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A Motivated Physics Course

Melvin Orvey Jeglum

A MOTIVATED PHYSICS COURSE

Thesis

by

Melvin Orvey Jeglum, III

In Partial Fulfillment of the Requirements for the Degree of

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This thesis, presented by Melvin Orvey Jeglum in partial fulfillment of the requirements for the degree of Master of Science in Education, is hereby approved by the Committee on Instruction in charge of his work.

Committee on Instruction

John A. Page

John M. Gillette (?)

Sewell L. Mason

J. V. Breitwieser

Director of the Graduate Division

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A MOTIVATED PHYSICS COURSE

INTRODUCTION

If we consider the teaching of physics in high schools today, we observe a number of weaknesses. These weaknesses include dull routine procedures, learning opportunities unadjusted for individual differences, inadequate association of subject content to practical life, lack of stimulation of pupil initiative, and an unsatisfactory system of grading or rewarding. The writer feels much can be done to correct these faults by the use of a motivated physics course.

The Problem

The purpose of this thesis is to present a motivated physics course. This Course is not necessarily new in content, but it is different in attitude. The writer has made it practical and spontaneously interesting. It includes a plan and a method of instruction. It is a course developed in the Proctor High School Physics Department, Proctor, Minnesota, from September, 1928 through May, 1939.

Previous Literature

Investigation into the problem of the teaching of physics reveals much has been written about special methods such as

lecture, recitation, laboratory, demonstration, and project; but comparatively little has been written about the method of motivation. C. C. Crawford in his book, How to Teach,[1] does suggest in explaining various kinds of methods (lecture, recitation, laboratory, demonstration, and project), the importance of pupil motivation. L. R. Willard in his textbook, Experience in Physics,[2] developes a practical course stressing pupil activities. Both of these books of recent date indicate there is a trend in the general direction of motivated physics teaching.

Source of Materials

The content of this thesis is drawn from a variety of sources. The Courses of Study from North Dakota, Minnesota, South Dakota, Iowa, Kansas, Wyoming, Montana, and North Carolina have been thoroughly analyzed. Observation visits have been made to Central High School, Grand Forks, North Dakota; Central and Denfeld High Schools, Duluth, Minnesota; Central High School Superior, Wisconsin; Washburn and Marshall High Schools, Minneapolis, Minnesota. Interviews have been made with administrators and teachers from North Dakota, South Dakota, Wisconsin,

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[1]Crawford, C. C. How to Teach, Southern California School Book Depository, Los Angeles, California, 1938. 511p.

[2]Willard, L. R. Experience in Physics, Ginn and Company, Chicago, Illinois. 1939. 662p.

and Minnesota. Worthy projects and reports contributed by pupils enrolled in Physics classes in Proctor High School, Proctor, Minnesota have been carefully considered and selected.

Technique

This Motivated Course of teaching has been based on the objectives and subject content outlined in the State of Minnesota Physics Course of Study[3] which has served as a criterion for the selective process used in the development of the Course. Study references from six high school physics textbooks[4] and experiments from H. F. Turner's Workbook and Laboratory Manual in

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[3]State of Minnesota, The Secondary School Curriculum and Syllabi of Subjects -- Biology, Physics, and Chemistry, Bulletin No. B-3, Department of Education, Capitol Bldg., St. Paul, Minnesota.

[4]Physics textbooks used:

Black and Davis, Elementary Practical Physics, The Macmillan Company, Chicago, Illinois. 1937.

Brownlee, Fuller, Baker, First Principles of Physics, Allyn and Bacon Company, Chicago, Illinois. 1937.

Dull, Modern Physics, Henry Holt and Company, Chicago, Illinois. 1934.

Henderson, New Physics in Everyday Life, Lyons and Carnahan, Chicago, Illinois. 1935

Millikan, Gale, Coyle, New Elementary Physics, Ginn and Company, Chicago, Illinois. 1936.

Stewart, Cushing, Towne, Physics for Secondary Schools, Ginn and Company, Chicago, Illinois. 1932.

Physics[5] have been used. Pupil contributions in the form of projects and reports have been included after a process of trial and constant sifting, covering a period of several years. A list of titles of films available on the subject of physics has been compiled with the cooperation of 82 film distributors in the United States. Review and test items that have been checked individually from year to year for effectiveness and merit, constitute those chosen for this Motivated Course.

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[5]Turner, H. F., Workbook and Laboratory Manual in Physics, College Entrance Book Company, New York City, 1937.

PREFACE

The primary purpose of this Motivated Physics Course is to supply a plan and a method of instruction replete with pupil motivating influences. This Course is based on the objectives set forth by the State of Minnesota Department of Education. "It is self-evident that a sound, fundamental knowledge of natural science is essential to the realization of each and all of the generally accepted ultimate aims of secondary education. It is the basis for personal and community health; it underlies all civic, social and moral progress; it is a vital consideration in vocational choice; it elevates the recreational and and esthetic interests of life by making them contribute to human welfare."[6]

As a means of obtaining these objectives the writer aims to:

1. Motivate pupils through activity (physical and mental); through experiences (recalled and new); and through immediate reward for every effort (with particular considerations for originality).
2. Interpret social purposes through association of subject content with practical life.

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[6]State of Minnesota, The Secondary School Curriculum and Syllabi of Subject--Biology, Physics, and Chemistry, Bulletin No. B-3, Department of Education, Capitol Bldg., St. Paul, Minnesota, p.4.

3. Adapt differences of sex and of individual ability to the subject content.
4. Present an improved course through the construction of new equipment, through the shifting of attention from teacher to pupil, through making the course one of participation in discovery and not one of repetition.

The Plan

The Plan of the Course embodies the following:

1. Index
2. Achievement Record (test, with key, on science experiences).
3. Five Units of Physics consisting of Mechanics, Heat, Sound, Light, and Magnetism and Electricity. Each Unit contains:
   a. Introductory Demonstrations.
   b. Related Student Activities
      1). Experimentations.
      2). Textbook Study References.
      3). Textbook Exercises.
      4). Special Activities
         a). Projects.
         b). Reports.
         c). Free Films.
      5). Supplementary Textbooks with Reference Pages.

c. Group Conference Reviews.

d. Achievement Records (tests with keys).

4. Library Reference Books and Magazines.

5. Equipment List.

6. Final Examination (with key).

7. Pupil Point Record.

This Plan necessitates the following steps of explanation:

1. A copy of the Course (without Achievement Record tests and keys) is given to each pupil in the class at the beginning of the school year. This copy is used as a guide for his work.

2. The Index of the Course presents a general survey of the year's work.

3. The first Achievement Record is a test for the purpose of acquainting the teacher with the pupil and acquainting the pupil with the course. A classification is given of the Achievement test questions according to vocational interests, permitting a better understanding of the pupil's interests and background. A classification is also given according to various divisions of physics, permitting the pupil an opportunity to receive a further survey of the course.

4. The plan of each Unit includes:

   a. <u>Introductory Demonstrations</u> are used to illustrate a principle or law of physics by means of

familiar equipment such as a washing machine, a bicycle, a pressure cooker, etc.

b. Related Student Activities present a means of continuing the study of the principles and laws explained in the Introductory Demonstration. Laboratory Experimentations from Turner's "Workbook and Laboratory Manuel in Physics" and Study References and Exercises from Brownlee, Fuller, Baker's "First Principles of Physics" are suitable for definite assignments on the subject. Special Activities such as projects, reports, and films give the pupil opportunity to offer original contributions. References to Supplementary Textbooks are listed for the purpose of inducing the pupil to further investigate the physical facts presented in the Introductory Demonstration.

c. Group Conference Reviews consist of a pupil's demonstration of a commonly used object such as an electric refrigerator. This demonstration gives the class opportunity to recognize and review the physical principles being studied; to correlate facts common to other experiments; to review vocabulary, definitions, formulas, and laws; to clarify vague ideas; and to focus attention on subject essentials. In addition, projects, reports, and films previously selected

and prepared are presented as a contribution to the group conference review.

d. Achievement Records are tests built around the physical principles involved in practical experiences of various occupations such as farming, piano tuning, engineering, and taxi driving. Keys are supplied for the rapid correction of each test.

4. Library Reference Books and Magazines are suggested for the investigation of special interests and current events.
5. Equipment and Supplies are enumerations of materials needed in this Course.
6. The Final Examination is similar in plan to that of the Achievement Record test. It is, however, more comprehensive and detailed. A key for correction is supplied.
7. The Pupil Point Record is included for the purpose of permitting the pupil opportunity to assume responsibility of tabulating his own grades.

The Method

The method of instruction in this Course is one in which pupil motivation is the dominating influence. The following is a description of the method.

Before the actual subject of physics is introduced, a knowledge of the pupils' background and general interests is obtained through an Achievement Record test. With this information as a guide, the subject of physics is introduced from the known and gradually proceeds to the unknown. For example, a familiar object such as a washing machine is used by the teacher as the first step leading into the rich realm of physical principles and laws. A natural interest is aroused in this familiar object, and pupils are motivated to contribute their past experiences and knowledge to the general discussions and procedure. One of the more active contributors is permitted to take charge of the class and continue with the demonstration. Naturally observations are made and questions are raised which call for more knowledge of the subject. In other words, a need is established. The Related Student Activities open the way. These related activities consist of experiments, textbook references, and textbook exercises, all of which are assigned to anser the pupils' questions and to give further information on the subject at hand. At the time these assignments are given, volunteer pupil leaders are scheduled for directing the activities assigned. Since emphasis is always on pupil initiative and responsibility, the teacher acts as a guide only (occasionally as instigator of ideas) in outlining the assigned work. The pupils and teacher together decide on the daily assignments at least one week in advance in order to obtain proper organization, to permit careful preparation by the pupils, and to give opportunity for pupil-teacher consultation.

In addition to these assigned activities, the pupils are encouraged to work out their own ideas. They may select and prepare Special Activities such as projects, reports, and films. These special activities are exceptional opportunities for developing initiative and originality. In participating in them, the pupils are aroused to the point whereby they are learning by self-engendered doing.

Individual interests and freedom of thought are encouraged in the above described pupil activities. Some means of securing united thought on the physical concepts being used is necessary. This need for correlation, plus the necessity of review, is taken care of in the Group Conference Review. Here the pupils are privileged to give their demonstrations and their reports, to display and explain their projects, to show films, and to offer their discoveries to the other members of the class. Thus in a variety of ways, the physical laws and principles being learned are fixed in a practical and emphatic way in the minds of the pupils.

After this Conference Review, an Achievement Record test is given for the purpose of measuring pupil progress. Each pupil compare his result with his previous Achievement Records. The record of the class as a whole is compared to records of classes of the previous year.

Further pupil motivation is secured through a Point System of

grading. Every pupil effort is rewarded with points from 1 to 15. Regardless of the nature of the effort, a written outline, description, or composition pertaining to the effort or activity is presented to the teacher. The teacher marks in points from 1 to 15, his evaluation on the paper presented to him by the pupil. If the paper is incomplete or incorrect, it is marked "INC" (Incomplete); if the work is mediocre but acceptable, a "✓" (Check) mark is given. These two marks may be converted into point value by the pupil if he corrects his work within a 24 hour period.

The pupil is responsible for each paper marked by the teacher. At the end of the month or six weeks period, each pupil presents to the teacher his marked papers together with his personal record (Pupil Point Record p. 128 of the Course) of points earned. The points marked on his papers are added to points earned on tests. In evaluating a test, points are withheld until the test is corrected. An exception to this is a test graded "F". Its value in terms of the point system, is minus one. If the paper is corrected, the value is changed to zero. The points earned on tests together with the points accumulated during any month or six weeks period, constitute a total which, in turn, is translated into a grade or mark. The final grade of the course consists of the average of the total of monthly or six weeks grades plus the final examination grade.

An outline of the point value of pupil activities and tests is as follows:

The Pupil Activity		Point Value
Directing class discussion	------	1-3
Conducting laboratory session	------	1-3
Written outline or composition on		
Laboratory experiment	------	1-3
Textbook study references	------	1-3
Textbook exercises	------	1-3
Reference report	------	1-3
Related experience	------	1-5
Observation of another class	------	1-5
Demonstration	------	1-10
Project	------	1-15
Test Result of		
A	------	4
B	------	3
C	------	2
D	------	1
F	------ minus	1-0

INDEX

INDEX
(continued)

ACHIEVEMENT RECORD NO. 1A

Science Experience

NAME _____ POINTS _____

A number of statements are given containing blanks. Select the correct response by underlining one of the four stated.

1. The atmospheric pressure decreases as the _____ increases. (wind; temperature; altitude; rain)

2. The air pressure at sea level is about _____ pounds per square inch. (3.1416; 15; 5,280; 144)

3. The normal body temperature is 98.6°_____.(centigrade; absolute; clinical; fahrenheit)

4. The condensation of atmospheric vapor results in _____. (rain; cold; lightning; northern lights)

5. The formation of _____ is the same as a cloud near the earth. (rust; dew; a cyclone; fog)

6. A vacuum cleaner motor is usually a _____ type. (universal; four cycle; alternating current; international)

7. If several electric lights go out in a circuit the _____ should be replaced. (filament; fuse; volts; push button)

8. The comparative cost of operating electrical appliances can be estimated by the number of_____. (watts; volts; cycles; dollars)

9. Fires may be produced by a _____. (kilowatt; blow fuse; short circuit; transfusion)

10. Unlike electrical charges _____. (radiate; repel; explode; attract)

11. The gasoline mixture is produced in the _____. (generator; radiator; distributor; carburetor)

12. Chemical energy is found in the _____. (differential; choke; storage cell; cold storage)

13. To lower the freezing point of water ____ is used. (a fan; oil; alcohol; octane)

14. The contents of the _____ should be changed for winter driving. (transmission; tires; generator; clutch)

15. Sharp highway curves are sloped so as to counteract _____ force. (centrifugal; gravitational; potential; traction)

ACHIEVEMENT RECORD NO. 1A

(continued)

16. A car traveling 60 miles per hour has more _____ than one traveling 20 miles per hour. (acceleration; momentum; hydraulic action; efficiency)

17. A shovel is known as a _____. (cathode; lever; vector; wedge)

18. A cream separator makes use of _____ force. (inertia; vitamin; centrifugal; radiation)

19. The wheelbarrow is an example of _____. (a lever; a dyne; an incline plane; a spectrum)

20. The boiling point of a liquid in a pressure cooker _____ with the increase of pressure. (is lowered; remains the same; increases; disappears)

21. Iron is a better _____than glass in cooking utensils because it is a better conductor. (radiator; detector; calorimeter; devitalizor)

22. The heat value of food is sometimes measured by its _____ content. (mineral; caloric; B. T. U.; ultra-violet)

23. Friction will produce _____. (heat; carbon dioxide; inertia; work)

24. In the laboratory,liquids are measured in _____. (pints; cubic centimeters; ounces; millimeters.

25. A science worker usually puts liquids for experimentation in _____. (thistle tubes; mortars; test tubes; resonating tubes)

26. As a precaution for acid burns a laboratory worker should wear_____. (wool clothing; silk gloves; rubber aprom; asbestos apron)

27. White clothing is cool because white ____ heat rays. (absorbs; transmits; radiates; reflects)

28. Since the rainbow is made up of seven colors, then _____ light is composed of these seven colors. (primary; diffused; black; white)

29. Any two lines that intersect form_____. (an angle; a bisector; a perpendicular; a triangle)

30. Two lines everywhere equally distant apart are _____ lines. (askew; oblique; parallel; perpendicular)

ACHIEVEMENT RECORD NO. 1A

(continued)

31. A large object on one end of a fireplace mantle can be _____ by two smaller objects on the other end. (bisected; balanced; syncronized; made congruent)

32. In taking moving pictures, increasing the number of pictures per second produces _____ motion. (slow; fast; reverse; blurred)

33. The device that causes light to be focused on the film in a camera is called a _____. (tripod, shutter, iris, lens)

34. Most of our music is written in the _____ chord. (minor; "G"; major; pianissimo)

35. The low frequencies in a stringed instrument are produced by the _____ strings. (long; copper; short; tight)

36. Moving pictures are put on the screen by a _____. (negative; camera; projector; spot light)

37. Pictures that appear sharp and clear are said to be _____. (exposed; out of focus; achromatic; in focus)

38. In the formula $\frac{1}{x} + \frac{1}{y} = \frac{1}{f}$ the value of "f" equals _____.

($\frac{xy}{x+y}$; $x+y$; 1; $\frac{1}{x+y}$)

39. The value of W is made _____ as large in the formula PW=X, if X is constant and P is made half as large. (twice; four times; one half; ten times)

40. In the proportion $\frac{M}{N} = \frac{m}{n}$, if M is doubled, but N and n remain the same then m is _____. (trebled; half as large; doubled; not changed)

41. A man purchased a telescope for forty dollars and sold it for eighty dollars, made a profit of _____. (200%; 20%; 2; 100%)

42. To multiply 39.54 by 100 move the decimal point _____. (to the left two places; to the right three places; to the left one place; to the right two places)

43. The hypotenuse of a right triangle is 10, one side is 6, and the other side is _____. (8, 16, 136, 4)

44. The sum of $\frac{1}{3} + \frac{1}{6} =$ _____. (2/9; 1/9; 2; 1/2)

ACHIEVEMENT RECORD NO. 1A

(continued)

45. The compliment of a 50° angle is _____. (130°; 40°; 25°; 5°)

46. The span of a bridge employs the principle of a _____. (an apothem; an arch; a transversal; a pyramid)

47. In finding the resulting temperature after mixing two quantities of water, it is to be noted that 200 grams of water at $70^{\circ}C$ gives off as much heat as 800 grams of water at $45^{\circ}C$ takes on. The equation would be _____. ($200(70-x) = 800(45-x)$; $200(70-x)=800(x-45)$; $200(70-x)=800x$; $800(70-x)=(45-x)$)

48. In determining the height of a bridge above the water, a stone is dropped. It took two seconds for it to hit the water and the acceleration of gravity is 32 feet per second. The velocity of the stone is then the product of 32 times two. The height of the bridge is one half of this velocity times the time of two seconds. The correct equation is _____. ($h= 1/2 \cdot 32 \cdot 2$; $h=32 \cdot 4$; $h=1/2 \cdot 32 \cdot 2 \cdot 2$; $h=32.32.4$)

49. The speaker on the radio is similar to the _____ in the telephone. (transmitter; dial; central; receiver)

50. The tone control knob on the radio is used _____. (to raise or lower the pitch; to operate television sets; to tune in stations; to decrease or increase the volume)

ACHIEVEMENT RECORD NO. 1A

Answer key

1. altitude
2. 15
3. Fahrenheit
4. rain
5. fog
6. universal
7. fuse
8. watts
9. short circuit
10. attract
11. carburetor
12. storage cell
13. alcohol
14. transmission
15. centrifugal
16. momentum
17. lever
18. centrifugal
19. a lever
20. increases
21. radiator
22. caloric
23. heat
24. cubic centimeters
25. test tubes
26. rubber apron
27. reflects
28. white
29. an angle
30. parallel
31. balanced
32. slow
33. lens
34. major
35. long
36. projector
37. in focus
38. $\frac{xy}{x+y}$
39. twice
40. doubled
41. 100%
42. to the right two places
43. 8
44. 1/2
45. 40^{0}
46. an arch
47. (200(70-x)=800(x-45)
48. h=1/2·32·2·2
49. receiver
50. to raise and lower the pitch

VOCATIONAL INTERESTS

1. Dietetics ----------20, 21, 22, 47.
2. Household ----------7, 8, 9, 20, 22.
3. Movies ----------7, 28, 32, 33, 37, 38.
4. Business ----------4, 5, 40, 41, 42, 45.
5. Agriculture --------4, 5, 11, 17, 18, 19.
6. Transportation -----4, 5, 13, 14, 15, 16.
7. Designing ----------9, 15, 27, 28, 29, 30, 31.
8. Laboratory ---------1, 2, 3, 24, 25, 26, 39.
9. Leisure ----------27, 34, 35, 36, 37, 49, 50.
10. Engineering --------1, 2, 4, 6, 7, 10, 12, 13, 14, 23, 29, 38, 43, 46, 48.

