Curriculum Construction in General Science

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CURRICULUM CONSTRUCTION IN GENERAL SCIENCE

BY

CORNELIUS F. BEK

A thesis submitted in partial fulfillment of the requirements of the degree of Master of Arts in Loyola University June, 1930
Preface.

In attempting such a work as this the author is fully aware of the fact that he invites a wealth of criticism. The sincere always welcome constructive criticism. The author gratefully acknowledges the kind assistance of Wilbur L. Beauchamp and O. D. Frank of the University of Chicago; the help given by Albert W. Evans, principal of Tilden Tech, Jerome Isenbarger of Crane College, Dr. A. Anderson of Roosevelt High, Mary Mulroy of Tilden Tech, C. E. Russel of Harrison High, Jennie Weinland of Sullivan Junior High, Dean Austin G. Schmidt of Loyola University, and Dr. Wm. H. Johnson, his advisor.

Whatever merits the thesis may have would have been impossible without the above assistance. The faults the work contains are assumed entirely by the author.
Vita.

The writer was born in Warren County, Missouri. Most of the early part of his life was spent in Richardson County, Nebraska. Here he attended the ordinary rural school.

At the age of seventeen he entered Elmhurst College, at Elmhurst, Illinois. Having finished four years' training as a teacher, he accepted his first position in a parochial school on the northwest side of Chicago. After teaching here for seven years, he resigned and entered the service of the Board of Education of Chicago teaching in the elementary schools. Intensive study and close application caused a nervous breakdown. He was forced to resign and seek outdoor employment as a provision salesman for thirteen years.

In 1920 he re-entered the service of the Board of Education, took his bachelor's degree at the University of Chicago, and is at the present time teaching in the Hirsch Junior High School.
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Curriculum Construction in General Science.
Grades 7-9.

Chapter I.

Statement of the Problem.

The aim of the writer of this thesis will be to reveal the modern theories of curriculum construction as they apply to the construction of a curriculum in general science for the junior high school of grades seven to nine.

There are several possible methods of approach to this problem. Only those will be considered which are used for the curriculum construction in the secondary schools. They are as follows:

(1) The traditional method;
(2) The method of imitation;
(3) Making selections from so called "Best Courses" in order of frequency of occurrence;
(4) Basing curriculum content on analysis of adult needs;
(5) Making a statement of adult abilities and listing pupil experiences necessary to carry them out. (34:116-17)

The Traditional Method.

The easiest method of approach is to accept the traditional content of the curriculum of the past. It is also the least efficient, because conditions in a dynamic society are changing. For instance, the old oxcart was supplanted by the horse
and buggy, the latter by the automobile. The automobile manu-
ufacturer of today continually makes improvements in new mo-
dels. He creates a dissatisfaction with the old in the pro-
spective customer, and a desire to possess the latest model.
A physician could not hope to make a decent living by employ-
ing methods in vogue fifty years ago. On account of the con-
tinual changes the traditional curriculum is too far behind
social life, and can have little influence in educating pupils
to meet the present day requirements.

The Method of Imitation.

In many cases numerous copies of courses of study are gath-
ered from various parts of the country. The courses of study
thus assembled were written from the viewpoint of the people
of their respective locality. Many items in them may be su-
perior to those found in the curriculum to be reconstructed.
Quite naturally, these will be taken and installed in place of
obsolete, deleted ones. This procedure is quite common.

Making Selections from So Called "Best Courses".

A new course of study is not made unless there is some dis-
satisfaction with the old one. As changes are made a lot of
sifting is done. New, improved items are substituted. If
enough copies from all over the country are gathered, the cur-
riculum constructors who use above method argue that the ideas
occurring most frequently in "best courses" are the ones to
select for the new one. Since time allotment for different
subjects will vary in different localities, the difficulty is overcome by taking the average time given to a subject as a guide.

Basing the Curriculum Content on Analysis of Adult Needs.

In this case trained investigators study activities in which the people are engaged in order to discover, for instance, the kind of arithmetic required, or the number of words most commonly used, the act performed in taking care of one's health, or motion made by an efficient mechanic. This method aims at utility and present use. Through this study ideals are established, and the activities necessary to achieve them are decided upon by repeated conferences. When these activities are listed and classified, the school system will select those items toward which it will direct its efforts. The curriculum then contains pupil experiences and activities that are justified because they fit the needs of the community. (34:116)

Making a Statement of Adult Abilities and Listing Pupil Experiences Necessary to Carry them out.

A city or locality may engage the services of thoughtful men and women to list abilities, and then select and list pupil experiences necessary to carry them out. It is assumed that a good citizen should possess the ability to do his individual share in promoting the mutual welfare of the community.
Bobbitt had Chicago graduate students list abilities under ten major headings. He took these abilities to Los Angeles and distributed them among 1200 high school teachers. Each teacher was requested to make as many additions as possible. When the list was completed, committees were organized whose membership included superintendents, leaders and teachers. A separate committee was appointed for each department. These committees sought out the abilities which their department should assist pupils to achieve. When all the objectives had been determined upon it was found that they coincided pretty well with the "Seven Cardinals of 1918". The next step was to select the activities necessary for the achievement of the objectives. Pupil experiences and activities constituted the curriculum. (34:117)

In this thesis the writer will show how the present Chicago Junior High School curriculum was evolved. The writer was a member of the committee which prepared the Junior High School Curriculum in General Science. The steps pursued may be set forth as follows:

1. Determining the objectives of education.
2. Determine the extent to which general science can assist in following the objectives of education.
3. The teaching procedure and its relations to curriculum construction.
4. The building of the curriculum.

5. The installation of the curriculum in the classroom. Before taking up the problem the writer will endeavor to present a résumé of the literature in the field which relates to curriculum construction in science, particularly general science. It will be noted that various principles of the above procedure for constructing a curriculum were applied at various stages.
Chapter II.

Curriculum Studies and Illustrative Units of Science Teaching.

In the first chapter several methods of approach in curriculum construction were mentioned. Below will follow a brief summary of curricular studies showing to what extent their method of approach conforms to those mentioned, and whether the unit topics chosen, as shown in a later chapter, are at variance or in harmony with the Chicago curriculum.

Dr. E. R. Downing made a study to see if children are more interested in plants, animals, or physical material, and if they chose the latter, in which phase their interest centers. He selected 301 boys and 411 girls to write questions and observations regarding above named items to a magazine in letter form. The average age of the boys was 11.9, that of the girls 12.08. He chose 295 observations and analyzed 447 questions. He found that the child's greatest interest was animals. Boys wrote more observations about plant materials, while the girls chose physical phenomena. Under plant material the preference was: Wild flowers, trees, wild spore-bearers, garden fruits, vegetables and garden flowers. Under animal material the preference was: Insects, birds, common mammals, reptiles, invertebrates, fish, spiders, human physiology and Indians. Under physical material the first
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choice was elementary physics. Then followed in order geo-
graphical, geological, astronomical, photographical, minerolog-
ical, mechanical and industrial material. More interest was
shown in activities than in identifications. (19:334-38)

Dr. Downing allowed himself to be guided by the mental and
emotional child life in finding the placement for general sci-
ence material. According to his findings the Chicago course
of study falls down on the first choice. The plant material is
taken care of in the ninth grade. Since nearly half of the
pupils manifested a preference for elementary physics the se-
lection made by the Chicago Curriculum Committee seems to co-
icide with Dr. Downing's findings.

Just what emphasis do textbook writers place on the topics
in general science? Hahor A. Webb selected eight large science
groups: Astronomy, biology, chemistry, household arts, physics,
physiography, physiology and miscellaneous topics. He tried to
determine the importance of these topics as indicated by the
number of pages devoted to them in 18 different textbooks. On-
ly the five topics which are highest on the list will be cited.
(51:1-40)

In astronomy the topics rank as follows:

1) The solar system.
2) Stars and constellations,
3) Earth and planets,
4) seasons,
5) Moon and eclipses.

In biology:
1) Stems,
2) Photosynthesis,
3) Yeast and molds,
4) Heredity,
5) Structure and function of flowers;

In chemistry:
1) Combustion,
2) Useful metals,
3) Acids,
4) Composition of atmosphere,
5) Oxygen;

In household arts:
1) Composition of foods,
2) Fuel values of foods,
3) Cleansing of textiles,
4) Preservation of foods,
5) Soap making;

In physics:
1) Humidity,
2) Causes of winds and storms,
3) Soil formation,
4) Erosion,
5) Weather forecast,
6- Rocks;

In physiology:
1) Bacteria and contagious diseases,
2) Digestion,
3) The eye,
4) Insect carriers of diseases;

In miscellaneous:
1) World commerce and transportation,
2) Value and method of science study,
3) Man's relation to nature,
4) Economic problems,
5) Prehistoric man.

The Chicago course of study has incorporated all items just listed under astronomy; in biology everything but heredity; in chemistry, all items, likewise in household arts and physics; in physiography all but rocks; in physiology all items; in miscellaneous, only man's relation to nature and economic problems receive any emphasis.

Newspaper editors and magazine publishers are usually wide awake as to public needs. They have to be to sell their goods. Giles M. Ruch and A. H Searles made an analysis of magazine articles over a period of from five to ten years to ascertain adult needs in the field of general science. They waded through ten years' issues of eight general magazines, five
and one half years' issues of Saturday Evenings Post, and five years' issues of scientific magazines.

Their findings in the distribution of material by topics in general science were as follows: Biology, 62.2 per cent, physics, 26.3 per cent; chemistry, 5.1 per cent; physiology, physiography, textiles, astronomy, food, meteorology, household animals together 4 per cent: agriculture, 2.4 per cent. (40:389-96)

F. D. Curtis tried to determine the sort of scientific knowledge necessary for an intelligent reading of the public press. He examined 83 issues of 6 representative papers and found that 41.4 per cent of the articles were biological science, and 49 per cent physical. (13:22)

L. Thomas Hopkins made a similar study. He analyzed articles in a month's issue of four Denver papers, six issues each of two scientific magazines, two home magazines, two weeklies, and two farm publications. He briefly summarized and classified the material as biology, physics, chemistry, astronomy, geology, biography and psychology.

He found that four times as much space was given to biology as to physical, and ten times as much as to chemical material. Of the chemical and physical material 98 per cent was found in the scientific magazines. Biology seems to be of greatest importance in secondary schools. Hopkins seems to incline to general science in the seventh grades and to
Comparing the Chicago course of study with the investigations we will find that it is well up to present day requirements.

In the preceding paragraphs the importance of general science topics, and their place in the curriculum have been discussed. The summaries also showed the guiding motive of the investigators which prompted them to undertake and consummate their task. The succeeding part of this chapter will be devoted to the discussion of illustrative units into which the curriculum is divided.

Arranging a general science course in units is by no means confined to Chicago alone, as we shall see in studying the procedure in several representative cities of our country. The summaries given below include only units, or parts of units that were available. The samples discussed are taken from school systems enrolled in the Co-operative Plan of Curriculum Revision. (17:172)

In Boston, Massachusetts, the units are broken into projects and problems. The arrangement is practically the same as that offered in this thesis. What is called projects in Boston is listed in this work as problem headings. Their projects are supplemented by sub-topics, while the writer has aided the pupil with questions which lead to the required understanding. In Boston each sub-topic is based on one or more
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experiments. The experiments are not listed, nor is any reference given. Their "Fire Unit" is broken up into eleven projects. They deal briefly with common fuels, kindling of fire, the remains of fire, how the candle burns, common fuels, how the kerosene lamp and wood burns, and extinction of fire. Nothing is said of work sheets or classroom procedure.

Glen L. Gebhardt, member of the Denver Junior High School General Science Committee, states that the use of sheets has met with encouraging results. When general science was introduced, the Denver teachers had the same difficulty as Chicago teachers. They did not know how to put the subject over. At first syllabus sections were written on the board and copied into notebooks by the pupils. The results were negative. Mimeographed outlines were later placed in the pupils hands. They contained instructions regarding demonstrations, questions, assignments and topics for discussion. Blank spaces were left to be filled out by the pupils. The results obtained from these outlines was not satisfactory. They were replaced by mimeographed work sheets, each pupil having his own copy. In purpose these sheets coincided with the writer's. They contained a serious of questions which the pupil must answer through the use of textbooks, reading assignments, observations, and classroom discussions. A blank space is left for written work by the pupil. The sheets differ from those offered in this thesis in as much as the pupils are given read-
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Assignments for home work which prepare them for class discussion the following day. This may work with Denver children; in Chicago it does not. The teacher is theoretically supposed to look over the notebooks after school. With a limited membership it can be done, but with the ordinary overloaded class, this supervision is impossible. (17:173-78)

Samples of three sheets show that they require from one to five week's time to finish. An exact copy of "7B Sheet One" will show that it is less detailed and specific than those offered in this thesis.

7B Sheet 1.

General Science

Name

Date

Subject: Air

Air as a substance: See textbook for chapter dealing with this topic.

List below the four important facts about air as a substance. Mention the experiment used to show each fact. Give other uses and examples of each fact.

