



1929

A Proposed Course in General Science for the Portola High School

Homer Dewitt Hildebrant

Follow this and additional works at: https://scholarlycommons.pacific.edu/uop_etds



Part of the [Arts and Humanities Commons](#), and the [Education Commons](#)

Recommended Citation

Hildebrant, Homer Dewitt. (1929). *A Proposed Course in General Science for the Portola High School*. University of the Pacific, Thesis. https://scholarlycommons.pacific.edu/uop_etds/3989

This Thesis is brought to you for free and open access by the University Libraries at Scholarly Commons. It has been accepted for inclusion in University of the Pacific Theses and Dissertations by an authorized administrator of Scholarly Commons. For more information, please contact mgibney@pacific.edu.

A
PROPOSED COURSE IN GENERAL SCIENCE
FOR THE
PORTOLA HIGH SCHOOL

A Thesis
Presented to the Department of Education
of the
COLLEGE OF PACIFIC

In partial fulfillment
of the
Requirements for the
Degree of Master of Arts

By
Homer DeWitt Hildebrant
June--1929

Contents

Topics	Page
Introduction	I
I. Location of Portola and the type of community.	
In the High Sierras-----	1
Railroad and lumber town-----	1
High School-----	2
II. Surveys	
Community survey-----	2
Student survey-----	5
Natural surrounding survey-----	13
III. Survey Results in Relation to General Science.	
In the Community-----	14
Among the Students-----	17
Natural Surroundings-----	17
IV. Proposed Course of Study.	
Aims of the Course-----	19
Criteria of Subject Matter-----	22
Supplementary Topics of the Course-----	25
Units Included-----	25
Special Studies-----	34
Unit I--Solar System-----	36
Unit II--Formation of mountains, lakes, rocks, and soil-----	38
Unit III--Conservation of Natural Community Resources-----	41

Contents

Unit IV--Travel and Communication-----	44
Unit V---The Uses of Water, Electricity, Steam and Gas for Power-----	47
Unit VI--Light and Its Uses-----	49
Unit VII--Energy and Man's Control of Heat-----	51
Unit VIII--Personal and Community Hygiene-----	53
Unit IX--Weather and Climate-----	57
Unit X---Plant Life and the Cultivation of Soil-----	59
Unit XI--Insects-----	62
Review of the Entire Course-----	63
V. Resume-----	64
Bibliography-----	66

Introduction

In this thesis the author's first aim is to set forth a science course that will awaken the students of this high school to a realization of the significance and value of their environment, and thereby stimulate their interest and appreciation of things scientific. We are living in the midst of a great scientific age, and application of scientific knowledge will continue more and more to dominate our life. It is essential then that our high school boys and girls should learn how to adapt themselves to this life of scientific application, and be able to interpret their own environment in relation to the knowledge gained.

The course outlined in these pages is the result of a careful study and analysis of this community, covering a period of approximately two years. The arrangement of the course according to season, the various field trips, the surveys, the bringing of men skilled in scientific subjects to address the class, the choice of material for the course, term papers, science discovery book, and collections are the writer's contribution to the course.

The course is planned, as the title indicates, to fit the needs of these boys and girls as the author views the situation. One cannot fore-tell exactly how many of these students will each year go on to colleges, but for those who do, it is hoped the course will have aroused sufficient

interest and desires that they will pursue some scientific study with more enthusiasm than would otherwise have been possible. For those who may not go farther than their high school studies, the author hopes that the insight into the wonders of their environment and man's control of natural forces, will lead them to a greater appreciation of the environment and to read with more understanding, the scientific achievements of each day and year.

The proposed course is made up of eleven units, so planned as to include information from several good science books and observations and experiments from the students' own environment. In this way each unit can be understood by the pupil in terms of its concrete meaning to his life and to that part of society of which he is a member.

Successful learning in this field, as well as in other fields, implies not only the gaining of a new concept and the attainment of new attitudes but it implies the desire to seek farther and the ability to do so. The essence of educating an American citizen is to set him going under his own power and to point him right.

Whether this course will result in all that the author hopes and plans for--in other words, whether it will be a success--depends not only upon the instructor and the course itself, but also upon what the pupil with his own intelligence will do with it. If the pupil elects to work out faithfully the projects, experiments, field trips, and other assignments, the aim of the course will in all probability be accomplished and the author will feel that he has made a worth while contribution to education.

I

Portola is an unincorporated town of approximately three thousand people, situated on the North Branch of the Feather River. It has an elevation of nearly five thousand feet, being in the high Sierras and surrounded by mountains as far as the eye can see.

The summer season is rather short as the frost begins early, and only hardy plants and flowers can be grown. The mountains are covered with pine forests, with some fir and cedar mingled in. Along the creeks are found the quaking aspen, a species of poplar tree.

There are very few birds of any kind near the town, perhaps due to the absence of fruit bearing trees or shrubbery, and of cultivated fields which would furnish insects of various kinds.

There are some rock formations well worth study, a number of gold mines with other minerals also, and numerous lakes and creeks.

During the winter there is a great deal of snow and rain. The long winter season would make it difficult to take any field trips for several weeks at a time, so material would have to be gathered when possible and preserved for winter study.

Portola is first and foremost a railroad town. It is a division point on the Western Pacific railway, and the population is largely made up of railway employees. In this

connection will later be discussed the splendid opportunity for studying machinery.

The vast pine forests mean another industry, that of lumbering. There are large lumber mills close to Portola, the finished product being shipped out over the Western Pacific railway. In this connection will also be discussed later the opportunity for studying the importance and conservation of our forests, as well as visits to logging camps and lumber mills.

The Portola High School with its faculty of seven teachers and its average enrollment of one hundred students, shares with the Junior High School a new, modern building with up-to-date equipment.

II

In order to understand thoroughly the type of community and to know what opportunities there are for general science study and science project work, the following surveys have been made. First, a community survey; second, a student survey; and third, a natural environment survey.

In the community survey data were tabulated on the following topics: First, the trades, industries, and businesses that represent the occupations of the people; second, on everything that in any way affects the health and sanitary conditions of the people; third, on all the fire-fighting apparatus.

After tabulating the results of this survey the following lists were made of the trades, industries, and business interests that represent the occupations of the people:

<u>Trades</u>	<u>Industries</u>	<u>Business Interests</u>
Carpenter	Round House	5 Grocery Stores
Machinist	Lumber Mills	2 Drug Stores
Electrician	Logging	3 Meat Markets
Painter	Laundry	3 General Merchandise
Plasterer		1 Hardware Store
Plumber		6 Hotels
Clerk		5 Restaurants
		2 Dairies
		2 Bakeries
		1 Ice Company
		2 Wood and Coal
		2 Cleaners
		1 Shoe Repairing
		2 Dentists
		1 Bank
		1 Lumber Yard
		7 Garages
		1 Electric Light Plant
		3 Barber Shops

These trades, industries and business interests are found here the year around although a great many of the employees comprise a "floating" population as is usually the case in a small railroad town.

The object of the community survey was to take up the health and sanitary conditions. The health of the community is watched over by two competent physicians and a staff of nurses at the local Western Pacific Hospital. This hospital is well equipped in every detail and can care for about one hundred patients. In the past two years the doctors have checked two epidemics, one of diphtheria and the other of small-pox, that might have resulted in very serious conditions. Besides the Western Pacific doctors, there is one other physician who has a local practice in the town, and two dentists.

One cannot speak so well for the sanitary conditions of the town. The water supply is very poorly cared for, as the low fence which surrounds the reservoir does not prevent boys from swimming in it. It is never cleaned or given any particular attention. However, the water itself is from springs in the mountains and seems to be pure. Another source of water supply is a well in the bed of the river. The water from the spring and river is turned into the same mains. There is a city sewer system which takes care of nearly all the houses in town. The disposal of the sewage is by draining it into a cesspool in the lowlands of the river. Some of the homes have private cesspools. A few of these are very unsatisfactory because they are open. Some of the people let all their wash water run through a pipe which empties on the ground near the house or runs down the street. There is no system of garbage disposal. Tin cans and other rubbish are dumped any where near the

boundaries of the town. Some of the main highways leading to Portola have great garbage heaps along them. Besides being very unsightly, this forms a breeding place for flies. Food materials in the stores are often left uncovered and exposed to the flies and to the careless handling of customers.

The survey regarding fire protection showed very little equipment. One chemical engine, a small one, is really the only equipment besides the town water supply. In a recent disastrous fire that swept over an entire block of business houses and residences, there was no way to fight the fire. The water supply is very inadequate and has very little pressure. When the main street was paved recently, some larger water mains were put in along that street, which will help to some extent in the business section. There is no fire department or regular crew; the citizens form a volunteer fire fighting crew when a fire breaks out.

This completes the community survey.

Next is the student survey made of the entire Portola High School. In this it was attempted first, to find out the personal interest or hobby of each high school student; second, to find out the degree of interest which each one had in science. This survey included not only the whole school, but also a special survey of the science class. The following is a copy of the questionnaire used:

1. What are you most interested in doing?
2. What are you most interested in becoming after you have finished your education?

