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A guide for laboratory work in elementary science in grades 7 and 8

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A GUIDE FOR LABORATORY WORK IN ELEMENTARY SCIENCE IN GRADES 7 AND 8

by

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I. BACKGROUND OF THEORY OF GENERAL SCIENCE

A. Historical

During the early part of the 20th century, conditions began to arise, both inside and outside of the school organization, which demanded the attention of educators. The most radical changes outside the school were the specialization in industry induced by inventions of various kinds, the crowding of large numbers of people into cities and suburban areas, and the improvement in communication and travel. The outstanding changes within the school organization were the destruction of faith in the transfer of skills and habits from one field to another, the arousing of a new faith in education based upon individual differences, and the new idea of the social value of education. There was a great increase in the number of pupils seeking high school education, and this fact, coupled with the changes that were taking place within and without the school organization, brought about a demand for a new type of school to meet the changing conditions.

The school systems of most European countries had a "Middle School" which accepted pupils from the elementary schools and passed them on to the upper secondary schools or to the continuation schools where the courses were more highly specialized. Most of the elementary schools of these countries covered six years work. The curriculum of the "Middle School" was of a general nature and provided opportunity for the pupils to explore many fields of knowledge. In this country, there developed in Berkeley, Baltimore, and several other large cities a new type of school organization. These experiments were watched carefully by the leading educators, and there grew out of these experiments a new type of school to care for the seventh, eighth, and ninth grades. This new type of school was called the junior high school.

B. Function of the Junior High School.

Along with the development of the new type school there came the controversy over just what its function should be. The following functions have been laid down by T. H. Briggs:

"1. To continue, in so far as it may seem wise and possible and in a gradually lessening degree, common integrating education.

"2. To ascertain and reasonably to satisfy pupils' important immediate and assured future needs.

"3. To explore by means of materials in themselves worth while the interests, aptitudes, and capacities of pupils.

"4. To reveal to pupils, by materials otherwise justifiable, the possibilities in the major fields of learning.

"5. To start each pupil on the career which, as a result of the exploratory courses, he, the school, and his parents are convinced is most likely to be of profit to him and to the investing state."[1]

In order to meet these functions the following curriculum was proposed:-[2]

Subject	No. of Periods per Week 7th Grade	8th Grade	9th Grade
English	5	5	5
General Mathematics	5	5	5*
General Science	3	3	5
Social Studies	5	5	5
Physical Education and Health	2	2	2

1 T. H. Briggs, Functions of the Junior High School, <u>The Classroom Teacher</u>, X, (1927-28) pp. 28-59.

2 Ibid p. 64

Subject	No. of Periods per Week 7th Grade	8th Grade	9th Grade
Activities	5	5	5
Music	3	3	5*
Fine Arts	2	2	5*
Shop and Home Management	5	5	5-10*
Study or Adjustment	5	5	3
Foreign Language		5*	5*
Business Training		5*	5*
Agriculture		5*	5*
Total	40	35--15*	25--15*

*Elective studies to be offered in order to make the curriculum fit local conditions or individual needs.

C. Aims and Objectives in Science Teaching in the Junior High School

The junior high school was established primarily as a testing place for the interests, aptitudes, and capacities of the pupils. Because of their natural inquisitiveness, they demand a knowledge of the principal facts of science with which they come in contact in their every-day lives. The following quotation from W. L. Eikenberry states the aim of teaching science in the junior high school:-

"It appears, then, that the primary aim in science teaching is: (1) to instruct the pupils in that scientific knowledge which is valuable as a preparation for life activities; (2) to use this knowledge and the processes of its acquisition in disciplining the mind in the scientific method; (3) to impart an insight into the nature and organization of the environment, so far as time and the limitations of the mind permit: secondarily, to use the materials of the course to train in right habits and to develop desirable ideals, tastes, and appreciations ******. It is the mission of general science to explain to the pupils those natural phenomena that have interest and significance for them, and to impart to them such additional knowledge as their interests and needs demand."[3]

The committee which constructed the tentative course of study in general science for Indiana, states the following objectives for the teaching of general science:-

"1. To provide through a series of experiences an understanding which will enable the learner to cope with and appreciate his environment.

"2. To develop the appreciation of the fact that science offers excellent solutions to man's diversified civic, social and industrial needs.

"3. To engender through a series of experiences a sustaining love for scientific reading, investigation, and thinking."[4]

Thus the junior high school becomes an integral part of the educational system of the country, having for one of its purposes the exploration of the pupil's interests, aptitudes, and capacities. In order to accomplish this purpose new content material was included in the field of social studies and mathematics. There were also placed in the curriculum new courses in science, music, fine arts, physical education, home economics, and business training.

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3 W. L. Eikenberry, _The Teaching of General Science_, Chicago, The University of Chicago Press.

4 Tentative Course of Study in General Science, _Department of Public Instruction of Indiana_, Bulletin No. 100E-1.

II. USUAL PRACTICES IN GENERAL SCIENCE AS TO LABORATORY WORK

A. Introduction

From its beginning the junior high school has lived up to one of its chief purposes - the exploration of the pupil's interests, aptitudes, and capacities. Not only has it given the pupil a chance to investigate the fields of knowledge but it has also given the teacher a chance to experiment with the various methods of teaching the subjects. The field of science is not different from the other fields in this respect. Many methods have been tried in the teaching of general science but gradually throughout the years one method after another has been discarded until at present there are only two outstanding methods; namely, the lecture-demonstration and the laboratory methods. It has not been definitely proved which of these methods is the better, but some of the conclusions of research work on this problem are submitted in an attempt to show what progress has been made in solving this problem.

B. Lecture-Demonstration vs. Laboratory Method of Instruction in General Science

The following is a composite study of several studies that have been made to determine whether the lecture-demonstration or the laboratory method is better for the teaching of general science. This study was made by Elliott R. Downing and the method used by the various investigators is as follows:-

"The method of conducting the experiments in the investigations reported is approximately as follows: On the basis of general intelligence tests or such tests and the pupils marks, the pupils to be instructed are divided into two or more sections, each pupil in one section having a mate of approximately the same intelligence in each of the other groups or sections.

In the case of the laboratory work the pupils are given their instructions either orally or in writing and proceed with the work without assistance from the teacher. In the lecture-demonstration method the instructor, as he performed the experiment, uses the same language found in the laboratory instructions with, of course, a change in the personal pronoun. He avoids any instruction by direct exposition. The text book work, recitation, and note book work were alike for the several sections. In other words, the attempt is made to keep all of the elements of the experiment identical except the one variable - in the lecture-demonstration method the experiments are performed by the instructor; in the laboratory method, by the pupil."[1]

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1 Elliott R. Downing, "Comparison of the Lecture-Demonstration and the Laboratory Method of Instruction in Science," School Review, XXXIII, pp. 688-97.

TABLE I[2]

IMMEDIATE TESTS

Investigators	Numbers of Exercises	Number of Sections	Number of Pupils per Section	Lecture-Demonstration method Average per cent Scores	Laboratory method Average per cent Scores
Anibal (1)	25	2	23	60.71	56.45
Anibal (2)	10	2	17	71.11	68.35
Cooprider (1)	24	3	14	72.55	70.80
Cooprider (2)	12	4	17	63.76	62.70
Cunningham (1)	13	2	12	64.33	61.15
Cunningham (2)	12	2	10	60.30	55.20
Kiebler and Woody	14	2	-	60.53	59.68
Wiley	3	3	8	56.30	56.60

2 Elliott R. Downing, op. cit., pp. 688.

TABLE II[3]

DELAYED TESTS

Investigators	Time Between Presentation and Test.	Average Percentage Scores	
		Lecture-Demonstration Method	Laboratory Method
Anibal (2)	5-months	28*	38*
Cooprider (2)	1-month	34.74	35.09
Cunningham (1)	1-month	46.10	49.50
Cunningham (2)	3-months	30.50	34.60
Kiebler and Woody	2-weeks	58.51	59.30
Wiley	4-weeks	38.30	39.70

*T-scores on the Rich test.

3 Elliott R. Downing, op. cit., pp. 689.

"Conclusions. The lecture-demonstration method yields better results than the laboratory method in imparting essential knowledge and is more economical of time and expense. This is true of both bright and dull pupils.

"The lecture-demonstration method appears to be the better method for imparting skill in laboratory technique in its initial stages and for the solving of new problems.

"Oral instructions are, in general, better than written instruction in the lecture-demonstration method but less effective in laboratory work."[4]

The following tables were prepared and conclusions were reached by George W. Hunter and Oscar H. Edinger from a study made by the questionnaire method of the methods of teaching science at the Junior and Senior high school levels. Questionnaires were sent to 1200 schools located in every state in the Union. The selection of schools was from a carefully prepared list obtained from government sources and from private information with reference to the schools. They received 520 answers, 206 from junior high schools, 117 from three year high schools, and 197 from four year high schools. The same questionnaires were sent to the 40 members of the National Association for Research in Science Teaching, from whom they received 28 replies. By weighting the replies the following tables were constructed to show tendencies rather than actual percentages of the use of the various methods of teaching indicated:

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[4] Elliott R. Downing, op., cit.

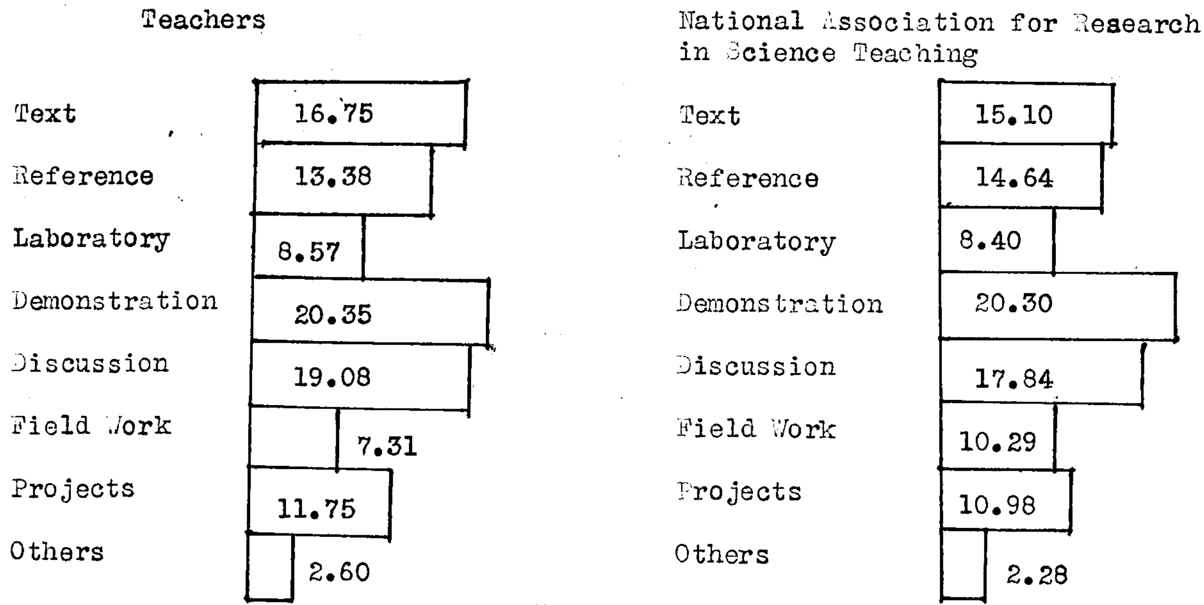

Figure 1[5]

Methods of Teaching Elementary Science in the 7th - 8th Grades

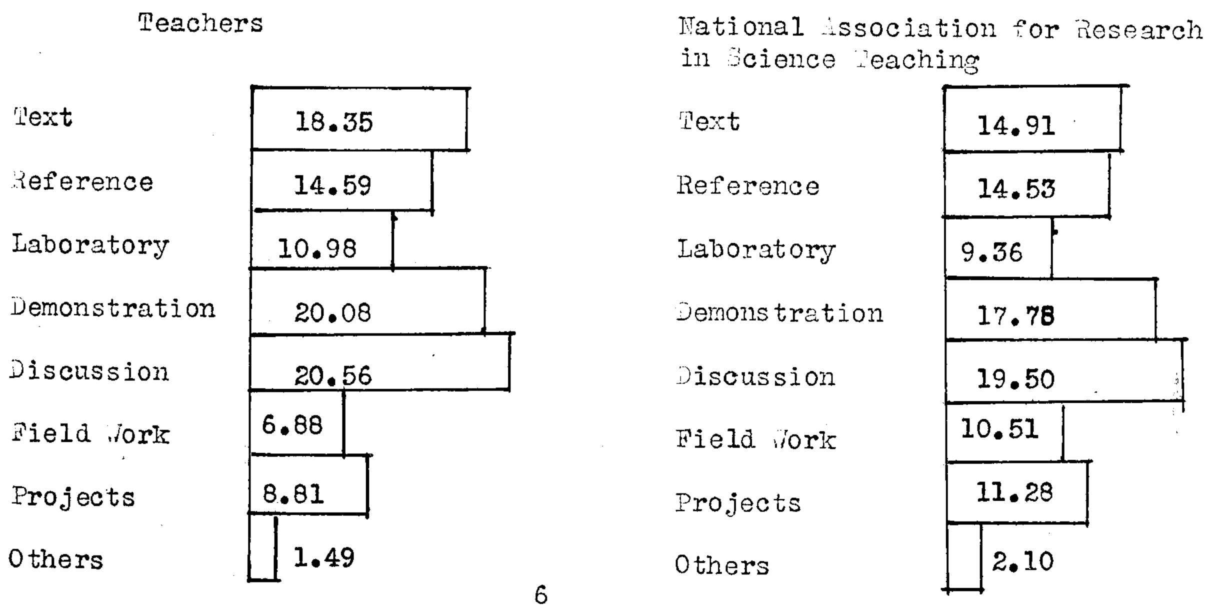

Figure 2[6]

Methods of Teaching General Science 9th Grade

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5 Geo. R. Hunter and Oscar H. Edinger, "Methodology in Science at the Junior and Senior-High-School Levels," Science Education. XVII, (1933) pp. 35-41.