Fact No. 1: (a) What experiment shows this? and, (b) Give other examples and uses of this fact.

Fact No. 2: (a) Experiments; and, (b) Other examples and uses.

Fact No. 3: (a) Experiments, and, (b) Other examples and uses.

Fact No. 4: (a) Experiments; and, (b) Other examples and uses.
Questions for class discussion:

1. How high does the mercury of the barometer stand in Lenver?
2. How high is it at sea level?
3. How high will the water rise in the lift pump at sea level?

Home study assignment:

Make a drawing in your notebook of the apparatus used in one important experiment with air. Tell how the experiment was performed. Use at least a whole sheet.

Experiments and Demonstrations.

Fact No. 1: (a) Pushing an inverted tumbler down into water
       (b) Allowing water to gurgle out of a bottle or jug.

Fact No. 2: (a) Weighing a hollow sphere before and after evacuation.

Fact No. 3: (a) Using a vacuum pump with bladder glass
           (b) Constructing a simple mercury barometer
           (c) Placing a sheet of paper over a tumbler of water and inverting.

Fact No. 4: (a) Lowering inverted test tube in a cylinder of water
           (b) Using Boyle's law tube.

Other Examples and Uses.

Fact No. 1: (a) Nature's dislike for a vacuum
           (b) To let any liquid in or out of a vessel, air
must be let out or admitted.

Fact No. 2: (a) If air were weightless, it could not be held to the earth.
(b) Computation of the weight of a room full of air

Fact No. 3: (a) Pressure is due to weight of air
(b) Cause of variation of pressure with altitude
(c) Cause and effect of varying atmospheric pressure
(d) Physiological effects of variation in pressure
(e) Use of vacuum cleaners
(f) Pneumatic tubes used in department stores.

Fact No. 4: (a) Use of compressed air for machinery, air brakes, and automobile tires
(b) Use of diving bells or caissons
(c) Operation of air guns.

The experiments are performed during the first period as a class demonstration. The second period is used for reading textbooks and other material. The third period is devoted to discussion, after which the pupil records his own reaction. The application of the principles to life situations is provided for under "Other examples and uses".

The second sheet in a similar manner deals with the properties of gases, their importance, air as a mixture. Sheet three deals with the relation of air to life and health. It is claimed that the pupil in using these sheets knows definite-
ly what he is to do, when the task is completed, and can find out what work has been missed, if he is absent.

Detroit, Michigan, offers a science "Unit XV- How Man Makes Light to take the Place of Sunlight". The unit is divided into two main parts. (17:169-71)

A. Pupil Goals.

I. Outcomes.

Here three objectives are listed:

1. "A knowledge of the development and function of lighting devices.
2. A knowledge of what constitutes good lighting.
3. An appreciation of the importance of artificial lighting in the present day life".

II. Standards and Attainments.

Under this caption ten minimum essentials are listed: 

"(1) The evolution of lighting devices; (2) importance of present lighting devices; (3) how different gases and electricity are produced for lighting purposes; (4) principles of gas and electric lights; (5) good lighting, voltage; (6) shape and color of bulbs; (7) methods of direct and indirect lighting; (8) placement of lights; (9) reading meters; (10) Edison's contribution to lighting".

For good measure five additional standards are thrown in: "(1) Measuring light in units of candle power; (2) transmission of electricity; (3) knowledge of tungsten filament; (4)
mercury lights, spot lights, color wheels, electric signs; (5) amperage and voltage.

In the body of this thesis the standards are not mentioned but implied in the working out of the problems. The second part of the above unit is captioned:

B. Lesson Plan.

Again there are four parts. The first consists of introductory material and additional standards. The introduction is limited to three statements concerning the time it took to improve our lighting system, the kind of laborers employed to supply us with light, and an irrelevant remark about meteors. Then follow three statements about "Standards", although nothing has been said about them up to this point.

In part two seven demonstrations and four additional ones are listed. Part three contains nine pupil activities with five added for superior pupils. Part four lists four problems supplemented by four to six questions. The last problem has no questions. The problems are:

"A. What were the earliest methods of artificial lighting?"
B. "What are the advantages of modern devices used in lighting?"
C. "What are the requirements of a good lighting system in the home, office, factory, in the street?"
D. "How did Edison develop our modern incandescent light?"

Then follow four additional problems similarly arranged.
"A. How does the amount of light which we need today differ
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from the amount used in colonial times?

B. Why is the nitrogen-filled tungsten electric light the most economical for general use?

C. Why is the indirect lighting system used in stores and most public buildings?

D. How is electricity conveyed from the power plant to the consumer?"

No comment is made as to length of periods or grade. In the writer's opinion it is a ninth grade unit, to complete it would require an entire semester.

In Emporia, Kansas, all eighth grade pupils must complete one year of general science. The periods are 55 minutes long, and the classes meet five times per week. There are five units: "(1) The air and how to use it, (2) Water and how to use it, (3) Foods and how to use them, (4) Protection-Homes and clothing, (5) The work of the world". Only an outline of the fourth is offered. It takes thirtyfive days to complete it. The unit is broken up into four problems. The problem headings are not supplemented by questions, instead definite assignments are made. Thus,

1. Building our Homes.

"Each pupil makes a report of what he thinks a desirable location for a home. Reports are given and discussed in class. The pupils select a plan of a moderately priced house and make a drawing of it."
After making a careful study of building materials each pupil makes a list of the material to be used in the house planned reasons for each kind of material selected are given."

The other three problems are treated in a similar manner. No further comments are offered as to teaching procedure. An outline presented in this form would require much close supervision and direct teaching. The indifferent pupil would get by without doing much work. (17:168)

An eighth grade unit from Glendale, California, on astronomy is much more to the point and coincides with the units offered in a later chapter. The above unit is divided into five parts. The first part states the purpose of the unit, namely, to acquaint the pupil with five constellations; introduce him to laboratory methods; and assist him in recognizing the magnitude of our solar systems, and their relations to the earth.

Part two deals with the preparation of the study which includes textbook information, interpretation and making of charts, recitation, notebook work, and experiments. In part three the activity consists of weekly reports on observations, notebook work and drawing of charts. The last part, five, concludes the unit with an oral or written quiz.

In Toledo, Ohio, general science begins with "The World in Which we Live—What is it?" in the seventh grade. After a brief motivation the class is launched into a simple study of astron–
any based on problems concerning the shape of the earth, standard time, change of seasons, phases of the moon, life on other planets, and the nature of the stars. This unit is supposed to contain thirty-five problems. Certainly they can not be problems as we understand them according the unit plan. The pupils are to observe the moon, illustrate gravity, centrifugal force, and make reports of astronomers. As nothing further is offered, the reader must draw his own conclusion as to the value of the unit. (17:166)

Tulsa, Oklahoma, worked out a nine-week's course of forty-five minutes per day for the seventh grade with an old tree trunk as the center of instruction. The aim is to use the community as a laboratory and have the children make contributions as citizens. As an introduction, exploratory trips are made about the school grounds, the vicinity and the woods to gather seedlings. Planting of seeds about the school grounds and homes is reported to the American Tree Association. A recognition from the association is usually forthcoming. An Arbor Day program in the assembly concludes the first part. The rest of the unit is taken up with insect, bird and animal study.

With the tree study the root, stem and leaf system receive attention in rotation. Each child chooses his own tree. The study of the root system includes a class demonstration in osmosis. The children gather types of seed roots and compare
them. The stem system follows with an experiment in capillary attraction, making whistles, and close observation of the chosen tree. To study the leaf system the children gather, identify leaves and make charts of them, perform experiments in photosynthesis, and list leaves used as foods.

The insect study is the outgrowth of observing the destruction of leaves by pests. The children compete with each other in bagging, listing and studying the life history of destructive insects. Helpful insects are also studied.

In the bird study their usefulness as destroyers of insects receives emphasis. Attention is called to the structure and characteristics of different birds. Bird houses are built, feeding stations established, and nesting habits observed as far as the season allows. Birds of remote regions are studied through colored slides and pictures.

The animal study is confined to those that inhabit trees.

In conclusion this unit emphasizes the economic relation of trees, birds and animals to the child. Coal, oil, leather, sugar, and cotton are studied from charts. Lantern slides show what means the government is taking for the conservation of the several items mentioned above.

The unit certainly is very practical. There is nothing bookish about it. The child learns by doing. Very likely the location of the school is on the outskirts of the town, and furnishes easy access to the required material.
Summary.

This chapter deals with the interest in science taken by people in all walks of life. To get definite information on this point various investigations have been made. Dr. Downing showed that the child's greatest interest is animals. Boys concentrate more on observations about plants, while girls are more interested in physical phenomena.

Hanor A. Webb found that the emphasis given by different textbooks to science topics is about equally divided among astronomy, physiology and miscellaneous subjects.

Present day magazines according to Giles M. Ruch and A. H. Searles stress in rotation biology, physics, chemistry, physiology, physiography, textiles, astronomy, food, meteorology, household animals and agriculture.

D. F. Curtis believes that physical and biological science receive the greatest attention; while L. Thomas Hopkins claims that discussion of chemical material predominates.

As to teaching procedure in general science, a modification of the unit plan seems to be in favor in the more progressive cities throughout the United States.
Chapter III.

The Aims of General Science.

The first step in curriculum construction is to determine the objectives in education. The objectives are determined upon by individuals, or groups contemplating to enter on some worthy enterprise. Before setting up objectives, there must be a clear definition or understanding as to what education is. L. Thomas Hopkins lists sixty of them by as many different authors. All of these, according to the same author, fall into four groups: Culture, discipline, growth or adjustment, preparation. (27:50-4) The authors of the "Seven Cardinal Principles of Secondary Education" very likely had this in mind when they established them. (15:11-16)

To function efficiently any body must have health. Since this is self-evident, health is naturally set down as the first objective.

The three R's, or fundamentals are necessary tools in life's affairs, therefore, the command of fundamental processes is imperative. More must be added to the three R's. Literature, social studies, instruction in household arts, etc, prepare for worthy home membership. Vocational education equips the individual to make a livelihood. In so doing he becomes interested in the welfare of the community, attains a sense of righteousness and co-operation as a citizen. To enjoy music, art, literature, sports, one must be instructed in worthy use
of leisure. A wise selection of the content and method of instruction, the social contact with one another makes for ethical character. From the above the reader will easily detect the seven cardinal principles which for greater emphasis are here set down in rotation:

2. Command of fundamental processes.
3. Worthy home-membership.
4. Vocation.
5. Citizenship.
7. Ethical character.

To what extent can general science assist in following the objectives of education?

The first thing we do when seriously ill is to call a doctor. He diagnoses our case and helps us out of the difficulty. It is of greater importance to keep well and healthy. General science teaches us to combat disease by killing off the pathogenic germs, instructs us in the principles of personal hygiene, food inspection and protection, care of the sick and wounded. For gaining this knowledge we make use of the fundamentals acquired in our early school life.

General science, biology, physiology, physics and chemistry all come into play in the organization and upkeep of the home. The pupil studies the location of the home, its proper sur-
roundings, minor repairs of the heating, plumbing, electrical systems, and ventilation. Science also shows how inventions have increased the comforts of the modern home. (16:12-15)

General science gives the pupil an intelligent understanding of the world's work, of cause and effect, and directs him in the selection of a vocation. He studies the elementary principles of applied electricity, chemistry of the household, care of the interior of the home which will open a possibility of a vocation.

In a democracy we need leaders scientifically trained. General science teaches respect for men and women who have devoted their lives to discover truths, make inventions to improve the human welfare.

There is practically no limit in the study of general science in affording a worthy use of leisure time. The principles of photography, the structure of the camera, and its use afford unlimited pleasure for youth. All nature, the seashore, the mountains, the immediate surroundings furnish abundant material for employing leisure time. Trips to industrial plants, to museums, the planetarium afford sources of enjoyment.

General science lends itself readily to training in character and citizenship. The execution of an experiment requires exactness, skillful manipulation, judgment and reflective thinking, any one of which may carry over into life. That miscalculation, poor judgment, faulty workmanship often cause
losses running into millions of dollars is clearly illustrated in the building of the Ambassador Bridge, that links Detroit to the border cities of Canada. Wire cables three feet in diameter made of twisted strands were to span the distance between the shores. One of the cables had already been anchored at the cost of two and one half million dollars, when one of the inspecting engineers said "The wire's got to come down, every strand of it". He had noticed minute cracks in the bright metal. Individual strands had snapped under the strain. If the catastrophe of the St. Lawrence Bridge was not to be repeated other cables had to be used. He had contended all along that strands of wire laid parallel alongside each other and spun over with another coating of wire, as one twists a rubber band about a dozen pencils, would stand any strain within reason. The success of the undertaking proved him right. By establishing a conception of truth and confidence in the laws of cause and effect general science assists in developing ethical character. (44:25)

A course in general science should afford culture. The pupil should be brought into contact with the most common phenomena of his environment. The understanding gained need not necessarily be exhaustive. It should comprise factors in life contributing to health and safety. For instance, he would not be required to go into the chemistry of food, or the pathological study of germs but should have information enough to safe-
guard his health and comfort. Likewise, the progress of mankind in partially gaining control of nature should be revealed to him. The elementary information gained may be very incomplete but it can serve as basis for later detailed and accurate knowledge. It would satisfy actual social needs, as mentioned above, and make the pupil more comfortable to participate in the solution of problems in the immediate surroundings.

