	II	19433–42504
50	4341.13	I	11258–34287
3.5	4343.04	I	0–23019

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4346.52	I	14123–37123
3.0	4347.22	I	570–23567
95	4347.89	I	8057–31050
3.0	4348.93	I	5541–28528
6	4358.74	I	4186–27122
26	4359.74	II	9969–32899
28	4360.81	I	4186–27111
32	4366.45	I	11017–33912
12	4370.95	II	9743–32615
3	4373.07	I	5889–28750
22	4379.78	II	12360–35186
3	4394.50	I	570–23320
12	4394.94	I	10885–33632
9	4395.21	I	4376–27122
8	4400.24	I	5889–28609
6	4402.95	I	4197–26902
6	4403.34	II	9553–32257
17	4413.04	I	11258–33912
3.0	4414.14	I	1241–23889
6	4414.54	II	9969–32615
22	4420.46	I	11017–33632
11	4427.24	I	18739–41320
5	4429.11	I	5102–27673
14	4431.49	I	10885–33445
8	4438.05	I	4376–26902
7	4440.46	II	9743–32257
13	4443.00	II	11984–34485
2.5	4444.33	I	11956–34451
2.5	4448.95	I	5102–27573
8	4450.28	I	10885–33350
5	4455.43	I	14791–37230
5	4456.30	I	14989–37422
10	4457.43	I	11017–33445
		II	9553–31981
2.5	4460.34	I	5102–27515
8	4461.22	II	8153–30562
10	4466.91	I	5102–27482
2.5	4468.22	I	11258–33632
4	4468.79	I	4186–26557
10	4470.31	I	12342–34706
17	4470.56	I	12773–35135
3	4480.77	I	14697–37008
4	4482.50	I	15120–37422
2.5	4491.56	I	4186–26444
5	4494.42	II	19433–41677
2.5	4494.94	I	14989–37230
18	4496.97	II	5753–27984
50	4507.12	I	4376–26557
2.5	4523.13	I	17753–39855
55	4535.75	I	4186–26227
7	4539.98	I	5102–27122
44	4542.22	I	5102–27111
18	4553.01	I	4197–26154
4	4553.97	II	19515–41468
18	4555.13	I	12503–34451
13	4555.52	I	12760–34706
4	4558.04	I	11258–33192
		I	12773–34706
2.0	4562.12	I	
4	4565.47	I	12342–34240
1.8	4574.50	II	19614–41468
44	4575.52	I	0–21849
3.5	4576.20	I	11641–33487
9	4582.29	I	14791–36608
7	4584.24	I	11956–33764
1.8	4590.16	I	11641–33420
13	4590.55	I	4376–26154
32	4602.57	I	15120–36841
13	4604.42	I	4186–25898
2.0	4609.15	I	12761–34451
2.0	4609.29	I	5249–26938
2.0	4609.83	I	4871–26557
2.0	4610.11	I	4376–26062
2.0 bl	4619.85	ZrO	
19	4626.41	I	14989–36597
2.0	4627.72	I	11956–33559
3.5	4629.07	II	20080–41677
60	4633.98	I	570–22144
2.0	4634.64	I	5541–27111
2.0 bl	4637.78	ZrO	
6	4640.13	I	14791–36336
18	4644.83	I	14697–36220
		I	11641–33164
3.0	4654.38	I	12761–34240
8	4657.64	I	11956–33420
3.0	4659.49	I	5102–26557
6	4667.14	I	5023–26444
22	4683.42	I	12342–33688
6	4684.25	I	5102–26444
2.0	4685.19	II	19515–40853
2.0	4686.57	I	11641–32972
200	4687.80	I	5889–27215
44	4688.45	I	1241–22564
2.0	4691.73	I	5249–26557
2.0	4695.04	I	17143–38436
4 h	4700.11	I	
	4700.18	I	4376–25646
9	4707.79	I	11956–33192
160	4710.08	I	5541–26766
14	4711.92	I	12342–33559