SUBJECT UNITS

1. Mechanics ----------1, 2, 11, 14, 15, 16, 17, 18, 19, 24, 48.
2. Heat ----------3, 4, 5, 13, 20, 21, 22, 23, 47.
3. Sound ----------34, 35, 50.
4. Light ----------27, 28, 32, 33, 36, 37, 38.
5. Mag. & El. ---------6, 7, 8, 9, 10, 12, 49, 50.
6. Mathematics --------29, 30, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48.

A MOTIVATED PHYSICS COURSE

Unit I
Mechanics

Proctor High School

Proctor, Minnesota

THE TRAVELING SALESMAN

Mechanics

Introductory Demonstration No. 1

NAME _____ POINTS _____

In order that we may perform experiments easily and accurately we must know the Metric System of Measurements.

PROBLEM: Suppose you were to plan the sales talk of the European representative of a washing machine company.

OUTLINE:

	Selling Points	Equipment
		Washing machine
I.	Size of tub	
	A. Working height	Meter stick, yard or foot rule.
II.	Dimensions of parts	Calipers.
	A. Parts easily removed	
	B. Parts subject to wear	
III.	Capacity of tub	Water pail, graduate, liter,
	A. Washing capacity	quart, measures.
	B. Total capacity	
IV.	Weight of repair parts	Spring scales, English and metric.

Data Table (Fill in as the above outline is given.)

Parts Name	Linear		Cubic		Weight	
I	English	Metric	English	Metric	English	Metric
II						

THE TRAVELING SALESMAN

(continued

Parts Name	Linear		Cubic		Weight	
III	English:	Metric:	English:	Metric:	English:	Metric:
IV						

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information reference

1. Text

2.

Related Student Activities

Demonstration No. 1

I. Experimentations[1] — Pages

Metric Units	3
Vernier Caliper	5

II. Study Reference[2]

Pages 1-15; 795

III. Exercises[2]

P. 16- (1-7)
P. 18- (1-17)

IV. Special Activities

A. Projects
1. Demonstration size Vernier Caliper*
2. Samples of Metric and English Measures with illustrative problems
3. Taking pictures of class activities for the year*
4. The Metric System in Sports

B. Reports
1. Contributors in the Field
2. The Origin of Units of Measure
3. The Relation of Measurements to Science
4. Why use the Metric System?

C. Free Films
1. Beyond the Microscope, one reel, silent, General Electric Co., Chicago, Ill.
2. Building, one reel, sound, International Harvester Co., Chicago, Ill.
3. Excursions in Science I, one reel, sound, General Electric Co., Chicago, Ill.

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[1]All Experimentations to follow are selected from Turner, H. F., Workbook and Laboratory Manual in Physics, College Entrance Book Co., New York City. 1937.

[2]All Study References and Exercises are selected from Brownlee, Fuller, Baker, First Principles of Physics, Allyn and Bacon Co., Chicago, Ill. 1937

*All projects so marked have been added to the equipment of the department.

Related Student Activities

Demonstration No. 1

(continued)

4. Excursions in Science II, one reel, sound, General Electric Co., Chicago, Ill.
5. Going Places, one reel, silent, Cadillac Motor Division, General Motors, Detroit, Michigan.
6. Great Lakes Exposition, one reel, sound, Goodyear Tire and Rubber Co., Akron, Ohio.
7. High Speed, one reel, sound, YMCA, Chicago, Ill.
8. Research Paves the Way, one reel, silent, YMCA, Chicago, Ill.
9. The World's Fair, two reels, silent, Goodyear Tire and Rubber Co., Akron, Ohio.

V. Supplementary Textbooks with reference pages

Title	Pages
Black and Davis, Elementary Practical Physics, Macmillan Company, Chicago, Ill., 1937	1-8
Dull, Modern Physics, Henry Hold and Co., Chicago, Ill., 1934	1-22
Henderson, New Physics in Everyday Life, Lyons and Carnahan, Chicago, Ill., 1935	1-30
Millikan, Gale, Coyle, New Elementary Physics, and Company, Chicago, Ill., 1936	1-14
Stewart, Cushing, Towne, Physics for Secondary Schools, Ginn and Co., Chicago, Ill., 1932	2-17

THE INSIDE STORY

Mechanics

Internal Properties
Introductory Demonstration No. 2

NAME _____ POINTS _____

History records how men of daring have gone out in search of new countries. They saw strange people with peculiar laws and customs. Equally as interesting, however, is it to investigate the laws and properties of the newly discovered regions about us. The realm of molecules, atoms, protons, and electrons challenge the spirit of every daring young man and woman.

PROBLEM: John just purchased a new car. The specifications called for the use of No. 20 oil. Dad has a 50 gallon drum of No. 40 oil that is used for the old family car. Now Dad having so much oil suggests that John use some of it. Since it is free should John use it in his new car?

OUTLINE

Physical properties	Equipment
I. Granular structure	Saw dust, wood block, desk
A. Comparison demonstration	Glass tube 3'x1/2", fitted corks, half filled with water, other half with alcohol.
II. States of Matter	
A. Solid	Wax
1. Tenacity	Ringstand, arm, No. 28 wire, weights.
2. Ductility	Copper wires of several sizes, Wire gauge.
3. Malleability	Gold, aluminum or tin sheets.
B. Liquid	Melted wax
1. Cohesion and Adhesion	Dish, Glass plates, mercury, water.
2. Surface tension	Needle or razor blade, dishes of water, kerosene, mercury, alcohol--spring scale, disk with a string--1 inch cedar shingle boat, ether--paper chute coated with camphor smoke, water--soap bubbles.
3. Cappillary action	Two lumps of sugar, dish of colored water, powdered and granulated sugar.
4. Viscosity	Oil samples of different SAE ratings.
5. Osmosis	Carrot, glass tube, sugar, water.

THE INSIDE STORY

(continued)

	C. Gases 1. Brownian movements 2. Diffusion	Boiling wax, cold plate Microscope, starch, water. Ink, water--perfume.
III.	Pascal's law	Sprinkling can.
IV.	Plasticity and Elasticity	Rubber ball, putty.
V.	Electricity	Rubber rod, flannel--tin can with three holes at the bottom filled with water hold charged rod near stream.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information references

1. Text

2.

Related Student Activities

Demonstration No. 2

I. Experimentations — Pages

II. Study Reference

Pages 20-37

III. Exercises

P. 27 - 1, 2, 4, 10, 11
P. 39 - (1-12)

IV. Special Activities

A. Projects
1. Diving Bell or Helmet--use the end of a hot water tank.*
2. Films and their uses--as soap, oil, wax, etc.
3. Gas Mask--use activated charcoal.*
4. Large Air Pressure Gauge.*
5. Model of Water Molecule.*
6. Putting Atoms to Work--exploding corn starch, gasoline, acetylene from carbide etc.
7. Plant Osmosis.
8. Spring Scales.
9. Wire stretchers with scales--tensile tester.

B. Reports
1. Contributors in the Field.
2. Dry Farming.
3. Films for Protection.
4. Industrial Proving Grounds.
5. Prevention of Erosion.
6. Snowflake Crystals.
7. Theories of Molecular Structure.
8. Work of the United States Bureau of Standards.

C. Free Films
1. Films of Endurance, four reels, sound, Pennzoil Co., Oil City Pa.
2. Heat Treatment of Steel, two reels, sound, U. S. Bureau of Mines, Pittsburgh, Pa.
3. Metals of a Motor Car, Two reels, silent, American Museum, New York City.
4. Metals of All Ages, five reels, silent, Reading Iron Co., Philadelphia, Pa.
5. Science Saves the Surface, two reels, sound, YMCA, Chicago, Ill.

Related Student Activities

Demonstration No. 2

(continued)

6. Science of a Soap Bubble, one reel, silent, Spire Film Corporation, Long Island, New York.
7. Wirecraft, four reels, sound, National Standard Co., New York City.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	9-16; 71; 134-160
Modern Physics	4-19; 113-124; 138-143; 205-216
New Physics in Everyday Life	2-5; 35-36; 65-66; 128-152; 175-178
New Elementary Physics	17-21; 56-58; 74-82; 131-143
Physics for Secondary Schools	8-10; 97-104; 127-143; 178-203

THE OUTLOOK

Mechanics

External Properties
Introductory Demonstration No. 3

NAME_____ POINTS_____

Certain laws operating within seem to control the properties of substances, while others from without tend to determine still other properties.

PROBLEM: In pedaling your bicycle to school you find that now and then it is possible to coast. Where does the energy come from that keeps you going?

OUTLINE:

Properties	Equipment
I. Inertia A. Pull slowly B. Pull rapidly	Heavy pendulum and string.
II. Mass and weight A. Law of gravitation 1. Law of inverse squares 2. Relation to magnetism and light formulas. B. Absolute and Gravity Units 1. Equator and Poles	Metric weights and globe of earth.
III. Inpenetrability	Flask, two hole stopper, funnel, water--kerosene can.
IV. Density	Graduate, water, objects such as bolt, glass stopper.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers
2. Workbook
   Page

Information reference

1. Text
2.

Related Student Activities

Demonstration No. 3

I. Experimentation — Pages

Density of Solids	5
Properties of Matter	1, 237

II. Study Reference

Pages 14-18; 214-216; 219; 511

III. Exercises

P. 16 - (7-15)

IV. Special Activities

A. Projects
1. Friction Toys--as trains and automobiles.
2. Safety and the Automobile--pictures and toy models showing inertia, impenetrability, etc.

B. Reports
1. An Irresistable Force meets an Immovable Object.
2. Contributors in the Field.
3. Theory of Weight Relativity.
4. Visit another class or school.

C. Free Films
1. Arc Welding in Building Erection, two reels, silent, General Electric Co., Chicago, Ill.
2. Bremen, one and one half reels, sound, German Railroad Co., New York City.
3. Everybody's Business, one reel, sound, Plymouth Corp., Detroit, Michigan.
4. Farther, Faster, Safe, three reels, sound, Pennzoil Co., Oil City, Pa.
5. Follow the White Marker, one reel, silent, YMCA, Chicago, Ill.
6. Jewels of Industry, two reels, silent, Douglas D. Rothsacker, New York City.
7. Keeping up with the Traffic, two reels, sound, Portland Cement Co., Chicago, Ill.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	11-14; 30-31; 213-215
Modern Physics	4-19; 113-120; 138-143; 205-216
New Physics in Everyday Life	2-5; 35-36; 65-66
New Elementary Physics	25-40; 85-86; 100
Physics for Secondary Schools	70; 127-143; 170

THE SERVICE STATION

Mechanics

Specific Gravity and Hydraulics
Introductory Demonstration No.4

NAME _____ POINTS_____

The noblest service is the type that has no thought of reward. Service stations are often called upon to exemplify this principle.

PROBLEM: One night about 9:30 o'clock a car came in to your station with very dim lights. However, every time the motor speeded up the lights became brighter. Immediately you tested the storage battery. The reading was 1050. What did you tell the car driver?

OUTLINE:

Characteristics	Equipment
I. Specific Gravity	
A. Battery test	Old storage cell, hydrometer
B. Radiator test	Anti-freeze solution.
C. Gasoline test	Several grades of gas, Hydrometer for light liquids
1. Hydrometer method	
2. Bottle method	
3. Displacement method	Solid, spring scale.
D. Test of Auto parts	
1. Geometric solids	Meter stick, calipers
a) Floating objects	Objects as gas floats.
b) Objects that sink	Objects as bolts, radiator caps.
2. Irregular solids that float	Paper, wood, sinker weight.
3. Irregular solids that sink	Car parts, overflow can and bucket.
II. Fluid Pressure	
A. Hydraulic action	Auto jack, hydraulic model
B. Pascal's law	Chart of Auto brakes from local garage.
C. Charles' law	Tire pump, chart of gas station air compressor.
D. Boyle's law	Two vertically mounted glass tubes connected with rubber tubing, one movable, the other fitted with a stop cock or cork, a meter stick, barometer, An auto manifold.

THE SERVICE STATION

(continued)

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information references

1. Text

2.

Related Student Activities

Demonstration No. 4

I. Experimentation

	Pages
Pressure in a Liquid	13
Archimedes' Principle	15-18
Specific Gravity	19-26
Boyle's Law	31
Gas Pressure	33, 231

II. Study Reference

Pages 41-60; 65-88; 114-126

III. Exercises

P. 45 - 5, 6, 7
P. 49 - (4-10)
P. 54 - 4, 5, 6, 7, 12, 13, 16, 17
P. 63 - 1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 16, 19
P. 68 - 5, 7, 8, 11
P. 75 - 1, 3, 4, 5, 8, 10, 11, 12, 13, 14, 15, 16
P. 81 - 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 17, 19
P. 87 - (2-13)
P. 89 - 2, 3, 7, 10, 11, 12, 14, 17
P. 126 - 4, 6, 7, 12, 13, 16, 18, 20, 22

IV. Special Activities

A. Projects
1. Air Compressor for Spray Painting.
2. A Toy Service Station.
3. Automatic Valves--toilet, cattle tank, chicken trough etc.
4. Drydock model
5. Hydraulic Press--using an auto jack.*
6. Hydraulic Auto Brake--use wrecked car parts.*
7. Hydraulic Ram.
8. Hydrometer or Freeze-ometer.
9. Model Submarine.
10. Model Airplane.*
11. Model City Water System.
12. Sailboat*
13. Specific Gravity of Common Place Things or Physics "G" Man.
14. The Cartesian Diver.
15. Westinghouse Air Brake Model.*

B. Reports
1. Contributors in the Field.
2. Government Inspectors.

Related Student Activities

Demonstration No. 4 (continued)

3. Life on a Submarine.
4. My interest in Aviation
5. The Hydraulics of the 20th Century.
6. The Great American Dams.
7. Sabotage on the Ocean.
8. Visit another class or school.

C. Free Films

1. Behind the Waterfront, two reels silent, R. B. Annis Co., Indianapolis, Indiana.
2. Boulder Dam, four reels, sound, International Harvester Co., Chicago, Ill.
3. Built to Stay Built, one reel, sound, Nash Motor Co., Racine, Wisc.
4. Cushioned Landings, one reel, sound, Goodyear Tire and Rubber Co., Akron, Ohio.
5. Elevators, two reel, silent, Otis Elevator Co., New York City.
6. Flying Clipper Cruises to Rio, two reel, sound, Pan American Airways Inc., New York City.
7. Follow the White Traffic Marker, one reel, sound, YMCA, Chicago, Ill.
8. Green Thunder, one reel, sound, New York Central Railroad Co., New York City.
9. Liquid Air, General Electric Co., Chicago, Ill.
10. Let's Try It, two reels, sound, B. F. Goodrich Co., Akron, Ohio.
11. U. S. S. Akron, one reel, sound, Goodyear Tire and Rubber Co., Akron, Ohio.
12. U. S. S. Macon, one reel, sound, " " " Rubber Co., Akron, Ohio.
13. Story of the Airship, one reel, sound, Goodyear Tire and Rubber Co., Akron, Ohio.
14. Submarine Service, one reel, sound, YMCA, Chicago, Ill.
15. Water Power, two reel, sound, YMCA, Chicago, Ill.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	91-144
Modern Physics	23-98; 108-110
New Physics in Everyday Life	33-76; 94-127
New Elementary Physics	32-71
Physics for Secondary Schools	48-106

HOME WEATHER BUREAU

Mechanics

Introductory Demonstration No. 5

NAME _____ POINTS _____

If you saved enough money last summer to buy a car, it would interest you to know that freezing weather is due tomorrow.

PROBLEM: The barometer has been falling steadily for 36 hours, the temperature is rising, humidity is high, the wind is from the southwest. What kind of weather might we have in the next 24 hours?