General science also produces growth and adjustment. The pupil is usually interested in understanding phenomena which continually confront him. If he is physically fit and mentally sound, he is an animated interrogation point. He may be trained to see more in his back yard than another sees who travels around the world.

The development of industry calls for considerable adjustment. The most important unit of a modern industrial plant is the laboratory of scientific research. The best paid men are no longer the ones who know it all, but the ones who are willing to improve our present methods by diligent scientific research. (31:909)

Preparation and laying the foundation for later study of special sciences is another function of general science. We realize that we can not justify a subject only because it prepares for other subjects unless we can prove that these subjects are of value. We can certainly do this for the special
sciences. Preparation in general science has developed such men as C.R. Sweeney of Iowa State College who is converting some of the 150 million tons of discarded cornstalks into boards nearly an inch thick, capable of being sawed and nailed like wood lumber. He is using the same material to make paper, smokeless powder, rayon, rubber, sweetening materials three hundred times as sweet as sugar. Straw and straw materials yield rice paper, ascetic acid, oxolic acid and tar.

Charles F. Ash of San Francisco has succeeded in turning waste pineapple material into pineapple syrup, sugar, citric acid, and industrial alcohol. The above quoted men could hardly have been intelligently guided in their choice of scientific research unless general science had first revealed to them the possibilities of their aptitudes and capabilities.

Summary.

The construction of a curriculum includes a knowledge of the objectives of education which are culture, discipline, growth or adjustment. The "Seven Cardinal Principles of Secondary Education", cited on page 24 are an expansion of the above.

General science follows these objectives by stressing the hygiene of the human body, guiding the pupil is studying biology, physiology, physics and chemistry used in the upkeep
of the home. It gives him an understanding of the world's work, aids him in selecting a vocation, acquaints him with the lives and accomplishments of leading scientists, inducing emulation.

Experiments in general science which call into action the various faculties of the mind and motor skills mold the character of the future citizen.

General science affords culture in making the pupil competent in participating in the solution of every day problems. It produces greatness and adjustment by training in observation, and it lays the foundation for study of the special sciences.
Chapter IV.

The Teaching Procedure and its Relation to Curriculum Construction.

We have so far familiarized ourselves with the approach in curriculum construction, determining the objectives, and how general science can assist in following these objectives in education. We must now consider how to impart the knowledge necessary to attain the objectives. To do so a method is selected. A method is nothing more but a way of doing things. The child has a way of occupying himself by play. The carpenter has a way of building a house. The street cleaner has a way of disposing of dirt.

The general science curriculum was constructed on the basis of the unit plan. One of the best methods of attaining the aims set up for general science is the so-called science type of instruction. (33:89)

In the science type the objectives are adaptations which form an understanding of the principles of cause and effect. The learning method calls for reflective thinking and rationalization. The outcome is an intelligent attitude toward the environment. Wherever understanding and rationalization is required the science type of teaching is most effective. This does not mean that if this method is chosen the teacher may start the machinery going, sit complacently at the desk, and everything and everybody will be happy ever after. Success
always depends on the teacher in applying a fund of knowledge to the solution of any teaching problem. The teacher's personality, vigor, and control technique will always be the prime factor in success. It is the teacher's job to pick the essential facts, the materials necessary to develop certain attitudes and skills, and the details required for illustration. These must be focused on the unit, upon studying the individual mind in order to develop proper study habits in the pupil.

In teaching any unit one must ascertain the past experience of the pupil in relation to the new unit. This experience connected with the new unit forms the basis of motivation to arouse curiosity in the pupil. Problem cases of the blase and indifferent kind, of course, require strenuous remedial efforts.

The first step in the science type of teaching is one of exploration. Its purpose is economy by determining the apperceptive mass of the pupil and orienting both pupil and teacher. The exploration begins with a series of preliminary exercises either oral or written. The writer prefers the latter because the individual deficiencies can be more definitely diagnosed. The exercises have a fourfold purpose: 1. They establish a basis of recall of previous experiences of knowledge which may be of value in the study of the unit. 2. They emphasize the points which give the pupil the greatest difficulty
32.

and require direct teaching. 3. They enable the teacher to pick out the poorly equipped. 4. They stimulate interest in the unit. The writer has found the completion test, or the best answer test the most applicable. There is a danger of the written test becoming too formalistic, while the oral totally lacks the element of precession. In checking over the results one will find the class divided into three groups. Some have no preparation, others have a fair background, and in rare cases there will be a few individuals who may be excused. The writer has so far not found any of the last type in his teaching experience.

The second step in the science type of teaching is the presentation. There must be a definite break between the exploration and the presentation. In this period the teacher gives a preview of the unit. One can not put too much care in the preparation of this phase. The more clear cut and precise the preview, the better the progress in the study of the unit. The preview is a skeleton of the unit in which the salient points are emphasized. It serves to guide the pupil in his studies; it raises questions in the pupil's mind and motivates him.

In a two week's unit the presentation should not occupy more than 10-15 minutes. While the teacher is talking there must be no interruption on part of the pupils. They are to listen, and later reproduce the lecture in writing. With be-
Beginners it is best to put an outline on the board, ask questions on the important points, or have a pupil repeat parts of the story before the writing is done. Once the writing has begun there are no more questions answered. This is memory training. The written papers must be in good English, good form and legible handwriting. With an intelligent ninth grade one may try outlining. In the lower grades this procedure has not been found satisfactory.

The following may serve as an illustration of a preview on the unit "Our Earth in the Universe". The earth is small compared with other heavenly bodies in the universe. The stars are suns. On a clear night one may see two thousand stars with the naked eye. Many are so far away that they can be seen only with the telescope. Among these stars one may see patches which look like wheels without rims. These are nebula.

The stars appear so small because they are so far away. Many are larger than the sun which is 886,540 miles in diameter. It is only a medium sized star ninety million miles away.

There are several bodies, not stars, near the sun. These are called planets. They move very rapidly, and get their light from the sun. All planets revolve around the sun.

Each planet has its own orbit. Our earth is the third from the sun and the fifth in size. It spins on its axis once in twenty four hours; this motion is called rotation.
It revolves once around the sun in three hundred and sixty-five days; this is called revolution. The earth interests us most because we live on it. It is our home.

Near the earth is a body about one third of the earth's diameter. It is the moon. The other planets also have moons. Between the four larger and the four smaller planets are several hundred planets called planetoids. The sun, planets, moons, planetoids constitute the solar system.

Some night you see shooting stars or meteors. They are small parts of stars which have fallen away. When they come within the sphere of the earth's atmosphere they become luminous through friction. A few fall to the earth.

Once in a great while we see luminous bodies with heads millions of miles in diameter followed by a fiery trail extending clear across the sky hurrying through the universe. They are comets.

All of these heavenly bodies are part of the universe. In this unit we are going to study the solar system and its relation to the universe.

A good presentation makes the most exacting demands on the teacher's personality, requires a great deal of exertion and complete mastery of the unit, effective group control to follow the minds of the members of the class in order to sense whether "they are taking it in".

The third step is assimilation. It is the period in which
the pupils are developed into students. The major objective includes "ability to form independent judgment" (33: 257)

There should be a motive, the needed tools of study, especially reading ability and accessible material present. Each desk in the general science room should be supplied with at least ten to twelve different science textbooks. The laboratory equipment for experiments should be within reach. To study effectively the pupil should be supplied with a work sheet. Upon this feature the writer intends to center the greatest amount of effort in the present thesis.

The Chicago Board of Education requires that two units of science be taught per grade in a semester. Here is where a large number of science teachers encounter the greatest difficulties. Many teachers had the subject assigned to them and have not had any training in teaching science. It is the purpose of the writer to present work sheets for the several units per grade so that a novice may take them to any class, and with a minimum of effort and expenditure of time make a success of teaching the subject.

The sheet is headed with the name of the unit, in 7B for instance: "Our Food Supply". This unit is broken up into six problems:

1. What are the important sources of our food?
2. How do we prepare our food?
3. What are the different purposes for which the food is
used in our body?

4. What are the important classes of foods?

5. Why is it necessary to have a well-balanced diet?

6. How should we take care of our food?

Each one of these problems is supplemented with five to ten questions. The answers to the questions the pupil must dig out of the textbooks on the desk. References are listed as to page and volume. In addition the sheet contains exercises for necessary practice, experiments illustrating principles, and diagrams clarifying understanding. The questions are listed in such a sequence that the pupil is able to present a coherent oral discourse at the conclusion of the problem. For beginners the specific page and textbook reference should be given at the end of each question until the working technique has become habituated.

Ideally the answers to the questions should be in writing, practically, on account of the large class membership this is not always possible. On the remaining questions notes should be taken and later used for oral discussion.

The assimilation is the busiest time for the teacher. To make this phase of the unit plan effective the pupils have to be taught how to study which for beginners includes prompt attack, keeping the question in mind, the use of the index, looking for black letter headings, the main thought of the sentence, evaluating the essential facts, etc. Drill in
study habits must be continual to inculcate the scientific at-
titude in the solution of problems. Care must be taken not to
give too much assistance. Pupils are ever ready to either
copy verbatim, or claim that the answer can not be found in
the reference given. Instead of keeping the question in mind
they will look at the picture on the particular page. The
science department should co-operate with the English depart-
ment in insisting on neat papers, observation of constants,
spelling and handwriting. Slovenly habits are easily acquir-
ed in the assimilation period. Sometimes the entire class
must be interrupted to clear up some difficult point by direct
teaching.

Experiments and exercises are also worked out in this
period. It is best for the teacher to demonstrate first, care-
fully developing the principle involved. There are usually
only one or two in a class of 48 who can do this independently,
while the rest will mechanically go through the manipulations
without being conscious of their significance.

Since most classes in general science alternate with the
art department a good deal of review work in necessary. In
the two or three days intervening pupils frequently forget
what has been taught.

The assimilation for one problem in science usually takes
about one week, while the entire unit, according to the Chica-
go plan, should be completed in five. Since only ten weeks
are allowed per semester for classes attending five periods per week, the grade work, two units, must be completed within this time limit. The alternating classes have the entire semester at their disposal. The science classrooms in the Chicago schools are usually equipped with numerous drawers for storage purposes. The notebooks are gathered at the end of each period and filed to forestall alibis.

The bulk of the class varies very little in its progress during assimilation. Those who finish earlier are assigned extra projects of their preference and given extra credit. The problem cases make the greatest demand on the teacher's vitality and resourcefulness. Various tests during the assimilation will show up the progress and deficiencies. It is in this period where the pupil is tested as to whether he has mastered the adaptation or not. Between the group work as a whole, those who finish earlier, the artists in stalling, and watching the experiments the teacher consummates a very busy period.

The fourth step in the unit plan is the organization. This is not a test, but a part of the learning process, a matter of growth and performance. All the notebooks are laid aside and the pupils prepare a topical or statement outline of the unit. With the seventh grade it is best to have some one pupil at the board writing while the rest of the class supplies contributions toward the formation of topical sentences. The two
upper grades should be able to do justice at their own initiative. No step in the school career will accomplish more in the direction of composition training than the organization of science topics.

The fifth and last step in the unit plan is the recitation period. This period is the reverse of the presentation. The class and teacher are now sitting in as an audience. The pupil has mastered the unit and is now ready in coherent, continued discourse to present it to the class. The recitation will by no means be perfect. The pupil has to be made conscious of the fact that he is to keep four or five points in mind and think about them while he is speaking. The floor talks train the pupil to stand on his feet, face the audience or class and speak convincingly. Those who have no opportunity to talk may be requested to turn in a written paper. The best results are obtained by having them written in letter form.

Summary.

The teaching of science requires a method, or way of doing things. The science type of teaching has been found most effective for this subject. Certain definite, dovetailing steps must be observed to make this method a success.

The first step, or exploration serves as a basis of recall, emphasizes the definite points of the unit, locates the poorly equipped, and stimulates interest.
The second step, or presentation requires the greatest skill of the teacher in control technique, use of language, clear, concise rendition, and complete mastery of the unit.

The third step, or assimilation develops pupils into students. The pupil is compelled to form independent judgment. This is the period to teach how to study, drill in expression, and language usage. Various tests should be given in this period to see if the adaptation has been mastered.

In the fourth period the pupil organizes the material assimilated previously without the use of notes or books. The outline of the unit presented by the pupil will show, if he has grasped the subject.

In the last period the pupil presents the organized material as floor talk to the class and teacher sitting in as an audience.
Chapter V. 

Building the General Science Curriculum.

