1939

Predictive value of the Thurstone psychological examination

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PREDICTIVE VALUE

OF THE

THURSTONE PSYCHOLOGICAL EXAMINATION

by

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B. A., Augsburg College, 1927

Presented in partial fulfillment of the requirement for the degree of Master of Arts.

State University of Montana

1939

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TABLE OF CONTENTS

Acknowledgments.

The writing of this thesis would have been impossible without the help of a number of people who have assisted very materially in its planning and development. The subject and method of attack was suggested by Dr. J. H. Hess, Professor of Education, at Kansas State University. Dr. Hess has also helped plan the statistical method used in this problem, and from time to time has given invaluable suggestions as to the best procedures to use. The mathematical methods employed have been checked and criticized by Dr. A. D. Merrill, Professor of Mathematics, at Kansas State University. Through his suggestions was made possible the use of simplification of the vast amount of data involved. Further indebtedness is owed the Registrar's Office of Kansas State University for the unlimited and courteous service rendered in making available the students' grades that were used in the study. Very valuable assistance was given by Dr. David Segel, Educational Consultant and Specialist in Tests and Measurements, U. S. Office of Education, in regard to sources of information concerning studies made by other research students. To these persons, and others, who have aided him so materially, the author wishes to express his most sincere thanks and appreciation.

INTRODUCTION.

Effective guidance of college students depends fundamentally upon knowledge and use of all available information concerning the individuals involved. Previous performances, capacities, and interests of prospective students need to be taken into consideration, in order that they may be helped to make their choice of curriculum as wisely as possible. Whatever is known about a student that may point him toward one line of work or definitely away from some other field of study should be used to help him as soon as possible when he is laying the first foundations for his higher educational endeavors.

It is a problem of society to consider the proper placement of youth, through education, in the fields where they will be best fitted to work, most able to render capable service to mankind, and most happy in their pursuits. Higher education is costly of time and money for society as well as for the individual student. The products of higher education can be of the greatest value to society in their chosen professions only in-so-far as they are suited for the fields of work that they enter. Society can ill afford to spend thousands of dollars to train young people for professions in which they can never hope to become better than mediocre practitioners. It costs no more to educate a good doctor or a good teacher than a poor one; the difference

in the cost to society when the practice their profession is almost immeasurable.

All good colleges and universities at the present time use the records and facilities thay have available to help their students make the best possible choices of courses of study and of life professions. Guidance is an important part of the proper functioning of institutions of higher education. This study is being made in an effort to add to the material available for use in guiding students in their choice of subjects in the freshman year in college. Based as it is on the records of students at Montana State University, the specific results will be applicable only at that institution, as far as the actual prediction of grades in college is concerned. However, it is hoped that the general findings and conclusions arrived at in the study may have some value in pointing out new possibilities in the field of forecasting college scholarship.

The fundamental purpose of this study has been to evolve prediction formulas for use in the prognosis of grades in specific subjects. By such predictions it will be possible to advise the individual student as to his probable chances of success in college, and in particular, as to his chances of securing a satisfactory grade in the various subjects of the freshman year. This application of the formulas that have been worked out will make it possible to

help the student to choose his subjects according to his chances of success. Further than that, on the basis of the predictions made, it will be possible to determine to a considerable extent which students are living up to their promises of success, and which ones are probably loafing on the job. In the case of failing students, the predicted scores will help determine whether their failure is due to inability to do the required work, or merely to lack of application.

Predictions of grades have been based entirely on the scores made by students in the American Council on Education Psychological Examination. This and similar examinations, very commonly used as entrance tests for college freshmen, have been used quite generally for predictive purposes in the past. In most cases, predictions have been based on gross scores of the examinations, or on the gross scores of a combination of tests. The purpose of this study has been to use the American Council on Education Psychological Examination as the sole means of prediction of success in specific subjects. This has been done by finding the multiple correlation between the five subtests of the examination and the various subject grades, and by working out the necessary prediction formulas from the partial regression coefficients obtained in connection with finding the multiple correlations. The results of this study do not in any way indicate the advisability of entire dependence

upon one examination for prediction of college grades, but it is hoped that the techniques used in this work may be of help in making further attacks upon the problem.

PREDICTION OF SUCCESS IN COLLEGE.

The earliest attempts to use psychological examinations for prediction of success in college were based on the use of the cancellation type of test developed by Wundt, Catell, and others [1]. The value of these tests for prognostic purposes was negligible, and it was not until the World War that any rapid or significant advances were made in the field.

The importance of the World War with respect to prediction of college success was the construction of the Army Alpha for use in testing intelligence of soldiers, and its subsequent use for prognosis of ability to do college work. Many studies of the value of the test in this field were made. As a result of the findings of these studies encouragement was given for the construction of other and more specific testing material to be used in forecast work. The development of the short-answer new-type tests was an outstanding advance of this period.

The first uses of general intelligence and other tests in prediction studies was for the purpose of prognosis of general success in college. Later the more definite task of forecasting probability of success in various limited fields became quite general, and at the present time there is a wealth of testing material available for determining more or less accurately the various specific traits, abilities, and

tendencies of college enrollees. Criteria to be used for the various types of prediction can be classified under three general heads: (1) The general mental tests, (2) general achievement tests, and (3) tests of specific traits, aptitudes, or achievements.

This study is concerned with prediction of success as based on the American Council on Education Psychological Examination, by L. L. Thurstone and Thelma Gwinn Thurstone. This examination is an example of the first type of test referred to above, and consequently findings from other studies of similar tests will be most significant for the purpose of validating this work. However, it seems advisable to include a summary of results found in studies based on the two other general types of tests. No attempt has been made to refer to all the findings in the field, but it is felt that the results given in the tables on the following pages are a good sampling of the data available, particular care having been used to compile only the results that are definite in character and backed by specific evidence.

The correlation coefficient is the best mathematical method of showing the relation between similar measures of individual capacities, such as intelligence test scores and subject grades. In spite of its general use for this purpose it is often misinterpreted, and it must be kept in mind that in no case does it mean the same as a per cent.

For instance, in order to have the ability to indicate the correct grade a pupil will earn in 50% of the cases, a test must show a coefficient of correlation with the grades involved of .866. On page 61 is given a table which shows the per cent of forecasting efficiency indicated by various coefficients of correlation.

In the tabulations on the following pages the examinations used for prediction are listed, followed by the names of the various research workers who have investigated the predictive value of these tests, and the various coefficients found for the different studied made by them. The grades involved are those earned during the whole or part of the first two years in college; in all cases the studies were on the basis of all grades earned in college up to the end of the time used. Thus, some may be for the first semester, others for the first year, and some few cases for the first two years.

Most of the coefficients of correlation showing relation between general college scholarship and general mental tests are between .40 and .50. Following the individual results for each examination is given the median of these figures; the highest median found was for the Scholastic Aptitude test of the College Entrance Examination Board (.58). This test also gave the highest single correlation (.70). The lowest median for any predictive item was that found for the Otis Intelligence Test (.38).

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP
USING GENERAL MENTAL TESTS.

PREDICTIVE ITEM	REFERENCE	CORRELATION COEFFICIENTS
American Council on Education psychological examination.	Boucher[2]	.39
	Condit[3]	.45
	Crane[4]	.27
	Hartson[5]	.50 women
		.53 men
	Hopkins[6]	.53
	Remmers[7]	.45
	Remmers[8]	.57
	Segel[9]	.48
	Stalnaker[10]	.57
	Thurstone and Thurstone[11]	.36, .48, .46, .45, .62, .40, .44, .54, .52, .40, .41, .47, .59, .32, .51, .45, .40, .49, .49, .56
	Whitney and Goodman[12]	.33
		Median .48
Anderson	Crawford[13]	.42
Army Alpha	Anderson[14]	.38
	Bridges[15]	.35
	Colvin[16]	.44
	DeCamp[17]	.41
	Ernst[18]	.41
	Jordan[19]	.48
	Miner[20]	.50
	Stoddard[21]	.49
	Stone[22]	.44, .50
	Terman[23]	.52, .43, .31
	Toll[24]	.33
	Van Wagenen[25]	.50
		Median .37
Brown Univ. Examination	MacPhail[26]	.37
Miller Mental Ability Test	Binneweis[27]	.43
	MacPhail[28]	.49
		Median .46

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP USING GENERAL MENTAL TESTS (Cont.).

PREDICTIVE ITEM	REFERENCE	CORRELATION COEFFICIENTS
Minnesota College Ability Test	Williamson [29]	.42
Ohio State University Psychological Examination	Blair [30]	.50, .49
	Bryns [31]	.36
	Edgerton and Toops [32]	.45
	Guiler [33]	.47
	Neuberg [34]	.47
		Median .47
Otis Intelligence Test	Binneweis [35]	.39
	Guiler [36]	.40
	Hill [37]	.20, .34
	Odell [38]	.38
	Thompson and Russell [39]	.43, .40
	Toll [40]	.38, .34
		Median .38
Scholastic Aptitude Test of the College Entrance Examination Board	Brown [41]	.46
	Crawford [42]	.70
		Median .58
Terman Group Test	Binneweis [43]	.49
	Guiler [44]	.52
	Terman [45]	.54
	Toll [46]	.28
		Median .51
Thorndike Intelligence Examination for High-school Graduates	Bolenbaugh and Proctor [47]	.45, .37
	Bridges [48]	.40
	Cleeton [49]	.52, .47, .48, .52, .50
	Columbia University [50]	.65
	Grauer and Root [51]	.39
	MacPhail [52]	.41
	Nelson [53]	.36, .37, .53, .27, .38, .53
	Root [54]	.51

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP
USING GENERAL MENTAL TESTS (Cont.).

PREDICTIVE ITEM	REFERENCE	CORRELATION COEFFICIENTS
Thorndike Intelligence Examination for High-school Graduates (Cont.)	Symonds [55] Tallman [56] Terman [57] Wood [58]	.42 .51 .41, .60 .55 Median .46
University of Washington Intelligence Test	Dvorak and Salyer [59]	.37
Yale Classification Tests	Anderson and Spencer [60]	.41, .38, .39 Median .39

Results of attempts to predict general college scholarship from general achievement tests vary only slightly from those found for the general mental tests. Most of the correlations for the achievement tests were between .40 and .50. The highest single correlation found was for the Iowa Placement Tests (.75), but only one study of this test is available. The highest median where more than a single study was made of one examination was found for the Carnegie Foundation Pennsylvania Study of 1927 (.59). Studies of achievement tests have yielded fewer low correlations than was the case for the general mental tests, with the result that on the basis of averages, predictions made from achievement tests give somewhat better results than those made from general mental tests. The difference does not appear to be

great enough to be especially significant.

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP USING GENERAL ACHIEVEMENT TESTS.

PREDICTIVE ITEM	REFERENCE	CORRELATION COEFFICIENTS
Achievement in high-school work measured by the Pennsylvania study by the Carnegie Foundation, 1927	Hill [61]	.52, .66 Median .59
College Entrance Examination Board	Beatley [62] Brigham [63] Crawford [64] Crawford and Burnham [65]	.50 .46, .39 .64 .43 Median .46
Iowa High-school Content Examination	Cleeton [66]	.49, .49 Median .49
Iowa Placement Tests	Stoddard [67]	.75
New York Regents	Gilkey [68] Jones [69]	.50 .70 women .40 men Median .50
Sones-Harry High-school Achievement Test	Boucher [70]	.57

There is considerable variation in the coefficients of correlation found between general college scholarship and various tests of specific traits, aptitudes, or achievements. In general, the coefficients are lower than for the two

previous types of tests, and in some cases they approach the zero mark, as for instance in the cases of the Science Section of the Iowa High-school Content Examination (.13), and the Iowa Placement Examination, English Aptitude, (.05). In only one case is a correlation of more than .50 found for the median of successive studies of a single test, this being for the Iowa Placement Examination, Chemistry Aptitude (.50 and .52, median .51). Other high correlations were found in single studies of various tests as follows: Aptitude Test for Elementary and High-school Teachers (.63), Iowa Placement Examination, Combined Physics Aptitude and Training (.55), and Iowa Placement Examination, Combined Mathematics Aptitude and Training (.58).

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP USING TESTS OF SPECIFIC TRAITS, APTITUDES, OR ACHIEVEMENTS.

PREDICTIVE ITEM	REFERENCE	CORRELATION COEFFICIENTS
Aptitude Test for Elementary and High-school Teachers	Fritz [71]	.63
Iowa High-school Content Examination:		
English Section	Segel [72]	.35
Mathematics Section	"	.22
Science Section	"	.13
Social-studies Section	"	.19
Iowa Placement Examinations:		
Chemistry Aptitude	Remmers [73]	.50
	Stoddard [74]	.52
		Median .51

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP DATA (GPA) ON SPECIFIC WRITE, SPRINGER, OR ACHIEVE TEST (cont.).

CRITERION	CRITERION	CORRELATION COEFFICIENTS
Iowa Placement Examinations:		
Chemistry Training	Stoddard 75	.35
English Aptitude	Remmers 76	.33
	Stoddard 77	.40
		Median .27
English Training	Drake 78	.44
	Remmers 79	.14
	Stoddard 80	.37
		Median .30
Mathematics Aptitude	Remmers 81	.12
	Stoddard 82	.42
		Median .27
Combined Physics Aptitude and Training	Drake and Selyon 83	.55
Combined Mathematics Aptitude and Training	Drake and Selyon 84	.33
Ohio State University Psychological Examination:		
Similarities-Opposites	Flagg 85	.44, .44
Arithmetic Problems	"	.40, .26
Analogies	"	.42, .43
Number Progression	"	.21, .28
Paragraph Meaning	"	.45, .39
Study-performance test, Ohio State University:	Meyers, Keep, and Adams 86	.40
Partial Comprehension	"	.37
Rough Words and Phrases	"	.37
Disarranged Sentences	"	.29
Study-habit Questions	"	.40
Note Taking Test		
Thurstone Vocational Guidance Tests:		
Geometry	Dewey and Glocker 87	.20
Technical Information	"	.25
Algebra	"	.42
Arithmetic	"	.30
Physics	"	.24

PREDICTION OF SCHOLARSHIP IN SPECIFIC COLLEGE SUBJECTS USING GENERAL MENTAL TESTS.

PREDICTIVE ITEM	SPECIFIC CRITERION ITEM	REFERENCE	CORRELATION COEFFICIENTS
American Council on Education Psychological	Marks in English	Boucher [88]	.37
		Segel [89]	.40
		Thurstone [90]	.52, .41
			Median .41
	Marks in Languages		
	Foreign Languages	Segel [91]	.42
	French	Boucher [92]	.35
	German	"	.32
	Spanish	"	.18
	Marks in mathematics	"	.45
		Remmers [93]	.46
		Thurstone [94]	.35, .33
			Median .40
	Marks in social studies:		
	General	Segel [95]	.33
	History	Boucher [96]	.47
		Thurstone [97]	.35
			Median .41
	Economics	Boucher [98]	.40
	Pol. Science	"	.20
	Marks in Science:		
	Biology	Thurstone [99]	.38
	Chemistry	Remmers [100]	.38, .41
		Thurstone [101]	.55
			Median .41
	Physics	Boucher [102]	.55
Army Alpha	Marks in English	Jordan [103]	.52
		Stone [104]	.50
			Median .51
	Marks in Languages		
	French	Stone [105]	.30
	German	"	.36
	Modern Languages	Jordan [106]	.31
	Spanish	Stone [107]	.12
	Marks in Mathematics	Jordan [108]	.21
		Stone [109]	.38
			Median .30
	Marks in Science:		
	General	Jordan [110]	.45
	Biology	Stone [111]	.22
	Chemistry	"	.31
	Physics	"	.44
	Marks in History	Jordan [112]	.54
		Stone [113]	.31
			Median .43

PREDICTION OF SCHOLARSHIP IN SPECIFIC COLLEGE SUBJECTS USING GENERAL MENTAL TESTS (Cont.)

PREDICTIVE ITEM	SPECIFIC CRITERION ITEM	REFERENCE	CORRELATION COEFFICIENTS
Brown University Examination	Marks in English	MacPhail[114]	.37
Otis Group Tests	Marks in Languages	Odell[115]	.32
	French	Tharp[116]	.32
			Median .32
	Latin	Odell[117]	.41
	Spanish	"	.27
	Marks in Algebra	"	.31
	Marks in Science:		
	Biology	"	.20
	Botany	"	.42
	Zoology	"	.37
	Marks in Social Studies		
	Economics	"	.28
	Polit. Science	"	.33
Thorndike Intelligence Examination for High-school Graduates	Marks in English	Lefever[118]	.26
		Root[119]	.36
		Stoddard[120]	.42, .36
			Median .35
	Marks in Languages		
	French	Lefever[121]	.19
		Root[122]	.40, .45
		Stoddard[123]	.25
			Median .33
	German	Root[124]	.50
	Spanish	Lefever[125]	.30
		Root[126]	.47
			Median .39
	Marks in Mathematics	Lefever[127]	.24
		Root[128]	.39, .58, .51, .61
		Stoddard[129]	.23
			Median .45
	Marks in Science:		
	Biology	Root[130]	.49, .52
			Median .51
	Chemistry	Lefever[131]	.24
		Root[132]	.43
			Median .34
	Physics	Root[133]	.50
	Zoology	Lefever[134]	.30

It can be seen from the table on the two previous pages that general mental tests do not give as high correlations with grades in specific subjects as they do when used for predicting general college scholarship. In most of the studies listed the correlations found were below the .40 mark. In only one instance, where more than one study of a particular relationship was made, was a result of better than .50 obtained. The two cases were the correlation between the Army Alpha Test and marks in English (.51), and the correlation between the Thorndike Intelligence Examination for High-school Graduates and marks in Biology (.51). The latter examination also yielded the highest correlation found, this being in one study of its relation to marks in Mathematics (.62). The average of all studies of the prognostic value of general mental tests in specific subjects were as follows: English, .30; Foreign Language, .35; Mathematics, .36; Exact Science, .45; and Social Studies, .33.

From the following table it is evident that general achievement tests are of no greater value than general mental tests for predicting grades in specific subjects. In most of the studies a correlation of less than .40 was found. The highest results were for marks in Mathematics as compared with the Iowa High-school Content Examination (.70), and for marks in English compared with the Iowa Comprehensive

PREDICTION OF SCHOLARSHIP IN SPECIFIC COLLEGE SUBJECTS USING GENERAL ACHIEVEMENT TESTS.

PREDICTIVE ITEM	SPECIFIC CRITERION ITEM	REFERENCE	CORRELATION COEFFICIENT
Iowa Comprehension Test	Marks in English	Stoddard[135]	.47, .44 Median .46
	Marks in Languages	"	.31
	Marks in Mathematics	"	.43
	Marks in Chemistry	"	.33, .33 Median .33
Iowa High-school Content Examination	Marks in English	Nelson [136] Stoddard [137]	.33 .39, .45 Median .39
	Marks in French	"	.42
	Marks in Mathematics	"	.50
	Marks in Chemistry	"	.24, .38 Median .31

Test (.47). It appears that general mental tests and general achievement tests have about the same value for the purpose of predicting specific subject grades.

The use of tests of specific traits, aptitudes, or achievements has produced some of the best predictions made for specific subjects, but in this field, as can be seen from the following table, the results vary greatly. Coefficients of correlation range from .02 (prediction of English marks from the Iowa High-school Content Examination, Mathematics Section) to .70 (prediction of Mathematics marks from the Iowa Placement Examination, Mathematics Training Section). Most of the high correlations were found for the Iowa Placement Examinations, and the Sones-Harry High-school

PREDICTION OF SCHOLARSHIP IN SPECIFIC COLLEGE SUBJECTS USING TESTS OF SPECIFIC TRAITS, APTITUDES, OR ACHIEVEMENTS.

PREDICTIVE ITEM	SPECIFIC CRITERION ITEM	REFERENCE	CORRELATION COEFFICIENT
College Entrance Exam. Board Comprehensive Chemistry	Marks in Chemistry	Crawford and Burnham [138]	.23
Comprehensive English	Marks in English	Brigham [139]	.43
		Crawford and Burnham [140]	.30
		Whitman [141]	.39
			Median .37
Comprehensive French	Marks in French	Brigham [142]	.44, .28
		Whitman [143]	.47
			Median .40
Comprehensive Mathematics	Marks in Mathematics	Brigham [144]	.32
		Crawford and Burnham [145]	.36
			Median .34
Iowa High-school Content Exam. English Section	Marks in English	Segel [146]	.36
		Stoddard [147]	.43
			Median .40
	Marks in Languages	Segel [148]	.29
	Marks in Social Studies	"	.35
Mathematics Section	Marks in English	"	.02
	Marks in Languages	"	.28
	Marks in Mathematics	Stoddard [149]	.28
	Marks in Social Studies	Segel [150]	.10
Science Section	Marks in English	"	.09
	Marks in Languages	"	.17
	Marks in Chemistry	Stoddard [151]	.28
	Marks in Social Studies	Segel [152]	.17
Social Studies Section	Marks in English	"	.13
	Marks in Languages	"	.05
	Marks in Social Studies	"	.23

PREDICTION OF SCHOLARSHIP IN SPECIFIC COLLEGE SUBJECTS USING TESTS OF SPECIFIC TRAITS, APTITUDES, OR ACHIEVEMENTS (Cont.)

PREDICTIVE ITEM	SPECIFIC CRITERION ITEM	REFERENCE	CORRELATION COEFFICIENT
Iowa Placement Examinations Chemistry Aptitude	Marks in Chemistry	Langlie [153]	.56, .56
		Miller [154]	.51[a]
		Remmers [155]	.28, .55
		Stoddard [156]	.51
			Median .51
Chemistry Training	Marks in Chemistry	Langlie [157]	.43
		Miller [158]	.54[b]
		Stoddard [159]	.34, .46
			Median .54
English Aptitude	Marks in English	Langlie [160]	.54, .46
		Miller [161]	.44[c]
		Stoddard [162]	.42, .56
			Median .44
English Training	Marks in English	Langlie [163]	.63, .59
		Miller [164]	.40[d]
		Nelson [165]	.48
		Stoddard [166]	.61, .64
			Median .40
Foreign Lang. Aptitude	Marks in French	Tharp [167]	.47
	Marks in Foreign Languages	Miller [168]	.48[e]
French Training	Marks in French		.52[f]
		Stoddard [169]	.63
			Median .52
Mathematics Aptitude	Marks in Mathematics	Miller [170]	.44[g]
		Stoddard [171]	.47
			Median .44
Mathematics Training	Marks in Mathematics	Miller [172]	.48
		Remmers [173]	.66
		Stoddard [174]	.53, .70
			Median .60

a- average of 20 coefficients
b- average of 18 coefficients
c- average of 24 coefficients
d- average of 28 coefficients
e- average of 7 coefficients
f- average of 4 coefficients
g- average of 32 coefficients

PREDICTION OF SCHOLARSHIP IN SPECIFIC COLLEGE SUBJECTS USING TESTS OF SPECIFIC TRAITS, APTITUDES, OR ACHIEVEMENTS (Cont.)

PREDICTIVE ITEM	SPECIFIC CRITERION ITEM	REFERENCE	CORRELATION COEFFICIENT
Iowa Placement Examinations			
Physics Aptitude	Marks in Physics	Bear [175]	.50
		Miller [176]	.40[a]
			Median .40
Physics Training	Marks in Physics	Miller [177]	.53[b]
Nelson-Denny College Reading Test	Marks in English	Nelson [178]	.37
New York Regents Examinations			
English	Marks in English	Gilkey [179]	.49
Anc. Language	Marks in Anc. Lang.	"	.39
Mathematics	Marks in Math.	"	.34
Social Science	Marks in Soc. Sci.	"	.34
Mod. Language	Marks in Mod. Lang.	"	.32
Exact Science	Marks in Science	"	.15
Foods Test	Marks in Foods	Brown [180]	.51
Sones-Harry High-school Achievement Test			
Lang. and Lit. Section	Marks in English	Boucher [181]	.45
Science	Marks in Chemistry	"	.59
	Marks in Geology	"	.40
	Marks in Physics	"	.60
Social Studies	Marks in Economics	"	.48
	Marks in History	"	.52
	Marks in Pol. Sci.	"	.52

a- average of 7 coefficients b- average of 4 coefficients

Achievement Test. For the various subjects the averages of the tests that seem to apply to each is as follows: Foreign Languages, .36; English, .42; Mathematics, .42; Chemistry .51; Physics, .53; Economics, .48; History, .52; and Political Science, .52. The greatest improvement in results is

in the exact sciences and social sciences; apparently the more specific tests give somewhat better results for prediction of grades in individual subjects than either the general mental tests or the general achievement tests.

It is interesting to compare the correlations between average high-school grades and college scholarship with the correlations found for the various types of tests. In general the high-school grades are better indicators of success than any single test. Most correlations found between average high-school marks and college marks are higher than .50. Many references give values well over .60,

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP USING AVERAGE HIGH-SCHOOL MARKS.

REFERENCES	CORRELATION COEFFICIENTS
Blair [182]	.66, .44, .62, .58
Brammell [183]	.52, .53
Cocking and Holy [184]	.55
Columbia University [185]	.29, .45, .47, .38, .61
Crawford [186]	.61
Edds and McCall [187]	.65
Edgerton and Toops [188]	.44
Goldthorpe [189]	.62
Hawks [190]	.66, .77, .72, .64, .69
Jones [191]	.48, women; .45, men
Lauer and Evans [192]	.49
Lincoln [193]	.68, .58
Odell [194]	.55, .54
Pierson and Nettels [195]	.52
Potthoff [196]	.60, .62
Proctor [197]	.41, .52
Scates [198]	.61
Seashore [199]	.35
Symonds [200]	.55, .39, .39
Terman [201]	.53, .63, .54, .54, .69, .69
Williamson [202]	.65

and Terman records two separate findings of .69. The highest coefficient listed was found by Hawks (.77). The average of the coefficients listed in the table on page 26 is .55.

A number of studies have been made in attempts to predict general college scholarship as well as grades in specific subjects on the basis of combinations of tests or other predictive items. In general, the findings of these studies are that better results are secured by this method than by the use of only one predictive item. Correlations

PREDICTION OF GENERAL COLLEGE SCHOLARSHIP USING A COMBINATION OF PREDICTIVE ITEMS.

PREDICTIVE ITEM COMBINATION	REFERENCE	CORRELATION
1 Ohio Psychological Examination 2 High-school marks average	Blair [203]	.69, .56
1 Ohio Psychological Examination 2 Specific High-school subject marks	Blair [204]	.70, .64
1 High-school English marks 2 High-school Natural Science marks 3 High-school Mathematics marks 4 Univ. of Washington Intelligence Test 5 Iowa Math. Aptitude and Training Test 6 Iowa Physics Aptitude and Training Test	Dvorak and Salyor [205]	.68
1 College Entrance Board Examination 2 Average High-school marks 3 Scholastic Aptitude Test 4 Age at Entrance	Crawford [206]	.74
1 Average High-school marks 2 American Council on Education Psychological Examination	Douglass [207]	.63

PREDICTION OF GENERAL GOOD OR SCHOLARSHIP GRADE
A SUMMARY OF EVIDENCE, PART (Cont.)

PREDICTIVE DEVICE	INVESTIGATOR	CORRELATION
1 Average High-school marks 2 Ohio State U. Intelligence Test. 3 Ohio Study-performance Test	Harbeson [20]	.75
1 Rank in High-school class 2 Minnesota Intelligence Test.	Johnston [20]	.67
1 Average High-school marks 2 Otis Group Intelligence Test	Jordan [20]	.50
1 Average High-school marks 2 American Council on Education Psychological Examination	Hay [21]	.65
1 Ohio U. Intelligence Test. 2 Average High-school marks	Norbury [22]	.67
1 Average High-school marks 2 Otis Intelligence Test	Grant [23]	.50
1 Terman Group Test 2 Average High-school marks 3 Thurstone Battery	Morgan and Bostelle [24]	.65
1 Average High-school marks 2 American Council on Education Psychological Examination	Lyman [25]	.59
1 Average High-school marks 2 Ten Hour Regents Examination 3 Thorndike Intelligence Test.	Wood [26]	.66

for a group of studies in the general scholastic field average .66, and two of the more important studies of prediction of specific grades give correlations that average .55, showing that general scholarship can probably be predicted somewhat more easily than grades in the particular subjects. However, both the highest and lowest correlations

RELATIONSHIP BETWEEN THE COMBINATION OF CERTAIN HIGH-SCHOOL RECORDS AND SCHOLARSHIP IN CERTAIN COLLEGE FRESHMAN SUBJECTS.
(Charles W. Odell [217])

HIGH-SCHOOL PREDICTIVE ITEMS	CRITERION	CORRELATION
1 Mathematics 2 Average Grades	Algebra	.53
1 Chemistry 2 Science 3 Intelligence Point Score	Chemistry	.53
1 Average Grades 2 History 3 Intelligence Point Score	Economics	.43
1 Average Grades 2 French 3 English 4 Intelligence Point Score	French	.60
1 Geometry 2 Mathematics 3 Intelligence Point Score	Geometry	.35
1 English 2 Foreign Language 3 Intelligence Point Score	German	.50
1 Average Grades 2 History 3 Intelligence Point Score	History	.46
1 English 2 Intelligence Point Score 3 Latin	Rhetoric	.52

found for the two types of prediction, were found in the particular subject studies, indicating that grades in some subjects can probably be predicted much better than in others, and possibly more accurately than general scholarship.

MULTIPLE CORRELATION COEFFICIENTS BETWEEN CERTAIN TEST RESULTS AND MARKS IN PARTICULAR COLLEGE SUBJECTS.
(G. D. Stoddard [218])

TESTS	CRITERION	CORRELATION
1 Iowa High-school Content 2 Iowa Comprehension 3 Thorndike, Part I 4 Iowa Placement, French Training	French	.76
1 Iowa High-school Content 2 Iowa Comprehension 3 Thorndike, Part I 4 Iowa Placement, Chemistry Training	Chemistry	.44
1 Iowa High School Content 2 Iowa Comprehension 3 Thorndike, Part I 4 Iowa Placement, Chem. Placement	Chemistry	.46
1 Iowa High-school Content 2 Iowa Comprehension 3 Thorndike, Part I 4 Iowa Placement, English Training	English	.64
1 Iowa High-school Content 2 Iowa Comprehension 3 Thorndike, Part I 4 Iowa Placement, English Aptitude	English	.52
1 Iowa High-school Content, English Section 2 Iowa Placement, English Training	English	.83
1 Iowa High-school Content 2 Iowa Comprehension 3 Thorndike, Part I 4 Iowa Placement, Mathematics Training	Mathematics	.60
1 Iowa High-school Content, Mathematics Section 2 Iowa Placement, Mathematics Training	Mathematics	.63

The results for predictions of general scholarship do not vary greatly, the range of the correlations being from

.56 to .81. The highest correlation was found by the use of a combination of items consisting of the average high-school marks, the Otis Group Intelligence Test, and the Cross English Test. Three of the studies give results obtained by the use of the American Council on Education, Psychological Examination, in combination with average high-school marks, the correlations found being as follows: .63 (Douglass), .63 (May), and .59 (Symonds).

The highest correlations were found for specific subject grades in the humanities field, with the average for the various English and Foreign Language correlations being .64, or practically the same as the figure found for general scholarship predictions. The best figure was obtained for English (.83), by using two tests, the Iowa High-school Content, English Section, and the Iowa Placement, English Training. Correlations found for the exact sciences and mathematics are rather low, the average being only .51. Only two figures are given for the social science field, these having an average of .45. This does not necessarily mean that mathematics, science, or social science grades can not be successfully predicted; it is more likely that most of the existing tests are a better measure of ability in English than in anything else, and that new tests that will evaluate the traits essential to success in other fields are needed.

THE AMERICAN COUNCIL ON EDUCATION PSYCHOLOGICAL EXAMINATION

The Psychological Examination by L. L. Thurstone and Thelma Gwinn Thurstone, published by the American Council on Education, is a general scholastic aptitude test, intended primarily for measuring the general ability to do the type of work required in college. It is composed of five parts, each of which is supposed to measure a somewhat different trait or capacity for doing college work. The test items in the five subtests have been arranged in order of difficulty.

The different forms of the test that are prepared from year to year are very similar, and the results based on one test correlate very well with results on a later test, as has been shown by various studies made from year to year. The same five subtests are used every year, and are composed of completion questions, questions based on analogies, arithmetic problems, sets of words having the same or the opposite meanings, and problems in translation of an artificial language, for which a short vocabulary and a few grammar rules are given.

The arithmetic test in the 1936 and 1937 forms of the examination consists of 20 problems, ranging in difficulty from easy computations in simple fractions to complex interest and successive discount problems.

The items of the opposites test are sets of four words, of which in each case two are related in such a way as to

have either the same or the opposite meanings. The student must find the two words that are related and must indicate them by number in one of the two columns provided for same and opposite meanings, so as to show that he knows in which way they are related.

The completion test is made up of a number of sentences, each of which is in the nature of a definition of a word which has been omitted from the sentence. The omitted word is indicated by a numeral in a parenthesis, and spaces are provided following each sentence on which the omitted word can be written in.

The artificial language test is composed of sentences to be translated from English to an artificial language, or vice versa. A short vocabulary of nouns, pronouns, and verb roots is given, together with rules for change of tense, and for changes to make other parts of speech.

The analogies test is composed entirely of geometric figures or symbols, and it is designed to test the ability to detect changes of varying degree that are made in the figures. In each question three figures are given, representing the first three parts of a proportion. The problem is to find, from the group of five figures following each set of three, the one figure that has the same relation to the third figure in the first group as the second has to the first. Changes that are made vary from mere ommissions of

a line to complicated reversals of the form of the figures used.

Three of the tests are primarily linguistic or verbal in character, these being the opposites, completion, and artificial language tests. The other two, arithmetic and analogies, are quantitative measures of specific abilities thought to be required for doing successful general college work.

The 1936 and 1937 forms of the examination have been used in the present study. These forms are similar in general nature, number of questions in each subtest, and general difficulty. One of the subtests of the 1937 edition has been found somewhat more difficult than the corresponding subtest for the previous year, namely the artificial language test; the other subtests show national medians that are very nearly identical. The difference in the medians of the gross scores for the two years is practically the same as the variation found between the two artificial language subtests.

The medians established for the 1936 examination were based on returns from 280 schools, involving about 53,000 students. The 1937 medians were derived from returns from 48 schools, including about 10,000 students. The results, as given in the following table, show how slightly the averages differ, except in the two cases already noted. The median for artificial language is 11.53 points higher

MEDIANS OF THE AMERICAN COUNCIL ON EDUCATION PSYCHOLOGICAL EXAMINATION. 219

TEST	1936 FORM	1937 FORM
Gross Score	177.23	167.08
Completion	31.09	30.32
Arithmetic	24.52	22.33
Artificial Language	35.24	24.71
Analogies	35.23	34.18
Opposites	50.51	54.35

in 1936 than in 1937, and the gross score of all tests combined is 10.15 points higher in 1936.

METHOD OF FINDING MULTIPLE CORRELATION AND ESTABLISHING PREDICTION FORMULAS

Prediction of college grades is made possible by the use of the mathematical concept of correlation. By this is meant the relationship that exists between various capacities, traits, functions, or other measures of ability, and a specific criterion, such as a subject grade. By correlation it is made possible to determine the value of predictive items, such as the five parts of a general mental test, to be used in this case in determining the probable grades in specific subjects.

Correlations used in this study are based on two sets of data; the scores made by freshmen entering the Montana State University on the various parts of the American Council on Education Psychological Examination, and the actual grades made by the same students in their first year at the university. The scores and grades used are for the freshman class that entered the Montana State University in the fall of 1936.

In order to facilitate the tremendous amount of mathematical work involved, five by eight inch cards have been prepared for each student. At the left side of the card, in a vertical column, are recorded the results on the various parts of the mental test and the total score. Following these, vertical columns are provided for recording cross-products between the scores on the parts of the test.

Headings for the various subjects that were studied by freshmen students are listed horizontally on the card, and the grade made in each subject has been entered, under the proper heading, from records in the registrar's office. Headings are also provided for the average grades in biological science, physical science, and humanities. No column for average grades in social science is needed as there is only one subject in this division open to freshmen. A column is also provided for journalism scores, and a final column is used to record the average of the grades in all the subjects studied.

Grades in the Montana State University are indicated by letters, ranging from A to F, with E being a grade of "Condition" in a subject, and F indicating failure. These letter grades have been converted to numbers by changing F to 1, E to 2, and so on, A becoming 6. In recording the grades the averages of the three quarters of work have been used for the full-year subjects. Grades are recorded to the nearest tenth; thus, two A's and a B in a subject give a grade of 5.7, and two C's and a B give a grade of 4.3.

In finding correlations without the use of a scattergram it is necessary to find the squares and cross-products of the scores involved. To provide for this, spaces are set aside after the mental test scores, and below the subject scores, for the squares of the respective numbers, and below each of the subject scores, blanks are provided in which the

cross-products of mental test scores and subject scores are entered. Calculation of squares and cross-products was simplified by the use of Holzinger's "Statistical Tables for Students in Education and Psychology". [220]

As a check on the accuracy of the cross-products, the gross score in the mental test was carried along in all calculations. The product of the gross score in the mental test times the score in a subject must equal the sum of all the products of the parts of the mental test times the subject score. Every column of cross-products was totaled to make sure there would be no mistake in this part of the work. All cards have been carefully rechecked to make sure no mistakes have been made in any of the computations involved. There are about 64 computations on each of the 664 cards, and every attempt was made to guard against possible errors.

When all the calculations on the cards for the individual students had been completed the actual correlation was begun. Special forms were used for this part of the work (see page 45). In the first line spaces are provided for the summations of the two items being correlated, and the summation of their cross-products. Next there is a blank for each of the summations of the squares of the two items involved, and a space for the number of cases included in the particular correlation. Below this is given the actual correlation formula, with adequate blank spaces for all the

work involved in its computation. Blanks are also provided for the standard deviations and the medians of the items being correlated. For all the work in finding the correlations a Marchant calculating machine was used. The work involved in preparing the prediction formula for the subject, "Introduction to Biological Science", will be presented in rather complete form, in order to make clear the exact procedures that were followed.

The chief part of the work was the computation of the various coefficients of correlation, and for that reason it was important to select a variation of the Pearson product-moment formula that would involve a minimum of calculation. Actual (raw) scores have been used, since this eliminates errors resulting from classification, and because in general more accurate results are possible by this method. Both the means and the standard deviations of the grades and scores involved are needed, and for that reason a formula that simplifies their calculation was selected. The following formula gives the totals needed for finding the means and standard deviations as a part of the work of calculating the coefficient of correlation:

$$r_{12} = \frac{N\Sigma X_1X_2 - \Sigma X_1 \Sigma X_2}{\sqrt{N\Sigma X^2_1 - (\Sigma X_1)^2}\ \sqrt{N\Sigma X^2_2 - (\Sigma X_2)^2}} \qquad 221$$

In the above formula "r" is the coefficient of

correlation, X_1, is the first and X_2 is the second of the two sets of data being correlated, the symbol Σ represents a summation, and N is the number of cases involved. Thus ΣX_1X_2 represents the sum of the individual products of scores of the two sets of data, and $\Sigma X_1 \Sigma X_2$ represents the product of the sum of all the scores of the first set multiplied by the sum of all the scores of the second set. The X_1 scores are the subject grades, and X_2 represents the scores of the completion test. The other four parts of the examination are represented as follows: X_3 indicates the arithmetic scores, X_4 the artificial language scores, X_5 the analogies scores, and X_6 the opposites scores.

The correlation formula contains the data needed to find both means. The part of the numerator following the minus sign is used; ΣX_1 divided by N gives the first mean, and ΣX_2 divided by N gives the second mean. The standard deviations are also found directly from the formula. The first radical in the denominator produces the first standard deviation and the second radical yields the second standard deviation when each is merely divided by N.