OUTLINE:

	Thought topics	Equipment
I.	Atmospheric pressure A. Highs and lows	Meter stick, glass tube 3' dish mercury. Weather maps.
II.	Relative humidity	Dry and wet bulb thermometers.
III.	Air Mass movements A. Air has weight B. Convection	Convection box, globe, 1 gallon tin can, scale, source of heat.
IV.	Temperature	Thermometers
V.	Keeping a Weather Record A. Earn extra points	Student record of___ weeks will bring _____ points.
	B. Recordings 1. Date 2. Temperature 3. Sky condition 4. Wind direction 5. Pressure 6. Location of Highs and Lows 7. Humidity 8. Student weather forecast 9. Government forecast.	Arrange to have all equipment at a definite location for observers.
VI.	Weather "Prophets" A. Rheumatic joints B. Pink sunsets C. Rising smoke D. Wet and dry moon	

HOME WEATHER BUREAU

(continued)

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information references

1. Text

2.

Related Student Activities

Demonatration No. 5

I. Experimentation — Pages

Atmospheric Pressure Effects — 235-236

II. Study Reference

Pages 93-110

III. Exercises

P. 98 - 5, 6, 9, 12
P. 105 - 3, 5, 6, 8, 10, 11, 12
P. 112 - 3, 5, 6, 8, 11, 13, 16, 17, 19, 23, 26, 28, 29

IV. Special Activities

A. Projects
1. A Six Weeks Weather Report.
2. Atomizer Principles--wind across the chimney, paint spray, etc.
3. Automatic Syphons.*
4. Air has Weight.
5. A collection of Air Pressure Experiments.
6. Barometers--a tumbler with a rubber membrane and lever pointer, glass tube with mercury or oil, super-saturated solution in a test tube, etc.*
7. Cloud Making Apparatus.*
8. Contour Maps.
9. Humidity Indicators--Chemical flowers such as chloride of cobalt on blue and pink paper, wet and dry bulb thermometers, twisted gut indicator, etc.*
10. Model Air Conditioning Plant.
11. Pop gun.
12. Pictures of different Clouds.
13. Pumps--simple, force and rotary.*
14. Respiratory System.*
15. Recording Rain Gauge.*
16. Windmill.

B. Reports
1. Altitude Determination in Aviation.
2. Are Droughts Cyclical?
3. American Industries and Weather.
4. Ancient versus Modern Forecasting.
5. Agriculture and Weather.
6. Contributors in the Field.
7. How does Uncle Sam Forecast Weather.
8. Relation of Weather to Aviation.
9. The Stratosphere and Weather.
10. Weather and Conservation.
11. Weather and the Grain Pit.

Related Student Activities

Demonstration No. 5

(continued)

C. Free Films

1. Breathing, one reel, silent, University of Missouri, Columbia, Mo.
2. Clouds, one reel, sound, U. S. Department of Agriculture, Washington, D. C.
3. Fire Weather, two reels, sound, U. S. Department of Agriculture, Washington, D. C.
4. Flood Weather, Three reels, sound, U. S. Department of Agriculture, Washington, D. C.
5. Rain on the Plains, three reels, sound, U. S. Department of Agriculture, Washington, D. C.
6. The River, three reels, sound, U. S. Film Service, Washington, D. C.
7. We Drivers, one reel, sound, General Motors Co., Detroit, Michigan.

V. Supplementary Textbooks with reference pages

Title	Pages
Elementary Practical Physics	115-127; 273-298
Modern Physics	285-310
New Elementary Physics	222-247; 284
New Physics in Everyday Life	292-303; 319-328
Physics for Secondary Schools	264-306

Refer to page 3 for authors and publishing companies.

GROUP CONFERENCE REVIEW NO. 1B

Mechanics

NAME_____ POINTS_____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our subject of Internal Mechanics is to be demonstrated by ironing clothes.

I. Equipment

A kerosene stove, flat irons, ironing board, materials for ironing, such as wool, cotton, real and artificial silk, linen, articles as a shirt, tie, etc.

II. Topics

A. Ironing
   1. Light the stove
      a) Explain its operation
   2. Prepare the equipment and materials
   3. Ironing process
      a) Various materials and proper temperature
      b) Methods for shirts, ties, etc.
   4. Theory of explanation

B. Metric system
   1. Linear
   2. Volume
   3. Weight
   4. Advantages

C. Terms for definition and illustration
   1. Weight
   2. Mass
   3. Density
   4. Atoms
   5. Molecules
   6. Tenacity
   7. Ductility
   8. Malleability
   9. Hardness
   10. Cohesion
   11. Adhesion
   12. Surface tension
   13. Viscosity
   14. Diffusion
   15. Contraction
   16. Expansion
   17. Elasticity
   18. Plasticity

D. Laws and principles
   1. Hooke's
   2. Pascal's
   3. Archimedes'
   4. Boyle's
   5. Torricelli's
   6. Capillarity

E. Formulas
   1. Fluid pressure
   2. Hydraulics

GROUP CONFERENCE REVIEW NO. 1B

Mechanics

3. Specific Gravity
   a) General
   b) Specials

F. Weather factors
   1. Temperature
   2. Pressure
   3. Air masses
   4. Sky condition
   5. Cyclones and Anti-cyclones
   6. Humidity
   7. Geographic location

III. Demonstration of Class Projects

IV. Class Questions

ACHIEVEMENT RECORD NO. 1B

Mechanics

NAME_____ POINTS_____

Sometime in your experience the following situation may arise. See what you can do about them. Fill in the blanks as suggested with the correct answers.

I. European Traveler.

A. You are spending a vacation in Switzerland. One day you decide to visit a neighboring resort a distance of___ kilometers or 3 miles. On the way you stop at a gasoline station buying 80 liters or an equivalent of ___gallons of gas. Here you meet a group of friends intent on a hike, so after some misgivings you accept the invitation to join them. At the end of a most strenuous day you weigh yourself and find to your delight that the scale records a loss of 1/2 a kilogram or _____ pounds in weight.

B. The next day on another trip you visit a souvenir shop and purchase a teapot to send home. At first thought it seemed that an article so fragile would be crushed in transportation, but the clerk insisted that since it was so small holding only 476 cubic centimeters or ___quarts, it could be packed in a box only ___ centimeters or 10 inches square, and weighing no more than 1000 grams or __pounds, so you agreed to the purchase.

II. Engineer

A. On a Federal project it is necessary to compute the water pressure on a dam 70 feet high, 80 feet wide. The answer is _____pounds per square foot. If the resulting lake had extended twice as far back from the dam the pressure would have been _____.

B. If the water level was maintained at a height of 68 feet by this dam, a hydraulic piston moving a distance of two feet by this pressure would move a large piston a distance of four inches with a pressure of ___ pounds per square inch.

C. The density of the products compressed by this hydraulic press is increased 60%, thus a two cubic foot object weighing one pound now has a density of ___ pounds per cubic foot.

III. Mining Laboratory

A tired and dusty prospector brings into the office a number

ACHIEVEMENT RECORD NO. 1B

(continued

specimens for analysis. No. 1 is a yellow nuggest weighing 26 grams in air and 22 grams in water. No. 2 is a liquid weighing 29.2 grams with the bottle, the bottle with water weighs 34 grams and the bottle empty 10 grams. No. 3 is a liquid in which an object weighing 30 grams, weighs only 20 grams when submerged in the liquid. In water the object submerged weighs 22 grams. A chart in the office states the specific gravity of gold is 19.3, "fool's" gold is 6.5, of alcohol is .9, crude oil .8, glycerine is 1.25, and water is 1. Therefore No. 1 is _____, No. 2 is _____, and No. 3 is _____.

IV. Stratosphere Engineer

A. In a particular experiment the following data was secured: Gas pressure 60 pounds per square inch
Volume is 6000 cubic feet
Gas pressure increased to 90 pounds per sq. inch
Temperature constant, the new volume is _____.

B. Another ascension showed a barometer reading at sea level to be 30 inches, while at an elevation of _____feet the reading was 2 inches.

C. In a third trial the oxygen tanks of 2 cubic feet capacity had been under a pressure of 400 pounds per square inch at a temperature of 68°F. At a temperature of -30°C the pressure was _____.

ACHIEVEMENT RECORD NO. 1B

Key

I.

A. 1.83
21
1.1

B. 1/2
25.4
2.2

II.

A. 2187.5, the same
B. 5
C. 0.8

III.

No. 1	"Fool's" Gold	6.5
No. 2	Crude oil	0.8
No. 3	Glycerine	1.25

IV.

A. 4000 cubic feet
B. 25,200
C. 331.7 pounds per square inch.

THE TOY SHOP

Mechanics

Forces
Introductory Demonstration No. 6

NAME_____ POINTS_____

It is not so long ago since you thrilled to the very core upon receiving the new fall and winter mail order catalog, or on visiting the corner store, just to see and perhaps feel the new toys on display.

PROBLEM: By experiment you find that a loaded Coaster weighing 200 pounds can be weighed by weighing each corner and totaling the weight. How much will your car weight if the weight registered under each wheel is 720, 715, 640, 632 pounds respectively?

OUTLINE:

Topics	Equipment
I. Forces at a point A. Linear B. Angular	 Two scales. Three scales, blocks, baby or doll swing.
II. Equilibrium A. Center of gravity	Top--toy auto--train
III. Composition of forces	Toy bridge, construction sets.
IV. Resolution of forces	Sailboat, airplane, skooter.
V. Parallel forces	Toy truck, suspension bridge, spring scales.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers
2. Workbook
   Page

Information references

1. Text
2.

THE LOCAL HARDWARE STORE

Mechanics

Forces

Alternate demonstration No. 6

NAME _____ POINTS_____

Since the atmospheric pressure is about 15 pounds per square inch, an interesting fact is suggested if we consider that a boy holding out his hand may be supporting 450 pounds.

PROBLEM: A coaster wagon loaded with a 49 pound sack of flour requires a pull of 60 pounds horizontally to keep it moving uniformily. The resultant pull on the handle as you walk along is 100 pounds. What is the vertical component or approximate weight of the coaster wagon and flour?

OUTLINE:

Topics	Equipment
I. Forces at a point	Chain, scales, wire stretcher.
A. Linear	
B. Angular	Lawn mower, bicycle frame.
II. Equilibrium	Coaster wagon, spring scales,
A. Center of gravity	rope, books.
III. Composition of forces	Same equipment
IV. Resolution of forces	" "
V. Parallel forces	Bathroom scales, students, Whiffle-tree on a wagon.

CONCLUSION:

Problem assignment	Information references
1. Text Page Numbers	1. Text
2. Workbook Page	2.

Related Student Activities

Demonstration No. 6

I. Experimentations

	Pages
Applied Forces	239
Center of Gravity	49
Equilibrium of Parallel Forces	51
Composition of Forces	53
Resolution of Forces	55
The Simple Pendulum	57

II. Study Reference

Pages 131-145; 148-155

III. Exercises

P. 145 - 1, 2, 3, 4, 5, 6, 10, 11, 12, 15, 16, 18, 19, 20, 25, 27
P. 154 - 2, 3, 4, 5
P. 156 - 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 18, 19, 22, 23, 24, 27, 28

IV. Special Activities

A. Projects
1. Air Glider.
2. A Bridge Model.
3. Center of Gravity Studies--a collection, as tops etc.
4. Defying Gravity--as a ping pong ball supported in mid-air by a water or air jet.
5. Highway Designs--curves, crossing etc.
6. Iceboat--mounted on rollers and with a fan show "tacking".
7. Airplane.
8. Momentum the Powerful--a comparative study of toy cars of different weight rolled down an incline.
9. Model Well Driller.
10. Model Building Architecture.
11. Principles of the Curve Ball.
12. Sailboat.
13. Traffic Safety--toy cars on model streets or highways.*
14. The Pile Driver.

B. Reports
1. Contributors in the Field.
2. Modern Safety Legislation.
3. The Age of Structural Steel
4. The Sea Captain
5. Visit another class or school.
6. What is a Navigator?
7. Why not be a Civil Engineer?

Related Student Activities

Demonstration No. 6
(continued)

C. Free Films

1. Across America in Eighteen Hours, two reels, silent, YMCA, Chicago, Ill.
2. A Chance to Lose, one reel, silent, Plymouth Corp., Detroit, Michigan.
3. Boulder Dam, four reels, sound, Dept. of Interior, Washington, D. C.
4. Bridging San Fransisco Bay, one and four reels, sound, U. S. Steel Corp., New York City.
5. Erection of the Goodyear Hangar, one reel, silent, Goodyear Tire and Rubber Co., Akron Ohio
6. Factory Safety, one reel, sound, Chevrolet Motor Co., Detroit, Michigan.
7. Follow the White Marker, one reel, silent, YMCA, Chicago, Ill.
8. Greatest Airship Dock, one reel, sound, Goodyear Tire and Rubber Co., Akron, Ohio
9. House that Ann Built, two reels, sound, Johns-Manville Corp.,New York City.
10. House that Jack Built, four reels, sound, American Gas Association, New York City.
11. Human Mileage, two reels, sound, YMCA, Chicago, Ill.
12. Making an All Steel Body, two reels, silent, American Museum, New York City.
13. One Point Landing, one reel, silent, Goodyear Tire and Rubber Co., Akron, Ohio.
14. Story of Time, two reels, silent, Elgin Watch Co., Elgin, Ill.
15. The World and Chrysler Motors, four reels, sound, Chrysler Corp., Chicago, Ill.
16. Tested on the Speedway, two reels, sound, YMCA, Chicago.
17. The King of the Rails, one reel, silent, General Electric Co., Chicago, Ill.
18. The Flying Cub, one reel, sound, YMCA, Chicago, Ill.
19. Whortle at the Wheel, one reel, sound, Hudson Motor Co., Detroit, Michigan.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	33; 167-183; 187-209
Modern Physics	138-169; 180-195; 268-269
New Physics in Everyday Life	157-178; 181-196; 205-218
New Elementary Physics	85-94; 102-128
Physics for Secondary Schools	8-11; 109-119; 145-171; 222-223

HOME MACHINES

Mechanics

Alternate demonstration No. 7

NAME_____ POINTS_____

In dealing with the problem of daily living it is often considered good philosophy to do things the easiest way. Suppose you wished to attend a football game in the neighboring city. Would you take an airplane, automobile, bicycle, or walk?

PROBLEM: How much work is it to carry a football fifty yards if the football player weighs 160 pounds in uniform, and the ball weighs 1 pound?

OUTLINE:

	Principles and Types	Equipment
I.	Moments and mechanical advantages	Typewriter, wheel barrow, crow bar, hammer, shovel.
	A. Levers	
	1. Classes	
II.	Mechanical advantages, work and effeciency.	
	A. Incline plane	Plank, wheel barrow.
	B. Wedge	Axe, saw.
	C. Screw	Jack Screw, bolts and nuts.
	D. Wheel and axle	Sewing machine, bicycle
	1. Gears	Cream separator, auto transmission.
	E. Pulleys	Wire stretcher, hay fork or carrier.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information references

1. Text

2.

KITCHEN MACHINES

Mechanics

Introductory Demonstration No. 7

NAME _____ POINTS_____

If a manager of a prominent hotel in New York City was to consider the hiring of a chef, it is probable that some man would secure the position. Yet if a guess should be made as to the sex of most of the "best cooks in the world", it is very likely that the women would be chosen.

PROBLEM; Suppose your uncle presented the family with a new electric refrigerator. It weighs 350 pounds, so how are you going to lift it up from the sidewalk to the porch, a height of four feet?

OUTLINE:

	Principles and Types	Equipment
I.	Moments and mechanical advantage	Fork, spoon, scissors,
	A. Levers	nut cracker, shovel,
	1. Glasses	axe.
II.	Mechanical advantage and efficiency	
	A. Incline plane	Bread board, table crumb remover.
	B. Wedge	Knife.
	C. Screw	Cork remover.
	D. Wheel and axle	Egg beater, flour sifter.
	E. Pulleys	Clothesline, pulley, window lift with pulley and weight.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers
2. Workbook
   Page

Information references

1. Text
2.

Related Student Activities

Demonstration No. 7

I. Experimentations — Pages

Principle of Moments	47
The Incline Plane	63
The Wheel and Axle	65
Pulleys	67
Coefficient of Sliding Friction	69
Machines and Efficiency	245

II. Study Reference

Pages 160-188

III. Exercises

P. 169 - 5, 6, 7, 8, 10, 11, 12, 14, 17
P. 179 - 3, 8, 9, 19, 20
P. 188 - 2, 9, 14, 17, 18, 19, 20, 25
P. 192 - 3, 7, 9, 10, 12, 13, 15, 18, 19, 20, 21, 23, 24

IV. Special Activities

A. Projects

1. Airplane Instructor--a device with a full size joy stick connected to elevators etc., of a mounted model plane to give actual response to manipulations.*
2. A disected Sewing Machine Head.*
3. An old Typewriter disected.*
4. Car Differential.*
5. Farm Machines--gears, bearings, pliers, etc.
6. Garden Tractor from discarded parts.
7. Model or Discarded Engines--auto, washing machine, etc.
8. Machine Samples from the Automobile.
9. Machines in the Kitchen.*
10. Model Airplanes.
11. Model Crane.*
12. Pulley Combinations.
13. Physics and Business.
14. Perpetual Water Faucet--a suspended faucet with a glass tube over which the water flows into a tank to be pumped up through the tube overflowing in the faucet spout etc.*
15. Steam Shovel.
16. Steam Turbine or Engine.*
17. Scoot-mobile or Power Bicycle.
18. The Human Body as a Machine--slides, pictures.
19. Transmission from an Auto.*
20. Westinghouse Air Brake.
21. Windmills.

Related Student Activities

Demonstration No. 7

(Continued)

B. Reports
1. Contributors in the Field.
2. How to Sew.
3. Historical Background of the Simple Machines.
4. Modern Business Machines.
5. Machines on the Playground.
6. Machines used at a Carnival.
7. Visit some other class or school.