Those who have not made study of the construction of curriculum may be somewhat hazy as to the meaning of the term. "The curriculum is an organization of subject matter." (36:210) It must fulfill certain objectives. The subject matter must be so arranged that it will be conducive to effective learning, inculcate skills, attitudes, appreciations, and establish habits which will insure mental growth. Individual differences and pupil needs must be considered. Its value is gauged by the manner in which it will enable the pupil through acquisition of knowledge to live life most effectively.

The scope of the task in constructing a curriculum makes it apparent that a wide range of knowledge, clear thinking, and careful analysis will be required.

A- Staff Organization for Curriculum Construction.

The work may be done either by educational experts or by committees of teachers and administrators. The experts are usually found in the ranks of the university faculties. In a skilled, scientific manner the experts determine the objectives which form the basis of school activities. The psychologists refine the laws regarding the nature of the pupil as related to school life. The school administrators study the teacher equipment and conditions of the community which affect education.
To be a real contribution the curriculum ought to be a composite effort of the three. The first selection of content material and school activities should be made by those who are specially adept in ascertaining the fundamental needs of society. When selecting suitable material, the psychologist should apply his knowledge of child life. The administrator should organize the content for the most effective learning. At the conclusion of this round robin affair, the three experts should meet again to make such revision as may be desirable.

The National Education Association advocates mutual participation of specialists, officials, and school personnel in curriculum making. (34:109-124) Writers of recent publications on education seem to be of the same opinion. Some claim that a good curriculum organization should involve all members of the educational staff. (27:292) It certainly would produce better results. If the total ideas of the entire corps are evaluated the result must be superior to the product of few individual minds. Including the entire corps also makes the installation of the curriculum easier. The teacher who knows the course of study and has had a hand in making it will, as a matter of pride, want to see it put over successfully. While participating in the construction of the curriculum requires a lot of extra work, the task will certainly broaden one's intellectual horizon.

If the entire organization is put to work, just how is this to be done? The entire personnel would be divided
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into groups. Individuals entering into consideration are the superintendent, curriculum director, principal, teachers, supervisors, subject matter specialists, curriculum specialists. Each of the above has a certain duty to perform. (27; 206-18)

The superintendent initiates the program, appoints the curriculum director, lays down the lines to be followed, contacts with the educational staff, and keeps the Board of Education sold.

The curriculum director aids the superintendent in setting up principles of organization; sees that the organization is in harmony with these principles, selects the personnel, makes recommendations regarding changes from time to time. Regarding the educational staff he has to educate its members, advise administrative committees. He must educate the teachers in a knowledge of the curriculum program, train the production committees, advise them, assist the teachers in installing the course. If there is any research committee he must keep them supplied with available research material, indicate what kind of research ought to be done, and measure results of the new course after it has been installed. He must also keep the public informed from time to time regarding the progress made.

The principal may serve on administrative committees, advise them if requested, furnish the schools with information regarding the execution of the program, supply substitutes where teachers have been released to do curricular work, in-
stall the course and do research work.

The supervisor does the same as the last two but acts most-
ly in an advisory capacity only.

The subject matter specialist assists in setting up aims, suggest content that will function with specific aims, ob-
jectives; passes on the soundness of material, its accuracy, passes on methods of instruction, and lends prestige to the program.

The curriculum specialist has practically the same duties as the curriculum director.

While the above plan may look highly efficient, it has its defects. They are: There is a failure to determine the aims. The machinery is overloaded. Responsibility is not centered enough. It is difficult to locate the right person for the right place. There are too many committees, and too much time is wasted. Work of one committee is reviewed too much by another. Too much work is crowded into a short period of time.

A modification of the above plan was adopted by the Chi-
cago Board of Education in 1927. A central committee consist-
ing of the superintendent, district superintendents, and the president of the Normal College formulated the plan and se-
lected the personnel. A reviewing committee of superintendents studied the drafts, and, after careful revision, passed on their fitness. Subject matter committees whose membership was composed of elementary, junior high, and senior high
school teachers were formed for all the different subjects. The subject committees with an elected, or appointed chairman each worked out their special problems. If difficulties were encountered, the specialist was called in. The three groups working together avoided placing too much emphasis on any one phase of the curriculum structure. Minor details were assigned to individual members of the groups. The fruits of labor done were discussed in following meetings, alterations or corrections made before the final draft was accepted.

To the subject committee fell the task of formulating the objectives. It was found a foolish waste of time to try to formulate new objectives. The best that could be done in the short space of time was to improve on the existing ones. After much waste of time it was agreed to accept "The Seven Cardinals" as a whole and formulate specific objectives for each individual unit.

To establish the unit textbooks found in the bibliography of this thesis were examined. The topics occurring most frequently were chosen to be placed in the curriculum. The individual members worked out the units for each grade.

The breaking up of the units into problems was left to the individual classroom teacher. Many find this task exceedingly difficult. Those who have any difficulty will find the units broken up in the last chapter of this thesis.
B-Criteria Used in Curriculum Construction in General Science

In constructing any kind of a curriculum certain criteria must be observed. The first criterion involves the conventional value of the subject. General science found itself in the same predicament as a new arrival in an established community. He has to justify his worth, and win the confidence of the old settlers. General science had to compete with subjects which had always held first rank since the beginning of the educational history of our country. It could not make any claim to priority, but through necessity it could claim a place in the curriculum on an equal footing with other subjects.

This is an age of machinery, efficiency and scientific research. The future citizen will be handicapped to a certain extent without fundamental knowledge of science. New inventions, due to research, are accumulating so rapidly that even the scientific expert can not rest on his oars, content that he is master of the field. In fact he can not keep up with the game by drawing on all the energy at his command. What is new today is obsolete tomorrow.

The second criterion to be considered is the cultural value. Here science can compete with any other subject. One of the new arrivals in the field of science is radio. Only a few years ago there were no homes with radio receivers. Today more than ten million are supplied with them. Radio has brought more real enjoyment to more people in less time and at
less cost than any other thing in our history. It is one of
the best means of communication. Vast oceans, inaccessible
mountains, frozen areas of the poles, dank, dismal swamps,
torrid deserts, depths of the earth are no obstacle to radio.
Should an unusual calamity occur anywhere, requiring immediate
help, radio stands by until the "S O S" rings throughout the
world. Forty million people can sit complacently in their
homes and listen to President Hoover, MacDonald, Hindenburg,
or an Australian lecturer. Musical programs have proved so
stimulating that many commercial enterprises have installed
radio to increase production among the workers. Its educa-
tional value can not be estimated. It surely assists in se-
curing the recognition of a place in the curriculum for gen-
eral science.

The third criterion the curriculum maker must consider is
the preparatory value of a subject. The value of general sci-
ence in this respect consists in imparting knowledge of the
laws and machinery which can be put into effective use. It
is an aid to higher education since it trains in the scientif-
ic solution of problems. The fundamental basis received in
the junior high school will make the more intensive work in
the senior high school easier. Most students, leaving school,
will be employees rather than employers. The latter demand
neatness, accuracy, faithfulness, sustained application and
loyalty. The teaching of general science involves all of
these.

The fourth and fifth criteria, the practical and disciplinary values of general science, are more obvious, and, as they have been discussed at some length in previous chapters, it is only necessary to casually mention them here in their sequence.

C-Other Factors of Immediate Concern.

Several other factors also enter into the construction of a modern general science curriculum. One of these is the re-statement and re-evaluation of general and specific objectives. This was done by the committee mentioned above. After search and discussion, it was found that traditional and formal discipline were to be considered secondary. The needs of modern civilization were summarized and interpreted at varying pupil age levels. Some of the general aims were found common to all units. The specific aims deal with characteristics of each individual unit. Since the writer was a member of the curriculum committee, the general and specific objectives agreed upon by that body will be used in working out the units in a succeeding chapter.

The second factor to be considered was the re-organization of the 3-4 plan in Chicago. General science now begins with the first grade and continues as nature study up to the sixth grade. In grades 7-9 it serves for the purposes of exploration and pupil adjustment. In spite of all the effort put into
this work, real curriculum construction has not yet been accomplished on account of the phenomenal growth of the junior high school.

A third factor in curriculum making is the adaptation of the subject matter to the capacity of different groups. The committee made the provision for this feature by incorporating minimum, average, and maximum requirements. The present supervisor of general science disregarded two of these group requirements and emphasized only the average. The writer has complied with the wish of his superior to the extent that he does not mention minimum and maximum requirements. It is left to the individual teacher to determine which members of a group can do all or only a part of the work.

The curriculum has been worked out as a three year course planned as a unit. It increases in difficulty from grade seven to nine. In chapter VII the curriculum of general science as it was finally built by the committee will be found.
Chapter VI.

Installing the Curriculum in the Classroom.

The proper installation of the curriculum in the classroom is of the utmost importance. The installation may either make or break an otherwise splendid course. There are several reasons why a good installation is important: 1. The reconstruction of a course can not be complete until it has been given a fair trial in the classroom. 2. The proper installation is the only real test of the course. (27:473-75)

Many teachers find the installation difficult because in the first place they are not familiar with its content, and second they are not experienced in the teaching of general science.

The following classroom procedure has been tried out by the writer and found very practical. It applies to the science classrooms of the Chicago Junior High Schools.

Each science room has seats for forty-two pupils. If the membership is larger, chairs are placed in the rear, around the aisles or any convenient place.

As the new classes come there is a mad scramble for the most favorable location. The first comers attain their desire, and the rest have to take the leavings. There they sit and "size up the teacher" while he reciprocates. As soon as the class comes to order typed sheets with preliminary exercises are passed to each individual pupil. The pupils are told to
answer the questions in writing. While they are struggling with the exercises, each pupil is called to the teacher's desk to give his name which is entered on a blott. This procedure occupies almost the entire period. The papers are collected at the end of the period to be scrutinized by the teacher.

The next day each pupil gets a folder which the teacher has procured for him, two fasteners, and a mimeographed work sheet. The pupils are shown how to fasten the work sheets with additional blank sheets in the folder. The folders are then closed. Each pupil writes his name in ink across the center of the folder with his homeroom number below it. Now the folders are gathered. The last pupil in the row is told to take his folder, place it on the folder of the pupil sitting ahead of him, until he reaches the front desk with the back of the folder toward the aisle. The first pupil to the extreme right in the first seat is told to take the stacks of folders, place them one on top of the other, until he comes to the sixth row. It will be found that there are three layers of folders with their backs to the right, and three with backs toward the left. This arrangement facilitates distribution the next day. The folders are then re-distributed and remain closed during the presentation.

No questions are asked during the presentation. During this phase the pupils are to listen in order to be able to reproduce what has been told them in writing. After the prese-
tation is finished very specific directions are given as to the appearance of the paper concerning the heading, indentation, margin, and blank lines after each paragraph.

While the pupils are writing the teacher passes up and down the aisles to inspect the work. A dozen or more will be found who entirely disregard the instructions. To these the teacher will say "That's fine, but since you did not follow directions, you will have to write it over"; then tear the paper in halves from top to bottom. This is a most effective way to make them tend to business.

Most pupils have a fountain pen but no ink. If one buys six pints of ink from The Waterman Company, the firm will supply a filler which works somewhat on the principle of a chicken trough. Here the pupils may fill their pens at the beginning of the period. The teacher had better charge a nominal sum for the ink and the sheets to reemburse himself for the outlay. When the money is paid a check is placed after the pupil's name on the plat.

In the third period the class is usually ready to begin work on the sheets. If the class is a low I. Q. several pupils should be called upon to read the name of the unit, the number of the problem and the problem heading. The first question is then read.

With beginners it is best to place the reference after each question. The meaning of the letters designating a particu-
lar textbook is explained on the sheets in the following chapter. Each reference must be thoroughly explained.

All the reference books are on the desk before the pupil, held in place by steel bookends. Be sure to have all of them replaced at the end of the period. This is a means of protection against theft.

After the first question has been read the entire class looks up the answer in the textbook. Insist upon complete answers. It is well to spend considerable time and drill on this phase. It prevents the pupil from copying verbatim whole pages when left to themselves.

Teaching "how to study," the use of the index, black letter headings, getting the thought of the paragraph and skimming has to be taught for several minutes during many succeeding periods.

Right here is the best time to acquaint the pupils with the most common implements used in science demonstrations. The choice is left to the teacher. Below are some of the most common ones. --------- rubber tubing Erlenmeyer flask
Bunsen burner glass tubing Florence flask
ring stand glass funnels graduate cylinder
Burette and ring clamps-thistle tubes medicine droppers
wire gauze test tubes thermometer C and F
test tube holder beakers rubber stopper, one
spring balance pneumatic tank and two holed.
While these articles are held up some child goes to the board and writes the name. After they are fairly familiarized papers with the outlines of the implements are passed to the individual pupil. Blank spaces are left to write in the proper name. The class is usually given ten minutes to write the names, after which the papers are exchanged and scored. Row 1 exchanges with row 4, row 2 with row 5, and row 3 with row 6. After the fifth repetition most every one gets a perfect score. Weeks apart the performance is repeated.

It requires about one week to finish a problem. At the end of the week a completion, best answer, or multiple choice test is given.