The different summations of data needed for the correlation formula were obtained by totaling the figures for the various subjects as found on the cards for the individual pupils. The type of card that was used is shown on the following page. On this card is contained the full set of computations for one pupil; in finding the

PUPIL'S SCORE AND CALCULATION CARD.

NAME _____ NUMBER 47

	Score	Squ	Cross-products Com	Arl	Ala	Ana	Int BS	Bot	Zoo	Psy	BS Tot
Sco							4.7				4.7
Squ							22.1				22.1
Pre							4.2				4.2
Com	42	1764					197.4				197.4
Arl	26	676	1092				122.2				122.2
Ala	37	1369	1554	962			173.9				173.9
Ana	38	1444	1596	988	1406		178.6				178.6
Opp	63	3969	2646	1638	2331	2394	296.1				296.1
G S	206	42436					968.2				968.2

	Int Num	Fla	Hum Tot	Int S S	Int P S	Cho	Mat	Hum	P S Tot	Jou	Ave Sco
Sco	4.0	4.0	4.3								4.3
Squ	16.0	16.0	18.5								18.5
Pre	4.0	4.1	4.2								4.2
Com	168.0	168.0	180.6								180.6
Arl	104.0	104.0	111.8								111.8
Ala	148.0	148.0	159.1								159.1
Ana	152.0	152.0	163.4								163.4
Opp	252.0	252.0	270.9								270.9
G S	824.0	824.0	885.8								885.8

prediction formula for "Introduction to Biological Science" only the first seven vertical columns of figures are used.

From the card above it can be seen that this pupil has scores on the psychological examination as follows: completion, 42; arithmetic, 26; artificial language, 37; analogies, 38; and opposites, 63. The gross score is 206. Immediately following the score for each part of the test is the square of the score. In the next column is given the product of the completion score times each of the other scores in the test; thus X_2X_3 (completion times arithmetic)

is 1092. The next three vertical columns successively give the cross-products with the arithmetic, artificial language, and analogies scores. Thus, in the vertical column headed Ana we find X_4X_5 (analogies times opposites) having a value of 2394.

The rest of the card is devoted to the various subject grades and the calculations directly connected with them. First of these columns is the one headed Int BS, which is for the subject "Introduction to Biological Science. The top number, 4.7, is the grade received in the subject, being the average of two B's and a C. Immediately below this is the square of the grade, and then the predicted grade, which was filled in after the formula had been worked out. Then follow the products of the grade times each subtest and times the gross score of the examination. The other columns following the one headed Int BS are not needed for the calculation of the prediction formula for "Introduction to Biological Science", but are used successively in combination with the first six vertical columns for finding the other subject formulas. Headings on the remaining columns refer to specific subjects as follows: Bot, Botany; Zoo, Zoology; Psy, Psychology; BS Tot, Biological Division Average Grade; Int Hum, Introduction to Humanities; Fla, Foreign Languages; Hum Tot, Humanities Division Average Grade; Int SS, Introduction to Social Science; Int PS, Introduction to Physical Science; Che, Chemistry; Mat,

Mathematics; HEc, Home Economics; PS Tot, Physical Science Division Average Grade; Jou, Journalism; and Ave Sco, average of all grades earned. The card has 64 calculations in addition to the 12 original entries, and is about average in this respect. Holzinger's Statistical Tables for Students in Education and Psychology [222] were used for finding the squares and cross-products, and a calculating machine was used in checking totals of all columns giving cross-products between subject grades and subtest scores.

When all the work on the cards for the individual pupils had been completed the totals were found for each item needed in the prediction work in "Introduction to Biological Science". The cards for the 198 pupils registered in the subject were segregated, and the totals for each of the 27 sets of figures in the first seven columns of the cards were found. An adding machine was used in this phase of the work since the record of the figures added was needed to make checking of accuracy possible. The following table gives the totals obtained for the subject:

TOTALS: INTRODUCTION TO BIOLOGICAL SCIENCE

N = 198

	SCORE	SQUARE	COM	ARI	ALA	ANA	INT BS
SCORE							735.1
SQUARE							2987.1
COM	6200	220960					24436.0
ARI	4196	116136	146252				16358.4
ALA	7286	323494	244058	162130			28784.8
ANA	5976	202208	199942	139252	232622		23127.6
OPP	10664	653366	369322	236182	424018	335498	41492.3

The completion of the tabulation of the totals from the cards for the 198 students enrolled in the subject is the last step before correlations can be begun. From these totals the simple correlations needed can be found. The calculation sheet for r_{12} (correlation between Introduction to Biological Science grades and completion test scores) is given on the following page. The calculating machine was of course used to carry out the work involved. It is seen that very large figures result when raw scores are used, but this disadvantage is compensated for by the increased accuracy of the results obtained over any other method that might be used.

In order to find the multiple correlation between the scores on the five subtests and the subject grades, it is necessary to compute the simple correlations for the subject grades with respect to each subtest, and also the simple correlations for the subtests with respect to each other. This involves a total of 15 correlations, which were all worked out on forms similar to the one used for r_{12}.

The results of the simple correlation work must be used a number of times in the subsequent process of finding coefficients of partial correlation, and for that reason they are all recorded on a separate sheet, in order to make it easier to refer to them (see page 46). On the same sheet are found the means, standard deviations, and below each coefficient the value of $\sqrt{1 - r^2}$ for that particular

CALCULATION OF THE SIMPLE CORRELATION r_{12}
FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

X_1 = Int BS $\qquad$ X_2 = Com

$\Sigma X_1 = 735.1 \qquad \Sigma X_2 = 6200 \qquad \Sigma X_1X_2 = 24436.0$

$\Sigma X^2_1 = 2987.1 \qquad \Sigma X^2_2 = 220960 \qquad N = 198$

$$r_{12} = \frac{N\Sigma X_1X_2 - \Sigma X_1 \Sigma X_2}{\sqrt{N\Sigma X^2_1 - (\Sigma X_1)^2} \quad \sqrt{N\Sigma X^2_2 - (\Sigma X_2)^2}} =$$

$$\frac{198 \times 24436.0 - 735.1 \times 6200}{\sqrt{198 \times 2987.1 - (735.1)^2} \quad \sqrt{198 \times 220960 - (6200)^2}} =$$

$$\sqrt{59143918 - 540372.0} \qquad \sqrt{43750080 - 38440000}$$

$$\frac{4838328 - 4557620.0}{\sqrt{51067.8} \quad \sqrt{5310080}} =$$

$\sigma_1 = \frac{226.0}{198} = 1.14 \qquad \frac{280708}{226.0 \times 2304.4} =$

$\sigma_2 = \frac{2304.4}{198} = 11.64$

$M_1 = \frac{735.1}{198} = 3.71 \qquad \frac{280708}{520748.3} = .539$

$M_2 = \frac{6200}{198} = 31.31$

$r_{12} = .539$

SIMPLE CORRELATIONS, MEANS, AND STANDARD DEVIATIONS
FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

STANDARD DEVIATIONS AND MEANS

	X_1	X_2	X_3	X_4	X_5	X_6
Means	3.71	31.31	21.19	36.80	30.18	53.86
S. D.	1.14	11.64	11.72	16.72	10.50	19.98

SIMPLE CORRELATIONS

		X_2	X_3	X_4	X_5	X_6
X_1	r	.539	.295	.459	.396	.421
	$1 - r^2$	.842	.956	.888	.918	.907
X_2	r		.550	.413	.530	.769
	$1 - r^2$		.835	.911	.848	.639
X_3	r			.199	.517	.220
	$1 - r^2$			.980	.856	.976
X_4	r				.366	.478
	$1 - r^2$				.931	.878
X_5	r					.328
	$1 - r^2$					.945

correlation. The latter values were found from a table in "Handbook of Statistical Nomographs, Tables, and Formulas"

by Dunlap and Kurtz [223].

In the calculation of the first order partial coefficients of correlation the results of the simple correlations are used. The following formula applies:

$$r_{12.3} = \frac{r_{12} - r_{13}r_{23}}{\sqrt{1 - r^2_{13}}\ \sqrt{1 - r^2_{23}}} \quad [224]$$

It is seen that the two factors of the denominator are the values previously entered below each coefficient of correlation. It is also seen that the two factors of the denominator are the $\sqrt{1 - r^2}$ values of the last two coefficients given in the numerator. Since this relationship holds true in all the partial correlation formulas used in the study, it is not necessary to write out the denominator part of the formula on the calculation sheets, since the values to be used can be seen from the numerator alone. The following page is a copy of the work involved in the calculation of the first order partial coefficients of correlation needed for this subject. In order to make it easier to refer to the results in subsequent calculations, the coefficients of correlation are entered at the left side of the page, just below their respective symbols, and are followed by the $\sqrt{1 - r^2}$ values for each coefficient. Only the 20 first order coefficients to be used later on have been calculated.

In finding a multiple correlation involving five

FIRST PARTIAL COEFFICIENTS OF CORRELATION FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$$r_{13.2} = \frac{r_{13}-r_{12}r_{23}}{} = \frac{.295-.539 \times .550}{.842 \times .835} = \frac{}{} = \frac{-.001450}{.703070}$$

$$\frac{.000}{r_{14.2}} = \frac{1.000}{r_{14}-r_{12}r_{24}} = \frac{.459-.539 \times .413}{.842 \times .911} = \frac{}{} = \frac{.236393}{.767062}$$

$$\frac{.308}{r_{15.2}} = \frac{.951}{r_{15}-r_{12}r_{25}} = \frac{.396-.539 \times .530}{.842 \times .848} = \frac{}{} = \frac{.110330}{.714016}$$

$$\frac{.155}{r_{16.2}} = \frac{.988}{r_{16}-r_{12}r_{26}} = \frac{.421-.539 \times .769}{.842 \times .639} = \frac{}{} = \frac{.006509}{.538038}$$

$$\frac{.001}{r_{34.2}} = \frac{1.000}{r_{34}-r_{23}r_{24}} = \frac{.199-.550 \times .413}{.835 \times .911} = \frac{}{} = \frac{-.028150}{.760685}$$

$$\frac{-.004}{r_{35.2}} = \frac{1.000}{r_{35}-r_{23}r_{25}} = \frac{.517-.550 \times .530}{.835 \times .848} = \frac{}{} = \frac{.325500}{.708080}$$

$$\frac{.318}{r_{36.2}} = \frac{.948}{r_{36}-r_{23}r_{26}} = \frac{.220-.550 \times .769}{.835 \times .639} = \frac{}{} = \frac{-.202950}{.532565}$$

$$\frac{-.380}{r_{45.2}} = \frac{.925}{r_{45}-r_{24}r_{25}} = \frac{.366-.413 \times .530}{.911 \times .848} = \frac{}{} = \frac{.147110}{.772528}$$

$$\frac{.190}{r_{46.2}} = \frac{.982}{r_{46}-r_{24}r_{26}} = \frac{.32x-.413 \times .769}{.911 \times .639} = \frac{}{} = \frac{.160403}{.582129}$$

$$\frac{.276}{r_{56.2}} = \frac{.961}{r_{56}-r_{25}r_{26}} = \frac{.328-.530 \times .769}{.848 \times .639} = \frac{}{} = \frac{-.079570}{.543772}$$

$$\frac{-.146}{r_{12.4}} = \frac{.989}{r_{12}-r_{14}r_{24}} = \frac{.539-.459 \times .413}{.888 \times .911} = \frac{}{} = \frac{.349433}{.808898}$$

$$\frac{.432}{r_{13.4}} = \frac{.902}{r_{13}-r_{14}r_{34}} = \frac{.295-.459 \times .199}{.868 \times .980} = \frac{}{} = \frac{.203659}{.870240}$$

$$\frac{.234}{r_{15.4}} = \frac{.972}{r_{15}-r_{14}r_{45}} = \frac{.396-.459 \times .366}{.888 \times .931} = \frac{}{} = \frac{.228006}{.826728}$$

$$\frac{.276}{r_{16.4}} = \frac{.961}{r_{16}-r_{14}r_{46}} = \frac{.421-.459 \times .478}{.888 \times .878} = \frac{}{} = \frac{.201598}{.779664}$$

$$\frac{.259}{r_{23.4}} = \frac{.966}{r_{23}-r_{24}r_{34}} = \frac{.550-.413 \times .199}{.911 \times .930} = \frac{}{} = \frac{.467813}{.892780}$$

$$\frac{.524}{r_{25.4}} = \frac{.852}{r_{25}-r_{24}r_{45}} = \frac{.530-.413 \times .366}{.911 \times .931} = \frac{}{} = \frac{.378842}{.848141}$$

$$\frac{.447}{} \quad \frac{.895}{}$$

FIRST PARTIAL COEFFICIENTS OF CORRELATION
FOR INTRODUCTION TO BIOLOGICAL SCIENCE (Cont.)

$$r_{26.4} = \frac{r_{26}-r_{24}r_{46}}{} = \frac{.769 - .413 \times .478}{.911 \times .878} = \frac{-}{} = \frac{.571586}{.799858}$$

$$\frac{.715}{r_{35.4}} = \frac{.699}{r_{35}-r_{34}r_{45}} = \frac{.517 - .199 \times .366}{.980 \times .931} = \frac{-}{} = \frac{.444166}{.912380}$$

$$\frac{.487}{r_{36.4}} = \frac{.873}{r_{36}-r_{34}r_{46}} = \frac{.220 - .199 \times .478}{.980 \times .878} = \frac{-}{} = \frac{.124878}{.860440}$$

$$\frac{.145}{r_{56.4}} = \frac{.989}{r_{56}-r_{45}r_{46}} = \frac{.328 - .366 \times .478}{.931 \times .878} = \frac{-}{} = \frac{.153052}{.817418}$$

$$\frac{.187}{} \quad \frac{.982}{}$$

variables it is necessary to calculate partial coefficients of correlation of the second, third, and fourth orders. The standard error of estimate for five variables, and the partial regression coefficients must be found. With this work completed the multiple correlation and the prediction formula can be computed. The general formula for partial coefficients of a higher order in terms of coefficients of a lower order, n variables, is:

225.

$$r_{12.34\ldots n} = \frac{r_{12.345\ldots(n-1)} - r_{1n.345\ldots(n-1)} r_{2n.345\ldots(n-1)}}{\sqrt{1 - r^2_{1n.345\ldots(n-1)}}\ \sqrt{1 - r^2_{2n.345\ldots(n-1)}}}$$

The formula for the standard error of estimate, n variables, is:

226.

$$\sigma_{1.23\ldots n} = \sigma_1 \sqrt{1-r^2_{12}}\ \sqrt{1-r^2_{13.2}}\ \sqrt{1-r^2_{14.23}}\ \sqrt{1-r^2_{1n.234\ldots(n-1)}}$$

The formula for the partial regression coefficient in terms

of standard errors of estimate and partial regression coefficients, n variables, is:

$$b_{12.34\ldots n} = r_{12.34\ldots n} \frac{\sigma_{1.234\ldots n}}{\sigma_{2.134\ldots n}} \quad 227$$

The order of integers in the subscripts of the coefficients of partial or multiple correlation can be altered; the one thing that must be kept in mind is that the integers before the period must not be rearranged. The integers following the period can be arranged in any manner that will make for the shortest computation of the desired result. This fact is important, since by this rearrangement the number of partial correlations to be found can be materially reduced; also, it makes possible as many different formulas for finding the multiple correlation as one less than the number of variables. This fact has been made use of in that two separate calculations of each multiple correlation have been made, so that a final check on the accuracy of the work is possible. The greatest difference between the two results that has been tolerated without making a recalculation is .002. This amount is in no case more than one-tenth of the probable error of the coefficient of correlation in which it occurs.

The general formula for the coefficient of multiple correlation in terms of partial correlation coefficients,

n variables is:

228

$$R_{1.23\ldots n} = \sqrt{1 - \left[(1-r^2_{12})(1-r^2_{13.2})\ldots(1-r^2_{1n.234\ldots(n-1)})\right]}$$

The two forms of the formula that have been used in this problem are shown on page 55.

The prediction formula to be used in forecasting the probable subject grades can be written out from the partial regression coefficients. The generalized formula (multiple regression equation) is:

229

$$\bar{X}_1 = b_{12.34\ldots n}X_2 + b_{13.24\ldots n}X_3 \ldots + b_{1n.234\ldots(n-1)}X_n + C.$$

The value of C can be derived from the following equation:

230

$$C = M_1 - b_{12.34\ldots n}M_2 - b_{13.24\ldots n}M_3 - \ldots - b_{1n.234\ldots(n-1)}M_n.$$

The following four pages contain the actual calculations needed to complete the work of finding the prediction formula for the subject, Introduction to Biological Science. It will be seen that the denominators of the partial coefficient formulas are not written out on the calculation sheets.

It was found to be much simpler to use the nomograph in Dunlap and Kurtz's "Handbook of Statistical Nomographs, Tables, and Formulas" [231], than to employ the formula which is generally used for this purpose. The formula for finding

SECOND PARTIAL COEFFICIENTS OF CORRELATION
FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$r_{14.23} = \frac{r_{14.2} - r_{13.2}r_{34.2}}{1 - r^2_{13.2}}\sqrt{1 - r^2_{34.2}} = \frac{.308 - .000 \times (-.004)}{1.000 \times 1.000} = \frac{-}{-} = \frac{}{}$

$r_{15.23} = \frac{r_{15.2} - r_{13.2}r_{35.2}}{1 - r^2_{13.2}}\sqrt{1 - r^2_{35.2}} = \frac{.155 - .000 \times .318}{1.000 \times .948} = \frac{-}{-} = \frac{.155000}{.948000}$

$r_{16.23} = \frac{r_{16.2} - r_{13.2}r_{36.2}}{1 - r^2_{13.2}}\sqrt{1 - r^2_{36.2}} = \frac{.001 - .000 \times (-.380)}{1.000 \times .925} = \frac{-}{-} = \frac{.001000}{.925000}$

$r_{45.23} = \frac{r_{45.2} - r_{34.2}r_{35.2}}{1 - r^2_{34.2}}\sqrt{1 - r^2_{35.2}} = \frac{.190 - (-.004) \times .318}{1.000 \times .948} = \frac{-}{-} = \frac{.191272}{.948000}$

$r_{46.23} = \frac{r_{46.2} - r_{34.2}r_{36.2}}{1 - r^2_{34.2}}\sqrt{1 - r^2_{36.2}} = \frac{.276 - (-.004) \times (-.380)}{1.000 \times .925} = \frac{-}{-} = \frac{.274480}{.925000}$

$r_{56.23} = \frac{r_{56.2} - r_{35.2}r_{36.2}}{1 - r^2_{35.2}}\sqrt{1 - r^2_{36.2}} = \frac{-.146 - .318 \times (-.380)}{.948 \times .925} = \frac{-}{-} = \frac{-.025160}{.876400}$

$r_{12.34} = \frac{r_{12.4} - r_{13.4}r_{23.4}}{1 - r^2_{13.4}}\sqrt{1 - r^2_{23.4}} = \frac{.432 - .234 \times .524}{.972 \times .852} = \frac{-}{-} = \frac{.309384}{.828144}$

$r_{15.34} = \frac{r_{15.4} - r_{13.4}r_{35.4}}{1 - r^2_{13.4}}\sqrt{1 - r^2_{35.4}} = \frac{.276 - .234 \times .487}{.972 \times .873} = \frac{-}{-} = \frac{.162042}{.842556}$

$r_{16.34} = \frac{r_{16.4} - r_{13.4}r_{36.4}}{1 - r^2_{13.4}}\sqrt{1 - r^2_{36.4}} = \frac{.197 - .234 \times .145}{.972 \times .987} = \frac{-}{-} = \frac{.165070}{.961308}$

$r_{25.34} = \frac{r_{25.4} - r_{23.4}r_{35.4}}{1 - r^2_{23.4}}\sqrt{1 - r^2_{35.4}} = \frac{.447 - .524 \times .487}{.852 \times .873} = \frac{-}{-} = \frac{.171812}{.743796}$

$r_{26.34} = \frac{r_{26.4} - r_{23.4}r_{36.4}}{1 - r^2_{23.4}}\sqrt{1 - r^2_{36.4}} = \frac{.715 - .524 \times .145}{.852 \times .987} = \frac{-}{-} = \frac{.659020}{.842628}$

$r_{56.34} = \frac{r_{56.4} - r_{35.4}r_{36.4}}{1 - r^2_{35.4}}\sqrt{1 - r^2_{36.4}} = \frac{.187 - .487 \times .145}{.873 \times .987} = \frac{-}{-} = \frac{.116285}{.863397}$

$r_{12.45} = \frac{r_{12.4} - r_{15.4}r_{25.4}}{1 - r^2_{15.4}}\sqrt{1 - r^2_{25.4}} = \frac{.432 - .276 \times .447}{.961 \times .894} = \frac{-}{-} = \frac{.500628}{.859095}$

$r_{13.45} = \frac{r_{13.4} - r_{15.4}r_{35.4}}{1 - r^2_{15.4}}\sqrt{1 - r^2_{35.4}} = \frac{.234 - .276 \times .487}{.961 \times .873} = \frac{-}{-} = \frac{.094588}{.839145}$

$r_{16.45} = \frac{r_{16.4} - r_{15.4}r_{56.4}}{1 - r^2_{15.4}}\sqrt{1 - r^2_{56.4}} = \frac{.259 - .276 \times .187}{.961 \times .982} = \frac{-}{-} = \frac{.207388}{.943702}$

.976

SECOND PARTIAL COEFFICIENTS OF CORRELATION FOR INTRODUCTION TO BIOLOGICAL SCIENCE (Cont.)

$$r_{23.45} = \frac{r_{23.4} - r_{25.4}r_{35.4}}{} = \frac{.259 - .276 \times .187}{.961 \times .982} = \frac{=}{.781335} = .306311$$

.392 .920

$$r_{26.45} = \frac{r_{26.4} - r_{25.4}r_{56.4}}{} = \frac{.524 - .447 \times .487}{.895 \times .873} = \frac{=}{.878890} = .631411$$

.718 .696

$$r_{36.45} = \frac{r_{36.4} - r_{35.4}r_{56.4}}{} = \frac{.145 - .487 \times .187}{.873 \times .982} = \frac{=}{.857286} = .053931$$

.063 .998

THIRD PARTIAL COEFFICIENTS OF CORRELATION FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$$r_{14.236} = \frac{r_{14.23} - r_{16.23}r_{46.23}}{} = \frac{.308 - .001 \times .297}{1.000 \times .955} = \frac{=}{.955000} = .307703$$

.322 .947

$$r_{15.236} = \frac{r_{15.23} - r_{16.23}r_{56.23}}{} = \frac{.164 - .001 \times (-.029)}{1.000 \times 1.000} = \frac{=}{1.000} = .164029$$

.164 .987

$$r_{45.236} = \frac{r_{45.23} - r_{46.23}r_{56.23}}{} = \frac{.202 - .297 \times (-.029)}{.955 \times 1.000} = \frac{=}{.955000} = .210613$$

.221 .975

$$r_{12.345} = \frac{r_{12.34} - r_{15.34}r_{25.34}}{} = \frac{.374 - .191 \times .258}{.982 \times .966} = \frac{=}{.948612} = .324722$$

.342 .940

$$r_{16.345} = \frac{r_{16.34} - r_{15.34}r_{56.34}}{} = \frac{.234 - .191 \times .135}{.982 \times .991} = \frac{=}{.973162} = .208215$$

.214 .977

$$r_{26.345} = \frac{r_{26.34} - r_{25.34}r_{56.34}}{} = \frac{.758 - .258 \times .135}{.966 \times .991} = \frac{=}{.957306} = .723170$$

.755 .656

$$r_{12.456} = \frac{r_{12.45} - r_{16.45}r_{26.45}}{} = \frac{.359 - .220 \times .718}{.976 \times .696} = \frac{=}{.679296} = .201040$$

.296 .955

$$r_{13.456} = \frac{r_{13.45} - r_{16.45}r_{36.45}}{} = \frac{.119 - .220 \times .063}{.976 \times .998} = \frac{=}{.974048} = .105140$$

.108 .994

$$r_{23.456} = \frac{r_{23.45} - r_{26.45}r_{36.45}}{} = \frac{.392 - .718 \times .063}{.696 \times .998} = \frac{=}{.694608} = .346766$$

.499 .867

FOURTH PARTIAL COEFFICIENTS OF CORRELATION FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$$r_{(12.3456}_{12.6543)} = \frac{r_{12.456} - r_{13.456}r_{23.456}}{} = \frac{.296 - .108 \times .499}{.994 \times .867} = - = \frac{.342108}{.861798}$$

.281 .960

$$r_{13.2456} = \frac{r_{13.456} - r_{12.456}r_{23.456}}{} = \frac{.108 - .296 \times .499}{.955 \times .867} = - = \frac{-.039704}{.827985}$$

-.048 .999

$$r_{14.2356} = \frac{r_{14.236} - r_{15.236}r_{45.236}}{} = \frac{.322 - .164 \times .221}{.987 \times .975} = - = \frac{.285876}{.962325}$$

.247 .955

$$r_{15.2346} = \frac{r_{15.236} - r_{14.236}r_{45.236}}{} = \frac{.164 - .322 \times .221}{.947 \times .975} = - = \frac{.092838}{.923325}$$

.101 .495

$$r_{16.2345} = \frac{r_{16.345} - r_{12.345}r_{26.345}}{} = \frac{.214 - .342 \times .755}{.940 \times .656} = - = \frac{-.044210}{.616640}$$

-.072 .997

STANDARD ERRORS OF ESTIMATE FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$$\sigma_{(1.23456}_{1.45632)} = \sigma_1\sqrt{(1-r_{14}^2)}\sqrt{(1-r_{15.4}^2)}\sqrt{(1-r_{16.45}^2)}\sqrt{(1-r_{13.456}^2)}\sqrt{(1-r_{12.3456}^2)}$$

.906 1.14 x .888 x .961 x .976 x .994 x .960

$$\sigma_{(2.13456}_{2.45631)} = \sigma_2\sqrt{(1-r_{24}^2)}\sqrt{(1-r_{25.4}^2)}\sqrt{(1-r_{26.45}^2)}\sqrt{(1-r_{23.456}^2)}\sqrt{(1-r_{12.3456}^2)}$$

5.494 11.64 x .911 x .895 x .696 x .867 x .960

$$\sigma_{(3.12456}_{3.45621)} = \sigma_3\sqrt{(1-r_{34}^2)}\sqrt{(1-r_{35.4}^2)}\sqrt{(1-r_{36.45}^2)}\sqrt{(1-r_{23.456}^2)}\sqrt{(1-r_{13.2456}^2)}$$

8.661 11.72 x .980 x .873 x .998 x .867 x .999

$$\sigma_{(4.12356}_{4.23651)} = \sigma_4\sqrt{(1-r_{24}^2)}\sqrt{(1-r_{34.2}^2)}\sqrt{(1-r_{46.23}^2)}\sqrt{(1-r_{45.236}^2)}\sqrt{(1-r_{15.2346}^2)}$$

13.543 16.72 x .911 x 1.000 x .955 x .975 x .955

$$\sigma_{(5.12346}_{5.23641)} = \sigma_5\sqrt{(1-r_{25}^2)}\sqrt{(1-r_{35.2}^2)}\sqrt{(1-r_{56.23}^2)}\sqrt{(1-r_{45.236}^2)}\sqrt{(1-r_{15.2346}^2)}$$

8.190 10.50 x .846 x .948 x 1.000 x .975 x .995

STANDARD ERRORS OF ESTIMATE FOR
INTRODUCTION TO BIOLOGICAL SCIENCE (Cont.)

$$\sigma_{(6.12345)} = \sigma_6\sqrt{(1-r^2_{46})(1-r^2_{36.4})(1-r^2_{56.34})(1-r^2_{26.345})(1-r^2_{16.2345})}$$

$$\underset{6.43521}{11.249} \qquad 9.98 \times .878 \times .989 \times .891 \times .656 \times .997$$

PARTIAL REGRESSION COEFFICIENTS
FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$$\underset{.046}{b_{12.3456}} = r_{12.3456}\frac{\sigma_{1.23456}}{\sigma_{2.13456}} = \frac{.281 \times .906}{5.494} = \frac{.254586}{5.494}$$

$$\underset{-.005}{b_{13.2456}} = r_{13.2456}\frac{\sigma_{1.23456}}{\sigma_{3.12456}} = \frac{-.048 \times .906}{8.661} = \frac{-.043488}{8.661}$$

$$\underset{.020}{b_{14.2356}} = r_{14.2356}\frac{\sigma_{1.23456}}{\sigma_{4.12356}} = \frac{.297 \times .906}{13.543} = \frac{.269082}{13.543}$$

$$\underset{.011}{b_{15.2346}} = r_{15.2346}\frac{\sigma_{1.23456}}{\sigma_{5.12346}} = \frac{.101 \times .906}{8.190} = \frac{.091506}{8.190}$$

$$\underset{-.006}{b_{16.2345}} = r_{16.2345}\frac{\sigma_{1.23456}}{\sigma_{6.12345}} = \frac{-.072 \times .906}{11.249} = \frac{-.065232}{11.249}$$

MULTIPLE CORRELATION COEFFICIENTS
FOR INTRODUCTION TO BIOLOGICAL SCIENCE.

$$\underset{(1.45632)}{R_{1.23456}} = \sqrt{1-(1-r^2_{14})(1-r^2_{15.4})(1-r^2_{16.45})(1-r^2_{13.456})(1-r^2_{12.3456})}$$

$$\underset{.607}{} \qquad \sqrt{1-(.789 \times .924 \times .952 \times .988 \times .921)} = \sqrt{1-.631} = \sqrt{.369}$$

$$\underset{(1.23645)}{R_{1.23456}} = \sqrt{1-(1-r^2_{12})(1-r^2_{13.2})(1-r^2_{16.23})(1-r^2_{14.236})(1-r^2_{15.2346})}$$

$$\underset{.608}{} \qquad \sqrt{1-(.710 \times 1.000 \times 1.000 \times .896 \times .990)} = \sqrt{1-.630} = \sqrt{.370}$$

the probable error follows:

$$P.E._{R_{1.23456}} = .6745 \frac{1-R^2_{1.23456}}{\sqrt{N}} \qquad 832$$

The probable error, found by either method, is ±.030. The coefficient of multiple correlation can thus be written .607 ± .030

The significance of the probable error is that it indicates the limits within which coefficients for other correlations based on an equal number in the same subject are likely to fall. Chances are even that in a second correlation the value of $R_{1.23456}$ would not differ from .607 by more than ±.030.

The value of C for the prediction formula must be found before individual grades can be predicted. By substituting in the formula given on page 51, the following equation can be set up:

$$C = 3.71 - .046 \times 31.31 + .005 \times 21.19 - .020 \times 36.80 - .011 \times 30.18 + .006 \times 53.86$$

The value found for C is 1.631. The prediction formula, with this value for C, becomes:

$$X_1 = .046X_2 - .005X_3 + .020X_4 + .011X_5 - .006X_6 + 1.631.$$

By referring to the student's grade card on page 41 the method of applying the formula becomes clear. For the

student whose grades and test scores are given on this card the calculation of a predicted grade in Introduction to Biological Science resolves itself into the following computation when the correct substitutions are made in the formula:

$$\bar{X}_1 = .046 \times 42 - .005 \times 26 + .020 \times 37 + .011 \times 38 - .006 \times 63 + 1.631.$$

The resulting predicted grade is 4.1; this is .6 of a letter grade less than the actual grade received. For this particular student better predictions were made in all other subjects in which he was enrolled.

The probable error of the predicted score is most easily found from a Dunlap-Kurtz table for converting the previously calculated standard error of estimate to a probable error. It can also be found from the following formula:

$$PE_{\bar{X}_1} = .6745 \times \sigma_{1.23456}$$

233

By either method the probable error of any estimated score in Introduction to Biological Science is ±.611. The difference between the actual and the predicted grade should not exceed this amount in more than 50% of the cases. In other words, this formula should make predictions that will be less than two-thirds of a letter grade different from the

grade actually received, in the case of about half of the students for whom predictions are made. Stating it a little differently, each student has a 50% chance of getting a grade that does not differ from the prediction made for him by more than ±.611 of a letter grade. The following table gives the percent of cases that will fall within the various number of probable error limits from the predicted grade.

PERCENTAGES OF CHANCES OF SCORE BEING WITHIN CERTAIN PROBABLE ERROR LIMITS. (David Segel [234])

Probable error units	Percent of cases	Probable error units	Percent of cases
- .5	26	- 3.0	96
- 1.0	50	- 3.5	98
- 1.5	69	- 4.0	99.3
- 2.0	82	- 5.0	99.96
- 2.5	91		

The prediction formula was applied to all the pupils who took the subject in 1936-37, and also to all the pupils in the sampling of the freshman class of 1937-38 who were enrolled in the subject. This sampling was made on the basis of every fifth freshman enrolled. The predictions were made from the table on page 193, which was derived from the prediction formula for the subject.

The chances of failure or success in the subject can be predicted by the use of the probable error of estimate. The

grade that a pupil should attain to be classified as successful is C, since any grade lower than this results in a negative grade point, and to graduate from Montana State University a student must secure as many grade points as credits. The deviation of the estimated grade of any pupil from a C grade in terms of tenths of the probable error of estimate is a criterion for predicting the chances of success or failure. The table on page 207 is the result of the application of this criterion.

The predicted grade for the pupil whose card is given on page 41 is 4.1 in Introduction to Biological Science. Referring to the table on page 207, it is seen that this pupil has a 45% chance of failing and a 55% chance of being successful in the subject; somewhat better than an even chance of maintaining a C grade in the subject.

The various mathematical results found in calculating the multiple correlation and prediction formula for the subject can best be analyzed by summarizing the various related figures. From the following table it is seen that the mean grade in the subject is 3.71, somewhat below a C, and the standard deviation is 1.14. Means for the subtests of the psychological examination are above the national medians in completion, artificial language, and opposites, and considerably below them in the other two subtests. Simple correlations between the subject grades and the subtests vary from .539 for completion to .295 in

MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR THE 1935-37 INTRODUCTION TO BIOLOGICAL SCIENCE CLASS.

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.71	1.14	X_4	36.80	16.72
X_2	31.31	11.64	X_5	30.18	10.50
X_3	21.19	11.72	X_6	53.86	19.98

arithmetic. However, the artificial language subtest is the most significant in making predictions, as seen from the fourth partial coffecients of correlation, in which the effects of the other subtests have been eliminated. It has a coefficient of .297 as compared with a fourth partial correlation for the completion test of .281. The lowest fourth partial coefficient of correlation is for the arithmetic subtest, being only -.048.

CORRELATIONS BETWEEN INTRODUCTION TO BIOLOGICAL SCIENCE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.539	.295	.459	.396	.421
X_2		.550	.413	.530	.769
X_3			.199	.517	.220
X_4				.366	.478
X_5					.328
P. E. range = ±.019 to ±.046					

CORRELATIONS BETWEEN INTRODUCTION TO BIOLOGICAL SCIENCE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

FIRST PARTIAL CORRELATIONS

$r_{13.2}$ = .000	$r_{35.2}$ = .318	$r_{12.4}$ = .432	$r_{25.4}$ = .447
$r_{14.2}$ = .308	$r_{36.2}$ = -.380	$r_{13.4}$ = .234	$r_{26.4}$ = .715
$r_{15.2}$ = .155	$r_{45.2}$ = .190	$r_{15.4}$ = .276	$r_{35.4}$ = .487
$r_{16.2}$ = .001	$r_{46.2}$ = .276	$r_{16.4}$ = .259	$r_{36.4}$ = .145
$r_{34.2}$ = -.004	$r_{56.2}$ = -.146	$r_{23.4}$ = .524	$r_{56.4}$ = .187

P. E. range = ±.024 to ±.048

SECOND PARTIAL CORRELATIONS

$r_{14.23}$ = .308	$r_{56.23}$ = -.029	$r_{26.34}$ = .758	$r_{23.45}$ = .392
$r_{15.23}$ = .164	$r_{12.34}$ = .374	$r_{56.34}$ = .135	$r_{26.45}$ = .718
$r_{16.23}$ = .001	$r_{15.34}$ = .191	$r_{12.45}$ = .359	$r_{36.45}$ = .063
$r_{45.23}$ = .202	$r_{16.34}$ = .234	$r_{13.45}$ = .119	
$r_{46.23}$ = .297	$r_{25.34}$ = .258	$r_{16.45}$ = .220	

P. E. range = ±.021 to ±.048

THIRD PARTIAL CORRELATIONS

$r_{14.236}$ = .322	$r_{12.345}$ = .342	$r_{12.456}$ = .296
$r_{15.236}$ = .164	$r_{16.345}$ = .214	$r_{13.456}$ = .104
$r_{45.236}$ = .221	$r_{26.345}$ = .755	$r_{23.456}$ = .499

P. E. range = ±.021 to ±.047

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$ = .281	$r_{14.2356}$ = .297	$r_{16.2345}$ = -.072
$r_{13.2456}$ = -.048	$r_{25.2346}$ = .101	

P. E. range = ±.044 to ±.048

MULTIPLE CORRELATION

$R_{1.23456}$ = $R_{1.45632}$ = .607	P. E. = ±.030
$R_{1.23456}$ = $R_{1.23645}$ = .608	P. E. = ±.030

The forecasting efficiency of the formula derived can be found by calculating the coefficient of alienation

$$K = \sqrt{1 - r^2} \qquad ^{235}$$

and using it in the formula for finding the predictive value as a percent, this being

$$E = 1 - K. \qquad ^{236}$$

The correlation coefficient to be used is the $R_{1.23456}$ value, since multiple correlation of all predictive items has been performed. From the multiple correlation of .607 the predictive value of the formula is found to be 21%. The efficiency in percentages for various correlation coefficients is given in the following table:

THE RELATION BETWEEN THE CORRELATION COEFFICIENT AND THE PERCENT OF FORECASTING EFFICIENCY.

COEFFICIENT	PERCENT	COEFFICIENT	PERCENT
10	1/2	65	24
20	2	70	29
30	5	75	34
40	8	80	40
50	13	85	47
55	16	90	56
60	20	95	69

The predicted grades for the two groups of students

previously mentioned are classified and compared with the actual grades in the following tables. The first of these compares the grades received with the grades predicted.