6 Ibid.

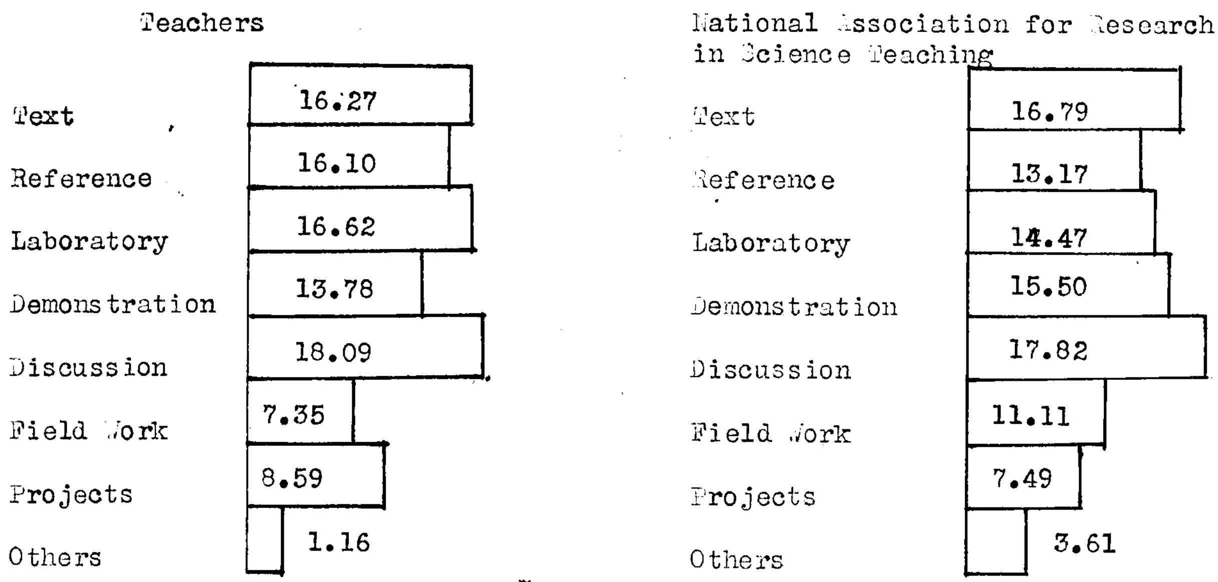

Figure 3[7]

Methods of Teaching Elementary Biology 10th Grade

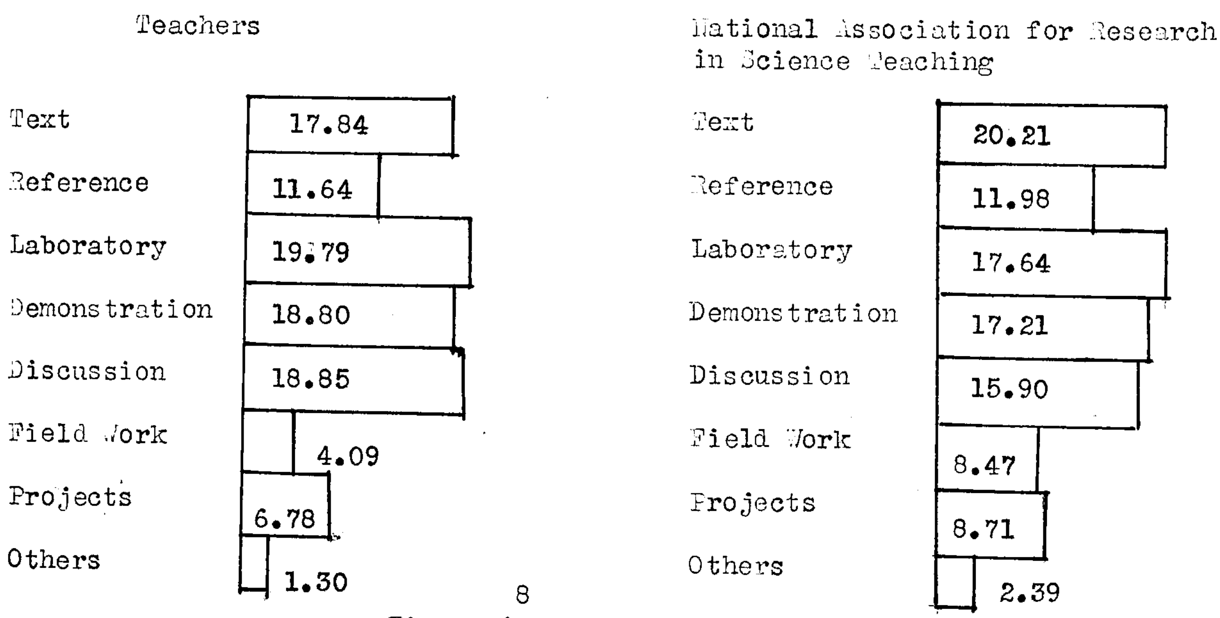

Figure 4[8]

Methods of Teaching Chemistry 11th Grade

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7 Geo. R. Hunter and Oscar H. Edinger, op., cit., pp. 39.

8 Geo. R. Hunter and Oscar H. Edinger, op., cit., pp. 40.

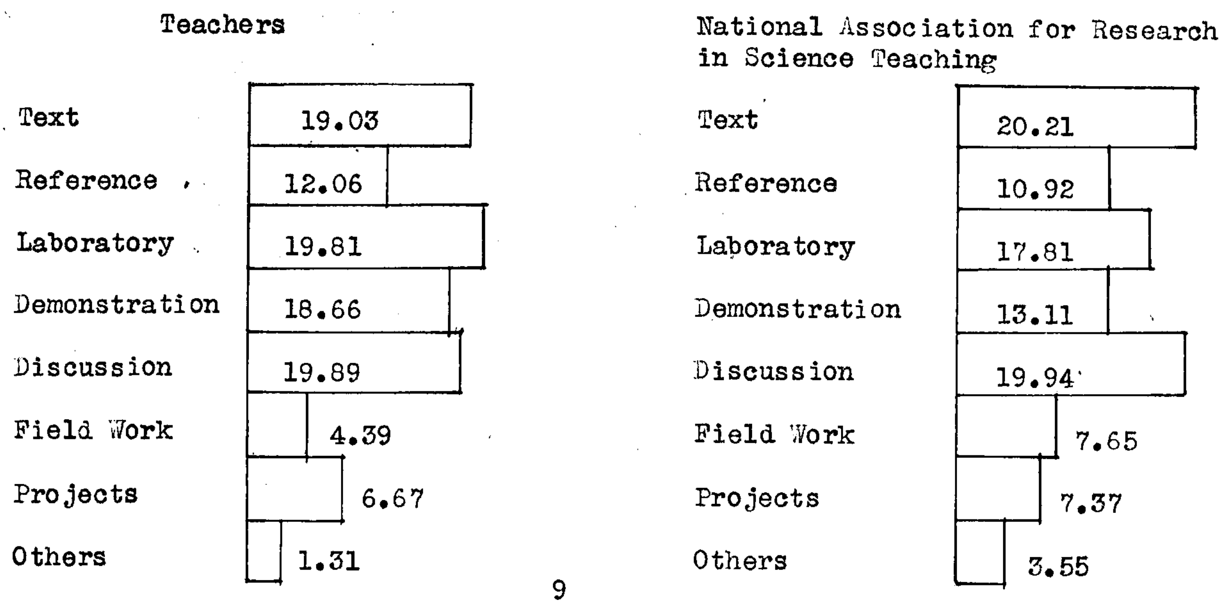

Figure 5[9]

Methods of Teaching Physics 12th Grade

"The above material is submitted as indicative of certain tendencies in our science teaching. It appears that the teaching of science at the junior-high-school level is much less static than at the senior-high-school level; teachers are much more willing to experiment with their students, and are evidently approaching subject matter from the student angle. At the senior-high-school level, however, if one reads the answers to the questionnaire carefully, it is obvious that the work is much more formal, that teachers are much more concerned in teaching subject matter than in teaching children and that there is in many parts of the country pressure brought to bear by the colleges and universities for the acquiring of subject matter rather than attitudes which should come from work in science. It is evidence that even with our best leadership, there is room for improvement in teaching science at this level."[10]

During the spring of 1930 an extensive questionnaire was sent to

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9 Geo. R. Hunter and Oscar H. Edinger, op., cit., pp. 40.

10 Ibid.

every teacher of science in the 2167 accredited schools of the North Central Association. Sets of blanks were returned from 1802, or 83.1 per cent, of the schools. These replies represented the opinions of 5481 teachers having one or more classes in science in these schools. Among the findings of these questionnaires, the methods of laboratory work in use revealed the following:

"With biology and general science the model number of teachers used a combination of individual pupil experimentation with teacher and pupil demonstrations; with chemistry and physics a majority of the teachers used individual pupil experimentation exclusively. . . . . 85.7 per cent of these (general science and biology) teachers used some form or other of the demonstration plan. Exclusive teacher demonstration was used by a relatively small percentage of teachers, except in general science."[11]

In an investigation to determine the relative effectiveness of teaching science in the high school by a "freedom" method and one of the conventional methods, Rudyard K. Bent reaches the following conclusions:-

"In the light of the qualitative results of this experiment and of the instructor's observations, it would appear that the method to be employed would depend upon the teacher's philosophy and purpose. If general science is meant to be merely exploratory and to create scientific interest, a considerable degree of freedom may be allowed. If, on the other hand, the main object of the course is propaedeutic and if the burden of it is the mastery of scientific principles fundamental to sequent courses, the subject matter probably should be dictated and outlined by the teacher and a conventional method of instruction employed.

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11 Francis D. Curtis "The Teaching of Science in the Secondary Schools of the North Central Association, Science Education XVII pp. 10

"Regardless of the purpose, however, it is probable that more freedom than is customary may safely be allowed general science pupils in both the planning and the executing of their work. Loss in time and the vexatious frustrations of the trial and error method may be more than compensated for in the larger opportunity which a relatively free method affords."[12]

The National Survey of Secondary Schools found the following trends in the instruction of science:-

"Observation of class room teaching and the different suggestions given in the courses of study indicate great confusion as to the method to be employed in the teaching of science. Since the great majority of school systems leave the choice of method to the teacher, it is evident, that, beyond the prescription of topics to be taught, the course of study has little effect upon the day-to-day teaching. . . . .

"The analysis of courses of study and class room observation indicate certain practices which may be considered as innovating and hence should be carefully examined and evaluated by those who are engaged in curriculum building and who are desirous of improving science instruction. The practices are as follows:-

"(h) Teacher or pupil demonstration has replaced individual experimentation to a marked degree in the junior high school. A great increase in the use of the demonstration method is also observable in the specialized courses.

"This list of innovating practices does not necessarily indicate the

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12 Rudyard K. Bent, "Comparative Effectiveness of a Freedom Method and a Conventional Method of Teaching High School Science," School Science and Mathematics, XXXIII, pp. 773-76.

changes that should be brought about in the teaching of science. The trends do, however, disclose the variations from the dominant practice which may well result in progress and which, as already stated, should be given careful consideration by those who are undertaking the improvement of instruction in science at the secondary school level."[13]

C. Conclusions

From the above data it seems that the lecture-demonstration method of teaching general science is the better. However, the laboratory method in most cases seems to be about as good. Since there are not enough data at present to determine fully which is the better of the two methods, it seems that better results will be accomplished by a combination of the two methods.

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13 Wilbur L. Beauchamp, Instruction in Science, United States Department of Interior, Monograph No. 22, (1932) pp. 61-63.

III. EXPERIMENTS FOR LABORATORY WORK IN GENERAL SCIENCE.

A. The Problem.

The junior high school pupil is placed in an environment that is teeming with the products of scientific research and the application of the results of this research to the solutions of the problems of civilization. Such things as the automobile, the airplane, the radio and other electrical devices, the weather, the earth's crust, the heavens, and many other things, are of much interest to pupils of junior high school age. The committee that made the tentative course of study for general science in Indiana has constructed several teaching units from the scientific material that is of interest to pupils of the junior high school. There is a need for a laboratory manual to supplement this course of study. It is the purpose of this paper to present a group of experiments that are suitable for use in the instruction of general science as prescribed by this course of study.

B. Procedure in Solving the Problem.

As each unit of the state course of study in general science was studied several experiments were tried, both by the lecture-demonstration and the laboratory method, and the ones that seemed best were kept. As they were reorganized and written into form they were sent to a teacher in a rural school who used them in teaching science in the eighth grade. Upon the criticisms and suggestions of this rural school teacher many of the experiments were reorganized in an attempt to make them more valuable for use in the rural schools as well as the small high schools. An attempt has been made to keep the apparatus simple and yet show the scientific principle involved.