Much direct teaching and review work will have to be done, especially if the classes alternate with the art department.

The answers to the questions are written on one side of the paper only. After a little practice the teacher will be able to check the answers in the supervision period.

When all problems of the unit are completed, most pupils ought to be able to get up before the class and give a continued discourse on all the problems of the unit. Those who have no chance to talk should be required to write a summary in letter form.

To make science instruction function smoothly the beginner will do well to use the following steps:

1. Distribute typed sheets with preliminary exercises when
meeting a class for the first time.

2. While the class is busy with the sheets enter each pupil's name on a plat.

3. Collect the papers at the end of the period and keep for diagnosis.

4. Distribute folders, fasteners, work sheets in the second period and give definite instructions as to use.

5. Allow no questions or interruptions during the presentation.

6. Give specific instructions as to appearance of written papers.

7. Charge a nominal sum for the use of ink, folders, work sheets, and check on plat when paid.

8. In third period begin work on sheets.

9. Various reference books should be on each desk.

10. Continue teaching how to study during many periods.

11. Acquaint pupils with the most common science implements.

12. Check progress with frequent tests.
Chapter VII.

The Curriculum.

This chapter contains the work sheets which the pupils use in class. Not every class will be able to complete all the work. It is left to the individual teacher to select whatever can be mastered.

Our Water Supply.

General Aims.

1. All water supplies are directly or indirectly dependent on rainfall, which is stored in rivers, ponds, reservoirs, and lakes.

2. Rainwater, caught before it touches the earth, is an important source of pure water in some regions.

3. Gravity carries surface water downward through porous earth until it reaches hard, firmly packed material known as hardpan.

4. The hardpan becomes a water table which determines the depth to which wells must be sunk for permanent supply.

5. Water in clouds is comparatively pure, but when it comes in contact with the earth it takes on impurities, such as excess of mineral matter, or some form of bacteria, which renders it unfit for use.

6. Surface water that percolates slowly through the earth may become safe.

7. Open and other wells may receive surface water and become
dangerous.

8. Water which contains some impurities may be treated in the accepted ways to make it fit for use.

9. Water should be treated by competent analysts before it is used to drink.

10. For health and comfort there should be an efficient distribution of water and disposal of sewage in the home and in the community.

11. In most cities, as in Chicago, water is distributed by pumps.

12. Water purification, distribution, and disposal of sewage, are civic and engineering problems of the community.

Key to References Used in Sheets.

1. C. Clement *Living Things*
2. H. Hessler *Junior Science. Book I.*
3. H.W. Hunter and Whitman *Civic Science in Home and Community*
4. M. Idoon *Biology for Beginners*
5. F.B. Pieper and Beauchamp *Everyday Problems in Science*
6. R. Ritchie *Sanitation and Physiology*
7. V.B. VanBuskirk and Smith *Science of Everyday Life*
8. W. Winslow *Healthy Living*
9. N.C. Wood and Carpenter *Our Environment Book III.*
10. W.D. Webb and Didcoct *Early Steps in Science*
11. T.C. Tower and Hunt *The Science of Common Things*
12. J.J. Jagggoner *Modern Biology*
Our Water Supply.

Problem 1.

What are the sources of our water supply?

1. Name some of the important sources of our water supply. P-B p 112.


4. From where does Chicago get its water supply? P-B p 117.

5. How should wells be constructed to furnish pure water? H-W p 66.

References:

H Pp 152-154
VBS Pp 90-94
P-B Pp 116-120
H-W Pp 62-66
W-C Pp 155-157

Experiments and Exercises.

Experiment 20, P-B p 118
Problem 3. VBS p 83.
Draw in outline Figure 99. P-B p 117.

Problem 2.

What are the chief instruments for bringing water to our homes?

1. Name the parts of a lift pump. Tell how they work. VBS p 7.


3. Why can a force pump throw a steady stream? P-B p 123.
4. How could you get water out of a barrel without a faucet? 
VBS p 14.

5. Describe the Chicago water supply system. P-B p 117.

References: 
VBS pp 7, 13, 14
H-W pp 67-68
P-B pp 120-124

1. Draw four positions of a lift pump. 
   Space them so they will cover the entire page. VBS p 7. H-W p 67.


Problem 3.

How is water controlled in our homes?

1. What devices are there in your home for controlling water? P-B p 127.

2. Name the different kinds of faucets. Tell how they work. P-B p 127 and W-C p 161.


5. What is the purpose of the trap under the wash bowl? H-W p 103.
Our Water Supply.

Problem 3.

(Con.)

6. With the aid of a diagram explain how hot water is supplied in your home. H-W p 140. P-B p 130.

References:

Experiment.

P-B pp 127-131

Experiment 24, P-B p 130.

H-W p 71, 102, 103.

VB3 p 93

H p 155

Problem 4.

How is water kept pure?

1. Which impurities must be kept from getting into water? P-B p 132.

2. Why are cesspools and septic tanks necessary on farms and in communities where wells are used as a source of water supply? P-B p 133.

3. How are septic tanks constructed? W-C p 175.


References:

1. Make a water filter. H p 159.

Experiments and Exercises
61.

7B.

Our Water Supply.

Problem 4.
(con.)

References: Experiments and Exercises.

VBS p 100
T-L p 79

Problem 5.

How is water purified.

1. Explain why water must be purified. P-B p 132.

2. What are the different methods of purifying water? VBS 102.

3. Which method is used in Chicago? P-B p 133.

4. Which methods are used in other cities? P-B p 112, 116, 137.

References: Experiments and Exercises.

H-W p 73

2. Do the same with a sewage disposal plant. Use full sheet for each.
W-C Pp 194, 196-197

P-B Pp 134-135.
Problem 6.

Why do cities construct reservoirs and standpipes.

1. Why do cities usually place a standpipe or reservoir at the highest point? P-B p 126.


References:

P-B Pp 125-126
W-C Pp 160-161

Exercises.

Make a drawing showing a lake, a pumping station, a reservoir, some buildings. Draw the pipes to show how the water flows to the building. VBS p 95.
Our Food Supply.

General Aim.

To develop the ability to make an intelligent choice in the use of foods.

Specific Aims.

1. Our food, whether plant or animal origin, represents stored energy from the sun.
2. Only green plants can use solar energy directly in making foods.
3. Directly or indirectly, animals depend on plants for food.
4. Food value is often lost by improper methods of preparation.
5. Food serves three main purposes in the body: To furnish energy, to repair, to supply material for growth.
6. Many foods are available, but for the sake of economy and health, a proper selection must be made which will furnish correct amounts for energy, repair, and growth.
7. Excess of any type of food means extra work for the body.
8. The value of food may be depreciated by improper methods of preparation.
9. Man's foods, in growth and after preparation, are often destroyed by organisms which are enemies of mankind.
10. The business of producing and preparing food by industrial processes is one of our largest national enterprises.
11. The smaller animals and plants, especially insects and
weeds, bacteria, yeasts and molds, are organisms which contribute most frequently to the destruction of foods. Some of the above organisms sometimes aid mankind.

12. There are fundamental methods which may be used to prevent the destruction and decay of foods.

13. There are methods which may be used to detect spoiled foods.

14. Local, state, and federal governments supervise the growth, storage, marketing, and preparation of foods.
Our Food Supply.

Problem 1.

What are the important sources of our food?

1. Name the principal sources of our food. VBS p 180
2. Which are the principal plant foods? P-B p 76.
3. Which animals are most commonly used for food? P-B p 76.
5. Name four elements found in the greatest amounts in plant and animal foods. VBS p 184.
6. Which are the most important mineral elements? Give reason for their importance. VBS 186.
7. Why is water of such importance to us? VBS p 186.

References:

Exercises.

P-B Pp 76, 77, 73, 80
VBS Pp 180, 184-186
H-W Pp 76-77
W-D Pp 529, 537.
T-L p 34

1. List six roots, six stems, six leaves, three buds, fourteen fruits, one flower, ten seeds used as foods.

2. Exercise 4, P-B p 82.

3. Home problem T-2 p 34.

4. Problem 1. VBS p 176.
Our Food Supply.

Problem 2.

How do we prepare our food?

2. What are their advantages and disadvantages? VBS p 159.
3. When and why should you use cold or boiling water in cooking meats? VBS p 161.
4. That makes the potato mealy or soggy? VBS p 161.
5. Why is much food wasted in the average kitchen? VBS p 161.

References:
P-B Pp 101-103
H-W p 85
W-D Pp 530-531
C Pp 183-184
M Pp 420-403
VBS Pp 159-162

Exercises.

1. Make a drawing of the appearance of the potato before and after cooking. P-B p 101
2. Experiment 17, P-B p 101.
3. Problems 2 and 3 VBS Pp 151-152.
67.

7B.

**Our Food Supply.**

Problem 3.

What are the different purposes for which food is used in our body?

2. Explain how the temperature in the body is kept constant. P-B p 84.
5. Explain how parts of the body are worn out? P-B p 86.
6. How do we supply the body with energy? P-B p 86.
7. Which is the best food? W-C p 548.

References:  

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Exercises:

2. Make a drawing and label the typical parts of a cell. P-B p 83.
3. Work Exercises 5, 6, 7 P-B p 87.
What are the important classes of foods?

1. Name six classes of foods. After the name of each tell in which foods it is found, and what purpose it serves in the body. B p 74.

2. What sickness is apt to result from the absence of vitamins? VBS p 137.

3. Into which classes are vitamins A, B, C, D divided? VBS p 188. W-D p 539.

4. Which are the most important minerals necessary for the upkeep of the body, and why are they important? VBS p 186.

5. Why should you drink six glasses of water a day? VBS p 102.

6. Name some of the condiments used in seasoning foods. C p 377

References:

P-B pp 74, 87

VBS pp 133-188, 196

W-D pp 524-529, 537-540

W-C pp 534-535

C pp 170-172

M pp 389-393

Exercises.

Test foods for starch, sugar, fat, protein, water, minerals. Write each test up separately. P-B pp 87-88

VBS pp 177-179.
Our Food Supply.

Problem 5.

Why is it necessary to have a well-balanced diet?


2. Why is it dangerous to eat too much of one kind of food? P-B p 90-91.

3. What is a calorie? VBS p 176.


5. Give the number and reason for calories used by the following:

   a) the person doing heavy work;
   b) the person doing light work;
   c) the child 13-14 years old;
   d) the child 10-12 years old? P-B p 95.


References: Exercises.

W pp 79-84
W-C pp 538-546
T-L pp 43-48
VBS pp 182-188
P-B pp 79-84

1. Make a booklet using pictures and descriptions to show where our principal foods are produced.

2. Tell how leaves manufacture starch.

Problem 6.

How should we take care of our food?

1. Which is the greatest enemy of food? P-B p 103.
3. Name three kinds of organisms harmful to food. P-B pp 102-104.
8. How do we detect spoiled foods?

References:

W-C pp 610-631
F-B pp 102-109
W-D pp 511-513
M pp 533-536

Exercises.

1. Use Experiment 18, P-B p 103 for home project.
2. By diagram show the course of air circulation in the refrigerator. H-W p 92.
3. Experiment in W-C p 613. What is its practical use?
71.
7A.

Keeping Physically Fit.

General Aims.

1. To establish the knowledge that health is largely due to correct habits of living.
2. To develop an understanding that serious injury or infection often may be avoided by proper first aid.

Specific Aims.

1. A fundamental knowledge of the structure, growth, and relation of the bones and muscles to human health, helps us to understand their uses and care.
2. Correct use and development of muscles and bones leads to correct posture, necessary for health.
3. Idleness causes parts of the body to waste away.
4. Fundamental knowledge of the structure, growth, and relation of skin to human health, helps us to understand its care.
5. The skin designed as an organ of protection, regulation of temperature, and elimination, must be kept clean and active in order that it may function properly.
Problem 1.

What is the purpose of the bony system?

1. What is the function of the skeleton?
2. Show how the skeleton protects parts of the body.
3. How is the total number of bones distributed?
4. Describe the structure of the cranium.
5. Why is the spinal column composed of so many small bones?
6. Where is the sternum?
7. Why do ribs come in pairs?
8. How are the bones of the arms and legs alike and different?
9. Describe the structure of the bones. Tell how they differ in adult and youth.
10. Why are cavities in the bones necessary?
11. Why should the skeleton be kept in proper shape during early life?
12. Mention four ways in which parts of the skeleton may be deformed.

References:

C Pp 145-146, 151, 153.
73.

7A.

**Keeping Physically Fit.**

**Problem 2.**

*How do joints enable the body to move?*

1. What are joints?
2. Which are the two great classes of joints?
3. Give examples of movable joints.
4. Why are joints necessary?
5. Give samples of ball-and-socket, hinge, gliding joints.

**References:**

R Pp 31-39
C Pp 144-146, 153
W Pp 25-27

**Problem 3.**

*What is the purpose of the cartilege and ligaments?*

1. What is cartilege?
2. How does cartilege enable the bones to grow?
3. How is the movement of the joints made easy?
4. What is the purpose of the ligaments?