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN INTRODUCTION TO BIOLOGICAL SCIENCE
M. S. U. Freshmen, 1936-37.
(Percentages based on totals for each predicted grade)

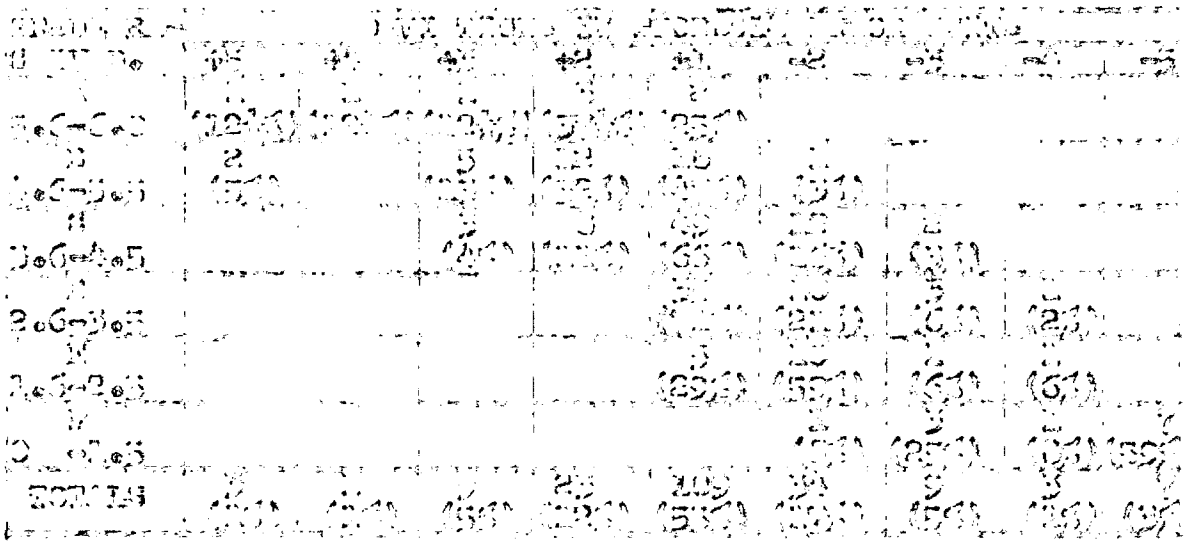
PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				1 (50%)		1 (50%)
B 4.6-5.5			4 (18%)	4 (18%)	10 (46%)	4 (18%)
C 3.6-4.5	4 (4%)	4 (4%)	17 (19%)	42 (45%)	24 (26%)	2 (2%)
D 2.6-3.5	6 (8%)	12 (16%)	24 (33%)	26 (36%)	4 (6%)	1 (1%)
E 1.6-2.5	2 (25%)	1 (12½%)	4 (40%)	1 (12½%)		
F 0 -1.5						
78 of 198 (40%) received grades predicted for them						

From the above table it is seen that 40% of the student group in this subject received the letter grade that was predicted for them. Only 29 (25%) of the students with a predicted grade of C or better failed to get at least a C. Of the students with predictions lower than a C, 49 (61%) failed to secure that high a grade, and only five students in this prediction range scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 109 (55%) of the actual grades varied

than the predicted grade by not more than one unit (.6 below grade). In 166 (8%) of the cases the actual grade varied from the predicted grade by not more than one probable error (1.2 below grade). The poorest predictions were in the A and F ranges: 3 (27%) of the A's received and 11 (52%) of the F's differed more than one unit from the forecasts. The best predictions were made for students who received B's: 35 (7%) of these grades varied by more than one unit from the grades forecast.

PREDICTION OF PERFORMANCE IN BIOLOGICAL SCIENCE GROUPS
FINAL GRADES IN PARENTHESES
On basis of ACE, L. W. U. Inventory, 1936-37
(Percentages based on totals for each grade)



The following table shows the relation between the actual and predicted grades of the students included in the sample of the 1936-38 freshmen class who enrolled in Introduction to Biological Science. Of these students, 4% received the grade predicted for them. Only 1 (7%) of the

COMPARISON OF ACTUAL AND PREDICTED GRADES IN INTRODUCTION TO BIOLOGICAL SCIENCE. SAMPLING OF MSU FRESHMEN, 1937-38. (Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5					1 (100%)	
C 3.6-4.5			1 (8%)	7 (54%)	5 (38%)	
D 2.6-3.5	2 (12%)		7 (41%)	7 (41%)	1 (6%)	
E 1.6-2.5			1 (33%)	2 (67%)		
F 0 -1.5						
15 of 34 (44%) received grades predicted for them						

students with a predicted grade of C or better failed to get at least a C, and none of these students failed. Of the students with predictions lower than a C, 10 (50%) failed to secure that high a grade, and only 1 (5%) of these students scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 17 (50%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades; 29 (85%) of the grades differed from the forecasts by not more than two probable error units. Only one student, whose grade was a B, varied more than three units from the predicted grade. In the D range 8 (89%) of the students varied not more than one unit from their predicted grades.

DEVIATION OF INTRODUCTION TO BIOLOGICAL SCIENCE GRADES FROM PREDICTED GRADES.

In terms of $PE_{est.}$ = ±.611. Sampling, MSU Freshmen, 1937-38

(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0									
B 4.6-5.5		1 (14%)		5 (72%)	1 (14%)				
C 3.6-4.5			2 (12%)	6 (38%)	8 (50%)				
D 2.6-3.5					8 (89%)	1 (11%)			
E 1.6-2.5									
F 0 -1.5							2 (100%)		
TOTALS		1 (3%)	2 (6%)	11 (32%)	17 (50%)	1 (3%)	2 (6%)		

CORRELATIONS AND FORMULAS FOR SPECIFIC SUBJECTS.

The procedures used in the calculation of correlation coefficients and prediction formulas have been the same for all subjects. The detailed outline of the steps involved in the complete calculation for each subject has already been given for Introduction to Biological Science. For all other subjects merely the summarized results of the essential calculations will be presented.

There were 161 students enrolled in Botany from the freshman class of 1936-37. The mean grade in the subject is 3.78, somewhat below a C, with a standard deviation of 1.09. Means for the completion and arithmetic subtests exceed the national medians by 2 and 4 points respectively; in the other three tests the means are less than the national medians, the variations being as follows: artificial language, 9 points, analogies, 4 points, and opposites, 3.5 points.

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 BOTANY CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.78	1.09	X_4	26.11	13.80
X_2	33.90	10.14	X_5	31.70	11.18
X_3	28.45	11.66	X_6	47.00	18.88

Simple correlations found between grades and examina-

tion-scores are rather low for this group. The highest correlation is with the arithmetic subtest (.412), and the lowest is with the analogies subtest (.205). By referring to the fourth partial correlation coefficients it is seen that the arithmetic subtest has the greatest and the opposites subtest the least predictive value, their fourth partial correlations being .272 and .025, respectively.

CORRELATIONS BETWEEN BOTANY GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS.

	X_2	X_3	X_4	X_5	X_6
X_1	.358	.412	.338	.205	.290
X_2		.408	.415	.422	.616
X_3			.400	.366	.326
X_4				.449	.470
X_5					.330
P. E. range = ±.032 to ±.050					

FIRST PARTIAL CORRELATIONS

$r_{13.2}$ = .312	$r_{35.2}$ = .234	$r_{12.4}$ = .254	$r_{25.4}$ = .290
$r_{14.2}$ = .223	$r_{36.2}$ = .104	$r_{13.4}$ = .321	$r_{26.4}$ = .524
$r_{15.2}$ = .064	$r_{45.2}$ = .332	$r_{15.4}$ = .063	$r_{35.4}$ = .227
$r_{16.2}$ = .094	$r_{46.2}$ = .299	$r_{16.4}$ = .158	$r_{36.4}$ = .170
$r_{34.2}$ = .278	$r_{56.2}$ = .098	$r_{23.4}$ = .290	$r_{56.4}$ = .151
P. E. range = ±.038 to ±.053			

CORRELATIONS BETWEEN BOTANY GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .149	$r_{56.23}$= .076	$r_{26.34}$= .504	$r_{23.45}$= .241
$r_{15.23}$= -.001	$r_{12.34}$= .178	$r_{56.34}$= .117	$r_{26.45}$= .507
$r_{16.23}$= .065	$r_{15.34}$= -.001	$r_{12.45}$= .247	$r_{36.45}$= .141
$r_{45.23}$= .286	$r_{16.34}$= .111	$r_{13.45}$= .316	
$r_{46.23}$= .282	$r_{25.34}$= .240	$r_{16.45}$= .150	
P. E. range = ±.038 to ±.053			

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .137	$r_{12.345}$= .184	$r_{12.456}$= .201
$r_{15.236}$= -.006	$r_{16.345}$= .112	$r_{13.456}$= .301
$r_{45.236}$= .277	$r_{26.345}$= .494	$r_{23.456}$= .199
P. E. range = ±.040 to ±.053		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .151	$r_{14.2356}$= .144	$r_{16.2345}$= .025
$r_{13.2456}$= .272	$r_{15.2346}$= -.046	
P. E. range = ±.049 to ±.053		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .484	P. E. = ±.041
$R_{1.23456}$= $R_{1.23645}$= .483	P. E. = ±.041

The multiple correlation found (.483) indicates that the formula will have a forecasting efficiency of about 12%. The prediction formula, based on the partial regression coefficients given in the following table is:

$$\bar{X}_1 = .020X_2 + .027X_3 + .013X_4 - .005X_5 + .002X_6 + 2.059.$$

STANDARD ERRORS OF ESTIMATE AND
PARTIAL REGRESSION COEFFICIENTS FOR BOTANY .

$\sigma_{1.23456}$= .96 $\sigma_{2.13456}$= 7.37	$\sigma_{3.12456}$= 9.72 $\sigma_{4.12356}$= 11.00	$\sigma_{5.12346}$= 9.44 $\sigma_{6.12345}$= 14.08
$b_{12.3456}$= .020 $b_{13.2456}$= .027	$b_{14.2356}$= .013 $b_{15.2346}$= -.005	$b_{16.2345}$= .002 C = 2.059
	P. $E._{est}$= ±.648	

The results of the predictions made for 1936-37 freshmen enrolled in Botany are summarized in the following table. It is seen that 39% of the students received the

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN BOTANY. M. S. U. Freshmen, 1936-37.
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				1 (100%)		
B 4.6-5.5			1 (7%)	9 (65%)	2 (14%)	2 (14%)
C 3.6-4.5	3 (3%)	4 (5%)	14 (16%)	43 (50%)	21 (25%)	1 (1%)
D 2.6-3.5	7 (12%)	8 (13%)	18 (30%)	21 (35%)	6 (10%)	
E 1.6-2.5						
F 0 -1.5						
63 of 161 (39%) received grades predicted for them						

grade predicted for them. Only 22 (22%) of the students with a predicted grade of C or better failed to get at least

a C. Only 3 (3%) of the forecasts of C or better resulted in failing grades. Of the students with predictions lower than a C, 33 (55%) failed to secure that high a grade, and only 6 (10%) of the students in this prediction range scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 90 (56%) of the actual grades varied not more than one unit (.65 letter grade) from the predicted grades. In 134 (83%) of the cases the actual grades varied

DEVIATION OF BOTANY GRADES FROM PREDICTED GRADES.
In terms of PE_{est} = ±.648. U. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED.	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			1 (33 %)	1 (33 %)	1 (33 %)				
B 4.6-5.5		1 (3%)	7 (24%)	15 (52%)	6 (21%)				
C 3.6-4.5			1 (1%)	13 (18%)	57 (77%)	3 (4%)			
D 2.6-3.5			1 (3%)	1 (3%)	25 (76%)	6 (18%)			
E 1.6-2.5					1 (8%)	5 (42%)	5 (42%)	1 (8%)	
F 0 -1.5							3 (30%)	6 (60%)	1 (10%
TOTALS		1 (1%)	10 (6%)	30 (18%)	90 (56%)	14 (9%)	8 (5%)	7 (4%)	1 (1%

from the predicted grades by not more than two probable errors (1.3 letter grade). The poorest predictions were in the E and F ranges; 6 (50%) of the E's received and all the F's differed more than two units from the forecasts. The

best predictions were made for students who received C's or D's; the number of students in these ranges who varied less than one unit from the forecasts made for them being 57 (77%) and 25 (75%) respectively.

The following table shows the relation between the actual and predicted grades of the students included in the sampling of the 1937-38 freshman class who enrolled in Botany. Of these students, 32% received the grade predicted for them. Only 3 (27%) of the students with a predicted grade of C or better failed to get at least a C, and only one of these predictions (9%) resulted in a failing grade.

COMPARISON OF ACTUAL AND PREDICTED GRADES IN BOTANY. SAMPLING OF M. S. U. FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5					1 (33⅓%)	2 (67%)
C 3.6-4.5	1 (12½%)		2 (25%)	2 (25%)	2 (25%)	1 (12½%)
D 2.6-3.5	1 (12½%)		3 (37½%)	3 (37½%)	1 (12½%)	
E 1.6-2.5						
F 0 -1.5						
6 of 19 (32%) received grades predicted for them						

Of the students with predictions lower than a C, 4 (50%) failed to secure that high a grade, and only 1 (12½%) of these students scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 9 (48%) of the actual grades varied no more than one unit (.65 letter grade) from the predicted grades; 15 (79%) of the grades differed from the forecasts made by not more than two probable error units (1.3 letter grade). Both the students who received F's were predicted grades more than four units higher than those earned. Even in this small a group the efficiency of prediction in the C and D ranges is apparent; none of these students earned grades that differed more than two units from the forecasts made for them.

DEVIATION OF BOTANY GRADES FROM PREDICTED GRADES
In terms of PE_{est}=±.648. Sampling, MSU Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED.	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (33⅓%)		1 (33⅓%)	1 (33⅓%)				
B 4.6-5.5			1 (25%)	2 (50%)	1 (25%)				
C 3.6-4.5				1 (20%)	4 (80%)				
D 2.6-3.5					3 (60%)	2 (40%)			
E 1.6-2.5									
F 0 -1.5								1 (50%)	1 (50%
TOTALS		1 (5%)	1 (5%)	4 (21%)	9 (48%)	2 (11%)		1 (5%)	1 (5%

There were 41 students enrolled in Zoology from the freshman class of 1936-37. The mean grade in the subject

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 ZOOLOGY CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.26	1.36	X_4	33.22	17.54
X_2	34.68	9.53	X_5	33.37	10.20
X_3	26.83	11.68	X_6	53.56	16.85

is only 3.26, a little better than a D, with a standard deviation of 1.36. The average grades in the completion, arithmetic, and opposites subtests exceed the national medians by about three points, and the average in artificial langauge and analogies falls below the national medians by about two points.

Simple correlations found between grades and examination scores are very low for this subject. The highest correlation is with the artificial language subtest (.382); the two very low negative correlations are with the arithmetic subtest (-.006) and with the opposites subtest (-.001). The fourth partial correlation coefficients are highest for the completion and artificial language subtests, (.614 and .556), and lowest for the arithmetic subtest (-.069).

The multiple correlation found (.688) indicates that the formula will have a forecasting efficiency of about 28%. The prediction formula for Zoology is:

$$X_1 = .120X_2 - .007X_3 + .045X_4 - .046X_5 - .041X_6 + 1.522.$$

CORRELATIONS BETWEEN ZOOLOGY GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.350	-.006	.382	.136	-.001
X_2		.317	.060	.546	.631
X_3			-.075	.400	.066
X_4				.433	.212
X_5					.413

P. E. range = ±.064 to ±.105

FIRST PARTIAL CORRELATIONS

$r_{13.2}$ = -.131	$r_{35.2}$ = .286	$r_{12.4}$ = .355	$r_{25.4}$ = .578
$r_{14.2}$ = .386	$r_{36.2}$ = -.182	$r_{13.4}$ = .025	$r_{26.4}$ = .634
$r_{15.2}$ = -.070	$r_{45.2}$ = .479	$r_{15.4}$ = -.035	$r_{35.4}$ = .481
$r_{16.2}$ = -.305	$r_{46.2}$ = .225	$r_{16.4}$ = -.091	$r_{36.4}$ = .170
$r_{34.2}$ = -.099	$r_{56.2}$ = .105	$r_{23.4}$ = .323	$r_{56.4}$ = .365

P. E. range = ±.064 to ±.105

SECOND PARTIAL CORRELATIONS

$r_{14.23}$ = .378	$r_{56.23}$ = .167	$r_{26.34}$ = .643	$r_{23.45}$ = .063
$r_{15.23}$ = -.034	$r_{12.34}$ = .367	$r_{56.34}$ = .371	$r_{26.45}$ = .557
$r_{16.23}$ = -.338	$r_{15.34}$ = -.054	$r_{12.45}$ = .460	$r_{36.45}$ = -.112
$r_{45.23}$ = .532	$r_{16.34}$ = -.093	$r_{13.45}$ = .048	
$r_{46.23}$ = .212	$r_{25.34}$ = .509	$r_{16.45}$ = -.084	

P. E. range = ±.062 to ±.105

CORRELATIONS BETWEEN ZOOLOGY GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .489	$r_{12.345}$= .459	$r_{12.456}$= .612
$r_{15.236}$= .024	$r_{16.345}$= -.079	$r_{13.456}$= .039
$r_{45.236}$= .516	$r_{26.345}$= .568	$r_{23.456}$= .152
P. E. range = ±.066 to ±.105		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .614	$r_{14.2356}$= .556	$r_{16.2345}$= -.465
$r_{13.2456}$= -.069	$r_{15.2346}$= -.306	
P. E. range = ±.066 to ±.105		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .688	P. E. = ±.055
$R_{1.23456}$= $R_{1.23645}$= .688	P. E. = ±.055

STANDARD ERRORS OF ESTIMATE AND
PARTIAL REGRESSION COEFFICIENTS FOR ZOOLOGY

$\sigma_{1.23456}$= .99	$\sigma_{3.12456}$= 10.00	$\sigma_{5.12346}$= 6.59
$\sigma_{2.13456}$= 5.03	$\sigma_{4.12356}$= 12.14	$\sigma_{6.12345}$= 11.09
$b_{12.3456}$= .120	$b_{14.2356}$= .045	$b_{16.2345}$= -.041
$b_{13.2456}$= -.007	$b_{15.2346}$= -.046	C = 1.522
P. $E._{est}$= ±.665		

The results of the predictions made for the freshmen who enrolled in Zoology in 1936-37 are summarized in the following table. It is seen that 39% of the students received the grade predicted for them. Only 3 (23%) of the students with a predicted grade of C or better failed to get

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN ZOOLOGY. M. S. U. FRESHMEN, 1936-37.
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				1 (50%)		1 (50%)
B 4.6-5.5						
C 3.6-4.5	1 (9%)		2 (18%)	6 (55%)	1 (9%)	1 (9%)
D 2.6-3.5	4 (20%)		7 (35%)	8 (40%)		1 (5%)
E 1.6-2.5	2 (33%)	1 (17%)	2 (33%)		1 (17%)	
F 0 -1.5	1 (50%)		1 (50%)			
	16 of 41 (39%) received grades predicted for them					

at least a C. Only 1 (8%) of the forecasts of C or better resulted in a failing grade. Of the students with predictions lower than a C, 18 (64%) failed to secure that high a grade, and only one of these students (3%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 20 (49%) of the actual grades varied from the predicted grades by not more than one unit (.7 letter grade), and 30 (73%) of the actual grades varied from the predicted grades by not more than two probable errors (1.3 letter grade). The poorest predictions are in the A range, where 2 (67%) of the students received grades that differed by more than two units from the forecasts made for

DEVIATION OF ZOOLOGY GRADES FROM PREDICTED GRADES.
In terms of PE_{est} = ±.665. M. S. U. Freshmen, 1936-37.
(Percentages based on totals for each grade).

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (33 %)	1 (33 %)		1 (33 %)				
B 4.6-5.5		1 (50%)		1 (50%)					
C 3.6-4.5				5 (33%)	9 (60%)		1 (7%)		
D 2.6-3.5			1 (8%)	1 (8%)	8 (67%)	2 (17%)			
E 1.6-2.5					1 (100%)				
F 0 -1.5					1 (12%)	1 (12%)	3 (38%)	2 (25%)	1 (12%
TOTALS		2 (5%)	2 (5%)	7 (17%)	20 (49%)	3 (7%)	4 (10%)	2 (5%)	1 (2%

them, and in the F range, where 6 (75% of the students scored two or more units highed than the predictions made for them. A perfect prediction was made for the one E grade received, and very good predictions are seen also in the C and D ranges, where 9 (60%) and 8 (67%) of the students scored within one unit of the forecasts made for them.

The sampling of the 1937-38 freshman class included only 5 students who enrolled in Zoology. One prediction of F resulted in a B grade; one prediction of E resulted in a C; two predictions of D resulted in B's; and one prediction of C resulted in an A grade. It is thus seen that all the predictions made for the group were fully two, and in some cases, three grades too low.

There were 133 students enrolled in Psychology from the freshman class of 1936-37. The mean grade in the subject is 3.93, just less than a C, and the standard deviation is .78. The completion and opposites subtests have means exceeding the national medians by 1.5 and 3 points respectively; means for the arithmetic and artificial language subtests are practically the same as the national medians; and the analogies subtest mean falls below the national median by almost 4 points.

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 PSYCHOLOGY CLASS.

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.93	.78	X_4	35.31	18.26
X_2	32.48	11.61	X_5	31.53	10.11
X_3	24.24	12.38	X_6	53.53	21.53

Simple correlations found between grades and examination scores are fairly high in the subject. The highest correlations are with the artificial langauge subtest (.462) and the analogies subtest (.459), and the lowest correlation is with the opposites subtest (.304). By referring to the fourth partial correlation coefficients the predictive value of each subtest with the effects of the other subtests eliminated can be seen, and the highest values are found again for the artificial language and analogies subtests (.354 and .336). The lowest fourth partial correlation is for the

CORRELATIONS BETWEEN PSYCHOLOGY GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.358	.337	.462	.459	.304
X_2		.433	.429	.521	.710
X_3			.229	.487	.307
X_4				.448	.515
X_5					.776

P. E. range = ±.023 to ±.055

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .216	$r_{35.2}$= .340	$r_{12.4}$= .200	$r_{25.4}$= .407
$r_{14.2}$= .366	$r_{36.2}$= -.001	$r_{13.4}$= .268	$r_{26.4}$= .632
$r_{15.2}$= .342	$r_{45.2}$= .291	$r_{15.4}$= .318	$r_{35.4}$= .442
$r_{16.2}$= .076	$r_{46.2}$= .331	$r_{16.4}$= .087	$r_{36.4}$= .227
$r_{34.2}$= .053	$r_{56.2}$= .675	$r_{23.4}$= .381	$r_{56.4}$= .712

P. E. range = ±.029 to ±.059

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .364	$r_{56.23}$= .718	$r_{26.34}$= .605	$r_{23.45}$= .246
$r_{15.23}$= .293	$r_{12.34}$= .110	$r_{56.34}$= .700	$r_{26.45}$= .534
$r_{16.23}$= .078	$r_{15.34}$= .231	$r_{12.45}$= .082	$r_{36.45}$= -.139
$r_{45.23}$= .291	$r_{16.34}$= .279	$r_{13.45}$= .150	
$r_{46.23}$= .331	$r_{25.34}$= .288	$r_{16.45}$= -.209	

P. E. range = ±.027 to ±.058

CORRELATIONS BETWEEN PSYCHOLOGY GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .359	$r_{12.345}$= .047	$r_{12.456}$= .234
$r_{15.236}$= .342	$r_{16.345}$= .169	$r_{13.456}$= .125
$r_{45.236}$= .081	$r_{26.345}$= .590	$r_{23.456}$= .382
P. E. range = ±.038 to ±.059		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .203	$r_{14.2356}$= .354	$r_{16.2345}$= .175
$r_{13.2456}$= .040	$r_{15.2346}$= .336	
P. E. range = ±.051 to ±.059		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .602	P. E. = ±.038
$R_{1.23456}$= $R_{1.23645}$= .602	P. E. = ±.038

arithmetic subtest (.040).

The multiple correlation found (.602) indicates that the formula will have a forecasting efficiency of about 20%. The prediction formula, based on the partial regression

STANDARD ERRORS OF ESTIMATE AND
PARTIAL REGRESSION COEFFICIENTS FOR PSYCHOLOGY

$\sigma_{1.23456}$= .62	$\sigma_{3.12456}$= 9.88	$\sigma_{5.12346}$= 5.31
$\sigma_{2.13456}$= 7.33	$\sigma_{4.12356}$= 14.50	$\sigma_{6.12345}$= 10.21
$b_{12.3456}$= .017	$b_{14.2356}$= .015	$b_{16.2345}$= .010
$b_{13.2456}$= .008	$b_{15.2346}$= .040	C = .858
P. $E._{est}$= ±.420		

coefficients given in the table immediately preceding is:

$$\bar{X}_1 = .017X_2 + .008X_3 + .015X_4 + .040X_5 + .010X_6 + .858.$$

The results of the predictions made for the 1936-37 freshmen enrolled in Psychology are summarized in the following table. It is seen that 38% of the students received the grade predicted for them. Only 22 (25%) of the students with a predicted grade of C or better failed to get at least a C, and none of these students scored lower than a

COMPARISON OF ACTUAL AND PREDICTED GRADES IN PSYCHOLOGY. M. S. U. FRESHMEN, 1936-37.
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				1 (12%)	3 (50%)	2 (38%)
B 4.6-5.5			6 (19%)	13 (42%)	12 (39%)	
C 3.6-4.5			16 (32%)	23 (46%)	8 (16%)	3 (6%)
D 2.6-3.5		1 (3%)	14 (43%)	16 (48%)	2 (6%)	
E 1.6-2.5	2 (16%)		5 (38%)	5 (38%)	1 (8%)	
F 0 -1.5						
51 of 133 (38%) received grades predicted for them						

D; 22 (48%) of the students with predictions lower than a C failed to secure that high a grade, and only 3 (8%) of these students scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which

follows, shows that 50 (38%) of the actual grades varied from the predicted grades by not more than one unit (.420 letter grade), and 92 (69%) of the actual grades varied from the predicted grades by not more than two probable errors (.84 letter grade). The poorest predictions are in the F range, where all the grades vary from the predicted grades by more than two probable errors; however this class includes only two students. Of the A grades, 2 (40%) vary by 5 probable errors from the predictions. The best predictions are in the B range, where 21 (80%) of the grades vary less than two units from the predictions made.

DEVIATION OF PSYCHOLOGY GRADES FROM PREDICTED GRADES. In terms of PE_{est} = ±.420. M. S. U. Freshmen, 1936-37. (Percentages based on totals for each grade)

GRADE RECEIVED.	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0	2 (40%)				3 (60%)				
B 4.6-5.5	2 (8%)	1 (4%)	1 (4%)	6 (23%)	12 (46%)	3 (11%)	1 (4%)		
C 3.6-4.5	2 (3%)	3 (5%)	11 (19%)	7 (12%)	22 (38%)	9 (16%)	3 (5%)	1 (2%)	
D 2.6-3.5		1 (2%)		7 (17%)	13 (32%)	9 (22%)	3 (7%)	4 (10%)	4 (10%
E 1.6-2.5						1 (100%)			
F 0 -1.5							1 (50%)	1 (50%)	
TOTALS	6 (4%)	5 (4%)	12 (9%)	20 (15%)	50 (38%)	22 (16%)	8 (6%)	6 (5%)	4 (3%

Only two students are included in the sampling of the 1937-38 freshmen class who enrolled in Psychology. A prediction of C was made for one and of B for the other;

they received B and A grades respectively. The first prediction varied slightly less and the second slightly more than two probable errors of estimate from the grade earned.

The total number of students enrolled in all the subjects included in the Biological Science Division was 472. Any student enrolled in more than one subject in the field is counted only once; the average grade earned in the field is used as the Biological Science Division grade. The mean grade for all students is 3.80, or slightly lower than a C. The standard deviation of the grades is 1.07. Means of the scores in completion, arithmetic, and opposites subtests exceed the national medians, the differences being .6, .2, and .8 points, respectively. The mean of the artificial language subtest falls below the national median by 2.4 points; the analogies average is also lower than the national median, the difference here being 3.7 points.

MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR 1936-37 BIOLOGICAL SCIENCE DIVISION.

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.80	1.07	X_4	32.86	16.82
X_2	32.72	11.05	X_5	31.55	10.64
X_3	24.71	12.29	X_6	51.29	19.85

Simple correlations found between grades and subtest scores are fairly high for this group. The highest correlation is with the analogies subtest (.485), and the lowest

CORRELATIONS BETWEEN BIOLOGICAL SCIENCE DIVISION GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.410	.314	.386	.485	.315
X_2		.452	.332	.450	.695
X_3			.130	.398	.215
X_4				.366	.266
X_5					.340

P. E. range = ±.016 to ±.030

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .158	$r_{35.2}$= .244	$r_{12.4}$= .324	$r_{25.4}$= .374
$r_{14.2}$= .291	$r_{36.2}$= -.155	$r_{13.4}$= .288	$r_{26.4}$= .667
$r_{15.2}$= .369	$r_{45.2}$= .257	$r_{15.4}$= .400	$r_{35.4}$= .379
$r_{16.2}$= .046	$r_{46.2}$= .052	$r_{16.4}$= .239	$r_{36.4}$= .189
$r_{34.2}$= -.024	$r_{56.2}$= .042	$r_{23.4}$= .437	$r_{56.4}$= .270

P. E. range = ±.017 to ±.031

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .299	$r_{56.23}$= .083	$r_{26.34}$= .661	$r_{23.45}$= .344
$r_{15.23}$= .345	$r_{12.34}$= .230	$r_{56.34}$= .129	$r_{26.45}$= .634
$r_{16.23}$= .072	$r_{15.34}$= .328	$r_{12.45}$= .205	$r_{36.45}$= .097
$r_{45.23}$= .271	$r_{16.34}$= .196	$r_{13.45}$= .161	
$r_{46.23}$= .049	$r_{25.34}$= .250	$r_{16.45}$= .148	

P. E. range = ±.017 to ±.031

CORRELATIONS BETWEEN BIOLOGICAL SCIENCE DIVISION GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .297	$r_{12.345}$= .162	$r_{12.456}$= .145
$r_{15.236}$= .341	$r_{16.345}$= .164	$r_{13.456}$= .149
$r_{45.236}$= .268	$r_{26.345}$= .655	$r_{23.456}$= .367
P. E. range = ±.018 to ±.030		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .098	$r_{14.2356}$= .227	$r_{16.2345}$= .078
$r_{13.2456}$= .104	$r_{15.2346}$= .284	
P. E. range = ±.028 to ±.030		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .569	P. E. = ±.021
$R_{1.23456}$= $R_{1.23645}$= .569	P. E. = ±.021

is with the arithmetic subtest (.314), followed closely by the opposites subtest (.315). By referring to the fourth partial correlations it is seen that the analogies subtest has the greatest and the opposites subtest the least predictive value, their fourth partial correlation coefficients being .284 and .078, respectively.

The multiple correlation found (.569) indicates that the forecasting efficiency of the prediction formula will be about 17%. The prediction formula, based on the partial regression coefficients given in the following table is:

$$X_1 = .013X_2 + .009X_3 + .013X_4 + .030X_5 + .005X_6 + 1.522.$$

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR BIOLOGICAL SCIENCE DIVISION.

$\sigma_{1.23456}$= .88	$\sigma_{3.12456}$= 10.37	$\sigma_{5.12346}$= 8.48
$\sigma_{2.13456}$= 6.91	$\sigma_{4.12356}$= 14.87	$\sigma_{6.12345}$= 14.07
$b_{12.3456}$= .013	$b_{14.2356}$= .013	$b_{16.2345}$= .005
$b_{13.2456}$= .009	$b_{15.2346}$= .030	C = 1.522
P. $E._{est}$= ±.594		

The results of the predictions made for the 1936-37 freshmen enrolled in the Biological Science Division are summarized in the following table. It is seen that 44% of the students received the grades predicted for them. Only

COMPARISON OF ACTUAL AND PREDICTED GRADES IN THE BIOLOGICAL SCIENCE DIVISION. MSU FRESHMEN, 1936-37. (Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				1 (50%)		1 (50%)
B 4.6-5.5		3 (6%)	3 (6%)	17 (33%)	19 (38%)	9 (17%)
C 3.6-4.5	8 (3%)	10 (4%)	52 (20%)	129 (51%)	49 (19%)	7 (3%)
D 2.6-3.5	16 (10%)	13 (9%)	56 (36%)	53 (34%)	17 (11%)	
E 1.6-2.5	3 (33 %)	3 (33 %)	3 (33 %)			
F 0 -1.5						
208 of 472 (44%) received grades predicted for them						

76 (25%) of the students with a predicted grade of C or better failed to get at least a C, and only 8 (3%) of these

students received failing grades. Of the students with predictions lower than a C, 94 (57%) failed to secure that high a grade, and only 17 (10%) of the students in this prediction range scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 264 (56%) of the actual grades varied from the predicted grades by not more than one unit. (.6 letter grade), and 345 (73%) of the actual grades varied from the predicted grades by not more than two probable

DEVIATION OF BIOLOGICAL SCIENCE DIVISION GRADES FROM PREDICTED GRADES.
In terms of $PE_{est.}$ =±.594. U. S. U. Freshmen, 1936-37.
(Percentages based on totals for each grade)

GRADE RECEIVED.	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		4 (23½%)	4 (23½%)	8 (47%)	1 (6%)				
B 4.6-5.5		4 (5%)	16 (19%)	34 (40%)	30 (35%)	1 (1%)			
C 3.6-4.5			5 (2%)	35 (17%)	150 (75%)	9 (5%)	1 (1%)		
D 2.6-3.5				2 (2%)	77 (67%)	28 (25%)	7 (6%)		
E 1.6-2.5					6 (20%)	8 (28%)	10 (35%)	3 (10%)	2 (7%
F 0 -1.5						2 (7%)	8 (30%)	7 (26%)	10 (37%
TOTALS		8 (2%)	25 (5%)	79 (17%)	264 (56%)	48 (10%)	26 (6%)	10 (2%)	12 (2%

errops (1.2 letter grade). The poorest predictions were made in the F range, with 25 (93%) of these students scoring two or more units lower than the predictions made for them. The number who varied more than two units was also large in

the A range (8 or 47%) and in the E range (15 or 52%). In the C range 150 (75%) of the students received grades that varied less than one unit from the predictions, and in the D range 77 (67%) of the students scored within one unit of the forecasts made for them.

The results of the predictions made for the students included in the sampling of the 1937-38 freshman class who enrolled in the Biological Science Division are summarized in the following table. Of these students, 40% received the grade predicted for them. Only 4 (14%) of the students with a predicted grade of C or better failed to get at least a C, and only 2 (7%) of these students received failing grades.

COMPARISON OF ACTUAL AND PREDICTED GRADES IN BIOLOGICAL SCIENCE DIVISION. SAMPLING, MSU FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade).

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5					3 (60%)	2 (40%)
C 3.6-4.5	2 (8%)		2 (8%)	8 (34%)	11 (46%)	1 (4%)
D 2.6-3.5	2 (8%)		11 (42%)	12 (46%)	1 (4%)	
E 1.6-2.5			1 (50%)	1 (50%)		
F 0 -1.5						
23 of 57 (40%) received grades predicted for them						

Of the students with predictions lower than a C, 14 (50%) failed to secure that high a grade, and only 1 (4%) of these

students scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 28 (49%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades, and 46 (80%) of the grades differed from the

DEVIATION OF BIOLOGICAL SCIENCE DIVISION GRADES FROM PREDICTED GRADES.
In terms of PE_{est}=±.594. Sampling of MSU Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED.	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (33 %)	1 (33 %)	1 (33 %)					
B 4.6-5.5			3 (20%)	8 (53%)	4 (27%)				
C 3.6-4.5			2 (10%)	7 (33%)	12 (57%)				
D 2.6-3.5					12 (86%)	2 (14%)			
E 1.6-2.5									
F 0 -1.5							1 (25%)	1 (25%)	2 (50%
TOTALS		1 (2%)	6 (11%)	16 (28%)	28 (49%)	2 (3%)	1 (2%)	1 (2%)	2 (3%

forecasts made by not more than two probable error units (1.2 letter grade). The four students who received F's and two of the three students who received A's earned grades that differed more than two units from their forecasts. Especially good predictions were made in the D range, since 12 (86%) of the scores vary no more than one unit from the forecasts. In the C range 12 grades (57% of the group) vary no more than one unit from the predictions made.

There were 248 students enrolled in Introduction to Humanities from the freshman class of 1936-37. The mean grade in the subject is 3.91, practically a C, and the standard deviation is .91. Means in the completion, artificial language, and opposites subtests exceed the national medians by 1.1, 2.6, and 3.8 points respectively; the averages for arithmetic and analogies fall below the national medians by .6 and 3.3 points respectively.

MEANS AND STANDARD DEVIATIONS FOR GRADES AND TESTS FOR 1936-37 INTRODUCTION TO HUMANITIES CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.91	.91	X_4	37.87	17.58
X_2	32.30	11.61	X_5	31.94	10.13
X_3	23.94	13.14	X_6	54.31	20.04

Some of the correlations found between the examination scores and the subject grades in Introduction to Humanities are quite high. The two highest coefficients are with the artificial language subtest (.534) and with the opposites subtest (.507). Two of the subtests show low correlations, these being arithmetic (.135) and analogies (.213). The artificial language subtest far exceeds the others in predictive value, as shown by its fourth partial correlation coefficient of .383. The arithmetic subtest has the lowest fourth partial correlation (-.006), and hence the least predictive value.

CORRELATIONS BETWEEN INTRODUCTION TO HUMANITIES GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.458	.135	.534	.213	.507
X_2		.422	.407	.409	.785
X_3			.148	.444	.229
X_4				.384	.496
X_5					.354

P. E. range = ±.016 to ±.042

FIRST PARTIAL CORRELATIONS

$r_{13.2}$ = -.072	$r_{35.2}$ = .328	$r_{12.4}$ = .312	$r_{25.4}$ = .300
$r_{14.2}$ = .428	$r_{36.2}$ = -.182	$r_{13.4}$ = .067	$r_{26.4}$ = .736
$r_{15.2}$ = .032	$r_{45.2}$ = .261	$r_{15.4}$ = .001,	$r_{35.4}$ = .424
$r_{16.2}$ = .268	$r_{46.2}$ = .312	$r_{16.4}$ = .330	$r_{36.4}$ = .181
$r_{34.2}$ = -.029	$r_{56.2}$ = .058	$r_{23.4}$ = .401	$r_{56.4}$ = .204

P. E. range = ±.020 to ±.043

SECOND PARTIAL CORRELATIONS

$r_{14.23}$ = .427	$r_{56.23}$ = .127	$r_{26.34}$ = .736	$r_{23.45}$ = .317
$r_{15.23}$ = .059	$r_{12.34}$ = .371	$r_{56.34}$ = .143	$r_{26.45}$ = .723
$r_{16.23}$ = .260	$r_{15.34}$ = .033	$r_{12.45}$ = .327	$r_{36.45}$ = .107
$r_{45.23}$ = .286	$r_{16.34}$ = .349	$r_{13.45}$ = .073	
$r_{46.23}$ = .312	$r_{25.34}$ = .157	$r_{16.45}$ = .337	

P. E. range = ±.020 to ±.043

CORRELATIONS BETWEEN INTRODUCTION TO HUMANITIES GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .377	$r_{12.345}$= .371	$r_{12.456}$= .128
$r_{15.236}$= .027	$r_{16.345}$= .348	$r_{13.456}$= .039
$r_{45.236}$= .261	$r_{26.345}$= .730	$r_{23.456}$= .199
P. E. range = ±.020 to ±.043		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .122	$r_{14.2356}$= .383	$r_{16.2345}$= .122
$r_{13.2456}$= -.006	$r_{15.2346}$= -.080	
P. E. range = ±.037 to ±.043		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .614	P. E. = ±.027
$R_{1.23456}$= $R_{1.23645}$= .612	P. E. = ±.027

The multiple correlation found (.612) indicates that the prediction formula will have a forecasting efficiency of about 21%. The prediction formula, based on the partial regression coefficients given in the table immediately

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR INTRODUCTION TO HUMANITIES.

$\sigma_{1.23456}$= .72	$\sigma_{3.12456}$= 10.96	$\sigma_{5.12346}$= 8.35
$\sigma_{2.13456}$= 6.50	$\sigma_{4.12356}$= 13.59	$\sigma_{6.12345}$= 11.48
$b_{12.3456}$= .013	$b_{14.2356}$= .020	$b_{16.2345}$= .008
$b_{13.2456}$= .000	$b_{15.2346}$= -.007	C = 2.522
$P. E._{est}$= ±.485		

preceding is:

$$\bar{X}_1 = .013X_2 + .020X_4 - .007X_5 + .008X_6 + 2.522$$

It is seen that the arithmetic scores do not enter into the predictions since that subtest has a regression coefficient of .000.

