DOCUMENT RESUME

ED 050 060 | SP 007 107

| | |
|---|---|
| AUTHOR | Starr, John W., 3rd., Ed. |
| TITLE | Basic Curriculum Guide--Science. Grades K-6. |
| INSTITUTION | Gary City Public School System, Ind. |
| PUB DATE | 68 |
| NOTE | 144p. |
| EDRS PRICE | EDRS Price MF-$0.65 HC-$6.58 |
| DESCRIPTORS | *Curriculum Guides, *Elementary School Science, *Elementary Science, Grade 1, Grade 2, Grade 3, Grade 4, Grade 5, Grade 6, Kindergarten, *Science Curriculum, *Science Education |

ABSTRACT

GRADES OR AGES: K-6. SUBJECT MATTER: Science. ORGANIZATION AND PHYSICAL APPEARANCE: The guide is in two parts--the background, philosophy, and instructional principles of science teaching, including a resource unit model, and the development by grade level of the various basic scientific concepts. The guide also includes information of audio-visual materials, children's book lists, and vocabulary lists. The guide is mimeographed and spiral bound with a soft cover. OBJECTIVES AND ACTIVITIES: The objectives of the program are described in considerable detail in chapter 2, and additional objectives are included in the program for each grade. Specific activities for each grade are not listed, but cross-references are provided to the American Book Company and the Macmillan Book Company Science Series. INSTRUCTIONAL MATERIALS: A list of apparatus and equipment is included, also bibliographies for children and teachers, and a film list. STUDENT ASSESSMENT: Evaluation is discussed in part 1, under the following headings: teacher observation and judgment, ratings of children's work, descriptive evaluations, informal teacher-made tests, essay questions, and objective questions. (MBM)

# BASIC CURRICULUM GUIDE - SCIENCE

GRADES K - 6





Dr. Clarence E. Swingley, Acting Superintendent of Schools
Dr. Haron J. Battle, Assistant Superintendent-Instruction
Dr. Norman R. Turchan, General Elementary Supervisor
Dr. William H. Watson, General Supervisor-Curriculum Development
Dr. John W. Starr, 3rd, Elementary Supervisor

SCHOOL CITY OF GARY
Gary, Indiana

1968

# ACKNOWLEDGMENTS

I wish to express appreciation to the members of the Elementary Science Materials Committee for their extra effort in the preparation of this publication. The publication is a composite of materials which have been developed previously, combined with new material. Much of the material presented in this publication is the result of their intensive work and effort.

| | |
|---|---|
| Pelham Chatman, Teacher | Brunswick School |
| Emmalynn Deal, Teacher | Washington School |
| Stella Hartley, Teacher | Aetna School |
| Elizabeth Jadoon, Teacher | Nobel School |
| Gerald Lind, Teacher | Melton School |
| Geneva Taylor, Teacher | Duncan School |

Final Preparation and Editorial Work

By

Dr. John W. Starr, 3rd

Dr. John W. Starr, 3rd
Elementary Supervisor

PREFACE

The teaching of science in the elementary school is a responsibility of major significance. Through our efforts pupils should be helped to gain an understanding of science in the development of our culture. Likewise, we should emphasize the development of the ability to write and recognize social uses of science in daily life. In developing the ability to understand their natural environment, the pupils must also have a complete understanding of the process involved.

There is a need to continuously improve teaching and learning in science. New materials of instruction, new teaching approaches, and the continuing responsibility to meet the individual needs of students place great demands on all professional staff members to appraise the quality of teaching and learning in science. This publication represents an effort on the part of staff members within our school system to assist all staff members in improving the teaching and learning in science. It is hoped that all staff members who use this publication will find it to be of value.

Norman R. Turchan
General Elementary Supervisor

TABLE OF CONTENTS

PART I - SCIENCE HANDBOOK

Chapter I - Introduction

The extensive interest in science education parallels the dynamic scientific accomplishments of the mid-twentieth century. An understanding of science is essential in today's world, not only because the impact of science is felt in every facet of life, but also because it is the means through which man strives to understand and control his environment.

The Basic Curriculum Guide for Science provides a foundation and framework upon which a teacher may establish an effective science program. Within this framework, a high degree of flexibility is provided to stimulate the imagination of the most creative teacher. Sufficient structure and detail are included in the guide to give support and assistance in meeting the diverse needs of all young people.

The K-6 science program is developmental and is based upon a firm framework of concepts rather than on isolated facts. The concepts which the student learns during the school year serve as a foundation for all future learning experiences. This total program is based upon experiences organized to provide a systematic approach to the spiral and continuing development of science concepts at an ever-deepening and widening level of understanding.

Science is an orderly interrelated arrangement of knowledge based upon critical observation and experimentation. The importance of science demands the study of efficient methods for transmitting the achievement of science to children together with some understanding of how these achievements were and are being attained. Recent research in this field of education indicates that children learn best by using methods of discovery, problem-solving and inquiry, followed by evaluation.

The process of science is a creative venture which no two scientists may perform in the same way. Science education in the Gary Public Schools is focused on the individual. The program is designed to stimulate his intellectual curiosity, to help him find out about his environment, and to challenge him to explore the unknown. Skills of problem-solving are developed through experiences and application of process of science. The developmental program in the foundation as preparation for understanding the world in which they live. The scientifically talented students may proceed in a program of greater depth to develop the skills and concepts necessary for advanced study.

## Statement of Purpose

The increasing emphasis on science makes a continous program from primary grades through the secondary school a very important part of the curriculum.

Man's concept of the universe is expanding so greatly and his understanding of scientific principles increasing so rapidly, that the science taught in earlier years may no longer be considered true. Truth does not change, but man's ideas concerning the truth do change. This concept of change is important for children to learn. The earth changes, living things change, and we change. These are scientific concepts that need to be developed as children grow. That scientists change their minds in the face of new evidence is one of the basic scientific attitudes you should teach.

There are many precise definitions of science. Among them are: that science is an accumulation of verified facts; that it is a closer approximation to the truth; and that it is a series of observations followed by experimentations. All of these definitions would indicate that science, whatever it is defined as, must be carried on by people, curious people who are actively engaged in a search for understanding of events or systems in their environments. Children, wide-eyed and curious, are actively engaged in this search for information.

This basic science guide and its resource booklet are a series of materials which have been written to help children in their search for understanding to guide them in their investigation of the world, and to lead them to organize and interpret the world. The child is the scientist. He tries to find the reasons for things he observes. He learns to try out his explanations to see if they work and he is involved in the process of discovery from the very activity in kindergarten. As he becomes more and more involved in the processes of observing, describing, categorizing, measuring, experimenting, inferring, and hypothesizing, he develops understanding of the big ideas in science.

Simply stated, elementary science is the study of the problems that are found wherever children live. More formally stated, it is a study of their natural environment. It is not pieces of chemistry, physics, biology, astronomy, and geology. Its contents come from these areas, but it is a study of problems that pop into curious children's minds as they live and grow from one day to the next, like: "What does a bell do when it rings?" "What makes the wind blow?" "How can a seed grow into a tree?" Anyone who has ever worked with elementary school boys and girls knows that most of them are full of questions like these and generally, they want to know the answers. The process of finding the answers is science.

Science does not have to be technical. The full explanation is not what the ten year old needs. He might not understand that. It is a foundation in the simplest terms of the how, the when, the where, and the what of the things that happen around them every day. This is his science. He does not need the technical terms, the formulas, and detailed explanations; those will come later, but, when he is ten years old, he needs to get satisfaction out of his tendency to be curious. He needs to have his interest nurtured, his curiosity broadened, and his enthusiasm encouraged. This is the kind of science which fits him and with which he is equipped to deal.

## The Plan Of This Guide

This publication represents the basic curriculum guide for the teaching of science in the elementary grade levels -- K through 6. It is divided into two parts. Part I deals with the background, philosophy, and instructional principles for teaching elementary school science. Part II teaches the development by grade level of the various basic scientific concepts. The Heath Science Series is the basic textbook series around which the guide is developed. The development of concepts are also cross-referenced with the American Book Company and Macmillan Book Company Science Series.

In additional publications the areas of Living Things, The Earth, Space Beyond the Earth, Matter and Energy, and the Human Body are developed in detail. Included, will be the basic concepts to be taught as noted in the basic curriculum guide with additional concepts added in each area to widen as well as deepen the understandings that the children may develop. Each concept will have suggested activities (experiments, demonstrations, constructions, etc.), described to help develop understandings. These activities are child-centered. Much other material for the teacher as well as the child will be given in each of these publications. This material includes: audio-visual materials, children's book lists, vocabulary list, and suggested evaluatory activities.

## Planning Your Science Program

There are two extreme approaches in planning the science program, the incidental and rigidly planned. Incidental planning capitalizes on the interest and questions of children and when used by exceptionally good teachers, results in the development of understandings and attitudes about the specific topics under consideration that might not be achieved in a more rigidly planned program. It also results in a science program in which little attention is given to a logical sequence of content and which usually involes an extreme amount of repetition of activities as children progress from grade to grade.

Teachers who are interested in helping children learn science support a planned science program which is flexible. This allows them to capitalize on the incidental interests and questions of children and to plan cooperatively the science program with children.

A planned program is essential. A teacher who teaches in a system that does not provide an instructional guide stated her point of view approximately as follows: "The public school system in which I teach does not have a planned science curriculum for the elementary school. Science is expected to be developed through incidental learning; so each teacher determines the kinds of science experiences to be emphasized in her room. A teacher has no idea of what has gone on before or what will follow. Therefore, there is a great deal of repetition and many areas of science are neglected."

It is felt that a broad outline and guides should be planned for each grade, but this does not mean that every sixth grade class in the system should have identical experiences, or that scope and sequence charts should be done in each grade. Teachers and pupils should plan their experiences together but within a broad framework that produces a common structure for all.

One of the common statements expressed about many school systems is that, "They have a good program -- on paper." The implication is that what is actually being done in the classrooms in the system may not be as good as the instructional guides indicate. Any preplanned program must be "on paper" and the assumption should be that it will enhance the chances of achieving the outcomes desired when it is implemented in classrooms by teachers working with children.

Some of the characteristics of a well-planned elementary school science program are:

1. It is a definitely planned part of the curriculum.

2. It is flexible enough to allow for cooperative planning and attention to incidental interests of children.

3. Content and activities are determined by definite objectives.

4. Each grade has the opportunity to engage in activities drawn from the broad areas of the natural sciences.

5. There is a logical sequence in the development of understanding in each of the broad areas of science.

6. Repetition of content is minimized and occurs only when necessary to improve learning.

7. Teaching units are outlined in enough detail to make adequate provision for individual differences and indicate teaching materials such as books and visual aids that are readily available.

# CHAPTER II - A PROBLEM APPROACH TO TEACHING

## Introduction

### Objectives of Teaching Science

This science instructional program has as its foundation five major areas of science: Living Things, The Earth, Space Beyond the Earth, Matter and Energy, and the Human Body. At each grade level, experiences are provided in the curriculum which enables students to develop important concepts about each of these areas. The reason for this is that children at each grade level have had experiences in all areas of science and would like to have additional ones. This is true of both boys and girls. The differences in the experiences at each grade level is determined by the maturity of the children and the concepts they have learned in the previous grades. The spiral plan provides an organization that enables the student each year to learn additional concepts that will help him better understand certain principles and generalizations in science. Simple concepts within a particular content area are learned in the early grades. These concepts contribute to the comprehension of larger concepts in the intermediate and upper grades. In many instances, more than one area is considered at the same time, showing the interrelationship of scientific knowledge. The basic philosophy behind our science curriculum is best stated as the answer to the question, "What is Science?" ---"It is the attempt by children to answer the questions they have about their natural and physical environment."

Acceptable principles of learning dictate that learning is a gradual process. Within the individual, thinking ability and problem solving ability take place over a period of many years. This science curriculum offers learning experiences which are designed to foster a proper scientific attitude and to develop the scientific method. There are three basic objectives underlying the elementary science program.