**References:**

R Pp 47-48
C p 144
W p 27
Keiiping Physically Fit.

Problem 4.

How does the body move?

1. What covers the skeleton?
2. How many muscles are there?
3. What is the function of the muscles?
4. How do the muscles move the body?
5. Name the classes of muscles, and tell how they benefit the body.
6. Why should muscles be exercised daily?

References:

W Pp 19, 39-47  C Pp 147-150
P-B Pp 140-142  R Pp 53-68

Problem 5.

How does the skin benefit the body?

1. Name the layers of the skin.
2. Tell four things the skin does.
3. How does the skin grow?
4. How do sweat glands help the body?
5. How does the skin assist the body in keeping warm?
6. Why should the skin, especially the hands, be kept clean?
7. How would you treat a wound? A fracture?

Proper Selection and Care of Clothing.

General Aim.
To develop an understanding of how to select proper clothing and how to take care of it.

Specific Aims.
1. The fiber used in different kinds of cloth are plant or animal origin.
2. Each kind of fiber has its own peculiar structure, which makes it suitable for particular purpose in clothing.
3. The manufacture of cloth from raw material is an important industrial problem.
4. There are accepted ways for removing dirt or foreign matter from clothing.
5. Dirty clothing is neither becoming nor sanitary.
6. Certain kinds of cloth are attacked by insects.
Problem 1.

What are the sources from which we get our clothing?

1. List the places where the following are grown:
   - Cotton, flax, hemp, rubber, jute, ramie, sisal.

2. Tell where the following come from:
   - Wool, silk, fur, leather, felt, cashmere, alpaca.

3. Describe the different kinds of cotton, how they grow, are harvested, and manufactured.

4. What is artificial silk? By what name does it go now?

5. Describe the process of making leather, of silken goods.

6. How is wool obtained?

7. Where are silk worms and sheep raised?

References:

Exercises.

W-C Pp 646-648
W-D Pp 124, 129, 130, 151-152.
VBS Pp 338-341
P-S Pp 173-174
H Pp 200

Look in old books and magazines for pictures of items mentioned in question 1 and 2. Cut them out. Paste them on the reverse side of the sheet you are writing on. Label them.
Problem 2.

What are the uses of clothing?

1. Name the different cloth fibers and give their uses.
2. Name the places which produce the most flax, hemp, the best flax.
4. How does clothing keep the body warm and cool?
5. Why do we use close weave cloth in winter and loose weave in summer? How could we use the latter in winter and still keep warm?
6.Give reasons for wearing different outer and under garments throughout the year.
7. State the advantage in using cotton, linen, wool, silk.
8. Ramie is one of the best fibers. Why is it so little used?

References:

VBS p 337-342
T-D p 151-155
3-B p 172-179

Exercises.

Work Experiments 38, 39, 40 in P-B p 177, 179.
Proper Selection and Care of Clothing.

Problem 3.

How can we identify fibers?

1. What is the meaning of warp, woof, selvage?
   How do the first two differ?

2. Examine wool, silk, linen, cotton under the microscope and describe their appearance.

3. Why do true colors show only in sunlight?

4. How can you tell real from artificial silk?

5. How can you tell linen-cotton mixed goods?

6. How can you tell animal from plant fibers by the burning test?

References:

W-D pp 127, 130, 135, 139, 142-145.

W-B pp 131-135

W-C p 645

Work Experiment 41 in W-B pp 182-183.
Proper Selection and Care of Clothing.

Problem 4.

How is clothing kept clean and sanitary?

1. What substance must be removed by washing?
2. What effect does soap have on grease?
3. What is an emulsion?
4. Give reasons for keeping clothing clean.
5. What advantages or disadvantages have wool, silk, linen, cotton when it comes to keeping them clean?
6. What kind of water is preferred for washing?
7. How can hard water be made soft?
8. Why must clothing made of wool and silk be washed more carefully than cotton and linen?
9. What are the steps necessary to washing?
10. How do we protect our clothing against injurious insects?
11. Why are clothes cleaned better when a funnel washing machine is used instead of a washboard?

References:

Experiments

VBS Pp 343, 347

Work numbers 42, 43, 44 in P-B

J-D Pp 156

Pp 184-186.

P-B Pp 184-188

H Pp 201-202
7A.

Proper Selection and Care of Clothing.

Problem 5.

How are spots and stains removed?

1. What two things must be known before we try to remove stains?

2. Which are the three general methods of removing spots and stains?

3. Tell just what you would do in using each one of the three methods.

4. Tell exactly how you would remove the following stains by each of the three methods:
   - Blood
   - Ink
   - Rust
   - Coffee
   - Scorch
   - Grease
   - Paint
   - Perspiration
   - Fruit stains

Use the same diagram as you see on Pp 331-333 VBS.

References:

VBS Pp 331-333, 345
P-B Pp 188-190
W-D Pp 148-149

Exercise:

For removing stains cut pieces of discarded cloth three inches square in pairs. Stain both pieces with the same stuff. Try to remove the stain from one piece. After the stain is removed, mount both pieces opposite each other and label them "before" and "after". You should have eighteen pieces.
Weather and Climate.

General Aim.
To develop a knowledge of the agencies that bring about weather and climate conditions.

Specific Aims.
To develop the following understandings:

1. Latitude, altitude, soil, proximity to bodies of water, air and ocean currents affect the climate.
2. Rain is due to condensation of water vapor.
3. Evaporation and condensation are governed by temperature and pressure.
4. Increase in temperature causes increase in volume of various substances.
5. Air pressure depends upon the weight of air.
6. Winds tend to blow toward the areas of low pressure and away from the areas of high pressure.
7. The rotation of the earth causes deflection of the great air currents in the wind belts encircling the earth.
8. By making and analyzing systematic observations all over the country, the U. S. Weather Bureau is able to forecast the weather.
Problem 1.

By what conditions is temperature affected?

1. Why does the length of day and night vary throughout the year?
2. The Frigid, Temperate and Tropical zones are all on the same earth, receiving the same sunlight. Why does their climate differ?
3. What is the distance north or south of the equator called?
4. How do latitude and altitude affect the climate?
5. Why are not all materials equally warmed by the sun?
6. How do ocean currents, winds, topography, soil and water affect the climate?

References:

W-D Pp 351-354, 332
N-V Pp 276-277
W33 Pp 121-123
P-B Pp 26-27, 40-42, 52, 56

Experiments

W-D p 332, Air pressure
P-B p 40, number 6.
P-B p 54, number 9.
P-B p 56, number 10.
Weather and Climate.

Problem 2.

What are the causes of precipitation?

1. What do we understand by a wet or dry climate?
2. What becomes of the water after a heavy rain in summer?
3. What other sources yield evaporation?
4. Why do your eyes and throat feel parched some days?
5. What is the usual word which refers to the amount of water vapor in the air?
6. Explain absolute, relative, and indoor humidity.
7. How are clouds formed? Describe four kinds of them?
8. What do you understand by condensation?
9. Explain the formation of hail, sleet, snow, dew, frost.
10. Why do some regions in the U. S. have more rain than others?

References:

W-D p 367
H-V pp 285, 290
P-B pp 47-51
VRS pp 56, 66-67, 118-120
W-C pp 456, 461-472

Experiments.

1. Show how evaporation increases or decreases. W-D p 367.
2. What determines how much water the air can hold? W-D p 367.
Weather and Climate.

Problem 3.

What are weather instruments, and how do they work?

1. What contribution did Galileo and Torricelli make to science?

2. What did Pascal add?

3. Describe the mercury barometer, an ordinary barometer, rain gauge, anemometer.

4. How do Centigrade and Fahrenheit thermometer differ?

References:

V&S Pp 6, 11, 12
P-B p 44-45, 58
7-D Pp 381, 387, 390, 401
E-W Pp 279-280, 290-291

Exercises.

Draw a C and F thermometer side by side on full page.

Draw the aneroid barometer. Label the parts. P-B p 45 and H-W p 280.
Weather and Climate.

Problem 4.

What causes "higns" and "lows" and different types of wind?

1. What is and what causes wind?
2. Explain the difference between wind and air current.
3. Name three causes of air pressure, explain existence of heat, pressure of moisture in the air, pressure of air waves.
4. Why is moist air lighter than dry air?
5. How much pressure does the air contain per square inch?
6. Explain low and high pressure.
7. Why does a "low" bring rain, and a "high" clear weather?
8. What causes the daily rains in the tropics?
9. Explain the terms "trade winds", "horse latitude".
10. What are the prevailing westerlies?

References:

VBS Pp 121-125
P-B Pp 56, 60-63
W-D Pp 379-389
W-C Pp 469-472
H-W Pp 281-283

Exercise.

Draw a region of high pressure and one of low pressure. Show with arrows the direction of the air currents.
Weather and Climate.

Problem 5.

What is the value of the weather bureau and the knowledge of climate and weather to us?

1. What is the difference between weather and climate?
2. What is the weather bureau? What is its value?
3. How many central offices are there in each state?
4. What is done with the reports sent to the central offices, and to Washington, D. C.?
5. Of what importance is knowledge of weather and climate to us?
6. Why has the importance of the weather bureau increased lately?
7. How does climate affect animals and plants?

References: Exercises.

P-B Pp 65-63

1. Of what value was the weather bureau in the World War?

V22 Pp 126-127

2. How does the weather bureau serve seamen?

E-W Pp 292-293

3. Work Exercises 20 and 21 in P-B p 64.

W-D Pp 406-407

4. Work Exercise 23 in P-B p 69
Our Earth in the Universe.

General Aims.

1. To develop an understanding of the orderly movement of bodies in the universe, of which the earth is only a small part.
2. To establish a knowledge of the relation of our earth to the other bodies in the universe.

Specific Aims.

1. The size of the universe has never been and never may be measured.
2. Many kinds of bodies, of which the universe is composed, become visible by night.
3. Constellations are imaged as groups to aid location.
4. All heavenly bodies move in precise order.
5. The sun, planets, and satellites constitute the solar system.
6. The sun and the moon are the principal bodies which influence our earth.
7. The earth moves in regular orbit about the sun, once in three hundred and sixty five and one fourth days. This, together with the inclination of its axis, explains the change of the seasons.
8. The earth rotates completely on its axis once in twenty-
four hours, causing day and night.

9. Our earth's shape, its revolution about the sun, and its rotation on its axis, give us ideas of time.

10. To keep accurate time, standard time belts have been adopted.
Our Earth in the Universe.

Problem 1.

How can you locate some of the heavenly bodies?

1. What are stars, and how many are visible?
2. What are some of the constellations?
3. Name seven of the principal constellations?
4. How can you locate these constellations?
5. What is the size of the sun compared with other stars?

References: 

Exercises.

P-B pp 2-11 1. Draw Figure 3 in P-B p 4.
T-D pp 316-319 2. Show by diagram how to locate Polaris.
W-C p 433 Ursa Minor, Cassiopeia, Cephus,
H pp 96-105 Perseus, Auriga.
Our Earth in the Universe.

Problem 2.

What do we know about the principal bodies of the solar system?

1. What is the solar system?
2. Describe the central body of the solar system.
3. What makes all heavenly bodies move in precise order?
4. Of what use is astronomy to us?
5. Which are the only bodies influencing our earth?
6. How many planets are there? How many groups?
7. What movements do planets make?
8. What are constellations?
9. Why does the moon appear to change its shape?
10. How does the moon affect the life on earth?
11. What is a comet?
12. How are meteors formed, and why are they sometimes called "shooting stars"?

References:

Exercises.

p 12-20

W-D pp 320-342

W-C pp 432-434

1. Perform the experiment on page 329 W-D, and tell what it illustrates.
2. Class demonstration: Why does the moon appear to change its shape?
3. Show by diagram the difference between sun and moon eclipse. P-B p 10.
Our Earth in the Universe.

Problem 3.

How did the earth come into its present condition?

1. How was the earth formed?
2. How old is the earth?
3. How was the rock surface turned into soil?
4. Explain why the earth does not fly away from the sun?

References:

- Experiment.
  P-B Pp 21-23
  To see the effect rotation has
  upon a body. H-W p 261.
  Y-D Pp 344-345
  H-7 Pp 259-270

Problem 4.

Why do days and nights vary in length?

1. What movements does the earth make?
2. Why is one half of the earth always in darkness?
3. Explain why the days and nights differ in length.

References

- Exercise.
  P-B Pp 24-25
  The entire class work out demonstration 39 in Y-C p 436-437.
  Y-C Pp 434-437
  YBS Pp 243, 251
What causes the change of seasons?

1. At what season of the year are the sun's rays most nearly vertical?

2. At what time of the day and in which season of the year would you cast the longest shadow?

3. When would you cast the shortest shadow?

4. Pupils usually say that it is warmer in summer than in winter, because the sun is nearer to the earth. Give true reason.

5. In summer we go to the north side of the building to get out of the sunlight. People in South America do the opposite. Why?

References:

Exercise

W-C p 435

By means of the diagram on page

P-B pp 26-29

25 in P-3 prove the answer to number

J-D pp 350-355

4.