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
6	4713.43	I	14791–36001
10	4717.62	I	4871–26062
18	4719.12	I	14989–36173
2.0	4731.14	I	5023–26154
26	4732.33	I	5102–26227
3.0	4734.36	I	18739–39855
120	4739.48	I	5249–26343
3.0	4742.94	I	12342–33420
3.5	4751.91	I	5023–26062
5	4753.05	I	15120–36153
16	4762.78	I	14791–35782
75	4772.31	I	5023–25972
18	4784.92	I	5541–26434
14	4788.67	I	5889–26766
3.5	4789.11	I	5023–25898
3.0	4793.28	I	14349–35206
2.5	4794.96	I	12342–33192
22	4805.87	I	5541–26343
3.0	4806.68	I	12761–33559
12	4809.47	I	12773–33559
16	4815.04	I	5249–26012
60	4815.63	I	4871–25630
24	4824.29	I	5249–25972
16	4828.04	I	5023–25730
9	4838.78	I	12503–33164
5	4838.98	I	12761–33420
1.6	4841.45	I	5249–25898
1.6	4846.35	I	5102–25730
18	4851.36	I	5023–25630
14	4866.06	I	5889–26434
		I	17556–38101
9	4881.24	I	5249–25730
9	4883.60	I	5541–26012
4	4893.12	I	12761–33192
1.6	4905.08	I	5249–25630
2.5	4930.87	I	15201–35476
6	4933.64	I	14784–35047
4	4948.76	I	4186–24388
2.5	4962.30	I	14989–35135
3.0	4963.72	I	15720–35861
1.8	4987.82	I	16317–36360
8	4994.76	I	15120–35135
7	4996.33	I	15201–35210
2.5	5011.46	I	17060–37008
20	5046.58	I	12342–32152
7	5060.39	I	15720–35476
29	5064.91	I	11956–31695
9	5065.22	I	18739–38476
8	5070.26	I	14989–34706
6	5073.98	I	4186–23889
38	5078.25	I	11641–31327
7	5085.26	I	14791–34451
4	5112.27	II	13428–32984
11	5115.24	I	16317–35861
4	5120.42	I	15932–35456
7	5133.40	I	4186–23661
24	5155.45	I	12761–32152
16	5158.00	I	16978–36360
3.0	5158.67	I	12773–32152
6	5160.99	I	11956–31327
7	5165.96	I	12342–31695
1.4	5178.99	I	4186–23489
8	5183.70	I	5102–24388
2.5	5187.03	I	15932–35206
8	5191.60	II	14163–33419
8	5201.15	I	4376–23597
7	5209.30	I	12503–31695
7	5224.93	I	4186–23320
2.5	5243.47	I	17060–36125
10	5277.41	I	4376–23320
6	5280.05	I	12761–31695
5	5294.82	I	8057–26938
10	5296.79	I	8057–26931
5	5301.97	I	17753–36608
9	5311.40	I	4197–23019
2.0	5321.26	I	5102–23889
1.8	5330.84	I	570–19324
1.0	5338.43	I	4871–23597
2.5	5350.09	II	14299–32984
2.5	5350.35	II	14733–33419
2.0	5350.90	I	18739–37422
2.0	5351.92	I	
6	5362.56	I	4376–23019
1.0	5363.35	I	5249–23889
1.4	5369.39	I	4871–23489
1.6	5382.37	I	5023–23597
22	5385.14	I	4186–22751
2.5	5386.65	I	5102–23661
1.4	5391.18	I	5023–23567
1.4	5395.88	I	17833–36360
2.0	5405.13	I	5102–23597
7	5407.62	I	5889–24376
1.4	5413.93	I	5541–24006
1.6	5421.86	I	17422–35861
1.2	5426.36	I	16787–35210
2.0	5428.42	I	17060–35476
2.0	5437.76	I	1241–19626
1.2	5440.41	I	4871–23246
3.0	5448.57	I	5541–23889
0.8	5474.92	I	16787–35047