EXPERIMENT No. 1

A Field Trip

Our Natural Environment

Aim: To acquaint the pupils with the factors of our natural environment.

Device: A field trip to a vacant lot, a field that has not been plowed for several years, or to a woods.

Procedure: What are the things that surround you? Which things are necessary for you to have in order to live? Name the things that nature provides without the assistance of man. As a supplement to the trip have the pupils bring to school pictures from magazines or papers that illustrate natural environment. Mount these pictures and place them on the wall of the school room for future reference.

Expected Achievements: The pupils should become familiar with the factors of the natural environment.

References:

Pieper and Beauchamp, pp. 23.

Wood and Carpenter, pp. 2-40.

Smallwood, Reveley, and Bailey, pp. 49, 163-4, 266.

Hunter and Whitman, pp. 18-19.

Powers, Neuner, and Bruner, pp. 387-409.

EXPERIMENT No. 2

A Field Trip

Our Artificial Environment

Aim: To show how man has changed his natural environment.

Device: A field trip to the main street of a town or about the school house and grounds.

Procedure: What are the things man has done to change his natural environment? Which of these things has made life more enjoyable for man? What are some of the problems that man must solve as a result of these changes in the natural environment? Has man been successful in solving these problems? Explain your answer? As a supplement to the field trip have the pupils bring pictures to school that illustrate man's artificial environment. Mount these pictures and place them on the wall of the school room near the ones illustrating the natural environment in order that they may be used for comparison and future reference.

Expected Achievements: The pupils should develop some idea of how and why man has changed his natural environment. They should also have a knowledge of some of the problems these changes have made for man.

References:

Smallwood, Reveley, and Bailey, pp. 266-267.

Wood and Carpenter, pp. 8-14.

Hunter and Whitman, pp. 625-628.

EXPERIMENT No. 3

A Laboratory Exercise

Chemical and Physical Change

Aim: To demonstrate chemical and physical change.

Apparatus: A splinter of wood, two test tubes, a piece of broken window glass, and an alcohol lamp.

Procedure: Place a splinter of wood in one of the test tubes and heat it until the wood is completely charred. Hold the piece of broken window glass at some distance from the mouth of the test tube in the smoke. What forms on the glass? What forms on the mouth of the test tube? In what way do these things resemble the original piece of wood? What has happened to the piece of wood? Hold a lighted match in the smoke that comes from the test tube. Explain what happens.

Fill the second test tube about half full of water and heat it until it boils. Hold the piece of broken window glass in the steam that comes from the test tube. What happens to the glass? How does this material compare with the water in the test tube? How did it get from the test tube to the glass? Hold a lighted match in the steam that comes from the test tube. Explain what happens. Compare the change that takes place in the wood with that which takes place in the water.

As a supplement to this experiment have the pupils wrap a damp cloth around a bright new nail and observe it for several days. The cloth should be kept damp. Have them dissolve some salt in a dish of water and let the water evaporate and note what remains in the dish.

Expected Achievements: The pupils should have developed an idea of what constitutes a physical and what a chemical change.

References:

Pieper and Beauchamp, pp. 53, 59, 328-329, 501-502.

Wood and Carpenter, pp. 112, 123, 431.

Smallwood, Reveley, and Bailey, pp. 28.

Hunter and Whitman, pp. 23-25.

Powers, Neuner, and Bruner, pp. 309-323.

EXPERIMENT No. 4

A Field Trip

A Study in Animal Adaptation

Aim: To study a grasshopper to determine how it is adapted to its natural environment.

Device: A field trip to a grassy plot containing grasshoppers.

Procedure: Have the pupils scatter out in the grass and search quietly until each has found a grasshopper. Have them observe the grasshopper for some time. How does the grasshopper attempt to hide in the grass? How does its color compare with the color of the grass? How does it move about in the grass? How does the grasshopper eat? Compare the size and length of the rear legs with the other legs. How are the claws of the rear legs an aid in jumping? What adaptations aid the grasshopper to live in its environment? What are some things that are a hindrance to it in its environment?

Expected Achievements: The pupils should have formed some idea as to why a grasshopper is able to live in its environment.

References:

Watson and Bedell, pp. 173-194.

Wood and Carpenter, pp. 8-9.

Smallwood, Reveley, and Bailey, pp. 21-24.

Hunter and Whitman, pp. 26-27.

Powers, Neuner, and Bruner, pp. 48-49.

EXPERIMENT No. 5

A Demonstration

Oxygen and its Properties

Aim: To generate oxygen and show its properties.

Apparatus: A test tube, a small amount of sodium peroxide, and a small splinter of wood.

Procedure: Place a small amount of sodium peroxide in the test tube and add a few drops of water. The chemical action will liberate oxygen. Light the splinter of wood and when it has burned a short time blow out the flame, and while the splinter is still glowing, thrust it into the test tube of oxygen. Notice what happens. What effect does oxygen have on the burning splinter? What is the color of the gas in the test tube? Does it have an odor? Can it be poured from one test tube to another? Is oxygen lighter than air?

Expected Achievements: The pupils should see that pure oxygen causes rapid burning. They should also see that oxygen is odorless, colorless, and can not be poured from one test tube to another.

References:

Pieper and Beauchamp, pp. 221, 326-329.

Wood and Carpenter, pp. 118-123.

Smallwood, Reveley, and Bailey, pp. 42.

EXPERIMENT No. 6

A Demonstration

Carbon Dioxide and Its Properties

Aim: To generate carbon dioxide and study its chief properties.

Apparatus: A small amount of baking soda, acetic acid, a splinter of wood, and two test tubes.

Procedure: Place a small amount of soda in one of the test tubes, fill it about half full of water, and add a few drops of acetic acid. The chemical action within the test tube will liberate carbon dioxide gas. After the chemical action has proceeded for a short time, thrust a burning splint into the test tube. What happens to the fire? Now tip the test tube containing the chemicals over to one side as though pouring something from it and place the other test tube under it as though catching the material being poured from the first test tube. After a short time thrust the burning splint into the second test tube. What happens to the fire? What does this experiment illustrate concerning the weight of carbon dioxide gas? What is its color? Its odor?

Expected Achievements: The pupils should know or realize that carbon dioxide does not support combustion, is heavier than air, is colorless and odorless, and is generated by chemical action.

References:

Smallwood, Reveley, and Bailey, pp. 32.

Wood and Carpenter, pp. 117-118.

Pieper and Beauchamp, pp. 226.

Hunter and Whitman, pp. 45.

Lake, Harley, and Welton, pp. 40-54.

EXPERIMENT No. 7

A Demonstration

Water Contains Air

Aim: To show the presence of air in water.

Apparatus: A flask of cold water, a ring stand, and an alcohol lamp.

Procedure: Clamp the flask of cold water to the ring stand. Observe the sides and bottom of the flask. What do you notice on the sides and bottom of the flask? Light the lamp and place it under the flask. What do you notice forming on the sides and bottom of the flask? Of what familiar substance do you think these objects are composed? Give reasons for your answer. What difference do you notice in the size and rate of escape of these bubbles as the water becomes hotter? What issues from the flask before the water boils? When the water boils?

Expected Achievements: The pupils should see that water contains air. They should also see that heating the water drives the air out of it.

References:

Hunter and Whitman, pp. 40-41.

Powers, Neuner, and Bruner, pp. 66-67.

EXPERIMENT No. 8

A Demonstration

Air Exerts Pressure

__Aim__: To show that air exerts pressure upon objects.

__Apparatus__: A varnish can (or any rectangular can), a ring stand, a cork to fit the opening in the varnish can, and an alcohol lamp.

__Procedure__: Pour a small amount of water into the varnish can and set it on the ring stand. Heat the water until it boils, and after it has boiled for a few minutes, place the cork in the varnish can and at the same time remove the lamp from under the can. Allow the can to cool. What happens to the can? What caused this? What happened to the air that was inside of the can? Why doesn't the air crush our bodies as it did the can?

__Expected Achievements__: The pupils should see that the air was displaced inside the can by water vapor or steam, and when the can cooled, there was formed a partial vacuum within the can. Thus the air pressure was greater outside the can than within the can. They should also see that air does exert pressure on objects. The body is not crushed because the air pressure is the same within the body as it is outside the body.

__References:__

Pieper and Beauchamp, pp. 114-127.

Wood and Carpenter, pp. 77-83.

Hunter and Whitman, pp. 54-62.

Lake, Harley, and Welton, pp. 32-35.

EXPERIMENT No. 9

A Demonstration

Air Exerts a Pressure Upward

Aim: To show that air exerts a pressure upward.

Apparatus: A glass tumbler and a piece of cardboard large enough to cover the opening in the tumbler.

Procedure: Fill the glass tumbler about three fourths full of water and place the cardboard over the opening of the tumbler. Hold the cardboard firmly with the hand and slowly invert the tumbler. Carefully remove the hand from the cardboard. What would happen within the tumbler if the water should move downward a very short distance? Why doesn't the cardboard fall off? In which direction is the air exerting a pressure on the cardboard?

Expected Achievements: The pupils should see that the air pressure in an upward direction is sufficient to hold the water within the tumbler. The water as it starts from the tumbler creates a partial vacuum in the top of the tumbler and the air attempting to eliminate this vacuum is responsible for the cardboard being held in place.

References:

Wood and Carpenter, pp. 76.

Pieper and Beauchamp, pp. 11, 114-115.

Hunter and Whitman, pp. 56-57.

EXPERIMENT NO. 10

A Demonstration

How Air Gets into the Lungs

Aim: To demonstrate how air gets into the lungs in the process of breathing.

Apparatus: A large glass bottle with the bottom removed, a one-hole rubber stopper to fit the opening in the neck of the bottle, a short piece of glass tubing to fit the hole in the rubber stopper, a small rubber balloon, and a piece of an old inner tube of an automobile.

Procedure: Place the piece of glass tubing through the hole in the stopper and tie the toy balloon securely to the end of the glass tube so that it will be inside of the bottle when the stopper is placed in the neck of the bottle. Place the stopper into the neck of the bottle. Now split the inner tube and cut off a piece that will fit the bottom of the bottle. Tie this securely to form a diaphragm. By pulling outward on the rubber diaphragm the toy balloon will fill with air and when the rubber diaphragm is pushed inward the toy balloon will be emptied of air. Why does this happen? Repeating the "pulling out" and "pushing in" process will give a good illustration of how the diaphragm of the body aids in breathing.

Expected Achievements: The pupils should have formed some idea of the functioning of the diaphragm in the process of breathing. They should also have formed some idea of how air gets into the lungs in the process of breathing.

References:

Smallwood, Reveley, and Bailey, pp. 298-303.

Pieper and Beauchamp, pp. 229-233.

Wood and Carpenter, pp. 129-141.

Powers, Neuner, and Bruner, pp. 172-173.

Hunter and Whitman, pp. 49-50.

EXPERIMENT No. 11

A Demonstration

To Show that Heated Air Expands

Aim: To show that heat applied to air causes it to expand.

Apparatus: A test tube, a one-hole stopper to fit the test tube, and a short piece of glass tubing to fit the hole in the stopper.

Procedure: Place a drop of water in the glass tubing and get it as near the middle of the tube as possible. Place the tube through the hole in the stopper so that the tube will be outside of the test tube when the stopper is placed in the test tube. Place the stopper in the test tube. Hold the test tube in the hand and note the movement of the drop of water. What causes the drop of water to move? Allow the test tube to cool and note the movement of the drop of water. What caused it to move in this direction? What effect does heating have upon air? What effect does cooling have upon air?

Expected Achievements: The pupils should see that heating a body of air causes it to expand. They should also see that cooling a body of air causes it to contract.

References:

Pieper and Beauchamp, pp. 96.

Hunter and Whitman, pp. 549-550.

EXPERIMENT No. 12

A Demonstration

A Siphon

Aim: To make and demonstrate the action of a siphon.

Apparatus: A small rubber tube about a foot long and two water glasses.

Procedure: Fill one of the glasses with water and put one end of the rubber tube in the water. Hold the other end of the tube below the level of the water in the glass and suck the air from the tube. Hold the empty glass to catch the water that flows from the tube. In which arm of the tube is the longer water column? When this water column starts downward what is formed at the bend in the tube? What does the air pressure do to this partial vacuum? Why doesn't the water flow in the other direction? What causes the siphon to work? Demonstrate this by having the level of the water the same in both glasses. Alternately raise one glass higher than the other and note the direction of the flow of water.

Expected Achievements: The pupils should see that liquids can be transferred from one container to another without the use of a pump. The siphon operates upon the principle "Nature abhors a vacuum."

References:

Pieper and Beauchamp, pp. 482-483.

Wood and Carpenter, pp. 87-88.

Hunter and Whitman, pp. 321.

Lake, Harley, and Welton, pp. 29-30.

EXPERIMENT No. 13

A Demonstration

Another Use of Air Pressure

Aim: To demonstrate another common use of air pressure.

Apparatus: A medicine dropper and two water glasses.

Procedure: Fill one of the water glasses about half full of water. Show that by using the medicine dropper the water can be transferred to the other glass. What causes the water to rise in the medicine dropper? To be expelled? What other application of this device have you seen? The medicine dropper is an application of the principle that "Nature abhors a vacuum."

Expected Achievements: The pupils should form an idea of the truth of the statement "Nature abhors a vacuum." Also that the principle of the medicine dropper is used in garages for putting water and acid into storage batteries and testing the percentage of alcohol in the automobile radiator, in the filling of fountain pens, etc.