3. From the following list check the one you are most interested in:

The study of plants

The study of animals

The study of electricity

The study of minerals

The study of the structure of the earth

The study of weather elements (weather conditions)

The study of planets and stars

The study of foods and care of the body

The study of machinery

The study of chemistry

The study of insect life

The study of forestry

The study of agriculture

The study of medicine

The study of birds

The study of heating systems

The study of light

The study of transportation

The study of hygiene and disease

The study of fire protection

The study of community health

The study of navigation

4. What is the occupation of your mother?

5. What is the occupation of your father?

The results of this survey are shown in the following tables:

Table I

(Question 1)

<u>Student Interests</u>	<u>No. of Students</u>		<u>No. of Students in</u> <u>General Science</u>	
	Boys	Girls	Boys	Girls
Music		11		1
Outdoor Life	8		3	4
Drawing	1	4		
Athletics	6	3		
Domestic Science		2		7
Mechanics	3			
Astronomy		2		
Minerals	2			
Nature Study	1	2		
Collecting Stamps		5		
Reading Books		2		2
Commercial Work		6		
Education	3	1		
Aviation	1			

Table II

(Question 2)

<u>Aim in Life</u>	<u>No. of Students</u>		<u>No. of Students in</u> <u>General Science</u>	
	Boys	Girls	Boys	Girls
Stenographer		17		10
Teacher		10		2
Mechanic	7		2	
Farmer	5			
Railroad Engineer	5			
Music Teacher		6		1
Bookkeeper		3		
Nurse		2		
Business Man	2			
Aviator	2		1	
Doctor	1			
Surveyor	1			
Lawyer	1			
Game Warden	1			
Druggist		1		
Dentist	1			
Sailor	1			
Telephone Operator				1

Table III

(Question 3)

<u>Check One in Which</u> <u>Most Interested</u>	<u>No. of Students</u>		<u>No. of Students</u> <u>in General Science</u>	
	Boys	Girls	Boys	Girls
Plants		3		1
Animals	6	1	3	1
Electricity	4	2		
Minerals	2			1
Structure of Earth		2		
Weather Elements	1			
Planets and Stars	1	8		6
Foods and Care of Body		6		1
Machinery	5			2
Chemistry	1			1
Insect Life				
Forestry	2			1
Agriculture	3			
Medicine		1		
Birds	3	2		
Heating Systems				
Light				
Transportation	1	1		
Hygiene and Diseases		1		
Fire Protection				
Community Health		1		
Navigation	1	5		

Table IV

(Question 4)

<u>Occupation of</u> <u>Students' Mothers</u>	Number
Rooming House Proprietor	1
Housewife	73
Teacher	2
Laundress	2
Waitress	1
Postmistress	1
Telegraph Operator	1

Table V

(Question 5)

<u>Occupation of</u> <u>Students' Fathers</u>	Number
Auto Mechanic	5
Railway Employee	41
Merchant	7
Carpenter	1
Farmer	2
Lumberman	16
Laborer	2
Plumber	1
Professional Cook	1
Contractor	1

The tabulated results of question one in the questionnaire shows that out of eighty students, nineteen had interest in science. Sixty-one students had other interests. Of the seventeen students in the science class, seven had personal interests in science and ten had interests in things entirely divorced from science. From this survey one can readily see that with this particular class there will be plenty of work to do in cultivating scientific attitudes and interests. Also, this survey gives the instructor an opportunity to discern the trend of the students' minds. The lack of scientific interests in Portola High School as shown in Table I is due, partially at least, to the fact that some of the students have never had science before, as it is given in the freshman year and, of course, they have not had an opportunity to become acquainted with the subject.

In Table II and question two, referring to the students' aim in life and the possible profession or vocation he might be interested in, out of sixty-six students who answered that question, sixteen chose professions that call for scientific training. In the science class, two out of seventeen, chose occupations in which scientific principles are necessary but which do not involve extensive training. The questionnaires of individual students seem to show no relation between their choice of a life profession or occupation. For example, one student wanted to become a dentist but was especially interested in making a study of animals. In only two or three

do the questionnaires show close relationship between the student's aim in life and his personal interests.

In Table III and question three, the topics in which most interest was expressed were astronomy, machinery, electricity, animals and birds. The reason for this seems to be that the planets and stars and electricity appear wonderful and to a certain degree mysterious. Electricity is so widely used today that it is natural that it should arouse much interest. The study of birds and animals appeals to those who enjoy outdoor life. These topics were chosen mainly by boys, while the girls showed little preference for them.

There seems to be a lack of interest in health problems, fire protection, forestry, heating systems, insect life, and medicine. Perhaps this is due to the apparent lack of home and community interest, or because young people have not given due consideration to such topics. Even after the recent disastrous fire not one student expressed an interest in fire protection. There is a splendid opportunity here to give the students instruction in these vital problems of everyday life. Most of the students in this high school will not go to college and therefore require more general information in every day living and need to know facts about the environment in which they find themselves.

Tables IV and V require little comment. It will be noted in Table V that the principal occupations of the students' fathers are the railway and the lumbering industries. In both of these industries have been tabulated all who were in any way

connected, whether in official positions or as day laborers. Most of them were day laborers. This shows to a certain degree the lack of education and training of most of the fathers.

The final survey which was made was that of the natural surroundings of Portola. Situated as it is in the midst of high mountain peaks, one would naturally expect to find many things of interest for the General Science course. First of all, the writer made the acquaintance of a local game warden who is thoroughly familiar with all sections of the nearby country. He also interviewed forest rangers who are familiar with things of scientific value in the mountains. In addition to this the students made a list of what they considered the most interesting and worth while field trips for general science. Fishing and hunting trips during the past year have revealed many points of interest where the students can go on scientific excursions. From this survey, there has been compiled a list of places that it is possible to reach either by a short automobile trip or a short trip on foot. After crossing the Beckwith grade, a distance of six miles, one enters the lower end of Sierra Valley. In the valley are the following points of interest for study: Sattley Creek, Grizzly Creek, Campbell's Hot Springs, Marble's Hot Springs, swamps and artesian wells. Leaving this valley over the Yuba Pass, one comes to the Yuba River with all its jagged boulders and rocks. South toward Truckee, one will find Independence Lake and just beyond Truckee about six miles is Donner Lake. All these are

accessible by automobile in one to three hours. Westward from Portola is a very interesting group of lakes, Gold Lake, Long Lake, Summit Lake, and Little Bear Lake. In the same vicinity are several mines and a Forest Service lookout station. The lakes and mines are within one hour's ride by automobile. The high school is at the foot of Beckwith Peak and is about one hour's ride from Grizzly Peak. Ten miles away are McClear's Hot Springs. Other points of interest near by are gold and copper mines. Down the Feather River canyon, only a few miles below Portola, are water falls, rock slides, glacial cuts, and numerous tunnels. The mountains around Portola are covered with several kinds of trees such as yellow pine, spruce, cedar, fir, mountain mahogany, and oaks. On the high points of the mountains, are lava flows and many examples of igneous rocks. The rocks show the effects of the weather elements upon them.

III

The next step is to relate all of this survey material to general science. In the community survey were found among the trades a carpenter, and in the industries lumber mills and logging camps, and among the businesses, a lumber yard and a wood and coal business. In the study of the conservation of the forests and the various phases connected with it, logging camps in the forest just a few miles from Portola might be visited to show how trees are cut, how the smaller brush is destroyed in the process, and the condition of the forest when the trees are removed. In such a visit one has a splendid opportunity to study the rings on trees to determine their age. One may

study, also, other things of interest in this connection, such as the Cambium layer and the growth of cells and the flow of the sap in the tree. At the lumber mill one can get an idea of the vast amount of lumber used each year. One can watch a log being sawed into boards and notice the amount of wasted material and learn about the rings of the trees as related to the graining on the boards. A carpenter or lumber dealer could discuss before the class during a regular school period, the various kinds of building materials and show how other materials are taking the place of lumber and thus tending to conserve our forests. After a visit to the wood and coal yard, the students could discuss the kinds of fuel used and how the coal has been formed.

Another interesting combination centers around the machinist, the railway round house and the garage. Here is a splendid opportunity for the study of steam and gas engines. At the round house there are numbers of steam railway engines that can be studied, and in the garages the students may see gas engines taken apart and learn how they are actually constructed and the principles on which they work.

Following this, electricity can be studied. The students can visit the local electric light plant and see how the lighting power is generated. Some electrician in town could explain the wiring of a house, how to read an electric meter, and how to connect an electric door bell. Other interesting studies would be coils, batteries and the entire ignition system of the motor car. Most boys are interested in these things, which of course, would have to be taken up in a very simple form and not include too much detail.

Plumbing is another interesting study. Many people are not able to do even the simplest plumbing jobs because they do not have any conception of what plumbing is like. In this connection, the students should be taken to a house under construction to see the simple methods and the various ways pipes are installed in order to send water to all the rooms. A study of the various kinds of plumbing fixtures for houses would be very valuable. Heating and ventilating systems for houses would be another interesting subject. The students should make personal investigations on many of these points.