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
0.8	5477.40	I	4871–23122
3.0	5478.33	I	17753–36001
3.0	5480.83	I	5249–23489
0.8	5481.16	I	
2.5	5486.09	I	5023–23246
11	5502.12	I	8057–26227
2.0	5507.87	I	17060–35210
2.5	5517.11	I	5541–23661
0.8	5518.05	I	5889–24006
6	5528.41	I	18277–36360
1.6	5532.30	I	5249–23320
3.5	5537.46	I	17422–35476
4.0	5545.32	I	17833–35861
1.8 bl	5551.75	ZrO	
2.0 bl	5553.17	ZrO	
1.0	5612.11	I	0–17814
10	5620.14	I	4186–21974
3.0	5623.53	I	4197–21974
2.0 bl	5629.02	ZrO	
2.0 bl	5629.58	ZrO	
13	5664.51	I	5102–22751
1.6	5666.28	I	17833–35476
10	5680.90	I	4376–21974
1.2	5685.42	I	18277–35861
2.5	5708.89	I	0–17512
6 bl	5718.21	ZrO	
10	5735.70	I	0–17430
3.0 bl	5748.17	ZrO	
1.4 bl	5778.57	ZrO	
13	5797.74	I	570–17814
2.5	5847.32	I	17143–34240
4	5868.27	I	1241–18277
9	5869.50	I	15120–32152
28	5879.80	I	1241–18244
7	5885.62	I	570–17556
4	5901.09	I	570–17512
2.5 bl	5908.61	ZrO	
11	5925.13	I	5102–21974
8	5935.20	I	0–16844
9	5955.35	I	0–16787
2.5 bl	5977.80	ZrO	
8	5984.23	I	14989–31695
1.4	5995.37	I	5889–22564
4	6001.05	I	12342–29002
2.5	6025.36	I	1241–17833
7	6032.61	I	11956–28528
14	6045.85	I	14791–31327
8	6049.24	I	19834–36360
11	6062.84	I	570–17060
4	6120.83	I	4186–20519
14	6121.91	I	8057–24388
7	6124.84	I	4197–20519
55	6127.44	I	1241–17556
28	6134.55	I	0–16297
8	6140.46	I	4186–20467
36	6143.20	I	570–16844
2.5	6155.61	I	12761–29002
6	6157.71	I	19626–35861
2.0	6160.20	I	12773–29002
3.0	6189.40	I	19324–35476
5	6192.96	I	4376–20519
7	6213.05	I	4376–20467
8	6214.69	I	17753–33839
14 bl	6226.51	ZrO	
8	6257.26	I	12773–28750
4 b	6261.05	ZrO	
3.0	6267.06	I	11956–27908
3.5 bl	6292.84	ZrO	
10	6299.66	I	12342–28212
1.2	6304.34	I	4376–20234
24	6313.02	I	12773–28609
2.5	6314.71	I	8057–23889
4	6321.35	I	12342–28157
1.8	6340.36	I	12761–28528
4 bl	6345.10	ZrO	
6	6345.22	I	12773–28528
6 bl	6378.56	ZrO	
3.0	6407.00	I	1241–16844
4 b	6412.39	ZrO	
1.0	6426.17	I	22144–37701
3.0	6434.33	I	22564–38101
5	6445.74	I	8057–23567
1.6	6451.62	I	5023–20519
1.6	6457.63	I	11641–27122
9	6470.21	I	12761–28212
5 bl	6473.79	ZrO	
0.9	6484.35	I	5102–20519
9	6489.64	I	12503–27908
1.8	6493.10	I	12761–28157
4	6503.26	I	12503–27876
4	6506.36	I	5102–20467
4 bl	6508.15	ZrO	
2.5 bl	6542.90	ZrO	
3.0	6550.54	I	11641–26902
2.5	6569.43	I	5249–20467
1.6	6576.56	I	0–15201
2.5 b	6578.06	ZrO	
4	6591.99	I	11956–27122
0.8	6596.71	I	11956–27111
0.8	6598.84	I	570–15720