VB3 pp 249-251
Our Earth in the Universe.

Problem 6.

How do we get our time?

1. How can the earth be used as a clock?
2. What is the difference between standard and solar time?
3. Why do we use standard instead of solar time?
4. If you made a transcontinental trip from Boston to Los Angeles, would your watch tally with the time of the latter place? If not, in what respect would it differ?
5. What observation would you make on the return trip?
6. Into how many time belts is the U. S. divided?
7. What and where is the International Date line?
8. Of what significance is it?
9. Why are the time belt boundaries in the U. S. not straight lines from north to south?

References:

Exercise.

2. On full sheet draw an outline map of the U. S. and indicate the boundaries of the time belts.
3. Work numbers 5, 6, 8, 9, 10 in P-B p 33.
8A.

Fire—Its Cause, Prevention and Control.

General Aim.

To develop an appreciation of the nature of fire its causes and control.

Specific Aims.

1. Fire is caused by a proper relation of combustible substance, oxygen, and the kindling temperature.
2. Fire may be controlled by regulating any one of three factors which cause it.
3. Substances which do not burn are those which will not unite or have previously been united with oxygen.
4. Combustion of different substances starts at different kindling temperatures and proceeds at different rates. This often results in the production of poisonous products of combustion and smoke.
5. Spontaneous combustion takes place when combustible substance reaches its kindling temperature without the aid of heat from the outside source.
6. The products of combustion of most common fuels are the same as those produced by oxidation in the human body.
Fire-It's Cause, Prevention and Control

Problem 1.

What causes combustion?

1. How did primitive man come into possession of fire?
2. What are conditions necessary to produce fire?
3. Which materials are most commonly used to make fire?
4. What are combustibles and incombustibles?
5. Name the characteristics of fuels used for fire?
6. What is a burning temperature?
7. What are the principal causes of fire?
8. Which of the gases in the air helps to make things burn?

References:

W-D pp 134-135
P-3 pp 256-250
W-C pp 244
J-L pp 145
H pp 27-29

Work problems 1, 2, 3 in VBS pp 23-24. Use the following headings for the write-up:

Name of the experiment.
Things needed. Steps taken.
Application. Place the headings in center of line.
Fire—Its Cause, Prevention and Control.

Problem 2.

How are fires controlled?

1. Explain why the striking of a match produces a flame?
2. What is a flame?
3. How is fresh air constantly supplied to burning material?
4. What does fire take out of the air?
5. Describe the Bunsen burner, gas, kerosene burners. Tell how they work.
6. Name several ways in which fires may be controlled.
7. How would you extinguish an oil, gasoline, wood fire?
8. How would you save a girl whose dresses were on fire?
9. Show by simple diagram of a stove or furnace where the damper, firedoor, grate and draft are located. Tell how they work.

References:  Experiments

W-D pp 60-61  1. Test for the two principal gases in the
P-B pp 231-239 air. W-D p 60.
H p 26-34 3. Experiment 51 in P-B p 223.
133-139 4. Exercises 6, 7 in P-B p 237.
133-139 5. Experiments 55, 56 in P-B pp 238-239.
Problem 3.

What is the purpose of fuels?

1. What are the different materials used for fire?
2. How was coal formed?
3. How is petroleum obtained and used as fuel?
4. State the difference between natural and artificial gas.
5. What is it that burns in fuels?
6. With what does a material combine or unite when it burns?
7. What do these fuels form?
8. What causes the excessive amount of smoke belching from chimneys?
9. Explain how gas is manufactured from coal.
10. Account for the popularity of oil as fuel.
11. Explain fractional distillation.

References: Experiments.

P-B Pp 242-251
PBS Pp 310-313
Fire-Its Cause, Prevention and Control.

Problem 4.

How are fires prevented and extinguished?

1. Name three common causes of fire.
2. Why are so many fires caused by cigarettes?
3. What causes spontaneous combustion?
4. Name three ways of putting a fire out.
5. How does water put fire out?
6. How do the fire extinguishers carried by the express wagons work?
7. Give a practical illustration of the fire loss in the U. S. in one year.

References: 

Exercises.

H-W Pp 140-160
P-B Pp 251-257
W-D Pp 184-198
VBS Pp 31-35

1. Make a full page drawing of the fire extinguisher Figure 238 in P-B, and label the parts.
2. Using the score card in H-W p 160 make a survey of your home.
Diseases—Causes and Prevention.

General Aim.

To develop an understanding of the ways and means of protecting ourselves and others against disease.

Specific Aims.

1. Many diseases are caused by entrance into the body, and subsequent reactions produced directly or indirectly by germs.

2. Some germs are helpful for soil enrichment, destruction of organic matter and other destructive organisms, and production of food.

3. Bacteria, the plant forms of germs, are microscopic in size and vary in form.

4. Under proper conditions, some bacteria feed upon tissue and eliminate poison in the body of the organism in which they grow.

5. Every contagious disease is caused by transferance of disease germs from sick to well.

6. The body is naturally well protected against disease germs both externally and internally.

7. Disease may be prevented by artificial immunization.

8. Cleanliness is the chief requirement in freeing a home from germs.
100.

8A.

Diseases—Causes and Prevention.

9. Carelessness in community health habits is a crime against ourselves and neighbors.

Problem 1.

Why may germs prove helpful and harmful?

1. Give some economic reasons for keeping in good health.
2. The spread of disease was long thought to be beyond human control. How did Pasteur prove this false?
3. What is a germ?
4. Name the three principal classes of germs.
5. How do bacteria differ from each other?
6. How do bacteria prove helpful and harmful?
7. Which diseases are caused by bacteria? By animal germs?
8. Which are the most dangerous germs and why?

References:

Exercise

N-C Pp 608, 612, 620-623
Cc Pp 253-258
V Pp 222-226
VBS Pp 68-70
2-B Pp 193-197
A-W Pp 68-89, 109-110

On full page in 2 by 3" oblongs
draw shapes of bacteria.
P-B p 196.
Diseases-Causes and Prevention.

Problem 2.

How do germs spread?

1. What are the different ways in which germs spread?
2. How are germs spread in case of small pox, typhoid fever, malaria, tuberculosis, colds, chickenpox, diphtheria?
3. Where do germs thrive best?

References:  
Exercises.

A-B pp 195, 202-203  
Work Problem 7 VBS p 59.

C p 273  
Work Problem 5 VBS p 57.

R pp 81-127 Part I.  
W pp 213-237, 261-277

X-7 pp 109-110
How does the body protect itself against disease?

1. How does the body protect itself against germs?
2. How are germs killed in the body?
3. Why do we have certain diseases only once?
4. Name three methods of raising the defensive power of the body against disease. Tell why they are effective?
5. How does the structure of the nose aid the body in its defense against disease?
6. What protection does the skin offer the body?

References:

Exercise

C  Pp 158, 211, 214, 224, 226
R  Pp 11-17, 168, Part I.
P-B Pp 150, 205
W  Pp 147-148
VBS Pp 71-78

Draw Figure 88 in R, Part II.
p 166.
103.

8A.

Diseases—Causes and Prevention.

Problem 4.

What can you do to prevent the spread of disease?

1. What are some of the precautions you should take in your association with the sick and people in general?
2. How can you protect yourself against impure water?
3. Give the life history of two insects which spread disease.
4. Which is the best method of exterminating them both?
5. How can you distinguish the Anopheles from other mosquitoes?
6. How can you make yourself immune against disease?
7. Which is the best procedure to follow when sick?
8. How does the government prevent the spread of disease?

References:

Exercises.

H-W Pp 105-108, 110-115, 251
W-D Pp 618-624
W-C Pp 659-671
R Pp 145-186. Part I
VBS Pp 73-78, 484-485
P-B Pp 206-224

Make an enlarged drawing of Fig. 298 in W-D p 623.
Draw on full page Fig. 196 in P-B p 216.
Source and Control of Energy.

General Aims.
1. To develop a fundamental understanding of the term "energy" and some simple methods of control.
2. To develop an appreciation of the value of machinery to mankind.

Specific Aims.
1. The probable source of all energy on earth is the sun.
2. Energy exists in many forms and may be converted from one to another.
3. Different forms of energy require different methods of control.
4. Machinery is a device used to control energy.
5. The complicated machinery is made up of a combination of simple machines.
9B.

Source and Control of Energy.

Problem 1.

What use does man make of mechanical energy?

1. What is energy?
2. What is the source of all energy?
3. List about nine different kinds of energy.
4. List devices using the energy mentioned.
5. What use is made of wind and water power?
6. How does atmospheric pressure work in the pump, siphon, balloon, airplane, caisson?
7. Name the simple machines controlling energy.
8. What are some of the advantages of using simple machines?
9. How would you find the mechanical advantage of the inclined plane? The block and tackle?
10. Tell how you are aided by different kinds of friction.

References: W-D pp 66-68
H-7 pp 162, 189, 190, 192, 194, 451, 458
VBS pp 231, 239-245, 362, 364.

Experiments.

Work experiments in P-B number 71 p 324, 72 p 327, 73 p 330, 74 p 330, 75 p 348, 76 p 351.
Problem 2.

How is man served by heat?

1. How is the surface of the earth heated by the sun?
2. Which gas supports burning, and where does it come from?
3. How does combustion prove a source of heat?
4. Name the different kinds of friction. Tell how you are benefited by them.
5. How do friction and gravity produce heat?
6. How does electricity produce heat and light?
7. By which methods is heat distributed?

References:

H-N Pp 46, 130-132, 162, 189, 206
VBS Pp 31, 44, 50, 242, 314-315, 362
W-D Pp 60, 64, 66, 69, 96

Experiments.

Work experiments in P-B numbers 62, 63 p 263, 96 p 428,
Problem 1 in VBS p 23.
9B.

Source and Control of Energy.

Problem 3.

What use does man make of light energy?

1. What is the original source of light?
2. List some of the past and present devices of artificial light.
3. What causes incandescence in modern devices?
4. What happens to light falling on a mirror, dark cloth, glass?
5. What do you learn from Figure 411, in P-B p 417?
6. Would absence of dust particles in the air affect our light?
7. Mention three things happening when light waves strike a glass.
8. Why is a ray of light entering water refracted?
9. How can this knowledge be applied to locating objects under water?
10. By which arrangement could you get the most light into your room?
11. Explain Count Mumford's contribution to science.
12. Why is the blackboard black, the ceiling white, other parts of the room brown or gray?
13. How can you apply this knowledge to your home?
Problem 3.
(con.)

References:
H-7 pp 162-171
W-D pp 34-38, 55, 142-144, 324
VBS pp 287-302
P-B pp 413-431

Experiments.

4. In P-B work experiments numbers 94 p 417, 95 p 418. Do the same with exercises 1, 2, 3 p 421, and 10, 11, 12 p 431.
5. In VBS work problems 3 p 280, 5 p 281, 16 p 286.
Problem 4.

What are the characteristics and value of magnetism?

1. From what does the magnet derive its name?
2. How does the mariner make use of magnetism?
3. Explain the terms "magnetic field", "lines of force".
4. Which parts of the bar magnet have the greatest attraction?
5. What is the difference between a permanent and temporary magnet?
6. What is an electro-magnet?
7. Of what importance is Oersted's discovery?
8. What use is made of the fact that unlike poles attract, and like repel?
9. How is magnetism used in the door bell? The dynamo?

References:

- W-C Pp 286-290
- VBS Pp 375, 386-389
- H-W Pp 197-204
- P-B Pp 404-409, 461, 497-498

Exercises.

1. Problem 6 in VBS p 379.
2. Problems 7 and 8 in VBS p 380
3. Problems 9, 10, 11 in VBS p 380.
4. Experiment 88 in P-B p 404.
Problem 5.

How is electricity produced and controlled?

1. Mention three ways in which electricity is produced.

2. In problem one we learned what energy is. To what does electrical energy change in the following: The electric toaster, electric motor, storage battery, door bell, dynamo?

3. Which is the best way of thinking of the source of electricity?

4. What is static electricity? How long has it been known?

5. How did Volta produce electricity?

6. Describe the dry cell.

7. Everything in the world is made up of atoms, electricity also. If an orange and an atom were enlarged proportionately, how large would either be?

8. To what is the attraction between a glass rod and sealing wax due?

9. How can you charge a metal rod?

10. How did Faraday produce electricity?

11. In which devices is this principle applied?

12. Describe the motor, the dynamo.

13. What is an electric circuit? a short circuit?

14. How can you guard against a short circuit?
111.

15. Name several good conductors and non-conductors of electricity.

16. What use is made of the electrode, the electrolyte?

17. How is electricity transmitted?

18. How is the flow of electricity controlled in our homes?

19. How is electricity measured?

References:

W-C Pp 288-303
VBS Pp 375, 383-397
H-W Pp 201-214
P-B Pp 389-401
W-D Pp 294-296, 393-397

Experiments:

1. VBS problem 1 and 2 p 376.


3. Experiment 83 in P-B p 392.

4. Exercises 4, 5, 6 in P-B 396.

5. Experiment 85 in P-B p 398.

6. Experiment 87 in P-B p 401.


The Hygiene of Some Parts of the Human Body.