The study of the dairy would include the dairy ranch, its products, methods of handling milk and sanitation. A visit to the local creamery would be valuable. At this time, also, a study of the various kinds of meat cuts and a visit to the local meat market would be profitable, followed by the history of cold storage and its development up to the present time; the making of ice, and the various kinds of chemical plants installed for refrigeration.

In conjunction with the topic of hygiene and health in General Science, the class could study the health conditions of Portola. They could make a trip to the local hospital and see the kind of equipment used in treating the ailments of people. One of the doctors could come and talk to the class about health problems and epidemics. The class could send away samples of drinking water for bacterial examination and write to the county health officer to see what might be done about disposing of local garbage. A dentist could be asked to

give a lecture on the care of the teeth and their relation to one's health.

In studying fire protection the class could be asked to ascertain methods used for fighting fire in other towns. They could make a group visit to see the local fire fighting equipment. They could see a demonstration of how an extinguisher works and how it is refilled and operated.

In the community survey we found out what materials we have outside the classroom with which to work. In the student survey one may get a general idea of the interest which the students have in science and the type of home life they have as a background for scientific education. In deciding upon themes or projects as special work for the individual students, we can be guided as to the students' interests by referring to the survey results. The survey also shows that most of the students' parents are of the laboring class and would probably give little or no sympathy or encouragement or help to a child in pursuing his scientific studies. The teacher, therefore, would have to strive to make the course interesting enough to overcome the indifference of the parents.

The natural surroundings survey suggests an interesting and profitable part of the course. The creeks of Sierra Valley offer an abundance of material for laboratory work. In the study of botany a trip to the creek will offer a very fine opportunity for studying the various aquatic plants. These may be studied not only in their natural surroundings but may be taken to the laboratory for further analysis and study. Many kinds of insects are found along the moist banks of the creeks.

Here, too, are found many plants and shrubs which can be used in studying the structure of leaves and stems.

While studying strata formation, a visit to the artesian wells and hot springs would prove interesting and worth while, and when we take up the topic of natural reservoirs and water conservation, a trip to the adjacent lakes would give the students an idea of the structure, size, and importance of such lakes and their relation to the forests and valleys. Snowfall, rain, and stream drainage in the mountains may be taken up in relation to the source of lake supply.

The mountain peaks offer the best opportunities for the study of igneous and metamorphic rocks. The Feather River canyon is an example of the results of glacial action, showing rock layers and the erosion caused by running water. The mines offer a splendid opportunity for examining mineral deposits and observing methods of mining. This concludes the comments on the various surveys made, and their relation to a General Science course.

IV

From these surveys there will now be developed a practical and scientific course of study for the Portola High School. This will be made up not only of all available local material, but will also include such other science topics as, according to present day usage, would seem to be important and profitable in the study of General Science. These topics have been gathered from various up-to-date and reliable texts. Before going

directly into the course of study, the author has chosen from various sources, several important aims and criteria to aid in the construction of a valuable course of study. In constructing such a course there are at least six aims to be considered:

1. to impart a knowledge of interesting things in the students' environment.
2. to emphasize this interest for those who will not go to college.
3. to help students to find a special scientific interest for study or work.
4. to help students to interpret their environment.
5. to arouse in students a spirit of investigation.
6. to help students to begin scientific thinking.

Twiss¹ emphasizes the fact that scientific teaching should aim:

To impart information from the scientific standpoint about the useful and interesting things that are all about us, especially for the benefit of those who will not go on to college and may not go farther in high school and who therefore would otherwise remain ignorant of scientific facts and of the scientific way of dealing with the materials and forces that are everywhere available for our use.

These two aims are especially applicable to this course of study; first, because the subject matter is largely made up of interesting things in the local environment about which the students of this school should know, and second, because many students after graduating from this high school do not go on

¹ G. W. Twiss, The Principles of Science Teaching, pages 415-16.

to college and so have no chance to learn, in a scientific way, of the forces of nature and man's control of them.

As will be seen by the natural surroundings and community surveys, this locality has abundant material with which to enrich a General Science course, so that these two aims should come foremost in considering the subject matter of this course.

The third aim is very clearly given in the following statement by Twiss¹:

To give the first year pupils an attractive view of the content of all the sciences, so that they may find out where their tastes and capabilities lie, and thus choose more wisely, among the studies that are offered them in later courses or that they may find the field in which they prefer to read, work, and study after leaving school.

This aim is likewise of great importance. In this General Science course a sufficient variety of science subjects will be touched on to enable a student to determine in what field he would be most interested. A good many students in this high school later wish to major in science or at least to continue science study.

In connection with the fourth aim, which is to help a student to interpret his environment, Eikenberry² makes the following statement:

General Science selects its subject matter and secures its results with the need for explanation and interpretation of the environment always in mind.

It is the mission of General Science to explain for the pupils those natural phenomena that have interest and significance for them and to impart such additional knowledge as their interests and needs demand, to encourage the pupils to solve the simple problems themselves as a beginning of

¹ G. W. Twiss, The Principles of Science Teaching.

² W. L. Eikenberry, The Teaching of General Science. pgs. 64-65

scientific thinking and to develop such easily comprehended principles as apply to the local environment and the pupils' interests.

This aim is of importance as a special part of the student's education. The high school student has to be taught how to interpret his environment and what methods to use in finding out what is involved in the natural things about him. A high school student's knowledge of natural science is very limited and a mystic atmosphere surrounds every living creature. To have this mystic atmosphere lifted and a real interpretation given to many of the secrets hidden in nature should enrich the student's mind to a finer understanding of his surroundings. It should enable him to enjoy nature and spur him on to a larger and more thorough investigation of his environment.

The fifth aim, to arouse in the student a spirit of investigation, and the sixth, to help the student to begin scientific thinking are both contained in this statement by Pieper and Beauchamp:¹

It should be an aim of General Science to arouse a spirit of inquiry and investigation and to have a desire to see and solve science problems arising in the environment.

The development of, and growth in, desirable attitudes toward appreciation of and adaptations to our environment in so far as an elementary knowledge of science and the proper development of the attitudes and habits of study, the abilities and the skills make this possible.

Up to the time students arrive in high school, very little has been done in training them in good mental habits of scientific thinking or investigation. This is a vital part of a student's education. If they leave high school with some

¹C. J. Pieper and W. L. Beauchamp, Teacher's Guide Book for Everyday Problems in Science, pages 2-3.

accomplishment in mental training their chances of success either in the business world or in some higher school of learning are greatly increased. There is no better place to begin such instruction than in the General Science course which in this high school is given in the freshman year. With the splendid natural environment and the many other opportunities for investigation a course of study can be constructed that will arouse a spirit of investigation and the beginning of scientific thinking.

The aims cited above point the way to the next step in the formulation of the course, namely, the selection of proper study materials. Student and community surveys, the study of various curricula¹ and class room observations have led to the establishment of a set of criteria by which the value of the subject matter in this course may be judged. The four major criteria are as follows:

- (1) Does the subject matter appeal to the interests of boys and girls as worth while and real in their daily lives?
- (2) Is it so organized that the method of study will give proper training and desirable attitudes, habits, skills, and ideals?
- (3) Is it such that the knowledge gained will have a real positive value in the life of the pupil?
- (4) Are the subject matter and method employed of the proper degree of difficulty?

Each of the above criteria is quite general in character.

¹C. J. Pieper and W. L. Beauchamp, Teacher's Guide Book, pgs.3-7

In order to give a more specific meaning to them each one will be stated again and answered specifically.

(1) Does the subject matter appeal to the interests of boys and girls as worth while and real in their daily lives?

Surely the marvels of the sky, water and rocks are common to the experience of every student.

Machines, engines, motors, heating, and lighting devices, electricity, gravity, and water power interest every wide awake boy.

Operation, construction, dissection, assembling, collection, and other forms of activity increase student self expression.

Radio, climatic and weather changes, modern methods of lighting, and transportation in the air form up-to-date subject matter.

All of the materials and applications which are to be studied are true to life, that is, they are man-sized rather than toys or models.

(2) Is it so organized that the method of study will give proper training and desirable attitudes, habits, skills and ideals?

The subject matter can be organized into such form that it presents practical everyday problems to be solved such as: How is the water supply of a city to be distributed?

The subject matter can be so organized that it brings out the relationship of science facts and thereby leads to an understanding of the environment rather than just a learning of facts.

The subject matter can be so outlined that the student may through his own study, develop the proper habits of study.

(3) Is it such that the knowledge gained will have a real positive value in the life of the pupil?

It relates to personal and community health.

It leads to adaptation and adjustment to the natural surroundings.

It deals with science in the home such as heating, lighting, water supply.

It relates to community problems such as garbage disposal, fire prevention, sanitation, etc.

It considers materials essential for life, such as food, water, clothing, and fuels.

The knowledge gained will lead the child to such interests as collection, construction, experimentation and other forms of outside study.

(4) Are the subject matter and method employed of the proper degree of difficulty?

The course is built upon the present and past experiences of the pupils and closely related to such experiences.

The problems and study material under each problem can be made to test the thinking power of the pupil.