The results of the predictions made for the 1936-37 freshmen enrolled in Introduction to Humanities are summarized in the following table. It is seen that 54% of the

COMPARISON OF ACTUAL AND PREDICTED GRADES IN INTRODUCTION TO HUMANITIES. HSU FRESHMEN, 1936-37
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				8 (25%)	19 (59%)	5 (16%)
C 3.6-4.5	3 (2%)	4 (3%)	22 (15%)	87 (59%)	26 (18%)	5 (3%)
D 2.6-3.5	4 (6%)	5 (7%)	28 (41%)	32 (46%)		
E 1.6-2.5						
F 0 -1.5						
134 of 248 (54%) received grades predicted for them						

students received the grades predicted for them. Only 29 (16%) of the students with a predicted grade of C or better failed to secure at least a C, and only 3 (2%) of these students received failing grades. Of the students with predictions lower than a C, 41 (59%) failed to secure that

high a grade, and none of these students scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 167 (67%) of the actual grades varied from the predicted grades by not more than one unit (.5 letter grade), and 219 (88%) of the actual grades varied from the predicted grades by not more than two probable errors

DEVIATION OF INTRODUCTION TO HUMANITIES GRADES FROM PREDICTED GRADES.
In terms of PE_{est} =±.483. M. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED.	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			6 (60%)	2 (20%)	2 (20%)				
B 4.6-5.5			5 (11%)	12 (27%)	28 (62%)				
C 3.6-4.5				15 (12%)	104 (82%)	7 (5%)	1 (1%)		
D 2.6-3.5				1 (2%)	33 (66%)	14 (28%)	1 (2%)	1 (2%)	
E 1.6-2.5						1 (11%)	6 (67%)	2 (22%)	
F 0 -1.5								1 (14%)	6 (86%
TOTALS			11 (4%)	30 (12%)	167 (67%)	22 (9%)	8 (3%)	4 (2%)	6 (3%

(1 letter grade). In the F range all students received grades that varied by more than three units from the predictions made for them. Only 1 (11%) of the E students scored within two units of the forecasts made for them. Very good predictions are seen in the C and D ranges; only 3 (2%) of the students in these combined groups failed to secure

grades that differed less than one letter grade from the forecasts made for them.

The following table shows the relation between the actual and predicted grades of the students included in the sampling of the 1937-38 freshman class who enrolled in Introduction to Humanities. Of these students, 54% received the grade predicted for them; only 1 (5%) of the students with a predicted grade of C or better failed to get at least a C, and none of these students failed; 11 (58%) of the students with predictions of D or lower failed to secure a grade of C or better, and only 2 (11%) of these students scored higher than a C.

COMPARISON OF ACTUAL AND PREDICTED GRADES IN INTRODUCTION TO HUMANITIES. SAMPLING, MSU FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade).

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				1 (33 %)	1 (33 %)	1 (33 %)
C 3.6-4.5			1 (6%)	9 (53%)	6 (35%)	1 (6%)
D 2.6-3.5			11 (58%)	6 (32%)	2 (20%)	
E 1.6-2.5						
F 0 -1.5						
21 of 39 (54%) received grades predicted for them						

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which

follows, shows that 25 (59%) of the actual grades varied no more than one unit (.5 letter grade) from the predicted grades, and 34 (87½%) of the grades differed from the forecasts made by not more than two probable errors (1.0 letter grade). It is thus seen that in this subject there are only 5 students, or 13% of the total number in the sampling of the 1937-38 class, who received grades that differed more than one letter grade from the forecasts made for them. None of the C students varied more than two units from the forecasts made for them, and 11 of the 12 D students received grades that differed less than one unit from the predictions made for them.

DEVIATION OF INTRODUCTION TO HUMANITIES GRADES
FROM PREDICTED GRADES
In terms of PE_{est} = ±.485. Sampling, MSU Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0	1 (50%)		1 (50%)						
B 4.6-5.5		1 (11%)	1 (11%)	6 (67%)	1 (11%)				
C 3.6-4.5				4 (25%)	11 (69%)	1 (6%)			
D 2.6-3.5					11 (92%)		1 (8%)		
E 1.6-2.5									
F 0 -1.5									
TOTALS	1 (3½%)	1 (3½%)	2 (7%)	10 (36%)	12 (43%)	1 (3½%)	1 (3½%)		

There were 218 students enrolled in Foreign Languages from the freshman class of 1936-37. The mean grade in the

MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR 1936-37 FOREIGN LANGUAGES CLASS.

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	4.19	1.13	X_4	38.72	17.17
X_2	33.24	11.27	X_5	31.94	10.12
X_3	22.14	12.01	X_6	56.41	19.80

subject is 4.19, slightly better than a C, and the standard deviation is 1.13. Means for the completion, artificial language, and opposites subtests exceed the national medians by 2.1, 3.5, and 2.1 points respectively. The average for the arithmetic subtest is 2.4 points below the national median, and the average for the analogies subtest is 3.3 points below the national standard.

The simple correlations found between grades and subtest scores are rather low for this group, except in one case. The single high correlation is with the artificial language subtest (.514). The lowest correlation is with the arithmetic subtest (.188). By referring to the partial correlation coefficients of the fourth order it is seen that the artificial language subtest has by far the greatest predictive value, since its coefficient is .439, the next highest value that for the completion subtest being only .164. The two lowest predictive values are held by the arithmetic and analogies subtests, with fourth partial correlations of .064 and -.051, respectively.

CORRELATIONS BETWEEN FOREIGN LANGUAGE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.328	.188	.514	.266	.297
X_2		.370	.379	.467	.799
X_3			.173	.430	.216
X_4				.463	.484
X_5					.403

P. E. range = ±.017 to ±.044

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .076	$r_{35.2}$= .313	$r_{12.4}$= .168	$r_{25.4}$= .356
$r_{14.2}$= .446	$r_{36.2}$= -.143	$r_{13.4}$= .117	$r_{26.4}$= .761
$r_{15.2}$= .135	$r_{45.2}$= .350	$r_{15.4}$= .037	$r_{35.4}$= .401
$r_{16.2}$= .061	$r_{46.2}$= .326	$r_{16.4}$= .064	$r_{36.4}$= .153
$r_{34.2}$= .038	$r_{56.2}$= .056	$r_{23.4}$= .334	$r_{56.4}$= .231

P. E. range = ±.019 to ±.045

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .445	$r_{56.23}$= .107	$r_{26.34}$= .762	$r_{23.45}$= .223
$r_{15.23}$= .117	$r_{12.34}$= .138	$r_{56.34}$= .187	$r_{26.45}$= .746
$r_{16.23}$= .073	$r_{15.34}$= -.011	$r_{12.45}$= .166	$r_{36.45}$= .068
$r_{45.23}$= .356	$r_{16.34}$= .047	$r_{13.45}$= .112	
$r_{46.23}$= .335	$r_{25.34}$= .257	$r_{16.45}$= .057	

P. E. range = ±.019 to ±.045

CORRELATIONS BETWEEN FOREIGN LANGUAGE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .448	$r_{12.345}$= .146	$r_{12.456}$= .186
$r_{15.236}$= .110	$r_{16.345}$= .050	$r_{13.456}$= .109
$r_{45.236}$= .342	$r_{26.345}$= .753	$r_{23.456}$= .259
P. E. range = ±.020 to ±.045		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .164	$r_{14.2356}$= .439	$r_{16.2345}$= -.092
$r_{13.2456}$= .064	$r_{15.2346}$= -.051	

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .546	P. E. = ±.032
$R_{1.23456}$= $R_{1.23645}$= .545	P. E. = ±.032

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR FOREIGN LANGUAGES.

$\sigma_{1.23456}$= .95	$\sigma_{3.12456}$= 10.43	$\sigma_{5.12346}$= 7.92
$\sigma_{2.13456}$= 6.19	$\sigma_{4.12356}$= 12.62	$\sigma_{6.12345}$= 11.01
$b_{12.3456}$= .025	$b_{14.2356}$= .033	$b_{16.2345}$= -.008
$b_{13.2456}$= .006	$b_{15.2346}$= -.006	C = 2.591
P. $E._{est}$= ±.639		

The multiple correlation found (.545) indicates that the prediction formula will have a forecasting efficiency of about 16%. The prediction formula, based on the partial regression coefficients given in the table above is:

$$X_1 = .025X_2 + .006X_3 + .033X_4 - .006X_5 - .008X_6 + 2.591.$$

The results of the predictions made for the 1936-37 freshmen enrolled in Foreign Languages are summarized in the following table. It is seen that 45% of the students received the grade predicted for them. Only 33 (18%) of the students with a predicted grade of C or better failed to get at least a C, and only 5 (3%) of these students received

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN FOREIGN LANGUAGES. MSU FRESHMEN, 1936-37.
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-					3 (43%)	4 (57%)
B 4.6-5.5			1 (2%)	14 (29%)	23 (47%)	11 (22%)
C 3.6-4.5	5 (4%)	4 (3%)	23 (17%)	65 (50%)	28 (21%)	6 (5%)
D 2.6-3.5	4 (13%)	3 (10%)	7 (22%)	14 (45%)	3 (10%)	
E 1.6-2.5						
F 0 -1.5						
	99 of 218 (45%) received grades predicted for them					

failing grades. Of the students with predictions of D or lower, 14 (45%) failed to secure a grade of C or better, and only 3 (10%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 120 (55%) of the grades varied from the forecasts made by not more than one unit (.6 letter grade), and 189 of the actual grades varied from the predicted

DEVIATION OF FOREIGN LANGUAGE GRADES
FROM PREDICTED GRADES.
In terms of PE_{est}=±.639. M. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (5%)	6 (28½%)	8 (38%)	6 (28½%)				
B 4.6-5.5			5 (9%)	27 (47%)	22 (39%)	3 (5%)			
C 3.6-4.5				7 (7%)	76 (82%)	10 (11%)			
D 2.6-3.5					16 (52%)	11 (35%)	4 (13%)		
E 1.6-2.5						3 (43%)	4 (57%)		
F 0 -1.5							2 (22%)	4 (45%)	3 (33%
TOTALS		1 (1%)	11 (5%)	42 (19%)	120 (55%)	27 (12%)	10 (5%)	4 (2%)	3 (1%

grades by not more than two probable errors (1.3 letter grade). The poorest predictions were in the F range, where all the grades received were two or more units lower than the forecasts made. In the A range 15 (72%) of the grades were more than one unit higher than the predictions, and 7 (33%) of the grades were more than two units above the forecasts. None of the grades in the C range differed more than two units from the forecasts, and only 5 (9%) of the B grades and 4 (13%) of the D grades varied from the predictions by the same amount. For the entire group only 29 (14%) of the grades differed more than two units from the forecasts made.

The following table shows the relation between the actual and predicted grades of the students included in the

COMPARISON OF ACTUAL AND PREDICTED GRADES IN FOREIGN LANGUAGES. SAMPLING OF MSU FRESHMAN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				1 (20%)	3 (60%)	1 (20%)
C 3.6-4.5				5 (50%)	4 (40%)	1 (10%)
D 2.6-3.5	2 (20%)		3 (30%)	3 (30%)	1 (10%)	1 (10%)
E 1.6-2.5						
F 0 -1.5						
11 of 25 (44%) received grades predicted for them						

sampling of the 1937-38 freshman class who enrolled in Foreign Languages. Of these students 44% received the grade predicted for them. None of the students with a predicted grade of C or better failed to get at least a C. Of the students with predictions lower than a C, 5 (50%) failed to secure that high a grade, and only 2 (20%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 12 (48%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades, and 19 (76%) of the grades differed from the forecasts made by not more than two probable error units (1.3 letter grade). Both the students who received F's were

DEVIATION OF FOREIGN LANGUAGES GRADES
FROM PREDICTED GRADES.
In terms of PE_{est} =±.639. M. S. U. Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			2 (67%)		1 (33%)				
B 4.6-5.5			2 (25%)	3 (37½%)	3 (37½%)				
C 3.6-4.5				3 (33%)	5 (56%)	1 (11%)			
D 2.6-3.5					3 (100%)				
E 1.6-2.5									
F 0 -1.5							1 (50%)	1 (50%)	
TOTALS			4 (16%)	6 (24%)	12 (48%)	1 (4%)	1 (4%)	1 (4%)	

forecast grades more than two units higher than they received. Only four other students received grades that varied more than two units from their forecasts. These were 2 (67%) of the A students and 2 (25%) of the B students.

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 HUMANITIES DIVISION.

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.95	.99	X_4	36.50	16.79
X_2	32.59	10.96	X_5	32.19	10.11
X_3	23.51	12.80	X_6	52.98	19.92

There were 384 students enrolled in one or more subjects in the Humanities Division. Subjects included in the division are Introduction to Humanities, Journalism, Speech, and the various foreign languages. The mean grade in the

CORRELATIONS BETWEEN HUMANITIES DIVISION GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.357	.133	.493	.198	.299
X_2		.425	.343	.424	.784
X_3			.151	.414	.249
X_4				.383	.438
X_5					.358
P. E. range = ±.013 to ±.033					

division is 3.95, practically a C, and the standard deviation is .99.

Two of the simple correlations between grades and subtests for this group are fairly high; in the case of the completion subtest the value is .357, and for the artificial language subtest the coefficient is .493. The other three correlations are less than .300, the lowest being that found for arithmetic (.133). By referring to the fourth partial correlations it is seen that the highest relationship to the grades, independent of other subtests, is held by the artificial language subtest, with a coefficient of .435, followed by the completion subtest with a value of .236. The arithmetic subtest has the

CORRELATIONS BETWEEN HUMANITIES DIVISION GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= -.022	$r_{35.2}$= .285	$r_{12.4}$= .230	$r_{25.4}$= .337
$r_{14.2}$= .423	$r_{36.2}$= -.150	$r_{13.4}$= .068	$r_{26.4}$= .751
$r_{15.2}$= .055	$r_{45.2}$= .279	$r_{15.4}$= .011	$r_{35.4}$= .390
$r_{16.2}$= .033	$r_{46.2}$= .299	$r_{16.4}$= .106	$r_{36.4}$= .206
$r_{34.2}$= .006	$r_{56.2}$= .045	$r_{23.4}$= .402	$r_{56.4}$= .229
P. E. range = ±.015 to ±.034			

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .423	$r_{56.23}$= .093	$r_{26.34}$= .745	$r_{23.45}$= .312
$r_{15.23}$= .064	$r_{12.34}$= .222	$r_{56.34}$= .165	$r_{26.45}$= .735
$r_{16.23}$= .030	$r_{15.34}$= -.017	$r_{12.45}$= .240	$r_{36.45}$= .130
$r_{45.23}$= .289	$r_{16.34}$= .094	$r_{13.45}$= .069	
$r_{46.23}$= .303	$r_{25.34}$= .214	$r_{16.45}$= .106	
P. E. range = ±.015 to ±.034			

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .434	$r_{12.345}$= .231	$r_{12.456}$= .241
$r_{15.236}$= .061	$r_{16.345}$= .098	$r_{13.456}$= .056
$r_{45.236}$= .275	$r_{26.345}$= .737	$r_{23.456}$= .322
P. E. range = ±.016 to ±.034		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .236	$r_{14.2356}$= .435	$r_{16.2345}$= -.110
$r_{13.2456}$= -.023	$r_{15.2346}$= -.067	
P. E. range = ±.027 to ±.034		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .543	P. E. = ±.023
$R_{1.23456}$= $R_{1.23645}$= .543	P. E. = ±.023

lowest fourth partial correlation (-.023).

The multiple correlation found (.543) indicates that the prediction formula will have a forecasting efficiency of about 16%. The prediction formula, based on the partial regression coefficients is:

$$\bar{X}_1 = .032X_2 - .002X_3 + .028X_4 - .007X_5 - .008X_6 + 2.589$$

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR HUMANITIES DIVISION.

$\sigma_{1.23456} = .83$	$\sigma_{3.12456} = 10.94$	$\sigma_{5.12346} = 8.39$
$\sigma_{2.13456} = 6.05$	$\sigma_{4.12356} = 13.00$	$\sigma_{6.12345} = 11.61$
$b_{12.3456} = .032$	$b_{14.2356} = .028$	$b_{16.2345} = -.008$
$b_{13.2456} = -.002$	$b_{15.2346} = -.007$	$C = 2.589$
	$P.E._{est} = \pm .561$	

The results of the predictions made for the 1936-37 freshmen enrolled in the Humanities Division are summarized in the following table. It is seen that 47% of the students received the grade predicted for them. Of the students with a predicted grade of C or better, 60 (21%) failed to get a C or better, and only 6 (2%) received failing grades. Of the students with forecasts lower than a C, 52 (53%) failed to secure that high a grade, and only 5 (5%) exceeded a C grade. No predictions of E or F grades were made, and only three students were predicted A grades.

The table of deviations of actual grades from predicted

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN HUMANITIES. MSU FRESHMAN, 1936-37.
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				1 (33%)	1 (33%)	1 (33%)
B 4.6-5.5			3 (6%)	15 (28%)	26 (49%)	9 (17%)
C 3.6-4.5	6 (3%)	9 (4%)	42 (18%)	121 (53%)	47 (20%)	5 (2%)
D 2.6-3.5	8 (8%)	8 (8%)	36 (37%)	41 (42%)	5 (5%)	
E 1.6-2.5						
F 0 -1.5						
182 of 384 (47%) received grades predicted for them						

grades in terms of the probable error of estimate, which follows, shows that 240 (63%) of the actual grades varied from the predicted grades by not more than one unit (.6

DEVIATION OF HUMANITIES DIVISION GRADES FROM PREDICTED GRADES
In terms of PE_{est} = ±.561. M. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (6%)	6 (40%)	4 (27%)	4 (27%)				
B 4.6-5.5		4 (5%)	9 (11%)	28 (36%)	37 (47%)	1 (1%)			
C 3.6-4.5			2 (1%)	21 (12%)	141 (79%)	12 (7%)	2 (1%)		
D 2.6-3.5					55 (68%)	17 (21%)	9 (11%)		
E 1.6-2.5					3 (18%)		12 (70%)	2 (12%)	
F 0 -1.5							2 (14%)	3 (21%)	9 (65%
TOTALS		5 (1%)	17 (4%)	53 (14%)	240 (63%)	30 (8%)	26 (7%)	5 (1%)	9 (2%

letter grade), and 323 (85%) of the actual grades varied from the predicted grades by not more than two probable errors (1.1 letter grade). In the F range all the grades were more than two units lower than the predictions made, and in the E range 14 (82%) of the grades were more than two units lower than the forecasts. In the A range 7 (46%) of the grades were more than two units above the forecasts. Especially good predictions were made in the C range, where 174 (98%) of the grades varied less than two units from the predictions.

COMPARISON OF ACTUAL AND PREDICTED GRADES IN HUMANITIES DIVISION. SAMPLING OF M. S. U. FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				3 (60%)	2 (40%)	
C 3.6-4.5			3 (11%)	11 (41%)	11 (41%)	2 (7%)
D 2.6-3.5	1 (4%)	1 (4%)	12 (46%)	9 (34%)	2 (8%)	1 (4%)
E 1.6-2.5						
F 0 -1.5						
25 of 58 (43%) received grades predicted for them						

The table given above shows the relation between the actual and predicted grades of the students inculded in the sampling of the 1937-38 freshman class who enrolled in

the Humanities Division. Of these students 43% received the grade predicted for them. Only 3 (10%) of the students with a predicted grade of C or better failed to do that well, and none of these students received grades lower than a D. Of the students with predictions of a D grade or lower, 14 (54%) failed to score as high as a C, and only 3 (12%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 31 (54%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades, and 45 (78%) of the grades differed from the forecasts by not more than two probable error units (1.1 letter grade). The one F received had been predicted as a D, and the two A's exceeded their forecasts by more than 3 units.

DEVIATION, HUMANITIES DIVISION GRADES FROM PREDICTED GRADES
In terms of PE_{est}=±.561. MSU Freshmen Sampling, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0	2 (67%)	1 (33%)							
B 4.6-5.5		1 (6%)	6 (40%)	5 (33%)	3 (20%)				
C 3.6-4.5			2 (9%)	7 (30%)	12 (52%)	2 (9%)			
D 2.6-3.5					15 (100%)				
E 1.6-2.5					1 (100%)				
F 0 -1.5									1 100%
TOTALS	2 (3%)	2 (3%)	8 (14%)	12 (21%)	31 (54%)	2 (3%)			1 (2%

In the D range no student varied more than one unit from his forecast, and in the C range 91% of the students varied not more than two units from their predicted grades.

There were 258 students enrolled in Social Science from the freshman class of 1936-37. The mean grade in the subject is 3.97, almost exactly a C, and the standard deviation is 1.05. Means for the completion, arithmetic, and opposites subtests exceed the national medians by 3.4, .4, and 2.9 points, respectively. The means in the artificial language and analogies subtests fall below the national medians by .1 and 3.2 points, respectively.

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 SOCIAL SCIENCE CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.97	1.05	X_4	35.12	16.11
X_2	34.45	11.40	X_5	32.05	10.93
X_3	24.91	13.24	X_6	53.45	19.91

Simple correlations found between grades and examination scores are not very high for this group, and there is very little variation in the coefficients; two subtests, completion and artificial language, both have values of .380 for the highest coefficient, and the lowest is for the analogies subtest, the value being .271.

By referring to the fourth partial correlation coefficients it is seen that the artificial language subtest has

CORRELATION BETWEEN SOCIAL SCIENCE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.380	.329	.380	.271	.365
X_2		.447	.275	.486	.765
X_3			.152	.400	.338
X_4				.446	.418
X_5					.474

P. E. range= ±.017 to ±.041

FIRST PARTIAL CORRELATIONS

$r_{13.2}$=	.192	$r_{35.2}$=	.234	$r_{12.4}$=	.310	$r_{25.4}$=	.422
$r_{14.2}$=	.310	$r_{36.2}$=	-.007	$r_{13.4}$=	.297	$r_{26.4}$=	.745
$r_{15.2}$=	.107	$r_{45.2}$=	.372	$r_{15.4}$=	.123	$r_{35.4}$=	.376
$r_{16.2}$=	.125	$r_{46.2}$=	.335	$r_{16.4}$=	.245	$r_{36.4}$=	.306
$r_{34.2}$=	.034	$r_{56.2}$=	.182	$r_{23.4}$=	.427	$r_{56.4}$=	.354

P. E. range= ±.019 to ±.042

SECOND PARTIAL CORRELATIONS

$r_{14.23}$=	.310	$r_{56.23}$=	.189	$r_{26.34}$=	.714	$r_{23.45}$=	.319
$r_{15.23}$=	.065	$r_{12.34}$=	.212	$r_{56.34}$=	.271	$r_{26.45}$=	.702
$r_{16.23}$=	.129	$r_{15.34}$=	.013	$r_{12.45}$=	.267	$r_{36.45}$=	.199
$r_{45.23}$=	.375	$r_{16.34}$=	.170	$r_{13.45}$=	.273		
$r_{46.23}$=	.336	$r_{25.34}$=	.312	$r_{16.45}$=	.217		

P. E. range = ±.021 to ±.042

CORRELATIONS BETWEEN SOCIAL SCIENCE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .285	$r_{12.345}$= .219	$r_{12.456}$= .194
$r_{15.236}$= .042	$r_{16.345}$= .173	$r_{13.456}$= .240
$r_{45.236}$= .337	$r_{26.345}$= .688	$r_{23.456}$= .257
P. E. range = ±.022 to ±.042		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .141	$r_{14.2356}$= .288	$r_{16.2345}$= .032
$r_{13.2456}$= .201	$r_{15.2346}$= -.060	
P. E. range = ±.039 to ±.042		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .508	P. E. = ±.031
$R_{1.23456}$= $R_{1.23645}$= .509	P. E. = ±.031

the greatest predictive value for grades in this subject, and the opposites subtest has the least, their coefficients being .288 and .032, respectively.

The multiple correlation found (.508) indicates that the prediction formula will have a forecasting efficiency of about 13%. The prediction formula, based on the partial regression coefficients given in the following table is:

$$\bar{X}_1 = .019X_2 + .016X_3 + .022X_4 - .006X_5 + .002X_6 + 2.230.$$

The results of the predictions made for the 1936-37 freshmen enrolled in Social Science are summarized in the second of the tables given on the following page. It is

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR SOCIAL SCIENCE

$\sigma_{1.23456} = .90$	$\sigma_{3.12456} = 11.25$	$\sigma_{5.12346} = 8.57$
$\sigma_{2.13456} = 6.77$	$\sigma_{4.12356} = 13.15$	$\sigma_{6.12345} = 12.03$
$b_{12.3456} = .019$	$b_{14.2356} = .022$	$b_{16.2345} = .002$
$b_{13.2456} = .016$	$b_{15.2346} = -.006$	$C = 2.230$
	$P.E._{est} = \pm .609$	

seen that 45% of the students received the grade predicted for them. Only 34 (17%) of the students with a predicted grade of C or better failed to get at least a C, and only 7 (3½%) of these students received failing grades. Of the students with predictions lower than a C, 29 (48%) failed to secure that high a grade, and only 1 (2%) of the students

COMPARISON OF ACTUAL AND PREDICTED GRADES IN SOCIAL SCIENCE. M. S. U. FRESHMEN, 1936-37
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-			1 (14%)	1 (14%)	2 (29%)	3 (43%)
B 4.6-5.5			1 (3%)	9 (30%)	13 (44%)	7 (23%)
C 3.6-4.5	7 (4%)	5 (3%)	20 (12%)	81 (50%)	45 (28%)	3 (3%)
D 2.6-3.5	5 (8%)	4 (7%)	20 (33%)	30 (50%)	1 (2%)	
E 1.6-2.5						
F 0 -1.5						
	117 of 258 received grades predicted for them (45%)					

included in this prediction range scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 152 (59%) of the actual grades varied from the predicted grades by not more than one unit (.6 letter grade), and 228 (88%) of the actual grades varied from the predicted grades by not more than two probable errors (1.2 letter grade). In the F range all the grades earned were at least four units lower than the corresponding forecasts. In the E range 6 (67%) and in the A range 4 (31%) of the grades varied more than two units from the predictions. In the other three ranges very good predictions were made; in the B range 58 (95%) of the grades and in the D range 38 (91%) of the grades do not exceed the two unit variation. The best predictions were made in the

DEVIATION OF SOCIAL SCIENCE GRADES FROM PREDICTED GRADES
In terms of PE_{est} = ±.609. M. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (8%)	3 (23%)	8 (61%)	1 (8%)				
B 4.6-5.5			3 (5%)	28 (46%)	29 (47%)	1 (2%)			
C 3.6-4.5				22 (18%)	92 (76%)	6 (5%)	1 (1%)		
D 2.6-3.5					30 (72%)	8 (19%)	2 (5%)	1 (2%)	1 (2%
E 1.6-2.5						3 (33 %)	3 (33 %)	3 (33 %)	
F 0 -1.5								4 (33%)	8 (67%
TOTALS		1 (1%)	6 (2%)	58 (22%)	152 (59%)	18 (7%)	6 (2%)	8 (3%)	9 (4%

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN SOCIAL SCIENCE. SAMPLING OF MSU FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				1 (25%)	2 (50%)	1 (25%)
C 3.6-4.5	1 (4%)		4 (16%)	16 (64%)	2 (8%)	2 (8%)
D 2.6-3.5	4 (19%)		5 (24%)	12 (57%)		
E 1.6-2.5						
F 0 -1.5						
23 of 50 (46%) received grades predicted for them						

C range, where 120 (99%) of the students did not vary over two units from the predictions made for them.

The table above shows the relation between the actual and predicted grades of the students included in the sampling of the 1937-38 freshman class who enrolled in Social Science. Of these students, 46% received the grade predicted for them. Only 5 (17%) of the students with a predicted grade of C or better failed to get at least a C, and only one of these predictions (3%) resulted in a failing grade. Of the students with predictions lower than a C, 43% failed to secure that high a grade, and none of them scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which

follows, shows that 30 (60%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades, and 41 (82%) of the grades differed from the forecasts by not more than two probable error units (.1.2 letter grade). The five students who received F's were forecast grades more than three units above those received; only three other students varied more than two units from the predictions made for them, of these one received an A and two received B's. In the C range 23 (80%) of the students varied no more than one unit from their forecasts.

DEVIATION OF SOCIAL SCIENCE GRADES FROM PREDICTED GRADES
In terms of PE_{est} = ±.609. Sampling MSU Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			1 (33%)	2 (67%)					
B 4.6-5.5			2 (50%)		2 (50%)				
C 3.6-4.5				5 (17%)	23 (80%)	1 (3%)			
D 2.6-3.5				1 (11%)	5 (56%)	3 (33%)			
E 1.6-2.5									
F 0-1.5								3 (60%)	2 (40%
TOTALS			3 (6%)	8 (16%)	30 (60%)	4 (8%)		3 (6%)	2 (4%

There were 237 students enrolled in Introduction to Physical Science from the freshman class of 1936-37. The mean grade in the subject is 3.79, somewhat below a C, and the standard deviation is 1.15. Means for two of the sub-

tests are lower than the national medians, the differences being 5.5 points for artificial language and 3.1 points for analogies. The other three subtests show means exceeding the national medians by 4, 3.3, and .4 points, for completion, arithmetic, and opposites, respectively.

MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR 1936-37 INTRODUCTION TO PHYSICAL SCIENCE CLASS.

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.79	1.15	X_4	29.75	15.55
X_2	35.09	10.24	X_5	32.11	11.22
X_3	27.86	11.75	X_6	50.12	20.35

Only one of the simple correlations found between grade and subtest values for this class is very high, this being for the arithmetic subtest (.511). The lowest simple correlation is with the artificial language subtest (.208). By referring to the fourth partial correlation coefficients it is seen that the arithmetic subtest has the greatest and the opposites subtest the least predictive value, their coefficients being .429 and -.060, respectively. The coefficient for the artificial language subtest is only .066.

The multiple correlation found indicates that the formula will have a forecasting efficiency of 17%. The prediction formula, based on the partial regression coefficients:

CORRELATIONS BETWEEN INTRODUCTION TO PHYSICAL SCIENCE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.334	.511	.208	.327	.242
X_2		.360	.389	.369	.661
X_3			.131	.266	.315
X_4				.421	.495
X_5					.327

P. E. range = ±.025 to ±.044

FIRST PARTIAL CORRELATIONS

$r_{13.2}$ = .444	$r_{35.2}$ = .154	$r_{12.4}$ = .281	$r_{25.4}$ = .246
$r_{14.2}$ = .090	$r_{36.2}$ = .110	$r_{13.4}$ = .499	$r_{26.4}$ = .585
$r_{15.2}$ = .233	$r_{45.2}$ = .324	$r_{15.4}$ = .270	$r_{35.4}$ = .235
$r_{16.2}$ = .030	$r_{46.2}$ = .344	$r_{16.4}$ = .164	$r_{36.4}$ = .290
$r_{34.2}$ = -.011	$r_{56.2}$ = .119	$r_{23.4}$ = .339	$r_{56.4}$ = .150

P. E. range = ±.029 to ±.045

SECOND PARTIAL CORRELATIONS

$r_{14.23}$ = .106	$r_{56.23}$ = .104	$r_{26.34}$ = .540	$r_{23.45}$ = .299
$r_{15.23}$ = .186	$r_{12.34}$ = .137	$r_{56.34}$ = .088	$r_{26.45}$ = .572
$r_{16.23}$ = -.021	$r_{15.34}$ = .181	$r_{12.45}$ = .230	$r_{36.45}$ = .265
$r_{45.23}$ = .330	$r_{16.34}$ = .023	$r_{13.45}$ = .465	
$r_{46.23}$ = .347	$r_{25.34}$ = .182	$r_{16.45}$ = .130	

P. E. range = ±.029 to ±.045

CORRELATIONS BETWEEN INTRODUCTION TO PHYSICAL SCIENCE GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .121	$r_{12.345}$= .108	$r_{12.456}$= .191
$r_{15.236}$= .189	$r_{16.345}$= .007	$r_{13.456}$= .450
$r_{45.236}$= .315	$r_{26.345}$= .535	$r_{23.456}$= .186
P. E. range= ±.032 to ±.045		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .122	$r_{14.2356}$= .066	$r_{16.2345}$= -.060
$r_{13.2456}$= .429	$r_{15.2346}$= .160	
P. E. range= ±.035 to ±.045		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .561	P. E. = ±.030
$R_{1.23456}$= $R_{1.23645}$= .562	P. E. = ±.030

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR INTRODUCTION TO PHYSICAL SCIENCE.

$\sigma_{1.23456}$= .95	$\sigma_{3.12456}$= 9.69	$\sigma_{5.12346}$= 9.60
$\sigma_{2.13456}$= 7.31	$\sigma_{4.12356}$= 12.72	$\sigma_{6.12345}$= 14.23
$b_{12.3456}$= .016	$b_{14.2356}$= .005	$b_{16.2345}$= -.004
$b_{13.2456}$= .042	$b_{15.2346}$= .016	C = 1.596
P. $E._{est}$= ±.642		

$$\bar{X}_1 = .016X_2 + .042X_3 + .005X_4 + .016X_5 - .004X_6 + 1.596$$

The results of the predictions made for the 1936-37 freshmen enrolled in Introduction to Physical Science are

summarized in the following table. It is seen that 45% of the students received the grade predicted for them. Only 20 (14%) of the students with a predicted grade of C or better failed to secure at least a C, and only 3 (2%) of the students in this group received failing grades. Of the

COMPARISON OF ACTUAL AND PREDICTED GRADES IN INTRODUCTION TO PHYSICAL SCIENCE. MSU FRESHMEN, 1936-37. (Precentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-					2 (100%)	
B 4.6-5.5				6 (25%)	14 (58%)	4 (17%)
C 3.6-4.5	3 (3%)	5 (4%)	12 (10%)	68 (56%)	29 (24%)	3 (3%)
D 2.6-3.5	10 (12%)	13 (15%)	24 (28%)	34 (39%)	5 (6%)	
E 1.6-2.5	3 (60%)		2 (40%)			
F 0 -1.5						
106 of 237 (45%) received grades predicted for them						

students with predictions lower than a C, 52 (57%) failed to secure that high a grade, and only 5 (5%) of the students in this prediction range scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 131 (55%) of the actual grades varied from the predicted grades by not more than one unit (.6 letter grade), and 200 (85%) of the actual grades varied from the predicted grades by not more than two probable errors

DEVIATION OF INTRODUCTION TO PHYSICAL SCIENCE GRADES FROM PREDICTED GRADES
In terms of PE_{est} =±.642. MSU Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			2 (29%)	5 (71%)					
B 4.6-5.5		3 (6%)	7 (14%)	20 (40%)	19 (38%)	1 (2%)			
C 3.6-4.5			2 (2%)	15 (14%)	87 (80%)	4 (4%)			
D 2.6-3.5				3 (8%)	25 (66%)	10 (26%)			
E 1.6-2.5						10 (56%)	8 (44%)		
F 0 -1.5						1 (6%)	5 (31%)	6 (38%)	4 (25%
TOTALS		3 (1%)	11 (5%)	43 (18%)	131 (55%)	26 (11%)	13 (5%)	6 (3%)	4 (2%

(1.3 letter grade). The poorest predictions were in the E and F ranges; 8 (44%) of the E's received and 15 (94%) of the F's differed more than two units from the forecasts. In the D range all the grades earned were within two units of the predictions, and in the C range all except two of the grades (98%) varied no more than two units from the forecasts, and 87 (80%) of these grades differed no more than one unit from the predicted grades.

The following table shows the relation between the actual and predicted grades of the students included in the sampling of the 1937-38 freshman class who enrolled in Introduction to Physical Science. Of these students 26% received the grade predicted for them. Only 1 (10%) of the students with a predicted grade of C or better failed to get

COMPARISON OF ACTUAL AND PREDICTED GRADES IN INTRODUCTION TO PHYSICAL SCIENCE. SAMPLING, MSU FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				2 (100%)		
C 3.6-4.5			1 (12½%)	4 (50%)	2 (25%)	1 (12½%)
D 2.6-3.5			2 (22%)	3 (33%)	4 (45%)	
E 1.6-2.5	1 (25%)		2 (50%)	1 (25%)		
F 0 -1.5						
	6 of 23 (26%) received grades predicted for them					

a C, and this grade was a D. Of the students with a forecast lower than a C, 5 (38%) failed to secure that high a grade, and 4 (17%) of the students in this group scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 7 (31%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades, and 16 (70%) of the grades differed from the forecasts made by not more than two probable error units (1.3 letter grade). None of the predictions varied more than three units from the grades earned, and in the C and D ranges combined, only 1 of the 15 students included varied more than two units from the predictions. The sampling

DEVIATION OF INTRODUCTION TO PHYSICAL SCIENCE GRADES FROM PREDICTED GRADES

In terms of PE_{est} = ±.642. Sampling, MSU Freshmen, 1937-38 (Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.8			1 (100%)						
B 4.6-5.5			4 (67%)	2 (33%)					
C 3.6-4.5			1 (10%)	2 (20%)	5 (50%)	2 (20%)			
D 2.6-3.5				2 (40%)	2 (40%)	1 (20%)			
E 1.6-2.5									
F 0 -1.5							1 (100%)		
TOTALS			6 (26%)	6 (26%)	7 (31%)	3 (13%)	1 (4%)		

happens to include almost as many B as C grades, which probably accounts for the fact that only 31% of the total group scored within one unit of the forecasts made for them.

There were 80 students enrolled in Chemistry from the freshman class of 1936-37. The mean grade in the subject is 3.82, somewhat below a C, with a standard deviation of 1.16. The means found for the subtests are all higher than the national medians by from .2 to 4.3 points.

MEANS AND STANDARD DEVIATIONS OF GRADES AND SUBTESTS FOR 1936-37 CHEMISTRY CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.82	1.16	X_4	39.53	17.00
X_2	34.32	9.94	X_5	35.48	9.04
X_3	27.48	14.32	X_6	53.43	18.62

Simple correlations found between grades and subtest scores are very low for this subject. The highest correlation is with the artificial language subtest (.382) and the lowest is with the analogies subtest (.141). By referring to the fourth partial correlations it is seen that the artificial language subtest has the greatest and the

CORRELATIONS BETWEEN CHEMISTRY GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.362	.245	.382	.141	.307
X_2		.540	.323	.410	.754
X_3			.249	.415	.454
X_4				.410	.456
X_5					.503
P. E. range= ±.033 to ±.074					

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .063	$r_{35.2}$= .252	$r_{12.4}$= .273	$r_{25.4}$= .322
$r_{14.2}$= .301	$r_{36.2}$= .085	$r_{13.4}$= .167	$r_{26.4}$= .721
$r_{15.2}$= -.009	$r_{45.2}$= .322	$r_{15.4}$= -.019	$r_{35.4}$= .354
$r_{16.2}$= .056	$r_{46.2}$= .342	$r_{16.4}$= .161	$r_{36.4}$= .395
$r_{34.2}$= .094	$r_{56.2}$= .324	$r_{23.4}$= .501	$r_{56.4}$= .389
P. E. range = ±.036 to ±.075			

CORRELATIONS BETWEEN CHEMISTRY GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .297	$r_{56.23}$= .314	$r_{26.34}$= .658	$r_{23.45}$= .437
$r_{15.23}$= -.026	$r_{12.34}$= .222	$r_{56.34}$= .290	$r_{26.45}$= .683
$r_{16.23}$= .051	$r_{15.34}$= -.085	$r_{12.45}$= .295	$r_{36.45}$= .299
$r_{45.23}$= .309	$r_{16.34}$= .105	$r_{13.45}$= .186	
$r_{46.23}$= .337	$r_{25.34}$= .179	$r_{16.45}$= .183	
P. E. range = ±.040 to ±.075			

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .297	$r_{12.345}$= .242	$r_{12.456}$= .237
$r_{15.236}$= -.044	$r_{16.345}$= .136	$r_{13.456}$= .140
$r_{45.236}$= .227	$r_{26.345}$= .644	$r_{23.456}$= .334
P. E. range = ±.044 to ±.075		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .204	$r_{14.2356}$= .315	$r_{16.2345}$= -.027
$r_{13.2456}$= .066	$r_{15.2346}$= -.120	
P. E. range = ±.067 to ±.075		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .474	P. E. = ±.059
$R_{1.23456}$= $R_{1.23645}$= .474	P. E. = ±.059

opposites subtest the least predictive value, their coefficients being .315 and -.027, respectively.