1. To develop an understanding of our natural environment.
2. To develop the skills of problem-solving.
3. To develop the habit of scientific thinking and to develop an appreciation of scientific contributions.

Primary K-3 | Intermediate 4-6

### To Develop an Understanding of Our Natural Environment

**Primary K-3:** Enabling the pupil to observe, predict, describe, and discover the natural occurrences persisting in his environment.

**Intermediate 4-6:** Enabling the pupil to discover, describe, and explain the cause and effect relationships in natural occurrences persisting around him.

To Develop the Skills of Problem-Solving

Enabling the pupil to practice processes involved in problem solving by using them in a variety of situations to become aware that an orderly system is always involved and to recognize that relationships exist between processes.

Enabling the pupil to compare and relate concepts and processes with other concepts or processes to formulate operations in solving problems.

To Develop the Habit of Scientific Thinking and
To Develop an Appreciation for Scientific Contributions

Enabling the pupil to recall or identify a concept or processes when met a second time and to understand that scientific thinking is based upon observable facts and the ability to use information previously compiled by others.

Enabling the pupil to understand that related information is applied to problems on the basis of his understanding of a concept or processes without prejudice or superstition and to recognize the interrelationship of science with all other human experiences.

Developing Science Concepts

Science has its place in the total school program because it is an accumulation of knowledge that has been acquired by a certain method, the scientific method. The body of knowledge called science is different from all other bodies of knowledge in that each fact can be supported by verifiable evidence. The evidence has been accumulated through the scientific world. If a child is to know about the world in which he lives, he must understand certain science concepts.

No one can refute the importance of subject matter in the field of science. This is the factual side of science, and it is important that the knowledge imparted in the classroom be correct and appropriate for the age level of the children. As the subject of science is developed in the classroom, pupils should retain certain basic ideas or concepts which they understand and find appropriate to further their scientific education.

It should be remembered that facts alone and of themselves are inadequate ends in the modern educative experience of children. The facts taught must be well organized, have continuity, and be of value to the child. The basic ideas and facts in science are necessary building blocks on which he can proceed to a more complex and detailed study of the subject. They are a part of the picture in science education and establish continuity for him. When the child is able to relate them to stimulating intellectual problems the value of factual knowledge is greatly increased.

## Using Science Concepts

Elementary school children can use science concepts to know the plants and animals in their communities and to explain the basic processes involved in the relationship of plants and animals to the rest of the environment. They can also use these concepts to explain their own bodies and how they function and why certain health practices are necessary.

Another group of concepts helps children explain the earth on which they live and the rest of the universe of which they are a part. Their curiosity at this level extends beyond their immediate environment. Still another group of concepts helps them to explain matter and energy in their environment and its uses and advantages to them.

## Developing and Using the Scientific Method

Abundant opportunity to use the scientific method is provided through the activities and experiments in books and the guides. They stress the stating of problems and the gathering of information. Most of the activities are designed so that the conclusions must be drawn from the evidence that the children gather.

## Developing Scientific Attitudes

Attitudes are developed through experiences and not through reading about them. The multitude of activities in the books and the guides stress the importance of basing conclusions on carefully recorded facts and not on opinions. This is the most important attitude for children to develop. A sense of failure may develop with some children whose experiments do not turn out as expected. This, too, is an important attitude of the scientist. The teacher must be cautious to exhibit this scientific attitude by showing no evidence of disappointment if experiments do not "turn out right." The teacher should accept the result as a challenge to learning and redesign and reorganize the planning to see if the desired results can be obtained. Science is always an adventure into the unknown.

It is not the function of science education to make scientists out of all children but teachers should strive to help children see situations in a scientific manner and combat superstition. The cause and effect relationship should be strengthened and reinforced by the teacher whenever possible. There is little doubt about the teacher's attitudes toward science being reflected in the attitudes of the children he teaches.

Other more specific attitudes should be fostered in the elementary school. The appreciation of science itself is actually an attitude toward science. When a child sees the importance of science in today's world and realizes that he uses science himself, this appreciation will surely develop. Seemingly in opposition to the above is the development of the attitude which reflects the realization that science has very definite limitations, i.e., that man's existence is not governed by scientific accomplishment alone. Since there is danger of science becoming a religion with some people, it is important that children learn how to function effectively within their scientific environment.

## Developing and Learning Science Skills

If children are to gain knowledge which will lead ultimately to independence in thinking and action, they need to develop and learn skills. Skills like attitudes, are developed through experiences. Many activities are provided throughout the guides. The teacher can utilize the activities to help develop skills. The following list of skills needs to be developed:

1. Skills in making observations.
2. Skills in making comparisons.
3. Skills in making relevant distinctions.
4. Skills in critical thinking.
5. Skills in experimentation.
6. Skills in investigation.

The child should be able to observe accurately. What he observed should be reported accurately and he should be able to use his findings himself and communicate them to others.

The child should be able to make valid and reliable comparisons. He should be able to see likenesses as well as differences. Making comparisons is critical in understanding both the biological and physical sciences. Applications of this skill open up a world of new experiences for the child and permit him to make firsthand investigations in science.

The child should be able to distinguish between pertinent and irrelevant data. Are the data relevant? Can they be used? How can you tell that this information will help solve the problem? Normally, a child can find a great deal of information in an experiment relative to a problem. When he is able to determine which data are usable then he has developed the skill of making relevant distinctions.

The child should be able to make intelligent use of the information already known to him. This means that the pupil should be able to think critically on a problem and come up with a relevant guess (hypothesis) as to the solution or meaning of the problem. The hypothesis is a familiar part of the experimental form of scientific method. It is not always important that the child be able to set up an experiment to find the right answer because this is often impossible. It is important, however, that children be able to use intelligent reasoning and the concepts at their command.

If experimentation is possible it is important that the child be able to formulate and carry out experimental procedures. Again, it is not the function of elementary school science to make research scientists out of all the pupils, but it is important that pupils have some idea of how to set up and conduct an experiment. There are many areas in science which are appropriate for experimentation in the elementary school. It is better for the pupil to work out a scientific problem than for him to be told the outcome in advance. A few examples of possible experimentation are:

1. Ways of decreasing friction.
2. Effect of light on growing plants.
3. Dietary needs of animals.
4. Advantages of levers.
5. Relationship of gravity to root growth.
6. Production of physical or chemical changes.

When experimentation is not possible or appropriate the pupil should have the ability to determine other suitable means of investigation. Can we study this first hand? How? Should we ask someone? Who? Can we read about it? Where? Children must be able to see that the scientists uses various means to collect information and that his ability to find the best method of investigation enables him to be an effective scientist.

There is a strong relationship between skills and the other objectives of science education. The use of these skills will result in the discovery of fundamental facts and concepts (knowledge) by the pupil. This method of finding basic science principles has much more meaning than the mere memorization of facts. Children will accept the challenge to discover for themselves. With guidance and direction, their discoveries can be accurate and stimulating. Given this opportunity their attitudes toward science should also develop in a healthy manner which, in itself, is a basic goal of science education.

## Developing Problem Solving Ability

Problem solving is a way of thinking and a method of teaching. Usually we do not follow the procedure for problem solving except when there is actually a need for it. All problems do not stimulate the same kind of attack, but all problem solving calls for a definite pattern of thinking, through a step-by-step approach.

1. The problem is recognized.
2. The problem is more exactly defined.
3. The search for evidence is made.
4. Results are discussed and evaluated.
5. A solution or conclusion is formulated.

The problem-solving method must be conditioned by the grade level at which it is used. The problem to be solved must always be suitable to the child's maturity and experience. The child must possess related information needed to solve the problem, or a knowledge of the methods for obtaining such information. Most important, the child must have interest in solving the problem.

Problems must be selected on the basis of the abilities of the children. When, as in elementary school, the child has a short attention span, and his knowledge and use of research materials is limited, the problems must be limited to those of simple nature which are easily solved. If he is successful in his first attempt at problem solving, the child will be encouraged to continue utilizing this method of thinking to solve more complex problems as he matures. In the elementary school his reading ability and experiences help a great deal in problem solving.

The problem-solving method is an excellent means to enrich a lecture or experiment; reading and written exercises can be woven into the solving of a problem. If the problem is of individual interest, the solution may involve only reading and written exercises. Conversely, if the problem is in the interest of the entire class, it may grow into an activity which incorporates many of the various teaching methods.

The role of the teacher in the development of the problem-solving attitude in the elementary school is significant. The teacher must guide scientific inquiry. The teacher can deliberately guide the learning situation so that problems will arise. In doing this, the teacher can gear the problem to the age and grade level of her particular children, and guide the children in the step-by-step development of the problem solving method. The teacher can aid in the following manner:

1. Help the children recognize the problem.
2. Aid in the exact definition of the problem.
3. Guide the search for evidence.
4. Help at relating the evidence to the problem.
5. Aid in evaluation of results.
6. Help in determining the solution or conclusion.

The teacher can stimulate the problem-solving process by providing the proper classroom environment. The environment includes not only the motivation by the teacher, but also the physical setting of the classroom. A work area for science, together with some simple equipment and reference books, and some time allotted for its use may encourage the student to go farther with problem solving. Most elementary science problems that require experimentation can be solved by using equipment and material that is readily available at home or in the neighborhood.

Problem solving is actually a part of everyday living. It is used in all teaching, yet unfamiliarity with science content may make some teachers hesitate to apply problem solving in this area. Science problems are so natural and interesting to children that their questions make it easy to develop the scientific method of solving problems. Problems may arise spontaneously or be initiated by the teacher. In teaching problem solving, the teacher must recognize suitable problems, know the steps in their solution, and be able to teach skills related to problem solving.

Many types of activities may be used in developing problem-solving ability. Knowledge gained through experiences is most satisfying and well learned. The activities used in the teaching of science in the elementary school involve the use of experiments and demonstrations, reading, discussion, field trips, resource persons, and audio-visual aids.

It should always be kept in mind that no single activity is superior to any other. Nor should one activity be constantly used in preference to others. A variety is desirable when teaching a science topic.

Some activities lend themselves better to a learning situation than do others. Often the availability of supplies and equipment, textbooks and references, or films and filmstrips will help determine the activity to be used. Also, the children like variety as well as a change of pace. Their attention span is not usually long. At the same time a variety of activities will provide different children with an opportunity to assume leadership roles while learning is in progress.

Experiments and demonstrations along with field trips are perhaps the most useful of the activities. Yet, all may become wasted time if not planned and directed to some purpose.

Experiments and Demonstrations

Actually the demonstration can be used in many ways, all of which should be employed. When properly planned and performed, the demonstration can accomplish almost everything that the experiment can. It can be used to illustrate a science understanding or concept. They can be used to help in solving problems and to help children think by having them apply what they have learned to new situations.

Nothing does more to begin a unit or daily lesson successfully than an experiment or demonstration that arouses the interest of the class and raises questions or problems.

Experiments and demonstrations are ideal activities for problem solving, which is basic to the teaching of elementary school science. Experiments and demonstrations are helpful in solving such problems as why eyeglasses fog in the winter when a person comes into the warm house from the cold outside, why airplanes fly, how plants get their food, and how heat travels. In the process of solving these problems the children are learning how to define the problem and the terms involved, to make accurate observations and to classify them, to formulate and test hypothesis, to understand the nature of controls and the value of numbers of experiments to ensure reliability and validity, and to draw conclusions.

In a sense this application serves as an evaluative device. If the children have really learned the desired science understandings, they should be able to apply what they have learned to a new situation.

The performance of experiments and demonstrations provides an excellent opportunity to help the slow learner. They help develop the ability to observe and report accurately. They help give the slow learner needed confidence in organizing data, in sensing problems and in solving these problems scientifically. They provide the satisfying status involved in ocassionally assisting the teacher and in having the opportunity to explain to the rest of the children the reasons or principles underlying the experiment or demonstration.

Experiments and demonstrations are also an excellent way to challenge the rapid learner. There are several ways in which this challenge can be accomplished. The rapid learner can repeat demonstrations done by the teacher to gain new insights. He can do additional experiments by himself with the consent and supervision of the teacher. He can assist the teacher in doing experiments and demonstrations.