The experiments to be used are such as will clearly show the results to be obtained even though simple laboratory apparatus is used.

Now that the reader has in mind the aims and criteria of the proposed General Science course, the author will turn to the subject matter of the course. This is made up of a group of special yearly studies and eleven other units

and a final review. The units have been arranged in an order that will make it possible to take the desirable field trips and collect the best specimens according to the time of the year when they are the most abundant. It would be impractical for instance, to study insects and flowers in December or to study electricity and motors when the plants were flourishing. The observation trip in Portola in regard to foods and sanitation, etc., can be taken in the more unfavorable weather. Before discussing the course and making assignments, a complete program of the course will be given:

Special Studies to be carried on outside of class period throughout the school year, as part of the course, namely:

A term paper on some topic of scientific interest.

A science discovery book, which includes accounts of field observations, pictures, and articles from scientific magazines.

Collections of insects, leaves, flowers, and ore.

Unit I-----Solar System

Stars

Planets

Gravity and Inertia

Seasons

Day and Night

Time

Longitude and latitude

Tides

Supplementary Activities for Unit I

Studying the heavens at night and finding the important

stars and star groups.

Writing a short paper on some subject about the stars and planets.

Teacher's demonstration of gravitation and inertia.

Experiment--To show why we have day and night.

Unit II-----Formation of Mountains, Lakes, Rocks and

Soil.

Formation of Mountains

Formation of Lakes

Story of the Rocks

Sedimentary

Igneous

Metamorphic

Fossils

Minerals

Formation of Soils

Glacial

Freezing

Water Erosion

Wind Erosion

Supplementary Activities for Unit II

A trip to the mountains

A trip to the lakes

A trip to a mine

A trip to a river

Unit III-----Conservation of Community Resources

Protection of birds

Reasons for bird protection

Birds as destroyers of weed seed

Birds as destroyers of rodent pests

Enemies of Birds

Bird protection by the government

Forests

Condition of the forests today

Uses of the forests

U. S. Forest Service at work

Enemies of the forests

Lumber industry

Supplementary Activity for Unit III.

Field trip to study birds and bird habits

Home project--Each child to study food habits of birds

Home project--Bird house building

Talk by game warden

Talk by forest ranger

Report on various forest subjects

Visit to logging camp

Visit to lumber mill

Unit IV-----Travel and Communication

Travel on land

Early methods

Steam locomotive

The automobile

Electric motor

Importance of good roads, bridges, easy curves

and grades in modern travel.

Travel on water

Early water travel

How a boat floats and is made stable in water

The use of steam in water transportation

Modern steamships

Principles of the submarine and balloons

How water travel is made safe.

Travel in the Air

Balloons

Airplanes

Dirigibles

Communication

Early communication

Telegraph

Telephone

Wireless telegraph

Wireless telephone

Radio

Television

Supplementary Activities for Unit IV.

Reports on early methods of land travel and water travel

Experiment to show why ships float

Visit to round house to see modern locomotives

Report on local community roads

Report on recent flights of air planes and dirigibles

Visit to printers' offices, telegraph office, and a
radio dealer.

Unit V-----The Use of Water, Electricity, Steam and Gas
for Power.

Water

In turning water wheels

In turning turbines

Electricity

From the mountain power house to the city

Dynamos

Transforming electric currents

Electric meters

Electrical devices

Batteries

Magnetism

Steam

Work of James Watt

Principle of the steam engine

Many uses for steam

Gas Engines

Principle of the gas engine

Uses made of gas engines

Supplementary Activities for Unit V.

A talk by a local electric light manager on
 electric transformers and meters

Experiment on how to read a meter

Experiment on wet battery

Experiment on magnetism

Experiment on properties of steam

Drawing to demonstrate the way a steam engine works

Visit to garage to see a gas engine taken apart

Unit VI-----Light and Its Uses.

Importance of light

Sources of light

How we use and control sunlight

Light in its relation to the human eye and
to lenses

How artificial light is produced and controlled

Light and color

Supplementary Activities for Unit VI

Survey of how a town is lighted and to
suggest improvements

Visit to power house and report to class

Experiment--To show that light travels in a
straight line

Experiment on the candle

Demonstration to show best methods of
house illumination

Unit VII----Energy and Man's Control of Heat

Energy

Kinds of energy

Man's control of heat

What heat is and how it is produced

How heat acts upon matter

How heat is released from fuels

How heat is used and controlled in the home

How heat is distributed in the home

Dangers and control of fire in the home

Supplementary Activities to Unit VII.

Visit to the school's heating plant

Experiment to show the effect of heat upon
liquids, gases and solids

Report on how a stove is built to control heat

Experiment on fireless cooker and thermos bottle

Demonstration of how a fire extinguisher works
and the method of refilling it

Unit VIII-----Personal and Community Hygiene.

Personal Hygiene

General structure of the human body

Posture and exercise

Air and breathing

Food and diet

Digestion and circulation and hygiene of
the alimentary canal

Care of the mouth, nose, and throat

Hygiene of the skin and the use of clothing

First aid

School and Home Hygiene

School hygiene

Hygiene of the home

Community Hygiene

Food distribution

Disposition of water

Insect enemies of man

Community control of disease

Supplementary Activities for Unit VIII.

Field trip to source of water supply

Student project--To find out how foods are protected from dust, etc., in the stores

Talk by school health nurse

Talk by dentist

Student project--Investigate community sewage disposal and possible breeding places for flies and mosquitoes

Experiment to show the presence of bacteria

Visit to the local dairies

Unit IX-----Weather and Climate

Temperature of the air

Thermometer

Clouds and rainfall, lightning

Tornadoes, snow, dew, frost, winds and their causes

Weather bureau forecasts

Supplementary Activities for Unit IX.

Experiment to show how the earth is warmed by the sun

Experiment to show the formation of frost

Report--Benefit of the weather bureau

Other reports

Unit X-----Plant Life and the Cultivation of Soils

Plant Life

Importance of plants

Plant structure

Plant processes

Monocotyledonous stem

Dicotyledonous stem

Algae

Cultivation of Soils

Present day agriculture

Methods of increasing crops

Putting new land to work

Protection of farm crops

Supplementary Activities for Unit X.

Experiments on

Seed and its development

Leaves and their structure

Stems and their structure

Roots and their structure

Manufacture of food

Reproduction in flowering plants

Algae

Soils

Reports

Field trips

Unit XI-----Insects

Anatomy of the insect

Beneficial insects

Harmful insects

Supplementary Activities for Unit XI.

Experiments--

Anatomy of several insects

Reports on friendly and unfriendly insects

Review of Entire Course.

Topics in text-book

Topics in experiments

Field trips and Science Discovery Books

The foregoing outline has given the reader a clear view of the entire course of study. The details of the course will now be shown. Special studies for the entire year have been arranged under three heads, namely, term paper, science discovery book, and collections. The term paper will have for its theme some topic of scientific interest chosen by each student with the approval of the instructor. For example, How are Contagious Diseases Spread? The student can study this topic in his own community and make a really interesting study of the conditions. Such topics bring the science class into contact with various phases of community life and problems. They also teach the student how to make investigations and to put his findings into organized form. Such topics create a real interest for the student, not only in science, but also in his community.

The Science Discovery Book will have in its contents facts gathered from scientific magazines, observations made on field trips, and other facts gathered from home and class discussion. Such procedure stimulates the student to read scientific magazines and helps in keeping his mind alert for scientific facts. Oral reports from the Science Discovery Book can be given every Friday. It is remarkable how many science facts of local interest the students include in their books. Students can make experiments at home with the sprouting of seeds and the cross-pollination of flowers.

Examination of insects is another field for home experimentation. Facts gathered by the student from such endeavors may all be put into his science discovery book.

The collection consists of insects, leaves, flowers, and ore-bearing rocks from the mines. This takes the student into the open and causes him to make a very definite study of natural surroundings. It also teaches him how to name and classify the various specimens in his collection. Students may collect butterflies, beetles, grasshoppers, flies, bees, insects harmful to trees and shrubs, and insects that are beneficial to mankind. Some student can make a special study of the fly problem as related to the community. Students may collect leaves of the various trees and shrubs and study their structure. It may be possible for them to exchange leaves with students in different states, and countries. They can collect the various specimens of wild flowers and study their structure, the conditions in which they live, and the season of the year in which they bloom. As they visit the various mines they can bring home with them samples of ores and get them assayed. This will create much interest.

The object of the special studies is definitely to connect the student in the class room with the community and the natural surroundings. These activities may be carried on throughout the year in connection with the regular class room work. Very definite check should be made of all student activities along these lines.

The assignments should be made by weeks. The text-book used in the Portola High School is General Science by William H. Snyder.

Unit I---Solar System. Two weeks' study from August 27 to September 7.

First week:

Text-book assignment--Chapter I. Classroom discussion of the chapter with questions as a guide.
Class meeting at night for the observation of the stars and location of groups, followed by written report in class the next day. Reference books for study of star groups:
Moseley--Trees, Stars, and Birds. Chapters 4, 5, 6, and 7.
Pieper and Beauchamp--Every Day Problems in Science. Chapter 1.
G. H. Trafton--Science of Home and Community. Chapter 32.
Caldwell and Eikenberry--Elements of General Science. Chapters 22 and 23.