The multiple correlation found indicates that the predictive value for this subject is very low; the correlation of ,474 indicates a forecasting efficiency of about

STANDARD ERRORS OF ESTIMATE AND
PARTIAL REGRESSION COEFFICIENTS FOR CHEMISTRY

$\sigma_{1.23456} = 1.02$ $\sigma_{2.13456} = 6.00$	$\sigma_{3.12456} = 11.66$ $\sigma_{4.12356} = 13.94$	$\sigma_{5.12346} = 7.33$ $\sigma_{6.12345} = 11.15$
$b_{12.3456} = .035$ $b_{13.2456} = .006$	$b_{14.2356} = .023$ $b_{15.2346} = -.017$	$b_{16.2345} = -.002$ $C = 2.251$
$P.E._{est} = \pm .688$		

12%. The prediction formula, based on the partial regression coefficients given above is:

$$X_1 = .035X_2 + .006X_3 + .023X_4 - .017X_5 - .002X_6 + 2.251.$$

The results of the predictions made for the 1936-37 freshmen enrolled in Chemistry are summarized in the table

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN CHEMISTRY. MSU FRESHMEN, 1936-37
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5			1 (14%)	2 (29%)	1 (14%)	3 (43%)
C 3.6-4.5	2 (4%)	3 (6%)	8 (17%)	25 (54%)	6 (13%)	3 (6%)
D 2.6-3.5	4 (15%)	1 (4%)	7 (27%)	13 (50%)		1 (4%)
E 1.6-2.5						
F 0 -1.5						
33 of 80 (41%) received grades predicted for them						

DEVIATION OF CHEMISTRY GRADES FROM PREDICTED GRADES
In terms of PE_{est}=±.688. M. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		1 (14%)	3 (43%)	2 (29%)	1 (14%)				
B 4.6-5.5				5 (72%)	1 (14%)	1 (14%)			
C 3.6-4.5				8 (20%)	31 (78%)	1 (2%)			
D 2.6-3.5					15 (94%)		1 (6%)		
E 1.6-2.5						2 (50%)	2 (50%)		
F 0 -1.5								6 (100%)	
TOTALS		1 (1%)	3 (4%)	15 (19%)	48 (60%)	4 (5%)	3 (4%)	6 (7%)	

on page 127. It is seen that 41% of the students received the grade predicted for them. Of the students with a predicted grade of C or better, 14 (26%) failed to get at least a C, and 2 (4%) received failing grades. Of the students with predictions lower than a C, 12 (46%) failed to secure a C grade, and only 1 (4%) scored higher than a C.

The table of deviations of actual grades from predicted grades, given above, shows that 48 (60%) of the actual grades varied from the predicted grades by not more than one unit (.7 letter grade), and 67 (84%) of the actual grades varied from the predicted grades by not more than two probable errors (1.4 letter grade). The poorest predictions were in the F range, where all the grades varied more than three units from the forecasts. In the combined B, C, and D

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN CHEMISTRY. SAMPLING OF MSU FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F	E	D	C	B	A
	0-1.5	1.6-2.5	2.6-3.5	3.6-4.5	4.6-5.5	5.6-6.0
A 5.6-						
B 4.6-5.5						2 (100%)
C 3.6-4.5	1 (17%)		1 (17%)	2 (33%)	2 (33%)	
D 2.6-3.5	5 (28%)		3 (17%)	5 (28%)	4 (22%)	1 (5%)
E 1.6-2.5	1 (50%)			1 (50%)		
F 0 -1.5						
5 of 28 (18%) received grades predicted for them						

ranges only 1 (2%) of the grades varied more than two units from the predictions made.

The relation between the actual and predicted grades of the students included in the sampling of the 1937-38 freshman class who enrolled in Chemistry is given in the table above. Of these students, 18% received the grades predicted for them. Of the students with a predicted grade of C or better, 2 (25%) failed to get at least a C, and 1 (13%) received a failing grade. Of the students with predictions lower than a C, 9 (45%) failed to secure that high a grade, and 5 (25%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, given on the next page, shows that 8 (29%) of the actual grades

DEVIATION OF CHEMISTRY GRADES FROM PREDICTED GRADES
In terms of PE_{est} =±.688. Sampling, MSU Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			2 (67%)	1 (33%)					
B 4.6-5.5			4 (67%)	2 (33%)					
C 3.6-4.5				3 (37%)	5 (63%)				
D 2.6-3.5					3 (75%)	1 (25%)			
E 1.6-2.5									
F 0 -1.5						1 (14%)	4 (57%)	2 (29%)	
TOTALS			6 (21%)	6 (21%)	8 (29%)	2 (7%)	4 (15%)	2 (7%)	

varied no more than one unit (.7 letter grade) from the predicted grades, and 16 (57%) of the grades differed from the forecasts by not more than two probable error units (1.4 letter grade). Of the students who received F's, 6 (86%) were forecast grades more than two units higher, and of the students included in each of the A and B groups, 67% exceeded the predictions made for them by more than two units. None of the C or D grades varied more than two units from the forecasts.

There were 313 students enrolled in Mathematics from the freshman class of 1936-37. The mean grade in the subject is 3.91, just below a C, and the standard deviation is 1.00. Means for the completion and arithmetic subtests exceed the national medians by 1.3 and 3.4 points, respectively. The other three subtests have means lower than the

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 MATHEMATICS CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.91	1.00	X_4	30.34	15.03
X_2	32.83	10.28	X_5	31.67	10.70
X_3	27.93	12.43	X_6	48.98	19.39

national standard, the deviations being: artificial language, 4.9; analogies, 3.6; and opposites, 1.5 points.

Simple correlations found between grades and subtest scores are fairly high in three cases; the other two are very low. The highest values are in the arithmetic subtest (.480) and in the analogies subtest (.437). The lowest value is in the case of the analogies subtest (.227). By referring to the fourth partial correlations it is seen that the arithmetic subtest has the greatest predictive value, with a coefficient of .355, followed by the analogies and artificial language subtests, with coefficients of .242 and .239, respectively. The other two correlations are both very small and negative, being -.044 for the completion subtest, and -.025 for the opposites subtest.

The multiple correlation found (.588) indicates that the forecasting efficiency of the prediction formula will be about 19%. The prediction formula for Mathematics is:

$$X_1 = -.005X_2 + .029X_3 + .015X_4 + .023X_5 - .001X_6 + 2.130.$$

CORRELATIONS BETWEEN MATHEMATICS GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.257	.480	.395	.437	.227
X_2		.434	.310	.426	.654
X_3			.277	.393	.316
X_4				.394	.418
X_5					.340

P. E. range = ±.022 to ±.036

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .423	$r_{35.2}$= .255	$r_{12.4}$= .154	$r_{25.4}$= .348
$r_{14.2}$= .343	$r_{36.2}$= .047	$r_{13.4}$= .420	$r_{26.4}$= .607
$r_{15.2}$= .375	$r_{45.2}$= .304	$r_{15.4}$= .333	$r_{35.4}$= .321
$r_{16.2}$= .081	$r_{46.2}$= .299	$r_{16.4}$= .074	$r_{36.4}$= .229
$r_{34.2}$= .166	$r_{56.2}$= .090	$r_{23.4}$= .381	$r_{56.4}$= .210

P. E. range = ±.024 to ±.038

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .305	$r_{56.23}$= .081	$r_{26.34}$= .577	$r_{23.45}$= .303
$r_{15.23}$= .305	$r_{12.34}$= -.007	$r_{56.34}$= .148	$r_{26.45}$= .582
$r_{16.23}$= .068	$r_{15.34}$= .230	$r_{12.45}$= .043	$r_{36.45}$= .174
$r_{45.23}$= .296	$r_{16.34}$= -.025	$r_{13.45}$= .351	
$r_{46.23}$= .296	$r_{25.34}$= .258	$r_{16.45}$= .004	

P. E. range= ±.025 to ±.038

CORRELATIONS BETWEEN MATHEMATICS GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .299	$r_{12.345}$= -.071	$r_{12.456}$= .050
$r_{15.236}$= .301	$r_{16.345}$= -.061	$r_{13.456}$= .356
$r_{45.236}$= .263	$r_{26.345}$= .564	$r_{23.456}$= .252
P. E. range = ±.026 to ±.038		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= -.044	$r_{14.2356}$= .239	$r_{16.2345}$= -.025
$r_{13.2456}$= .355	$r_{15.2346}$= .242	
P. E. range = ±.033 to ±.038		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .589	P. E. = ±.025
$R_{1.23456}$= $R_{1.23645}$= .588	P. E. = ±.025

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR MATHEMATICS

$\sigma_{1.23456}$= .81	$\sigma_{3.12456}$= 10.08	$\sigma_{5.12346}$= 8.73
$\sigma_{2.13456}$= 7.21	$\sigma_{4.12356}$= 12.61	$\sigma_{6.12345}$= 14.00
$b_{12.3456}$= -.005	$b_{14.2356}$= .015	$b_{16.2345}$= -.001
$b_{13.2456}$= .029	$b_{15.2346}$= .023	C = 2.130
P. $E._{est}$= ±.546		

The results of the predictions made for the 1936-37 freshmen enrolled in Mathematics are summarized in the following table. It is seen that 42% of the students received the grade predicted for them. Only 49 (23%) of the

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN MATHEMATICS. MSU FRESHMEN, 1936-37
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				2 (100%)		
B 4.6-5.5			6 (15%)	15 (38%)	10 (25%)	9 (22%)
C 3.6-4.5	3 (2%)	6 (4%)	34 (19%)	96 (54%)	34 (19%)	4 (2%)
D 2.6-3.5	8 (9%)	12 (13%)	25 (27%)	45 (49%)	2 (2%)	
E 1.6-2.5	2 (100%)					
F 0 -1.5						
	131 of 313 (42%) received grades predicted for them					

students with a predicted grade of C or better failed to get at least a C, and only 3 (1%) of the students included in this group failed. Of the students with predictions lower than a C, 47 (50%) failed to secure that high a grade, and 2 (2%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 160 (51%) of the actual grades varied from the predicted grades by not more than one unit (.5 letter grade), and 265 (84%) of the grades varied from the forecasts by not more than two probable errors (1.1 letter grade). The poorest predictions were in the F range, where 12 (92%) of the students scored more than two units below their forecasts. In the C range 154 (97%) of the students

DEVIATION OF MATHEMATICS GRADES FROM PREDICTED GRADES
In terms of PE_{est}=±.546. M. S. U. Freshmen, 1936-37.
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		2 (15%)	4 (31%)	6 (46%)	1 (8%)				
B 4.6-5.5		3 (7%)	7 (15%)	23 (50%)	13 (28%)				
C 3.6-4.5		1 (1%)		36 (23%)	110 (69%)	8 (5%)	2 (1%)	1 (1%)	
D 2.6-3.5				1 (2%)	34 (52%)	22 (34%)	4 (6%)	4 (6%)	
E 1.6-2.5					2 (11%)	8 (44%)	7 (39%)	1 (6%)	
F 0 -1.5						1 (8%)	1 (8%)	8 (61%)	3 (23%
TOTALS		6 (2%)	11 (4%)	66 (21%)	160 (51%)	39 (13%)	14 (4%)	14 (4%)	3 (1%

varied less than two units from their forecasts; in the D range 8 (12%) of the students had a similar variation.

The following table shows the relation between the actual and predicted grades of the students included in the

COMPARISON OF ACTUAL AND PREDICTED GRADES
IN MATHEMATICS. SAMPLING OF MSU FRESHMEN, 1937-38
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-6.0					1 (100%)	
B 4.6-5.5			1 (25%)		1 (25%)	2 (50%)
C 3.6-4.5	1 (5%)		2 (10%)	11 (55%)	4 (20%)	2 (10%)
D 2.6-3.5	6 (26%)		6 (26%)	10 (44%)	1 (4%)	
E 1.6-2.5			1 (100%)			
F 0 -1.5						
18 of 49 (37%) received grades predicted for them						

DEVIATION OF MATHEMATICS GRADES FROM PREDICTED GRADES
In terms of $PE_{est.}$ = ±.546. SAMPLING MSU FRESHMEN, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0	1 (25%)		3 (75%)						
B 4.6-5.5		1 (14%)	1 (14%)	4 (58%)	1 (14%)				
C 3.6-4.5			3 (14%)	7 (33%)	10 (48%)			1 (5%)	
D 2.6-3.5				3 (30%)	4 (40%)	1 (10%)	2 (20%)		
E 1.6-2.5									
F 0 -1.5								2 (29%)	5 (71%
TOTALS	1 (2%)	1 (2%)	7 (14%)	14 (29%)	15 (31%)	1 (2%)	2 (4%)	3 (6%)	5 (10%

sampling of the 1937-38 freshman class who enrolled in Mathematics; 37% of these students received the grade predicted for them. Only 4 (16%) of the students with a predicted grade of C or better failed to get at least a C, and only one of these predictions resulted in a failing grade. Of the students with predictions lower than a C, 13 (54%) failed to secure that high a grade, and only one scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, given above, shows that 15 (31%) of the actual grades varied no more than one unit (.5 letter grade) from the predicted grades, and 30 (62%) of the grades differed from the forecasts by not more than two probable error units (1.1 letter

grade). All the students who received A's or F's were forecast grades that were two or more units nearer a C than the ones they received. In the C range 4 (29%) of the grades differed more than two units from the forecasts; in the D range a similar variation was found for 2 (20%) of the grades.

There were 454 students from the freshman class of 1936-37 enrolled in the Physical Science Division. The subjects included are: Introduction to Humanities, Chemistry, Mathematics, and Home Economics. The mean grade in the subject is 3.85, slightly below a C, and the standard deviation is 1.06. Three subtests have means exceeding the national medians by the following amounts: completion, 2.1 points; arithmetic, 2.1 points; and analogies, 2.9 points. Means of the artificial language and opposites subtests fall below the national medians by 2.7 and .2 points, respectively.

Simple correlations found between grades and subtest scores are rather low for this group. The highest correlation is with the arithmetic subtest (.391), and the lowest is with the opposites subtest (.227). By referring to the

MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR 1936-37 PHYSICAL SCIENCE DIVISION

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	3.85	1.06	X_4	32.56	16.33
X_2	33.22	10.68	X_5	32.30	10.67
X_3	26.57	12.78	X_6	50.34	19.81

CORRELATIONS BETWEEN PHYSICAL SCIENCE DIVISION GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.248	.391	.298	.319	.227
X_2		.439	.309	.414	.668
X_3			.166	.354	.322
X_4				.432	.458
X_5					.392

P. E. range = ±.017 to ±.031

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .324	$r_{35.2}$= .211	$r_{12.4}$= .172	$r_{25.4}$= .327
$r_{14.2}$= .240	$r_{36.2}$= .044	$r_{13.4}$= .363	$r_{26.4}$= .623
$r_{15.2}$= .245	$r_{45.2}$= .351	$r_{15.4}$= .221	$r_{35.4}$= .317
$r_{16.2}$= .085	$r_{46.2}$= .356	$r_{16.4}$= .107	$r_{36.4}$= .281
$r_{34.2}$= .035	$r_{56.2}$= .171	$r_{23.4}$= .413	$r_{56.4}$= .242

P. E. range= ±.019 to ±.032

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .242	$r_{56.23}$= .166	$r_{26.34}$= .580	$r_{23.45}$= .345
$r_{15.23}$= .191	$r_{12.34}$= .026	$r_{56.34}$= .168	$r_{26.45}$= .593
$r_{16.23}$= .075	$r_{15.34}$= .120	$r_{12.45}$= .108	$r_{36.45}$= .222
$r_{45.23}$= .352	$r_{16.34}$= .006	$r_{13.45}$= .317	
$r_{46.23}$= .355	$r_{25.34}$= .227	$r_{16.45}$= .057	

P. E. range = ±.021 to ±.032

CORRELATIONS BETWEEN PHYSICAL SCIENCE DIVISION GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .231	$r_{12.345}$= -.001	$r_{12.456}$= .092
$r_{15.236}$= .182	$r_{16.345}$= -.014	$r_{13.456}$= .313
$r_{45.236}$= .318	$r_{26.345}$= .564	$r_{23.456}$= .272
P. E. range = ±.022 to ±.032		

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .008	$r_{14.2356}$= .186	$r_{16.2345}$= -.016
$r_{13.2456}$= .301	$r_{15.2346}$= .118	
P. E. range = ±.028 to ±.032		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .470	P. E. = ±.025
$R_{1.23456}$= $R_{1.23645}$= .469	P. E. = ±.025

fourth partial correlations it is seen that the arithmetic subtest has the greatest and the completion subtest the least predictive value, their coefficients being .301 and .008, respectively.

The multiple correlation found (.470) indicates that the prediction formula will have a forecasting efficiency of about 11%. The formula is:

$$\bar{X}_1 = .001X_2 + .026X_3 + .013X_4 + .013X_5 - .001X_6 + 2.333.$$

The results of the predictions made for the 1936-37 freshmen enrolled in the Physical Science Division are summarized on the following page. It is seen that 43%

STANDARD ERRORS OF ESTIMATE AND
PARTIAL REGRESSION COEFFICIENTS FOR PHYSICAL SCIENCE

$\sigma_{1.23456}$= .94	$\sigma_{3.12456}$= 10.68	$\sigma_{5.12346}$= 8.81
$\sigma_{2.13456}$= 7.42	$\sigma_{4.12356}$= 13.51	$\sigma_{6.12345}$= 12.89
$b_{12.3456}$= .001	$b_{14.2356}$= .013	$b_{16.2345}$= -.001
$b_{13.2456}$= .026	$b_{15.2346}$= .013	C = 2.333
P. $E._{est}$= ±.632		

of the students received the grade predicted for them. Only 67 (21%) of the students with a predicted grade of C or better failed to get at least a C. Only 8 (3%) of the forecasts of C or better resulted in failing grades. Of the students with predictions lower than a C, 67 (47%) failed to secure that high a grade, and only 7 (5%) scored higher than a C.

COMPARISON OF ACTUAL AND PREDICTED GRADES IN
PHYSICAL SCIENCE DIVISION. MSU FRESHMEN, 1936-37
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						1 (100%)
B 4.6-5.5			3 (8%)	8 (22%)	17 (46%)	9 (24%)
C 3.6-4.5	8 (3%)	15 (6%)	41 (15%)	143 (52%)	61 (22%)	6 (2%)
D 2.6-3.5	15 (10%)	17 (12%)	35 (25%)	68 (48%)	7 (5%)	
E 1.6-2.5						
F 0 -1.5						
196 of 454 (43%) received grades predicted for them						

DEVIATION OF PHYSICAL SCIENCE DIVISION GRADES FROM FORECASTS. IN TERMS OF PE_{est}=.632. MSU FRESHMEN, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			7 (44%)	8 (50%)	1 (6%)				
B 4.6-5.5			12 (14%)	39 (46%)	34 (40%)				
C 3.6-4.5				49 (22%)	163 (75%)	4 (2%)	3 (1%)		
D 2.6-3.5					47 (60%)	26 (33%)	6 (7%)		
E 1.6-2.5					2 (6%)	17 (53%)	11 (35%)	1 (3%)	1 (3%
F 0 -1.5							4 (17%)	12 (52%)	7 (31%
TOTALS			19 (4%)	96 (21%)	247 (55%)	47 (10%)	24 (5%)	13 (3%)	8 (2%

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, given above, shows that 247 (55%) of the actual grades varied from the predicted grades by not more than one unit (.6 letter grade), and 390 (86%) of the actual grades varied from the predicted grades by not more than two probable error units (1.3 letter grade). The poorest predictions were in the F range, where all the grades fell more than two units below the forecasts; in no other range did the grades received vary more than two units from the predictions for more than half of the students in that group. In the C and D ranges combined only 9 (3%) of the grades received differed more than two units from the grades forecast.

The following table shows the relation between the actual and predicted grades of students included in the sampling

COMPARISON OF ACTUAL AND PREDICTED GRADES IN PHYSICAL SCIENCE DIVISION. SAMPLING, MSU FRESHMEN, 1937-38. (Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				1 (25%)	2 (50%)	1 (25%)
C 3.6-4.5	2 (6%)	1 (3%)	5 (15%)	15 (46%)	8 (24%)	2 (6%)
D 2.6-3.5	5 (16%)	4 (12%)	6 (19%)	13 (41%)	3 (9%)	1 (3%)
E 1.6-2.5						
F 0 -1.5						
23 of 69 (33%) received grades predicted for them						

of the 1937-38 freshman class who enrolled in the Physical science Division. Of these students 33% received the grades predicted for them. Of the students with a predicted grade of C or better, 8 (22%) failed to get at least a C, and only 2 (5%) received failing grades. Of the students with predictions lower than a C, 15 (47%) failed to secure that high a grade, and only 4 (11%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 26 (38%) of the actual grades varied no more than one unit (.6 letter grade) from the predicted grades, and 52 (76%) of the grades differed from the forecasts by not more than two probable errors (1.3 letter grade). All the students who received F's were predicted

DEVIATION OF PHYSICAL SCIENCE GRADES FROM PREDICTED GRADES
In terms of $PE_{est.}$=±.632. Sampling, MSU Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		2 (50%)	1 (25%)	1 (25%)					
B 4.6-5.5			6 (46%)	5 (39%)	2 (15%)				
C 3.6-4.5				13 (45%)	16 (55%)				
D 2.6-3.5					6 (55%)	5 (45%)			
E 1.6-2.5					2 (40%)	2 (40%)	1 (20%)		
F 0 -1.5								5 (71%)	2 (29%)
TOTALS		2 (3%)	7 (10%)	19 (28%)	26 (38%)	7 (10%)	1 (1%)	5 (7%)	2 (3%

grades more than three units higher than those received. In the C and D ranges none of the grades varied more than two units from the predictions made.

There were 51 students enrolled in Journalism from the freshman class of 1936-37. The mean grade in the subject is 4.21, somewhat better than a C, and the standard deviation is only .74. Means for the completion and opposites sub-

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 JOURNALISM CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	4.21	.74	X_4	34.78	18.12
X_2	37.26	12.47	X_5	32.86	10.80
X_3	23.76	12.92	X_6	55.04	21.10

CORRELATIONS BETWEEN JOURNALISM GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.266	.167	.370	.313	.264
X_2		.579	.274	.490	.606
X_3			-.001	.547	.520
X_4				.403	.348
X_5					.494
P..E. range = ±.059 to ±.094					

tests exceed the national medians by 6.2 and 4.5 points, respectively. Means for the other subtests are all slightly lower than the national medians.

Simple correlations found between grades and examination scores are very low for this group. The highest correlation is with the artificial language subtest (.370), and the lowest is with the arithmetic subtest (.167). The probable errors of these correlations (grades vs subtests) vary from -.081 to -.092, and amount to over one-fifth of the correlation found in all cases; for the lowest correlation the probable error is more than one-half of the coefficient of correlation. For that reason no further work has been performed toward establishing a prediction formula.

A total of 641 students was enrolled in the freshman class of 1936-37 long enough to receive grades. For the purpose of establishing a general prediction formula that may show probability of general success in college, the averages of all the grades received by each pupil have been used in comparison with the subtest scores received. Under this consideration the data that have been found will be referred to as results for the freshman class.

The mean grade for the freshman class is 3.92, practically a C. The standard deviation is .90. Means for the completion, arithmetic, and opposites subtests slightly exceed the national medians; means for the other two subtests were a little lower than the standards for the whole country.

Simple correlations found between grades and subtest scores are comparatively high for this group. Two of the coefficients exceed .400, the value for completion being .416, and that for artificial language being .473. None of the others are very low; arithmetic is the lowest with a

MEANS AND STANDARD DEVIATIONS
OF GRADES AND TESTS FOR 1936-37 FRESHMAN CLASS

SCORE	MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR 1936-37 FRESHMAN CLASS				S. D.
X_1	3.92	.90	X_4	33.97	16.90
X_2	33.23	10.95	X_5	31.93	10.67
X_3	25.14	12.71	X_6	51.89	19.83

CORRELATIONS BETWEEN FRESHMAN GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6
X_1	.416	.326	.473	.360	.361
X_2		.457	.337	.434	.704
X_3			.149	.380	.265
X_4				.373	.493
X_5					.387

P. E. range = ±.013 to ±.026

FIRST PARTIAL CORRELATIONS

$r_{13.2}$= .168	$r_{35.2}$= .227	$r_{12.4}$= .309	$r_{25.4}$= .353
$r_{14.2}$= .389	$r_{36.2}$= -.090	$r_{13.4}$= .293	$r_{26.4}$= .656
$r_{15.2}$= .219	$r_{45.2}$= .267	$r_{15.4}$= .225	$r_{35.4}$= .353
$r_{16.2}$= .106	$r_{46.2}$= .382	$r_{16.4}$= .167	$r_{36.4}$= .223
$r_{34.2}$= -.006	$r_{56.2}$= .127	$r_{23.4}$= .437	$r_{56.4}$= .252

SECOND PARTIAL CORRELATIONS

$r_{14.23}$= .396	$r_{56.23}$= .152	$r_{26.34}$= .637	$r_{23.45}$= .357
$r_{15.23}$= .188	$r_{12.34}$= .210	$r_{56.34}$= .190	$r_{26.45}$= .626
$r_{16.23}$= .123	$r_{15.34}$= .136	$r_{12.45}$= .252	$r_{36.45}$= .148
$r_{45.23}$= .276	$r_{16.34}$= .109	$r_{13.45}$= .234	
$r_{46.23}$= .383	$r_{25.34}$= .236	$r_{16.45}$= .117	

P. E. range = ±.016 to ±.026

CORRELATIONS BETWEEN FRESHMAN GRADES
AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

THIRD PARTIAL CORRELATIONS

$r_{14.236}$= .382	$r_{12.345}$= .185	$r_{12.456}$= .231
$r_{15.236}$= .173	$r_{16.345}$= .085	$r_{13.456}$= .220
$r_{45.236}$= .239	$r_{26.345}$= .620	$r_{23.456}$= .343

FOURTH PARTIAL CORRELATIONS

$r_{12.3456}$= .170	$r_{14.2356}$= .356	$r_{16.2345}$= -.038
$r_{13.2456}$= .154	$r_{15.2346}$= .091	
P. E. range = ±.023 to ±.026		

MULTIPLE CORRELATION

$R_{1.23456}$= $R_{1.45632}$= .574	P. E. = ±.016
$R_{1.23456}$= $R_{1.23645}$= .574	P. E. = ±.018

value of .326. From the fourth partial correlations it is seen that the artificial language subtest has the greatest and the opposites subtest the least predictive value, their coefficients being .356 and -.038, respectively.

The multiple correlation found, (.574) indicates that the prediction formula will have a forecasting efficiency of about 18%. The prediction formula is:

$$\bar{X}_1 = .018X_2 + .011X_3 + .020X_4 + .008X_5 - .002X_6 + 2.214.$$

The results of the predictions made for the 1936-37 freshman class are summarized on the following page. It is seen that 45% of the students received the grade predicted for them. Only 89 (19%) of the students with a predicted

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR FRESHMAN GRADES

$\sigma_{1.23456}$ = .74	$\sigma_{3.12456}$ = 10.80	$\sigma_{5.12346}$ = 8.94
$\sigma_{2.13456}$ = 6.98	$\sigma_{4.12356}$ = 13.35	$\sigma_{6.12345}$ = 12.95
$b_{12.3456}$ = .018	$b_{14.2356}$ = .020	$b_{16.2345}$ = -.002
$b_{13.2456}$ = .011	$b_{15.2346}$ = .008	C = 2.214
P. $E._{est}$ = ±.497		

grade of C or better failed to get at least a C, and only 4 (1%) of these students received F's. Of the students with predictions lower than a C, 91 (52%) failed to secure that high a grade, and only 5 (3%) received grades higher than a C.

The table of deviations of actual grades from predicted

COMPARISON OF ACTUAL AND PREDICTED FRESHMAN GRADES. M. S. U. FRESHMEN, 1936-37
(Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-				2 (40%)	1 (20%)	2 (40%)
B 4.6-5.5		1 (1%)	1 (1%)	26 (35%)	32 (44%)	14 (19%)
C 3.6-4.5	4 (1%)	16 (4%)	67 (17%)	215 (56%)	81 (21%)	5 (1%)
D 2.6-3.5	6 (3%)	24 (14%)	61 (35%)	78 (45%)	5 (3%)	
E 1.6-2.5						
F 0 -1.5						
290 of 641 (45%) received grades predicted for them						

DEVIATION OF FRESHMAN GRADES FROM PREDICTED GRADES
In terms of PE_{est} = ±.497. H. S. U. Freshmen, 1936-37
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0			7 (33%)	11 (53%)	14 (14%)				
B 4.6-5.5		2 (2%)	18 (14%)	49 (38%)	60 (46%)				
C 3.6-4.5			8 (3%)	43 (13%)	242 (75%)	19 (6%)	9 (3%)		
D 2.6-3.5				1 (1%)	73 (61%)	35 (29%)	10 (9%)		
E 1.6-2.5					2 (5%)	14 (34%)	16 (39%)	7 (17%)	2 (5%
F 0 -1.5								5 (50%)	5 (50%
TOTALS		2 (0%)	33 (5%)	104 (16%)	380 (59%)	68 (11%)	35 (6%)	12 (2%)	7 (1%

grades in terms of the probable error of estimate, given above, shows that 380 (59%) of the actual grades varied from the predicted grades by not more than one unit (.5 letter grade), and 552 (86%) of the actual grades varied from the predicted grades by not more than two probable errors (1.0 letter grade). The poorest predictions were in the E and F ranges; 25 (61%) of the E's received and all the F's differed more than two units from the forecasts. The best predictions were made for the students who received C's or D's; the number of students in these ranges who varied less than one unit from the forecasts made for them was 242 (75%) and 73 (61%), respectively.

The following table shows the relation between the actual and predicted grades of the students included in the

COMPARISON OF ACTUAL AND PREDICTED FRESHMAN GRADES. SAMPLING OF M. S. U. FRESHMEN, 1937-38. (Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE					
	F 0-1.5	E 1.6-2.5	D 2.6-3.5	C 3.6-4.5	B 4.6-5.5	A 5.6-6.0
A 5.6-						
B 4.6-5.5				1 (20%)	1 (20%)	3 (60%)
C 3.6-4.5		3 (5%)	7 (12%)	25 (42%)	21 (36%)	3 (5%)
D 2.6-3.5	2 (5%)	7 (16%)	20 (45%)	14 (32%)	1 (2%)	
E 1.6-2.5						
F 0 -1.5						
46 of 108 received grades predicted for them (43%)						

sampling of the 1937-38 freshman class. Of these students 43% received the grade predicted for them. Of the students with a predicted grade of C or better, only 10 (15%) failed to get at least a C, and none received a failing grade. Of the students with predictions lower than a C, 29 (66%) failed to secure that high a grade, and only 1 (2%) scored higher than a C.

The table of deviations of actual grades from predicted grades in terms of the probable error of estimate, which follows, shows that 53 (49%) of the actual grades varied no more than one unit (.5 letter grade) from the predicted grades, and 85 (78%) of the grades differed from the forecasts made by not more than two probable error units (1.0 letter grade). In the A, E, and F ranges the grades

DEVIATION OF FRESHMAN GRADES FROM PREDICTED GRADES
In terms of PE_{est} = ±.497. Sampling, MSU Freshmen, 1937-38
(Percentages based on totals for each grade)

GRADE RECEIVED	DEVIATIONS IN PROBABLE ERROR UNITS								
	+5	+4	+3	+2	±1	-2	-3	-4	-5
A 5.6-6.0		3 (50%)	1 (16 %)	1 (16 %)	1 (16%)				
B 4.6-5.5		1 (4%)	6 (26%)	11 (48%)	5 (22%)				
C 3.6-4.5			2 (5%)	10 (25%)	27 (68%)	1 (2%)			
D 2.6-3.5					19 (70%)	7 (26%)	1 (4%)		
E 1.6-2.5					1 (10%)	2 (20%)	5 (50%)	2 (20%)	
F 0 -1.5									2 100%
TOTALS		4 (4%)	9 (8%)	22 (20%)	53 (49%)	10 (9%)	6 (6%)	2 (2%)	2 (2%

received differed considerably from the predictions, with 13 (72%) of these marks varying more than two units from the forecasts. In the B range only 7 (30%) of the grades varied more than two units from the predictions, and in the combined C and D ranges the value of the predictions is seen from the fact that only 3 (4%) of the grades varied more than two units from the forecasts.

SUMMARY OF RESULTS OF THE STUDY.

The results of the more important phases of the statistical work of this study are summarized in the following pages, for the purpose of giving a better opportunity for comparisons between the various subjects, and in order to make possible a more unified presentation of the chief results of the investigation.

The following table summarizes the means found for each of the subject grades, and for each of the subtests in the various subject fields. It is seen that the highest average grade occurs in Journalism, and the lowest in Zoology, but both these subjects are composed of students from other classes than just the freshman year. In the regular freshman subjects the highest average is held by the Foreign Language group, and the lowest by the Introduction to Biological Science class. Variations in average subject grades are not large (3.71 to 4.19 for freshman subjects), and are probably as much due to differences in grading as to differences in type of students in the various subjects.

The Journalism class has the highest average completion score, followed by the Introduction to Physical Science class and the Zoology class. The highest score on the arithmetic test is held by the Botany class, followed by the Mathematics and Introduction to Physical Science classes. The small Chemistry group has the highest average on the artificial

SUMMARY OF MEANS OF GRADES AND SUBTESTS.

SUBJECT	X_1	X_2	X_3	X_4	X_5	X_6
Int. to Bio. Sci.	3.71	31.31	21.19	36.80	30.18	53.86
Botany	3.78	33.90	28.45	26.11	31.70	47.00
Zoology	3.26	34.68	26.83	33.22	33.37	53.56
Psychology	3.93	32.48	24.24	35.31	31.53	53.53
Bio. Sci. Ave.*	3.80	32.72	24.71	32.86	31.55	51.29
Int. to Hum.	3.91	32.30	23.94	37.87	31.94	54.31
Foreign Languages	4.19	33.24	22.14	38.72	31.94	56.41
Humanities Average*	3.95	32.59	23.51	36.50	32.19	53.98
Social Science	3.97	34.45	24.91	35.12	32.05	55.45
Int. to Phys. Sci.	3.79	35.09	27.86	29.75	32.11	50.12
Chemistry	3.82	34.32	27.48	39.53	35.48	53.43
Mathematics	3.91	32.83	27.93	30.34	31.67	48.98
Phys. Sci. Ave.*	3.85	33.22	26.57	32.56	32.30	50.34
Journalism	4.21	37.26	23.76	34.78	32.86	55.04
Average Grade*	3.92	33.23	25.14	33.97	31.93	51.89

*Values given as averages were computed separately and are not the means of other figures given in this table.

language test, followed by the Foreign Languages and Introduction to Biological Science Classes. The three highest averages for the analogies test are found in the Chemistry, Zoology, and Journalism classes (all small groups), and the best averages for the opposites test in Foreign Languages, Journalism, and Introduction to Humanities classes. The

only tendencies that stand out in the above table are the high arithmetic averages for the physical science subjects and the high artificial language averages for the humanities subjects. Evidently the students with the better scores in these two subtests are selecting the subjects in which the abilities tested by these tests are needed.

The lowest means of the various subtests are found in the following subjects: completion - Introduction to Biological Science, arithmetic - Introduction to Biological Science, artificial language - Botany, analogies - Introduction to Biological Science, and opposites - Botany. All the lowest subtest averages are found in two subjects; the average grades are also low in these subjects. It is very probable that the students enrolled in these two classes are below the general average of the freshman class as a whole in ability.

The table on the following page gives the correlations between the subject grades and subtest scores. It is seen that there are only two negative values in the table, these being found for the Zoology class, which is a very small group.

Correlations between the grades and the completion subtest vary from .248 for the Physical Science Average to .539 for Introduction to Biological Science. These correlations are found under the heading r_{12}. In general fairly high

correlations are found for this subtest, with most of the low values occuring in the physical science subjects.

Correlations between the grades and the arithmetic

CORRELATIONS BETWEEN GRADES AND SUBTESTS

SUBJECT	r_{12}	r_{13}	r_{14}	r_{15}	r_{16}
Int. to Bio. Sci.	.539	.295	.459	.396	.421
Botany	.358	.412	.338	.205	.290
Zoology	.350	-.006	.382	.136	-.001
Psychology	.358	.337	.462	.459	.304
Bio. Sci. Ave.	.410	.314	.386	.485	.315
Int. to Hum.	.458	.135	.534	.213	.507
Foreign Languages	.328	.188	.514	.266	.297
Humanities Average	.357	.133	.493	.198	.299
Social Science	.380	.329	.380	.271	.365
Int. to Phys. Sci.	.334	.511	.208	.327	.242
Chemistry	.362	.245	.382	.141	.307
Mathematics	.257	.480	.395	.437	.227
Phys. Sci. Ave.	.248	.391	.298	.319	.227
Journalism	.266	.167	.370	.313	.264
Average Grade	.416	.326	.473	.360	.361

subtest (r_{13}) are very low for all subjects except most of those included in the physical science field. Here the highest correlation is found, .511 for Introduction to

...physical science. The lowest correlation is -.000, with the ...zoology grades. For this subtest 7 of the 15 correlations are lower than .000. The other value seems to be for the subjects in which considerable variability is reported. The general idea with subjects in the humanities field are all very low.

The mathematical language subtest has rather high correlations, in nearly all cases, with the subject marks (r_{1g}). In 9 of the 15 subjects this correlation is higher than that found for any of the other subtests. The values vary from .NN for the physical science average to .NN for Education to Humanities. Of the 15 coefficients 6 are higher than .400, with three of these highest values being in the subjects included in the humanities field.

Very few of the correlations between the mathematical subtest and subject grades (r_{2g}) are high, only 3 of the coefficients exceed .400, and 9 are lower than .000. The coefficients are considerably higher in the different subjects of any field of study. The highest value is for the biology-lab. group average (.NNN), and the lowest is for the ...logy class (.NNN).

The correlations between the groups and the other subtest are also very low. In nearly all cases, but there are ...er values below .000 than in the case of the symbolic subtest. However, 8 of the coefficients are lower than .000,

and only 2 exceed .400. Introduction to Humanities has the highest coefficient, this being .507, and Zoology the lowest, this being -.001.

The following table lists the fourth partial coefficients between the various subject grades and the five subtests. These values are of special significance since in

FOURTH PARTIAL CORRELATIONS BETWEEN GRADES AND SUBTESTS

SUBJECT	$r_{12.3456}$	$r_{13.2456}$	$r_{14.2356}$	$r_{15.2346}$	$r_{16.2345}$
Int to Bio Sci	.281	-.048	.297	.101	-.072
Botany	.151	.272	.144	-.046	.025
Zoology	.614	-.069	.556	-.306	-.465
Psycah	.203	.040	.354	.336	.175
Bio Sci Ave	.098	.104	.227	.284	.078
Int to Hum	.122	-.006	.393	-.080	.122
For Language	.164	.064	.439	-.051	-.092
Hum Average	.236	-.023	.435	-.067	-.110
Social Science	.141	.201	.288	-.060	.032
Int to Phys Sci	.122	.429	.066	.160	-.060
Chemistry	.204	.066	.315	-.120	-.027
Mathematics	-.044	.355	.239	.242	-.025
Phys Sci Ave	.008	.301	.186	.118	-.016
Average Grade	.170	.154	.356	.091	-.038

these correlations the effects resulting from the other four tests are eliminated in the value found for each subtest. Thus the values given for the completion subtest are a measure of its relation to each of the particular subjects, all items covered by the other subtests being eliminated.

It is easily seen that the artificial language test has the greatest predictive value, since most of its coefficients are fairly high, and since in all but three subjects the coefficients exceed .200. In seven of the fifteen subjects the coefficients found for it are higher than those found for any of the other tests. Some high coefficients are found in all of the subject fields.