C. Free Films
1. Automobile Lubrication, one reel, sound, Standard Oil Co., Chicago, Ill.
2. All American Choice, four reels, sound, Ray-Bell Films Inc., St. Paul, Minnesota.
3. Aces of Action, five and one half reels, sound, Minneapolis Moline Equipment Co., Minneapolis, Minn.
4. Accident Prevention, one reel, sound, Glen Falls Insurance Co., Glen Falls, New York City.
5. Body Framework, one reel, silent, University of Missouri, Columbia, Mo.
6. Conquest of the Forest, one reel, silent, YMCA, Chicago.
7. Diesel Engines, three reels, sound, International Harvester Co., Chicago, Ill.
8. Diesels working on the Railroad, one reel, sound, General Motors Co., Detroit, Michigan.
9. Evolution of Harvesting, one reel, sound, Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
10. Farmall does the Job; one reel, sound, International Harvester Co., Chicago, Ill.
11. Facts behind the News, three reels, sound, YMCA, Chicago.
12. Four Stroke Gas Engine, one reel, silent, W. H. Dudely, Visual Education Service, Chicago, Ill.
13. Indianapolis Speedway, two reels, sound, Gulf Oil Corp., Pittsburgh, Pa.
14. Indianapolis Race of 1937, two reels, sound, Firestone Tire and Rubber Co., Akron, Ohio.
15. International Harvester at the Century of Progress, one reel, sound, International Harvester Co., Chicago, Ill.
16. International Harvester Diesel, three reels, sound, International Harvester Co., Chicago, Ill.
17. International Power in Industry, one reel, sound, International Harvester Co., Chicago, Ill.
18. Knights of the Highway, one reel, sound, Chevrolet Motor Co., Detroit, Michigan.
19. Looking into the Farmall, three reels, sound, International Harvester Co., Chicago, Ill

Related Student Activities

Demonstration No. 7

(continued)

20. Modern Industrial Methods, four reels, silent, Singer Mfg., New York City.
21. Modes and Motors, one reel, sound, YMCA, Chicago, Ill.
22. Mountains of Copper, one reel, sound, General Electric Co., Chicago, Ill.
23. On the Job at the Ford Rouge Plant, four reels, sound, Ford Motor Co., Dept. of Photography, Dearborn, Mich.
24. One Point Landings, one reel, sound, Goodyear Tire and Rubber Co., Akron, Ohio.
25. Progress on Parade, three reels, sound, YMCA, Chicago.
26. Saving Seconds, two reels, silent, YMCA, Chicago, Ill.
27. The Car that outvalues them all, two and one half reels, sound, Pontiac Division, General Motors Co., Pontiac, Michigan.
28. The Gray Armada, one reel, sound, YMCA, Chicago, Ill.
29. Where Mileage Begins, two reels, sound, YMCA, Chicago

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	18-65; 178; 217-226
Modern Physics	196-247
New Physics in Everyday Life	219-265
New Elementary Physics	147-187
Physics for Secondary Schools	19-41; 178-199

ENERGY HORSES

Mechanics

Moving Bodies

Introductory Demonstrations No. 8

NAME _____ POINTS _____

Man's most rapid conquest of the physical earth began when he was able to harness energy forces other than his own.

PROBLEM: You are a traffic cop. Cars that travel at high rates of speed are a menace to human life. A 3000 pound car traveling 60 miles an hour will produce how many pounds force if it strikes a stationary object?

OUTLINE:

Energy and Forces	Equipment
I. Potential A. Molecular theory	Tin can with cover, gasoline, weights.
II. Kinetic A. Velocity and Acceleration 1. Piston travel 2. Traffic accidents B. Momentum and inertia 1. Traffic accidents	Old car engine, garage charts of automobiles, charts for insurance companies, last year's projects on Safety. Flywheel, student's automobile, pictures, news clippings, charts on gas mileage, instruction booklets for cars. Coin and paper the same size, moving pistons.
III. Gravitational A. Falling bodies B. Velocity and acceleration C. Momentum D. Inertia	Pendulum and falling weight.
IV. Reaction A. Centrifugal and centripetal B. Gyroscopic	Air cleaner for auto, diagram of driving on a curve, cream separator. Bicycle or car wheel

CONCLUSION:

ENERGY HORSES

(continued)

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information references

1. Text

2.

Related Student Activities

Demonatration No. 8

I. Experimentation — Pages

Motion — 241
Work, Energy and Power — 243

II. Study Reference

Pages 195-229; 233-248

III. Exercises

P. 207 - 4, 5, 6, 9, 13, 14
P. 211 - 4, 5, 6, 8, 10, 11, 14, 16, 21, 24, 25, 26
P. 230 - 2, 3, 4, 6, 8, 10, 11, 14, 15, 17, 19, 21, 23, 27
P. 249 - 2, 3, 7, 9, 10, 11, 13, 16, 19, 21, 22, 23, 24, 25
P. 254 - (1-10)

IV. Special Activities

A. Projects
1. Acceleration of Gravity--as a falling steel ball and a swinging pendulum arranged to strike.
2. A Babcock Tester.
3. Car Momentum in terms of Falling Objects.
4. Dissected Cream Separator.
5. Fly-ball Governor.
6. Gyro-car-a frame with two wheels designed to travel on a cable, the gyroscope being built into the frame*
7. Lawn Sprinker.
8. Model Highways.
9. Proney Brake--use on an electric motor.*
10. Roly-poly.
11. Tower of Pisa.

B. Reports
1. Contributors in the Field.
2. Centrifugal Clothes Dryer.
3. Energy Transformations in Sports.
4. Perpetural Motion.
5. Rotor Ships.
6. Tricks in Atheletics--curve ball, slicing, etc.
7. The Trajectory of Bullets.
8. The Physical Effects of High Speed Aviation.
9. Visit some other class or school.

C. Free Films
1. Cross-road Puzzle, two reels, sound, American Auto Association, Chicago, Ill.
2. Criminal on the Spot, one reel, sound, Standard Oil Ohio, Cleveland, Ohio.

Related Student Activities

Demonstration No. 8

(continued)

3. Diesel, The Modern Power, two reels, sound, YMCA, Chicago, Ill.
4. Farm and Industrial Use of the Tractor, one reel, silent, Cleveland Tractor Co., Cleveland, Ohio.
5. Farmall Farming Marches On, one reel, sound, International Harvester Co., Chicago, Ill.
6. Picture Story of Modern Power, one reel, silent, Cleveland Tractor Co., Cleveland, Ohio.
7. Power on Parade, four and one half reels, sound, Minneapolis Moline Power Implement Co., Minneapolis, Minnesota.
8. Progress on Parade, four reels, sound, General Motors Co., Detroit, Michigan.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	187-216
Modern Physics	170-196
New Physics in Everyday Life	157-178; 198-214
New Elementary Physics	93-94; 105-115; 121-128
Physics for Secondary Schools	145-166; 168-171

GROUP CONFERENCE REVIEW NO. 1 C

Mechanics

NAME_____ POINTS_____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our subject of External Mechanics is to be demonstrated by the operation of a bicycle.

I. Equipment

A. bicycle or engine.

II. Topics

A. Forces
1. Linear and angular
2. Equilibrium and stability
3. Vector
4. Composition and resolution
5. Parallel
6. Centrifugal and centripetal
7. Kinetic and Potential
8. Gravitational
a) Units of measure
b) Falling bodies
c) Velocity and acceleration
d) Momentum
e) Reaction

B. Machines
1. Lever
2. Incline plane
3. Wedge
4. Screw
5. Wheel and axle
6. Pulley

C. Formulas (General)
1. Moments
2. Mechanical advantage
3. Work
4. Power
5. Efficiency
6. Coefficient of friction

III. Demonstration of Class Projects

IV. Class Questions

ACHIEVEMENT RECORD NO. 1 C

Mechanics

NAME_____ POINTS_____

The following occupations are related to your course, do your best in filling the blanks.

I. Farmer

A. In the shipping of potatoes over long distance by truck during the late fall, it is to be noted that rising pressure means the approach of a _____and consequent _____skies with_____nights.

B. A wire stretcher with 2 fixed and 3 movable pulleys will give a maximum mechanical advantage of _____.

C. A wheelbarrow having a handle 6 feet from the axle, the center of gravity of the load 1 1/2 feet from the axle, can be used to haul_____pounds of dirt with a force of 80 pounds on the handles.

D. A snow shovel holds 15 pounds of snow. Used as a third class lever the right hand is one foot from the center of gravity of the snow, the left hand being used as a fulcrum is three feet from the right hand. The effort exerted by the right hand is _____ pounds.

II. Highway Patrol

A. If you observe that a car travels between two markers 176 feet apart on the highway in 2 seconds time, the speed of the car would be _____miles per hour.

B. A car weighing 2500 pounds and traveling 45 miles per hour would exert_____poundals or_____ pounds of momentum force in striking a stationary object.

C. A 3000 pound automobile would produce_____pounds of centrifugal force on the curve of a highway if its velocity is 60 miles per hour, the radius of the curve being 200 feet.

III. Shop Foreman

A. One of the men in the shop designed an engine for a derrick capable of lifting 3300 pounds to a height of 20 feet in one second. The horsepower rating of this engine is _____.

B. In constructing a supporting brace in the shape of a

ACHIEVEMENT RECORD NO. 1 B

(continued)

right triangle, the vertical force is 600 pounds, the horizontal force is 800 pounds and so the resultant or hypotenuse stress will be _____ pounds.

C. The company's official car was brought in for inspection. The ignition was checked including the spark plugs, distributor, _____, coil, generator, and storage battery. The fuel system, beginning with the gas tank, fuel line, _____, and pump, was cleaned. The valves were inspected and the intakes were found to be good, but the _____valve in cylinder number 3 was badly burned, resulting in a weakened_____stroke.

ACHIEVEMENT RECORD NO. 1 C

Key

I.

A. high
clear
cold
B. 6
C. 320
D. 60

II.

A. 60
B. 165,000
5,156,25
C. 3626.8

III.

A. 120
B. 1000
C. switch
carburetor
exhaust
compression or power

A MOTIVATED PHYSICS COURSE

Unit II

Heat

Proctor High School

Proctor, Minnesota

THE COOKING SCHOOL

Heat

Introductory Demonstration No. 9

NAME_____ POINTS_____

One of the interesting things about a cooking school is that whatever food there is prepared is usually given away to the patrons. With this thought in mind we might try a few experiments.

PROBLEM: The human body maintains an almost constant temperature of 98.6° F. To keep a stove at this temperature would require considerable fuel and care. How much heat is necessary to warm a tea kettle with one liter of water from 68° F. to 212° F., if the kettle alone requires 4000 calories?

OUTLINE:

	Topics	Equipment
I.	Source of heat	Oil stove, gasoline stove.
	A. Combustion	
	B. Friction	Flint and steel, match.
	C. Compression	Tire pump.
	D. Hammering	Hammer and iron.
	E. Electricity	Light bulb and suitable circuit.
II.	Nature of heat	
	A. Kinetic theory	Candle, piece of glass.
	B. Relation of heat and light	Glass painted black, sunlight, radiometer.
III.	Heat effects	
	A. Heat transfer	
	1. Conduction	
	2. Convection	
	3. Radiation	Thermos bottle.
	B. States of matter	
	1. Solid	
	2. Liquid	
	3. Gas	Source of heat, wax, ice.
	C. Temperature	Thermometers.
	D. Boiling point and pressure	Pressure cooker, cooking
	1. Plan a menu	chart, bring in meat, etc.
	E. Specific heat	
	F. Calorie	Food and fuel charts.

THE COOKING SCHOOL

(continued)

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

2. Workbook
   Page

Information references

1. Text

2.

Related Student Activities

Demonstration No. 9

I. Experimentation

II. Study Reference

Pages 256-365

III. Exercises

P. 259 - 2, 5, 6, 7
P. 263 - 1, 5, 6, 8, 9, 12
P. 269 - 2, 3, 5, 9, 11, 12, 13, 15, 17, 18, 19
P. 284 - 9, 10, 11, 14, 16, 20, 22
P. 291 - 7, 8, 9, 12
P. 292 - 1, 3, 10, 12, 13, 16, 21, 22
P. 312 - (1-25)
P. 343 - (1-37)
P. 345 - 2, 3, 4, 5, 7, 8, 9
P. 365 - (1-28)

IV. Special Activities

A. Projects
1. Arc Furnace.
2. A Cold Flame--carbon bisulfied and carbon tetrachloride mixed in equal parts can be burned on the hand.
3. A Davey Safety Lamp.
4. Blow Torch.
5. Building Materials and Insulations.
6. Boiling Water on Ice--test tube with boiling water on the top and ice at the bottom weighted.
7. Boiling Water by Cooling.*
8. Crucible Heater.
9. Conductivity Tests of Kitchen Utensils.
10. Coefficient of Expansion Recorder.
11. Distillation Apparatus.
12. Electric Stove using a Light Bulb.

Related Student Activities

Demonstration No. 9

(continued)

13. Exploding Gas Can.
14. Electric Toaster.
15. Food Values--calorie content and comparative costs.
16. Fireless Cooker.
17. Model Gas Engine.*
18. Molecular Giants--contraction and expansion due to heat.
19. Model Home Heating Plants--hot air, hot water, steam.
20. New and Old Kitchens--pictures, slides, or models.
21. Physics in the Kitchen.
22. Rating of Fuels.
23. Steam Engine.
24. Steam Turbine.*
25. Thermometers to Scale--Absolute, Centigrade, Fahrenheit*
26. Table Menu.
27. Thermostat.
28. Testing Fuels.

B. Reports

1. Automatic Heat Control Systems.
2. Comparative Study of Home Refrigerators.
3. Cutting down on the Fuel Bill.
4. Coal, Wood or Oil Furnaces.
5. Does Home Insulation Pay?
6. Efficient Cooking Methods.
7. Extreme Temperature Measures.
8. Evolution of the Steam Engine.
9. Fire Prevention in the Home.
10. Gas versus Diesel Power.
11. How to build Fires.
12. Mother Nature's Oven--volcanoes, geysers, etc.
13. Spontaneous Combustion.
14. The Modern Kitchen.
15. The Contributors in the Field.
16. Visit another class or school.
17. What is Air Conditioning?

C. Free Films

1. Automatic Arc Welding, two reels, silent, General Electric Co., Chicago, Ill.
2. Before and After, five reels, sound, Johns-Manville Corporation, New York City.
3. Beneath the Surface, three reels, sound, Johns-Manville Corp., New York City.
4. Burst into Flame, one reel, silent, Sinclair Coal Co., Kansas City, Mo.

Related Student Activities

Demonstration No. 9

(Continued)

5. Cool Heads, two reels, sound, Pu Pont de Nemours, Wilmington, Del.
6. Flame Hardening, one reel, silent, Linde Air Products, New York City.
7. How the General Electric Icing Unit Works, two reels, silent, General Electric Co., Chicago, Ill.
8. Just around the Corner, one reel, sound, General Electric Co., Cleveland, Ohio.
9. Modern Magic in Fire Protection, three reels, sound, Rockwood Sprinkler Co., Chicago, Ill.
10. Sounding the Alarm, one reel, sound, Aetna Casuality and Surety Co., Hartford, Conn.
11. Steam of the Turbine, one reel, silent, General Electric Co., Chicago, Ill.
12. Twin Power, one reel, sound, The Massey-Harris Inc., Racine, Wisc.
13. The Red Robber Fire, one reel, silent, Pyrene Mfg. Co., Newark, N. J.
14. The Bad Master, one reel, sound, Aetna Casuality and Surety Co., Hartford, Conn.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	232-322
Modern Physics	251-334
New Physics in Everyday Life	270-303; 319-361
New Elementary Physics	188-219; 222-271; 279-292
Physics for Secondary Schools	207-252; 256-340

GROUP CONFERENCE REVIEW NO. 2

Heat

NAME_____ POINTS_____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our subject, heat, is to be demonstrated by the operation of an electric refrigerator.

I. Equipment

An electric refrigerator, a steam engine, or Diesel engine.

II. Topics

A. Sources of Heat
   1. Combustion
   2. Friction
   3. Compression
   4. Hammering
   5. Electricity

B. Heat Measure
   1. Degrees
   2. Calories
   3. B. T. U.

C. Heat Effects
   1. Specific heat
   2. Heat of fusion
   3. Heat of vaporization

D. Heat Transfer
   1. Conduction
   2. Convection
   3. Radiation

E. Heat and Work
   1. Joule's law
   2. Law of Conservation of Energy

III. Demonstration of Class Projects

IV. Class Questions

ACHIEVEMENT RECORD NO. 2
Heat

NAME_____ POINTS_____

The following examples show how your course is related to practical life cases. The blanks are to be filled in as you think best.

I. Gardener

A. In protecting the potatoes in a pit from freezing, two tubs each containing 110 pounds of water were placed near by. In freezing this water would give off a total of _____calories heat.

B. Having broken the regular thermometer for the greenhouse, a Centigrade thermometer had to be substituted. The reading of 20° C. is equivalent to _____° Fahrenheit.

II. Housekeeper

A. In putting up a wire clothesline it was decided to use several short lengths, in place of two long ones, because 100 feet of wire having a coefficient of expansion of .0001 would under a temperature change of 100° expand _____.

B. If an apple contains 100 CALORIES of heat, this energy would be sufficient to heat 2 liters of water _____° C.

III. Plumber

A. Realizing that steam at the same temperature as hot water is much hotter, a radiator with a capacity of 2000 grams of steam would be equivalent to one of _____ grams of hot water capacity, all other factors being equal.

B. An experiment in the construction of radiators resulted in the computation of its specific heat. For instance 100 grams of the metal changing 1° C. requires as much heat as 89 grams of water changing only .1° C. Therefore the specific heat is _____.

IV. Cooking Demonstrator

A. If a pound of coal contains 8,500 BTU's of heat, a stove that is 25% efficient should heat _____ pounds of water 4° change in Fahrenheit temperature.