References:

Wood and Carpernter, pp. 87-89.

Hunter and Whitman, pp. 58-60.

Powers, Neuner, and Bruner, pp. 174-176.

EXPERIMENT No. 14

A Laboratory Experiment

The Speed of Sound in Air

Aim: To demonstrate how fast sound travels in air.

Apparatus: A hammer, a piece of iron pipe or some other object to hammer on that will give a sharp sound.

Procedure: This experiment must be performed out of doors. Have one of the pupils hit the iron pipe every second. This can be roughly done by having him count 1001, 1002, 1003, etc., at the ordinary rate of counting. A little practice in counting with the use of a watch, that has a second hand on it, before the experiment starts, will help the student in his counting and make for accuracy of the timing. As the student counts and says the 1, 2, 3, 4, etc., have him strike the pipe with the hammer. Have the remainder of the class start walking backward from the boy who is striking the pipe until they come to a place where the sound coming from the pipe seems to reach them simultaneously with the fall of the hammer. The distance to the boy who is doing the hammering is roughly the distance sound travels in one second. How fast does sound travel in air?

Expected Achievements: The pupils should get a rough idea of how far sound travels per second. They should also understand that sound travels rather slowly when compared with the speed of light.

References:

Pieper and Beauchamp, pp. 592-601.

Wood and Carpenter, pp. 96-104.

Watkins and Bedell, pp. 406-408.

Hunter and Whitman, pp. 64-65.

Lake, Harley, and Welton, pp. 55-56.

EXPERIMENT No. 15

A Demonstration

Water Can Be Formed by Burning Hydrogen in Air

Aim: To demonstrate that water can be formed by burning hydrogen in air.

Apparatus: A test tube, a one-hole rubber stopper to fit the test tube, a piece of glass tubing to fit the hole in the rubber stopper and having one end drawn to a fine point, some pieces of zinc, or iron tacks, hydrochloric acid, and a piece of broken white dish.

Procedure: Place the pieces of zinc or the tacks in the test tube and add enough water to cover them. Add a few drops of hydrochloric acid, a drop at a time, until there is vigorous action within the test tube. Put the glass tubing through the rubber stopper, so that the fine point will be outside when the stopper is placed in the tube. Place the stopper in the test tube. Allow the gas to escape into the air for a few minutes for a mixture of air and hydrogen is explosive. Light the gas that escapes from the test tube and hold the piece of broken white dish in or near the flame. What is deposited on the piece of dish? Where did it come from? What can you say happens when hydrogen burns in air?

Expected Achievements: The pupils should see that the burning of hydrogen in air forms water. Water may be considered as an oxide of hydrogen.

EXPERIMENT No. 16

A Demonstration

Ground Water Contains Materials Dissolved in it.

Aim: To show that ground water contains various minerals in solution.

Apparatus: A beaker of rain water, a beaker of water from a well or spring, and an alcohol lamp.

Procedure: Evaporate the water in the beakers, being careful to heat very slowly while evaporating the last few drops of water to prevent breaking the beakers. Note the materials that remain in the beakers. Where did this material come from? How did it get in the water? If a little hydrochloric acid is placed on the residue in the beakers the presence of lime is indicated by a bubbling action.

Expected Achievements: The pupil should see that most ground water contains materials dissolved in it.

References:

Pieper and Beauchamp, pp. 59.

Wood and Carpenter, pp. 165-166.

Hunter and Whitman, pp. 169-170.

Powers, Neuner, and Bruner, pp. 127-129-132.

Lake, Harley and Welton, pp. 75-76.

EXPERIMENT No. 17

A Demonstration

The Temperature of Boiling Water

Aim: To show the temperature of boiling water.

Apparatus: A glass beaker, a ring stand and clamp, a thermometer that will register a temperature of 212^{o}, and an alcohol lamp.

Procedure: Fill a beaker about half full of water and clamp it to the ring stand. Suspend the thermometer in the beaker so that the bulb will be just a little above the bottom of the beaker. Heat the water until it boils vigorously and note the temperature registered by the thermometer. The air pressure will affect the boiling point so that there may be a variation from a temperature of 212^{o}. This latter point may be demonstrated by performing the experiment on a damp cloudy day and then repeating the experiment on a clear cool day and note the diffenence in the temperature at which the water boils. What is the temperature of boiling water?

Expected Achievements: The pupils should understand that the temperature of boiling water is 212^{o} but that the pressure of the air causes it to vary. The boiling point of water is one of the fixed points of the thermometer.

References:

Pieper and Beauchamp, pp. 96-98, 376-377.

Wood and Carpenter, pp. 453-454.

Watkins and Bedell, pp. 74-75.

Powers, Neuner, and Bruner, pp. 82-85.

Lake, Harley, and Welton, pp. 366, 368.

EXPERIMENT No. 18

A Demonstration

The Temperature at Which Water Freezes

Aim: To show the temperature at which water freezes.

Apparatus: A beaker of water, some ice, and a Fahrenheit thermometer.

Procedure: Fill a beaker about half full of cold water and then add about an equal amount of ice. Stir the mixture with the thermometer until the temperature remains constant. More ice may be added if the temperature remains above 32^{o}. The temperature of the water that is constant is the temperature at which water freezes. What is the temperature at which water freezes?

Expected Achievement: The pupil should learn that water freezes at a temperature of 32^{o} Fahrenheit.

References:

Watkins and Bedell, pp. 76.

Wood and Carpenter, pp. 453-454.

Pieper and Beauchamp, pp. 54-55, 395-397.

Powers, Neuner, Bruner, pp. 114-116.

EXPERIMENT No. 19

A Demonstration

Purification of Water by Distillation

Aim: To show that water may be purified by distillation.

Apparatus: Two flat-bottom flasks, a one-hole rubber stopper, a ring stand, a clamp, an alcohol lamp, and a two-foot piece of glass tubing.

Procedure: Fill one of the flat-bottom flasks about half full of water. Add a little salt and some ink to the water. Use a piece of glass tubing that will go through the hole in the stopper. This tubing should be about two feet long and about six inches from one end it should be bent to an angle of about 45^{o}. Place the short arm of the tube through the rubber stopper and place the stopper in the flask containing the water. Place the flask on the ring stand and clamp it securely. Over the end of the long arm of the glass tube place the other flat bottom flask. Boil the water in the flask and keep the other flask cool by placing a damp cloth over it. The cloth should be changed frequently to keep the flask as cool as possible. Compare the distilled water with the boiling water as to color. Evaporate some of the water from both flasks as was done in experiment 16 and note the distilled water. Does the distilled water contain salt, or ink? What has purified the water?

Expected Achievements: The pupils should see that water may be purified by distillation.

References:

Wood and Carpenter, pp. 194.

Pieper and Beauchamp, pp. 199-200.

Lake, Harley, and Welton, pp. 75.

EXPERIMENT No. 20

A Demonstration

Water Exerts a Pressure

Aim: To demonstrate that water exerts a pressure on objects immersed in it, and the deeper they are immersed, the greater the pressure exerted on them.

Apparatus: A test tube, a glass dish or vase about twelve inches deep, and a rubber band.

Procedure: Fill the glass dish or vase with water. Fill the test tube about half full of water and then hold the thumb over its opening and invert it in the glass dish of water. Mark the level of the water in the test tube with the rubber band. Gradually push the test tube down in the vase of water. What happens to the level of the water in the test tube? Why? Gradually raise the test tube to the top of the water in the vase. What happens to the level of the water in the test tube? Why? What effect does water have on objects immersed in it?

Expected Achievements: The pupils should see that water exerts a pressure on objects immersed in it and the deeper the water the greater the pressure.

References:

Pieper and Beauchamp, pp. 446-447.

Watkins and Bedell, pp. 61.

Wood and Carpenter, pp. 152, 158-159.

Hunter and Whitman, pp. 171-172.

Powers, Neuner, and Bruner, pp. 99.

EXPERIMENT No. 21

A Demonstration

The Effect of Soap on Hard and Soft Water

Aim: To show the effect of soap on hard and soft water.

Apparatus: A soap solution, a beaker of distilled or rain water, a beaker of water from a well or spring (hard water).

Procedure: Make a soap solution by dissolving Ivory or Castile soap in a beaker of distilled or rain water until no more soap will dissolve after shaking vigorously. With a medicine dropper add soap solution, a drop at a time, to the beaker of soft water until there is about an inch of suds after shaking vigorously. Count the number of drops of soap solution added. Repeat the process with the hard water until the same amount of suds is produced on it. The number of drops of soap solution added to the hard water as compared with the number of drops added to the soft water gives the relative hardness of the hard water. Which requires the most soap? What is formed in the hard water besides suds? What do you think this material is?

Expected Achievements: Much more soap is needed to cleanse with hard water than soft water. The soap is used to precipitate the dissolved chemicals that make the water hard.

References:

Pieper and Beauchamp, pp. 184, 200-202.

Wood and Carpenter, pp. 165-166.

Hunter and Whitman, pp. 169-170, 207.

Powers, Neuner, and Bruner, pp. 127-129.

Lake, Harley, and Welton, pp. 75-76.

EXPERIMENT No. 22

A Demonstration

How Moisture Gets into the Air

Aim: To demonstrate how moisture gets into the air.

Apparatus: A shallow dish and a piece of glass large enough to cover the dish.

Procedure: Put some water in the dish and set it in a window for a few days. What happens to the amount of water in the dish? After a few days cover the dish with the piece of glass. Observe the covered dish for a few days. What forms on the glass cover of the dish? Where does this water come from? How did it get on the glass cover? How do you think moisture gets into the air?

Expected Achievements: The pupils should see that moisture gets into the air by the process known as evaporation.

References:

Watkins and Bedell pp. 34.

Powers, Neuner and Bruner, pp. 175-176.

Pieper and Beauchamp, pp. 103-104.

Lake, Harley and Welton, pp. 43, 91-94.

EXPERIMENT No. 23

A Demonstration

Condensation and Dew Point

Aim: To show that air contains water vapor that is not visible and to determine the temperature at which condensation takes place, or the dew point of a given day at a given time.

Apparatus: A tin cup or a bright new tin can, a thermometer, and some ice or snow.

Procedure: Place some water in the tin cup and gradually add ice or snow. Keep the mixture stirred thoroughly with the thermometer. As soon as moisture begins to form on the outside of the cup, read the temperature of the mixture of water and ice. This temperature is the dew point for that time of that day. Repeat this experiment on a damp, cloudy day and a clear, cool day. The moisture that collects on the outside of the cup is sometimes called sweat. What is the source of this water? What is the temperature at which it forms? What is the dew point? Is the dew point always the same? How do you account for this change?

Expected Achievements: The pupils should see that air contains water vapor that is not visible. The temperature at which the vapor begins to condense or form into droplets is the dew point.

References:

Pieper and Beauchamp, pp. 108.

Watkins and Bedell, pp. 35.

Wood and Carpenter, pp. 461-462.

Powers, Neuner, and Bruner, pp. 86-89.

Hunter and Whitman, pp. 533-535.

EXPERIMENT No. 24

A Demonstration

Air Currents

Aim: To demonstrate how air currents are started.

Device: A pine splint and the source of heat in the room, as the stove or radiator.

Procedure: Hold the ignited smoking splint a few inches above the floor and near the stove. In what direction does the smoke move? Why do you think it moves in this direction? Hold the smoking splint near the ceiling above the stove. In what direction does the smoke move? Why? What causes these air currents? Air currents that are found on the earth, which move in a horizontal direction are known as winds. The unequal heating of the earth's surface acts on the air in much the same way as the stove acts on the air in a room.

Expected Achievements: The pupils should see that heat causes air currents to start and also that unequal heating of the air is one of the causes of winds.

References:

Watkins and Bedell, pp. 25-29.

Wood and Carpenter, pp. 460-461.

Pieper and Beauchamp, pp. 109-110.

Hunter and Whitman, pp. 541-542.

Powers, Neuner, and Bruner, pp. 157-159.

EXPERIMENT No. 25

A Laboratory Experiment

The Dependability of Some Weather Lore

Aim: To determine the dependability of weather lore.

Device: A list of the more common weather lore of the community.

Procedure: Have the pupils make a list of the more common weather lore of the community. Such things as "A rainbow in the morning is a sailor's warning, and a rainbow at night is a sailor's delight" should be listed and placed on the bulletin board for future use. Have the pupils keep watching the weather to see when one or more of the sayings applies and is dependable or not dependable. When a saying applies and is dependable for a given instance, a plus sign may be placed after that particular saying; and if it is not dependable, a minus sign may be placed after that saying. At the end of the year the number of minus and plus signs will give roughly the dependability of the various sayings that make up the weather lore of the community.

Expected Achievements: The pupils should see that some of the weather lore is not very dependable and yet some of it is very dependable.

Reference:

Wood and Carpenter, pp. 452.

EXPERIMENT No. 26

A Laboratory Experiment

The North Star

Aim: To teach the pupil how to locate the North Star.

Device: If possible have the pupils meet some clear night.

Procedure: The usual method of finding the North Star is to locate the Big Dipper in the northern heavens. The two stars that form the side of the dipper opposite the handle are known as the "pointers." A line connecting these two stars and then produced toward a point about 40° above the horizon, for central Indiana, will give the approximate location of the North Star. How does the North Star appear in size and brightness when compared with the other stars of that part of the heavens? Why is the North Star so important? What was it used for before the invention of the compass?