Every experiment or demonstration should have a definite purpose, either as a planned, integral part of a daily lesson or as a learning situation that has arisen extemporaneously. Moreover, this purpose should be altogether clear, so that it is known and understood by all the children. In every experiment or demonstration the children should know just what they are looking for. Otherwise the results may be ineffective and meaningless.

Experiments and demonstrations should be planned carefully and exactly. The necessary materials should be collected in advance and be ready for assembling or distributing so that there will be no delay or break in continuity of the learning situation. Also, the experiment or demonstration should be tried out in advance, regardless of whether it is a simple or complicated procedure and whether the teacher is inexperienced or experienced. Nothing is as embarrassing as an experiment that does not work in class. Even though the instructions in the text or reference book are usually clear, sometimes there are slight ambiguities or tricky manipulations. By doing the experiment or demonstration in advance, the teacher can clear up these complications and revise or amplify the instructions so that successful performance will be assured.

The children can help in defining the purpose of the experiment or demonstration. Children can often state the purpose in a much more challenging way than the teacher. When this kind of statement is made, the experiment or demonstration now becomes much more meaningful to the children. In a sense, it has become their personal property and problem. Whenever possible, let the children do the experiment or demonstration themselves.

Children themselves can orginate experiments and demonstrations. Often an experiment or demonstration will raise further questions and problems that suggest or call for original investigation. Take advantage of the situation because it involves the children in all elements of the problem-solving process. It also has the added advantage of offering a challenge to children, especially the gifted.

Whenever possible, conduct the experiments and demonstrations in such a way as to arouse thinking and discussion. Do not tell the children the answer or have them read the answer in advance because, if you do, there is often no point in doing the experiment or demonstration.

Open-ended experiments lend themselves very well to thinking and discussion because children cannot anticipate the results before they do the experiment. Open-ended experiments excite the children's curiosity and stimulate the imagination; they respond instantly to the challenge of the question, "What will happen if..." Through thinking and discussion they can devise other ways and means of solving the problem, even devise equipment at times, make careful observations and notations, and check their conclusions to see if they are correct.

Use simple, familiar materials rather than complicated and specialized equipment. Complicated unfamiliar equipment will often distract the children's attention. They become much more interested in the way the equipment works rather than in results of the experiment or demonstration. In many cases the simpler and more familiar the materials, the more effective the experiment or demonstration.

The experiment or demonstration should be easily visible to all children. This is an aspect that many teachers forget or ignore. There is no reason to assume that, because the equipment is easily visible to the children in front of the room, all the other children can see it as well. In many cases it may be helpful to have the experiment or demonstration done in the middle of the room, so that all the children can gather around to watch it.

Experiments and demonstrations should do more than answer the immediate questions and problems. If there is to be any real value gained, the experiment or demonstration should also help answer questions about things that are happening in the children's daily environment.

Sometimes the understandings or concepts involved in an experiment or demonstration are quite complex or numerous, so that it is necessary to repeat the experiment if the learning is to be profitable to all children. Teachers and children, when doing a demonstration, often run through it quickly without giving the rest of the class an opportunity to grasp all the understandings and implications involved. They forget that what seem like simple ideas or relationships to them may be unfamiliar to the other children. Whenever this problem occurs it is advisable to repeat the demonstration.

The use of controls in experiments and demonstrations is one of the tools of the scientist. Children are able to understand very easily the need for, as well as the nature of, a control experiment. In an experiment using a control, all the conditions of the experiment are duplicated except one, and this single condition is the one being tested. For example, when studying the effect of heat upon the rate of evaporation, a control helps prove conclusively that heat makes liquids evaporate more quickly.

Field Trips

If properly conducted, a field trip may be an important aid in solving science problems. A trip must have a definite purpose in order to meet a need of learning something outside of the classroom.

The teacher should plan a trip in advance and if possible, visit the intended site herself before she takes the children. If the purpose of the excursion is to view birds, she should make sure the birds are in the area they plan to visit. Birds are elusive and cannot be tagged and made to stay in any one place. A nest that is being built or the work of a woodpecker will also be good. With a definite objective in mind, the teacher is sure to prevent disappointment and aimless looking.

A large group should be organized into small units with a leader for each. They may be working on the same problem or different problems. If unusual things are found, the whole group may be called together to see them.

It is very important in any science work to respect the discoveries and ideas of children. When they see or find things on a trip, the group should give as serious attention to them as to the teacher's contributions. This encourages children to observe, and it intensifies their interest.

Other experiences that will help children develop scientific ways of thinking and working are given throughout this set of guides. Ways of evaluating outcomes are also suggested.

With the opening of the Deep River Education Center, teachers should plan to use this facility in broadening and supplementing our present educational program of subject matter content and cultural experiences. Provision should be made to enrich student experiences by providing opportunities for learning in an outdoor laboratory atmosphere, and to develop an awareness of the importance of conserving our natural resources.

To supplement the subject matter areas and objectives of the classroom through direct experiences, the following science activities will be emphasized at the Deep River Education Center. This is by no means a complete list.

1. Making clue charts for identification of trees, flowers and birds.
2. Collecting and pressing leaves, and other plentiful plant specimens.
3. Collecting and mounting seeds and insects.
4. Felling a tree.
5. Studying leaves by means of blueprints, potato prints, spatter prints, crayon and clay.
6. Studying animal tracks and making clay molds of tracks.
7. Sketching.
8. Using microscope and hand lens for close up study.
9. Building shelters and feeding stations.
10. Observing animals and keeping field notes on habits.
11. Collecting bird nests and noting their construction.
12. Finding animal homes.
13. Taking adventure hikes.
14. Building a terrarium or aquarium.
15. Learning to recognize bird and animal sounds.
16. Making weather observations and predictions.
17. Studying erosion prevention and soil samples.
18. Collecting rocks, soils, and fossils.
19. Studying slope at different elevations.
20. Estimating time by shadow of sun.

21. Observing and sketching clouds.
22. Building weather instruments.
23. Conducting water and air experiments.

These are just a few of the many opportunities for learning that await the children at the Deep River Education Center.

## Evaluating Science Teaching

Evaluation is the "how well" of science teaching and learning. Earlier has been the discussion of the "why," "what," and "how" of science teaching. These three factors are the three components considered essential for the effective teaching and learning of science in the elementary school. The term "why" refers to the objectives of elementary science, the term "what" to the science content, and the term "how" to the methods of teaching science.

Evaluation then, refers to how well the teacher has achieved the objectives of the elementary science program, how well the children have learned the basic science information and developed desirable behaviors, and how well the teacher has used appropriate learning techniques in the classroom. It should be obvious, therefore, that evaluation is vital to teaching and learning, and must be an integral part of the science program in the elementary school if the program is to be effective.

In this section, some of the commonly used devices or techniques of evaluation such as teacher observation and judgment, ratings of children's work, descriptive evaluations, and informal teacher-made tests are discussed in terms of their adaptability of evaluating attainment of the specified objective.

Accurate evaluation is primarily important because of its effect on the teacher's and the children's performance and on improvement of curriculum. It is also important because of its value in promoting good public relations. An elementary school that can produce evidence to show that teaching science is actually helping children attain desirable objectives is likely to have whole-hearted parental support. This support can mean the difference between inadequate and adequate facilities and equipment for teaching science.

### Teacher Observation and Judgment

The most commonly used technique for determining children's growth is teacher observation of children's behavior. An elementary teacher who works with a group children approximately six hours a day for five days each week of the school year learns to know a great deal about each child and has many opportunities to observe all types of behavior. Teacher observation is the chief basis for determining children's growth in developing problem-solving skills, desirable attitudes, interest, and appreciations. It is also a basis for judging of knowledge and the development of understandings.

Teacher judgment is the least objective of all evaluation devices. Because it is the easiest to administer, it is often used to the exclusion of other more objective techniques. It is most effective in evaluation if teachers carefully clarify objectives in terms of desired changes in pupil behavior. This means that in making judgments concerning pupil's growth in the development of study and problem solving skills, it is necessary to list the specific skills desired in statements such as the following.

Uses textbook and supplementary books to find information.

Looks up topics in the index.

Uses the table of contents in locating appropriate chapters.

Uses aids such as glossary and illustrations.

Find supplementary books quickly.

Without such lists to help teachers make judgments concerning children's growth, there is considerable danger of seeking extremely biased judgments about different children. This bias may depend on factors which actually have little or nothing to do with growth in the attainment of the objectives which are supposedly being evaluated.

Ratings of Children's Work

If the activities carried on by the children who are working on a science unit result in the production of tangible products, these products can be judged by teachers. Examples of a few common products are: notebooks, collections of various kinds, and models which children construct. In rating the children who produce these materials, it is assumed that the quality of the product indicates the degree of attainment of the objectives or objective toward which the children are working. Although this relationship may not exist, it is a common and desirable practice to include such ratings in evaluating elementary school science.

In many instances the fallacy of the rating of an individual child's work may be discovered as a result of using some other evaluative device. For example, an intermediate grade child may construct an excellent working model of an electric motor. The teacher may discover that the same child has a limited understanding of how the different parts function on causing the motor to run. Since, in this case, the reason for assembling the motor is obviously to help the child learn more about the basic principles of its operation, a rating based only on the product is misleading.

In this form of evaluation the objective being evaluated must be clearly understood by both the child and the teacher.

Descriptive Evaluations

Good descriptive evaluations depend upon the same clarification of objectives that were described in the preceding section. The basic difference lies in the fact that the description must be of specific situations in which a child does or does not listen courteously to the opinion of others, shows interest in the contributions of his classmates, asks other children for their opinions or is courteous in an argument.

## Informal Teacher-Made Tests

Teacher-made tests can be one of the most efficient devices for evaluating children's growth in acquiring and developing ability to use science subject matter. Teacher-made tests over the subject matter included in science units are particularly desirable because there is reasonable assurance of validity. This is true because no one knows more about the subject matter included in the unit, and the amount of emphasis or the proportion of time spent on various materials, than the teacher who works through the unit with the children. The teacher is in the best position to construct a test which measures what the children have had an opportunity to learn. Both essay and objective type tests may be used in evaluating growth in science. However, because of the nature of science subject matter, objective tests are more commonly used than essay.

Essay Questions: The chief reason that essay questions are used in evaluating growth in science is that they do measure how well children can organize and present what they have learned. The ability to analyze a problem or to reach conclusions on the basis of data can be determined more effectively by using essay questions because the writing children do gives a clearer picture of their thought processes than can be obtained on the basis of their answers on an objective tests. Younger children cannot be expected to write lengthy, well organized answers to questions, but they can write answers to questions such as the following: "What are some of the things most green plants need in order to grow?" "What did we do to show that each of these things are needed?" Such a question gives a clear indication of the type of information desired. Older children can write answers to essay type questions such as, "What characteristics of the roots, leaves, and seeds of dandelions help them to compete sucessfully with the grass in a lawn?" --which requires a higher degree of ability to organize the information included in the answer.

The major criticism of essay tests is that they cannot be scored accurately. Studies have shown that teachers vary a great deal in marking of pupils' answers to the same questions. It has also been demonstrated that this variation can be reduced by more careful attention to the wording of essay questions so that the essential parts of an acceptable answer are easy to identify. This is illustrated in the preceding question concerning dandelion plants. The essential parts of an acceptable answer are identified by specifying roots, leaves, and seeds. This makes it easier for children to answer and for a teacher to compare answers than it would be if the questions were, "What adaptions enable a dandelion to compete successfully with the grass in a lawn?" The chief reason why essay questions are used in evaluating growth in science is that they measure how well pupils can organize and present what they have learned. For these purposes the essay test is the preferable form. On the other hand, if a teacher's purpose is to determine what knowledge a pupil has in a given subject other testing techniques are more efficient.

Objective Questions: Short answer objective tests are preferred by most teachers because they can be scored accurately and they make broad sampling possible. There are many kinds of objective questions including alternative-response, short answer, completion, matching and multiple choice.

The following paragraphs include some specific suggestions for constructing several different types of objective questions. Wherever sample questions appear, they are written in a form that is recommended for similar items in teacher-made tests.