General Aim.

To gain a fundamental understanding of some parts of the human body as a basis of knowledge of proper care.

Specific Aims.

1. Digestion

   a. The changing of food into such a form that parts of the elements pass through the walls of the food tube and become part of the blood is called digestion. The proper elimination of excretion of waste material is necessary to good health.

   b. Digestion takes place in a series of organs, each one of which plays a distinctive part in the whole digestive process.

   c. The organs of digestion are delicate but are efficient when properly cared for.

2. Circulation

   a. When in proper condition, the organs of circulation supply the different parts of the body with blood, carrying the proper amount of food and oxygen, and removing waste materials.

   b. A proper amount of daily physical exercise is necessary to secure a normal development and correct functioning of the circulatory system.
c. The blood is subject to infection from an open wound.

3. Respiration
   a. By respiration the parts of the body receive a fresh supply of oxygen and give off their excess carbon dioxide and some other waste materials.
   b. Certain precaution should be taken to keep the respiratory organs functioning properly.

4. Sight and hearing
   a. Many defects of the eye can be avoided by proper care of this organ.
   b. Many defects of the eye can be corrected by properly fitted glasses.
   c. The direct connection between the middle ear and the throat make it necessary to treat colds promptly and carefully in order that dangerous infections of the ear may be avoided.
The Hygiene of Some Parts of the Human Body.

Problem 1.

How is the digestion of our food brought about?

1. Show how the energy of the food you eat had its origin in the sun.
2. What is digestion?
3. Where does the digestion take place?
4. Which are the most important parts of the alimentary canal?
5. Which process of digestion takes place in the mouth?
6. Give the number of temporary and permanent teeth.
7. Describe the structure of the tooth.
8. Name, locate and give the purpose of the salivary glands.
9. Locate and describe the pharynx and esophagus.
10. What is the purpose and structure of the stomach?
11. Describe the juice which acts on the food in the stomach, and tell how this is accomplished.
12. Which foods are largely digested in the stomach?
13. How long are the small intestines?
14. Describe and name the process by which the food is passed along in the small intestines.
15. What classes of foods are digested in the small intestines?
16. How does the structure of the small intestines provide for absorption?
17. Why is food so long delayed in the small intestines?
18. What is the nature of the pancreatic juice and the bile?

19. Describe the organs which manufacture each.

20. Discuss the care of teeth.

References:

P-B Pp 140-141, 145-149
W-C Pp 558-565, 573-575
W Pp 51-72
C Pp 211-217, 219, 221-224
R Pp 88-102 Part II.

Exercises and Experiments.

1. Experiment 29 in P-B p 146.

2. Experiment 30 in P-B p 147.

3. Draw on full page the alimentary canal in C p 214.

4. Draw on full page Figure 135 in P-B p 146.

5. Draw on full page Figure 19 in W-C 558.

6. Experiment 32 in P-B p 152.

7. Show the action of gastric juice. See W Pp 56-57.

8. Make a cross section drawing of a tooth. Label parts
The Hygiene of Some Parts of the Human Body?

Problem 2.

How is the circulation of the human body carried on?

1. By what process do digested foods get from the intestines to the tissue which they build and repair?
2. How are the waste products of the tissues carried away?
3. Name and describe the different blood vessels.
4. How does the blood look under the microscope?
5. What gives the red color to the blood?
6. How is oxygen distributed throughout the body?
7. What causes anemia?
8. How does the lymph differ from the blood?
9. What disease is brought about by the lack of exercise?
10. What are the four principal purposes of the blood?
11. What is the nature of fibrin?
12. Describe the structure of the heart.
13. How is the temperature of the body regulated?
14. State the affect of exercise, stimulants, and narcotics on the body.
15. How do alcohol and tobacco affect the circulation?
16. How is the waste matter of the body disposed?
1. Observe the circulation of the blood in a frog's foot and describe. C p 231


3. By diagram show the path of the blood in the body. Label blood vessels. W-C p 568, Plate V. R p 138, Part II.

4. Make a drawing of the heart showing its internal structure. Label the parts. W p 118. R p 137, Part II. T p 128.
The Hygiene of Some Parts of the Human Body.

Problem 3.

What are the functions of the respiratory system?

1. Which are the most important parts of the respiratory system?

2. To what does breathing refer in the human body?

3. Since respiration includes breathing and oxidation, compare the oxidation of the food in the cells with the burning of wood in the stove.

4. What is the composition and function of the red corpuscles?

5. Describe the action of the ribs and diaphragm in breathing.

6. Locate and describe the structure and function of the lungs.

7. It was formerly thought that carbon dioxide was a poison causing headaches and nausea in crowded rooms. Disprove the theory.

8. Why should one always breathe through the nose?

9. Trace the passage of the air from the nose to the air sacs of the lungs.

10. Describe the trachea and the bronchi.

11. How is artificial respiration produced?

12. Discuss several methods of ventilation in present use.
References:

W-D Pp 551-556  W-C Pp 131-147
C Pp 156-168  W Pp 100-111
P-B p 151  VBS Pp 48-52
R Pp 160-176, Part II.

Exercises.

1. Draw Figure 44. in W p 108. Locate adenoids and tonsils. See also W-D p 202.


3. Prove that heat is generated in the body. C p 166.


5. With skeleton diagram show Schafer's method or resuscitation. W-D p 554.
The Hygiene of Some parts of the Human Body.

Problem 4.

How do we hear and see?

1. With what can the outer part of the ear be compared?
2. Name the principal parts of the ear.
3. How do vibrations from the air reach the middle ear?
4. Explain the arrangement whereby these vibrations reach the nerves of hearing and the brain.
5. Why do gunners open their mouths during the discharge of a cannon?
6. Name the principal parts of the eye.
7. How is the amount of light entering the eye regulated?
8. What similar arrangement admits light to the camera?
9. In which part of the eye are images formed?
10. How does the lens of the eye adjust itself to differences in distances?
11. Explain "near-sightedness", "far-sightedness", "astigmatism".
12. What are eye glasses for?
13. How is the eye protected from injury?

References:

P-B Pp 162-166
H-W Pp 174-183, 222
W Pp 188-198
W-C Pp 104-105, 259-268
W-D Pp 47-54.
121.

Experiments and Exercises.

1. Experiments 34 and 35 in P-B p 164.
4. How are images formed in the eye? W-D p 47.
5. Why do we have two eyes? W-D p 47.
7. How does the eye adjust itself to variations of distances?
Some Reproductive Processes in Plants.

General Aim.

To gain a fundamental understanding of some reproductive processes in plants, and their similarity to like processes in the human body.

Specific Aims.

1. All life has its beginning in a single cell.
2. Reproduction is often accomplished by cell division without fertilization.
3. When the reproduction is sexual, the egg cell must be fertilized in order to develop.
4. The reproductive organs of many plants are to be found in the flower.
5. Some plants reproduce by fertilization of the egg cell.
6. Fertilization is accomplished by transfer of pollen.
7. The seed is the embryo.
Some Reproductive Processes in Plants.

Problem 1.

Which are the principal parts of the flower?

1. What is the function of the flower?
2. When is a flower complete, incomplete, perfect, imperfect, irregular, regular?
3. Describe the structure and use of the petal, the sepal.
4. Point out the difference between the corolla and the perianth.
5. Which are the essential parts of the flower?
6. Locate and give the use of recepticle, stamen, filament, anther, calyx.
7. Give the parts of the pistil and describe their function.
8. Place the following in vertical order in your notebook, and define them in short, concise sentences:
   Calyx  pollen  corolla  sepal  petal  pistil  filament  anther  ovary  stamen  recepticle

References:

Wag  Pp 19-29  C  Pp 330-341
M  Pp 117-124  H-W Pp 504-507

Exercises.

Make a full page drawing of a flower. Label parts.

Prepare an oral report on "With the Wild Flowers".
Some Reproductive Processes in Plants.

Problem 2.

What is the function of the fruit?

1. List twelve of the most common fruits.
2. What peculiarity do you notice in different fruits as to the walls and the outer part of the ovary, the part outside the seed cavity, the skin or rind, the recepticle?
3. Where do you find the calyx in the apple, the quince, the pear?
4. Which are the two general classes of fruits?
5. What are the characteristics of each?
6. What is the function of the fruit?

References:


Exercises.

A study of fruits.

Materials: Orange, tomato, apple, pea, pecan.

Method: Study each separately.

Observation: Observe and describe both the external and the internal appearance of each sample. Mention parts of flower represented in each. Mention several agencies that aid in the disposal of fruits and seeds, and give examples of each.
125.

9A.

Some Reproductive Processes in Plants.

Problem 3.

How are seeds distributed?

1. What conditions are necessary before seeds can be produced?
2. Name fruits reproduced without seeds.
3. Describe six ways in which seeds are distributed.
4. State how seeds of the following are distributed:
   The dandelion, milkweed, tumbelweed, locust, cocoanut.
5. Who else assists in distributing seeds?

References:

C Pp 345-350   Wag Pp 41-45
M Pp 130-133   W-D Pp 470-471

Exercise.

Growing trees have the power to split rocks. Give an example showing that seeds possess this power also.
126.

9A.

Some Reproductive Processes in Plants.

Problem 4.

How do seeds germinate?

1. Which is the most important part of the mature seed?
2. Describe the three parts.
3. Name specific types of seeds.
4. Describe and locate the main parts of the bean.
5. How do these act in growing seeds?
6. What is an embryo?
7. How deep should seeds be planted?
8. What conditions are detrimental to sprouting?
9. How are seeds fed?
10. How can you test seeds?
11. How does nature prevent the extermination of seeds?
12. What is natural and artificial selection?
13. Describe several methods of pollination.
14. How is the sprouting seed nourished?
15. How do flowers prevent self-pollination?
16. How does fertilization take place?
17. What is asexual reproduction?
References:

C  Pp 330-337, 338  W-D Pp 469-482
VBS Pp 477-482  M Pp 49-55
Wag Pp 45-56

Exercises.

1. Show how seeds are tested.  W-D p 479
2. Prove that seeds require water and air for sprouting.  
   W-D p 474.
Some Reproductive Processes in Plants.

Problem 5.

How do plants grow?

1. What is the purpose of the roots?
2. Describe the tap and brace roots.
3. What is the function of the root hairs?
4. How do plants secure water?
5. Why do plants die if too much fertilizer is used?
6. Which are the most important parts of the plants?
7. Why are the stems or trunks of plants so long?
8. Why does ringing a tree kill it?
9. What is the purpose of the bark?
10. How do we prevent injured trees from rotting?
11. What is the function of the leaves?
12. How does the plant secure oxygen, carbon dioxide, hydrogen?
13. Describe the activity going on in the plant at night.
14. Why do plants need less oxygen than animals?
15. In times of drought how does a plant protect itself against water scarcity?
16. Why should a tree be cut back when transplanted?
17. Describe layering, grafting.

References:

N-D Pp 484-501
C Pp 291-328
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5. Describe the Chicago water supply system. P-B p 117.

Experiments and Exercises

1. Draw four positions of a lift pump. Space them so they will cover the entire page. VBS p 7. H-W p 67.


Problem 3.

How is water controlled in our homes?

1. What devices are there in your home for controlling water? P-B p 127.


5. What is the purpose of the trap under the wash bowl? H-W p 103.
Weather and Climate.

Problem 3.

What are weather instruments, and how do they work?

1. What contribution did Galileo and Torricelli make to science?
2. What did Pascal add?
3. Describe the mercury barometer, an ordinary barometer, rain gauge, anemometer.
4. How do Centigrade and Fahrenheit thermometer differ?

References:

VBS Pp 6, 11, 12
P-B Pp 44-45, 58
W-D Pp 381, 387, 390, 401
H-W Pp 279-290, 290-291

Exercises.

Draw a C and F thermometer side by side on full page.
Draw the aneroid barometer. Label the parts. P-B p 45. H-W p 280
Weather and Climate.

What is the value of the weather bureau and the knowledge of climate and weather to us?

1. What is the difference between weather and climate?
2. What is the weather bureau? What is its value?
3. How many central offices are there in each state?
4. What is done with the reports sent to the central offices and to Washington, D.C.?
5. Of what importance is knowledge of weather and climate to us?
6. Why has the importance of the weather bureau increased lately?
7. How does climate affect animals and plants?

References:

P-B Pp 65-68
VBS Pp 126-127
H-W Pp 292-293
W-D Pp 406-407

Exercises.

1. Of what value was the weather bureau in the World War?
2. How does the weather bureau serve seamen?
3. Work Exercises 20 and 21 in P-B p 64.
86.

8B.

Weather and Climate:

What is the value of the weather bureau and the knowledge of climate and weather to us?
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The thesis "Curriculum Construction in General Science", written by Cornelius F. Bek, has been accepted by the Graduate School of Loyola University with reference to form, and by the readers whose names appear below, with reference to content. It is, therefore, accepted as a partial fulfilment of the requirements of the degree conferred.

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