Expected Achievement: Each pupil should be able to find the North Star since it is the outstanding "land mark" in finding one's directions.

References:

Pieper and Beauchamp, pp. 26-27.

Wood and Carpenter, pp. 35.

Watkins and Bedell, pp. 142.

Hunter and Whitman, pp. 500-501.

Lake, Harley, and Welton, pp. 186-187.

EXPERIMENT No. 27

A Laboratory Exercise

A Study of the Common Rocks

Aim: To study and recognize the common rocks of the community.

Device: Have the pupils to make a collection of the common rocks that can be found in the community.

Procedure: Examine the rocks and note their structure, color; test their hardness with a knife. The most common sedimentary rocks are sandstone, limestone, and shale (which is commonly called slate in the mining section of Indiana), and coal. There are several forms of igneous rocks to be found in Indiana, especially in the glaciated area. A good college textbook on geology should be consulted concerning this class of rocks. Metamorphic rocks may also be found in the glaciated area of Indiana and the textbook on geology will give names and discussions of this type of rocks. As supplementary work to this experiment each pupil can make a "stone board." A piece of light wood, about 18" x 24" can be sanded and varnished. On this board, the various stones may be mounted with glue, and their names pasted immediately below them. Pill bottles filled with soil may also be added in the same way.

Expected Achievements: The pupils should be able to recognize and name many of the rocks found in the community.

References:

Watkins and Bedell, pp. 100-105.

Pieper and Beauchamp, pp. 77-80.

Lake, Harley, and Welton, pp. 207-213.

Hunter and Whitman, pp. 558-561.

Powers, Neuner, and Bruner, pp. 279.

EXPERIMENT No. 28

A Laboratory Exercise

A Study of the Common Minerals and Metals

Aim: To acquaint the pupils with the most common minerals and metals found in the earth.

Device: Have the pupils make a collection of the most common metals and minerals that are to be found in the community.

Procedure: The specimens collected should contain such things as iron, copper, silver, gold, aluminum, tin, salt, sulphur, asbestos, coal, crude oil, etc. Study these metals and minerals as to their color, odor, hardness, brittleness, cost, places where they are obtained, and their usefulness.

Expected Achievements: The pupils should gain a knowledge of the various characteristics that are common to the different minerals and metals that are to be found in the community. They should also gain a knowledge of the usefulness and the places from which they are obtained.

References:

Pieper and Beauchamp, pp. 59, 66-67, 415-417.

Wood and Carpenter, pp. 310-317.

Watkins and Bedell, pp. 450-452, 106-111.

Lake, Harley, and Welton, pp. 266-275.

Powers, Neuner, and Bruner, pp. 301-302, 330-331.

EXPERIMENT No. 29

A Laboratory Exercise

A Study of the Common Types of Soil

Aim: To study the composition of the common types of soil in the community.

Apparatus: A sample of each type of soil found in the community and a bottle of the same size and shape for each type of soil.

Procedure: Put the same amount of soil into each of the bottles, so that each bottle will contain a different type of soil. Pour the same amount of water into each bottle and shake the bottle vigorously until all of the soil is mixed with the water. When all of the soil has been mixed allow it to settle to the bottom of the bottle. This may take several days for the clay. Examine the layers of soil in the bottom of the bottles and the thickness of each layer compared with the thickness of the total layer of soil will be roughly the percentage of that material in the soil. For example loam may be composed of 40% sand, 50% silt, and 10% humus. What is the composition of each type of soil? The humus in some soils will float on top of the water.

Expected Achievements: The pupils should learn the approximate percentages of the different elements making up the various types of soil common in the community.

References:

Pieper and Beauchamp, pp. 55-56, 62-66, 68-76.

Watkins and Bedell, pp. 88-89.

Wood and Carpenter, pp. 483-485.

Hunter and Whitman, pp. 570-571.

Lake, Harley, and Welton, pp. 228-230.

EXPERIMENT No. 30

A Laboratory Exercise

Osmosis

Aim: To demonstrate the process of osmosis.

Apparatus: A large carrot, a one-hole rubber stopper, a piece of glass tubing about eight inches long, and a tablespoonful of sugar.

Procedure: With a sharp knife cut the leaves off the carrot, then very carefully "hollow out" the inside of the carrot making a hole in the top just large enough for the rubber stopper to fit in rather tightly. The hole inside of the carrot need not be very large, about the size of the thumb. Wrap a few turns of string around the upper part of the carrot to keep it from splitting when the stopper is placed in it. Put the sugar into the hole in the carrot and fill with water. Place the stopper, with the glass tube through it, in the hole in the carrot. Seal the stopper in the hole with melted paraffin. Place the carrot in a jar that contains just enough water to immerse it. Set the jar and carrot where they can be observed for a few days. What happened to the water in the tube? How do you think this happened?

Expected Achievement: The pupils should see that water enters the carrot. This illustrates the principle of osmosis by means of which water enters the roots of plants.

References:

Wood and Carpenter, pp. 488-490.

Smallwood, Reveley, and Bailey, pp. 45.

Watkins and Bedell, pp. 442.

Hunter and Whitman, pp. 589-590.

Pieper and Beauchamp, pp. 146-147.

EXPERIMENT No. 31

A Laboratory Experiment

A Demonstration of the Presence of Starch in Certain Roots, Stems, and Fruits.

Aim: To demonstrate the presence of starch in certain roots, stems, and fruits commonly used for food.

Apparatus: A sample of the most common roots, stems, and fruits used for food, a solution of iodine in potassium iodide. This solution may be made by dissolving potassium iodide in water and then adding a few iodine crystals.

Procedure: Prepare thin slices of the various foods collected and smear over them a little of the iodine solution. What color does the iodine solution turn the foods? Those that turn blue or black contain starch, and those that are not affected do not contain starch. What foods contain starch?

Expected Achievements: The pupils should learn the foods that contain starch. They should also see that starch is found in a large number of foods.

References:

Wood and Carpenter, pp. 493.

Hunter and Whitman, pp. 79-80.

Lake, Harley, and Welton, pp. 613.

EXPERIMENT No. 32

A Demonstration

A Test for Proteins in Foods

Aim: To demonstrate the presence of proteins in certain foods.

Apparatus: Use the foods collected for the previous experiment and prepare another thin slice of each. Use a test tube for each sample of food, some dilute nitric acid, dilute sodium hydroxide, and an alcohol lamp.

Procedure: Place a sample of one of the foods in a test tube and add enough water to cover the sample of food; then add a few drops of the dilute nitric acid. Carefully boil the mixture. Allow the mixture to cool and then add several drops of sodium hydroxide. A deep yellow indicates the presence of protein in the food. Repeat the experiment with all of the foods. Which of the foods contain proteins? What is the origin of most foods that contain proteins?

Expected Achievements: The pupils should make a list of the foods that contain protein. They should also see that there are some foods of plant origin that have protein in them.

References:

Wood and Carpenter, pp. 535.

Pieper and Beauchamp, pp. 153-154.

Hunter and Whitman, pp. 83-84.

Lake, Harley, and Welton, pp. 610-612.

EXPERIMENT No. 33

A Demonstration

A Balanced Aquarium

Aim: To demonstrate the interrelationship between plants and animals.

Apparatus: A glass jar (a fish bowl, a battery jar, or a half gallon fruit jar may be used), some small aquatic plants, and some small aquatic animals such as snails, minnows, or bugs.

Procedure: Place a layer of sand or soil in the bottom of the jar and place the plants in this soil if they grew in the soil in their natural habitat. It may be necessary to weight the plants down until they start to grow. If the plants are of the floating type they need not be weighted. Fill the aquarium with water from a stream or a pond and place in it the animals that have been collected. The number of animals and the number of plants the aquarium will support depends upon many things and by experimenting with the number of animals and the number of plants in the aquarium a balance can be established in a few weeks. When a balance has been established, the aquarium may be sealed or covered with a piece of window glass. The aquarium should be placed where it will receive much sunshine.

Expected Achievements: The pupils should form some conception of the interrelation of plants and animals in the aquarium. Also that this interrelation exists outside of the aquarium in the world about us.

References:

Wood and Carpenter, pp. 499-500.

Watkins and Bedell, pp. 517.

Smallwood, Reveley and Bailey, pp. 644.

EXPERIMENT No. 34

A Laboratory Exercise

Plants and Their Uses

Aim: To acquaint the pupil with the uses man makes of plants.

Apparatus: A good encyclopedia, pencil, and paper.

Procedure: Make a list of the different classes of plants such as the cereals, forage crops, vegetables, fruits, plants yielding fibers for clothing, etc. Under these classes list as many plants as can be found. From the encyclopedia find the uses man makes of each of the plants in the list that has been made. Pupils who have a special interest in certain plants should be allowed to investigate these and report their findings to the class.

Expected Achievements: The pupils should become acquainted with the most common uses man makes of the various plants. They should also find many new uses that are made of plants which most people do not know about. They should also learn that many modern industries depend upon plants to supply them with the raw materials with which they work.

References:

Lake, Harley, and Welton, pp. 507-547.

Powers, Neuner, and Bruner, pp. 427-432.

EXPERIMENT No. 35

A Laboratory Exercise

Animals and Their Uses

Aim: To acquaint the pupil with the numerous uses man makes of the animals.

Apparatus: A good encyclopedia, paper, and pencil.

Procedure: Make a list of the animals that man uses and do not limit the animals to the immediate community but include the whole world. Make a list of the various uses that are made of each of the animals. Those pupils who have a special interest in certain animals should be permitted to investigate the uses made of the animals and report to the class what they have found concerning those animals.

Expected Achievements: The pupils should become acquainted with the great number of uses that man makes of the animals. They should appreciate the fact that the same animal is used for different purposes in different parts of the world.

References:

Lake, Harley and Welton, pp. 570-601.

Powers, Neuner, and Bruner, pp. 387-409.

EXPERIMENT No. 36

A Laboratory Exercise

Contagious Diseases

Aim: To acquaint the pupil with some of the more pertinent facts concerning the common contagious diseases.

Devices: A good encyclopedia, a sheet of paper, and a pencil.

Procedure: Rule the sheet of paper so that it will have six vertical columns. Head these columns as follows:- (1) disease, (2) common symptoms, (3) method of communication, (4) period of incubation, (5) period of quarantine, (6) terminal and concurrent fumigation. The table when completed should contain the above data concerning all of the most common diseases. Each pupil should choose one or two diseases that he is interested in to be responsible for and report his findings to the class.

Expected Achievements: The pupils should master the important facts concerning the most common contagious diseases.

References:

Watkins and Bedell, pp. 474-495.

Wood and Carpenter, pp. 663-675.

Pieper and Beauchamp, pp. 253-289.

Smallwood, Reveley, and Bailey, pp. 431-460.

Hunter and Whitman, pp. 284-307.

EXPERIMENT No. 37

A Demonstration

A Test for Reducible Sugar in Foods

Aim: To demonstrate the presence of sugar in certain foods.

Apparatus: Benedict's solution, two test tubes, alcohol lamp, and a piece of ripe fruit, milk sugar and "Karo", or some similar food.

Procedure: Place the food to be tested in a test tube and fill the test tube half full of water. Add a few drops of Benedict's solution to the mixture in the test tube. Heat the mixture gently until it boils in the flame of the alcohol lamp. What color change has taken place in the mixture in the test tube? A brick red color indicates the presence of sugar in the food tested.

Expected Achievements: The pupils should see the method of testing foods for the presence of sugar. They should also know the color changes that take place in the test that indicate the presence of sugar.

References:

Pieper and Beauchamp, pp. 153.

Wood and Carpenter, pp. 534.

Hunter and Whitman, pp. 82.

Lake, Harley, and Welton, pp. 623.

EXPERIMENT No. 38

A Laboratory Exercise

Test for Fat

Aim: To demonstrate the presence of fat in certain foods.

Apparatus: A piece of clean white paper and samples of the foods that are to be tested.

Procedure: Rub the food that is to be tested on the piece of white paper. Hold the paper toward the light and the presence of fat is indicated by a semi-transparent spot on the paper. Do not confuse the spot made by water for it will also be semi-transparent, but when it dries it will disappear while the spot made by fat will not disappear. What foods contain fats? What are their origins?

Expected Achievements: The pupils should be able to make the simple test for fats. They should list the most common foods that contain fats. They should realize plant and animal sources. There are no other sources in nature.

References:

Wood and Carpenter, pp. 535.

Pieper and Beauchamp, pp. 154.

Lake, Harley, and Welton, pp. 612.

Hunter and Whitman, pp. 82-83.

EXPERIMENT No. 39

A Laboratory Exercise

Bacteria, Yeasts, and Molds Cause Food Spoilage

Aim: To demonstrate the cause of food spoilage.

Apparatus: Some, boiled potatoes, a banana, a piece of fresh meat, and two fruit jars.

Procedure: Place some of the cooked potato, one half of the peeled banana, and some of the meat in one of the fruit jars, seal it and set it in a warm place. Place some of the same foods in the other fruit jar and set it in a cool place. Observe the two jars of foods for several days. What happens to the foods in the jar that was in a warm place? To the foods in the jar that was in the cool place? What differences do you notice in the growths on the different kinds of foods? The growths on the potato are usually molds and bacteria while those on the banana are usually yeasts. What kind of growths do you think are found on the meat? What do you think are the chief causes of food spoilage? How does the temperature affect the spoilage of foods?