Alternative-Response: Each true-false statement included in a test should be all right or all wrong. Children resent missing a test item because a qualifying clause changes what otherwise seems to be the correct answer. An example of such a poor item is:

T or F A grasshopper is an insect which has biting mouth parts and feeds on nectar.

This item is improved by changing it to read:

T or F A grasshopper is an insect which has biting mouth parts and feeds on plant leaves.

This change makes the entire statement true. It can also be improved by writing three items instead of one.

T or F Grasshoppers are insects.

T or F Grasshoppers have biting mouth parts.

T or F Grasshoppers feed on nectar.

The examples used illustrate the recommended form for true-false items. Asking pupils to place a circle around with the T or F to indicate their choice is preferable to having them write the letters because there can be no question concerning the letter intended. The proportion of true and false statements in a unit test should be approximately the same so that pupils will not become concerned about a "pattern" of answers.

Some tests authorities recommend scoring true-false tests by subtracting the number wrong from the number right and ignoring the omitted items. This recommendation is made because pupils have a fifty-fifty chance of responding correctly even though they may not know the correct answer. Studies on testing have shown that rank of pupils in a group is essentially the same when the test scores are based on the number correct as it is when the scores are "corrected for guessing." Since almost all pupils prefer the scores be based on number correct there is no justification for using a correction formula.

Short Answer: Short-answer items should always be written as direct questions. They require pupils to recall correct answers rather than to simply recognize them as correct. They are especially useful in elementary science test because of the highly factual of the subject matter in science units. The following examples are representative well-written short answer questions. Notice that the blanks in which pupils are to write their answers are lined up along the right hand side of the page. This makes the use of a scoring key much easier than it is when answers are scattered all over a page.

1. What is the process by which green plants manufacture food? 1.________________

2. What gas from the air do green plants use in manufacturing food? 2.________________

3. What gas do green plants produce as a by-product in the process of manufacturing food? 3.________________

4. In what part or parts of green plants is most of the food manufactured? 4.________________

Completion: Most questions such as the above may also be written in the form of completion questions. These are statements in which certain important words are omitted and pupils are expected to fill in the missing words. Both short-answer and completion tests tend to become vocabulary tests and their exclusive use is likely to result in a test that lacks validity. However, since all science units do include specialized words, a good unit test needs to include a section that measures how well pupils have learned them. It is easy for a teacher who is writing completion test items to fall into the bad habit of using sentences from the science textbook exactly as they are written. This encourages pupils to depend on rote learning rather than understanding and can be avoided by rewriting the statements suggested by the text.

In the following examples of completion items the blanks in which pupils are to write their answers are placed on the right side of the page to facilitate scoring. This arrangement also provides blanks of equal length and reduces pupil concern over words of proper length for a given blank. The second item illustrates good numbering procedure for statements that omit more than one word. The rule illustrated is simply one point for each correct answer which in this case eliminates the possibility of dealing with fractions rather than whole numbers. Definite articles such as "a" or "an" should not precede a blank because they decrease the range of a choice of words by providing a grammatical clue to the correct response. Children often use words in the blanks of completion items that are correct but are not those that were expected. Consequently, completion tests must be scored carefully to avoid penalizing a child who has a correct but unexpected answer. Such mistakes are most often made becuase of using a scoring key, that provides only one correct answer, rather than reading each of the completion items on the pupil's test paper.

| | | |
|---|---|---|
| 1. | The process by which green plants manufacture food is called __?__ | 1.__________ |
| 2-3. | Green plants use __?__ from the air and __?__ from the soil in the process of manufacturing food. | 2.__________ <br> 3.__________ |
| 4. | The __?__ furnishes the energy necessary for green plants to manufacture food. | 4.__________ |

Matching: Matching test items are made up with words or phrases in one column with explanatory phrases that match these words or phrases in a second column. The following example illustrated a form that may be used in the primary grades. The pupils are expected to associate words in the two columns and to show associations by drawing lines as indicated.

| | | |
|---|---|---|
| 1. | Duck | Hair |
| 2. | Woodchuck | Feathers |
| 3. | Snake | Smooth Skin |
| 4. | Frog | Scales |

The form of this matching exercise may be varied by using diagrams in the right hand column and using arrows to show the associations between words and the drawings.

Another form of the matching item differs from the above in that children are asked to place the number of the correct word or phrases in the left column on the right. The following example also demonstrates the uses of unbalanced columns so that the last word of phrases in the left column cannot be matched simply by the process of elimination. Both examples illustrate the desirable practice of keeping all the words or phrases in the column on the left in the same category. If unrelated words are used it is much easier for a pupil to eliminate some of the phrases in the column on the basis of common sense.

| | | |
|---|---|---|
| 1. | Gully erosion | ____A layer of small rocks |
| 2. | Subsoil | ____Soil is removed in layers. |
| 3. | Humus | ____Rain water runs over the surface of soil |
| 4. | Topsoil | ____Ditches form in the soil |
| 5. | Sheet erosion | ____Material immediately below the topsoil |
| | | ____Fertile part of the soil |

Matching items using diagrams in addition to the two columns are very useful in determining how well children are able to identify the part of organisms or equipment used in teaching science.

Multiple Choice: A multiple choice item consists of a direct question with four or five completions. The following examples illustrate these two forms.

_____1. What is the chief value of the root hairs on plant roots?

a. They protect other cells from being crushed.
b. They help anchor the plant more firmly.
c. They protect surface cells from water loss.
d. They increase the surface through which water enters.
e. They are the growing points of young roots.

_____2. Root hairs are of greatest value to a plant because they

a. Protect other cells from being crushed.
b. Help anchor a plant more firmly.
c. Protect surface cells from water loss.
d. Increase the surface through which water enters.
e. Are the growing points of young roots.

Using an incomplete statement, as is illustrated in the above mentioned item, usually makes it possible to shorten each of the responses by one or more words. This is the only advantage over using a direct question and it does tend to make the item a series of true-false-statements. In writing multiple choice items it is acceptable to change from one form to the other in the same section of a test.

All of the responses used in multiple choice items should be reasonably plausible. If no pupil in a group selects a response, it has no value in the test. In the question about root hairs, four of the responses are incorrect but are written so that they may appear to be correct to a pupil who has not learned the function of the root hairs. The problem teachers face in writing plausible responses is deciding on the degree of plausibility. If all responses are very nearly correct all pupils may miss the item and if only one response is at all plausible all pupils answer the item correctly. In either case the item does not help to measure various levels of learning by individuals in the group being tested. It is a common practice to use incorrect responses that are suggested by errors commonly made by pupils as one means of increasing the number of plausible responses.

Multiple choice items make the best objective test for measuring children's ability to reason and to demonstrate understanding. Problem situations such as the one in the second example which follows are of greater value in discriminating between pupils who have good and poor understanding than items that simply test for retention of isolated facts as is illustrated in the following example.

_____1. Magnets will attract

a. Paper.
b. Iron.

c. Brass.
d. Rubber.
e. Glass.

_____2. Steve made a compass by pushing a magnetized needle through the small end of a cork and placing the large end of a cork on water in a galvanized bucket. The cork and needle would not stay away from the edge of the bucket, and swing freely into a north-south position as a magnet should, because the

a. Needle was larger on one end than the other.
b. Water was not deep enough.
c. Cork floated too high on the water.
d. Magnetized needle exerted a pull on the galvanized bucket.
e. Needle was not properly magnetized.

## CHAPTER III - THE RESOURCE UNIT

Construction of a unit entails careful planning and preparation by the teacher. When units bog down or collapse, the failure is generally because of a lack of adequate planning and preparation. A very hastily prepared or poorly constructed unit will create "dead spots" in a learning situation, which cannot ordinarily be remedied by the teacher's ingenuity or ability to think quickly.

Before suggesting one of the many outlines that can be used to plan and construct resource units, it may be helpful to point out certain pitfalls that the teacher should avoid. First, teachers who begin constructing their units by selecting the learning activities first, without considering exactly what basic science information is involved, almost invariably encounter difficulties. Not only do they find themselves without a logical sequence of learning, but also they are likely to be embarrassed during the unit when they discover that they cannot explain science principles associated with the activity. It seems the more logical way of beginning would be first to select the basic science information to be learned, and then to look for the best possible learning activities that will result in the learning of this information and in the process develop desirable behaviors.

Another pitfall to be avoided, is concerned with the use or development of resource units. Resource units as we will see consist of a collection of learning activities, materials, bibliography, and evaluative materials, which the teacher may use or organize into a specific unit. The activities contained are more than are needed for any "one" learning situation. At no time does the resource unit imply that all activities are to be used. The idea is to have enough activities available so that the teachers can select the activity or activities that are most suitable for her particular class.

The following outlines for a resource unit is an example of only one of many outlines that can be used. And because it is only one example, teachers need not feel obligated to use this kind, or even follow it exactly. There are others available that achieve the same purpose and objectives. This outline serves as a guide, and illustrates the main points of which to be aware when constructing resource units. An actual illustration of a resource unit that can be prepared according to this outline is given in the later portion of this chapter.

### Organizing Resource Teaching Units

An important step in the improvement or development of a science program is the preparation of resource teaching units for each area taught. These resource units differ from a teaching unit in that they include materials, activities and resources suitable for different age children and are far more comprehensive than a typical teaching unit. It should be possible to get much help needed to pre-plan a unit for any given group of children from these resource units. Many sources of information and ideas are used in this process.

A resource unit as the phrase is used here, is an organization of science subject matter, activities and resources. It is designed to help a teacher working with a group of children in developing understandings, skills, attitudes and appreciations. This definition is acceptable to those who believe in a planned science program rather than a program of broad units of work that may include some science.

## The Unit Title

The exact wording of a title is more important to a teacher who has had little experience in developing units than it is to one who has had experience. This is true because a unit title may help to indicate the emphasis in the development of the unit. A teacher attempting to develop a unit on "Animals" could plan more rapidly and with confidence if the title gave more indication of the emphasis considered desirable. Simply by changing it to "The Different Kinds of Animals," indicates that the emphasis is on helping children understand some of the important characteristics of the common groups of animals. Stating the title in question form often helps to indicate the emphasis.

## Introduction to the Unit

The introduction is a brief statement about the nature of the unit and what it includes. Teachers often omit this section because they are working with a given group of children and the title and objectives indicate the place of the unit in the science program.

## Unit Objectives

The advantages of using objectives as guides to the selection of science content and activities are many. If they are guides the unit objectives must have an obvious relationship to them. In order to show this relationship it is common practice to list unit objectives under headings such as understandings and concepts, appreciations and attitudes, and abilities and skills. They are an extremely important part of a resource unit because they provide the direction that is needed in determining the amount and kinds of subject matter and activities to be included. For example: A unit on the composition of matter that has as one of its objectives, the development of an understanding of chemical changes in our daily lives, must include some content and suggestions for activities that give reasonable assurance that the understanding may be developed. A fairly accurate method of making a final check on the care with which a unit has been developed is to examine the sections on subject matter and activities to see if appropriate consideration has been given to each of the objectives listed.

## Initiatory Activities

Teachers know that it is impossible to help anyone learn anything that he has no interest in learning. Consequently, the activities which are used to introduce a unit are more important than anything which has preceded or follows in determining the enthusiasm with which a group of children will work together in developing a unit. The best types of initiatory activities are those which have their origin in the on-going activities of children in and out of the school. They may grow out of questions raised by children, discussions, or events which occur in the community.

Many of the commonly used initiatory activities are not the result of on-going activities but are developed by the teacher. This is, in part the result of pre-planning units which must be done without the benefit of a group of children. For example, it is common practice to arrange an attractive and interesting exhibit on the bulletin board or on a table in an area that may be reserved for such exhibits. After a period of a few days during which the children have observed the display and asked questions about specific items, the teacher may actually proceed with the organization of children's suggestions for further study so that they are almost identical with those that she had included in her pre-planned unit.

Other types of initiatory activities include showing an appropriate film or filmstrip, reading interesting material from a book, inviting a guest speaker or taking a field trip. Whatever the type, the primary purpose is motivation and these activities should be judged almost entirely on the basis of how well they serve the purpose.