B. In the preparation of a picnic lunch a thermos bottle is used for the coffee, since the glass container prevents heat loss by _____, the vacuum a loss by _____, and the silvery finish a loss by _____.

ACHIEVEMENT RECORD NO. 2

Key

I.

A. 8,000,000
B. 68° F.

II.

A. one foot
B. 50° C.

III.

A. 12,800
B. 0.089

IV.

A. 2,125
B. conduction
convection
radiation

A MOTIVATED PHYSICS COURSE

Unit III

Sound

Proctor High School

Proctor, Minnesota

THE MUSIC STORE

Sound

Introductory Demonstration No. 10

NAME_____ POINTS_____

The possession of a pleasing voice is always an asset. Sound tends to classify as noisey or musical. Since we are judged very often by people we meet on "first impressions", the cultivation of pleasing voice tones is very important.

PROBLEM: A whistle is heard from a machine shop at 4 o'clock every afternoon, a distance of five miles away. Can a person located at this distance set his watch with accuracy?

OUTLINE:

Topics	Equipment
I. Nature of sound	Rubber band, pencil, tuning fork.
A. Wave patterns	Rubber hose, dish of water,
1. Mediums of transmission	weights, soap bubbles, oscillograph.
2. Longitudenal and transverse waves	
3. Condensation and rarefactions	
4. Velocity, frequency and wave length	
II. Noise and music	Old phonograph, new and old record, sticks of various lengths, bottles or glasses containing various amounts of water.
A. Musical instruments	
1. Strings	Violin.
2. Reed	Clarinet
3. Pipes	Trombone, fife.

CONCLUSION:

Problem assignment

1. Text
   Page
   Number

THE MUSIC STORE

(continued)

2. Workbook Page

Information reference

1. Text

2.

Related Student Activities

Demonstration No. 10

I. Experimentation — Pages

Wave Length of sound	173
Vibration Rate of a Tuning Fork	175
Vibrating Strings	177
Sound Measurements	273

II. Study Reference

Pages 371-419

III. Exercises

P. 381 - 5, 6, 7, 8, 11, 12, 14
P. 385 - 6, 7
P. 396 - (1-18)
P. 407 - (1-12)
P. 417 - 10, 11, 12, 15
P. 421 - (1-13)

IV. Special Activities

A. Projects
1. Drums.
2. Model Ear Structure.
3. Organ Pipes or Boat Whistles.
4. Piano Mechanism.
5. String Instruments--made from cigar boxes, glued wood.*
6. Siren.
7. Toy Piano.
8. Telephone.*
9. Toy Phonograph*
10. Xylophone--broom handles, bottles, glass tumbler, gas pipes.*

B. Reports
1. Contributors in the Field.
2. Let's Vacalize.
3. Noise or Music.
4. Pecularities of Ultra High Frequency Sound Waves.
5. Playing in the Band or Orchestra.
6. Radio Transcriptions in Education.
7. Sounding Devices in War.
8. The Hammond Organ.
9. Talking Pictures.
10. The Teletype Machine.
11. The Dictophone.
12. Visit another class or school.
13. Wave Recorders--phonograph, seismograph, etc.

Related Student Activities

Demonstration No. 10

(continued)

C. Free Films
1. Ambassadors of Safety, one reel, sound, Durkee-Atwood Co., Minneapolis, Minnesota.
2. Far Speaking, one reel, sound, Bell Telephone Co., City.
3. Finding His Voice, one reel, sound, Western Electric Co., New York City.
4. Magic of Communication, one reel, sound, Bell Telephone Co., City.
5. Operator, one reel, sound, Bell Telephone Co., City.
6. Out of the Silence, one reel, sound, YMCA, Chicago, Ill.
7. Telephone Memories, two reels, sound, Bell Telephone Co., Philadelphia, Pa.
8. The Voice of the City, one reel, sound, Bell Telephone Co., City.
9. The Voice that Science Made, one reel, sound, Bell Telephone Co., City.
10. Voices in the Air, one reel, sound, Bell Telephone Co., City.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	457-461; 503-539; 525-551
Modern Physics	356-376; 380-392
New Physics in Everyday Life	597-627; 633-647
New Elementary Physics	435-470
Physics for Secondary Schools	525-538; 549-568

GROUP CONFERENCE REVIEW NO. 3

Sound

NAME_____ POINTS _____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our subject, sound, is to be demonstrated by the operation of a piano. Removing the top and bottom case boards will enable us to study its construction and action as well.

I. Equipment

A. piano.

II. Topics

A. Nature of Sound
   1. Piano strings
      a) Tension
      b) Length
      c) Diameter
   2. Resonance
   3. Tone
      a) Pitch
      b) Quality
      c) Quantity
   4. Standards of Pitch

B. Noise and Music
   1. Harmony and discord
   2. Chords
   3. Scales
      a) Diatonic
      b) Chromatic
      c) Even tempered
   4. Fundamentals and overtones

C. Sound Effects
   1. Absorption
   2. Reflection
   3. Sympathetic vibration
   4. Interference
   5. Beats
   6. Velocity
   7. Doppler effect
   8. Echoe

D. Laws
   1. Strings
   2. Air columns
   3. Wave length

GROUP CONFERENCE REVIEW NO. 3

(continued)

E. Other Sound Instruments
   1. Lip
   2. Voice
   3. Reed
   4. Pipe
   5. String
   6. Radio tube

F. Instrument Combinations and Voice Groups

III. Demonstration of Class Projects

IV. Class Questions.

ACHIEVEMENT RECORD NO. 3

Sound

NAME_____ POINTS_____

The study of Sound has acquainted you with a number of problems common to the following occupations. Fill in the blanks correctly.

I. Piano Tuner

The key of A has 440 vibrations per second, but if the key of B makes 3 beats with it per second its frequency would then be _____ per second.

II. Violin Player

The G string of a violin has the _____ diameter. To increase its pitch it is only necessary to _____ the tension. To obtain other tones from this string it must be changed in _____.

III. Pipe Organ Builder.

In using a closed pipe for middle C of 256 vibrations per second, at a temperature of 20°C. it must be _____ long. An open pipe for the key of C' an octave higher would be _____feet long.

IV. Saxophone Artist

The tones of the saxophone are produced by a _____ and an open pipe. The chromatic scale contains_____ tones. In tuning the instrument the _____is changed.

V. Factory Worker

Hearing the seven o'clock morning whistle you set your watch but when you get to work you find that your watch is _____ slow. The temperature was 59°F and the distance 4 miles.

VI. Auto Driver

In driving to work you notice that the pitch of the horn of an oncoming car goes up, while that of a car going away goes down. This illustrates that _____effect.

ACHIEVEMENT RECORD NO. 3

Key

I.

443

II.

largest
tighten
length

III.

17.64 feet
4.41 feet

IV. vibrating reed
13
air column

V.

18.8 seconds

VI.

Doppler effect

A MOTIVATED PHYSICS COURSE

Unit IV

Light

Proctor High School

Proctor, Minnesota

THE MIRACLE

Light

Introductory Demonstration No. 11

NAME _____ POINTS _____

One of the world's most ancient miracles yet unsolved is that of light. Theories have been put forth in explanation, but in certain details they are not complete.

PROBLEM: If light travels at an approximate speed of 186,000 miles a second, how many times could it go around the earth in a second?

OUTLINE:

Topics	Equipment
I. Light sources	Candle, matches.
II. Light transmission	
A. Corpuscular theory	Pea shooter.
B. Wave theory	Soap bubbles
C. Quantum theory	News print showing concentric circles, magnifying glass.
III. Light measures	
A. Velocity	Chart showing Romer's method.
B. Foot-candles	Photometer, Light meter.
IV. Light properties	
A. Shadows, eclipses	Globe, ball, light source.
B. Reflection and refraction	Mirrors, plane and curved; lenses, convex and concave; screen, oil on water.
C. Transparent, translucent, and opaque.	Clear, frosted, and painted glass.
D. Color	Prism, color chart, paints, color wheel or top.
V. Light uses	
A. Vision	Convex lens and screen, model of the eye, box camera.
1. Shortsightedness	
2. Farsightedness	
3. Astigmatism	
4. Fatigue	
B. Illusions	
1. Refraction	Spoon, glass tumbler, water.
2. Reflection	Plate glass, candle, tumbler.
a) Mirage	
C. Interference	Flame, table salt, 2 glass plates, rubber bands.

THE MIRACLE

(continued)

VI.	Applications	
	A. Common	Reading glass, spectacles, camera, field glasses, projector, stereoscope.
	B. Unusual	
	1. Motion at rest	Stroboscope card, rotator or phonograph.
	2. Electrical eye	Photo-electric cell and relays,
	3. Polarized light	polaroid glass,
	a) Stress and strain studies	samples of cellophane, mica
	b) Non-glare applications	crystals, flashlight.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

Information reference

1. Text

2.

Related Student Activities

Demonstration No. 11

I. Experimentation

	Pages
The Photometer	183
The Law of Reflection	185
Images in a Plane Mirror	187
Images in a Curved Mirror	189
Light Waves	275
Index of Refraction	195
Convex Lens	197
Magnifying Power of Lenses	199
The Compound Microscope	201
The Telescope	203
Light Application	277-280

II. Study Reference

Pages 423-516

III. Exercises

P. 436 - (1-11)
P. 454 - 2, 3, 5, 7, 9, 10, 11, 15, 17, 19
P. 483 - 3, 9, 11, 12, 15, 16, 19, 21, 23, 24, 25, 28
P. 496 - (1-13)
P. 507 - (1-20)
P. 517 - 1, 2, 6, 9, 12, 13, 14, 15, 16, 20

IV. Special Activities

A. Projects
1. Arc Light.
2. Camera--pin hole for a lens.*
3. Color Fan--illustrate color combination or spectrum.
4. Clothes and Colors--use doll models.
5. Curtains, Rugs, etc.--center of interest being on color.
6. Davey Lamp.
7. Enlarger--an old camera suitably adapted.*
8. Good Pictures--composition, principality, balance, etc.*
9. Interior Decorating--wall samples, furniture, drapes, etc., might use cross-section of model doll house.
10. Inverse Square Apparatus.
11. Lighting the stage--puppet stage, school stage.*
12. Light Reflector for the Home--a clock operated reflector that throws the light into the north windows, particularly for apartment houses.

Related Student Activities

Demonstration No. 11

(continued)

13. Light Waves--a candle with curved pieces of tin mounted to represent light.*
14. Lighted or Colored Water Fall--light source, gelatin sheet of suitable color, light focused thru water into falling stream or fountain.*
15. Micro-projector--a hood placed over a microscope with a 45° angle mirror and ground glass viewer.*
16. Microphotography--camera adapted to a microscope.*
17. Model of the Eye.*
18. Models of the Eclipse.
19. Non-glare Auto Lights and Windshields--use polaroid film.*
20. Opaque Picture Projector--lights, mirror, and lens.*
21. Pictures on Silk.
22. Photography Processes-developing, printing, enlarging.
23. Projector Slides of Local Interest.*
24. Periscope.
25. Photometer.
26. Radio Light--moving scenes about a light due to a rotating fan above the bulb.
27. Singer Color Mixer--three lights with gelatin color slides and a piece of opal glass or ground glass for viewing.*
28. Stroboscope.*
29. Telescope.
30. "X-ray"--mirrors reflecting light around objects.
31. Yellow or Orange Flame reflections--burning table salt to give a single colored light in a dark room, use colored papers or cloth for testing.

B. Reports

1. Artistic Photography.
2. Colored Pictures.
3. Contributors in the Field.
4. Health and Light Rays.
5. Modern Improvements in Glass.
6. Photography as a Hobby.
7. Optical Illusions.
8. Printing in Colors.
9. Proper Lighting in the Home.
10. Range Finders.
11. Re-decorating the Home.
12. "Shooting" the Sun.
13. The 200 inch Telescope.
14. The Solar System.
15. Visit another class or school.
16. What is the Sun?

Related Student Activities

Demonstration No. 11

(continued)

C. Free Films

1. Brighter Times Ahead, one reel, sound, General Electric Co., Chicago, Ill.
2. Glass Magic, three reel, silent, Bausch and Lomb Optical Co., Rochester, New York.
3. How Movies Move and Talk, one reel, sound, Castle Films, Chicago, Ill.
4. Light for Living, three reels, sound, General Electric Co.
5. Light for Sight, two reels, sound, General Electric Co., Cleveland, Ohio.
6. Lenses, one reel, silent, Eastman Kodak Co., Rochester, New York.
7. Mazda Lamps Preferred, two reels, silent, General Electric Co., Chicago, Ill.
8. Stronger Lens for To-day's Hazards, one reel, sound, American Optical Co., Southbridge, Mass.
9. The Eyes of Science, one reel, silent, American Optical Co., Southbridge, Mass.
10. The Light of a Race, one reel, silent, General Electric Co., Chicago, Ill.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	555-636
Modern Physics	404-498
New Physics in Everyday Life	662-744
New Elementary Physics	487-556
Physics for Secondary Schools	580-660

GROUP CONFERENCE REVIEW NO. 4

Light

NAME_____ POINTS_____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our subject, light, is to be demondstrated by the operation of a moving picture projector.

I. Equipment

A moving picture projector, film and screen.

II. Topics

A. Operation of a Projector.
   1. Threading of the film
   2. Adjusting of the lens
   3. Framing
   4. Speed
   5. Single frame projection
   6. Reverse action

B. Operation of a Sound Projector (if available)
   1. Sound track
   2. Exciter and photo-electric cell lamps
   3. Speed
   4. Amplifier system

C. Light Effects
   1. Lenses
   2. Mirrors
   3. Transparent substances
   4. Translucent substances
   5. Opaque Substances
   6. Polarizing
   7. Crystals
   8. Liquids
   9. Gases

D. Spectrums

E. Color
   1. Primary
   2. Secondary

F. Formulas
   1. Wave length
   2. Focal length
   3. Image size
   4. Foot candles

GROUP CONFERENCE REVIEW NO. 4

(continued)

III. Demonstration of Class Projects

IV. Class Questions

ACHIEVEMENT RECORD NO. 4

Light

NAME_____ POINTS_____

The following occupations may be a part of your experiences some day. Fill in the blanks with the correct responses.

I. Window Decorator

A. Since white clothes _____light and radiant energy, it is called a seasonal color. Thus at the end of the summer the store manager orders a window display featuring a closing out sale of white goods. The background is requested to be in the primary colors of _____, _____, and _____.

B. A fall display of ladies dresses in the colors of rust, blue, and green is later ordered. The approved order of colors in the display should be _____, _____, and _____. A background of grey should be used because of its _____quality.

II. State Auto Light Inspector

The method of checking illumination consists in comparing the auto light with a standard 2 candle power lamp for equal illumination on a movable screen. The distance from the standard to the screen is 3 feet, from the screen to the light tested is 10 feet. Therefore the auto light has _____candle power.

III. Architect

In the design of a school house the window space should be _____ of the floor space in each class or study room. The wall surface should be of such a color and nature so as to give _____ light. The use of _____ brick is recommended as a means of securing more light. Angles of _____ always equal angles of reflection, consequently seats in the classroom must be arranged so that the light comes over the _____shoulder. Prismatic light fixtures are to be avoided since prisms give us the _____.

IV. Photographer

A. In constructing a box camera with a lens of 4 inch focal length, the object 40 feet away; the film must be _____ from the lens.

ACHIEVEMENT RECORD NO. 4

(continued)

B. To project an 8 mm moving picture upon a screen 8 meters away, the picture on the screen to be 1 meter in width requires that the lens be _____mm from the film.

V. Lens Salesman

Opening up the sample case you display a convex glass used for reading. The objects to be seen must be placed _____ focal length, the resulting image being _____. Next a camera lens, object must be _____ the focal length giving a _____ image. A copy camera lens is now shown, the object for this lens must be located at _____ and the image at _____. A projector lens requires the object being at _____ and the image located _____. Lastly, an objective lens for a microscope is shown in which the object must be placed _____ producing a _____ image.

ACHIEVEMENT RECORD NO. 4

Key

I.

A. reflect
red
yellow
blue

B. blue
rust
green
neutral

II.

22.2

III.

¼
soft or reflected
glass
incidence
left
spectrum

IV.

4.03 inches
64 mm.

V.

within
virtual or erect
beyond twice the
real or inverted
twice the focal length or 2 F
twice the focal length or 2 F
between F and 2 F
beyond 2 F
just beyond F
real or inverted

A MOTIVATED PHYSICS COURSE

Unit V

Magnetism and Electricity

Proctor High School

Proctor, Minnesota

THE PARTY LINE

Magnetism

Introductory Demonstration No. 12

NAME_____ POINTS_____

Curiosity is said to have been the mother of Invention. If this be accepted, Invention must have been her favorite son. Particularly is this demonstrated if the telephone receiver is gently lifted from the hook to "listen in".

PROBLEM: As district manager of the telephone system you are called on to give a demonstration before a local club. What kind of an educational program would you give?

OUTLINE:

Topics	Equipment
I. Permanent Magnetism	Lodestone, telephone or magneto U magnets, cobalt steel magnets, iron filings, compass, paper, copper strip, brass strip, tin strip.
A. Lines of force	
B. Earth's magnetism	Globe with bar magnet.
C. Theory of Magnetism	Test tube and iron filings, knitting needle, dip needle.
D. Formula	
II. Temporary Magnetism	Party line telephone
A. Electro-magnetism	Receiver, earphone, doorbell.
III. Magnetism and Electricity	
A. Current and a magnet field	Telephone or tractor magneto, students hold hands, first and last hold wires to magneto.
B. Induced currents	

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

Information reference

1. Text

Related Student Activities

Demonstration No. 12

I. Experimentation

	Pages
Magnetic Properties	101
Magnetic Fields	103
Applications of Magnetism	255
Magnetic Field	131
The Electro-magnet	133
The Electric Bell	135
Direct Current Motors	137

II. Study Reference

Pages 522-568

III. Exercises

P. 544 - (1-18)
P. 552 - 1, 4, 5, 6, 7, 8
P. 568 - 2, 3, 5, 9, 11, 14, 18, 21, 22

IV. Special Activities

A. Projects
1. Dipping Compass.
2. Declination Compass.
3. Derrick with a Lifting Magnet.
4. Door Bell Indicator--points to circuit on which bell was rung.
5. Electric Door Bell--various circuit combinations possible.
6. Electric Buzzer.
7. Electro-magnet with Experimentations.
8. Electric Chimes.
9. Electric Motor.
10. Lie Detector.
11. Nerve Tester--door bell in series with a tin plate having a number of graduated holes, an insulated needle completes the circuit, the object being to place the needle in the smallest hole without ringing the bell.
12. Ore Locator.
13. Telephone System.
14. Telegraph System.
15. The Submarine--made of cork with a piece of iron and controlled in the water by an electro-magnet under the water.
16. Watch De-magnetizer.
17. World Globe with magnetized Poles.