Expected Achievements: The pupils should learn that bacteria, yeasts and molds cause food to spoil. They should also learn that a warm temperature causes more rapid growth of bacteria, yeasts and molds thus hastening food spoilage.

References:

Pieper and Beauchamp, pp. 168-170.

Hunter and Whitman, pp. 104-106, 109.

Lake, Harley and Welton, pp. 662-663.

EXPERIMENT No. 40

A Demonstration

Cooling by Evaporation

Aim: To demonstrate the cooling effect of the evaporation of liquids.

Apparatus: A thermometer, some chloroform, a piece of cotton and a string.

Procedure: Wrap the piece of cotton around the bulb of the thermometer and tie it securely with the string. Dip the cotton in water and be sure that it is saturated. Hold the thermometer in the air and note the temperature. When the temperature becomes constant, swing the thermometer around for a few minutes and note the temperature again. What is the difference in the two temperatures? How do you account for this difference? Repeat the above experiment using chloroform in place of water. Which liquid causes the greater cooling effect? Which liquid evaporates the more rapidly? How do you account for the greater cooling effect of choloroform?

Expected Achievements: The pupils should see that the evaporation of liquids causes cooling. They should also see that the more rapid cooling is caused by the more rapid evaporation.

EXPERIMENT No. 41

A Laboratory Exercise

What Kind of Water-saturated Cloth Dries in the Shortest Interval of Time?

Aim: To demonstrate which kind of water-saturated cloth dries in the shortest interval of time.

Apparatus: Samples of the different kinds of cloth used in making clothing such as cotton, wool, rayon, linen, silk, etc., and a pan of water.

Procedure: Cut the pieces of cloth so that they will have as nearly the same weight as possible. Saturate them with water and hang them up to dry. Which pieces of cloth absorb water the more readily? Which pieces of cloth dry in the shortest interval of time? Which hold the most water?

Expected Achievements: The pupils should see that there is a marked difference in the rate at which cloth of different kinds dries. There is also a difference in the rate of the absorption of water. These facts, to a large extent, determine the kinds of cloth we should wear as clothing.

References:

Pieper and Beauchamp, pp. 301-302.

EXPERIMENT No. 42

A Demonstration

Colored Clothing Affects the Temperature of the Body

Aim: To demonstrate the effect of colored clothing on the temperature of the body.

Apparatus: A sample of dark and light colored cloth, a thermometer, and some string.

Procedure: Tie a piece of dark colored cloth (preferably black) around the bulb of the thermometer and place it in the sunshine. Observe the temperature registered by the thermometer from time to time and make a record of it when it becomes constant. Repeat the procedure using a piece of light colored cloth in place of the black cloth. Record the temperature when it becomes constant. What is the difference in the temperatures? Explain why there is a difference in the two temperatures. Why do people wear dark clothing in winter and light colored clothing in summer?

Expected Achievements: The pupils should see that the color of cloth effects the temperature of the body. The reason for wearing light colored clothing in summer and dark colored clothing in winter should also be evident.

References:

Pieper and Beauchamp, pp. 301-305.

Wood and Carpenter, pp. 649-650.

EXPERIMENT No. 43

A Laboratory Exercise

A Study of the Fibers of Common Cloth

Aim: To demonstrate to the pupils some of the common physical characteristics of the various fibers used in making cloth.

Apparatus: A large lens or reading glass (the "bull's eye" from a large flash-light may be used), and samples of the different kinds of cloth as cotton, wool, silk, rayon, linen, etc.

Procedure: Take fibers from each of the various kinds of cloth and lay them on a piece of white paper. Have the pupils examine them with the lens and make a simple drawing of the appearance of the threads. Have them notice the different kinds of scales, twists, thickness and roundness of the different kinds of thread and fibers.

Expected Achievements: The pupils should become familiar with the physical characteristics of the common kinds of fibers used in making cloth.

References:

Wood and Carpenter, pp. 645-648.

Smallwood, Reveley, and Bailey, pp. 509, 573, 644.

Pieper and Beauchamp, pp. 285-300.

Hunter and Whitman, pp. 196-202.

EXPERIMENT No. 44

A Demonstration

The Removal of Stains from Cloth

Aim: To show how some of the more common stains may be removed from cloth.

Apparatus: Some pieces of cloth that have been stained with ink, fruit juice, iron rust, grease, paint. Some oxalic acid, boiling water, naphtha, turpentine, and ammonia.

Procedure: Apply oxalic acid directly to the spot of ink on the cloth. The acid may be applied with a glass rod. After the stain has disappeared apply weak ammonia to the spot and rinse thoroughly with water. This same treatment will remove iron rust rather effectively.

To the stain caused by fruit juice apply boiling water. Pour the water through the part of the cloth that is stained and after the stain has disappeared rinse with cold water. Grease stains may be removed by absorption.Place the stain between two blotters and apply a hot iron. The last traces of stain may be removed by sponging with alcohol or naptha. Since these materials are highly inflammable they should be kept from an open flame. The spots of paint may be removed from cloth by applying turpentine. Three or four applications of turpentine may be necessary and if the paint is thoroughly dry more applications may be necessary. After the paint has been partly dissolved,gasoline or naphtha may be used to complete the removal.

Expected Achievements: The pupils should be able to remove some of the more common stains from cloth. However, the removal of stains from cloth is an art as well as a science and failure is not uncommon.

<u>References</u>:

Pieper and Beauchamp, pp. 309-311.

Hunter and Whitman, pp. 208-210.

EXPERIMENT No. 45

A Laboratory Exercise

A School Display of Native Woods

Aim: To acquaint the pupil with the physical characteristics of the native building woods.

Apparatus: Have the pupils collect a sample of all the native trees. The sample should be about three inches in diameter and about six inches long. Use a saw, a plane, a quantity of clear varnish, and a varnish brush in preparing the display.

Procedure: Make a cross section cut of the sample and split the remaining piece to make a longitudinal section. The cross section should be about one inch thick. A better display will be accomplished if all the cross sections are the same thickness and the specimens are all as nearly the same diameter as possible to obtain.

A surface of the cross section and the longitudinal section should be planed and sanded to a smooth finish, the surface dampened; allowed to dry, sanded again, and then given a coat or two of varnish. The specimen may be mounted on a piece of wall board with string and placed on the wall of the school room for further reference. The pupils should study the different specimens by comparing the grain, color, and hardness. A good encyclopedia will give much other information concerning the uses made of the wood, its strength, rate of growth, density, etc.

Expected Achievements: The pupils should become acquainted with the physical characteristics of the common native building woods.

EXPERIMENT No. 46

A Laboratory Exercise

The Use of Triangles in Building

Aim: To acquaint the pupils with the use of triangles in building.

Apparatus: Eight small boards about twelve or fourteen inches long, a hammer, and some nails.

Procedure: Nail four of the small boards together to form a square. Is it rigid? Nail one of the other boards diagonally across the square. Is it rigid now? Why? Nail the three remaining boards together to form a triangle. Is this structure rigid? Make a list of the places where the triangle is used in building structures, such as houses, bridges, etc.

Expected Achievements: The pupils should see that the triangle is the most rigid of structures. It is used in structures where rigidity is necessary.

References:

Pieper and Beauchamp, pp. 421-431.

EXPERIMENT No. 47

A Demonstration

The Conductivity of Heat of Building Materials

Aim: To demonstrate the conductivity of heat of building materials.

Apparatus: A small sample of all the building materials, an alcohol lamp, and a pair of pliers.

Procedure: The building materials should be broken or cut into pieces of about the same length and thickness. With the pliers hold each piece in the flame for one half minute and then test with the finger the distance the heat has traveled up the piece of material from the flame. In which piece has the heat traveled the farthest? The least distance? Which one of these building materials would keep the heat of the sun out best in summer? Which one would retain the heat of the furnace best in winter? Which material is best for the construction of homes in this climate? What other factors must be taken into consideration in building homes other than the conductivity of heat of the materials?

Expected Achievements: The pupils should see that some materials are better conductors of heat than others. The poor conductors retain the heat in winter, and keep out the heat of the sun in summer. The theory of insulation of homes and refrigerators is based upon the conductivity of heat by materials. The pupils should also see that there are other factors to be considered besides the conductivity of heat by materials in building a home.

References:

Pieper and Beauchamp, pp. 404-417.

Hunter and Whitman, pp. 324-333.

EXPERIMENT No. 48

A Demonstration

The Forms of Matter

<u>Aim</u>: To demonstrate to the pupils the three forms of matter.

<u>Apparatus</u>: A test tube, an alcohol lamp, and some ice.

<u>Procedure</u>: Place some ice in the test tube and heat it until it melts. Continue to heat the water until it boils. In what three forms did the water exist? What caused the change from one form to another? Does all matter go through these three forms when heated? Name some that do not. Sublimation may be discussed in connection with this experiment. Iodine crystals will sublime readily when heated.

<u>Expected Achievements</u>: The pupils should see that matter may exist in three forms. They should also see that there are some kinds of matter that do not go through the three stages upon being heated.

<u>References</u>:

Wood and Carpenter, pp. 48.

Smallwood, Reveley, and Bailey, pp. 27.

Hunter and Whitman, pp. 18-19.

Powers, Neuner, and Bruner, pp. 314.

Lake, Harley, and Welton, pp. 250.

EXPERIMENT No. 49

A Demonstration

The Two Chief Characteristics of Matter

Aim: To demonstrate the two chief characteristics of matter.

Apparatus: Two books, a glass tumbler, a flat-bottom flask, an alcohol lamp, and a rubber stopper to fit the flask.

Procedure: Place a book on the table and try to place the second book in the same place and at the same time the first book is occupying the space. Why is it impossible to place the second book in the space occupied by the first book? Fill the glass tumbler with water. What becomes of the air that was in the tumbler? Heat some water in the flat bottomed flask to boiling and when it boils place the stopper in the flask and remove it from the flame. Let the flask cool. Try to remove the stopper, What holds the stopper in place? Compare the weight of a tumbler full of water with the weight of the tumbler full of air. Compare the weight of two books with the weight of one book. What are the two chief characteristics of matter?

Expected Achievements: The pupils should see that the two chief characteristics of matter are weight and capacity to occupy space.

References:

Wood and Carpenter, pp. 49-50.

EXPERIMENT No. 50

A Demonstration

The Two Chief Divisions of Matter

Aim: To demonstrate the two chief divisions of matter.

Apparatus: A sample of several pieces of matter such as wood, iron, rubber, rock, tin, bread, etc., and an alcohol lamp.

Procedure: With a pair of pliers hold, one at a time, the different pieces of matter in the flame. What happens to the pieces of matter when they are held in the flame? What is the origin of the pieces of matter that burn? Those that do not burn? What are the two chief divisions of matter?

Expected Achievements: The pupils should see that on the basis of origin, there are two divisions of matter--those that burn are organic in origin and those that do not burn are inorganic in origin.

References:

Smallwood, Reveley, and Bailey, pp. 26.

Wood and Carpenter, pp. 47.

EXPERIMENT No. 51

A Demonstration

The Forms of Energy

Aim: To demonstrate the three forms of energy.

Apparatus: Two baseballs, an alcohol lamp, a flat-bottom flask, a piece of cardboard to cover the flask, a dry cell, and a small electric motor from a toy or an old electrically-driven auto horn.

Procedure: Energy is possessed by anything that is able to produce motion. Place one of the base balls on the table and roll the other one along the top of the table so that it strikes the first one. What happens to the first base ball when the second one strikes it? What kind of energy do you think this represents? Pour some water in the flat-bottom flask and heat it with the alcohol lamp. When the water is boiling, place the cardboard cover on the flask. What happens to the cardboard? Where did the energy come from that moved the cardboard? What caused the steam? What kind of energy do you think is represented by the burning of alcohol? Connect the dry cell to the small motor. What happens to the motor? Where did the energy come from that caused the motor to run? What kind of energy do you think this represents?

Expected Achievements: The pupils should see that there are three forms of energy. They should see that energy may be transformed into different forms as in the case of the burning alcohol into mechanical energy of steam.

References:

Watkins and Bedell, pp. 310-312.

Powers, Neuner, and Bruner, pp. 431-432.

Pieper and Beauchamp, pp. 136-138, 147-148, 324-333.

Lake, Harley and Welton, pp. 249, 281-283.

EXPERIMENT No. 52

A Demonstration

Work

Aim: To acquaint the pupil with the scientific conception of work.

Apparatus: A rock that weighs approximately a pound, and a foot ruler.

Procedure: Have one of the pupils hold the ruler perpendicular to the top of the table. Have another pupil lift the rock from the top of the table to the top of the ruler. How much weight has been lifted? How high has it been lifted? How much work has been done? This is the unit of work in the English system. Have the pupils compute the amount of work they do in climbing up a flight of stairs. This amount of work can be changed into horse-power by dividing the number of foot-pounds of work times the number of seconds it takes them to climb the stairs by 550.

Expected Achievements: The pupils should develop the idea of the scientific conception of work. They should also get some idea what it means to rate an engine as capable of developing a certain amount of horse-power.

References:

Pieper and Beauchamp, pp. 442-443.

Wood and Carpenter, pp. 53-54.

Lake, Harley, and Welton, pp. 310-315.

EXPERIMENT No. 53

A Demonstration

The Two Kinds of Friction

Aim: To demonstrate the two kinds of friction.