## Developmental Activities

If the interest and enthusiasm of a group of children is adequately developed as a result of the initiatory activities it is important to have available a rather extensive list of suggestions for further activities. In the instructional areas included in this set of publications, the appropriate concepts are stated, followed by a list of suggested activities that help develop understanding of the concept. The same practice is recommended in preparing teaching units because there is greater assurance that both the subject matter and the activities necessary to achieve the objectives of the unit will be included. This is especially important in planning science units because of the need for and importance of adequate subject matter.

Since all suggestions for activities involve doing something, they should begin with verbs such as read, observe, tell, listen, write, construct, perform, make, memorize, or draw. In each case they should tell as precisely as possible what should be done. If the suggestion begins with read it should indicate the pages, author, and title of a book to be read that is available to the group of children with whom the unit is to be developed. The exact nature of the kind, variety, and number of activities included should be influenced by the abilities and interests of a given group of children. It is important to remember that there will be no learning unless pupils do something. Since both abilities and interest vary in any group it is the teacher's responsibility to consider these variations when planning activities.

## Culminating Activities

In any pre-planned unit the culminating activities naturally follow those activities which have been suggested to achieve the objective of the unit. They are intended to terminate the unit in a way that emphasizes important understandings, attitudes or abilities that have been developed. They often consist of programs given before parent audiences or other groups of children. They may consist of a series of individual pupil reports, informal group discussion, a dramatization, one or more exhibits, or a series of demonstrations. Regardless of the type chosen, their real purpose is to help children identify and emphasize the most important aspects of the unit.

Vocabulary

All subject matter areas have a vocabulary unique to the area. Children are continually being expected to develop an understanding of and an ability to use words that are not included in any word list for their grade level. This is especially true in the natural sciences and all elementary school science units should include a list of the specialized words that children should be able to use with facility and understanding as the unit progresses. Selection of the words for these lists requires some discrimination on the part of the person developing the specialized vocabulary. One extreme is to avoid the use of all technical words and the other is to include as many as possible. In order to discriminate one must know when a given word is essential and when an easier substitute is adequate. For example: evaporation and condensation are two words which are commonly used by first grade children in ways that demonstrate that they really understand their meaning. Obviously teachers who have developed units in which changes in the physical state of water have been demonstrated and discussed have found no adequate substitutes for the words and consequently include them and help their pupils understand their meaning. In contrast, the word petiole rarely is heard in an elementary school classroom. It seems logical to conclude that teachers and pupils who might have had occasion to use the word have sensibly substituted the phrase "leaf stalk," and at least postponed the necessity for learning another technical word.

The real function of a sub-division on vocabulary in a science teaching unit is to encourage a teacher to make decisions about essential and non-essential words and to insure enough attention to the words in connection with various types of activities so that pupils will have an opportunity to learn to use them correctly.

Correlation with Other Content Areas

Science and other subject matter areas are important in the elementary school curriculum, in part because of their contribution to the teaching and learning of skills. The possibilities and necessity for correlating language arts and science are very obvious but even these may be neglected unless they are considered in the preparation of a teaching unit outline. The following suggestions for correlating science and other areas in the elementary school curriculum are not intended to encourage activities just for the sake of correlation. They are included to suggest ideas for correlation that make a real contribution to learning.

Language Arts: The recommended emphasis in science on developing ability to use the scientific method in problem solving and the accompanying emphasis on developing critical-mindedness requires that children learn to express themselves accurately and precisely. The nature of the content and activities of science provides many opportunities for both oral and written expression.

Learning new words further increases a child's ability to speak and write precisely. Some specific suggestions for correlating oral and written expression with science are:

Reading reference books.

Planning weekly programs.
Taking field notes.
Keeping a new vocabulary list.
Reporting on special experiences to entire class.
Listening to directions and identifying sounds.
Having evaluation sessions.
Writing poems and creative stories.
Labeling and identifying specimens.
Having demonstrations.

The chief problem that confronts teachers is providing a variety of good science reading materials on various levels of vocabulary and content difficulty which children can use to supplement their science activities. For this reason each booklet in this set of publications includes a list of supplementary science books for children. If appropriate books are available, children will use them for reasons such as:

Finding additional information.
Answering a question.
Solving a problem.
Preparing oral reports.
Checking conclusions.
Getting directions for performing an experiment.

Social Studies: New discoveries in science are creating social problems while others are solving problems. The mass production of consumer goods and the introduction of more and more machines to reduce the need for human labor are continually affecting the way in which people live. Communication and transportation have developed to the point that people of all countries are drawn very close together. Medical discoveries have lengthened the life span of individuals and increased the social problem of caring for old people. Atomic science has developed to the point that many people believe our civilization may be destroyed unless all people on earth learn to get along.

It is for these and many other reasons that social studies and science frequently compete with each other for time in the school day. Although the most urgent problems facing us today are of a social nature, we seem to be in a position where we cannot afford to lose sight of the importance of new developments in science and the additional social problems created by them.

There are many possibilities for correlation between science and social studies such as the following:

Showing that the beginnings of science and astronomy go back to the ancient civilization.

Showing that science has helped through the discovery of fossils and other natural records to add to the information about ancient civilization.

Finding out what men knew about electricity and magnetism 2000 years ago.

Tracing the development of the methods of measuring time from early days to the present.

Studying the history of artificial lighting from the early cave men to present time.

Studying the life of men like Alexander Graham Bell and their contribution to science.

Studying the importance of transportation and its development.

Comparing the activities in a beehive with a large metropolis.

Discussing how the earth's movements affect different peoples.

Studying the history and geography of the Deep River Education Center area.

Finding the source of Deep River, where it flows, and in what direction it flows.

Tracing the history of the Indian tribes located in the area.

Constructing maps and models of the area.

Making craft projects from native materials.

Mathematics: At the elementary school level, science may contribute more to mathematics than mathematics does to science because most of the science taught in elementary schools does not require a high level of ability in mathematics. Science also functions in the motivation of mathematical skills as it does in reading. A boy who wished to perform an experiment may discover that he needs to weigh, measure, add, subtract, multiply or handle fractions before he can proceed. He may change his attitude toward the drill necessary to help him learn the mathematical skills because he feels the need for the skills.

A few examples that indicate how mathematics may be utilized in the development of science activities are:

Estimating distances and time.
Measuring areas of land.
Measuring circumference of trees.
Planning time schedules.
Making scale drawings.
Finding wind velocity.
Finding height of trees.
Estimating speed of river.
Finding geometric shapes in nature.
Averaging barometer and temperature reading.
Measuring the per cent of slope.
Pacing distance in hiking.
Going compass hiking.

Arts and Crafts: Some teachers beleive that there is a limited number of art activities that can be profitably correlated with science while others believe that there are many. The latter group believes that a child who makes leaf prints using crayons and a warm iron may become interested in the identification, range and economic importance of the trees from which the leaves came. In the same way, they believe that making a frieze showing the types of fish in a locality may develop an interest in the characteristics and life habits of fish.

Some of the types of activities that seem desirable either because of their value in helping children acquire information or in developing interest are to:

Sketch and draw various scenes.

Use native material (clay, grasses, weeds, berries) for pottery, floral arrangements, mats, pictures, etc.

Notice designs found in nature.

Conduct photography studies.

Make plaster casts.

Make leaf printing.

Draw maps and scale drawings.

Draw cloud and tree shapes and other formations.

Sketch leaves, flowers, trees, tracks, etc., for identification purposes.

## Evaluation

Since evaluation is a process that goes on continually as a teacher works with children in a classroom, it is impossible to complete this section of a teaching unit during the preplanning period. Many of the outcomes desired involve understanding or attitudes and appreciations; and evaluation must depend on observation of pupil behavior in different situations. Evaluation may also involve the measurement of knowledge and understandings. Indicate here the type of evaluative devices that may be use.

## Bibliography

This subdivision of a unit may be divided into a list of books intended primarily for teacher use and another list for children to read. There is no value in copying a long list of books for a teaching unit unless the books are available to the teacher and a given group of children who are developing the unit. Since books are very important aids in helping teachers and children develop a unit, the bibliography should list all books specifically referred to in the outline of activities for the unit as well as others which contain useful supplementary material.

Visual Aids

Teaching units should include lists of available visual aids such as pictures, charts, slides, film strips, films, and models. The resource unit in this publication includes some specific examples of visual aids but these are of no value in the preparation of a teaching unit unless they are owned by the school system or are readily avaliable through other agencies.

## Resource Unit Model

It is often said that "a picture is worth a thousand words." This saying is particularly true for resource unit construction. No matter how precise and explicit a set of instructions may be, nothing helps as much as a representative model of a resource unit to clarify the directions and to illustrate the techniques involved in resource unit construction.

It is not necessary to follow the format of this sample unit rigidly; the unit can be modified to suit the individual preferences and needs of the teacher. However, the basic rationale for setting up this kind of unit should not be overly distorted.

Title: Composition of Matter

Initiatory Activities

Have the children:

1. Read the life stories of some of the great scientists and discuss their contribution to our way of living.

2. Bring some objects to class such as a piece of iron or some other objects and discuss their characteristics.

3. Make an exhibit of pictures showing the importance of chemical change. These might show the making of pottery, glass, cement, or paper.

4. Bring newspaper or magazine clippings of stories of newly developed materials.

5. Examine the appearance, feel, smell, and taste of selected forms of matter.

Developmental Activities

Concept: Water occupies space and has weight.

1. Weigh a jar containing air, then water, then sand. Note the differences in weights.

2. Pour water into a jar that has a two-hole stopper. Stop up one hole and note the result when water is poured into the second hole.

Concept: Materials are made up of elements, compounds, or mixtures of elements and/or compounds.

1. Collect samples of several elements and learn their characteristics.

2. Mix 5.6 grams of iron powder with 7 grams of sulfur. Place this mixture in a test tube. Heat the test tube until the tube glows. Cool the test tube. Break the tube, examine the product, test the new product with a magnet.

Concept: Every kind of material has it own characteristics.

1. Discuss the techniques of looking, feeling, smelling, tasting, and other tests that are used to learn the characteristics of each kind of material.

2. Hold a rubber band; stretch it; feel it; look at it. What are the observable characteristics. Examine various materials to determine their characteristics. Develop a chart showing the characteristics of the materials.

3. Discuss why aluminum is used in the production of airplanes and cooking utensils.

Concept: Materials may dissolve in liquids to make solutions.

1. Place some copper sulfate crystals in a test tube. Put some more copper sulfate crystals in another test tube. Now place some copper sulfate powder in a test tube. Compare the speed by which the copper sulfate dissolves with and without agitation.

2. Try to make a solution of castor oil and water.

Concept: Materials may be changed in form from a solid to a liquid or to a gas.

1. Discuss the way water may change to ice or steam.

2. Demonstrate how paraffin changes from a solid to a liquid.

3. Hold a cold plate over boiling water, Note that the vapor changes from a gas to a liquid.

4. Wet a section of the chalkboard and outline the spot with chalk. Note that the liquid changes to a gas in the process of evaporation.

Concept: In a mixture, each element keeps its own characteristics.

1. Mix some rice and sand in a glass. Look at it. Note that the sand and rice have not combined. Note that the characteristics of each have not changed.

2. Place some iron filings and sulfur in a dish. Stir them up. Separate the iron from the mixture using a magnet.

Concept: Chemical change occurs when the characteristics of a material are changed so that a new material is formed.

1. Discuss what happens after filling a test tube about one-fourth full of sugar and heating it. Watch the sugar turn to a brown liquid and finally to a black solid substance.

2. Show chemical change by burning wood. Examine the ashes, the end result of burning.

3. Test for chemical change using starch. Put a small piece of bread or cracker in your mouth and chew it for a long time. Notice how the taste becomes sweet. What has happened?

4. Burn a match about half way up its length. What is left of the burned part? Has the chemical change taken place? Compare this with the carbon produced in the heating of sugar.