The completion subtest seems to be next in order of general value. Few high coefficients are found; most of them fall between .122 and .236. It has one negative value, and one value that is practically zero. Its coefficients rank second to the artificial language values in six subjects, and in one subject it ranks highest of all the tests.

The arithmetic subtest has relatively high coefficients in all subjects involving considerable use of mathematics and ranks first in four of the subjects. In most other cases the values are very low, four of them being negative. Seven of the coefficients are lower than .100.

The analogies subtest and the opposite subtest both have very few high coefficients, and in both cases about half

of the values are negative. Coefficients lower than .100 number six for the former and 10 for the latter subtest. The opposites subtest does not have any positive value higher than .175. The analogies subtest has fairly high coefficients in subjects involving mathematics, and also in some of the subjects in the biological science field.

The following table gives the multiple and simple correlations between subject grades and the subtests of the

COEFFICIENTS OF CORRELATION BETWEEN SUBJECT GRADES AND THE THURSTONE PSYCHOLOGICAL EXAMINATION

SUBJECT	MULTIPLE CORRELATION	P. E.	SIMPLE CORRELATION	P. E.
Int. to Bio. Sci.	.607	-.030	.381	-.042
Botany	.483	-.041	.352	-.047
Zoology	.665	-.055	.212	-.100
Psychology	.602	-.038	.435	-.047
Bio. Sci. Average	.569	-.021	.408	-.025
Int. to Humanities	.612	-.027	.450	-.032
Foreign Languages	.545	-.032	.430	-.037
Humanities Average	.543	-.023	.423	-.028
Social Science	.508	-.031	.415	-.039
Int. to Phys. Sci.	.561	-.030	.401	-.038
Chemistry	.474	-.059	.331	-.067
Mathematics	.588	-.025	.421	-.032
Phys. Sci. Average	.469	-.025	.397	-.027
Average Grade	.574	-.018	.441	-.021

psychological examination. It is at once evident that the multiple correlations are considerably higher than the simple correlations, the difference in every case being at least .072, and in most cases being at least .150.

The multiple correlations vary from .469 to .665. All except three are higher than .500. The median value is .561. This is higher than almost all the coefficients of correlation found in previous studies in which specific subject grades and single tests were compared. It compares favorably with the results found in other studies of the prediction of specific subject scholarship from a number of predictive items combined. The multiple correlations found in this study are higher than most of the correlations found in previous studies of prediction of scholarship in the subjects outside of the humanities field.

The coefficient for the average grade is lower than correlations that have been found for prediction of general scholarship by the use of a number of predictive items. In many of these studies values exceeding the one here found by .130 have been attained. Apparently a number of tests have an advantage over the method here used, when these tests are used as combinations, for the prediction of general scholarship. However, for prediction of success in specific subjects the values here found compare favorably with the results of the majority of previous studies.

The following table shows the deviation of the actual grades from the predicted grades in the various subjects in the terms of probable error units. Reference to page 58 shows that 50% of the grades received should vary less than

COMPARISON OF DEVIATIONS OF ACTUAL GRADES FROM PREDICTED GRADES FOR STUDENTS OF 1936-37 AND SAMPLING OF STUDENTS ENROLLED IN 1937-39.
(Percentages based on total enrollment for each subject)

SUBJECT	DEVIATION IN PROBABLE ERROR UNITS					
	Less than 1 PE_{est}		Less than 2 PE_{est}		Less than 3 PE_{est}	
	1936-1937	1937-1938	1936-1937	1937-1938	1936-1937	1937-1938
Int. to Bio. Sci.	55%	50%	84%	85%	94%	97%
Botany	56%	48%	83%	80%	94%	85%
Zoology	49%		73%		88%	
Psychology	38%		69%		84%	
Bio. Sci. Ave.	56%	49%	83%	80%	94%	94%
Int. to Hum.	67%	59%	88%	87%	95%	94%
For. Languages	55%	48%	86%	76%	96%	96%
Hum. Average	63%	54%	85%	78%	96%	92%
Social Science	59%	60%	88%	84%	92%	90%
Int. to Phys. Sci.	55%	31%	84%	70%	94%	100%
Chemistry	60%	29%	84%	57%	92%	93%
Mathematics	51%	31%	85%	62%	93%	80%
Phys. Sci. Ave.	55%	38%	86%	76%	95%	87%
Average Grade	59%	49%	86%	78%	97%	92%

one probable error of estimate from the predictions, 82% should vary less than two probable errors, and 96% should vary less than three probable errors. All except two of the classes meet this requirement for the group included in the one and two probable error ranges for the 1936-1937 group meet the requirement, but all except two of the others, the same two as before, namely Zoology and Psychology, have 92% or more of the grades included within the three probable errbr range of variations.

Predictions for the 1937-38 freshman class were not quite so good, but this may be partly due to the fact that a sampling of only one-fifth of the class was used. The results for Zoology and Psychology are not given, since less than five students were included in each case. In seven of the subjects there are too few students included in the one probable error range, but four of these seven have at least 48% of the grades within the specified limit. Only three classes meet the requirement of having at least 82% of the grades included in the two probable error variation range, but this is partly offset by the fact that all except four of the classes have as good predictions as the 1936-37 class when the limit is extended to three probable errors.

CONCLUSIONS.

The purpose of this thesis has been to evaluate the various parts of the American Council on Education Psychological Examination, in order to determine the predictive value of each part. The immediate result has been the development of the various prediction formulas, but the work would be incomplete without some analysis of the other facts that have appeared as indirect results of the study.

The first question that arises is with respect to the value of the various subtests. Does each one have a specific purpose, as is claimed for it, and does each one have definite value in measuring the college capacity of the prospective student?

This question can possibly be best answered by comparing the simple correlations of the various subtests with the subject grades, and the correlations found between the gross examination score and the subject grades. In six of the subjects the correlation between the completion subtest and the grades is higher than the similar correlation for the gross score of the complete examination. Arithmetic subtest correlations exceed the gross score correlations in three subjects; artificial language subtest correlations exceed the gross score correlations in eight subjects; analogies subtest correlations exceed the gross score correlations in four subjects; and opposites

subtest correlations exceed the gross score correlations in two subjects. For these various subjects in which the subtests are better measures of student ability than the test as a whole, the subtests must have specific application. It may be possible to find better means of measuring general college ability than through the use of the subtests included in this battery of tests, but for the present it is apparent that not a single one of the parts of the examination can be eliminated without loss of measuring effectiveness for at least two of the subjects included in this study.

The multiple correlations exceed the simple correlations, found for the gross scores in the same subjects, by rather considerable amounts. The median of the simple correlations is .408; the median of the multiple correlations is .561. These coefficients represent a predictive effectiveness of 8% and 17% , respectively. The latter figure is still a very low value when efficient prediction is considered, but it can at least be said for it that the value is twice that of the one found for simple correlations based on the same examination, and that certainly is a step in the right direction. The use of multiple correlation on the subtests of a single examination reveals which parts of the examination have the greatest predictive value, and if other criteria for prediction

are available, the use of the most effective subtests in conjunction with other measures of ability will undoubtedly give better results than any combination in which merely the gross score of the examination is used.

The coefficients of multiple correlation are higher in almost every case than the results found in previous studies in which general mental tests were the predictive criteria for specific subjects. The use of general achievement tests for predictions in specific subjects has yielded very few coefficients as high as the ones found in this study. Very few tests of specific traits, aptitudes, or achievements, used singly, have yielded results as good as the ones found here for predictions in specific subjects.

Combinations of tests have been used very effectively in previous studies for the purpose of prediction of success in various college subjects. Some of these predictions have yielded considerably higher coefficients than those found in this study. In all cases where very high coefficients have been found, at least two tests made especially to fit the subject in question have been used. The parts of the American Council on Education Psychological Examination have been devised as general measures of ability, and can not be expected to be the best measures of specific subject needs. However, if the parts of the

examination that best fit the various subjects are used in conjunction with specific tests designed to cover the field of a given subject, it is more than likely that very good predictions can be made.

The prediction formulas found in this study give varying results for the different subjects, but in general a very large part of the predictions come within one letter grade of the marks finally earned by the students. The mean probable error of estimate is .610. Over 80% of the students in all the classes combined received grades that varied no more than two probable-error-of-estimate units from their forecasts. In other words, four-fifths of the grades earned vary only slightly more than one letter grade from the predictions made. In every subject at least three-fourths of the students with C predictions or better received grades higher than a C; in every subject at least 45% of the students with predictions lower than a C failed to receive that high a grade.

Predictions far more effective than those outlined above are to be desired, but even these results can surely be of some value in helping a student select the course in which he is most likely to succeed, and in helping a teacher or counselor to find the student who is missplaced in a subject, or who is not doing the work that he should be capable of.

Changes in the American Council on Education Psychological Examination make it impossible to use directly, for predictive purposes, the results found in this study. The form of the examination for 1938 has an additional subtest, and various changes in the method of scoring have been made. It is possible that the prediction formulas found in this study can be converted to a usable form, but the result would be more or less of a make-shift, at best. It appears that the best procedure would be to apply the methods that have been used in the present study to the new form of examination, for the purpose of developing new formulas, based on the parts of the examination that most effectively measure the qualifications needed for the various subjects.

Results of the present study show the effectiveness of the completion and artificial language subtests. The artificial language subtest has higher correlation coefficients than the gross examination score in eight of the fifteen subjects; the same is true for the completion subtest in six subjects. It would appear that the use of the subtest scores in place of the gross score, for the purpose of estimating a student's ability, in subjects in which any subtest has a considerable correlation advantage over the gross score, should be the most effective immediate method of applying results of the new form of the examination.

As soon as possible prediction formulas should be worked out from the new examination form, but until such work can be completed, the subtest scores can be of more value in various specific subjects than the gross score.

When work is undertaken to develop new prediction formulas it would be well to use other, more specific tests of the qualifications needed for each subject, in connection with the general psychological examination, and from such a combination it is almost certain that formulas could be derived that would be far more efficient than any that have been worked out in the present study.

No formula that may at any time be worked out will be usuable for any great length of time. Other colleges that have such formulas in use find that it is advisable to revise them at no greater intervals than two years. Tests will change, and subject requirements will vary from time to time; prediction formulas can only be effective when they keep up with the changes in the subjects in which they attempt to forecast probability of success.

LIST OF REFERENCES

1. David Segel, Prediction of Success in College, U. S. Department of Interior, Bulletin 1934, No. 15, page 57

2. C. S. Boucher, Some Studies of Freshmen Admission at The University of Chicago, mimeographed, 1932.

3. P. M. Condit, "The Prediction of Scholastic Success by Means of Classification Examinations," in Journal of Educational Research, (May 1929), p. 331-35.

4. E. Crane, "The Results of Some Psychological Tests at Bryn Mawr College," in School and Society, XXV (May 28, 1937), p. 640-44.

5. L. D. Hartson, The Most Valid Combination of 23 Tests for Predicting Freshmen Scholarship at Oberlin College, Ohio College Association, Bulletin No. 58, 1928.

6. L. T. Hopkins, "The Reliability of the Wilkins Prognosis Test for Predicting Success in Modern Foreign Languages," in Prognosis Tests in Modern Foreign Languages, (New York, 1929).

7. H. H. Remmers, A Report on Progress of a Diagnostic and Remedial Study of Failing Students at Purdue University, Purdue University Bulletin, XXVII, No. 14, 1927.

8. H. H. Remmers, A Study of Freshmen Placement Tests at Purdue University, Purdue University Bulletin, XXIX, No. 13, 1929.

9. David Segel, "Prediction of Success in Junior College," in Junior College Journal, I (May 1931), p. 499-502.

10. John M. Stalnaker, "American Council Psychological Examination for 1926 at Purdue University," in School and Society, XXVII (Jan, 21, 1928), p. 86-88.

11. L. L. Thurstone and Thelma G. Thurstone, "The 1930 Psychological Examination," in Educational Record, XII (April 1931), p. 160-78.

12. F. L. Whitney and A. K. Goodman, The Relationship of Intelligence and Classification Scores to Mortality and Scholastic Ratings, Department of Research, Colorado State Teachers College, Greeley, Colo., 1930.

13. A. B. Crawford, "Forecasting Freshmen Achievement," in School and Society, XXXI (Jan, 25, 1930), p. 125-30.

14. J. E. Anderson, "Intelligence Tests of Yale Freshmen," in School and Society, XI (Apr. 3, 1920), p. 417-20.

15. J. W. Bridges, "The Correlation Between College Grades and the Alpha Intelligence Tests," in Journal of Educational Psychology, XI (Oct. 1920), p. 361-67.

16. S. S. Colvin, "The Use of Intelligence Tests," in Educational Review, LXII (Sept. 1921), p. 134-48.

17. J. E. Decamp, "Studies in Mental Tests," in School and Society, XIV (Oct. 1, 1921), p. 254058.

18. Johm L. Ernst, "Psychological Tests Versus the First Semester Marks as a Means of Academic Prediction," in School and Society, XVIII (Oct. 6, 1923), p. 419-40.

19. A. M. Jordan, "Correlations of Four Intelligence Tests with the Grades of Students and with Each Other," in Psychological Bulletin, XIX (Feb, 1922), p. 93-94.

20. J. B. Miner, "Scholarship and Intelligence," in Personnel Journal, VI (Aug, 1927), p. 113-18.

21. G. D. Stoddard, Iowa Placement Examinations, University of Iowa Studies in Education, III, No. 2, 1925.

22. C. L. Stone, "The Significance of Adpha in College," in Journal of Educational Psychology, XIII (May 1922), p. 298-302.

23. L. M. Terman, "Intelligence Tests in Colleges and Universities," in School and Society, XIII (Apr. 23, 1921), p. 481-94.

24. C. H. Toll, "Scholastic Aptitude Tests in Amherst College," in School and Society, XXVIII (Oct. 27, 1928), p. 524-28.

25. M. J. Van Wagenen, "Some Results and Influences Derived from the Use of the Army Tests at the University of Minnesota," in Journal of Applied Psychology, IV (March 1920), p. 59-72.

26. A. H. Macphail, "Classification of Freshmen at Brown University," in Journal of Educational Research, XIV (Dec. 1926), p. 365-69.

27. W. G. Binnewies, "Freshman Grades and Mental Tests," in Educational Administration and Supervision, IX March 1923), p. 161-62.

28. A. H. MacPhail, loc. cit.

29. E. G. Williamson, "An Analysis of Scholastic Aptitude of Freshmen in Some Private Colleges in Minnesota," in School and Society, XXXIV (Nov. 14, 1931), p. 674-80.

30. J. L. Blair, Significant Factors in the Prediction of the Success of College Freshmen, University of Chicago Libraries, Chicago, 1933.

31. Ruth K. Bryns, "Scholastic Aptitude and Freshman Achievement," in School and Society, XXXV, (May 21, 1932), p. 713-18.

32. H. A. Edgerton and H. A. Toops, Academic Progress, Ohio State University Press, Columbus, Ohio, 1929.

33. W. S. Guiler, "The Predictive Value of Group Intelligence Tests," in Journal of Educational Research, XVI (Dec. 1927), p. 365-74.

34. M. J. Neuberg, The Relative Values of Several Means of Prognosticating Success in College, Ohio College Association, Bulletin No. 60, Ohio State University, Columbus, Ohio.

35. Binnewies, loc. cit.

36. Guiler, loc. cit.

37. H. D. Hill, The Relative Weight of Certain Factors in Predicting Academic Success in College, Pennsylvania State Studies in Education, Pennsylvania State College.

38. Charles W. Odell, "Attempt at Predicting Success in the Freshman Year at College," in School and Society, XXV (June 11, 1927), p. 702-706.

39. C. O. Thompson and Dale Russell, Some Factors Affecting the Scholastic Success of Teachers of College Freshmen, Bulletin of Indiana State Normal School, Eastern Division II, No. 4, 1927.

40. Toll, loc, cit.

41. Ruth A. Brown, A Comparison of Data on Freshmen Entering The University of Michigan In the Fall of 1927, University of Michigan Administrative Studies I, No. 1, University of Michigan, Ann Arbor, Michigan, 1930.

42. Crawford, loc, cit.

43. Binnewies, loc. cit.

44. Guiler, loc. cit.

45. Terman, loc. cit.

46. Toll, loc. cit.

47. L. Bolenbaugh and W. M. Proctor, "Relation of Subjects Taken in High School to Success in College," in Journal of Educational Research, XV (Feb. 1927), p. 87-92.

48. J. W. Bridges, "The Value of Intelligence Tests in Universities," in School and Society, XV (Mar. 18, 1922), p. 295-303.

49. Glen U. Cleeton, "The Predictive Value of Certain Measures of Ability in College Freshmen," in Journal of Educational Research, XV (May 1927), p. 357-70.

50. Columbia University, Report on the Use of Intelligence Examinations in Columbia University, 1927.

51. David Grauer and W. T. Root, "The Thorndike Intelligence Test and Academic Grades," in Journal of Applied Psychology, XI (August 1927), p. 297-318.

52. A. H. MacPhail, The Intelligence of College Students, Baltimore, Md., 1924.

53. M. J. Nelson, The Thorndike Intelligence Examinations for High School Graduates as a Criterion for Predicting College Success, Unpublished M. A. Thesis, University of Wisconsin, Madison, Wisconsi.

54. W. T. Root, "The Freshmen: Thorndicke College Entrance Tests, First Semester Grades, Binet Test," in Journal of Applied Psychology, VII (March 1923), p. 77-92.

55. P. M. Symonds, Measurement in Secondary Education, New York, 1927.

56. R. W. Tallman, A Critical Analysis of Student Persistence at the State University of Iowa, University of Iowa Studies IV, No. 1, 1927.

57. Terman, loc. cit.

58. Ben D. Wood, Measurement in Higher Education, New York, 1923.

59. A. Dvorak and R. C. Salyer, "Significence of Entrance Requirements for the Engineering College at the University of Washington," in Journal of Engineering Education (new series), XXIII (April 1933), p. 618-23.

60. J. E. Anderson and L. T. Spencer, "The Predictive Value of the Yale Classification Tests," in School and Society, XXIV (Sept. 4, 1926), p. 305-12.

61. Hill, loc. cit.

62. B. Beatley, "The Relative Standing of Students in Secondary School, in Comprehensive Entrance Examinations and in College," in School Review, XXX (Feb. 1922), p. 141-47.

63. C. C. Brigham, "Correlation of the Examination of the College Entrance Examination Board with College Standing," in Journal of Engineering Education, XV (May 1925), p. 653-89.

64. Crawford, loc. cit.

65. A. B. Crawford and Paul S. Burnham, "Entrance Examinations and College Achievement," in School and Society, XXXVI (Sept. 10 and 17, 1932), p. 344-52 and 378-84.

66. Cleeton, loc. cit.

67. Stoddard, loc. cit.

68. Royal Gilkey, "The Relation of Success in Certain Subjects in High School to Success in the Same Subjects in College; in School Review, XXXVI (Oct. 1929) p. 576-88.

69. E. S. Jones, "Predictions from High School Performance," in School and Society, XXVII (Mar. 17, 1928), p. 339-40.

70. Boucher, loc. cit.

71. R. A. Fritz, "Predicting College Marks and Teaching Success for Students in a Teachers College," in Journal of Applied Psycholoby, XVII (Aug. 1933) p. 439-46.

72. Segel, loc. cit.

73. Remmers, Study of Freshmen Placement Tests, loc. cit.

74. Stoddard, loc. cit.

75. Stoddard, idem.

76. Remmers, Study of Freshmen Placement Tests, loc. cit.

77. Stoddard, loc. cit.

78. Brown, loc. cit.

79. Remmers, Study of Freshmen Placement Test, loc. cit.

80. Stoddard, loc. cit.

81. Remmers, Study of Freshmen Placement Test, loc. cit.

82. Stoddard,,loc. cit.

83. Dvorak and Salyer, loc. cit.

84. Dvorak and Salyer, idem.

85. Blair, loc. cit.

86. Lorenz Meyers, D. Atkins, and H. A. Toops, A Follow-up Investigation of a Study Performance Test at Ohio State University, Ohio College Association Bulletin No. 66, Ohio State University, Columbus, Ohio.

87. J. D. Beatty and Glen U. Cleeton, "Predicting Achievement in College and After Graduation," in Personnel Journal, VI (Feb. 1928), p. 344-51.

88. Boucher, loc. cit.

89. Segel. loc. cit.

90. Thurstone, loc. cit.

91. Segel, loc. cit.

92. Boucher, loc. cit.

93. Remmers, Study of Freshmen Placement Tests, loc. cit.

94. Thurstone and Thurstone, loc. cit.

95. Segel, loc. cit.

96. Boucher, loc. cit.

97. Thurstone, and Thurstone, loc. cit.

98. Boucher, loc. cit.

99. Thurstone and Thurstone, loc. cit.

100. Remmers, Study of Freshmen Placement Tests, loc. cit.

101. Thurstone and Thurstone, loc. cit.

102. Boucher, loc. cit.

103. A. M. Jordan, "Some Results and Correlations of Army Alpha Tests," in School and Society, XI, (May 20, 1920), p. 354-58.

104. Stone, Significance of Alpha, loc. cit.

105. Stone, idem.

106. Jordan, Results of Army Alpha, loc. cit.

107. Stone, Significance of Alpha, loc. cit.

108. Jordan, Results of Army Alpha, loc. cit.

109. Stone, Significance of Alpha, loc. cit.

110. Jordan, Results of Army Alpha, loc. cit.

111. Stone, Significance of Alpha, loc. cit.

112. Jordan, Results of Army Alpha, loc. cit.

113. Stone, Significance of Alpha. loc. cit.

114. MacPhail, Classification of Freshmen, loc. cit.

115. Charles W. Odell, Predicting the Scholastic Success of College Freshmen, University of Illinois, Urbana, Illionis.

116. James B. Tharp, "Sectioning Classes in Romance Languages," in Modern Language Journal, XII (Nov. 1927), p. 95-114.

117. Odell, Predicting Scholastic Success of Freshmen, loc. cit.

118. David W. Lefever, The Prognostic Value of Certain Groupings of the Test Elements of the Thorndike Examination for High School Graduates, University of Southern California Studies, Education Series, No. 9, University of Southern California, 1930.

119. Root, loc. cit.

120. Stoddard, loc. cit.

121. Lefever, loc. cit.

122. Root, loc. cit.

123. Stoddard, loc. cit.

124. Root, loc. cit.

125. Lefever. loc. cit.

126. Root, loc. cit.

127. Lefever, loc. cit.

128. Root, loc. cit.

129. Stoddard, loc. cit.

130. Root, loc. cit.

131. Lefever, loc. cit.

132. Root, loc. cit.

133. Root, idem.

134. Lefever, loc. cit.

135. Stoddard, loc. cit.

136. M. J. Nelson, "Some Data From the Freshmen Tests", in School and Society, XXXI (June 7, 1930), p. 772-74.

137. Stoddard, loc. cit.

138. Crawford, and Burnham, loc. cit.

139. Brigham, loc. cit.

140. Crawford, and Burnham, loc. cit.

141. A. D. Whitman, The Value of the Examination of the College Entrance Examination Board as Predictions of Success in College, Bureau of Publications, Teachers College, Columbia University, 1926.

142. Brigham, loc. cit.

143. Whitman, loc. cit.

144. Brigham, loc. cit.

145. Crawford and Burnham, loc, cit.

146. Segel, loc. cit.

147. Stoddard, loc. cit.

148. Segel, loc. cit.

149. Stoddard, loc. cit.

150. Segel, loc. cit.

151. Stoddard, loc. cit.

152. Segel, loc. cit.

153. T. A. Langlie, "The Iowa Placement Examinations at the University of Minnesota," in Journal of Engineering Education, XVII (May 1927), p. 842-60.

154. L. W. Miller, An Experimental Study of the Iowa Placement Examination, Univeristy of Iowa Studies in Education, V, No. 6, first series, No. 181, University of Iowa, Iowa City, Iowa, 1930.

155. Remmers, Study of Freshmen Placement Tests, loc. cit.

156. Stoddard, loc. cit.

157. Langlie, loc. cit.

158. Miller, loc. cit.

159. Stoddard, loc. cit.

160. Langlie, loc. cit.

161. Miller, loc, cit.

162. Stodderd, loc. cit.

163. Langlie, loc. cit.

164. Miller, loc. cit.

165. Nelson, loc. cit.

166. Stoddard, loc. cit.

167. Tharp, loc. cit.

168. Miller, loc. cit.

169. Stoddard, loc. cit.

170. Miller, loc. cit.

171. Stoddard, loc. cit.

172. Miller, loc. cit.

173. Remmers, Study of Freshmen Placement Tests, loc. cit.

174. Stoddard, loc. cit.

175. R. M. Bear, "The Predictive Value of the Iowa Physics Aptitude Placement Test," in Journal of Applied Psychology, XI (Oct. 1927), p. 381-84.

176. Miller, loc. cit.

177. Miller, idem.

178. Nelson, Some Data From Freshmen Tests, loc. cit.

179. Gilkey, loc. cit.

180. Clara M. Brown, "An Experiment in Sectioning," in Journal of Higher Education, I (May 1930), p. 269-73.

181. Boucher, loc. cit.

182. Blair, loc. cit.

183. P. Roy Brammell, Articulation of High School and College, Washington, D. C., National Survey of Secondary Education, Monograph No. 10, Office of Education Bulletin 1932, No. 17.

184. W. D. Cocking and T. C. Holy, "Relation of Intelligence Scores to High School and University Marks" in Educational Research Bulletin, VI (Dec. 7, 1927), p. 383-84.

185. Columbia University, loc. cit.

186. Crawford, loc. cit.

187. J. H. Edds and W. M. McCall, "Predicting the Scholastic Success of College Freshmen," in Journal of Educational Research, XXVII (Oct. 1933), p. 127-30.

188. Edgerton and Toops, loc. cit.

189. J. H. Goldthorpe, "The Relative Rank in High School and the First Two Years of the University," in School and Society, XXX (July 27, 1929), p. 130-34.

190. Lema J. Hawks, Certain Relationships Between Scholarship in High School and College, Baltimore, Md., Johns Hopkins Press, 1929.

191. Jones, loc. cit.

192. Alvah R. Lauer and J. E. Evans, "The Relative Predictive Value of Different High School Subjects on College Grades," in School and Society, XXXI (Feb. 1, 1930), p. 159-60.

193. Edward A. Lincoln, "The Relative Standing of Pupils in High School, in Early College, and on College Entrance Examinations," in School and Society, V (April 7, 1917), p. 417-20.

194. Odell, Predicting Scholastic Success of Freshmen, loc. cit.

195. C. C. Pierson and C. H. Nettels, "A Study of High School Seniors to Determine Who Shall be Recommended to College, in School and Society, XXVIII (Aug. 18, 1929), p. 215-16.

196. E. Potthoff, "The Effectiveness of Certain Requirements in the Selective Admission of College Students," in School Review, XXXVII (Sept. 1929), p. 519-28.

197. William M. Proctor, "The High School's Interest in Methods of Selecting Students for College Admission," in School and Society, XXII (Oct. 10, 1925), p. 441-48.

198. Douglas E. Scates, "A Study of High School and First Year University Grades," in School Review, XXXIII (March 1924), p. 182-92.

199. C. E. Seashore, Notes on the Use of Mental Tests in College, National Research Council, Washington, D.C., Dec. 30, 1921.

200. P. M. Symonds, "The Significance of Intelligence Tests in the University of Hawaii," in School and Society, XX, (Nov, 8, 1924), p. 601-606.

201. Terman, loc. cit.

202. Williamson, loc. cit.

203. Blair, loc. cit.

204. Blair, idem.

205. Dvorak and Salyer, loc. cit.

206. Crawford, loc. cit.

207. Harl R. Douglass, The Relation of High School Preparation and Certain Other Factors to Academic Success at the University of Oregon, University of Oregon Publications, III, No. 1, Sept. 1931.

208. Hartson, loc. cit.

209. J. B. Johnston, "Predicting College Success for the High School Senior," in Vocational Guidance Magazine, VI (April 1928), p. 289-94.

_____, "Predicting Success in College at the Time of Entrance," in School and Society, XXIII (Jan, 16, 1926), p. 82-88.

_____, "Predicting Success or Failure in College at The Time of Entrance," in School and Society, XIX (Jan, 16, 1924), p. 82-88.

_____, "The Selection of College Students," in Problems of College Education, Minneapolis, University of Minnesota Press, 1928.

210. Jordan, Correlations of Four Intelligence Tests, loc. cit.

211. Mark A. May, "Predicting Academic Success," in Journal of Educational Psychology, XIV (Oct. 1923)

212. Neuberg, loc. cit.

213. Odell, Predicting Scholastic Success of College Freshmen, loc. cit.

214. Pierson and Nettels, loc. cit.

215. Symonds, Measurement in Secondary Education, loc. cit.

216. Wood, loc. cit.

217. Odell. Predicting Scholastic Success of College Freshmen, loc. cit.

218. Stoddard, loc. cit.

219. . . . "The American Council on Education Psychological Examination," in Education Record, April 1937 and April 1938.

220. Karl J. Holzinger, Statistical Tables for Students in Education and Psychology, University of Chicago Press, 1937.

221. J. W. Dunlap and A. K. Kurtz, Handbook of Statistical Monographs, Tables, and Formulas, New York, 1932, World Book Company, p. 118.

222. Holzinger, op. cit.

223. Dunlap and Kurtz, op. cit., p. 84-45.

224. Dunlap and Kurtz, op. cit., p. 130.

225. Dunlap and Kurtz, op. cit., p. 130.

226. Dunlap and Kurtz, op. cit., p. 135.

227. Dunlap and Kurtz, op. cit., p. 134.

228. Dunlap and Kurtz, op. cit., p.131.

229. Dunlap and Kurtz, op. cit., p. 135.

230. Dunlap and Kurtz, op. cit., p. 135.

231. Dunlap and Kurtz, op. cit., p. 33.

232. Dunlap and Kurtz, op. cit., p. 107 and 132.

233. Dunlap and Kurtz, op. cit., p. 107 and 135.

234. David Segel, Prediction of Success in College, United States Department of the Interior, Office of Education, Bulletin 1934, No. 15, p. 41.

235. Dunlap and Kurtz, op. cit., p. 132.

236. Segel, Prediction of Success in College, op. cit., p. 37.

BIBLIOGRAPHY.

The writers to who reference is made in the following list of educational works are almost all students of educational statistics, and almost every work deals directly with the problem of prediction of college scholarship. The references selected have been chosen because of the recognized standing of the author or because of the immediate value of the material presented. Every title in the list has been recognized as having sufficient validity to be included in the bibliography on "prediction of success in college", as presented by David Segel, Educational Consultant and Specialist in Tests and Measurements, U. S. Office of Education. It is not felt that any further evaluation of the specific works is necessary, in view of the similarity of the titles and the number of references involved. The bibliography follows:

Anderson, J. E., "Intelligence Tests of Yale Freshmen," in School and Society, XI (Apr. 3, 1920), p. 417-20.

_____ and Spencer, L. T., "The Predictive Value of the Yale Classification Tests," in School and Society, XXIV (Sept. 4, 1926), p. 305-12.

Bear, R. M., "The Predictive Value of the Iowa Physics Aptitude Placement Test," in Journal of Applied Psychology, XI, (Oct. 1927), p. 381-84.

Beatley, B., "The Relative Standing of Students in Secondary School, in Comprehensive Entrance Examinations, and in College," in School Review, XXX (Feb. 1922), p. 141-47.

Binnewies, W. G., "Freshman Grades and Mental Tests," in Educational Administration and Supervision, IX (Mar, 1923), p. 161-62.

Blair, J. L., Significant Factors in the Prediction of the Success of College Freshmen, University of Chicago Libraries, Chicago, 1933.

Bolenbaugh, L., and Proctor, W. M., "Relation of Subjects Taken in High School to Success in College." in Journal of Educational Research, XV (Feb. 1927), p. 87-92.

Boucher, C. S., Some Studies of Freshmen Admission at the University of Chicago, Mimeographed, 1932.

Brammell, P. Roy, Articulation of High School and College, Washington, D. C., National Survey of Secondary Education, Monograph, No. 10, Office of Education Bulletin 1932, No. 17.

Bridges, J. W., "The Correlation Between College Grades and the Alpha Intelligence Tests," in Journal of Educational Psychology, XI (Oct. 1920), p. 361-67.

_____, "The Value of Intelligence Tests in Universities," in School and Society, XV (Mar. 18, 1922), p. 295-303.

Brigham, C. C., "Correlation of the Examination of the College Entrance Examination Board with College Standing," in Journal of Engineering Education, XV (May 1925), p. 653-89.

Brown, Clara M., "An Experiment in Sectioning," in Journal of Higher Education, I (May 1930), p. 269-73.

Brown, Ruth A., A Comparison of Data on Freshmen Entering the University of Michigan in the Fall of 1927, Ann Arbor, Michigan, University of Michigan, 1930, (University of Michigan Administrative Studies I, No. 1)

Byrns, Ruth K., "Scholastic Aptitude and Freshmen Achievement," in School and Society, XXXV (May 21, 1932), P. 713-18.

Cleeton, Glen U., "The Predictive Value of Certain Measures of Ability in College Freshmen," in Journal of Educational Research, XV (May 1927), p. 357-70.

Cocking, W. D., and Holy, T. C., "Relation of Intelligence Scores to High School and University Marks," in Educational Research Bulletin, VI (Dec. 7, 1927), p. 383-84.

Columbia University, Report on the Use of Intelligence Examinations in Columbia University, 1927.

Colvin, S. S., "The Use of Intelligence Tests," in Educational Review, LXII (Sept. 1921), p. 134-48.

Condit, P. M., "The Predictions of Scholastic Success by Means of Classification Examinations," in Journal of Educational Research, XIX (May 1929), p. 331-35.

Crane, E., "The Results of Some Psychological Tests at Bryn Mawr College," in School and Society, XXV (May 28, 1927), p. 640-44.

Crawford, A. B., "Forecasting Freshmen Achievement," in School and Society, XXXI (Jan, 25, 1930), p. 125-30.

_____, and Burhham, Paul S., "Entrance Examinations and College Achievement," in School and Society, XXXVI (Sept. 10 and 17, 1932), p. 344-52-and 378-84.

DeCamp, J. E., "Studies in Mental Tests," in School and Society, XIV (Oct. 1, 1921), p. 254-58.

Douglas,Harl R., The Relation of High School Prepartion and Certain Other Factors to Academic Success at the University of Oregon, University of Oregon Publications, III, No. 1, Sept. 1931.

Dvorak, A., and Salyer, R. C., "Significance of Entrance Requirements for the Engineering College at the University of Washington," in Journal of Engineering Education, (new series), XXIII (April 1933), p. 618-23.

Dunlap, Jack W., and Kurtz, A. K., Handbook of Statistical Monographs, Tables, and Formulas, Yonkers, N. Y., World Book Co., 1932.

Edds, J. H., and McCall, W. M., "Predicting the College Success of College Freshmen," in Journal of Educational Research, XXVII (Oct. 1933), p. 127-30.

Edgerton, H. A., and Toops, H. A., Academic Progress, Columbus, Ohio, Ohio State University Press, 1929.

Ernst, John L., "Psychological Tests Versus the First Semester Marks as a Means of Academic Prediction," in School and Society, XVIII (Oct. 6, 1923), p. 419-40.

Fritz, R. A., "Predicting College Marks and Teaching Success for Students in a Teachers College," in Journal of Applied Psychology, XVII (Aug. 1933), p. 439-46.

Gilkey, Roayl, "The Relation of Success in Certain Subjects in High School to Success in the Same Subjects in College," in School Review, XXXVII (Oct. 1929), p. 576-88.

Goldthorpe, J. H., "The Relative Rank in High School and the First Two Years of the University," in School and Society, XXX (July 27, 1929), p. 130-34.

Grauer, David, and Root, W. T., "The Thorndike Intelligence Test and Academic Grades," in Journal of Applied Psychology, XI (Aug. 1927), p. 297-318.

Guiler, W. S., "The Predictive Value of Group Intelligence Tests," in Journal of Educational Psychology, XVI (Dec. 1927), p. 365-74.

Hartson, L. D., The Most Valid Combination of 23 Tests for Predicting Freshmen Scholarship at Oberlin College, Columbus, Ohio, Ohio College Association Bulletin, No. 58, 1928.

Hawks, Lena J., Certain Relationships Between Scholarship in High School and in College, Baltimore, Md., Johns Hopkins Press, 1929.

Hill, H. D., The Relative Weight of Certain Factors in Predicting Academic Success in College, Pennsylvania State Studies in Education in Abstracts of Studies in Education at Pennsylvania State College.

Holzinger, Karl J., Statistical Tables for Students in Education and Psychology, University of Chicago Press, 1937.

Hopkins, L. T., "The Reliability of the Wikins Prognosis Test for Predicting Success in Modern Foreign Languages," in Prognosis Tests in Modern Foreign Languages, New York, N. Y., Macmillan Co., 1929.

Johnston, J. B., "Predicting College Success for the High School Senior," in Vocational Guidance Magazine, VI (April 1928), p. 289-94.

_____, "Predicting Success in College at the Time of Entrance," in School and Society, XXIII (Jan. 16, 1926), p. 82-88.

_____, "Predicting Success or Failure in College at the Time of Entrance," in School and Society, XIX (Jan, 16, 1924), p. 82-88.

_____, "The Selection of College Students," in Problems of College Education, Minneapolis, University of Minnesota Press, 1928.

Jones, E. S., "Predictions from High School Performance," in School and Society, XXVII (Mar. 17, 1928). p. 339-40.

Jordan, A. M., "Correlations of Four Intelligence Tests with the Grades of Students and with Each Other," in Psychological Bulletin, XIX (Feb. 1922), p. 93-94.

_____, "Some Results and Correlations of Army Alpha Tests," in School and Society, XI (May 20, 1920), p. 354-58.

Langlie, T. A., "The Iowa Placement Examinations at the University of Minnesota," in Journal of Engineering Education, XVII (May 1927), p. 842-60.

Lauer, Alvah R., and Evans, J. E., "The Relative Predictive Value of Different High School Subjects on College Grades, in School and Society, XXXI (Feb. 1, 1930), p. 159-60.

Lefever, David, W., The Prognostic Values of Certain Groupings of the Test Elements of the Thorndike Examination for High School Graduates, Los Angeles, University of Southern California Press, 1930, (University of Southern California Studies, Education Series, No. 9.)

Lincoln, Edward A., "The Relative Standing of Pupils in High School, in Early College, and on College Entrance Examinations," in School and Society, V. (April 7, 1917), p. 417-20.

MacPhail, A. H., "Classification of Freshmen at Brown University," in Journal of Educational Research, XIV (Dec. 1926), p. 365-69.

_____, The Intelligence of College Students, Baltimore, Md., Warwick and York, 1924.

May, Mark A., "Predicting Academic Success," in Journal of Educational Psychology, XIV (Oct. 1923), p. 429-40.

Miller, L. W., An Experimental Study of the Iowa Placement Examination, Iowa City, Iowa, University of Iowa, 1930. (University of Iowa Studies in Education, V. No. 6, First Series, No. 181)

Miner, J. B., "Scholarship and Intelligence," in Personnel Journal, VI (Aug. 1927), p. 113-18.

Nelson, M. J., "Some Data From Freshmen Tests," in School and Society, XXXI (June 7, 1930), p. 772-74.

_____, The Thorndike Intelligence Examinations for High School Graduates as a Criterion for Predicting College Success, Madison, Wisconsin, University of Wisconsin, Unpublished M. A. Thesis.

Neuberg, Maurice J., The Relative Values of Several Means of Prognosticating Success in College, Columbus, Ohio, Ohio State University, Ohio College Association Bulletin No. 60.

Odell, Charles W., "Attempt at Predicting Success in the Freshmen Year at College," in School and Society, XXV (June 11, 1937), p. 702-706.