The instructor at this time starts the class in their Science Discovery Books. Because of organization and registration of the school, this is about all that may be covered during the first week. The papers written in class should be corrected by the instructor and returned for revision and finally placed in the Science Discovery Book. When the class met at night for observation and study of star groups, a small telescope borrowed from a local man, made this much more interesting. Many questions were asked on that evening and the stars took on a new significance to the students.

Second week of Unit I.

Text-book, chapter 2. Classroom discussion with questions as a guide. Teacher's demonstration of the principle of

inertia. This is carried on with a classroom discussion of inertia. The demonstration consists of placing a coin on a smooth card extending slightly beyond the edge of the table. Suddenly snap the card horizontally. Second demonstration is rolling a marble or ball along a smooth floor to show that it continues to roll unless stopped by some object or overcome by gravity. A simple demonstration is also given to show the force of gravitation. These demonstrations are written up in the experiment books. Besides classroom discussion, it is very profitable to have classroom reports. Some really good topics for reports are these:

The cause of day and night.

The causes of our seasons.

The moon and its effect upon the tides.

Eclipse of sun and moon.

Classroom discussion is also carried on at the close of a report if there are any questions asked or if the instructor wishes to emphasize any part of a report or some particular thing that the student has left out. References for the above topics are found in these books:

Wood and Carpenter--Our Environment, How We Use and Control It.

Moseley--Trees, Stars and Birds.

Caldwell and Eikenberry--Elements of General Science.

Experiment--To show why we have day and night and why they vary in length. This can be very nicely shown by the use of a small rotating globe and a flash light. After the experiment is over, the students are required to make a drawing

illustrating these facts and making the necessary explanations. The class can then have a short written lesson of about six questions on the solar system.

Unit II--Formation of Mountains, Lakes, Rocks and Soil.

This unit will cover a period of three weeks--September 17 to October 5.

First week.

Text-book assignment--Chapter 12.

Classroom discussion, guided by questions.

As Portola is situated in the mountains, it is an easy matter to take the class on Tuesday and Thursday morning to the top of a small mountain and to a lake near the school. The class in General Science meets the first period in the morning and on Tuesday and Thursday has a double period. When going on trips, we usually meet at eight o'clock and plan to return by ten-thirty at which time our double period is over and be ready to pass to other classes. The topics, mountains, formation of lakes and rocks are all closely related. The author usually treats these topics together, but at the same time brings out the distinctive features of each. A black-board drawing and explanations of formations precede the hike to the mountain and lake. On the hikes, the students examine and classify rocks and the structure of mountains and lakes is again explained. The effects of freezing, water, and heat upon rocks, erosion by water, and the depositing of various formations of strata and their up-heaval to the earth's

surface, can be easily shown. Following the hike is a classroom discussion with questions answered. The instructor brings to the classroom samples of sedimentary, igneous and metamorphic rocks for further examination. The rest of the week is devoted to a write-up of the trip, explaining the various things which were seen and were told about. Besides this, the class will have reports from their science discovery books.

Second week of Unit 2.

At the end of the first week, the following assignments are made for the beginning of the second week. These assignments are discussed with questions in class.

Volcanic action

Strata formation

Formation of lakes and their uses

Fossils

Earthquakes and faults

Igneous, sedimentary and metamorphic rocks

Formation of coal

Reference books for these reports are these:

Trafton--Science of Home and Community. Chapter 31.

Carpenter and Wood--Our Environment and Its Relation to Us.
Chapter 5.

Blackwelder and Barrows--Elements of Geology. pp. 65-78,
302-303, 274-284, 261-268, 23-53.

This week the class will be taken to a near-by gold mine. The gold ore veins, the way the mineral was deposited, and the methods of mining are all explained. The class will bring home a few sample rocks with gold ore in them. If possible, a mineralogist, or a man who runs and operates a mine can be

asked to come before the class and tell them about valuable mineral deposits and methods of mining. Such men can usually be found in this region. The class can send away some of the rock with ore and have it assayed for valuation. A short report on the trip to the mine and information gathered from books and the speaker can be written up and put into their Science Discovery Books. Writing the reports during the classroom periods makes possible additional explanations and answering of many questions that will be raised. Friday of the second week will be given to science magazine reports of a general nature. Such reports help to keep the class reading the science magazines.

Third week of Unit 2.

At the end of the second week, the instructor should make the following special assignment for the beginning of the third week:

Carpenter and Wood--Our Environment, Its Relation to Us.

Chapters 6 and 7. These chapters deal with soil formation and the kinds of soils. Every student in the class will be required to read this assignment and it will be followed by classroom discussion guided by questions. This third week we will take the class on a short hike to near-by cliffs and to a river. On this trip we shall examine the way in which soil has been made by freezing, water erosion, decaying of vegetation and estimate the amount of sediment carried by small streams and rivers. The class will bring back with them jars of water containing sediment from the river. After allowing this to stand, the water will be poured off and

measured. The sediment will also be measured to enable the student to form some idea of how much sediment is carried by rivers. Following this will be an experiment to show how much water soil will hold. This can be done by saturating some soil with water and then driving the water out by heat. The difference in the weight of the soil before and after the water was driven out, will give the results. These experiments will be written up and put in the experiments books. The remainder of the week will be spent on the following reports:

Glacial action and its relation to soil

Freezing and its relation to soil

Soil erosion by the elements.

Transportation of soils

References for these reports are as follows:

Caldwell and Eikenberry--Elements of General Science.

chapters 6 and 7.

G. H. Trafton--Science of Home and Community. pp. 529--535,
539--541.

Blackwelder and Barrows--Elements of Geology. pp. 86-93,
125-137, chapter 6.

These reports will be followed by classroom discussion.

Now that the students have finished the first two units and have been studying for five weeks, the instructor will give a written examination covering the important points in Units I and II.

Unit III--Conservation of Community Resources. This unit will extend over a period of three weeks, from October 8,

to October 26. The first week and a half will be devoted to birds and the latter week and a half will be devoted to forests.

First week and a half of Unit III--Birds

Text-book assignment pages 467--479.

The reading of this assignment will be followed by a talk on birds by the game warden. Time will be given for the students to ask questions on birds and game laws. This will be followed by a hike in the woods to find the various kinds of birds in this locality and to teach the students to recognize them by their songs and colors. Each student will then be assigned a certain bird of which to make a special and very thorough study. Each student will write up and report in class his findings. These findings will be put in the Science Discovery Books. The students will be asked to build bird houses and place them around their homes so as to encourage birds to live in the town. The students will be asked to bring pictures of various common birds to be shown in the class. A series of reports will be given on the following topics:

- Birds as insect destroyers
- Value of birds in destroying weed seed
- Government protection of birds
- Work of the Audubon Society
- Bird refuges
- Enemies of birds

Reports for the above topics will be found in the following books:

- Peabody and Hunt--Biology and Human Welfare. pp. 433--450.
 G. H. Trafton--Science of Home and Community. Chapter 28.
 Moseley--Trees, Stars, and Birds, Chapters 1--28. (This
 book is to be used for reports on various individual birds.)
 T. J. Moon--Biology for Beginners. Chapter 33.
 G. W. Hunter--New Civic Biology. pp. 359--361, 375--379.

The second week and a half of Unit III. Forests.

Text-book assignment pp. 207--217.

The first trip will be through the woods to a near-by logging camp where can be studied cross sections of tree trunks to determine the structure and approximate age, the effect of cutting away large areas of trees in relation to dense underbrush and water sheds and erosion, how trees are cut and logs are handled in the woods on their way to the mill, and the harmful effect of insects that bore into the bark and tree trunks. The following are assigned topics for readings, followed by classroom discussion and questions:

- Economic value of trees
- Methods of forest conservation
- U. S. Forest Service at work
- Enemies of the forests
- Products of the forests
- Tree surgery

References for the topics are:

- G. W. Hunter--New Civic Biology. Chapter 26 and pp. 368--370.
 Peabody and Hunt--Biology and Human Welfare. pp. 328--337.
 Moseley--Trees, Stars and Birds. Chapter II.
 G. H. Trafton--Science of Home and Community. Chapter 29

T. J. Moon--Biology for Beginners. pp. 557--575.

A visit to a lumber mill will be the last field trip in the study of forests. On this occasion we will study the structure of various kinds of woods; the way logs are sawed and the different grain effects; the methods used in the seasoning of lumber and the quantity of lumber cut and shipped in this community. The following chapters will be assigned in connection with this trip:

Moseley--Trees, Stars, and Birds. Chapter 6. "Woods and their Properties." Chapter 16. "Figures in Wood."

An oral quiz will be given upon the completion of this unit.

Unit IV--Travel and Communication.

This unit will take up a period of three weeks dating from October 29 to November 16. The topics that will be studied during this period will be "Travel on Land", "Travel on the Water", "Travel in the Air", and "Communication". The first two weeks will be devoted to travel and the third week to communication.