B. Reports
1. Contributors in the Field
2. Clearing the Highway of Nails.

Related Student Activities

Demonstration No. 12

(continued)

3. Discovery of the Magnetic Poles.
4. Electro-magnetic "Cures" on the Market.
5. History of the Compass.
6. Motors and their many uses.
7. Practical uses for the Electro-magnet.
8. The Earth Inductor Compass
9. Visit another class or school.

C. Free Films

1. Dynamic America, one reel, sound, Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.
2. Story of Electricity, one reel, sound, McCrory Studios, New York City.
3. The Modern Zeus, one reel, sound, General Electric Co., Chicago, Ill.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	329-343
Modern Physics	500-513
New Physics in Everyday Life	365-381
New Elementary Physics	297-309
Physics for Secondary School	345-362

GIANTS AT REST

Electricity

Static

Introductory Demonstration No. 13

NAME_____ POINTS _____

One of natures wonders, recognized and marvelled at ever since the earliest dawn of man, is that of lightning. Strange and forboding this "Giant" may seem, yet its constitutents are common to all things about us.

PROBLEM: A certain general science teacher has requested you to demonstrate before her class how to make electricity. If Benjamin Franklin could have done so in the 18th century, how would you go about it today?

OUTLINE:

	Topics	Equipment
I.	Charges by friction	Combing dry hair.
	A. Negative charge	Rubber rod, flannel.
	B. Positive charge	Glass rod, silk.
	C. Induced charge	Pitch balls, scraps of paper, pencil and paper.
II.	Charges by Static Machine	
	A. Interesting demonstrations	Dancing pith dolls, gas tubes such as neon, mercury; bells, demountable condensor cups, lightning plate, whirling points, etc.

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

Information reference

1. Text

2.

MYSTERY RADIATIONS

Electricity

Ionization

Introductory Demonstration No. 14

NAME_____ POINTS_____

An interesting, yet peculiar phenomenon of nature is the transmission of energy around and even through our bodies without affecting us.

PROBLEM: You are a local dentist. A. P. T. A. committee has asked you to speak on "Radiations and their usefulness". What are you going to show and tell them?

OUTLINE:

	Topics	Equipment
I.	Electrical charges	Electroscope, luminous dial clock, hair comb.
	A. Positive	
	B. Negative	
II.	Ionization	
	A. Liquids	Tumbler of salt water solution, cup of clean water, electrodes, light bulb, suitable circuit. Three hole jar, stoppers, two electrodes, glass tubing, two dishes of soap solution, battery
	B. Gases	High tension coil as Model T coil, batteries, gas tubes, old neon signs.
III.	Infra-red rays	
	A. Trial picture in the dark	Camera, infra-red film, flat-iron object like a small bust.
	B. Trial picture of clouds of distance	As above but with infra-red filter, use usual film with filter.
IV.	Ultra-violt rays	Mercury arc lamp, flourescent material and paints.
	A. Trial Pictures	XX-Super-sensitive film, filter,
	B. Black light alarm	Photo-electric cell and relays.
V.	Radium	Microscope, radium slide, black cloth hood.

MYSTERY RADIATIONS

(continued)

VI. X-rays
A. Theory — Diagram, x-ray, tube for static machine, film, flourescent screen, local dentist equipment pictures.

B. Trial pictures

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

Information reference

1. Text

2.

THE ELECTRIC SHOP

Electricity

Measurement

Introductory Demonstration No. 15

NAME_____ POINTS_____

It is perhaps about as important to appreciate and understand the operation and functions of a modern electrical household appliance as it is to know hot to use the fountain pen.

PROBLEM: Dad has asked you to help him pick out a flat iron for mother's birthday present. At the local store irons are stamped 550, 660, 750, and 1000 watts. What explanation can you offer?

OUTLINE:

	Topics	Equipment
I.	Home Appliances	Vacuum cleaner, electric shaver,
	A. Motor type	washing machine, electric mixer,
	B. Resistance style	Stove, curling iron, percolator,
	C. Transformer type	toaster.
		Radio, door bell transformer.
II.	Meters	
	A. Current indicator	Galvanometer
	B. Voltage recorder	Voltmeter
	C. Current measure	Ammeter
	D. Resistance indicator	Ohmmeter, Wheatstone bridge.
	E. Power recorder	Meter dial board, Watt-meter.
III.	The Electric Power and Light bill.	
	A. Chart to be filled	Equipment as listed above.

Appliance	Volts	Amperes	Watts	Cost	Hours	Monthly Cost

THE ELECTRIC SHOP

(continued)

Appliance	Volts	Amperes	Watts	Cost	Hours	Monthly Cost

CONCLUSION:

Problem assignment

1. Text
   Page
   Numbers

Information reference

1. Text
2.

Related Student Activities

Demonstrations No. 13, 14, and 15

I. Experimentations — Pages

A. No. 13
Static Charges — 256

B. No. 14
Cells — 109-111
Electromotive Force — 113
Electroplating — 141
The Lead Storage Cell — 143
Electrical Chemical Effects — 263

C. No. 15
Laws of Resistance — 115-121
Cells in Series and Parallel — 123
Wheatstone Bridge — 125
Practical Electricity — 257
Electrical Hook-ups — 259
Efficiency of Electrical Heating Devices — 145, 265

II. Study Reference

A. Pages 571-586
B. Pages 662-677; 650-660
C. Pages 589-632; 635-646; 680-711

III. Exercises

A. P. 586 -(11-23)

B. P. 675 - 1, 6, 9, 10, 13
P. 678 - 1, 2, 7, 12, 13, 14, 15, 17, 20, 22, 23
P. 661 - (1-17)

C. P. 605 - 2, 3, 6, 7, 8, 10, 12, 14, 15, 18, 21, 23
P. 618 - 4, 7, 11, 13, 18
P. 630 - 3, 5, 6, 8, 10, 11, 13, 14, 15
P. 633 - 4, 5, 11, 14, 15, 20
P. 647 - 2, 6, 7, 8, 9, 14, 15, 16
P. 688 - 3, 7, 9, 11
P. 698 - 4, 6, 8, 10
P. 704 - 1, 3, 7, 10
P. 711 - 4, 7, 8, 12
P. 714 - 4, 13, 20, 23, 25, 26, 28, 30

IV. Special Activities

A. Projects
1. Alarm Clock Time Switch--for radio, stove etc.
2. Arc Light.
3. Automobile Ignition System--old car parts.*

Related Student Activities

Demonstrations No. 13, 14 and 15

(continued)

4. Arc Furnace.
5. Ammeter.
6. Burglar Proof Car--starter in circuit with the horn using a two way switch.
7. Burglar Alarm for the House--hidden contact switch on windows and doors.
8. Board of Meter Dials.
9. Electric Motor.*
10. Electro-plating Apparatus.
11. Electric Shocking Chair.
12. Edison Cell.
13. Electric Toaster.
14. Electric Decorating Needle.
15. Electrolysis of Water--arrange apparatus so that gases may be led to combine in a soap solution forming bubbles that may be ignited.*
16. Electric Watt Meter--old one dissected.
17. Generators.
18. Galvanometer.
19. Insect Killer.
20. Induction Coil.
21. Jumping Ring--1000 turn solenoid.
22. Model House with Lighting System.*
23. Mystic Light--light with hidden wires.
24. Magneto Shocking Device.*
25. Portable Electric Stove--resistance wire or light bulb in a black can.
26. Reactance Coil and Spot Welding.*
27. Reaction Tester--regular auto parts as a seat, steering wheel, clutch, brakepedal, gas accelerator, three semaphore lights and switches so arranged that a sensitive timing device records the time between the flash of the red light and application of the brake etc.*
28. Rectifiers--liquid or tube.
29. Static Machine--use junk parts.
30. Static Electrification Materials.
31. Swinging Coil--a coil of insulated wire swung thru the earth's magnetic field, in circuit with a sensitive relay and a light hook-up.*
32. Soldering Iron.
33. Simple Cell.
34. Storage Cell.
35. Synchronous Motor.
36. Short Wave Diathermy.
37. Table Lamp.
38. Tesla Coil.*
39. Thermostat Circuit.
40. Transformer with Lights in the Primary and Secondary.*

Related Student Activities

Demonstrations No. 13, 14 and 15

(continued)

41. Voltmeter.
42. Weiner Electrocuter--two insulated pegs in series with a 75 watt lamp.*

B. Reports

1. Contributors in the Field.
2. Electricity for the Farmer.
3. Electric Welding.
4. Federal or Private Ownership of Utilities.
5. How to become an Electrician.
6. Long Distance Power Transmission.
7. National Electrification.
8. Operating an Electrical Shop.
9. Prevention of Accidents.
10. Pictures and Lighting.
11. Pictures by Wire.
12. Servicing Appliances.
13. Signs on the Street.
14. The Electric Light Bill.
15. Visit another class or school.
16. Wiring a Five Room House--include a diagram.
17. What Happens in the Local Telephone Exchange.

C. Free Films

1. Along the Firing Line, two reels, silent, American Museum of Natural History, New York City.
2. Alternating Current Motors, three reels, silent, Otis Elevator Co., New York City.
3. Approved by the Underwriters, four reels, silent, Underwriters Laboratories, Chicago, Ill.
4. Arc Welding, one reel, silent, Lincoln Electric Co., Cleveland, Ohio.
5. A Modern Knight, two reels, sound, Bell Telephone Co., City.
6. Champions at Work, one reel, sound, Champion Spark Plug Co., Toledo, Ohio.
7. Champions Use Champions, one reel, sound, Champion Spark Plug Co., Toledo, Ohio.
8. Chemical Effects of Electricity, one reel, silent, Akin and Bagshaw Inc., Denver, Colorado.
9. Diesel Electric Switchers, three reels, sound, Westinghouse Electric Co., East Pittsburgh, Pa.
10. Enameling by Electric Heat, one reel, silent, General Electric Co., Chicago, Ill.
11. Electric Spot Welding, one reel, sound, General Electric Co., Chicago, Ill.
12. Electric Needle, two reels, silent, General Electric Co., Chicago, Ill.
13. Electric Heat In Industry, three reels, silent, General Electric Co., Chicago, Ill.

Related Student Activities

Demonstrations No. 13, 14 and 15

(continued)

14. General Electric at the World's Fair, one reel, sound, General Electric Co., Chicago, Ill.
15. Getting Together, one reel, sound, Bell Telephone Co., City.
16. Induced Currents, one reel, silent, Eastman Kodak Co., Rochester, New York.
17. Induction Voltage Regulator, two reels, silent, General Electric Co., Chicago, Ill.
18. Kilowatt Trail, one and one half reels, sound, Westinghouse Electric Co., East Pittsburgh, Pa.
19. Mazda Lamp Manufacture, two reels, silent, General Electric Co., Chicago, Ill.
20. Moving the Millions Electrically, five reels, sound, General Electric Co., Chicago, Ill.
21. New Frontiers, two reels, sound, Westinghouse Electric Co., East Pittsburgh, Pa.
22. Power Transformers, two reels, silent, General Electric Co., Chicago, Ill.
23. Prime Electric Fence, one reel, silent, Prime Mfg. Co., Milwaukee, Wisc.
24. Ready Kilowatt, one reel, sound, Packard Electric Division, General Motors Corp., Warren, Ohio.
25. Story of Electricity, one reel, sound, McCrory Studios, New York City.
26. Storage Battery Power, one reel, sound, Thomas A. Edison Inc., Orange, N. J.
27. Trackless Electric Transportation, one reel, sound, General Electric Co., Chicago, Ill.
28. The Conductor, one reel, silent, General Electric Co., Chicago, Ill.
29. The Benefactor Thomas A. Edison, two reels, silent, General Electric Co., Chicago, Ill.
30. The Busybody, one reel, silent, General Electric Co., Chicago, Ill.
31. Volt comes into its own, two reels, sound, General Electric Co., Chicago, Ill.
32. Willard and You, four reels, sound, Willard Storage Battery Co., Cleveland, Ohio.
33. What's Watt, one reel, sound, Packard Electric Div., General Motors Corporation, Warren, Ohio.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages		
	A	B	C
Elementary Practical Physics	346-366	368-371 : 396-399 : 418-428	371-417 : 429-298

Related Student Activities

Demonstrations No. 13, 14 and 15

(continued)

	A	B	C
Modern Physics	516-534	570-582	547-665
New Physics in Everyday Life	385-410	414-443	443-564
New Elementary Physics	312-333	338-342	355-366
		368-381	382-434
Physics for Secondary Schools	365-387	391-395	395-438
		438-446	450-521

GROUP CONFERENCE REVIEW NO. 5A

Magnetism and Electricity

NAME_____ POINTS____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our two subjects, magnetism and electricity are so closely related that they shall be taken together. The demonstration of the high frequency coil shall be used to recall to mind some of the important topics studied.

I. Equipment

-A high frequency coil with accesories as an iron rod, a 10 watt lamp, gas filled tubes such as neon, mercury, etc., Crooke's tube, gas burner; a photo-electric cell with relays; or a high tension coil with accessories as listed above.

II. Topics

A. Demonstrations.
1. Making Ozone
2. Human electrode
3. Brush discharge thru the hair
4. Lighting the gas burner
5. Wireless electric light
6. Gas tube illumination
7. Crooke's tube
8. Series and parallel circuits with students
9. Jacob's ladder

B. Magnetism
1. Natural
2. Artificial
   a) Permanent
   b) Temporary

C. Electro-magnets
1. Communications
   a) Bells
   b) Telegraphs
   c) Telephones
2. AC and DC motors
3. Generators and Magnetoes
4. Transformers and Induction Coils

D. Resistances
1. Lights
2. Heating units

GROUP CONFERENCE REVIEW NO. 5A

(continued)

E. Electro-chemical
   1. Dry cells
   2. Storage batteries
   3. Rectifiers

F. Ionization
   1. Metal plating
   2. Gas tubes
   3. Photo-electric cell
   4. Radio tubes

G. Electrical Measure
   1. Galvanometer
   2. Ammeter
   3. Voltmeter
   4. Ohmmeter
   5. Wheatstone bridge

H. Formulas and Rules
   1. Ohm's
   2. Right hand
   3. Polarity
   4. Capacity
      a) Series
      b) Parallel
   5. Resistance
      a) Series
      b) Parallel

   6. Watts
   7. Heat
   8. Power cost.

III. Demonstration of Class Projects

IV. Class Questions.

ACHIEVEMENT RECORD NO. 5A

Magnetism and Electricity

NAME_____ POINTS_____

Problems always come up in occupations, Your experiences in the future might include one or more of the following. Fill the blanks correctly.

I. A Jeweler

An electrician brought his watch in to your establishment since it had become magnetized by _____. In de-magnetizing the north polarity should be rubbed with a _____. The lines of force passing from the two ends of a magnet constitute a_____.

II. An Aviator

The earth inductor compass consists of a coil of wire rotated thru the _____magnetic field. It is only in the plane of a _____ direction that a current will be produced thus acting as a _____.

III. An Author

The theory of magnetism supposes the particles of a magnet to be as _____. Thus a piece of soft iron if _____ by another magnet will become_____by re-arrangement of molecules. An increased number of electrons beyond the state of neutrality is called a_____charge. Such a charge may produce an_____charge in the immediate vicinity. The equalizing of two charges by a movement of electrons is called a_____.

IV. Trouble Shooter

In a telegraph set, coils of insulated wire wound around an iron core makes up an_____. The strength of such a device depends upon _____ and the strength of the current. If the resistance is 200 ohms and the current is .1 amperes the voltage must be_____.

V. An Armature Winder

An alternating current motor has _____ rings while a direct current motor has _____rings or commutator. ACmotors usually have a _____field. If the current divides(some going thru the armature, some thru the field) the motor is known as _____. A motor rated as 1/2 h.p. if 100% efficient, would use_____watts of electricity.

ACHIEVEMENT RECORD NO. 5 A

Key

I.

induction
south
field

II.

earth's
north and south
compass

III.

magnets
stroked
magnetized
negative
induced
current

IV.

electro-magnet
number of turns, or size of the wire
20

V.

slip
split
rotating
shunt wound
373

THE RADIO BUG

Electricity

Introductory Demonstration No. 16

NAME_____ POINTS_____

Since in previous demonstrations we have been able to detect invisible transmissions of energy, it should be possible to continue by explaining how the so called radio waves are transmitted and received.

PROBLEM: A group of friends were gathered in your home about the radio. The general discussion has swung to radios and how they operate. You are going to explain this for them.