Apparatus: A large steel ball or a base ball, and a block of wood weighing about the same amount as the ball.

Procedure: Place the ball and the block of wood on the top of the table. Give each a slight push. Which object moved the farthest? Why? Why are ball bearings used in machines? Why are lubricants used in the operation of machines?

Expected Achievements: The pupils should see that there are two kinds of friction. They should also understand the use of ball bearings and lubricants in the operation of machines.

References:

Lake, Harley, and Welton, pp. 529-331.

Pieper and Beauchamp, pp. 473-474.

Wood and Carpenter, pp. 54-55.

EXPERIMENT No. 54

A Demonstration

Inertia

Aim: To demonstrate to the pupils the principle of inertia.

Apparatus: A small express wagon, enough books to load the wagon heavily, and a large spring balance.

Procedure: Load the express wagon with books and hook the spring balance to the handle of the wagon. Pull the wagon along the floor in such a manner that the balance will register the amount of pull applied to the wagon. Pull slowly until the wagon starts and then continue to pull the wagon at a slow rate of speed. How many pounds of pull were necessary to start the wagon moving? How many pounds of pull were necessary to keep the wagon in motion? Why this difference in the amount of pull? Now hook the balance to the rear of the bed of the wagon and have a pupil start the wagon moving in the same direction at about the same speed that it was pulled in the first part of the experiment. Then hold the balance stationary and note the amount of pull necessary to stop the wagon. How does this amount of pull compare with the amount necessary to start the wagon moving?

Expected Achievements: The pupils should develop the idea that an object in motion has a tendency to remain in motion and an object at rest has a tendency to remain at rest.

References:

Lake, Harley and Welton, pp. 238.

Wood and Carpenter, pp. 54.

Pieper and Beauchamp, pp. 449-450.

Watkins and Bedell, pp. 238.

EXPERIMENT No. 55

A Demonstration

Levers

Aim: To demonstrate the advantage of the three different kinds of levers.

Apparatus: A stout yard stick, a apring balance, and a pound weight.

Procedure: Set up a first class lever using the weight for the resistance and the spring balance for the effort. What is the relation between the effort and the resistance? Place the weight at different places on the lever and note the relation between the effort and the resistance. What is the relation between the length of the effort-arm times the effort and the length of the resistance-arm-times and resistance? Repeat this procedure using the second class lever and the third class lever.

What are the advantages of the different types of levers? When should a first class lever be used? A second class? A third class? Mention several machines that make use of the different classes of levers and explain why each class of lever is used.

Expected Achievements: The pupils should see the advantage in using the different classes of levers. They should also see that a great amount of the work of the world is done by the use of levers.

References:

Lake, Harley, and Welton, pp. 318.

Wood and Carpenter, pp. 56-59.

Pieper and Beauchamp, pp. 459-562.

EXPERIMENT No. 56

A Demonstration

The Inclined Plane

Aim: To demonstrate the use of the inclined plane.

Apparatus: A small toy car, a spring balance, and a board about three or four feet long.

Procedure: Place the board to make an inclined plane with one end a foot higher than the other. Weigh the toy car. Tie the spring balance to the car so that it can be pulled up the inclined plane with the balance. What is the relation between the weight of the car and the effort necessary to pull the car up the plane? Adjust the plane until the raised end is two feet above the other end and make the same comparison. Continue to raise the end of the plane until it is nearly perpendicular, making the same comparison as it is raised each time. What is the relation between the effort over the weight and the height of the plane over its length in each case?

Expected Achievement: The pupils should see the advantage of the inclined plane in doing work. They should also see that there is a definite relation between the height and length of the plane and the amount of work necessary to pull the weight up the plane.

References:

Lake, Harley, and Welton, pp. 326-327.

Wood and Carpenter, pp. 56-59.

Pieper and Beauchamp, pp. 458-459.

EXPERIMENT No. 57

A Demonstration

The Advantage of the Movable Pulley

Aim: To demonstrate the advantage of the movable pulley.

Apparatus: A small pulley, a piece of cord, a weight, and a spring balance.

Procedure: Attach the pulley to a support so that it will be fixed. Tie the weight to one end of the cord, thread the cord through the pulley, and tie the spring balance to the end of the cord opposite the weight. Compare the effort necessary to lift the weight using the pulley, and the effort to lift the weight without using the pulley. Now set up the apparatus so that the pulley will be movable. This can be done by tying one end of the cord to a support, threading the cord through the pulley and tying the free end of the cord to the balance. The weight is tied to the pulley. Now lift the weight by pulling up on the balance. What is the relation between the effort and the resistance when the pulley is fixed? When it is movable? What is the advantage of using a movable pulley?

Expected Achievements: The pupils should see the advantage of using a movable pulley. They should also see the reason for using a fixed pulley.

References:

Lake, Harley, and Welton, pp. 323-324.

Wood and Carpenter, pp. 58-59.

Pieper and Beauchamp, pp. 462-465.

Watkins and Bedell, pp. 250-251.

EXPERIMENT No. 58

A Demonstration

The Role of Oxygen in Burning

Aim: To demonstrate that burning depends upon a supply of oxygen (air) reaching the fire.

Apparatus: Two glass cans, two candles, and a cover for one of the cans.

Procedure: Place a lighted candle in each of the cans. When the candles are burning at full flame place the cover over one of the cans. What happens to the flame in this can? Hold a smoking splint near the mouth and to one side of the other can. In what direction does the smoke move? How do you account for this? Why does the flame in the covered can refuse to burn while the one in the uncovered can continues to burn? What do you think is the function of oxygen in burning?

Expected Achievement: The pupils should see that a supply of air is necessary for burning to take place.

References:

Wood and Carpenter, pp. 114-115.

Pieper and Beauchamp, pp. 325-326.

Hunter and Whitman, pp. 125-126.

Lake, Harley, and Welton, pp. 44-47.

EXPERIMENT No. 59

A Demonstration

A Simple Fire Extinguisher

Aim: To make and demonstrate the use of a simple fire extinguisher.

Apparatus: A flat bottom flask or a pint bottle, a one hole rubber stopper to fit the flask or bottle, a piece of glass tubing to fit the hole in the stopper, some baking soda, and sulphuric acid.

Procedure: Fill the flask or bottle about three fourths full of water and add a level teaspoonful of baking soda. Shake the mixture until the soda dissolves. Cut a piece of glass tubing about three inches long and heat one end of it until the opening is nearly closed and then put the tubing through the hole in the stopper so that the end of the tubing with the small opening will be outside of the flask or bottle when the stopper is placed in the flask or bottle. Now pour a few drops of sulphuric acid into the mixture in the flask or bottle and place the stopper in the bottle. If a small amount of paper has been set on fire the stream of liquid may be directed on the fire to extinguish it. What are the parts of a simple fire extinguisher? Could you make one for home use? How?

Expected Achievements: The pupils should see the essential parts of a simple fire extinguisher. The possibilities of making a fire extinguisher for the home should be discussed.

References:

Wood and Carpenter, pp. 244-248.

Pieper and Beauchamp, pp. 360-363.

Hunter and Whitman, pp. 255.

Lake, Harley, and Welton, pp. 43.

Powers, Neuner, and Bruner, pp. 319-320.

EXPERIMENT NO. 60

A Demonstration

The Transference of Heat

Aim: To demonstrate how heat is transferred from one place to another.

Apparatus: An alcohol lamp, a chalk box with a hole one inch in diameter in each end, a large wire nail, and a thermometer.

Procedure: Light the alcohol lamp and set it in the chalk box. The box should be set up on end so that air can get into it through the opening in the bottom of the box. Hold the thermometer near the opening in the bottom and record the temperature. Now hold the thermometer a few inches above the opening in the top of the box and record the temperature. What is the reason for the difference in the temperature? What carried the heat from the box? Hold the thermometer a few inches to one side of the flame and note the temperature. What is the difference between this and the temperature of the room? How did the heat get from the flame to the thermometer?

Hold one end of the iron nail in the flame and from time to time rub a piece of cotton that has been saturated with water along the nail. What is happening to the nail? How is the heat being carried along the nail? Which of these three methods of transferring heat is used in heating homes? Which method is used in heating the school room? Which method transfers heat from the sun to the earth?

Expected Achievements: The pupils should see the three methods of transferring heat from place to place. They should also see how these methods are used in heating homes.

References:

Lake, Harley, and Welton, pp. 369-382.

Pieper and Beauchamp, pp. 301, 304, 365-367.

Wood and Carpenter, pp. 233, 238.

EXPERIMENT No. 61

A Demonstration

Simple Reflection

Aim: To demonstrate simple reflection of light.

Apparatus: A small mirror and a beam of light.

Procedure: Darken the room and arrange the shades so that a small beam of light will enter the room. Allow the beam to fall on the mirror, at first perpendicular to it and then gradually shift the mirror until the angle of incidence approaches 0^{o}. What effect does the mirror have on the beam of light when it is perpendicular to the beam? When is at an angle of 45^{o} to it? When it is parallel to it? If a pencil is held perpendicular to the mirror at the point where the beam of light strikes the mirror the angle of incidence can be compared with the angle of reflection.

Expected Achievements: The pupils should form an idea of what simple reflection is. They should also see that the angle of incidence is equal to the angle of reflection.

References:

Lake, Harley, and Welton, pp. 407-409.

Wood and Carpenter, p. 257.

Pieper and Beauchamp, pp. 554-555, 575-576.

EXPERIMENT No. 62

A Demonstration

The Refraction of Light

Aim: To demonstrate the refraction of light.

Apparatus: A glass of clear water and a pencil.

Procedure: Place a pencil in the glass of water. The pencil should extend diagonally through the water. Hold the glass containing the pencil on the level of the eye with the pencil to the right or left of the observer. Look at the pencil through the glass. What appears to have happened to the pencil at the point where it enters the water? Place the pencil perpendicular to the bottom of the glass. Compare the appearance of the pencil now with its former appearance. Why this difference in appearance?

Expected Achievement: The pupils should see that the pencil appears broken at the edge of the water due to the refraction of light.

References:

Lake, Harley, and Welton, pp. 410-419.

Wood and Carpenter, pp. 259.

Pieper and Beauchamp, pp. 553-554.

Watkins and Bedell, pp. 333-334.

EXPERIMENT No. 63

A Demonstration

The Solar Spectrum

Aim: To demonstrate that white light is composed of many colors of light.

Apparatus: A glass prism and a convex lens.

Procedure: Arrange the shades of the room in such a manner that a beam of sunlight will be available for use. Hold the glass prism in the beam of light so that there will appear on the ceiling, or a piece of white paper, the solar spectrum. What are the colors of the spectrum? Where do the colors come from? Hold a convex lens in the spectrum and focus it on a piece of white paper. What is the color of the light at the focal point of the lens? What has happened to the colors of the spectrum? What do you conclude as to the colors of light composing sunlight?

Expected Achievements: The pupils should see that sunlight is composed of several colors of light. They should also see that sunlight is broken into its component colors by the prism and the colors are mixed into white light by the lens.

References:

Lake, Harley, and Welton, pp. 159-161.

Watkins and Bedell, pp. 341-342.

EXPERIMENT No. 64

A Demonstration

Illumination Depends Upon the Distance from the Source and the Intensity of the Light

Aim: To demonstrate that the intensity of illumination depends upon the distance of the object from the source of the light and the intensity of the light.

Apparatus: Two sources of light, a candle and a flash light, and a piece of paper with a grease spot on it.

Procedure: Light the candle and place it on the table. Place the flash light on the opposite side of the table and turn it on. Hold the piece of paper with the grease spot on it between the two sources of light. What is the appearance of the grease spot from each side of the paper? Why this appearance? Move the paper until a place is found where the grease spot appears the same from both sides. Why does the spot appear the same at this position? Which source of light is the farthest from the paper? Why? What do you think the intensity of the light has to do with the intensity of illumination? What do you think the distance of an object from the source of light has to do with the intensity of illumination?

Expected Achievements: The pupils should see that the intensity of illumination depends upon the distance of the object from the source of the light and the intensity of the light.

References:

Lake, Harley, and Welton, pp. 388-390.

Wood and Carpenter, pp. 277.

Pieper and Beauchamp, pp. 567-569.

Watkins and Bedell, pp. 331-332.

EXPERIMENT No. 65

A Demonstration

The Intensity of Illumination Depends upon the Distance of the Object from the Source of Light

Aim: To demonstrate the relation of the intensity of illumination to the distance of the object from the source of light.

Apparatus: A flash light, a piece of cardboard one inch square, and a larger piece of cardboard about the size of the back of a tablet.

Procedure: Lay the lighted flashlight on a two books, one upon the other. Hold the small piece of card board one foot from the flashlight so that it will make a shadow on the larger piece of cardboard that is held two feet in front of the flashlight. What is the size of the small piece of cardboard? What is the size of the shadow on the larger piece of cardboard? Place the larger piece of cardboard three feet in front of the light keeping the small piece of cardboard one foot in front of the light. What is the relation of the size of the shadow to the size of the small piece of cardboard? What is the relation of the size of the shadow on the large piece of cardboard compared to the distance from the source of light?

Expected Achievement: The pupils should see that the intensity of illumination depends upon the distance of the object from the source of light.

References:

Pieper and Beauchamp, pp. 570-571.

Lake, Harley, and Welton, pp. 388-389.

Watkins, and Bedell, pp. 331.

EXPERIMENT No. 66

A Demonstration

The Uses of Lenses

Aim: To demonstrate the chief uses of lenses.