Intensity and Character	Wavelength in A	Spectrum	Energy Levels in K
4	6603.27	I	12342–27482
1.2	6620.56	I	18739–33839
1.0	6678.01	II	19515–34485
2.0	6688.18	I	4376–19324
1.0	6702.12	I	11641–26557
1.6	6709.61	I	4197–19097
2.5	6717.88	I	11017–25898
3.5	6752.73	I	8057–22862
7	6762.38	I	0–14784
8	6769.16	I	12342–27111
2.5	6772.89	I	10885–25646
1.4	6787.15	II	20080–34810
3.0	6790.85	I	12761–27482
0.7	6796.68	I	14349–29058
4	6828.78	I	11258–25898
4	6832.89	I	570–15201
0.6	6833.67	I	11017–25646
1.2	6845.33	I	10885–25490
1.6	6846.34	I	5023–19626
9	6846.97	I	11956–26557
2.5	6849.26	I	12342–26938
1.2	6852.56	I	12342–26931
0.8	6854.63	I	5249–19834
0.4	6857.90	I	14697–29275
0.6	6883.23	I	5102–19626
12	6888.29	I	11641–26154
3.0	6900.59	I	11956–26444
2.0	6904.36	I	1241–15720
3.0	6907.37	I	11017–25490
2.0	6916.87	I	4871–19324
0.6	6922.23	I	12773–27215
1.6	6932.38	I	11641–26062
3.0	6948.46	I	11258–25646
15	6953.84	I	5249–19626
6	6966.44	I	12761–27111
1.0	6975.91	I	11641–25972
15	6990.84	I	5023–19324
8	6994.32	I	5541–19834
1.0	7005.46	I	11956–26227
10	7027.40	I	4871–19097
2.5	7057.36	I	12773–26938
1.4	7057.96	I	
14	7087.30	I	4871–18976
2.5	7089.43	I	12342–26444
3.5	7094.46	I	12342–26434
5	7095.59	I	11641–25730
55	7097.70	I	5541–19626
28	7102.91	I	5249–19324
17	7103.72	I	5023–19097
14	7111.68	I	4186–18244
4	7112.82	I	11956–26012
1.8	7113.52	I	12503–26557
1.2	7132.95	I	11956–25972
0.8	7138.28	I	12761–26766
1.6	7140.74	I	12342–26343
1.2	7144.47	I	12773–26766
60	7169.09	I	5889–19834
5	7201.62	I	15120–29002
1.2	7258.17	I	11956–25730
3.5	7264.76	I	14989–28750
0.8	7284.69	I	12503–26227
2.0	7306.21	I	12761–26444
0.6 h	7307.32	I	
2.5	7311.62	I	12761–26434
3.5	7313.72	I	12342–26012
9	7318.08	I	12773–26434
1.0	7327.82	I	
5	7335.97	I	4186–17814
5	7343.96	I	14791–28404
2.0	7373.50	I	12503–26062
0.8	7374.80	I	12342–25898
2.5	7383.63	I	14989–28528
0.8 h	7399.30	I	
1.4	7400.90	I	12503–26012
1.0	7411.39	I	15120–28609
0.8 h	7417.89	I	14123–27600
1.0	7422.75	I	12503–25972
1.0	7433.10	I	14123–27573
11	7439.86	I	4376–17814
1.8	7467.57	I	12342–25730
1.6	7479.58	I	14791–28157
0.9	7502.92	I	14349–27673
0.9	7506.51	I	
1.4 h	7515.70	I	15700–29002
1.2	7517.95	I	17753–31050
0.9 h	7521.03	I	15457–28750
2.0 h	7540.62	I	15146–28404
2.0	7544.59	I	12761–26012
3.0	7551.46	I	12773–26012
0.7 h	7553.00	I	4186–17422
4	7554.70	I	4197–17430
2.5	7558.45	I	12503–25730
1.2	7560.09	I	14349–27573
0.7	7560.31	I	14989–28212
1.2	7562.12	I	5023–18244
8	7607.15	I	5102–18244
0.8	7610.83	I	4376–17512
1.4	7612.08	I	14349–27482
2.0	7621.17	I	11258–24376
0.5	7621.61	I	14791–27908