OUTLINE:

Topics	Equipment
I. Radio in the home	House radio, "Radio Digest" magazine.
A. Operation	
B. Trouble "shooting"	
1. Fading	
2. Weak signals	
3. Noise	
4. Poor reproduction	
C. Program selection	Free bulletins such as "Day by Day" from NBC, "Am. School of the Air" from CBS, "Ed. by Radio" by Nat. Comm. on Ed. by Radio, New York City, bulletins from Dept. of Interior, Washington.
II. Radio communication	
A. Tuned systems	Two similar tuning forks.
B. Tuned radio systems	
1. Transmitting station	Block diagram on board
a) Oscillator	
b) Microphone	Spark coil, key, batteries, antenna; or a simple tank circuit of induction coil, condensor, 01A tube, battery, key.
c) Modulator	
d) Antenna	
2. Transmission	
a) Carrier wave	
b) Sound wave	Prepare a chart of waves for comparison.
c) Modulated wave	
e) Radiated wave	

THE RADIO BUG

(continued)

3. Receiving station
   a) Aerial
      1) Tuned in modulated carrier wave — Crystal set with aerial and phones
   b) Detector
      1) AC high frequency to audio DC
   c) Phones
      1) Audio DC to sound

III. Radio circuits
   A. Principles of tuning — One tube radio of single circuit or regenerative design.
      1. Formulas
         a) Wave length
         b) Ohm's law
         c) Radio frequency
   B. Detection
      1. Crystal
      2. Tube
   C. Amplification — One tube transformer amplifier.
      1. Tube
      2. Transformer
      3. Resistance coupling
      4. Push-pull

IV. Modern radio
   A. Hetrodyne circuits — Two tuning forks as in part II, except one should be weighted with a piece of chalk.
   B. Latest type of circuit — Block diagram on board.

CONCLUSION:

Problem assignment
   1. Text
      Page
      Numbers

Information reference

   1.

Related Student Activities

Demonstration No. 16

I. Experimentation — Pages

The Vacuum Tube	167
Communication Circuits	269 -274

II. Study Reference

Pages 719-751

III. Exercises

P. 725 - 1, 2, 4, 6, 9
P. 729 - (1-11)
P. 736 - 1, 2, 3, 5, 7, 8
P. 753 - (1-9)

IV. Special Activities

A. Projects
1. Crystal Set Receiver
2. Five Meter Transreceivers.
3. One Tube Radio.
4. Photo-electric Cell Circuits.
5. Phonograph Pick-up.
6. Short-wave Radio Sets.
7. Two Tube Radio
8. Three Tube Radio
9. Television Receiver.
10. Wireless Telegraph.

B. Reports
1. A Survey of Local Schools using the Radio in the Classroom.
2. Contributors in the Field.
3. Educational Radio Programs for School Use.
4. How to obtain a License.
5. Possibilities of Television.
6. Should Radio Broadcasting Systems be Privately or Publically owned?
7. The Radio Service Man.
8. Visit Anther class or school.
9. What's New on the Air?
10. What is the Latest in Radio?

C. Free Films
1. Cathode Ray Tube, one half reel, sound, General Electric Co., Chicago, Ill.
2. Earth's Four Corners, one reel, silent, American Museum of Natural History, New York City.
3. Magic Versus Science, one reel, sound, General Electric Co., Chicago, Ill.

Related Student Activities

Demonstration No. 16

(continued)

4. Network Broadcasting, one reel, sound, Bell Telephone Co., City.
5. New Voice Highways, one reel, sound, Bell Telephone Co., City.
6. Wizardry of Wireless, two reels, silent, General Electric Co., Chicago, Ill.

V. Supplementary Textbooks with reference pages. Refer to page 3 for authors and publishing companies.

Title	Pages
Elementary Practical Physics	603-606; 637-640; 646-687
Modern Physics	473-475; 667-704
New Physics in Everyday Life	571-594; 727-737; 756-765
New Elementary Physics	565-606; 620-622
Physics for Secondary Schools	583-586; 660-665; 678-720

GROUP CONFERENCE REVIEW NO. 5 B

Electricity and Radio

NAME_____ POINTS_____

The class has been called into conference for the purpose of reviewing the work of the past weeks. Our study of electricity continues with radio and will be demonstrated by means of a public address system. (If possible remove the chassis.)

I. Iquipment

A. Public address outfit, or a large radio.

II. Topics

A. The sending circuit
   1. Oscillator
   2. Miscrophone
   3. Modulator
   4. Antenna system

B. Radio waves
   1. Characteristics
      a) Related wave properties
      b) Wave lengths
      c) Frequencies
         1) Broadcast
         2) Short Wave
         3) Ultra-short Wave
      d) Heaviside layer
   2. Audio frequency waves
   3. Radio frequency waves

C. Receiving Circuits
   1. Tuning
   2. Detector
   3. Amplifier
   4. Hetrodyne

D. Electrical Circuits
   1. Crystal
   2. One tube
   3. Phonograph pick-up and recording
   4. Public address
   5. Remote control
   6. Television

III. Demonstration of Class Projects

IV. Class Questions

ACHIEVEMENT RECORD NO. 5 B

Electricity and Radio

NAME_____ POINTS____

The field of Electricity holds many opportunities for service. Fill in the following blanks to the best of your ability.

I. An Electric Shop Apprentice

Some of the customers have purchased rectifiers that change_____for the purpose of charging batteries. Generators or dynamos consist of rotating coils cutting _____field. A magneto is similar to a generator except that the field is furnished by_____and the current is of_____commonly known as high tension.

II. A Home Owner

The light fixtures are all connected in_____and the switches are in_____. The usual size of wire is No.____. Sockets for appliances should be wired with No. 12 so as to prevent_____. Appliances with resistance units like flat irons and stoves usually cost_____to operate than those with motors. For instance a washing machine motor using 200 watts, four hours a month at 10 cents a KWH would cost_____while a flat iron of 800 watts used only 4 hours a month would cost_____at the same rate of 10 cents a KWH.

III. X-ray Operator

Electrical currents travel thru liquids by means _____ and thru gases by means of_____. The less air in a vacuum tube the_____the current travels. In x-ray tubes the flow of electricity strikes a target producing_____ radiations.

IV. Radio Expert

In the broadcast of programs as _____ is used to set up a carrier wave, while a_____patterns the microphone current, the combination being the current in the _____ circuit. A simple receiver consists of an aerial,_____ _____, _____, and phones. The purpose of a _____ tube is for amplification and _____. Loud speakers are similar in function to _____on a simple set. Radio waves travel at the rate of _____. Tuning dials are calibrated in_____. A station having a wave length of 300 meters would have a frequency of _____.

ACHIEVEMENT RECORD NO. 5 B

Key

I.

AC to DC
a magnetic
permanent magnet
high voltage

II.

parallel
series
14
fire or overloading
more
0.08
0.32

III.

ions
ions or electrons
faster
light or x-ray

IV.

oscillator
modulator
antenna
tuning coil
detector
rectification
receiver
light or 186, 284 miles per second
kilocycles
1000 kilocycles

LIBRARY REFERENCE BOOKS

Abbot, C. G. Everyday Mysteries, MacMillan Company, New York City. 198p.

American Radio League Staff The Radio Amateur's Handbook, 14th edition American Radio Relay League, West Hartford, Conn. 422p.

Andrade, E. N. da C. An Hour of Physics, J. B. Lippincott & Co., Philadelphia, Pa. 160p.

Bridges, T. C. Young Folks Book of Inventions, Little Brown and Co., Boston, Mass. 287p.

Buckley, H. A Short History of Physics, D. Van Nostrand Co. Inc., New York City. 254p.

Buckingham, E. Principles of Interchangeable Manufacturing, Industrial Press, New York City. 254p.

Bucher, E. E. Practical Wireless Telegraphy, Wireless Press Inc., New York City. 336p.

Bucher, E. E. The Wireless Experimenter's Manual, Wireless Press Inc., New York City. 340p.

Carpenter, H. A. and Wood, G. C. Our Environment--How We Use and Control It, Allyn and Bacon, Chicago, Ill. 704p.

Caldwell, O. W. and Slosson, E. E. Science Re-making the World, Doubleday Page & Co., New York City. 292p.

Cotter, J. and Jaffe, H. Heroes of Science, Little Brown & Co., Boston, Mass. 189p.

Collins, A. F. Boy's Book of Experiments, Thos. Y. Crowell Co., Springfield, Ohio. 315p.

Collins, A. F. New World of Science, J. B. Lippincott & Co., Philadelphia, Pa. 297p.

Collins, A. F. Fun with Electricity, D. Appleton & Co., New York City, 238p.

Collins, A. F. Amateur Mechanic, D. Appleton & Co., New York City. 208p.

Collins, A. F. Experimental Mechanics, D. Appleton & Co., New York City. 302p.

Crew, H. General Physics, MacMillan Co., New York City. 617p.

Darrow, F. L. Boy's Own Book of Science, MacMillan Co., New York City. 331p.

LIBRARY REFERENCE BOOKS

(continued)

Decker, W. F. Story of the Engine, Chas. Scribner's Sons, New York City. 277p.

DeKruf, P. Microbe Hunters, Harcourt Brace & Co., New York City. 363 p.

Dillon, J. H. and Lewis, M. S. Electricity, McGraw Hill Book Co., New York City. 91p.

Duncan, R. K. The New Knowledge, A. S. Barnes Co., New York City. 263p.

Einstein, A. and Infield, L. The Evolution of Physics, Simon and Schuster, New York City. 319p.

Exelby, C. L. and Gambill, L. B. Science Club Manual, National Club Manual Co., Lansing, Michigan. 92p.

Fabre, J. H. Story Book of Science, The Century Co., New York City. 400p.

Ghirardi, A. Radio Physics Course, Radio Technical Publishing Co., New York City. 972p.

Gibson, C. R. How Telephones and Telegraphs Work, Seeley Service & Co., London, England. 156p.

Gibson, C. R. Scientific Amusements and Experiments, Seeley Service & Co., London, England. 209p.

Hart, I. B. Makers of Science, Oxford University Press, London, England. 314p.

Hawkins, V. D. Applied Physics, Longmans Green & Co., New York City. 199p.

Hill, C. H. and Johnston, W. H. New Wonder Book of Knowledge, John C. Winston Co., Philadelphia, Pa. 594p.

Holland, M. Industrial Explorers, Harper & Brothers, New York City. 347p.

Hoag, J. B. Electron Physics, D. Van Norstrand Inc., New York City. 208p.

Hodge, C. Nature Study and Life, Ginn and Co., Chicago, Ill. 514p.

Houston, E. J. Wonder Book of the Atmosphere, Fredrick A. Stokes & Co., New York City, 326p.

LIBRARY REFERENCE BOOKS

(continued)

Hull, G. F. An Elementary Survey of Modern Physics, The MacMillan Co., New York City. 457p.

Iles, G. Leading American Inventories, Henry Holt & Co., New York City. 447p.

Jeans, J. H. Mysterious Universe, MacMillan Co., New York City. 188p.

Kallet, A. and Schlink, F. J. 100,000,000 Guinea Pigs, Van Guard Press, New York City. 312p.

Lansing, M. F. Great Moments in Science, Doubleday Doran & Co., New York City. 265p.

Lodge, O. Pioneers of Science, MacMillan Co., New York City. 404p.

Millikan, R. A. Science and the New Civilization, Chas. Scribner's Sons, New York City. 194p.

Monteith, J. Popular Science Reader, American Book Co., Chicago, Ill. 360p.

Morgan, A. P. Boy's Book of Science and Construction, Lothrop Lee & Shepard Co., Boston, Mass. 451p.

Newcomb, S. Astronomy for Everybody, Doubleday Page & co., New York City. 333p.

Norris, M. Heroes of Hazards, MacMillan Co., New York City. 184p.

Osborn, F. A. Physics of the Home, McGraw Hill, New York City. 390p.

Person, F. J. General Physics for Home Economic Students, John Wiley & Sons, New York City. 286p.

Phillips, M. C. Skin Deep, Van Guard Press, New York City. 254p.

Rohan, B. J. Exploratory Science, Thomas Nelson & Sons, New York City. 252p.

Rush, C. E. and Winslow, A. Science of Things About Us, Little Brown Co., Boston, Mass. 310p.

Rusk, R. D. How to Teach Physics, J. B. Lippincott & Co., Philadelphia, Pa. 186p.

LIBRARY REFERENCE BOOKS

(continued)

Serviss, G. P. Astronomy with a Naked Eye, Harper & Brothers Co., New York City. 247p.

Sater, L. E. and Peet, L. J. Household Equipment, John Wiley & Sons, New York City. 315p.

Sheldon, H. H. Space Time and Relativity, University Society Inc., New York City. 98p.

Sheldon, L. Continuous Bloom in America, Charles Scribner's Sons, New York City. 145p.

Skilling, W. T. Tours Through the Fields of Science, McGraw Hill, New York City. 758p.

Sloane, T. O. How to become a Successful Electrician, Norman Henley Publishing Co., New York City. 202p.

Small, S. A. Boy's Book of Electricity, E. P. Dutton & Co., New York City.

Smith, L. R. Elementary Industrial Electricity, McGraw Hill Book Co., New York City. 287p.

Smith, E. L. Everyday Science Projects, Houghton Mifflin Co., Chicago, Ill. 341p.

Smith, L. R. Mechanics, McGraw Hill Book Co., New York City. 226p.

Smith, A. and Hall, E. H. Teaching Chemistry and Physics in the Secondary Schools, Longmans Green & Co., New York City. 371p.

Thomson, A. J. Outline of Science, G. P. Putnam, New York City. 447p.

Tower, S. F. and Lunt, J. R. Science of Common Things, D. C. Heath & Co., New York City. 397p.

VanBuskrik, E. F. and Smith, E. L. Science of Everyday Life, Houghton Mifflin Co., Chicago, Ill. 416p.

Williams, A. Romance of Modern Engineering, Seeley Service and Co., Ltd., London, England. 376p.

Wiggam, A. F. New Decalogue of Science, Bobbs Merrill Co., Indianapolis, Indiana. 302p.

Williams, A. Thinking it Out, Thomas Nelson & Sons, New York City. 407p.

LIBRARY REFERENCE BOOKS

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Woodring, M. N. and Others. Enriched Teaching of Science in the High School, Bureau of Publications, Teachers' College, Columbia College, New York City. 374p.

Younger, F. B. Our Common Elements on Air, Fire and Water, Thomas Nelson & Sons, New York City. 210p.

------- The Boy Mechanic, Popular Mechanics Co., Chicago, Illinois, Volumes I, II, III, and IV.

LIBRARY MAGAZINES

(Bound)

Popular Mechanics, Vol. LVIII, 1932 and on. Popular Mechanics Co., Chicago, Ill.

Popular Science, Vol. 122 No. I, 1934 and on. Popular Science Publishing Co. Inc., New York City.

Scientific American, Vol. 131 No. 1, July 1924 and on. Munn and Company Inc., New York City.

(Current)

Popular Mechanics. Popular Mechanics Co., Chicago, Ill.

Popular Science, Popular Science Publishing Co. Inc., New York City.

Popular Photography, Ziff-Davis Publishing Co., Chicago, Ill.

Radio-Craft, Radcraft Publications Inc., Springfield, Mass.

Radio News, Ziff-Davis Publishing Co., Chicago, Ill.

Scientific American, Munn and Company Inc., New York City.

Science Observer, The American Institute of the City of New York, New York City.

Science News Letter, Science Service Inc., Washington, D. C.

EQUIPMENT AND SUPPLIES

The usual equipment and supplies are used in this course.[1] Other materials as listed in Demonstrations and Experimentations can be brought to class by the pupils. The following items should be either purchased, rented or loaned:

1. A 16mm Sound-on-Film Projector complete with a Screen.
2. An old Car Motor, Transmission, and Differential.
3. Camera.
4. High Frequency Coil and Accessories.
5. Magneto.
6. Old Phonograph.
7. Photo-electric Cell Equipment.
8. Pressure Cooker.

Items carried by the local merchants can often be loaned. Rotating the display of goods among the various business concerns from year to year is a good practice. The following equipment is used in the course:

1. Automobile Charts.
2. Bathroom Scales.
3. Bicycle.
4. Cream Separator.
5. Coaster Wagon.
6. Electrical Home Appliances.
7. Engines--Gas, Steam, or Diesel.
8. Lawn Mower.
9. Oil Stove.
10. Refrigerator--Electric.
11. Sewing Machine.
12. Shovel.
13. Tire Pump.
14. Telephone.

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[1] Turner, H. F., Workbook and Laboratory Manual in Physics, College Entrance Book Co., New York City. 1937.

EQUIPMENT AND SUPPLIES

(continued)

15. Thermos Bottle.
16. Toys--automobiles, construction sets, sailboats, trains, trucks, doll houses, etc.
17. Typewriters.
18. Washing Machine.
19. Whiffle-tree.
20. Wheelbarrow.
21. Wire Stretcher.

PHYSICS FINAL EXAMINATION

NAME _____ POINTS _____

One of the purposes of your course has been to acquaint you with science as found in the "Everyday Life." Let us see what you can do with the following occupations.

I. Customs Inspector

A young man approached your desk of inspection. Below are listed some properties relative to certain questionable items he has that might be subject to duty. Find their specific gravity and check with the table.

A. An object weighs 40 grams in air and 32 grams when submerged in water.

Answer _____

B. A cube of metal 2 centimeters long on each edge, weighs 62 grams.

Answer _____

C. A can of clear liquid was tested by floating a stick that sank 20 cm., while in water it sank 16 cm.

Answer _____

D. Fifteen cubic centimeters of another liquid just as clear weighed 24 grams.

Answer _____

Table of Specific Gravity:

Quartz	2.65	Water	1.00
Zinc	5.00	Carbon tetrachloride	1.58
Sulfur	1.25	Alcohol	0.8
Tin	7.75	Glycerine	1.60

Related topics

A. Ice has a _____ specific gravity than water.

B. If the pressure on a gas increased, its volume is _____.

C. Density is the _____ per unit volume.

II. Airplane Test Pilot

A newly designed airplane having a three cylinder motor capable of real traveling economy, is to be placed on the market in competition with the automobile. It is your job to report on tests that you make.

A. This airplane can fly 150 miles per hour in still air. The wind is blowing from the west toward the east with a velocity of 30 miles per hour.