First and second weeks of Unit IV. Travel.

Special assignment for the entire class will be from:

Wood and Carpenter, chapter 12. There will be classroom discussion guided by questions.

The first trip will be to the railroad round house. This will give the students an opportunity to see various parts of a large locomotive and watch the parts work as the engine is moving. They can also compare the size of the engines today with the ones used in early travel of which they have pictures.

They can see the huge snow plows and have explained to them just how they work. Snow plows are a necessity to travel in this region.

An experiment can be made in class to show the students why a boat floats. This is accomplished as follows: Calculate the weight of a small block of wood. Completely fill a beaker or small jar with water. Calculate the weight of the displaced water. The student will find that the water displaced will weigh more than the block of wood. From this experiment can be shown the reasons why a boat floats. This experiment will be written up and placed in the experiment books. The students will be assigned a community project. The project will be to examine the conditions of the roads. Students should be guided in their report by the following suggestions:

Are the roads paved or graveled? If not, what is the foundation of the road?

Are the roads kept graded or are they full of ruts?

What streets in the community seem to get the most attention?

The students should examine the road scraper and machines used in the care of the roads. Suggestions for improvement of roads in the community will also be included in the report. The following reports will be assigned to the students:

Early land travel

Early water travel

Importance of good roads, bridges and easy

curves in modern travel

Methods of travel

How water travel is made safe

Some of the recent air voyages

Work of James Watt

Causes and remedies or prevention of automobile
accidents

How a submarine works

Early history of the balloon

Why a balloon rises

References for these reports are found in:

G. H. Trafton--Science of Home and Community. Chapter 15-19.

Pieper and Beauchamp--Every Day Problems in Science.

pages 477--511.

Third week of Unit IV. Communication.

Special assignment for all the class from Wood and Carpenter--Our Environment; How We Use and Control It. Chapter 13. This chapter will be discussed in class.

The trip will consist of a visit to the telegraph office, printer's office, telephone office and to a radio shop. This will enable the students to see the modern ways of communication. At the telephone office they will have explained the work of the telephone operator and the construction of the telephone outfit. At the telegraph office they will have the radio explained. This trip will serve as a basis for an interesting discussion. From scientific magazines they will be required to read about the recent development in wireless telephone, radio and television. This will be followed by a class discussion.

References for additional reading:

Caldwell and Eikenberry--Elements of General Science. Chap. 20.

Wood and Carpenter--Our Environment--How We Use and Control It.

Chapter 13.

G. H. Trafton--Science of Home and Community. Chapters 20-22.

There will be given at this time an examination covering

Unit III and IV.

Unit V--The use of water, electricity, steam and gas for power. This unit will cover a period of three weeks from November 19 to December 7.

First week.

Text-book assignment page 252--263, Chapters 18--19.

This assignment will be discussed in class, followed by field trips. Since water is used in generating electricity, the first trip will be to the power house. The students will have explained to them how electricity is generated and will see the machinery do the actual work. The local electric light manager will be asked to come before the class and talk on transformers and meters and on any other phase of electricity and water power that he may choose. The demonstration this week will be on how to read electric and water meters. The class will be required to draw a meter and explain in writing how to read it.

Additional readings will be assigned from the following books:

Wood and Carpenter--Our Environment--How We use and Control It.

"The Work of Air, Water, Heat and Electricity in Industry."
Caldwell and Eikenberry--Elements of General Science. Chap. 18.

G. H. Trafton--Science of Home and Community. Chapter 9.

"Application of Electricity."

These readings will be followed by classroom discussion and questions.

Second week of Unit V.

This week the class will study batteries and magnetism. Text-book assignment pp. 545--553, 559--566. This assignment will be followed by classroom discussion. Some of the boys in the class will be asked to go to the garages and obtain some worn out coils. These coils will be taken apart in class and studied and the function of the various parts will be explained to the class. Experiments on the wet battery will be the next exercise. A battery from an automobile will be taken apart and explained to the students. They will make a drawing of the battery and also in writing indicate the positive pole, negative pole, positive and negative plates, and tell from which pole the current leaves the battery and through which one it returns. A short explanation as to how the battery should be cared for will be given.

In the experiment on the magnet, the following properties will be studied: magnetic substances, magnetic field, and how to make magnets. For this experiment the instructions given in G. H. Trafton's Science of Home and Community page 154 should be followed. This is a splendid exercise and is simple enough to be understood and carried out by the freshmen in high school. A good project for the students at this time

will be to learn about the electric door bell and actually know how to connect one with the batteries. A demonstration and explanation will be given in class and each student will be required to connect the bell with the battery. It is hoped that some of the members of the class will then be eager to install electric bells in their homes. To round out these experiments and projects, a class discussion will follow.

Third week of Unit V.--Steam and gas engines.

Text-book assignment pages 523--541. Discussion of this assignment in class. The students will be required to make a simple drawing of a steam engine and give a short explanation of how it works. They will make a drawing from studying a diagram in the book, which is a good one and easily understood. Following this, a demonstration will be given by the instructor, showing the properties of steam.

The trip this week will be to a local garage where the students will see a gas engine that has been taken apart and one that has been assembled. They will have the principles explained to them and if possible, will see the engine working. Another opportunity that should not be over-looked while at the garage is that of seeing how a battery is charged. This will be of value to the students, as it is both useful and interesting knowledge. This week will close with a classroom discussion and a short written lesson covering the essentials in Unit V.

Unit VI--Light and Its Uses.

This unit will cover a period of two weeks dating from December 10 to 21.

First week of Unit VI.

Text-book assignment pages 365--394. Discussion of the assignment in class. Following the discussion, the class will have an experiment to show that light will travel only in a straight line through a uniform medium, bringing out the fact that light rays do not shine around an object. This experiment is performed by the use of several pieces of cardboard with a hole through the center of each one. They are put in line so the holes are opposite one another. A light placed at one end will shine through the holes and can be seen by placing a black screen at the end of the line of cardboards. Complete details of this can be found on page 254 in Wood and Carpenter--Our Environment--How We Use and Control It. Another experiment will be to show why objects differ in color. Several pieces of cloth of different colors are placed in a dark room where rays of light from a Bunsen burner will strike them. The burner is adjusted so it will not give off much light. A glass rod dipped in a solution of common salt is placed in the flame. The cloth will have different colors according to the kind of light it transmits or reflects. The directions for this experiment can be found in our text-book on page 376. These experiments will be written up by the students and put into their experiment books.

Second week of Unit VI.

Demonstration by teacher to show how a convex lense produces an inverted image. This demonstration can be found in the text-book on page 384. A good community project will be to have the students study the town lighting system and suggest

improvements in the number and placing of lights. Additional references for reading this week will be these:

G. H. Trafton--Science of Home and Community. Chapter IV.

Wood and Carpenter--Our Environment--How We Use and Control It.

Chapter 9. The rest of the week will be devoted to classroom discussion and reports from the Science Discovery Books. At this time the instructor will have each student give a report upon the progress made on the term paper and on the collections. If necessary the instructor will give a double period to helping students with the term paper. This can be very profitably done just before the Christmas vacation which starts at the time when we are finishing Unit VI.

Unit VII---Energy and Man's Control of Heat. This unit will take up a period of three weeks dating from January 7 to 25.

First week of Unit VII--Energy.

Text-book assignment--Chapter IV. Discussion of this assignment in class. References for reading and discussion are:

Pieper and Beauchamp--Every Day Problems in Science. pp. 39-42

"Radiant Energy" p. 237. "Electrical Energy", 370-371.

"Exploding Gas", "Transformation of Energy", pg. 402.

G. H. Trafton--Science of Home and Community. pg. 266.

"Energy." The various kinds of energy and the work performed will be the main trend of discussion. Simple experiments will be carried on to show how energy is created and transformed. It will be well for the students to name many processes and tell what kind of energy is found in each. Some of the time during this week will be spent helping the students with their term papers. An examination will be given on the week's work.

Second week of Unit VII.

Text-book assignment--chapter V. Classroom discussion and questions to guide. Demonstration to show the effect of heat upon liquids, gases and solids. Instructions for the demonstration can be found in Wood and Carpenter--Our Environment--How We Use and Control It. page 216. The students will be required to write this up and put it into their experiment books. The class will also visit the heating plant of the high school. The engineer will explain how it works and where the various pipes lead. The following reports will be assigned:

- Use of heat in the home
- Dangers and control of fire in the home
- Hot water system
- Report on the efficiency of the local
fire fighting system
- Early methods of heating
- Primitive methods of making fire

References for these reports are these:

Pieper and Beauchamp--Every Day Problems in Science, pgs. 226-224

Wood and Carpenter--Our Environment--How We Use and Control It.
chapter 8.

G. H. Trafton--Science of Home and Community, chapter 2.

Project for class--To make a survey of community to find out what different kinds of heating systems are used.

Third week of Unit VII.

Demonstration with fire extinguisher in putting out a fire.
The principles of the extinguisher will be explained and very

definite instruction given for using it and a demonstration showing how to refill it. The students will be required to draw the extinguisher, explain what chemicals go into it, what gas is formed when it is in use, and the amount of chemicals used in refilling it.