Intensity and Character		Wavelength in A	Spectrum	Energy Levels in K
3.0		7658.60	I	4376–17430
1.8		7690.83	I	14123–27122
1.4		7704.27	I	14697–27673
1.0		7708.42	I	12761–25730
0.6		7722.48	I	22145–35091
0.9		7723.95	I	4871–17814
0.8		7765.70	I	4186–17060
1.0		7766.55	I	11017–23889
0.6		7800.74	I	21801–34617
1.2		7816.32	I	5023–17814
11		7819.35	I	14697–27482
3.5		7822.94	I	14123–26902
4		7826.72	I	14349–27122
9		7849.35	I	5541–18277
3.5		7869.99	I	5541–18244
1.4		7876.25	I	22398–35091
1.6		7882.18	I	4376–17060
1.0		7897.98	I	4186–16844
1.6		7908.46	I	4871–17512
0.6		7924.20	I	22145–34762
2.0		7940.47	I	4197–16787
16		7944.61	I	5249–17833
8		7956.66	I	5249–17814
8		7959.98	I	4871–17430
2.0		7963.63	I	14349–26902
16		8005.27	I	5023–17512
0.7		8015.26	I	11017–23489
0.4	h	8040.10	I	14123–26557
2.5		8046.05	I	14697–27122
1.6		8053.06	I	14697–27111
2.0		8055.29	I	4376–16787
2.0		8055.76	I	5102–17512
6		8058.08	I	5023–17430
15		8063.09	I	5023–17422
80		8070.08	I	5889–18277
1.0		8114.28	I	5102–17422
2.0		8120.17	I	18739–31050
40		8132.99	I	5541–17833
2.0		8152.58	I	5249–17512
1.2		8188.77	I	14349–26557
4		8194.73	I	10885–23085
6		8201.73	I	4871–17060
28		8212.53	I	5249–17422
2.0		8240.37	I	17143–29275
4		8283.81	I	11017–23085
0.7		8299.81	I	12342–24388
14		8305.90	I	5023–17060
0.7		8309.50	I	14123–26154
0.7		8320.16	I	5541–17556
1.4		8332.44	I	17060–29058
5		8370.23	I	5889–17833
12		8389.41	I	4871–16787
7		8414.00	I	5541–17422
5		8453.17	I	11258–23085
0.6		8457.48	I	5023–16844
5		8464.65	I	5249–17060
0.9		8495.98	I	17143–28910
4		8498.44	I	5023–16787
0.5		8513.78	I	5102–16844
0.5		8515.06	I	17060–28801
0.8		8568.54	I	5889–17556
0.7		8571.05	I	12342–24006
1.8		8584.21	I	15120–26766
0.7		8587.84	I	11956–23597
0.5		8610.24	I	11956–23567
0.5		8641.01	I	
1.0		8734.86	I	14989–26434
1.2		8749.48	I	4871–16297
0.6		8762.93	I	
1.0		8786.23	I	11641–23019
1.6		8804.98	I	14989–26343
7		8836.09	I	15120–26434
6		8899.52	I	12773–24006

Selected Publications of the National Bureau of Standards

Table of Wavenumbers, C. D. Coleman, W. R. Bozman, and W. F. Meggers:

Monograph 3, Volume I. 2000 A to 7000 A. 508 p. (1960) $6.00

Monograph 3, Volume II. 7000 A to 1000 μ. 542 p. (1960) $6.00

New Description of Thorium Spectra, Romuald Zalubas, Monograph 17, 106 p. (1960) $0.65

Atomic Energy Levels, C. E. Moore:

Circular 467, Volume I. H to V (Z=1 to 23) 206 spectra. 309 p. (1949) $5.50

Circular 467, Volume II. Cr to Nb (Z=24 to 41) 152 spectra. 227 p. (1952) $4.00

Circular 467, Volume III. { Mo to La (Z=42 to 57) / Hf to Ac (Z=72 to 89) } 124 spectra. 245 p. (1958) $2.50

An Ultraviolet Multiplet Table, C. E. Moore:

Circular 488, Section 1. H to V (Z=1 to 23); Selected Multiplets of 79 Spectra. 78 p. (1950). $0.55

Circular 488, Section 2. Cr to Nb (Z=24 to 41); Selected Multiplets of 46 Spectra. 115 p. (1952). $0.70

The above publications may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.

A Multiplet Table of Astrophysical Interest, C. E. Moore. A Reprinting of the 1945 Multiplet Table (Princeton Univ., Obs. Contr. No. 20):

Technical Note 36 (PB151395), Part I. Table of Multiplets and Part II. Finding List, λλ2951Å–13164Å. 242 p. (1959). $4.00

The above Technical Note may be purchased by the PB number from the Department of Commerce, Office of Technical Services, Washington 25, D.C.

U.S. GOVERNMENT PRINTING OFFICE : 1962 O—609065