PHYSICS FINAL EXAMINATION

(continued)

1. The velocity of the airplane in miles per hour when flying east is _____.

2. When flying northeast the velocity is _____.

3. When flying west the velocity is _____.

Related topics

A. For every action there is an _____and opposite _____.

B. Energy due to motion is called _____.

C. The formula representing the distance of falling objects is _____.

D. An automobile traveling 60 miles per hour covers _____ feet per second.

E. A vector is a mathematical measure showing _____ and _____.

III. Musician

Having made piano tuning one of your specialties, certain problems come up occasionally for solution.

A. A wire vibrates at the rate of 128 times per second. Its rate of vibration when the tension is increased four times will be _____.

B. A wire with a frequency of 256 made half as long will produce _____ vibrations.

Related topics

A. The wave length of a sound wave equals its _____ divided by the frequency.

B. The American Federation of Musicians require _____ vibrations as the standard for the key of A.

C. The Doppler effect accounts for the pitch of a locomotive whistle _____ as it approaches you.

D. A minor chord has relative vibrations of _____, _____, and _____.

PHYSICS FINAL EXAMINATION

(continued)

IV. Garage Foreman

Many different problems come up every day. The following are perhaps typical.

A. In the cool of the morning the pressure in an automobile tire is 35 pounds per square inch at a temperature of 32° F. While driving in the afternoon what will the pressure in the tire be if the temperature rises to 120° C.?

Answer _____

B. A six cylinder motor capable of accelerating a 3000 pound car at a speed of 13.2 feet per second per second will develop _____ horse power.

Related topics

A. In a four cycle six cylinder engine there are _____ explosions for every revolution.

B. The purpose of a _____ is to mix air and gas properly.

C. A Diesel engine uses _____ for ignition instead of spark plugs.

D. The absolute temperature reading of 68° Fahrenheit is _____.

V. Cooking Demonstrator

Having been employed by a large newspaper to conduct a cooking school, certain questions have been brought to your attention.

A. An electric percolator of 550 watts is used for ten minutes.

1. It will give off _____ calories of heat.

2. If all this heat was used, _____ grams of water could be raised from 20° C. to boiling.

3. Assuming one gram of water equals one cubic centimeter this would make _____ quarts.

Related topics

A. One calorie of heat (food) equals _____calories (physics).

PHYSICS FINAL EXAMINATION

(continued)

B. Copper has a specific heat of 0.09, aluminum has 0.21, iron has 0.11, and glass 0.16. Therefore _____ kettles will heat up most quickly.

C. An electric refrigerator consists of an electric motor operating a _____. Heat is absorbed from the food when the gas _____ in the refrigerating unit.

VI. Electrician

Having been employed in an electric shop during the Christmas rush, the following situations arose.

A. A lady called up requesting information on the size bulbs to purchase for replacement in a string of ten Christmas tree lights to be hooked up in series on a 110 volt line. You answered _____ volt bulbs.

B. How many amperes will be required by two 60 watt, 110 volt lamps in parallel in a 110 volt circuit?

Answer _____

C. What would it cost if a family of four used on the average two 60 watt lamps three hours each day; one flat iron of 800 watts, one hour a day; and a radio of 50 watts, four hours a day; all for a period of 30 days, at $0.06 a kilowatt hour?

Answer _____

Related topics

A. One volt is the electromotive force used in driving _____ thru a resistance of _____.

B. A radio _____ tube has for its purpose the changing of the tuned-in high frequency alternating current into pulsating direct current.

C. A transformer having a winding ratio of 2 to 9 will change 110 volts to _____ volts.

D. In an electrical circuit the ammeter is hooked up in _____.

VII. Movie Projector Operator

A certain school board called on you for advice on the installation of a moving picture projector in their auditorium.

PHYSICS FINAL EXAMINATION

(continued)

A. The screen will permit an image 9 feet high, the object on the film measures 0.5 of an inch in height, the distance from the lens to the object is 4 inches, and you are to calculate how far back from the screen the projector should be placed.

Answer _____

Related topics

A. In the projector problem in order to obtain a good picture, the object will have to be placed _____ relative to the focal length of the lens.

B. A movie camera takes _____ pictures a second normally, and _____ for slow motion.

PHYSICS FINAL EXAMINATION

Key

I.

A. 5.00 zinc
B. 7.75 tin
C. 0.80 alcohol
D. 1.60 glycerine

Related topics

A. less
B. decreased
C. mass

II.

A. 180
B. 120
C. 152.9

Related topics

A. equal, reaction
B. kinetic
C. $S = 1/2\ at^2$
D. 88
E. direction and force

III.

A. 256
B. 512

Related topics

A. velocity
B. 440
C. increasing
D. 10, 12, 15

IV.

A. 50.34
B. 72

Related topics

A. 3
B. carburetor
C. compressed air
D. 293° A.

V.

A.
1. 79,200
2. 99
3. .76-

Related topics

A. 1000
B. copper
C. released

VI.

A. 11
B. 3.98
C. $2.448

Related topics

A. One ampere, one ohm
B. detector
C. 495
D. series

VII.

A. 72 feet

Related topics

A. between F and 2F
B. 16, 64 or 72

PUPIL POINT RECORD

Unit I Mechanics

	Points		
	Regular	Special	Total
A. Demonstrations			
Traveling Salesman			
Inside Story			
The Outlook			
The Service Station			
Home Weather Bureau			
The Toy Shop			
The Local Hardware Store			
Home Machines			
Kitchen Machines			
Energy Horses			
_____			
_____			
B. Experimentations			
Metric Units			
Vernier Caliper			
Molecular Mechanics			
Hooke's Law			
Tensile Strength			
Density of Solids			
Properties of Matter			
Pressure in a Liquid			
Archimedes' Principle			
Specific Gravity			
Boyle's Law			

PUPIL POINT RECORD
(continued)

	Points		
	Regular	Special	Total
Gas Pressure			
Atmospheric Pressure Effects			
Applied Forces			
Center of Gravity			
Equilibrium of Parallel Forces			
Composition of Forces			
Resolution of Forces			
The Simple Pendulum			
Principle of Moments			
The Incline Plane			
The Wheel and Axle			
Pulleys			
Coefficient of Friction			
Machines and Efficiency			
Motion			
Work, Energy and Power			
_____			
_____			
C. Demonstrations and Projects			
_____			
_____			
_____			
D. Reports			
_____			
_____			

PUPIL POINT RECORD
(continued)

	Points		
	Regular	Special	Total
_____			
E. Extras			
Achievement Record 1A Score _____			
Group Conference Review 1B			
Achievement Record 1B Score _____			
Group Conference Review 1C			
Achievement Record 1C Score _____			
_____			
_____			
Unit II Heat			
A. Demonstrations			
The Cooking School			
_____			
_____			
B. Experimentations			
Fixed Points on a Thermometer			
Coefficient of Linear Exp.			
Volume Exp. of a Gas			
Temperature Characteristics			
Specific Heat			
Heat of Fusion			
Heat of Vaporization			
Cooling by Evaporation			
Cooling thru the Melting Point			
Dew Point and Rel. Humidity			

PUPIL POINT RECORD
(continued)

	Points		
	Regular	Special	Total
Heat Measurements			
_____			
_____			
C. Demonstrations and Projects			
_____			
_____			
_____			
D. Reports			
_____			
_____			
_____			
E. Extras			
Group Conference Review 2			
Achievement Record 2 Score _____			
_____			
_____			
Unit III Sound			
A. Demonstrations			
The Music Store			
_____			
_____			
B. Experimentations			
Wave Length of Sound			
Vibration Rate of a Fork			
Vibrating Strings			

PUPIL POINT RECORD
(continued)

	Points		
	Regular	Special	Total
Sound Measurements			
_____			
_____			
C. Demonstrations and Projects			
_____			
_____			
_____			
D. Reports			
_____			
_____			
_____			
E. Extras			
Group Conference Review 3			
Achievement Record 3 Score _____			
_____			
_____			
Unit IV Light			
A. Demonstrations			
The Miracle			
_____			
_____			
B. Experimentations			
The Photometer			
The Law of Reflection			
Images in a Plane Mirror			

PUPIL POINT RECORD
(continued)

	Points		
	Regular	Special	Total
Images in a Curved Mirror			
Light Waves			
Index of Refraction			
Convex Lens			
Magnifying Power of Lenses			
The Compound Microscope			
The Telescope			
Light Application			
_____			
_____			
C. Demonstrations and Projects			
_____			
_____			
_____			
D. Reports			
_____			
_____			
_____			
E. Extras			
Group Conference Review 4			
Achievement Record 4 Score_____			
_____			
_____			

PUPIL POINT RECORD
(continued)

Unit V Magnetism and Electricity	Points		
	Regular	Special	Total
A. Demonstrations			
The Party Line			
Giants at Rest			
Mystery Radiations			
The Electric Shop			
The Radio Bug			
_____			
_____			
B. Experimentations			
Magnetic Propertie			
Magnetic Fields			
Applications of Magnetism			
Magnetic Field about a Wire			
The Electro-magnet			
The Electric Bell			
Direct Current Motors			
Static Charges			
Cells			
Electromotive Force			
Electroplating			
The Lead Storage Cell			
Electrical Chemical Effects			
Laws of Resistance			
Cells in Series and Parallel			
Wheatstone Bridge			

PUPIL POINT RECORD
(continued)

	Points		
	Regular	Special	Total
Practical Electricity			
Electrical Hook-ups			
Eff. of El. Heating Devices			
The Vacuum Tube			
Communication Circuits			
_____			
_____			
C. Demonstrations and Projects			
_____			
_____			
_____			
D. Reports			
_____			
_____			
_____			
E. Extras			
Group Conference Review 5 A			
Achievement Record 5 A Score _____			
Group Reference Review 5 B			
Achievement Record 5 B Score _____			
_____			
_____			
_____			
_____			

STATISTICAL SUMMARY OF THE COURSE

Description		Number
Achievement Record (pupil experience test)	---	1
Introductory Demonstrations	---	16
Related Student Activities	---	16
Experimentations	---	73
Textbook Study pages	---	753
Textbook Exercises	---	728
Supplementary Textbook pages	---	3,498
Projects	---	227
Constructed Laboratory Equipment	---	66
Reports	---	137
Free Films	---	169
Group Conference Review	---	7
Achievement Record tests	---	7
Library Reference Books	---	75
Library Magazines (bound)	---	3
Library Magazines (current)	---	8
Final Examination	---	1
Average Annual Number of Pupils enrolled for the Course (1928-1938)	---	23

RESULTS OF THE USE OF THE MOTIVATED PHYSICS COURSE IN TERMS OF THE MINNESOTA STATE BOARD EXAMINATIONS

In the grading of Minnesota State Board Examinations the following percentiles are used:[7]

Highest	25%	Received	a grade of	Pass Plus	(P +)
Middle	50%	"	"	Pass	(P)
Lowest	25%	"	"	Failure	(F)

In Figure 1. the percentage of Passes Plus for the State in the Physics State Board Examinations is indicated by the brown line. The percentage of Passes Plus for the Proctor classes using the Motivated Course is indicated by the red line. This graph shows a general increase in the percentage of Proctor class Passes Plus for 1929-1936.

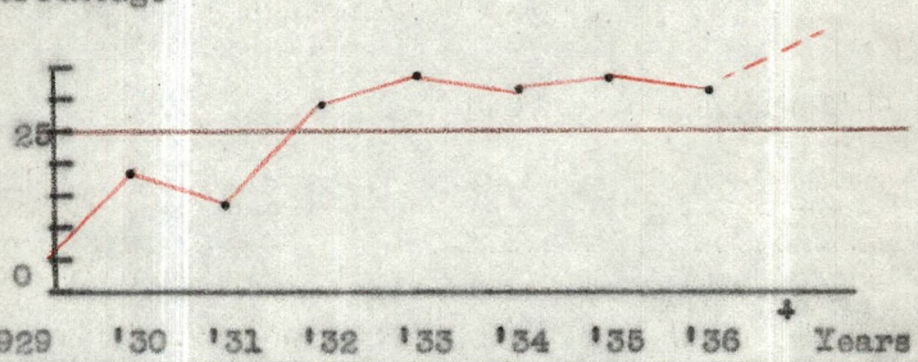

FIGURE 1. A COMPARISON OF THE PERCENTAGE OF PHYSICS PASSES PLUS FOR THE STATE OF MINNESOTA, HIGHEST 25% AND THE PROCTOR CLASS —— ON STATE BOARD EXAMINATIONS.[7]

[4] Since 1936 no state examinations have been given in Physics.

7. All data given by Miss Gensander, State Department of Education, St. Paul, Minnesota.

In Figure 2. the percentage of Passes for the State in the Physics State Board Examinations is indicated by the section between the two brown lines. The percentage of Passes for the Proctor classes using the Motivated Course is indicated by the red line. The graph shows a general increase in the percentage of Proctor class Passes from 1929-1936.

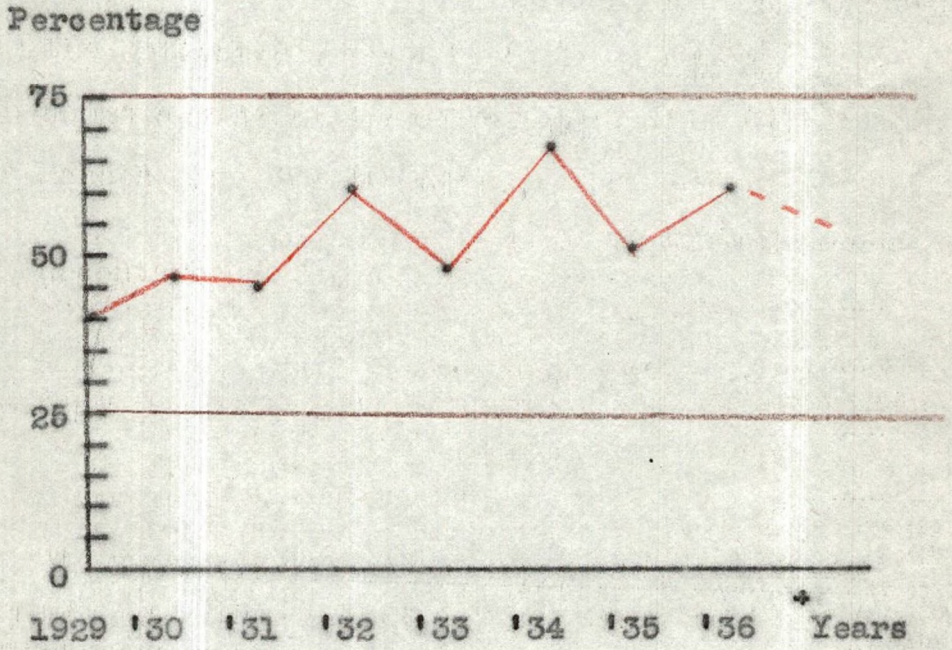

FIGURE 2. A COMPARISON OF THE PERCENTAGE OF PHYSICS PASSES FOR THE STATE OF MINNESOTA, THE MIDDLE 50% (SECTION BETWEEN THE TWO LINES)——— AND THE PROCTOR CLASS——ON THE STATE BOARD EXAMINATIONS.[7]

In Figure 3. the percentage of Failures for the State in the Physics State Board Examinations is indicated by the brown line. The percentage of Failures for the Proctor classes using the Motivated Course is indicated by the red line. The graph shows a general decrease in the percentage of Proctor class Failures from 1929-1936

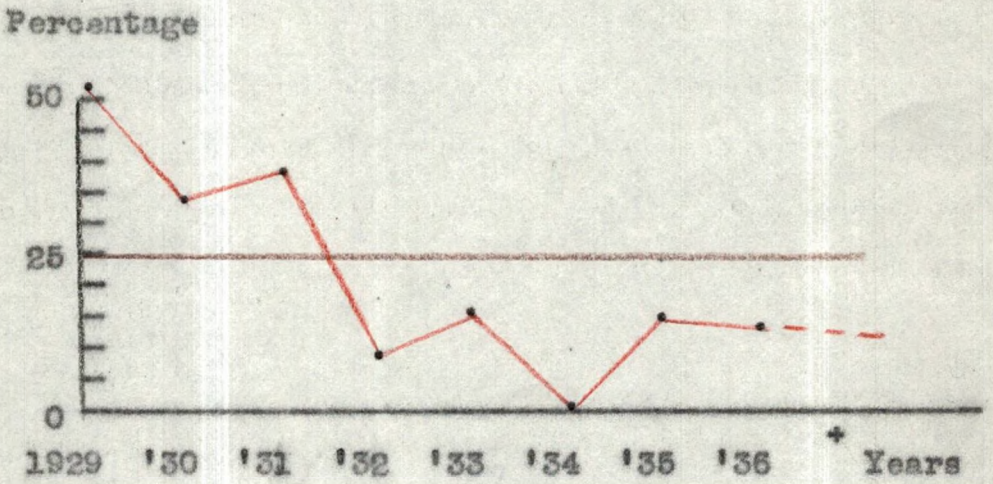

FIGURE 3. A COMPARISON OF THE PERCENTAGE OF PHYSICS FAILURES FOR THE STATE OF MINNESOTA, LOWEST 25%—— AND THE PROCTOR CLASS —— ON STATE BOARD EXAMINATIONS.[7]

SUMMARY

The problem of this thesis was to present a motivated physics course. The writer wishes to summarize the following significant characteristics of the Course presented.

1. The Course is introduced with an achievement test which acquaints the teacher with the background and interests of the pupils, and acquaints the pupils with the general nature of the course.
2. The principles and laws of physics are applied to concrete situations familiar to every day living. This method is the basis of understanding which motivates the pupil to further investigation and discovery.
3. Differences of sex and of individual abilities of pupils are generously provided for through the unlimited variety of activities (projects, demonstrations, and reports) through which the physical concepts of physics are understood.
4. Pupil initiative and leadership are stimulated by the gradual shifting of responsibilities from teacher to pupil. Originality is particularly stressed because it developes special interests. These interests developed into hobbies or vocations, prove to be good security for happiness and stability.
5. Immediate reward or "pay" for every pupil effort is given in the form of points from 1 to 15. The sum of these

points is "redeemed" in terms of the usual grades of A, B, C, D, and F.

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