While studying Heat, each student should study the principles and construction of a thermos bottle, a fireless cooker and a cook stove. There will be class room discussion on the experiments, demonstrations, and drawings. The students will have reports from their Science Discovery Books.

Unit VIII----Work and Care of Our Bodies. This unit will cover a period of six weeks dating from January 28 to March 8. Health and the physical condition of the body is so important that it should be given more attention and time in the classroom than the other topics of this course.

First week. Personal Hygiene.

Text-book assignment--chapter 17. Classroom discussion will follow this assignment. The following chapters will be assigned for the study of the structure of the body:

J. W. Ritchie--Human Physiology. Chapters 4, 5, and 6.

G. W. Hunter--The Essentials of Biology. Chapter 23.

T. J. Moon--Biology for Beginners--Chapter 38.

The topics on the study of the skeleton and muscles will be studied and discussed quite thoroughly. The next topic to be studied is Man and Disease. The class will be asked to read chapter 2 in Health and Efficiency by J. D. McCarthy. Experiment with Bulgarian bacteria. Buy the bacteria at a drug store in compressed masses and grow some in milk. A drop of

the milk can then be stained with dye and viewed under a microscope. The bacteria will stand out clearly. This experiment can be found in the above mentioned book on page 20. Experiment to show the presence of bacteria on foods that have been exposed to the air. Cut a boiled potato in halves with a sterile knife, expose the cut portion to the air for thirty minutes and then seal it in a sterile jar. Colonies of bacteria will form in a few days. Stain some of the bacteria culture and examine it under a microscope. Talk by a doctor on disease germs, bacteria and vaccination.

Second week of Unit VIII. Personal Hygiene continued. Posture and exercise will be studied next. Demonstrations of good and bad posture will be given in class. A local army man will be asked to come and discuss the importance of good posture and exercise in the making of a good soldier. The class will then formulate a set of good health rules. An assignment on chapter 4 from Health and Efficiency by J. D. McCarthy, on air and breathing will be used as a basis for classroom discussion. The next topic studied will be food and diet. The assignment will be chapter V from J. D. McCarthy--Health and Efficiency. Menus should be made and discussed as to their value as well balanced meals and the calories which they contain. Experiments to detect the presence of starch and sugar in foods. Experiment to detect the presence of fats and proteins. Experiment to show that foods contain minerals. Directions for these experiments are found in Our Environment--How We Use and Control It, by Wood and Carpenter, pgs. 534-535.

Third week of Unit VIII--Personal Hygiene continued.

This week we will study digestion, circulation and hygiene of the alimentary canal. The following readings will be assigned to the class:

J. D. McCarthy--Health and Efficiency, chapter VII.

Wood and Carpenter--Our Environment, How We Use and Control It. pages 559-572.

J. W. Ritchie--Sanitation and Physiology, chapters 9 and 11.

Classroom discussion will follow this reading. Experiment to show the action of saliva upon starch. This experiment is carried on by testing saliva and starch separately with Fehling's solution, then combining some saliva and starch and testing it with Fehling's solution. Experiment to demonstrate the composition of the blood. Mount a drop of blood on a glass slide and examine under a microscope. This will show the red and the white corpuscles. Demonstration to show how blood circulates in a tadpole's tail. These experiments can be found in Our Environment--How We Use and Control It. by Wood and Carpenter, pages 560, 566, 569. The class will write up these experiments and put them into their experiment books. The next topic will be the care of the nose, mouth and throat. The assignment for this will be chapter 6 in Health and Efficiency, by J. D. McCarthy. At this time there will be a talk by the school nurse and one by the local dentist.

Fourth week of Unit VIII--Personal Hygiene continued.

We will study this week hygiene and first aid, and the use of clothing. Assignments will be chapter 8 in Health and Efficiency by J. D. McCarthy. Wood and Carpenter--Our Environment--How We

Use and Control It, pages 645--655.

Pieper and Beauchamp--Every Day Problems in Science, pages 171--180. This assignment will be followed by discussion and questions. The county health nurse will be asked to come for two or three days and give demonstrations on first aid. The students will write their observations in their experiment books. As a preliminary assignment for this they may read chapter 11 on first aid found in Health and Efficiency by J. D. McCarthy. An examination will be given on personal hygiene at the close of the week.

Fifth week of Unit VIII--School and Home Hygiene.

Assignment J. D. McCarthy, Health and Efficiency, chapters 12 and 13. Discussion. Experiment--A study in school hygiene. The instructions for this experiment will be found in Health and Efficiency, page 180. The students will write the results of this experiment in their experiment books. The public health officer will talk to the class on Home Hygiene. Classroom discussion will follow.

Sixth week of Unit VIII---Community Hygiene.

The first study in community hygiene will be food distribution. This will be taken up as a community project. The class will divide itself into three committees--water committee, milk committee and food committee. Each committee will investigate the local conditions with reference to its topic and report to the class. The water committee will collect information regarding the source of the water supply, the possibility of pollution,

means taken to purify the water or to prevent pollution, the means of distribution, cost, measurement of water used, and further steps needed to protect the water supply. A bacterial examination will be made of a sample of water from the town reservoir. The milk committee will visit the local dairies and collect information regarding sanitation, pasteurization, handling and cooling of milk, care of milk bottles and milk utensils. The food committee may investigate the care given to food in the stores, visit the meat markets where they may study the refrigerating plant, take a turn through the bakery and if possible, the restaurants. Classroom discussion and suggestions will follow these committee reports. The class should investigate the disposal of garbage from houses and make a report on the town sewage system.

Assignment on insect enemies of man--chapter 16, J. D. McCarthy, Health and Efficiency. Classroom discussion will follow. The class will investigate the community for possible breeding places for flies and mosquitoes. The study of community hygiene will be finished with a talk from the head of the local hospital concerning the prevention and isolation of contagious diseases.

Unit IX--Weather and Climate.

This unit will cover a period of two weeks dating from March 8 to March 22.

First week of Unit IX. Weather and Climate.

Assignment--text-book, chapter XI. Classroom discussion with questions as a guide. Experiment--How is the earth warmed by the sun? This is shown by using two test tubes,

one blackened in a candle flame. Fill each with clear water and record the temperature of the water. Put them in the sunlight and after a time record the temperature of the water again. Details of this experiment are found in Every Day Problems in Science, by Pieper and Beauchamp page 40. The class will write up the experiment and put it in their note books. Experiment--To show whether the rate of evaporation of water depends upon the temperature of the air. Directions for carrying on this experiment are found in Every Day Problems In Science on page 47. The results of this experiment will also be written up by the class. Weather bureau reports will be brought to class to be studied and read. Oral reports from the Science Discovery Books.

Second week of Unit IX.

Experiment--To show the formation of frost. Place a mixture of ice and salt in a beaker. Let it stand for a time in a warm room. Frost will form on the outside of the beaker. Reasons can be explained by instructor. A study of the thermometer and barometer. Reports to be assigned to different members of the class:

Benefits of the weather bureau

Winds and their causes

Why rainfall varies in different localities

References for these reports are these:

Pieper and Beauchamp--Every Day Problems in Science. pp. 36-69

G. H. Trafton--Science of Home and Community--pages 506-520.

Wood and Carpenter--Our Environment, How We Use and Control It.

pages 451--477. There will be a written lesson at the close of this week on Unit IX.

Unit X--Plant life and the cultivation of soils.

This unit will take a period of four weeks, dating from March 25 to April 26.

First week of Unit X--Plant life.

Text-book assignment, chapter 15. Classroom discussion guided by questions. The instructor will ask the students to bring to class several plants that can be used in experiments. The structure of the plant will be studied first. Experiment-- leaf, stem and root structure. This experiment is given in the text-book on page 357. A cross-section of a leaf is examined under a microscope to show cell layers. Experiment-- How moisture goes up the plant stem by osmosis. Make a hole in the center of a raw potato and fill it with a dense solution of sugar and water. Place potato in a vessel of clear water so that the water is lower than the level of the solution, in the potato. There will be a decided rise of the solution, showing the flow to be from the water toward the denser solution. A more complete discussion is found on page 332 of the text-book. The instructor will bring to class two kinds of stems and show the class the difference between monocotyledonous and dicotyledonous stems. This experiment will be written up and put in the experiment books. Classroom discussion on the experiments.

Second week of Unit X--Plant life (continued)

This week we shall take up plant processes.

Assignment for class--Wood and Carpenter--Our Environment

How We Use and Control It, pages 493--5000

E. N. Transeau--Science of Plant Life, chapter III.

Experiment on food manufacture in the leaf. Directions for this experiment will be found on page 493 in Our Environment How We Use and Control It, by Wood and Carpenter. Experiment to show that plants give off water through their leaves. Place a heavy cardboard around the stem of a potted plant covering the top of the flower pot to prevent moisture from coming up from the soil. Place a bell jar over all and let it stand over night. Drops of moisture will be seen on inside of jar next morning. This experiment is found in Our Environment, How We Use and Control It, on page 492. These experiments will be written up by the class and placed in their experiment books. The instructor will at this time find out how the students are progressing with Science Discovery Books, term papers and collections. Special note will be made of the different science magazines which have been read.