_____, Predicting the Scholastic Success of College Freshmen, Urbana, Ill., University of Illinois Bulletin, XXV, No. 2, (College of Education, Bureau of Educational Research, Bulletin No. 37.)

Pierson, C. D., and Nettels, C. H., "A Study of High School Seniors to Determine Who Shall be Recommended to College," in School and Society, XXVIII (Aug. 18, 1928), p. 215-16.

Pothoff, E., "The Effectiveness of Certain Requirements in the Selective Admission of College Students," in School Review, XXXVII (Sept. 1929), p. 519-28.

Proctor, William M., "The High-School's Interest in Methods of Selecing Students for College Admission," in School and Society, XXII (Oct. 10, 1925), p. 441-48.

Remmers, H. H., A Report on Progress of a Diagnostic and Remedial Study of Failing Students at Purdue University, Lafayette, Ind., Purdue University, 1927, (Purdue University Bulletin, XXVII, No. 14, and Educational Reference Circular No. 1.)

_____, "A Study of Freshmen Placement Tests at Purdue University, 1926-29, Lafayette, Ind., Purdue University, 1929, (Purdue University Bulletin, XXIX, No. 13.)

Root, W. T., "The Freshmen: Thorndike College Entrance Tests, First Semester Grades, Binet Tests," in Journal of Applied Psychology, VII (March 1923), p. 77-92.

Scates, Douglas,E., "A Study of High School and First Year University Grades," in School Review, XXIII (March 1924), p. 182-92.

Seashore, C. E., Notes on the Use of Mental Tests in College, National Research Council, Washington, D. C., March 1924.

Segel, David, Prediction of Success in College, United States Office of Education, Bulletin 1934, No. 15.

_____, "Prediction of Success in Junior College," in Junior College Journal, I, (May 1931), p. 499-502.

Stalnaker, John M., "American Council Psychological Examination for 1926 at Purdue University," in School and Society, XXVII (Jan. 21, 1928), p. 86-88.

Stoddard, G. D. Iowa Placement Examinations, Iowa City, Iowa, University of Iowa, 1925, (University of Iowa Studies in Education, III, No. 2.)

Stone, C. L., "The Disparity Between Intelligence and Scholarship," in Journal of Educational Psychology, XIII (May 1922), p. 298-302.

Symonds, P. M., Measurement in Secondary Education, New York, N. Y. Macmillan Co., 1927.

_____, "The Significance of Intelligence Tests in the University of Hawaii," in School and Society, XX, (Nov. 8, 1924), p. 601-606.

Tallman, R. W., A Critical Analysis of Student Persistence at the State University of Iowa, Iowa City, Iowa, University of Iowa, (University of Iowa Studies, IV, No. 1, 1927),

Terman, L. M., "Intelligence Tests in Colleges and Universities", in School and Society, XIII (Apr. 23, 1921), p. 481-94.

Tharp, James B., "Sectioning Classes in Romance Languages," in Modern Language Journal, XII (Nov. 1927), p. 95-114.

Thompson, C. O., and Russell, Dale, Some Factors Affecting the Scholastic Success of Teachers of College Freshmen, Bulletin of Indiana State Normal Schoo, Eastern Division II, No.4, 1927

Thurstone, L. L., and Thurstone, Thelma G., "The 1930 Psychological Examination", in Educational Record, XII (April 1931), p. 160-78.

Toll, C. H., "Scholastic Aptitude Tests in Amherst College," in School and Society, XXVIII (Oct. 27, 1928), p. 524-28.

Toops, H. A., Atkins, D., and Meyer, Lorenz, A Follow-UP Investigation of a Study Performance Test at Ohio State University, Columbus, Ohio, Ohio State University, Ohio College Association Bulletin No. 66.

Van Wagenen, M. J., "Some Results and Influences Derived from the Use of the Army Tests at the University of Minnesota," in Journal of Applied Psychology, IV, (Mar. 1920), p. 59-72.

Whitman, A. D., The Value of the Examination of the College Entrance Examination Board as Predictions of Success in College, Bureau of Publications, Teachers College, Columbia University, 1926.

Whitney, F. L., and Goodman, A. K., The Relationship of Intelligence and Classification Scores to Mortality and Scholastic Ratings, Department of Research, Coloredo State Teachers College, Greeley, Colo., August 1930.

Williamson, E. G., "An Analysis of Scholastic Aptitude of Freshmen in Some Private Colleges in Minnesota," in School and Society, XXXIV (Nov. 14, 1931), p. 674-80.

Wood, Ben D., Measurement in Higher Education, Yonkers, N. Y., World Book Co., 1923.

APPENDIX

On the following pages two sets of tables are given; they have been prepared for use in predicting the grades in the various subjects that have been studied in this thesis, and for the prognosis of the probability of attaining a C grade, on the basis of the grade forecast.

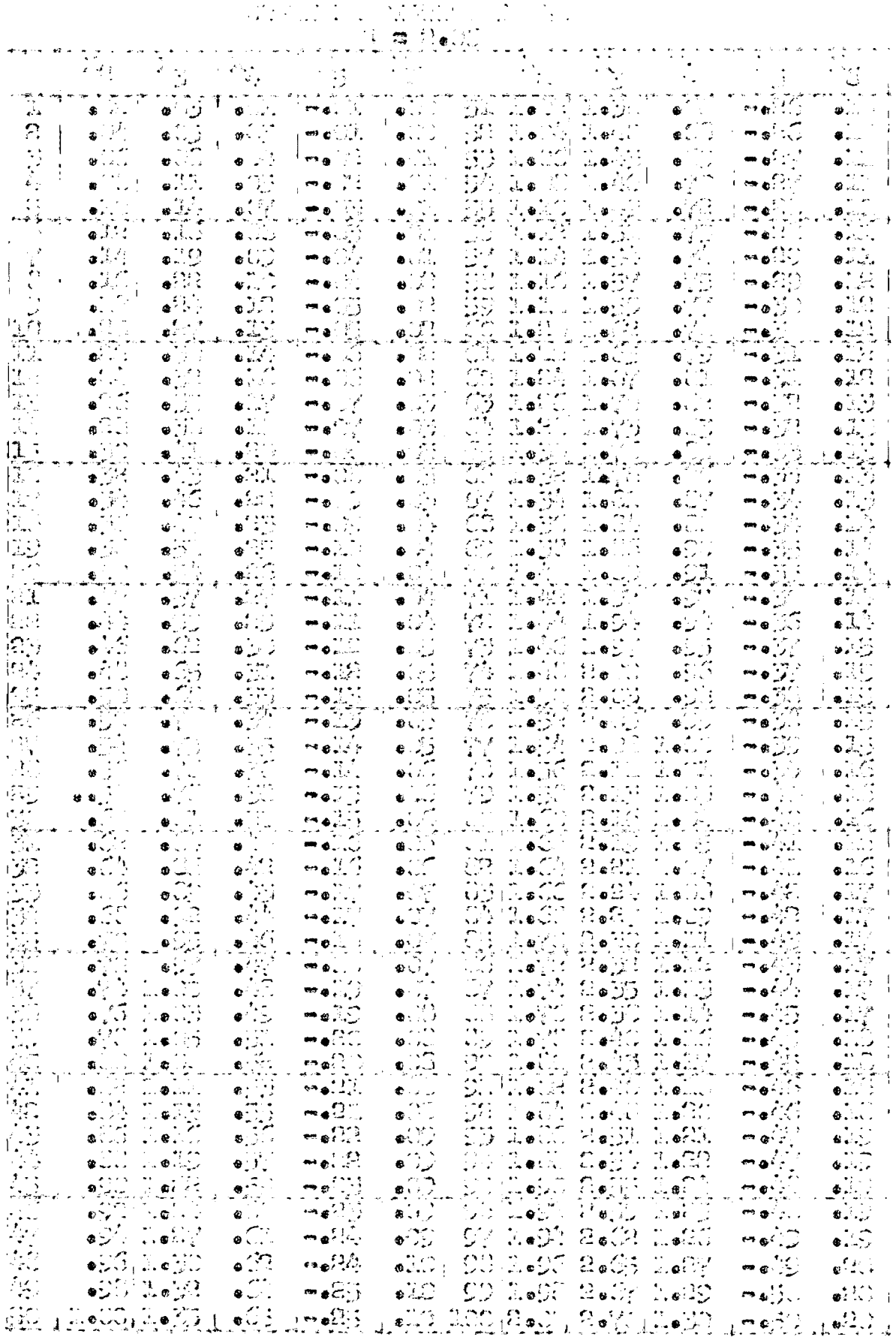
The six columns in the first set of tables are: (1) the score received, (2) predictive weight of completion score, (3) predictive weight of arithmetic score, (4) predictive weight of the artificial language score, (5) predictive value of the analogies score, and (6) predictive value of the opposites score. The student card given on page 41 can be used as an example. If the Introduction to Humanities grade is to be predicted, the predictive value of each subtest is found from the table for this subject, given on page 196. Thus, a completion score of 42 has a weight of .55, the arithmetic score of 26 has a weight of .00, and so on, each weight being found by locating the score in the first column and then reading the weight under the proper heading. The weights for the other subtests for the predictive grade in this subject are found to be: artificial language, .74; analogies, -.27; and opposites, .50. The five weights are added to the constant, C, which has a value of 2.52, and the predicted score is found to be 4.0.

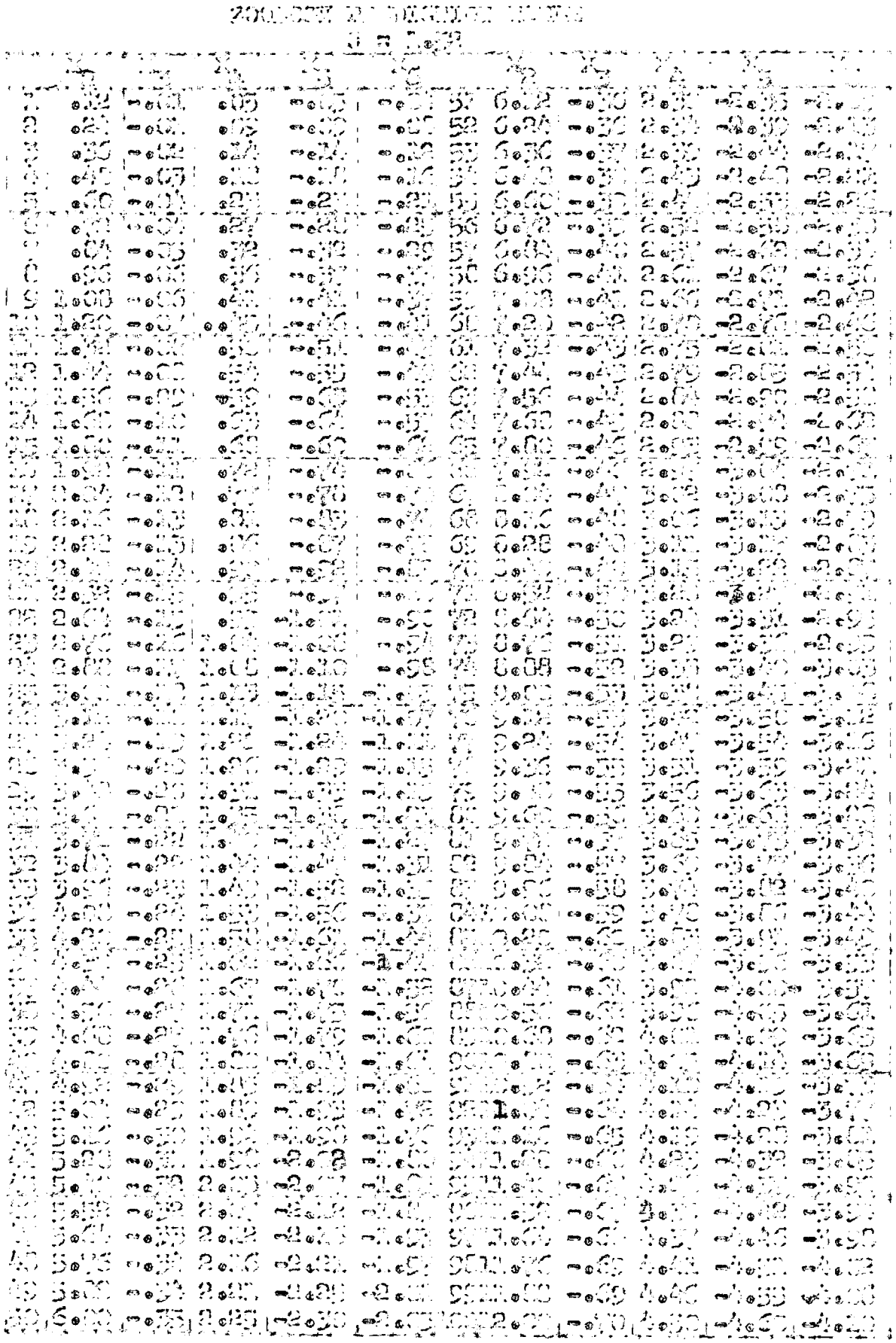
This predicted score can now be used as an estimate of the pupil's chance of success in the subject. Reference is made to the "Chances of Success" table for Introduction to Humnaities, given on page 212, from which it is seen that a predicted grade of 4.00 is a prognosis of a 50% chance of attaining a C grade in the subject. By referring to the student's card again it is seen that the grade received is exactly the same as the one predicted.

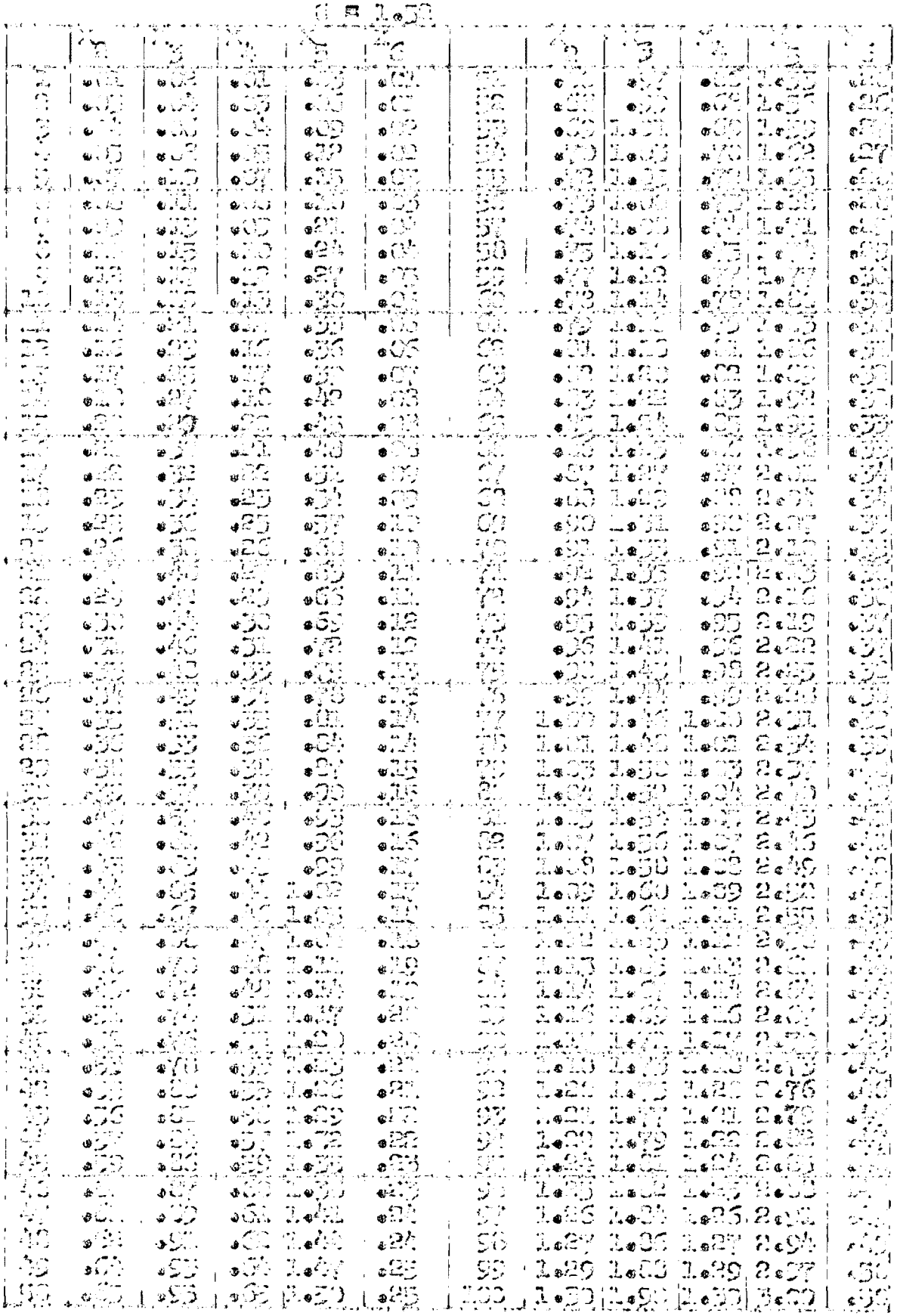
INTRODUCTION TO BIOLOGICAL SCIENCE PREDICTION TABLE

C = 1.63

	X_2	X_3	X_4	X_5	X_6		X_2	X_3	X_4	X_5	X_6
1	.05	-.01	.02	.01	-.01	51	2.35	-.26	1.02	.56	-.31
2	.09	-.01	.04	.02	-.01	52	2.39	-.26	1.04	.57	-.31
3	.14	-.02	.06	.03	-.02	53	2.44	-.27	1.06	.58	-.32
4	.18	-.02	.08	.04	-.02	54	2.48	-.27	1.08	.59	-.32
5	.23	-.03	.10	.06	-.03	55	2.53	-.28	1.10	.61	-.33
6	.28	-.03	.12	.07	-.04	56	2.58	-.28	1.12	.62	-.34
7	.32	-.04	.14	.08	-.04	57	2.62	-.29	1.14	.63	-.34
8	.37	-.04	.16	.09	-.05	58	2.67	-.29	1.16	.64	-.35
9	.41	-.05	.18	.10	-.05	59	2.71	-.30	1.18	.65	-.35
10	.46	-.05	.20	.11	-.06	60	2.76	-.30	1.20	.66	-.36
11	.51	-.06	.22	.12	-.07	61	2.81	-.31	1.22	.67	-.37
12	.55	-.06	.24	.13	-.07	62	2.85	-.31	1.24	.68	-.37
13	.60	-.07	.26	.14	-.08	63	2.90	-.32	1.26	.69	-.38
14	.64	-.07	.28	.15	-.08	64	2.94	-.32	1.28	.70	-.38
15	.69	-.08	.30	.17	-.09	65	2.99	-.33	1.30	.72	-.39
16	.74	-.08	.32	.18	-.10	66	3.04	-.33	1.32	.73	-.40
17	.78	-.09	.34	.19	-.10	67	3.08	-.34	1.34	.74	-.40
18	.83	-.09	.36	.20	-.11	68	3.13	-.34	1.36	.75	-.41
19	.87	-.10	.38	.21	-.11	69	3.17	-.35	1.38	.76	-.41
20	.92	-.10	.40	.22	-.12	70	3.22	-.35	1.40	.77	-.42
21	.97	-.11	.42	.23	-.13	71	3.27	-.36	1.42	.78	-.43
22	1.01	-.11	.44	.24	-.13	72	3.31	-.36	1.44	.79	-.43
23	1.06	-.12	.46	.25	-.14	73	3.36	-.37	1.46	.80	-.44
24	1.10	-.12	.48	.26	-.14	74	3.40	-.37	1.48	.81	-.44
25	1.15	-.13	.50	.28	-.15	75	3.45	-.38	1.50	.83	-.45
26	1.20	-.13	.52	.29	-.16	76	3.50	-.38	1.52	.84	-.46
27	1.24	-.14	.54	.30	-.16	77	3.54	-.39	1.54	.85	-.46
28	1.29	-.14	.56	.31	-.17	78	3.59	-.39	1.56	.86	-.47
29	1.33	-.15	.58	.32	-.17	79	3.63	-.40	1.58	.87	-.47
30	1.38	-.15	.60	.33	-.18	80	3.68	-.40	1.60	.88	-.48
31	1.43	-.16	.62	.34	-.19	81	3.73	-.41	1.62	.89	-.49
32	1.47	-.16	.64	.35	-.19	82	3.77	-.41	1.64	.90	-.49
33	1.52	-.17	.66	.36	-.20	83	3.82	-.42	1.66	.91	-.50
34	1.56	-.17	.68	.37	-.20	84	3.86	-.42	1.68	.92	-.50
35	1.61	-.18	.70	.39	-.21	85	3.91	-.43	1.70	.94	-.51
36	1.66	-.18	.72	.40	-.22	86	3.96	-.43	1.72	.95	-.52
37	1.70	-.19	.74	.41	-.22	87	4.00	-.44	1.74	.96	-.52
38	1.75	-.19	.76	.42	-.23	88	4.05	-.44	1.76	.97	-.53
39	1.79	-.20	.78	.43	-.23	89	4.09	-.45	1.78	.98	-.53
40	1.84	-.20	.80	.44	-.24	90	4.14	-.45	1.80	.99	-.54
41	1.89	-.21	.82	.45	-.25	91	4.19	-.46	1.82	1.00	-.55
42	1.93	-.21	.84	.46	-.25	92	4.23	-.46	1.84	1.01	-.55
43	1.98	-.22	.86	.47	-.26	93	4.28	-.47	1.86	1.02	-.56
44	2.02	-.22	.88	.48	-.26	94	4.32	-.47	1.88	1.03	-.56
45	2.07	-.23	.90	.50	-.27	95	4.37	-.48	1.90	1.05	-.57
46	2.12	-.23	.92	.51	-.28	96	4.42	-.48	1.92	1.06	-.58
47	2.16	-.24	.94	.52	-.28	97	4.46	-.49	1.94	1.07	-.58
48	2.21	-.24	.96	.53	-.29	98	4.51	-.49	1.96	1.08	-.59
49	2.25	-.25	.98	.54	-.29	99	4.55	-.50	1.98	1.09	-.59
50	2.30	-.25	1.00	.55	-.30	100	4.60	-.50	2.00	1.10	-.60







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INTRODUCTION TO SOCIAL SCIENCE PREDICTION TABLE

C = 2.23

	X_2	X_3	X_4	X_5	X_6		X_2	X_3	X_4	X_5	X_6
1	.02	.02	.02	-.01	.00	51	.97	.82	1.12	-.31	.10
2	.04	.03	.04	-.01	.00	52	.99	.83	1.14	-.31	.10
3	.06	.05	.07	-.02	.01	53	1.01	.85	1.17	-.32	.11
4	.08	.06	.09	-.02	.01	54	1.03	.86	1.19	-.32	.11
5	.10	.08	.11	-.03	.01	55	1.05	.88	1.21	-.33	.11
6	.11	.10	.13	-.04	.01	56	1.06	.90	1.23	-.34	.11
7	.13	.11	.15	-.04	.01	57	1.08	.91	1.25	-.34	.11
8	.15	.13	.18	-.05	.02	58	1.10	.93	1.28	-.35	.12
9	.17	.14	.20	-.05	.02	59	1.12	.94	1.30	-.35	.12
10	.19	.16	.22	-.06	.02	60	1.14	.96	1.32	-.36	.12
11	.21	.18	.24	-.07	.02	61	1.16	.98	1.34	-.37	.12
12	.23	.19	.26	-.07	.02	62	1.18	.99	1.36	-.37	.12
13	.25	.21	.29	-.08	.03	63	1.20	1.01	1.39	-.38	.13
14	.27	.22	.31	-.08	.03	64	1.22	1.02	1.41	-.38	.13
15	.29	.24	.33	-.09	.03	65	1.24	1.04	1.43	-.39	.13
16	.30	.26	.35	-.10	.03	66	1.25	1.06	1.45	-.40	.13
17	.32	.27	.37	-.10	.03	67	1.27	1.07	1.47	-.40	.13
18	.34	.29	.40	-.11	.04	68	1.29	1.09	1.50	-.41	.14
19	.36	.30	.42	-.11	.04	69	1.31	1.10	1.52	-.41	.14
20	.38	.32	.44	-.12	.04	70	1.33	1.12	1.54	-.42	.14
21	.40	.34	.46	-.13	.04	71	1.35	1.14	1.56	-.43	.14
22	.42	.35	.48	-.13	.04	72	1.37	1.15	1.58	-.43	.14
23	.44	.37	.51	-.14	.05	73	1.39	1.17	1.61	-.44	.15
24	.46	.38	.53	-.14	.05	74	1.41	1.18	1.63	-.44	.15
25	.48	.40	.55	-.15	.05	75	1.43	1.20	1.65	-.45	.15
26	.49	.42	.57	-.16	.05	76	1.44	1.22	1.67	-.46	.15
27	.51	.43	.59	-.16	.05	77	1.46	1.23	1.69	-.46	.15
28	.53	.45	.62	-.17	.06	78	1.48	1.25	1.72	-.47	.16
29	.55	.46	.64	-.17	.06	79	1.50	1.26	1.74	-.47	.16
30	.57	.48	.66	-.18	.06	80	1.52	1.28	1.76	-.48	.16
31	.59	.50	.68	-.19	.06	81	1.54	1.30	1.78	-.49	.16
32	.61	.51	.70	-.19	.06	82	1.56	1.31	1.80	-.49	.16
33	.63	.53	.73	-.20	.07	83	1.58	1.33	1.83	-.50	.17
34	.65	.54	.75	-.20	.07	84	1.60	1.34	1.85	-.50	.17
35	.67	.56	.77	-.21	.07	85	1.62	1.36	1.87	-.51	.17
36	.68	.58	.79	-.22	.07	86	1.63	1.38	1.89	-.52	.17
37	.70	.59	.81	-.22	.07	87	1.65	1.39	1.91	-.52	.17
38	.72	.61	.84	-.23	.08	88	1.67	1.41	1.94	-.53	.18
39	.74	.62	.86	-.23	.08	89	1.69	1.42	1.96	-.53	.18
40	.76	.64	.88	-.24	.08	90	1.71	1.44	1.98	-.54	.18
41	.78	.66	.90	-.25	.08	91	1.73	1.46	2.00	-.55	.18
42	.80	.67	.92	-.25	.08	92	1.75	1.47	2.02	-.55	.18
43	.82	.69	.95	-.26	.09	93	1.77	1.49	2.05	-.56	.19
44	.84	.70	.97	-.26	.09	94	1.79	1.50	2.07	-.56	.19
45	.86	.72	.99	-.27	.09	95	1.81	1.52	2.09	-.57	.19
46	.87	.74	1.01	-.28	.09	96	1.82	1.54	2.11	-.58	.19
47	.89	.75	1.03	-.28	.09	97	1.84	1.55	2.13	-.58	.19
48	.91	.77	1.06	-.29	.10	98	1.86	1.57	2.16	-.59	.20
49	.93	.78	1.08	-.29	.10	99	1.88	1.58	2.18	-.59	.20
50	.95	.80	1.10	-.30	.10	100	1.90	1.60	2.20	-.60	.20

INTRODUCTION TO PHYSICAL SCIENCE PREDICTION TABLE

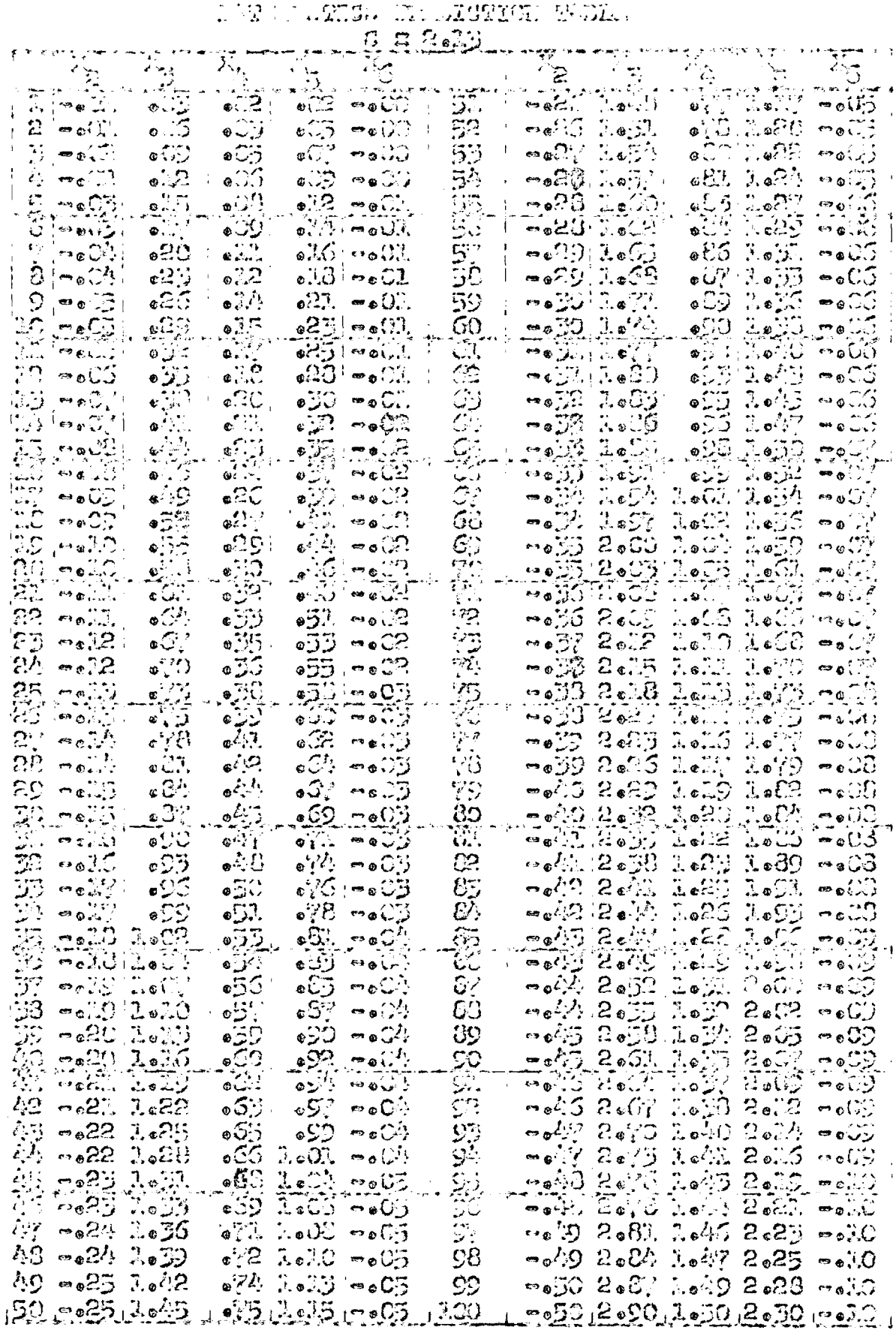
C = 1.60

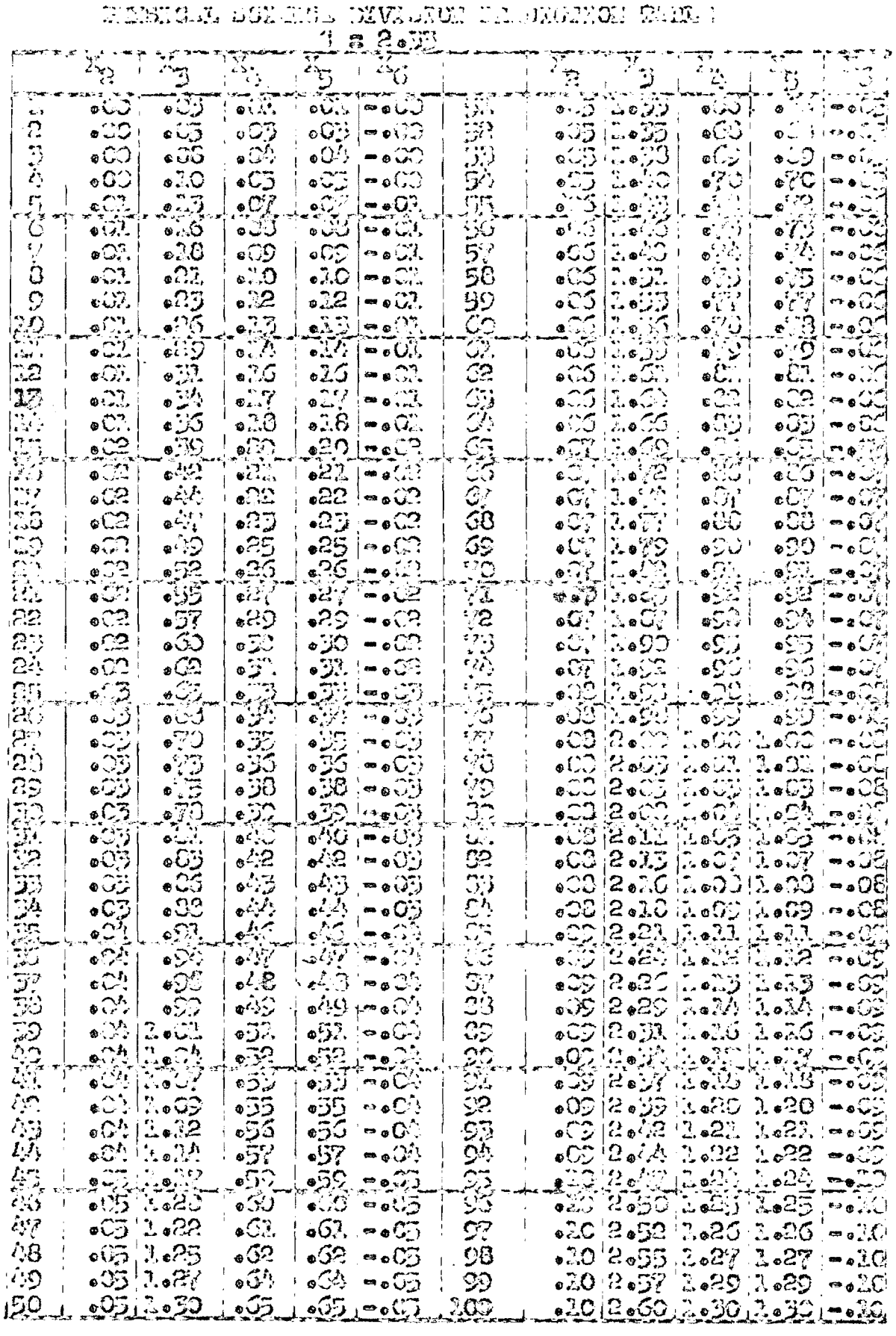
	X_2	X_3	X_4	X_5	X_6		X_2	X_3	X_4	X_5	X_6
1	.02	.04	.01	.02	-.00	51	.82	2.14	.26	.82	-.20
2	.03	.08	.01	.03	-.01	52	.83	2.18	.26	.83	-.21
3	.05	.13	.02	.05	-.01	53	.85	2.23	.27	.85	-.21
4	.06	.17	.02	.06	-.02	54	.86	2.27	.27	.86	-.22
5	.08	.21	.03	.08	-.02	55	.88	2.31	.28	.88	-.22
6	.10	.25	.03	.10	-.02	56	.90	2.35	.28	.90	-.22
7	.11	.29	.04	.11	-.03	57	.91	2.39	.29	.91	-.23
8	.13	.34	.04	.13	-.03	58	.93	2.44	.29	.93	-.23
9	.14	.38	.05	.14	-.04	59	.94	2.48	.30	.94	-.24
10	.16	.42	.05	.16	-.04	60	.96	2.52	.30	.96	-.24
11	.18	.46	.06	.18	-.04	61	.98	2.56	.31	.98	-.24
12	.19	.50	.06	.19	-.05	62	.99	2.60	.31	.99	-.25
13	.21	.55	.07	.21	-.05	63	1.01	2.65	.32	1.01	-.25
14	.22	.59	.07	.22	-.06	64	1.02	2.69	.32	1.02	-.26
15	.24	.63	.08	.24	-.06	65	1.04	2.73	.33	1.04	-.26
16	.26	.67	.08	.26	-.06	66	1.06	2.77	.33	1.06	-.26
17	.27	.71	.09	.27	-.07	67	1.07	2.81	.34	1.07	-.27
18	.29	.76	.09	.29	-.07	68	1.09	2.86	.34	1.09	-.27
19	.30	.80	.10	.30	-.08	69	1.10	2.90	.35	1.10	-.28
20	.32	.84	.10	.32	-.08	70	1.12	2.94	.35	1.12	-.28
21	.34	.88	.11	.34	-.08	71	1.14	2.98	.36	1.14	-.28
22	.35	.92	.11	.35	-.09	72	1.15	3.02	.36	1.15	-.29
23	.37	.97	.12	.37	-.09	73	1.17	3.07	.37	1.17	-.29
24	.38	1.01	.12	.38	-.10	74	1.18	3.11	.37	1.18	-.30
25	.40	1.05	.13	.40	-.10	75	1.20	3.15	.38	1.20	-.30
26	.42	1.09	.13	.42	-.10	76	1.22	3.19	.38	1.22	-.30
27	.43	1.13	.14	.43	-.11	77	1.23	3.23	.39	1.23	-.31
28	.45	1.18	.14	.45	-.11	78	1.25	3.28	.39	1.25	-.31
29	.46	1.22	.15	.46	-.12	79	1.26	3.32	.40	1.26	-.32
30	.48	1.26	.15	.48	-.12	80	1.28	3.36	.40	1.28	-.32
31	.50	1.30	.16	.50	-.12	81	1.30	3.40	.41	1.30	-.32
32	.51	1.34	.16	.51	-.13	82	1.31	3.44	.41	1.31	-.33
33	.53	1.39	.17	.53	-.13	83	1.33	3.49	.42	1.33	-.33
34	.54	1.43	.17	.54	-.14	84	1.34	3.53	.42	1.34	-.34
35	.56	1.47	.18	.56	-.14	85	1.36	3.57	.43	1.36	-.34
36	.58	1.51	.18	.58	-.14	86	1.38	3.61	.43	1.38	-.34
37	.59	1.55	.19	.59	-.15	87	1.39	3.65	.44	1.39	-.35
38	.61	1.60	.19	.61	-.15	88	1.41	3.70	.44	1.41	-.35
39	.62	1.64	.20	.62	-.16	89	1.42	3.74	.45	1.42	-.36
40	.64	1.68	.20	.64	-.16	90	1.44	3.78	.45	1.44	-.36
41	.66	1.72	.21	.66	-.16	91	1.46	3.82	.46	1.46	-.36
42	.67	1.76	.21	.67	-.17	92	1.47	3.86	.46	1.47	-.37
43	.69	1.81	.22	.69	-.17	93	1.49	3.91	.47	1.49	-.37
44	.70	1.85	.22	.70	-.18	94	1.50	3.95	.48	1.50	-.38
45	.72	1.89	.23	.72	-.18	95	1.52	3.99	.48	1.52	-.38
46	.74	1.93	.23	.74	-.18	96	1.54	4.03	.48	1.54	-.38
47	.75	1.97	.24	.75	-.19	97	1.55	4.07	.49	1.55	-.39
48	.77	2.02	.24	.77	-.19	98	1.57	4.12	.49	1.57	-.39
49	.78	2.06	.25	.78	-.20	99	1.58	4.16	.50	1.58	-.40
50	.80	2.10	.25	.80	-.20	100	1.60	4.20	.50	1.60	-.40

CHEMISTRY PREDICTION MODEL

C = 2.25

	X_2	X_3	X_4	X_5	X_6		X_2	X_3	X_4	X_5	X_6
1	.04	.01	.02	-.02	-.00	51	1.79	.31	1.17	- .87	-.10
2	.07	.01	.05	-.03	-.00	52	1.82	.31	1.20	-. .88	-.10
3	.11	.02	.07	-.05	-.01	53	1.86	.32	1.22	- .90	-.11
4	.14	.02	.09	-.07	-.01	54	1.89	.32	1.24	- .92	-.11
5	.17	.03	.12	-.09	-.01	55	1.92	.33	1.27	- .94	-.11
6	.21	.04	.14	-.10	-.01	56	1.96	.34	1.29	- .95	-.11
7	.25	.04	.16	-.12	-.01	57	2.00	.34	1.31	- .97	-.11
8	.28	.05	.18	-.14	-.02	58	2.03	.35	1.33	- .99	-.12
9	.32	.05	.21	-.15	-.02	59	2.07	.35	1.36	-1.00	-.12
10	.35	.06	.23	-.17	-.02	60	2.10	.36	1.38	-1.02	-.12
11	.39	.07	.25	-.19	-.02	61	2.14	.37	1.40	-1.04	-.12
12	.42	.07	.28	-.20	-.02	62	2.17	.37	1.43	-1.05	-.12
13	.46	.08	.30	-.22	-.03	63	2.21	.38	1.45	-1.07	-.13
14	.49	.08	.32	-.24	-.03	64	2.24	.38	1.47	-1.09	-.13
15	.52	.09	.35	-.26	-.03	65	2.27	.39	1.50	-1.11	-.13
16	.56	.10	.37	-.27	-.03	66	2.31	.40	1.52	-1.12	-.13
17	.60	.10	.39	-.29	-.03	67	2.35	.40	1.54	-1.14	-.13
18	.63	.11	.41	-.31	-.04	68	2.38	.41	1.56	-1.16	-.14
19	.67	.11	.44	-.32	-.04	69	2.42	.41	1.59	-1.17	-.14
20	.70	.12	.46	-.34	-.04	70	2.45	.42	1.61	-1.19	-.14
21	.74	.13	.48	-.36	-.04	71	2.49	.43	1.63	-1.21	-.14
22	.77	.13	.51	-.37	-.04	72	2.52	.43	1.66	-1.22	-.14
23	.81	.14	.53	-.39	-.05	73	2.56	.44	1.68	-1.24	-.15
24	.84	.14	.55	-.41	-.05	74	2.59	.44	1.70	-1.26	-.15
25	.87	.15	.58	-.43	-.05	75	2.62	.45	1.73	-1.28	-.15
26	.91	.16	.60	-.44	-.05	76	2.66	.46	1.75	-1.29	-.15
27	.95	.16	.62	-.46	-.05	77	2.70	.46	1.77	-1.31	-.15
28	.98	.17	.64	-.48	-.06	78	2.73	.47	1.79	-1.33	-.16
29	1.02	.17	.67	-.49	-.06	79	2.77	.47	1.82	-1.34	-.16
30	1.05	.18	.69	-.51	-.06	80	2.80	.48	1.84	-1.36	-.16
31	1.09	.19	.71	-.53	-.06	81	2.84	.49	1.86	-1.38	-.16
32	1.12	.19	.74	-.54	-.06	82	2.87	.49	1.89	-1.39	-.16
33	1.16	.20	.76	-.56	-.07	83	2.91	.50	1.91	-1.41	-.17
34	1.19	.20	.78	-.58	-.07	84	2.94	.50	1.03	-1.43	-.17
35	1.22	.21	.81	-.60	-.07	85	2.97	.51	1.96	-1.45	-.17
36	1.26	.22	.83	-.61	-.07	86	3.01	.52	1.98	-1.46	-.17
37	1.30	.22	.85	-.63	-.07	87	3.05	.52	2.00	-1.48	-.17
38	1.33	.23	.87	-.65	-.08	88	3.08	.53	2.02	-1.50	-.18
39	1.37	.23	.90	-.66	-.08	89	3.12	.53	2.05	-1.51	-.18
40	1.40	.24	.92	-.68	-.08	90	3.15	.54	2.07	-1.53	-.18
41	1.44	.25	.94	-.70	-.08	91	3.19	.55	2.09	-1.55	-.18
42	1.47	.25	.97	-.71	-.08	92	3.22	.55	2.12	-1.56	-.18
43	1.51	.26	.99	-.73	-.09	93	3.26	.56	2.14	-1.58	-.19
44	1.54	.26	1.01	-.75	-.09	94	3.29	.56	2.16	-1.60	-.19
45	1.57	.27	1.04	-.77	-.09	95	3.32	.57	2.19	-1.62	-.19
46	1.61	.28	1.06	-.78	-.09	96	3.36	.58	2.21	-1.63	-.19
47	1.65	.28	1.08	-.80	-.09	97	3.40	.58	2.23	-1.70	-.19
48	1.68	.29	1.10	-.82	-.10	98	3.43	.59	2.25	-1.72	-.20
49	1.72	.29	1.13	-.83	-.10	99	3.47	.59	2.28	-1.73	-.20
50	1.75	.30	1.15	-.85	-.10	100	3.50	.60	2.30	-1.75	-.20





AVIATION CREDIT REDUCTION TABLE

§ 8.242.