5. Find a piece of iron that is rusted. Scrape off some of the rust and see if it has the same characteristics as the iron.

6. Compare materials before and after chemical change occurs, such as: sour milk and sweet milk; new and faded construction paper; tarnished and polished silver; sweet cider and vinegar.

7. Find out how glass, rayon, steel, synthetic rubber, and other products are made. Keep a list of materials and what they are made of.

8. Obtain a recipe for baking powder biscuits and bake a small amount with and without baking powder. Discuss the reason for the different results.

9. Put a piece of iron outside in moist air and another piece in a box where it is dry. Which one rusts? Why?

Concept: There are special tests for identifying various materials.

1. Test for acid: Dip a piece of blue litmus paper in vinegar and watch it turn red. Dip a piece of blue litmus paper in water and watch what happens. The one dipped in vinegar turns red because vinegar is an acid.

2. Test for starch: Put a drop of iodine in water and watch it. The iodine and water will mix. Put a drop of iodine on a slice of potato or a piece of bread and notice that it immediatley turns a bluish color. This shows that these materials contain starch.

3. Test for alkali or base: Dip a piece of red litmus paper in a solution of limewater and watch it turn blue. Dip a piece of blue litmus paper in water and watch what happens. The one dipped in limewater turns blue because limewater is a base or alkali.

4. Test for carbon dioxide: Place some clear limewater in a glass jar. Dip the end of a straw into the limewater and blow through it for a few minutes. The lime water turns milky. Lime water always does this when it comes in contact with carbon dioxide.

   Pour some baking powder in a glass. Pour some boiling water in the glass. It immediately boils up. When baking powder is put into moist cake batter, bubbles of carbon dioxide form and puff up the batter.

   Bend a stiff wire around a short candle. Light the candle and lower it into a wide-mouthed bottle or jar. Cover the bottle with a piece of glass. After the candle has gone out, pour a little limewater into the bottle or jar and shake. What happens? Why?

5. To test for molecules in motion: Place a glass of water on a table and do not disturb it for a few minutes. When the jar is perfectly still, very carefully place a drop of ink from a medicine dropper right on the surface of the water. Try not to disturb the water any more than is necessary. As you watch the drop, you will notice the ink stays on the surface for a few seconds and then spreads out to various parts of the water. Examine the water again in 15 minutes. The ink will have traveled to every part of the water and the whole glassful will be a light shade of the color of the ink. Explain what has happened.

6. Color tests to find out what elements are in a substance: To test for sodium, dip the end of a stick in water. Then dip the wet end in table salt. Hold that end of the stick in a flame and notice the yellow color that results.

   Dip the wet end of another stick in powdered boric acid. Hold in a flame. The flame turns green; boric acid burns with a green color.

Experiments and Demonstrations

Showing Chemical Change

Procedure: Put the first nail in a test tube with only air and stopper it. Place a second nail in a test tube with tap water and stopper it. Place a third nail in a test tube with boiling water. Compare how the three nails rust in each case.

Results: The nail should rust in the second tube since both oxygen and air are needed. In the case of the boiled water the air has been expelled by the boiling. Rust is a mixture of iron oxide and iron hydroxide.

Procedure: Mix together in a bowl four tablespoons of salt, four tablespoons of water, four tablespoons of laundry bluing, one tablespoon of ammonia, a few drops of mercurochrome. Pour this mixture over pieces of coke or brick which are in a saucer. Place the saucer where it will not be disturbed. Watch for crystals to grow and grow.

Physical and Chemical Change

Procedure: Cut up a piece of paper or wood into small pieces, and burn the paper or wood.

Results: Note that cutting paper or wood is a physical change, but burning the material is a chemical change. Compare the basic difference between physical and chemical change.

Cohesion and Adhesion

Procedure: Allow a drop of water to fall on a mirror or a piece of glass.

Results: Point out that the drop of water remains intact because of the cohesion of the water molecules, whereas the water adheres to the glass because of adhesion.

Symbols

Have the children make an alphabetical list of all well-known elements and their symbols. Such information can be found in a chemistry book or an encyclopedia. Note how the symbols in most cases provide a clue to the name of the element. Where the symbol does not correspond with the name of the element, have the children find out from the encyclopedia the element's name in another language from which the symbol was derived.

Chemical Formulas

Write on the chalkboard the names and chemical formulas of such common materials as salt, sugar, vinegar, rubbing alcohol, hydrogen peroxide, and sodium bicarbonate. Have the children name the elements in such formulas and state how many atoms of each element are present.

## Solutions

Obtain three tumblers of the same size. Fill each tumbler about three-quarters full of tap water of the same temperature. To one tumbler add one-fourth teaspoon of sugar and stir until all the sugar is dissolved, to the second tumbler add two teaspoons of sugar and stir until the sugar is dissolved. Taste both solutions and note which is diluted and which is concentrated. To the third tumbler add one-half teaspoon sugar and stir until all the sugar is dissolved. Continue adding sugar one-half teaspoon at a time and stirring after each addition, until no more sugar will dissolve and a small pile of undissolved sugar remains at the bottom of the tumbler. Total the number of teaspoons of sugar you added to obtain a saturated sugar solution.

## Effect of Pressure on the Solubility of Gases in Liquids

Procedure: Obtain two identical bottles of soda pop. Place one bottle in the refrigerator and allow it to stand overnight. Keep the other bottle at room temperature. The next day remove the caps from both bottles. Place the cold open bottle back in the refrigerator, and let the warm, open bottle stand at room temperature. At the end of the hour pour the contents of both bottles into each of two tumblers.

Results: The soda pop from the cold bottle will fizz fairly vigorously, showing the presence of dissolved gas. The soda pop from the warm bottle will fizz weakly, if at all, showing that most of the dissolved gas has been driven from the pop by the increases in temperature.

## Effect of Temperature on the Solubility of Solids in Liquids

Pour a measured amount of water at room temperature into a tumbler. Add sugar, a teaspoon at a time and stirring after each addition, until no more will dissolve. Repeat the experiment, using an equal amount of hot water this time. Compare the number of teaspoons of sugar that dissolved in the cold and hot water respectively.

## Making and Using Carbon Dioxide

Procedure: Place a small amount of baking soda in a glass tumbler. Pour some vinegar on the baking soda. Bubbles of gas will appear. Hold a lighted match in the bubbles.

Results: The burning match extinguished. Carbon dioxide does not burn and prevents other things from burning. Carbon dioxide is used in some fire extinguishers.

Procedure: Fill a jar almost full of cold water and dissolve two or three tablespoonsful of baking soda in the water and add food coloring. Put several mothballs in the jar. Add several crystals of citric acid.

Results: The mothballs will sink to the bottom. When the citric acid is added, they will rise to the surface one by one and then sink and rise again. Mothballs are only a little heavier than the solution. When the citric acid is added, carbon dioxide is formed and collects on the mothballs. The carbon dioxide increases the total weight. Therefore, the mothballs now float because the total body weight is less than the weight of the liquid having the same volume.

Culminating Activities

1. Prepare a display that illustrates the uses of various materials.

2. Find out what kind of work a pharmacist does.

3. Hold a science exhibit, for parents and other classes, using demonstrations that have been performed.

Vocabulary

| | | |
|---|---|---|
| acid | dilute | litmus paper |
| base | dissolve | materials |
| carbon | element | matter |
| characteristics | energy | mineral |
| chemical | evaporates | mixture |
| chemist | expand | molecules |
| chemical change | formula | oxygen |
| compound | gas | physical change |
| condense | hydrogen | solid |
| conductor | iodine | starch |
| contrast | liquid | symbol |

Evaluation - Sample Item:

1. A list of terms is given below. Select the term from the list that goes with each statement. Write the term in the space before the statement.

Ice　Attraction　Motion of molecules　Repulsion

Gas　Lox　Atmospheric pressure

(Attraction) strong pull among molecules

(Lox) liquid oxygen

(Gas) substance with no definite size or shape

(Mot.of mol.) gives a balloon its shape

(Ice) water in a solid state

2. Complete the following sentences.

The smallest single particle of a substance is called a (molecule).

When a solid is heated, the speed at which its molecules vibrate (increases).

When gas is cooled sufficiently, the state of matter formed is (liquid).

3. Answer the following.

What are two different ways in which a liquid can change to a gas? How do these ways differ from one another?

(The two ways are boiling and evaporation. In boiling, a definite temperature must be reached for the liquid to change to a a gas. The gas bubbles rise and break out into the space above the liquid. Evaporation may go on whether the liquid is heated or not. It always takes place at the surface of the liquid, where molecules are bumped out into the space above the liquid. The larger the surface of the liquid, the faster evaporation will take place.)

4. Underline the correct answer in each of the following statements.

The number of elements is about

50   <u>100</u>   150   200

Rust forms when oxygen combines with

tin   <u>iron</u>   zinc   aluminum

The nucleus of the common hydrogen atom consists of

one neutron   <u>one proton</u>   one electron   one neutron and one proton

5. Draw a line under the word in the parentheses that should be used to make a correct statement.

A (solid, liquid, <u>gas</u>) has no size of its own.

The changing of a solid or a liquid to a gas is called (condensation, <u>evaporation</u>, freezing).

The changing of a gas to liquid is called (<u>condensation</u>, evaporation, freezing).

6. On the blank after each material listed below, tell whether the material is a solid, a liquid or a gas.

| | |
|---|---|
| rock (solid) | ice (solid) |
| mercury (liquid) | mirror (solid) |
| oil (liquid) | baking soda (solid) |
| hydrogen (gas) | water vapor (gas) |

Apparatus and Equipment

aluminum
ammonia (household)
baking powder
baking soda
boric acid
bottles (assorted)
bottle gas burner
brick
bread
candle
castor oil
citric acid crystals
coke
copper sulfate crystals
copper sulfate powder
examples of various elements
filter paper
food coloring
hot plate
ink
iodine
iron (filings)
jars (assorted)
laundry bluing
limewater
litmus paper - blue
litmus paper - red
magnet
matches
mercurochrome
milk (sweet & sour)
mothballs
nails (same size)
paint
paraffin
rice
salt
sand
saucer
silverware
stoppers
straws (drinking)
sulfur
test tubes
test tube holder
various minerals
vinegar
wire
water
wood

Bibliography - Children's

Barr, George. More Research Ideas for Young Scientist. New York: McGraw Hill Book Co. Inc., 1961. Contains more than eighty projects in the field of chemistry, several dealing with molecules and atoms.

Beeler, Nelson F. and Branley, Franklyn M. Experiment with Atomics. Crowell Press, 1954. Such devices as Geiger counters, the Wilson cloud chamber, particle accelerators, and radioisotopes are explained, followed by experiments for the reader.

Colby, Carroll B. Aluminum, Miracle Metal. New York: Coward-McCann Inc., 1958. A study in molecular actions through the processing of aluminum.

Freeman, Ira M. All About the Atom. New York: Random House., Inc., 1956.

Kohn, Bernice. The Peaceful Atom. Englewood Cliffs: Prentice-Hall, Inc., 1963. A history of atomic energy, how it was discovered, how it is controlled, its present uses, and its future.

Meyer, Jerome S. Picture Book of Chemistry. Lothrop Publisher, 1957. An introduction to physical and chemical changes, molecules, elements and compounds, acids and bases and simple equations.

Morgan, Alfred. Simple Chemical Experiments. Appleton Press, 1941. Contains more than two hundred experiments that can be performed at home.

Munch, Theodore W. What is Heat? Chicago: Benefic Press, 1960. A science book which explains heat and motion of molecules.

Posin, Daniel Q. What is Matter? Chicago: Benefic Press, 1960. The author presents the building blocks of the universe.

Victor, Edward. Molecules and Atoms. Chicago: Follett Publishing Co., 1963. Here is a simple description of molecules and atoms and of the composition of some everyday things such as water and salt.

Bibliography - Teacher's

Adler, Irving. Energy and Power. New York: Alfred A. Knopf Inc., 1958. How men have learned to control and use the sources of energy.

Barrow, George. Your World in Motion. New York: Harcourt, Brace and World Inc., 1956. The story of energy in its many forms and how motion affects man.