Third week of Unit X--Plant life (continued)

This week we shall take up plant pollination, leaf coloration, and algae. The students should bring flowers to class and study their structure. They will be asked to draw the flowers and label their parts and explain how pollination takes place until the seed develops. The assignment on pollination will be from G. W. Hunter--New Civic Biology, pages 34--41. Students will be encouraged to carry on experiments in pollination, with an assignment on leaf coloration from E. N. Transeau--Science of Plant Life, chapter 6. Along with classroom discussion the students may bring different colored leaves to class for study. Experiment--To show the presence of yellow and green pigments in a leaf. Make a chlorophyll

extract by placing plant leaves in warm alcohol. Dilute alcohol with a little water and add enough benzine to double the volume of the solution. Then shake thoroughly and allow to stand until the benzine has separated. The benzine will contain the chlorophyll, while the yellow pigments will remain in the alcohol. This experiment is found in Science of Plant Life on page 62. Next, the class will be asked to bring in samples of algae for study with the microscope. An assignment will be made from Science of Plant Life, by Transeau, chap. 18. Following the classroom discussion, a short written lesson will be given.

Fourth week of Unit X--Soils.

Text-book assignment, chapter XIII. Classroom discussion on this assignment. The first experiment will be the sprouting of seed in the soil. Ideas for this experiment are found in Science of Plant Life, by E. N. Transeau, on page 181. Experiment--To show the amounts of water absorbed by different soils. Experiment to demonstrate that there are substances in the soil that are soluble in water. Demonstration to show that dust mulch prevents the evaporation of water from the soil. Instructions for these experiments are found in Our Environment, Its Relation to Us, Carpenter and Wood on pages 88, 84 and 87. These experiments will be written up and added to the experiment books. The following reports will be assigned to the class and classroom discussion will follow each report:

The work of the earthworm.

Soil enemies of the farmers

Contrast the early and modern methods of
agriculture.

Methods of increasing crop production

Reclamation projects

References for these reports are these:

Wood and Carpenter--Our Environment, How We Use and Control It.
chapter 17.

Carpenter and Wood--Our Environment, Its Relation to Us,
chapter 7-8. A written examination will follow on Unit X.

Unit XI.--Insects. This topic will cover a period of
three weeks dating from April 29 to May 17.

Text-book assignment, chapter 16. Classroom discussion will
follow. The instructor believes that reports on the various
insects should come before the experiments are carried out.
The following reports will be assigned, which will take up
the study of such insects as the butterfly, the bee, the fly,
the grasshopper and others:

T. J. Moon--Biology for Beginners, chapters 23, 24, 25.

J. C. Peabody and A. C. Hunt--Biology and Human
Welfare, chapter 19.

T. D. A. Cockerell--Zoology--chapters 38, 39, 40, 42.

These reports on the insects will be studied during the entire
week.

Second and third weeks of Unit XI--Anatomy of Insects.
These two weeks will be devoted to experiments and microscop-
ic study of insect anatomy. Emphasis will be laid on insect
collections. In studying the butterfly, the class will follow
the laboratory directions given in Biology and Human Welfare,

by Peabody and Hunt, pages 366 and 367. This includes the study of the butterfly's anatomy, microscopic study of the butterfly's wings, antenna and legs, and a drawing showing the different parts studied. In much the same way, the grasshopper will be studied, following the directions from the above mentioned book on pages 378 and 379. Experiments and microscopic work will also be done on the fly, mosquito, and the honey-bee. These studies will be drawn and written up in the experiment books. The class will be required to make a list of beneficial and harmful insects and state the good or harmful effects of each. A field trip to a nearby ranch will be made to determine which insects are most commonly found and to what extent they affect the crops. A written lesson will be given at the close of Unit XI.

The review will take up a period of three weeks, dating from May 20 to June 7. The first week of this period will be devoted to the reading of some of the term papers, the inspection and study of collections of insects, leaves, rocks and wild-flowers. At this time there will be an inspection of the Science Discovery Books and a final correction of the experiment books. The next two weeks will be devoted to a review of the entire course, emphasizing the important points. In this review students will be given a number of important questions, involving text-book study, work from the experiment books and Science Discovery Books. Part of the examination week which will be from June 7 to 13, will also be devoted to this general review. The work this week will be easier because of the final examinations.

V.

Resume

In outlining a course of study for the Portola High School, the writer has first given the reader a short description of the community in order to acquaint him with the surroundings and give him some idea of the material at hand. This has been done by means of the various surveys made; these include the town, the school, the mountains, valleys and lakes which are in close proximity to the town. These surveys were then analyzed to show the possibilities of this community as a field for the study of General Science and to show also, the interest or lack of interest in the subject among the students. Numerous opportunities were found for projects, for interesting field trips, for first-hand observations of mechanical and power processes, and for abundant material for collections.

In preparing any course of study, there should be definite aims to guide one in selecting the subject matter and in presenting the topics to the class. In this paper, six clearly defined aims precede the course of study and are to be kept in mind throughout the year's work, as each one has an important place. In this way more real profit will be derived from the program.

The course of study, as presented has been divided into several units, each unit consisting of one topic, or several closely related topics which are so arranged that each may be studied in the month best suited to that particular subject.

The work of each unit is outlined by the week so that it may clearly be seen just how thoroughly the various topics are studied. The weekly outline also shows where the supplementary material in the books is to be found, gives the text-book assignment and states the nature of each field trip or project which is to be undertaken. All of the books mentioned in the course of study are in the Portola High School library and each year new books are being added to the General Science Department. The course is sufficiently elastic to be modified as new material, either in the community, or the library becomes available, and its chief value lies in its adaptation to the characteristics of the locality and to the seasonal variations in the environment.

Bibliography

I. Books intensively studied in the preparation of the course.

Caldwell, Otis William and Eikenberry, W. L.

Elements of General Science

Ginn and Company, Boston, 1924.

A text-book in General Science which is easily understood and well arranged.

Carpenter, Harry A. and Wood, George C.

Our Environment--Its Relation to Us.

Allyn and Bacon, San Francisco, 1928

This book is developed in accordance with the problem method.

Eikenberry, W. L. The Teaching of General Science.

University of Chicago Press, Chicago, 1923

This is a book for the teacher, and deals with aims, principles, and methods of instruction.

Pieper, Charles John and Beauchamp, Wilbur Lee,

Everyday Problems in Science

Scott, Foresman and Co., Chicago, 1925.

An excellent text book; topics arranged as a series of problems.

Snyder, William H. General Science.

Allyn and Bacon, San Francisco, 1925.

A well written text-book, now being used
in this high school.

Trafton, Gilbert H. Science of Home and Community.

Revised Edition

The Macmillan Co., New York, 1926.

A very practical book for the students' use.

Transeau, Edgar Nelson, Science of Plant Life.

World Book Company, Yonkers-on-Hudson, New York, 1924

Very interesting and accurate.

Twiss, George Ransom, Principles of Science Teaching.

The Macmillan Co., New York, 1923

An excellent book for a science instructor.

Wood, George C. and Carpenter, Harry A.

Our Environment--How We Use and Control It.

Allyn and Bacon, San Francisco, 1927.

An organized study of our environment for beginners
in science.

II. Other Authorities.

Blackwelder, Eliot, and Barrows, Harlan H.

Elements of Geology.

American Book Co., New York, 1911.

An elementary text in geology. Useful as a reference book in General Science.

Brownell, Herbert, Laboratory Lessons in General Science.

The Macmillan Co., New York, 1917

An aid in planning laboratory work.

Cockerell, T. D. A. Zoology.

World Book Company, Yonkers-on-Hudson, New York, 1921.

An excellent and interesting book on this subject.

Hunter, G. W. New Essentials of Biology.

American Book Co., New York (1926)

A very concrete study in the field of elementary biology.

Hunter, G. W. New Civic Biology

American Book Co., New York 1926.

A practical and useful book in studying community problems.

McCarthy, J. D. Health and Efficiency.

Henry Holt and Company, New York, 1922.

An excellent guide in studying practical hygiene.

Moon, Truman J. Biology for Beginners.

Revised Edition, Henry Holt and Co., New York 1928

A well-planned text-book for beginners.

Moseley, Edwin Lincoln, Trees, Stars and Birds.

World Book Co., Yonkers-on-Hudson

New York, 1925

This book is simple, well-written, and practical.

Peabody, J. E. and Hunt, A. E.

Biology and Human Welfare.

The Macmillan Co., New York, 1926

Shows the intimate relationship between biologic science and human welfare. Written in a manner easily understood by students.

Pieper, Charles J. and Beauchamp, Wilber Lee,

Teachers' Guidebook for Everyday Problems in Science.

Very good directions for the teacher's use.

Ritchie, John W. Human Physiology

World Book Co., Yonkers-on-Hudson, New York 1919.

Ritchie, John W. Sanitation and Physiology.

World Book Co., Yonkers-on-Hudson, New York, 1926.