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN INTRODUCTION TO BIOLOGICAL SCIENCE.

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL
6.44	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.14	3.5	.9	99.1	3.88	- .2	55.4	44.6
5.83	3.0	2.2	97.8	3.82	- .3	58.0	42.0
5.53	2.5	4.6	95.4	3.76	- .4	60.6	39.4
5.22	2.0	8.9	91.1	3.69	- .5	63.2	36.8
5.16	1.9	10.0	90.0	3.63	- .6	65.7	34.3
5.10	1.8	11.2	88.8	3.57	- .7	68.2	31.8
5.04	1.7	12.6	87.4	3.51	- .8	70.5	29.5
4.98	1.6	14.0	86.0	3.45	- .9	72.8	27.2
4.92	1.5	15.6	84.4	3.39	-1.0	75.0	25.0
4.85	1.4	17.3	82.7	3.33	-1.1	77.1	22.9
4.79	1.3	19.0	81.0	3.27	-1.2	79.1	20.9
4.73	1.2	20.9	79.1	3.21	-1.3	81.0	19.0
4.67	1.1	22.9	77.1	3.15	-1.4	82.7	17.3
4.61	1.0	25.0	75.0	3.08	-1.5	84.4	15.6
4.55	.9	27.2	72.8	3.02	-1.6	86.0	14.0
4.49	.8	29.5	70.5	2.96	-1.7	87.4	12.6
4.43	.7	31.8	68.2	2.90	-1.8	88.8	11.2
4.37	.6	34.3	65.7	2.84	-1.9	90.0	10.0
4.31	.5	36.8	63.2	2.78	-2.0	91.1	8.9
4.24	.4	39.4	60.6	2.47	-2.5	95.4	4.6
4.18	.3	42.0	58.0	2.17	-3.0	97.8	2.2
4.12	.2	44.6	55.4	1.86	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.56	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCE OF PASSING OR FAILING A C GRADE ON BASIS OF PREDICTED GRADE IN HOUSE.

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL
6.59	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.37	3.5	.9	99.1	3.87	- .2	55.4	44.6
5.93	3.0	2.2	97.8	3.81	- .3	58.0	42.0
5.62	2.5	4.6	95.4	3.74	- .4	60.6	39.4
5.30	2.0	8.9	91.1	3.68	- .5	63.2	36.8
5.23	1.9	10.0	90.0	3.61	- .6	65.7	34.3
5.17	1.8	11.2	88.8	3.55	- .7	68.2	31.8
5.10	1.7	12.6	87.4	3.48	- .8	70.5	29.5
5.04	1.6	14.0	86.0	3.42	- .9	72.8	27.2
4.97	1.5	15.6	84.4	3.35	-1.0	75.0	25.0
4.91	1.4	17.3	82.7	3.29	-1.1	77.1	22.9
4.84	1.3	19.0	81.0	3.22	-1.2	79.1	20.9
4.78	1.2	20.9	79.1	3.16	-1.3	81.0	19.0
4.71	1.1	22.9	77.1	3.09	-1.4	82.7	17.3
4.65	1.0	25.0	75.0	3.03	-1.5	84.4	15.6
4.58	.9	27.2	72.8	2.96	-1.6	86.0	14.0
4.52	.8	29.5	70.5	2.90	-1.7	87.4	12.6
4.45	.7	31.8	68.2	2.83	-1.8	88.8	11.2
4.39	.6	34.3	65.7	2.77	-1.9	90.0	10.0
4.32	.5	36.8	63.2	2.70	-2.0	91.1	8.9
4.26	.4	39.4	60.6	2.38	-2.5	95.4	4.6
4.19	.3	42.0	58.0	2.07	-3.0	97.8	2.2
4.13	.2	44.6	55.4	1.73	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.41	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN ZOOLOGY.

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL
6.66	4.0	0.4	99.6	3.93	-0.1	52.7	47.3
6.33	3.5	.9	99.1	3.87	- .2	55.4	44.6
6.00	3.0	2.2	97.8	3.80	- .3	58.0	42.0
5.66	2.5	4.6	95.4	3.73	- .4	60.6	39.4
5.33	2.0	8.9	91.1	3.67	- .5	63.2	36.8
5.26	1.9	10.0	90.0	3.60	- .6	65.7	34.3
5.20	1.8	11.2	88.8	3.53	- .7	68.2	31.8
5.13	1.7	12.6	87.4	3.47	- .8	70.5	29.5
5.06	1.6	14.0	86.0	3.40	- .9	72.8	27.2
5.00	1.5	15.6	84.4	3.33	-1.0	75.0	25.0
4.93	1.4	17.3	82.7	3.27	-1.1	77.1	22.9
4.86	1.3	19.0	81.0	3.20	-1.2	79.1	20.9
4.80	1.2	20.9	79.1	3.14	-1.3	81.0	19.0
4.73	1.1	22.9	77.1	3.07	-1.4	82.7	17.3
4.67	1.0	25.0	75.0	3.00	-1.5	84.4	15.6
4.60	.9	27.2	72.8	2.94	-1.6	86.0	14.0
4.53	.8	29.5	70.5	2.87	-1.7	87.4	12.6
4.47	.7	31.8	68.2	2.80	-1.8	88.8	11.2
4.40	.6	34.3	65.7	2.74	-1.9	90.0	10.0
4.33	.5	36.8	63.2	2.67	-2.0	91.1	8.9
4.27	.4	39.4	60.6	2.34	-2.5	95.4	4.6
4.20	.3	42.0	58.0	2.00	-3.0	97.8	2.2
4.13	.2	44.6	55.4	1.67	-3.5	99.1	.9
4.07	.1	47.3	52.7	1.34	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN PSYCHOLOGY

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-
5.68	4.0	0.4	99.6	3.96	-0.1	52.7	47.3
5.47	3.5	.9	99.1	3.92	- .2	55.4	44.6
5.26	3.0	2.2	97.8	3.87	- .3	58.0	42.0
5.05	2.5	4.6	95.4	3.83	- .4	60.6	39.4
4.84	2.0	8.9	91.1	3.79	- .5	63.2	36.8
4.80	1.9	10.0	90.0	3.75	- .6	65.7	34.3
4.76	1.8	11.2	88.8	3.71	- .7	68.2	31.8
4.71	1.7	12.6	87.4	3.66	- .8	70.5	29.5
4.67	1.6	14.0	86.0	3.62	- .9	72.8	27.2
4.63	1.5	15.6	84.4	3.58	-1.0	75.0	25.0
4.59	1.4	17.3	82.7	3.54	-1.1	77.1	22.9
4.55	1.3	19.0	81.0	3.50	-1.2	79.1	20.9
4.50	1.2	20.9	79.1	3.45	-1.3	81.0	19.0
4.46	1.1	22.9	77.1	3.41	-1.4	82.7	17.3
4.42	1.0	25.0	75.0	3.37	-1.5	84.4	15.6
4.38	.9	27.2	72.8	3.33	-1.6	86.0	14.0
4.34	.8	29.5	70.5	3.29	-1.7	87.4	12.6
4.29	.7	31.8	68.2	3.24	-1.8	88.8	11.2
4.25	.6	34.3	65.7	3.20	-1.9	90.0	10.0
4.21	.5	36.8	63.2	3.16	-2.0	91.1	8.9
4.17	.4	39.4	60.6	2.95	-2.5	95.4	4.6
4.13	.3	42.0	58.0	2.74	-3.0	97.8	2.2
4.08	.2	44.6	55.4	2.53	-3.5	99.1	.9
4.04	.1	47.3	52.7	2.32	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN BIOLOGICAL SCIENCE

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL	MARK	P.E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL
6.38	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.08	3.5	.9	99.1	3.88	- .2	55.4	44.6
5.78	3.0	2.2	97.8	3.82	- .3	58.0	42.0
5.49	2.5	4.6	95.4	3.76	- .4	60.6	39.4
5.19	2.0	8.9	91.1	3.70	- .5	63.2	36.8
5.13	1.9	10.0	90.0	3.64	- .6	65.7	34.3
5.07	1.8	11.2	88.8	3.58	- .7	68.2	31.8
5.01	1.7	12.6	87.4	3.52	- .8	70.5	29.5
4.95	1.6	14.0	86.0	3.47	- .9	72.8	27.2
4.89	1.5	15.6	84.4	3.41	-1.0	75.0	25.0
4.83	1.4	17.3	82.7	3.35	-1.1	77.1	22.9
4.77	1.3	19.0	81.0	3.29	-1.2	79.1	20.9
4.71	1.2	20.9	79.1	3.23	-1.3	81.0	19.0
4.65	1.1	22.9	77.1	3.17	-1.4	82.7	17.3
4.59	1.0	25.0	75.0	3.11	-1.5	84.4	15.6
4.53	.9	27.2	72.8	3.05	-1.6	86.0	14.0
4.48	.8	29.5	70.5	2.99	-1.7	87.4	12.6
4.42	.7	31.8	68.2	2.93	-1.8	88.8	11.2
4.36	.6	34.3	65.7	2.87	-1.9	90.0	10.0
4.30	.5	36.8	63.2	2.81	-2.0	91.1	8.9
4.24	.4	39.4	60.6	2.51	-2.5	95.4	4.6
4.18	.3	42.0	58.0	2.22	-3.0	97.8	2.2
4.12	.2	44.6	55.4	1.92	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.62	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN INTRODUCTION TO HUMANITIES

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL
5.94	4.0	0.4	99.6	3.95	-0.1	52.7	47.3
5.70	3.5	.9	99.1	3.90	- .2	55.4	44.6
5.46	3.0	2.2	97.8	3.85	- .3	58.0	42.0
5.21	2.5	4.6	95.4	3.81	-..4	60.6	39.4
4.96	2.0	8.9	91.1	3.76	- .5	63.2	36.8
4.92	1.9	10.0	90.0	3.71	- .6	65.7	34.3
4.87	1.8	11.2	88.8	3.66	- .7	68.2	31.8
4.82	1.7	12.6	87.4	3.61	- .8	70.5	29.5
4.78	1.6	14.0	86.0	3.56	- .9	72.8	27.2
4.73	1.5	15.6	84.4	3.51	-1.0	75.0	25.0
4.68	1.4	17.3	82.7	3.47	-1.1	77.1	22.9
4.63	1.3	19.0	81.0	3.42	-1.2	79.1	20.9
4.58	1.2	20.9	79.1	3.37	-1.3	81.0	19.0
4.53	1.1	22.9	77.1	3.32	-1.4	82.7	17.3
4.49	1.0	25.0	75.0	3.27	-1.5	84.4	15.6
4.44	.9	27.2	72.8	3.22	-1.6	86.0	14.0
4.39	.8	29.5	70.5	3.18	-1.7	87.4	12.6
4.34	.7	31.8	68.2	3.13	-1.8	88.8	11.2
4.29	.6	34.3	65.7	3.08	-1.9	90.0	10.0
4.24	.5	36.8	63.2	3.03	-2.0	91.1	8.9
4.19	.4	39.4	60.6	2.79	-2.5	95.4	4.6
4.15	.3	42.0	58.0	2.54	-3.0	97.8	2.2
4.10	.2	44.6	55.4	2.30	-3.5	99.1	.9
4.05	.1	47.3	52.7	2.06	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN FOREIGN LANGUAGE.

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL
6.56	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.24	3.5	.9	99.1	3.87	- .2	55.4	44.6
5.92	3.0	2.2	97.8	3.81	- .3	58.0	42.0
5.60	2.5	4.6	95.4	3.74	- .4	60.6	39.4
5.28	2.0	8.9	91.1	3.68	- .5	63.2	36.8
5.21	1.9	10.0	90.0	3.62	- .6	65.7	34.3
5.15	1.8	11.2	88.8	3.55	- .7	68.2	31.8
5.09	1.7	12.6	87.4	3.49	- .8	70.5	29.5
5.02	1.6	14.0	86.0	3.42	- .9	72.8	27.2
4.96	1.5	15.6	84.4	3.36	-1.0	75.0	25.0
4.89	1.4	17.3	82.7	3.30	-1.1	77.1	22.9
4.83	1.3	19.0	81.0	3.23	-1.2	79.1	20.9
4.77	1.2	20.9	79.1	3.17	-1.3	81.0	19.0
4.70	1.1	22.9	77.1	3.11	-1.4	82.7	17.3
4.64	1.0	25.0	75.0	3.04	-1.5	84.4	15.6
4.58	.9	27.2	72.8	2.98	-1.6	86.0	14.0
4.51	.8	29.5	70.5	2.91	-1.7	87.4	12.6
4.45	.7	31.8	68.2	2.85	-1.8	88.8	11.2
4.38	.6	34.3	65.7	2.79	-1.9	90.0	10.0
4.32	.5	36.8	63.2	2.72	-2.0	91.1	8.9
4.26	.4	39.4	60.6	2.40	-2.5	95.4	4.6
4.19	.3	42.0	58.0	2.18	-3.0	97.8	2.2
4.13	.2	44.6	55.4	1.79	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.44	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN HUMANITIES.

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL
6.24	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
5.96	3.5	.9	99.1	3.88	- .2	55.4	44.6
5.68	3.0	2.2	97.8	3.83	- .3	58.0	42.0
5.40	2.5	4.6	95.4	3.78	- .4	60.6	39.4
5.12	2.0	8.9	91.1	3.72	- .5	63.2	36.8
5.07	1.9	10.0	90.0	3.66	- .6	65.7	34.3
5.01	1.8	11.2	88.8	3.61	- .7	68.2	31.8
4.95	1.7	12.6	87.4	3.55	- .8	70.5	29.5
4.90	1.6	14.0	86.0	3.50	- .9	72.8	27.2
4.84	1.5	15.6	84.4	3.44	-1.0	75.0	25.0
4.79	1.4	17.3	82.7	3.38	-1.1	77.1	22.9
4.73	1.3	19.0	81.0	3.33	-1.2	79.1	20.9
4.67	1.2	20.9	79.1	3.27	-1.3	81.0	19.0
4.62	1.1	22.9	77.1	3.21	-1.4	82.7	17.3
4.56	1.0	25.0	75.0	3.16	-1.5	84.4	15.6
4.50	.9	27.2	72.8	3.10	-1.6	86.0	14.0
4.45	.8	29.5	70.5	3.05	-1.7	87.4	12.6
4.39	.7	31.8	68.2	2.99	-1.8	88.8	11.2
4.34	.6	34.3	65.7	2.93	-1.9	90.0	10.0
4.28	.5	36.8	63.2	2.88	-2.0	91.1	8.9
4.22	.4	39.4	60.6	2.60	-2.5	95.4	4.6
4.17	.3	42.0	58.0	2.32	-3.0	97.8	2.2
4.12	.2	44.6	55.4	2.04	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.76	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN INTRODUCTION TO SOCIAL SCIENCE.

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL
6.44	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.13	3.5	.9	99.1	3.88	- .2	55.4	44.6
5.83	3.0	2.2	97.8	3.82	- .3	58.0	42.0
5.52	2.5	4.6	95.4	3.76	- .4	60.6	39.4
5.22	2.0	8.9	91.1	3.70	- .5	63.2	36.8
5.16	1.9	10.0	90.0	3.63	- .6	65.7	34.3
5.09	1.8	11.2	88.8	3.57	- .7	68.2	31.8
5.03	1.7	12.6	87.4	3.51	- .8	70.5	29.5
4.97	1.6	14.0	86.0	3.45	- .9	72.8	27.2
4.91	1.5	15.6	84.4	3.39	-1.0	75.0	25.0
4.85	1.4	17.3	82.7	3.33	-1.1	77.1	22.9
4.79	1.3	19.0	81.0	3.27	-1.2	79.1	20.9
4.73	1.2	20.9	79.1	3.21	-1.3	81.0	19.0
4.67	1.1	22.9	77.1	3.15	-1.4	82.7	17.3
4.61	1.0	25.0	75.0	3.09	-1.5	84.4	15.6
4.55	.9	27.2	72.8	3.03	-1.6	86.0	14.0
4.49	.8	29.5	70.5	2.97	-1.7	87.4	12.6
4.43	.7	31.8	68.2	2.91	-1.8	88.8	11.2
4.37	.6	34.3	65.7	2.84	-1.9	90.0	10.0
4.30	.5	36.8	63.2	2.78	-2.0	91.1	8.9
4.24	.4	39.4	60.6	2.48	-2.5	95.4	4.6
4.18	.3	42.0	58.0	2.17	-3.0	97.8	2.2
4.12	.2	44.6	55.4	1.87	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.56	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN INTRODUCTION TO PHYSICAL SCIENCE

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESS-FUL
6.57	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.25	3.5	.9	99.1	3.87	- .2	55.4	44.6
5.93	3.0	2.2	97.8	3.81	- .3	58.0	42.0
5.61	2.5	4.6	95.4	3.74	- .4	60.6	39.4
5.28	2.0	8.9	91.1	3.68	- .5	63.2	36.8
5.22	1.9	10.0	90.0	3.61	- .6	65.7	34.3
5.16	1.8	11.2	88.8	3.55	- .7	68.2	31.8
5.09	1.7	12.6	87.4	3.49	- .8	70.5	29.5
5.03	1.6	14.0	86.0	3.42	- .9	72.8	27.2
4.96	1.5	15.6	84.4	3.36	-1.0	75.0	25.0
4.90	1.4	17.3	82.7	3.29	-1.1	77.1	22.9
4.83	1.3	19.0	81.0	3.23	-1.2	79.1	20.9
4.77	1.2	20.9	79.1	3.17	-1.3	81.0	19.0
4.71	1.1	22.9	77.1	3.10	-1.4	82.7	17.3
4.64	1.0	25.0	75.0	3.04	-1.5	84.4	15.6
4.58	.9	27.2	72.8	2.97	-1.6	86.0	14.0
4.51	.8	29.5	70.5	2.91	-1.7	87.4	12.6
4.45	.7	31.8	68.2	2.84	-1.8	88.8	11.2
4.39	.6	34.3	65.7	2.78	-1.9	90.0	10.0
4.32	.5	36.8	63.2	2.72	-2.0	91.1	8.9
4.26	.4	39.4	60.6	2.39	-2.5	95.4	4.6
4.19	.3	42.0	58.0	2.07	-3.0	97.8	2.2
4.13	.2	44.6	55.4	1.75	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.43	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN CHEMISTRY

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL
6.75	4.0	0.4	99.6	3.93	-0.1	52.7	47.3
6.41	3.5	.9	99.1	3.86	- .2	55.4	44.6
6.06	3.0	2.2	97.8	3.79	- .3	58.0	42.0
5.72	2.5	4.6	95.4	3.72	- .4	60.6	39.4
5.38	2.0	8.9	91.1	3.66	- .5	63.2	36.8
5.31	1.9	10.0	90.0	3.59	- .6	65.7	34.3
5.24	1.8	11.2	88.8	3.52	- .7	68.2	31.8
5.17	1.7	12.6	87.4	3.45	- .8	70.5	29.5
5.10	1.6	14.0	86.0	3.38	- .9	72.8	27.2
5.03	1.5	15.6	84.4	3.31	-1.0	75.0	25.0
4.96	1.4	17.3	82.7	3.24	-1.1	77.1	22.9
4.89	1.3	19.0	81.0	3.17	-1.2	79.1	20.9
4.83	1.2	20.9	79.1	3.11	-1.3	81.0	19.0
4.76	1.1	22.9	77.1	3.04	-1.4	82.7	17.3
4.69	1.0	25.0	75.0	2.97	-1.5	84.4	15.6
4.62	.9	27.2	72.8	2.90	-1.6	86.0	14.0
4.55	.8	29.5	70.5	2.83	-1.7	87.4	12.6
4.48	.7	31.8	68.2	2.76	-1.8	88.8	11.2
4.41	.6	34.3	65.7	2.69	-1.9	90.0	10.0
4.34	.5	36.8	63.2	2.62	-2.0	91.1	8.9
4.28	.4	39.4	60.6	2.28	-2.5	95.4	4.6
4.21	.3	42.0	58.0	1.96	-3.0	97.8	2.2
4.14	.2	44.6	55.4	1.59	-3.5	99.1	.9
4.07	.1	47.3	52.7	1.25	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PREDICTED GRADE IN MATHEMATICS

MARK	P. L. RATING	PERCENT FAILING	PERCENT SUCCESSFUL	MARK	P. L. RATING	PERCENT FAILING	PERCENT SUCCESSFUL
6.18	4.0	0.4	99.6	3.95	-0.1	52.7	47.3
5.91	3.5	.9	99.1	3.89	- .2	55.4	44.6
5.64	3.0	2.2	97.8	3.84	- .3	58.0	42.0
5.37	2.5	4.6	95.4	3.78	- .4	60.6	39.4
5.09	2.0	8.9	91.1	3.73	- .5	63.2	36.8
5.04	1.9	10.0	90.0	3.67	- .6	65.7	34.3
4.98	1.8	11.2	88.8	3.62	- .7	68.2	31.8
4.93	1.7	12.6	87.4	3.56	- .8	70.5	29.5
4.87	1.6	14.0	86.0	3.51	- .9	72.8	27.2
4.82	1.5	15.6	84.4	3.45	-1.0	75.0	25.0
4.76	1.4	17.3	82.7	3.40	-1.1	77.1	22.9
4.71	1.3	19.0	81.0	3.34	-1.2	79.1	20.9
4.66	1.2	20.9	79.1	3.29	-1.3	81.0	19.0
4.60	1.1	22.9	77.1	3.24	-1.4	82.7	17.3
4.55	1.0	25.0	75.0	3.18	-1.5	84.4	15.6
4.49	.9	27.2	72.8	3.13	-1.6	86.0	14.0
4.44	.8	29.5	70.5	3.07	-1.7	87.4	12.6
4.38	.7	31.8	68.2	3.02	-1.8	88.8	11.2
4.33	.6	34.3	65.7	2.96	-1.9	90.0	10.0
4.27	.5	36.8	63.2	2.91	-2.0	91.1	8.9
4.22	.4	39.4	60.6	2.63	-2.5	95.4	4.6
4.16	.3	42.0	58.0	2.36	-3.0	97.8	2.2
4.11	.2	44.6	55.4	2.09	-3.5	99.1	.9
4.05	.1	47.3	52.7	1.82	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF ATTAINING OR EXCEEDING A C GRADE ON BASIS OF PRACTICAL GRADE IN PHYSICAL SCIENCE

MARK	P. E. RATING	PERCENT PASSING MARKING	PERCENT FAILING	MARK	P. E. RATING	PERCENT PASSING MARKING	PERCENT FAILING
6.53	4.0	0.4	99.6	3.94	-0.1	52.7	47.3
6.21	3.5	.9	99.1	3.87	- .2	55.4	44.6
5.90	3.0	2.2	97.8	3.81	- .3	58.0	42.0
5.58	2.5	4.6	95.4	3.75	- .4	60.6	39.4
5.26	2.0	8.9	91.1	3.68	- .5	63.2	36.8
5.20	1.9	10.0	90.0	3.62	- .6	65.7	34.3
5.14	1.8	11.2	88.8	3.56	- .7	68.2	31.8
5.07	1.7	12.6	87.4	3.49	- .8	70.5	29.5
5.01	1.6	14.0	86.0	3.43	- .9	72.8	27.2
4.95	1.5	15.6	84.4	3.37	-1.0	75.0	25.0
4.88	1.4	17.3	82.7	3.30	-1.1	77.1	22.9
4.82	1.3	19.0	81.0	3.26	-1.2	79.1	20.9
4.76	1.2	20.9	79.1	3.18	-1.3	81.0	19.0
4.70	1.1	22.9	77.1	3.12	-1.4	82.7	17.3
4.63	1.0	25.0	75.0	3.05	-1.5	84.4	15.6
4.57	.9	27.2	72.8	2.99	-1.6	86.0	14.0
4.51	.8	29.5	70.5	2.93	-1.7	87.4	12.6
4.44	.7	31.8	68.2	2.86	-1.8	88.8	11.2
4.38	.6	34.3	65.7	2.80	-1.9	90.0	10.0
4.32	.5	36.8	63.2	2.74	-2.0	91.1	8.9
4.25	.4	39.4	60.6	2.42	-2.5	95.4	4.6
4.19	.3	42.0	58.0	2.10	-3.0	97.8	2.2
4.13	.2	44.6	55.4	1.79	-3.5	99.1	.9
4.06	.1	47.3	52.7	1.47	-4.0	99.6	.4
4.00	.0	50.0	50.0				

CHANCES OF OBTAINING OR EXCEEDING A G GRADE ON BASIS OF PREDICTED AVERAGE GRADE

MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL	MARK	P. E. RATING	PERCENT FAILING	PERCENT SUCCESSFUL
5.99	4.0	0.4	99.6	3.95	-0.1	52.7	47.3
5.74	3.5	.9	99.1	3.90	- .2	55.4	44.6
5.49	3.0	2.2	97.8	3.85	- .3	58.0	42.0
5.24	2.5	4.6	95.4	3.80	- .4	60.6	39.4
4.99	2.0	8.9	91.1	3.75	- .5	63.2	36.8
4.94	1.9	10.0	90.0	3.70	- .6	65.7	34.3
4.89	1.8	11.2	88.8	3.65	- .7	68.2	31.8
4.84	1.7	12.6	87.4	3.60	- .8	70.5	29.5
4.80	1.6	14.0	86.0	3.55	- .9	72.8	27.2
4.75	1.5	15.6	84.4	3.50	-1.0	75.0	25.0
4.70	1.4	17.3	82.7	3.45	-1.1	77.1	22.9
4.65	1.3	19.0	81.0	3.40	-1.2	79.1	20.9
4.60	1.2	20.9	79.1	3.35	-1.3	81.0	19.0
4.55	1.1	22.9	77.1	3.30	-1.4	82.7	17.3
4.50	1.0	25.0	75.0	3.25	-1.5	84.4	15.6
4.45	.9	27.2	72.8	3.20	-1.6	86.0	14.0
4.40	.8	29.5	70.5	3.16	-1.7	87.4	12.6
4.35	.7	31.8	68.2	3.11	-1.8	88.8	11.2
4.30	.6	34.3	65.7	3.06	-1.9	90.0	10.0
4.25	.5	36.8	63.2	3.01	-2.0	91.1	8.9
4.20	.4	39.4	60.6	2.76	-2.5	95.4	4.6
4.15	.3	42.0	58.0	2.51	-3.0	97.8	2.2
4.10	.2	44.6	55.4	2.26	-3.5	99.1	.9
4.05	.1	47.3	52.7	2.01	-4.0	99.6	.4
4.00	.0	50.0	50.0				

PREDICTION BASED ON 1939 PSYCHOLOGICAL EXAMINATION.

The 1939 form of the American Council on Education Psychological Examination differs considerably from the ones previously in use. The number series subtest is an addition to the examination; scoring is based on gross scores instead of weighted scores; and the examination has been divided into two parts, represented by the Q-score and the L-score, which can be used as separate prediction criteria. These two scores are derived from all the totals of the mathematical tests for the Q-score, and the totals of all the linguistic tests for the L-score.

The following study of this new test has been made to ascertain the possible differences in prediction to be expected from the new form, to discover whether the Q- or L-scores may be better predictive items than the subtest scores, and to bring the prediction formula up to date for the one subject studied.

The chief reason for selecting the grades in Introduction to Humanities for this study was that in that subject was found the highest multiple correlation derived in the previous study. It seems most logical to begin by working out prediction formulas for the subjects in which they are to have most value before other subjects are studied.

There were 164 students enrolled in the Introduction to Humanities class in the first quarter of the 1938-39 school

MEANS AND STANDARD DEVIATIONS OF GRADES AND TESTS FOR 1938-39 INTRODUCTION TO HUMANITIES CLASS

SCORE	MEAN	S. D.	SCORE	MEAN	S. D.
X_1	2.97	.93	X_5	10.98	4.35
X_2	7.45	2.38	X_6	14.13	6.50
X_3	9.34	5.59	X_7	36.24	7.43
X_4	8.59	3.46			

year. Individual cards for statistical work for these students were prepared as in the previous study. The one change in procedure was the substitution of a weight of 5 for an A grade, 4 for a B, and so on down to 1 for an F, with no separate classification for E's, these being considered as a sub-class of F's.

The average grade for the class was 2.97, or practically a C; the standard deviation is .93. The means and standard deviations are given in the following table. The designations are as follows: X_1= Humanities grade, X_2= arithmetic grade, X_3= analogies grade, X_4= number series subtest, X_5= completion subtest, X_6= artificial language subtest, and X_7= opposites subtest.

All the correlations for the linguistic subtests are fairly high, the highest value being .606 for the analogies test. The lowest correlation found is for the number series test, being only .179. The correlation for the Q-score is .226, and for the L-score it is .591. The correlation found

CORRELATIONS BETWEEN INTRODUCTION TO HUMANITIES GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION.

SIMPLE CORRELATIONS

	X_2	X_3	X_4	X_5	X_6	X_7
X_1	.260	.200	.179	.511	.554	.606
X_2		.376	.502	.332	.236	.357
X_3			.348	.345	.434	.376
X_4				.329	.282	.284
X_5					.505	.662
X_6						.512
P. E. range = ±.029 to ±.051						

FIRST PARTIAL CORRELATIONS

$r_{12.7}$= .059	$r_{26.7}$= .066	$r_{13.2}$= .114	$r_{37.2}$= .279
$r_{13.7}$= -.038	$r_{34.7}$= .271	$r_{14.2}$= .058	$r_{45.2}$= .199
$r_{14.7}$= .009	$r_{35.7}$= .138	$r_{15.2}$= .466	$r_{46.2}$= .194
$r_{15.7}$= .184	$r_{36.7}$= .303	$r_{16.2}$= .525	$r_{47.2}$= .130
$r_{16.7}$= .356	$r_{45.7}$= .196	$r_{17.2}$= .563	$r_{56.2}$= .465
$r_{23.7}$= .279	$r_{46.7}$= .166	$r_{34.2}$= .199	$r_{57.2}$= .617
$r_{24.7}$= .447	$r_{56.7}$= .258	$r_{35.2}$= .397	$r_{67.2}$= .471
$r_{25.7}$= .137		$r_{36.2}$= .383	
P. E. range = ±.033 to ±.053			

by using the gross scores is .574. The simple correlations found in this study are slightly higher for each subtest

CORRELATIONS BETWEEN INTRODUCTION TO HUMANITIES GRADES AND SUBTESTS OF THE THURSTONE EXAMINATION (Cont.)

SECOND PARTIAL CORRELATIONS

$r_{12.76}$ = .038	$r_{24.76}$ = .443	$r_{14.23}$ = .036	$r_{46.23}$ = .130
$r_{13.76}$ = -.164	$r_{25.76}$ = .124	$r_{15.23}$ = .461	$r_{47.23}$ = .079
$r_{14.76}$ = -.054	$r_{34.76}$ = .235	$r_{16.23}$ = .524	$r_{56.23}$ = .369
$r_{15.76}$ = .102	$r_{35.76}$ = .065	$r_{17.23}$ = .557	$r_{57.23}$ = .574
$r_{23.76}$ = .272	$r_{45.76}$ = .161	$r_{45.23}$ = .133	$r_{67.23}$ = .411
P. E. range = ±.035 to ±.053			

THIRD PARTIAL CORRELATIONS

$r_{12.765}$ = .026	$r_{24.765}$ = .432	$r_{17.234}$ = .556
$r_{13.765}$ = -.172	$r_{34.765}$ = .228	$r_{56.234}$ = .358
$r_{14.765}$ = -.072	$r_{15.234}$ = .461	$r_{57.234}$ = .570
$r_{23.765}$ = .267	$r_{16.234}$ = .524	$r_{67.234}$ = .405
P. E. RANGE = ±.036 to ±.053		

FOURTH PARTIAL CORRELATIONS

$r_{12.7654}$ = .063	$r_{14.7653}$ = -.035	$r_{57.2346}$ = .498
$r_{13.7654}$ = -.160	$r_{24.7653}$ = .395	$r_{16.2345}$ = .433
$r_{23.7654}$ = .192	$r_{15.2346}$ = .344	$r_{17.2345}$ = .402
$r_{12.7653}$ = .076	$r_{17.2346}$ = .441	$r_{67.2345}$ = .262
P. E. range = ±.040 to ±.053		

FIFTH PARTIAL CORRELATIONS

$r_{12.76543}$ = .097	$r_{14.76532}$ = -.065	$r_{16.23457}$ = .371
$r_{13.76542}$ = -.176	$r_{15.23467}$ = .181	$r_{17.23456}$ = .332
P. E. range = ±.046 to ±.052		

MULTIPLE CORRELATION

$R_{1.234567}$ = .689	$R_{1.765432}$ = .689	P.E. = ±.028

than the ones found for the 1936-37 class.

The multiple correlation of .689 indicates that the prediction formula will have a forecasting efficiency of about 29%. This is an increase of 8% over the formula previously found. Every plausible combination of subtests with Q- and L- scores was tried to secure a better correlation than the one found by using all the subtests, but none of the other combinations gave a multiple correlation higher than .650. The percentile ranks were used instead of raw scores in a separate calculation of simple correlations between the subject grades and the subtest scores, but the coefficients found by this method were not as high as the ones given in the previous table. The new prediction formula for the subject is:

$$\bar{X}_1 = .034X_2 - .025X_3 - .015X_4 + .041X_5 + .051X_6 + .045X_7 + .197.$$

STANDARD ERRORS OF ESTIMATE AND PARTIAL REGRESSION COEFFICIENTS FOR INTRODUCTION TO HUMANITIES

$1.234567 = .67$	$4.123567 = 2.88$	$7.123456 = 4.97$
$2.134567 = 1.94$	$5.123467 = 2.98$	
$3.124567 = 4.63$	$6.123457 = 4.85$	$P.E._{est} = .452$
$b_{12.34567} = .034$	$b_{14.23567} = -.015$	$b_{16.23457} = .051$
$b_{13.24567} = -.025$	$b_{15.23467} = .041$	$b_{17.23456} = .045$
	$C = .197$	

The grades for all the students in the class were predicted from the formula and the correlation between these predicted grades and the actual grades was found to be .625. The average predicted grades for students who received A was 3.74, for B students it was 3.35, for C students it was 2.99, for D students it was 2.33, and for F students it was 1.84.

The following table shows more clearly the relation between the predicted and actual grades. It is seen that

COMPARISON OF ACTUAL AND PREDICTED GRADES IN INTRODUCTION TO HUMANITIES. MSU FRESHMEN, 1938-39. (Percentages based on totals for each predicted grade)

PREDICTED GRADE	ACTUAL GRADE				
	F 0-1.5	D 1.6-2.5	C 2.6-3.5	B 3.6-4.5	A 4.6-5.0
A 4.6-				1 (100%)	
B 3.6-4.5			8 (31%)	11 (42%)	7 (27%)
C 2.6-3.5		9 (11%)	55 (66%)	18 (22%)	1 (1%)
D 1.6-2.5	8 (16%)	23 (46%)	15 (30%)	4 (8%)	
F 0 -1.5	3 (75%)		1 (25%)		
92 of 164 (59%) received grades predicted for them					

59% of the students received the grades predicted for them. The predictions were especially good in the C range, since 55 (66%) of these students received the grades forecast for them. None of the students with predictions better than a C scored below that mark. Only 4 (7%) of the students with