Blackwood, Paul E. Push and Pull. New York: McGraw-Hill Book Co. Inc., 1959. A theoretical basis for energy production and application.

Gamow, George. Matter, Earth, and Sky. Englewood Cliffs: Prentice-Hall, A study of matter, energy, and molecules.

Glasstone, Samuel. Sourcebook on Atomic Energy. Princeton: D. Van Nostrand Co. Inc., 1958. An authority on atomic science.

Hogben, Lancelot. The Wonderful World of Energy. New York: Garden City Books, 1957. A beautifully illustrated book which describes man's harnessing of the energy of nature, falling water, the heat of the sun, air pressure, wind, natural fuel and the atom.

Irwin, Keith G. The Romance of Chemistry. New York: Viking Press, 1959. The growth of chemical knowledge through the ages, from alchemy in ancient Egypt to the creation of artificial elements from the windmill to nuclear energy.

Victor, Edward. Science for the Elementary School. New York: The Macmillan Co., 1965. An excellent section on changes in matter and energy.

Films

Atomic Energy - Inside the Atom, 14 minutes, color, grades 5 and 6.

Chemical Changes, 12 minutes, color, grades 4, 5, and 6.

Evidence for Molecules and Atoms, 19 minutes, color, grades 5 and 6.

How Materials Are Alike and Different, 11 minutes, color, grades 4, 5, and 6.

How Materials Are Changed, 13½ minutes. color, grades 4, 5, and 6.

Materials of Our World, 13½ minutes, color, grades 3 through 6.

Our Friend the Atom, Parts I and II, color 50 minutes, grades 5 and 6.

Particles of Matter, 13½ minutes, color, grade 6.

Simple Changes in Matter, 10 minutes, black and white, grades 4, 5. and 6.

Wonder of Chemistry, 11 minutes, black and white, grades 4, 5, and 6.

## PART II - SCIENCE CONCEPTS

### Introduction

This section of the basic curriculum guide for the teaching of science at the elementary grade level, K-6, develops the various scientific concepts necessary for understanding and meaning.

Each chapter of each grade level textbook of the D.C. Heath Science Series is analyzed to determine the single main concept to be developed. This main concept is in turn broken down into the various subconcepts which as a whole teach the main concept. The location of information pertaining to each main concept and subconcept in the D.C. Heath Series, the Macmillan Series, and the American Book Series is identified in each of the individual chapter analyses.

These detailed chapter outlines should be used by the teacher in organizing her overall teaching program and adjusting her teaching to meet the needs of the children she teaches. They provide a basic framework for developing scientific understanding and generalizations and hence units of work.

It is hoped that this will further help in the development of pupil-centered science curriculum.

## Science in the Kindergarten

This outline provides for the following areas of major emphasis in the Kindergarten, as noted by an (*).

1. Living Things
    a. Plants*
    b. Animals*
    c. Interdependence*

2. The Earth
    a. Structure and History*
    b. Air, Atmosphere, and Weather*
    c. Conservation*

3. Space Beyond the Earth
    a. Sun and Other Heavenly Bodies
    b. Space Exploration

4. Matter and Energy
    a. Heat
    b. Sound*
    c. Light
    d. Electricity and Magnetism
    e. Friction and Machines*
    f. Atomic and Nuclear Energy
    g. Composition of Matter*

5. The Human Body
    a. Structure and Function*
    b. Health and Safety

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This inventory of background would serve as the basis for selecting only those instructional materials, activities, experiments and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understanding, and generalizations in a different sequence, different grouping, or in correlation with other curriculum areas. This also will be dependent upon the background and special needs of the class. Likewise, this guide provides a basic framework for developing science understandings and generalizations. Classes of individuals with special interests and abilities could proceed beyond the scope of this outline.

Chart I | Animals On the Farm | Kindergarten

Main Concept:

Mammals and birds are different kinds of animals.

Understanding to be developed:

1. Mammals are warm-blooded animals.

    a. Mammals have hair or fur.
    b. Mammals give birth to babies.
    c. Mammals feed milk to their babies.
    d. Most mammals have four legs.

2. Birds are warm-blooded animals.

    a. Birds have feathers.
    b. Birds hatch from eggs.
    c. Birds have two legs and two wings.

3. Birds and mammals care for their babies until the babies are able to care for themselves.

4. Animals need food, water, shelter, rest and sleep.

Chart 2 | Keeping Animals | Kindergarten

Main Concept:

Mammals, birds, reptiles, and fish are different kinds of living things.

Understandings to be developed:

1. Mammals and birds care for their young.

2. Birds and reptiles lay eggs.

3. Reptiles and fish both have scaly skins and usually do not take care of their young.

4. Reptiles and fish are cold-blooded animals.

5. Animals live in different kinds of places.

   a. Mammals, birds, and reptiles may live on land or in the water.
   b. Fish live in water.

6. When we take an animal from its natural habitat, we are responsible for its care.

Chart 3 | Planting and Harvesting | Kindergarten

Main Concept:

When seeds are planted, they grow into plants. We grow some plants for food. We eat different parts of different plants.

Understandings to be developed:

1. There are many different kinds of seeds.
2. Each kind of seed grows into a different kind of plant.
3. Each plant has its own type of leaf, fruit, flower and seed.
4. Plants need food, air, water, and sun to grow.
5. We eat the leaves, stems, or fruits of some plants.
6. We eat the underground or root parts of other plants.

Chart 4 | Seeds and Fruit | Kindergarten

Main Concept:

Most plants have a life cycle which starts and ends with the seed.

Understanding to be developed:

1. When seeds are planted, they can grow into plants.
2. When young plants have grown into adult plants, they can develop flowers and then fruit.
3. Within the fruit are new seeds.
4. Sometimes we eat the seeds within the fruit.

Chart 5 | About Our Senses | Kindergarten

Main Concept:

We find out about the world around us by means of our senses.

Understandings to be developed:

1. We see with our eyes.

   We distinguish size, shape, and color with our sense of sight.

2. We hear with our ears.

   We can tell whether sounds are loud or soft, high or low, by listening.

3. We taste with our tongues.

   We can tell whether a thing is sweet, sour, salty, or bitter by tasting.

4. We smell with our noses.

   We can tell whether an odor is pleasant, strong or weak by smelling.

5. We touch and feel with our fingers and skin.

   We can tell whether a thing is rough or smooth, soft or hard, hot or cold, and even its size and shape, by touching it.

6. We usually learn about something by using more than one of our senses.

Chart 6 | Our Sense of Sound | Kindergarten

Main Concept

We hear many sounds which tell us about the world.

Understandings to be developed:

1. There are many different kinds of sounds.

    -- Sounds may be loud or soft, pleasant or unpleasant.

2. All sounds are made in the same way.

    a. Sounds are made by causing something to vibrate.
    b. The outside of the ear catches the sound; the inside of the ear does the hearing.

3. We use sound to communicate with one another.

Chart 7 | Machines and Tools | Kindergarten

Main Concept

We use machines in almost all of our activities. Machines do work. They make our work easier.

Understandings to be developed:

There are many kinds of machines made up of combinations of six simple machines.

a. Levers, such as see-saws, scissors, nutcrackers, hammers used as nail-pullers.
b. Inclined planes, such as ramps, stairways, sloping roads.
c. Screws, such as propeller, wood screws, nuts and bolts.
d. Wedges, such as knives, nails.
e. Wheels and axles, such as those used in egg beaters and pencil sharpeners.
f. Pulleys, such as those used in clotheslines or flagpoles.

Chart 8 | Moving Loads with Machines | Kindergarten

Understandings to be developed:

-- Machines make work easier.

  -- Wheels make pulling and lifting a load easier.

Chart 9 | See-Saws and Balances | Kindergarten

Main Concept:

The lever, a simple machine, can be used to do work. It is possible to balance a lever even with loads of unequal weights.

Understandings to be developed:

-- A balanced lever will become unbalanced when unequal weights are placed at each end.

Chart 10 | Watching the Weather | Kindergarten

Main Concept

There are different kinds of weather. We can tell what the weather is by sensing various conditions around us. We do certain things because of the weather.

Understandings to be developed:

1. The sky changes with the weather.

   a. A sunny day shows a clear blue sky.
   b. A cloudy day shows clouds in the sky.
   c. A rainy day show clouds forming before it rains.
   d. A snowy day shows snowflakes falling from the sky.

2. The ground changes with the weather.

   -- There are puddles of water on the ground after it rains.

3. The air seems different in different kinds of weather.

   -- On a snowy day, the air feels cold.

4. We dress according to the weather.

   a. On a cloudy day, we take our raincoats.
   b. When it snows, we wear boots, scarves, and mittens.
   c. We wear fewer clothes on warm days.

5. We plan according to the weather.

   -- Sunny days are good for playing and working outdoors.

Chart 11 | We Use Water | Kindergarten

<u>Main Concept</u>

All living things must have water to stay alive and healthy. People need water. All plants need water.

<u>Understandings to be developed:</u>

We use water for many purposes other than drinking.

-- We use water to clean, cook, cool, bathe, keep things fresh, put out fires, and have fun.

Chart 12 | Water Changes Many Things | Kindergarten

<u>Main Concept</u>

Water has different effects on different things.

<u>Understandings to be developed:</u>

1. Many things dissolve in water.

   -- Cocoa, paint, gelatin and other substances dissolve in water.

2. Some things do not dissolve in water.

   -- Flour, soil, oil and other substances do not dissolve in water.

3. Some expand as prunes and paper.

4. Some float as cooking oils.

Chart 13 | Water Changes State | Kindergarten

<u>Main Concept</u>

Matter can exist in three states - solid, liquid, and gas.

<u>Understandings to be developed:</u>

1. Water can be solid, as ice.

   -- Solid things have shape and are rigid.

2. Water can be a gas as steam.

   -- Gases have no shape and are very light.

Chart 13 (Continued)

3. Water can be a liquid.

   -- Liquids have no shape and flow freely.

4. We can change the state of matter by changing the temperature.

   a. Water changes to ice in the cold.
   b. Water changes back to water at room temperature.
   c. Water changes to steam when it reaches its boiling point.

Chart 14

Main Concept

Night follows day and day follows night.

Understandings to be developed:

1. The sun is always shining.

   a. It is day when our part of the earth faces the sun.
   b. It is night when our part of the earth is turned away from the sun.

2. Day differs from night.

   a. The night sky shows the moon and stars.
   b. It is usually warmer during the day and cooler at night.

3. Most people and animals work and play during the day and sleep during the night, but some are active during the night and sleep during the day.

## Science in the 1st Grade

This outline provides for the following areas of major emphasis in the 1st grade, as noted by an (*)

1. Living Things

   a. Plants*
   b. Animals*
   c. Interdependence*

2. The Earth

   a. Structure and History*
   b. Air, Atmosphere, and Weather*
   c. Conservation*

3. Space Beyond the Earth

   a. Sun and Other Heavenly Bodies*
   b. Space and Exploration

4. Matter and Energy

   a. Heat*
   b. Sound
   c. Light*
   d. Electricity and Magnetism
   e. Friction and Machines*
   f. Atomic and Nuclear Energy
   g. Composition of Matter

5. The Human Body

   a. Structure and Functions*
   b. Health and Safety*

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This inventory of background would serve as the basis for selecting only those instructional materials, activities, experiments, and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understandings, and generalizations in a different sequence, different groupings or in correlation with other curriculum areas. This also will be dependent upon the background and special needs of the class. Likewise, this guide provided a <u>basic</u> framework for developing science understandings and generalizations. Classes or individuals with special interests and abilities could proceed beyond the scope of this outline.