Apparatus: A convex and a concave lens and a piece of white notebook paper.

Procedure: Adjust the shades of the room so that a beam of sunlight will be available for use. Hold the convex lens in the beam of light and focus it on the white piece of paper. The path of the light will be shown better if a little chalk dust is blown between the lens and the paper. What happens to the beam of light that goes through the lens? Hold the concave lens in the beam of light and repeat the above procedure. What happens to the beam of light that goes through the lens? Let each pupil hold each lens above the printing in his book. What does the lens do to the size of the letters? Why do you think the different types of lenses are used in spectacles?

Expected Achievements: The pupils should see that the different types of lenses have different effects upon light going through them. They should see that this principle has a practical application in such things as spectacles, and other optical instruments.

References:

Lake, Harley, and Welton, pp. 412-416.

Wood and Carpenter, pp. 261-266.

Pieper and Beauchamp, pp. 243-246, 578-579.

Watkins and Bedell, 334-337.

EXPERIMENT No. 67

A Demonstration

The Study of a Camera

Aim: To study the camera as an aid in understanding how the human eye functions.

Apparatus: A small box camera and a piece of thin white paper to be used as a screen.

Procedure: Open the back of the camera and remove the part around which the film is placed. Place the piece of thin white paper in the place that is usually occupied by the film but leave the back of the camera open so that the image that is formed may be observed on the paper screen. Fix the shutter so that it will remain open. Focus the camera on some luminous object such as a burning candle and observe the image on the paper screen. What is the size of the image as compared with the size of the candle flame? Why is it inverted? What part of the eye corresponds to the shutter? The lens? The box of the camera? The paper screen?

Expected Achievements: The pupils should gain some knowledge of the structure and the function of the eye from this study.

References:

Lake, Harley and Welton, pp. 391, 413-415.

Wood and Carpenter, pp. 259-262.

Pieper and Beauchamp, pp. 573-575.

EXPERIMENT No. 68

A Laboratory Experiment

The Law of Magnetic Attraction and Repulsion

Aim: To demonstrate the law of magnetic attraction and repulsion.

Apparatus: Two bar magnets that have the poles marked, and a piece of string.

Procedure: Suspend one of the bar magnets with the piece of string. Hold the N-pole of the other magnet near the S-pole of the suspended magnet. What is the result? Hold the N-pole of the magnet to the N-pole of the suspended magnet. What is the result? Repeat the procedure using the opposite poles. What are the results? What is the law of magnetic attraction and repulsion?

Expected Achievements: The pupils should be able to demonstrate and formulate the law of magnetic attraction and repulsion.

References:

Wood and Carpenter, pp. 286-288.

Pieper and Beauchamp, pp. 520-521.

Watkins and Bedell, pp. 372-374.

Hunter and Whitman, pp. 354-355.

Lake, Harley, and Welton, pp. 440-441.

EXPERIMENT No. 69

A Demonstration

A Study of a Magnetic Field

Aim: To demonstrate the magnetic field about a compass.

Apparatus: A magnet, some iron filings, a piece of white notebook paper or a piece of white cardboard.

Procedure: Lay the magnet on the table and place the piece of white notebook paper or cardboard over it. Better results will be obtained if a book is placed on each side of the magnet and the paper placed on top of the books. Sprinkle the filings on the paper over the magnet. If a good picture of the magnetic field does not appear, tap the paper lightly with a pencil and the filings will arrange themselves into a definite pattern on the paper. In what direction do the lines of force, along which the filings arrange themselves, seem to run? Where do the filings form the more definite pattern? Where is the magnetic field the stronger? If two magnets are available, demonstrate the magnetic field about two like poles in the same manner as above. In what direction do the lines of force seem to run? Demonstrate the magnetic field about two unlike poles. In what direction do the lines of force run in this field? In the light of this experiment how do you explain magnetic attraction and repulsion?

Expected Achievements: The pupils should see that the magnetic field extends about a magnet, being stronger at the ends of the magnet. In case of two magnets with like poles the lines of force seem to push each other apart, while with unlike poles they seem to go from one pole to the other.

References:

Watkins and Bedell, pp. 373.

Pieper and Beauchamp, pp. 520-521.

Wood and Carpenter, pp. 287.

Lake, Harley, and Welton, pp. 444-445.

Hunter and Whitman, pp. 354-355.

EXPERIMENT No. 70

A Laboratory Exercise

A Simple Compass

Aim: To make a simple compass.

Apparatus: A small sewing needle, a magnet, and a shallow dish of water.

Procedure: Magnetize the needle by stroking a magnet with it. The needle should always be drawn across the magnet in the same direction. Test the needle from time to time with iron filings to determine whether or not it is becoming magnetized. As soon as it is magnetized sufficiently to lift a few iron filings, float it on the surface of the dish of water. Observe the action of the needle for a few minutes. In what direction does it move? How do you explain this movement? When the needle becomes stationary, change its position and observe its motion again. Why does the needle arrange itself in a north-south direction? Each pupil should be allowed to test a needle. If there is trouble in floating the needle lay it across a small piece of tablet paper and then gradually sink the paper.

Expected Achievements: The pupils should see that a compass is a magnet that is free to arrange itself along magnetic lines of force.

References:

Pieper and Beauchamp, pp. 651-653.

Wood and Carpenter, pp. 286.

Lake, Harley and Welton, pp. 442-443.

EXPERIMENT No. 71

A Laboratory Exercise

A Simple Electromagnet

<u>Aim</u>: To make and demonstrate a simple electro-magnet.

<u>Apparatus</u>: A large iron nail (a ten or twenty penny), about three feet of insulated copper wire, a dry cell, and some iron filings.

<u>Procedure</u>: Wrap the insulated wire around the nail leaving enough free end on the wire to attach it to the dry cell. Attach one end of the wire to one of the posts of the dry cell. Lay a quantity of iron filings on a piece of paper, hold the magnet near the filings, and attach the other end of the wire to the other post of the dry cell. What happens to the iron filings? Break the circuit by disconnecting the wire from one of the posts of the dry cell. What happens to the iron filings? What caused the nail to become a magnet? What is an electro-magnet? Which is the stronger, a permanent magnet or an electro-magnet of the same size? Does the nail retain some of its magnetism?

<u>Expected Achievements</u>: The pupils should see that a current of electricity flowing around an iron core makes a magnet. They should also see that an electro-magnet is stronger than a permanent magnet of the same size. The soft iron also retains some of its magnetism. Harder iron would retain more.

<u>References</u>:

Pieper and Beauchamp, pp. 521.

Watkins and Bedell, pp. 373-374.

Wood and Carpenter, pp. 401-402.

Lake, Harley, and Welton, pp. 446-449.

Hunter and Whitman, pp. 355.

EXPERIMENT No. 72

A Demonstration

Static Electricity

Aim: To generate static electricity and study some of the things it does.

Apparatus: A rubber comb, a glass rod, a piece of silk cloth, a few pith balls (pith of a corn stalk), silk thread, and some very small pieces of paper.

Procedure: String the pith balls on the silk thread, one ball on a thread, and suspend them from some suitable support so that they have freedom to move in all directions. Charge the rubber comb by rubbing it on the sleeve of a woolen coat or sweater. Bring the comb near the pith balls. What effect does it have on the pith balls? Touch one of the pith balls with the comb. What effect does this have on the movement of the pith ball when near the comb? What do you think has happened to the pith ball? Now, while it is still charged from the comb, charge the glass rod by rubbing it with the silk cloth and bring it near the charged pith ball. How does it react toward the glass rod? How do you account for this? What caused the charge of electricity on the comb and the glass rod? Discharge the pith balls by touching them with the hand and reverse the above process. In what way does the action of the charged pith balls toward the charged comb and glass rod resemble the law of magnetic attraction and repulsion? What is the law of attraction and repulsion of charges of static electricity?

Expected Achievements: The pupils should see that there are two kinds of static electricity, and that they react toward each other in a similar way that magnets react toward each other. Static electricity is generated by friction.

<u>References</u>:

Wood and Carpenter, pp. 289.

Watkins and Bedell, pp. 370-372.

Pieper and Beauchamp, pp. 512-513.

Hunter and Whitman, pp. 342-343.

EXPERIMENT No. 73

A Demonstration

Current Electricity

Aim: To generate current electricity and study some of the things it causes.

Apparatus: A glass tumbler, sulphuric acid, a strip of zinc, a strip of copper, the simple electro-magnet constructed in a previous experiment, and some iron filings.

Procedure: Fill the tumbler about three fourths full of water and add a tablespoonful of acid. If the tumbler is a large, two tablespoonfuls of acid will be required. Place the strips of copper and zinc in the mixture in the tumbler. Do not let the metal strips touch each other. Fasten a piece of copper wire to each of the strips. When the action becomes rather vigorous in the tumbler attach the electro-magnet to the free ends of the wires. Hold them close to some iron filings. What happens to the electro-magnet? Where did the electricity come from that made the electromagnet? What do you think generated the electricity? Touch the loose ends of the wire from the strips of metal to the tongue. What sensation do you notice? What do you think causes this sensation?

Expected Achievements: The pupils should see that current electricity can be generated by chemical action. Current electricity causes a sensation that can be detected by the body and it may be used in making an electro-magnet.

References:

Pieper and Beauchamp, pp. 514-515.

Watkins and Bedell, pp. 355-360.

Wood and Carpenter, pp. 290-291.

Lake, Harley, and Welton, pp. 434.

Hunter and Whitman, pp. 346-348.

EXPERIMENT No. 74

A Demonstration

A Study of a Simple Dynamo

Aim: To study a simple dynamo.

Apparatus: A dynamo from a discarded telephone, the bell from a discarded telephone, a simple electro-magnet, and some copper wire.

Procedure: Examine the dynamo. What are the two essential parts of the dynamo? Have the class hold hands and form a circle about the dynamo with one pupil holding his hand on the top of the dynamo and the pupil next to him holding his finger of the end of the shaft of the rotating coil of wire opposite the crank that turns the coil of wire. Turn the crank slowly. What sensation do you feel? What effect does it seem to have on the muscles of your arms? Fasten an electro-magnet to the dynamo by attaching the wires in place of the hands of the pupils that were touching the dynamo in the above prodedure. Place the electro-magnet near some iron filings and turn the crank. What happens to the electro-magnet? Where do you think the electricity came from that magnetized the electro-magnet? What do you think generated the electricity? How? Attach the electric bell in the place of the electro-magnet and turn the crank of the dynamo. What happens?

Expected Achievements: The pupils should see that a current of electricity is generated by a coil of insulated wire rotating in a strong magnetic field. They should see that current electricity can be made to do work and that strong electric currents are harmful to the body.

References:

Wood and Carpenter, pp. 33-335.

Pieper and Beauchamp, pp. 522-525.

Lake, Harley, and Welton, pp. 449-451.

Watkins and Bedell, pp. 362-379.

Hunter and Whitman, pp. 402-403.

EXPERIMENT No. 75

A Demonstration

The Heating Effect of an Electric Current

Aim: To demonstrate the heating effect of an electric current.

Apparatus: A dry cell, pieces of copper wire (very fine wire), iron wire (screen wire), steel wire (a very fine needle), if possible a piece of the heating element of an electric toaster or electric iron, and a piece of aluminum wire.

Procedure: Place each of the wires across the terminals of the dry cell, noting the time that it takes each one of them to become red hot and the length of time it takes to burn them. Which wire burned the more readily? Which wire became red hot in the shortest length of time? Which ones did not burn? Which wire do you think is most suitable for the construction of heating elements in electrical heating devices? Why?

Expected Achievements: The pupils should see that an electric current produces heat. They should also see that some wires will burn and others will get hot without burning. Those that will not burn and yet produce heat are suitable for heating elements in electrical devices.

References:

Watkins and Bedell, pp. 388-389.

Pieper and Beauchamp, pp. 358, 535-539.

Wood and Carpenter, pp. 228-229.

Hunter and Whitman, pp. 357-362.

Lake, Harley, and Welton, pp. 458-459.

IV. APPENDIX

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B. Suggested List of Apparatus.

Quantity	Size	Name	
12	$4 \times \frac{1}{2}$	Test tubes	.25
1	4 oz.	Alcohol lamp	.55
4	200 cc.	Flat bottom flasks	.80
1	12 in.	Thermometer (-10° to 220° F.)	2.00
1	4 rings	Ring stand and clamps and rings	1.75
2		Burette Clamps	1.10
2 doz.		Rubber Stoppers (assorted sized)	1.75
		Glass tubing (assorted sized)	.70
6	150 cc.	Beakers	1.25
1	0-64 oz.	Spring balance	.85
1	25x75 mm.	Glass prism	.75
1 set		Demonstration lenses	1.75
2		Bar magnets	.70
4 oz.	spool	B&S guage no. 24 Copper wire	.65
$\frac{1}{4}$ lb.		Iron filings	.15
		Total	15.00

C. Suggested List of Chemicals

Quantity	Name	
1 oz. can	Sodium peroxide	.30
1 box	Baking Soda	.05
4 oz.	Acetic acid	.25
1 lb.	Hydrochloric acid	.40
1 lb.	Nitric acid	.65
1 lb.	Sulphuric acid	.55
4 oz.	Iodine in potassium iodine sol.	.25
1 oz.	Benedicts solution	.45
4 oz.	Sodium hydroxide	.30
1 gal.	Alcohol	.75