Chapter I The Sun Grade I

<u>Main Concept</u>: The sun gives us light. The sun is always shining. Daylight comes from the sunlight. The sun warms the earth. We see shadows on sunny days but not on cloudy days.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. The sun is a star. | 9 | | 57 |
| 2. The sun shines all the time. | 8 | | 57-59 |
| 3. The earth turns around once each day. | 8-9 | | 62 |
| When a part of the earth is in the sunlight, it has day. When a part of the earth is in the earth's shadow, it has night. | | | |
| 4. Shadows form when things block the light. | 3 | | 50-56 |
| 5. The sun gives us warmth and light; helps make rain which supplies water to plants and animals. | 1-2<br>10-11 | 84 | 69 |
| 6. We seldom see the sun on rainy and cloudy days. | 10-11 | 1-6,16 | 56 |

Chapter II We Find Out Grade I

Main Concept: We use our senses to find out about our environment. We see, touch, hear, taste, and smell to find out about things around us.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. We learn by seeing and listening. | 12-13 | 82-83 | |
| 2. We see the color of things when light shines on them. | 14-15 | 85-88 | |
| 3. Things have many different shapes and sizes. | 21-25 | | |
| 4. We need light to see. | 33-35 | 82 | |
| 5. Sounds we hear can tell us many things. | 40-42 | | |
| 6. Some sounds are alike, but vary in loudness, and some sounds are different. | 41 | 83 | |
| 7. The outside of the ear catches the sound; the inside of the ear does the hearing. | 43 | 83 | |

Chapter III Animals Grade I

Main Concept: All animals are born; eat, move, grow, and become adults. As adults, they resemble their parents in many ways. Some animals need to be cared for when they are young; others are born able to care for themselves.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. There are many kinds of animals. | 52-55 | 98 | 2-3 |
| 2. Mammals are warm-blooded, have fur or hair, and are fed with milk from their mothers. | 56 | 99 | 14 |
| 3. Birds are animals with feathers. They help their babies to get food. Other baby animals get their own food. | 55 | 99 | 16 |
| 4. Animals need food, air, water and proper homes to live and grow. | 52-55 | 99 | 12-13 |
| 5. Baby animals grow up and are like their parents. | 60-61 | 98 | |
| 6. Some animals need to be cared for when they are young; others are born able to care for themselves. | 59<br>64-65 | | |
| 7. Most birds, turtles, frogs and fish are hatched from eggs. | 70-71 | 99 | |

Chapter IV — Children Grow — Grade I

Main Concepts: Proper food, rest, and care help children to grow from newborn babies into strong healthy adults.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Muscles and bones grow and repair themselves while you are asleep or awake. | 78-79 | 77 | |
| 2. Food helps children to grow | 78-81 | 64 | |
| a. Children grow taller and heavier. | 78 | 64-66 | |
| b. Children's bodies change as they grow. | 78 | 67 | |

Chapter V — Seeds to Plant — Grade I

Main Concept: Most plants grow from seeds. Seeds may be scattered in various ways. The seeds, under proper conditions, will develop into young plants.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. There are many kinds of seeds. | 82-84 | | |
| 2. In a seed, there is a tiny plant. | 85 | | |
| 3. Seeds need moisture and warmth to grow. | 85 | | |
| 4. Most seeds contain food for the young plant. | 85 | | |
| 5. Some seeds have two food parts: some have one | 85 | | |
| 6. The flowers of some trees become fruit. | 93-94 | | |
| 7. Plants grow roots, stems, and leaves from seeds. | 93-94 | | |
| 8. Seeds are carried in different ways; by wind, man, animals, gravity, and water. | 96-97 | | |
| 9. Some kinds of plants can be grown from roots, bulbs, or stems. | 99-101 | | |

Chapter VI Collections Grade I

Main Concepts: Most people like to collect things. We can often learn about things around us by collecting and sorting them. We can collect seeds, leaves, nests, shells, fossils, and other things.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. We can learn by collecting, observing and sharing our collections with others. | 102, 108-109 | | 42-43 |
| 2. We can learn about the earth's history from fossils. | 104-107 | | 22-24 |
| -- Fossils are remains found in rocks. | 104 | | |
| 3. There are many kinds of rocks. | 103-104 | | 26-34 |
| 4. Rocks may be different in color, in texture, in hardness and softness. | 103-104 | | 34 |

Chapter VII We Use Air Grade I

Main Concept: Air is a real substance that takes up space. It cannot be seen. It can hold things up. Fires need air to burn.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Wind is moving air. | 110-112 | 10 | |
| a. Wind moves things. | 116 | | |
| b. Air cannot be seen, but it can be felt. | | | |
| c. We use air in many ways. | 112 | | |
| d. Air is real, but it has no shape or color. | 115 | | |
| 2. Air can hold something up. | 115-116 | | |
| -- Air takes up space. | 117-119 | | |
| 3. Fires need air to burn. | 120-124 | | 74 |
| -- Fires give off heat and light. | | | 75 |
| 4. Fire protection is necessary for our safety. | 125 | | 76-77 |
| 5. Fires can be put out by covering them to keep air away. | 124 | | 78 |

Chapter VIII Machines Grade I

Main Concept: Machines help make work easier or faster.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Some things that help us with work are called machines. | 126-128 | 44 | 98-105 |
| a. Machines move things. | 129-131 | 44-47 | 98-105 |
| b. Machines cut things. | 129-131 | 44-47 | 98-105 |
| 2. Tools are small machines. | 128-131 | 47 | 99 |
| 3. Some toys are small machines. | 132-133 | 46 | 14 |
| 4. Machines can be used for work or play. | 132-133 | | |
| 5. Machines move many kinds of heavy things. | 134-135 | | |
| 6. Machines can move some things by pushing, pulling, forcing and lifting. | 134-135 | 44 | |
| 7. Wheels help us move things. | 134-135 | 44 | |

Chapter IX Day and Night Grade I

Main Concept: The earth is always turning. Night follows day, and day follows night. The sun is always shining.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. The earth is always turning. | 140 | | 58-59 |
| a. When our side of the earth is toward the sun, we have day. | 143-142 | | 57-62 |
| b. When our side of the earth is away from the sun, we have night. | 143-142 | | 57-62 |
| 2. The earth turns around once each day. | 146-147 | | 58 |
| -- The sun always shines on the earth. | 142-143 | | 62 |
| 3. We see shadows on a sunny day. | 136-137 | | 50-56 |
| 4. Shadows point in a direction opposite to that of the sun. | 136-137 | | 50-56 |
| a. When the sun is low in the sky, the shadows are long. | | | |
| b. When the sun is high in the sky, shadows are short. | | | |
| 5. Shadows form when things block the light. | 3-5 | | |

Science in the 2nd Grade

This outline provides for the following areas of major emphasis in the 2nd grade, as noted by an (*).

1. Living Things
   - a. Plants*
   - b. Animals*
   - c. Interdependence*

2. The Earth
   - a. Structure and History*
   - b. Air, Atmosphere, and Weather*
   - c. Conservation

3. Space Beyond the Earth
   - a. Sun and Other Heavenly Bodies*
   - b. Space Exploration

4. Matter and Energy
   - a. Heat
   - b. Sound*
   - c. Light*
   - d. Electricity and Magnetism
   - e. Friction and Machines*
   - f. Atomic and Nuclear Energy
   - g. Composition of Matter

5. The Human Body
   - a. Structure and Function
   - b. Health and Safety

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This inventory of background would serve as the basis for selecting only those instructional materials, activities, experiments and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understandings, and generalizations in a different sequence, different grouping, or in correlation with other curriculum areas. This also will be dependent upon the background and special needs of the class. Likewise, this guide provides a basic framework for developing science understandings and generalizations. Classes or individuals with special interests and abilities could proceed beyond the scope of this outline.

Chapter I | The Four Seasons | Grade II

<u>Main Concept</u>: There are four seasons in each year. Plants and animals are affected by the change of seasons.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The four seasons are: | 1-10 | | 48 |
| a. Fall. | 11-12 | | |
| b. Winter. | | | |
| c. Spring. | | | |
| d. Summer. | | | |
| 2. In the cold season, we get food from warm places. | 14-15 | | |
| 3. Animals react differently to cold weather. | 2-4 | | |
| 4. Plant life usually begins with a seed. | 6-8 | 88-100 | 37 |
| 5. Plants need: | | 91-93 | 44,47,48 |
| a. Soil. | | | |
| b. Water. | | | |
| c. Air. | | | |
| d. Light. | | | |
| 6. Plants grow and multiply | 6-8 | | |
| 7. Plants and animals are affected by their environment. | | | 45-47,49 |
| 8. Most plants have: | | 86-89 | |
| a. Root. | | | |
| b. Stem. | | | |
| c. Flowers. | | | |
| d. Green Leaves. | | | |
| 9. Seeds travel by: | | 96-97 | |
| a. Wind. | | | |
| b. Water. | | | |
| c. Animals. | | | |
| 10. Most plants do not grow in cold weather. | 5-6 | | 45-47,49 |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 11. We use many parts of the plants. | 14 | | |
| 12. Changes in living things parallel changes in the season. | 1-17 | | |
| 13. In the cold season, we get food from warm places. | 14-15 | | |

Chapter II We Do Work Grade II

Main Concept: Machines make work easier for people. We do work when we move something.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Simple machines: | 20-22 | 48-53 | 114 |
| a. Wheel | | | |
| -- Gear | | | |
| b. Lever | | | |
| c. Incline plane (ramp) | 23-24 | 50-51, | |
| d. Pulley | 25-26 | 54-55 | |
| 2. When friction is overcome, work is easier. | 216-263 | | 106-115 |

Main Concept: We use devices to aid our senses. We get more information by using devices. We can measure and record this information.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Each person's eye is made up of several parts:<br>a. Cornea. d. Pupil.<br>b. Retna. e. Iris.<br>c. Lens. f. Optic Nerve. | 28-31 | | |
| 2. Devices used to extend vision:<br>a. Lenses.<br>b. Microscopes.<br>c. Telescopes. | 32-36 | | |
| 3. The ear is made up of several parts:<br>a. Outer. d. Nerves to Brain.<br>b. Middle. e. Eardrum.<br>c. Inner. | 38 | | |
| 4. Sounds are caused by vibrating objects.<br>a. Slow Low tones.<br>b. Fast High tones. | 37-41 | | |
| 5. Humans produce sound with their vocal chords. | 40 | 146-147 | |
| 6. We can keep records of sounds. | 41 | | |
| 7. We measure temperature with thermometers. | 42-47 | 113-114 | |

<u>Main Concept</u>: Lumber comes from trees. Lumber is an excellent building material. Man is affected by and dependent on his environment.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. A house is a shelter. | 50-52 | | |
| 2. Many materials are used in building houses: | | | |
| a. Stone. e. Iron.<br>b. Glass. d. Wood. | 55-63 | | |
| 3. Wood is not as heavy as: | 58-60 | | |
| a. Iron.<br>b. Stone. | | | |
| 4. Trees begin growing from a seed. | 56 | | |
| 5. Trees take many years to grow. | 56 | 85 | |
| 6. Forests must be replanted. | 56,57 | | |
| 7. Many steps must be taken to turn trees into lumber. | 56,57 | | |
| 8. Wood comes from many kinds of trees. | 62,63,<br>16,17 | | |

Chapter V Rocks and Minerals Grade II

Main Concept: Building materials such as iron, concrete, and glass, come mainly from rock formations. Each material possesses its own specific qualities.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Some parts of houses are made of rock materials. | 66-67 | | |
| 2. All rocks are made of minerals. | 68 | | 74-75 |
| 3. Concrete is made with: | 69 | | |
| a. Sand.<br>b. Gravel.<br>c. Cement.<br>d. Water. | | | |
| 4. Gravel, sand, and cement are small bits of different kinds of rock. | 70-73 | 76-81 | |
| 5. Iron comes from iron ore. | 74-79 | | |
| 6. Some materials do not burn: | 80-81 | | |
| a. Stone.<br>b. Iron. | | | |
| 7. Quartz sand is one of the main materials in glass. | 82-84 | 71 | |
| 8. Some materials do not let in light. | 85-86 | | |
| 9. Each material has its own uses. | 87-88 | | |
| 10. We can change things with heat: | 76-77<br>80-81 | 117-122 | |
| a. Metal.<br>b. Jello.<br>c. Candle. | | | |
| 11. Rust is a chemical change. | 79 | | |

Chapter VI The Winter Season Grade II

Main Concept: During the winter, especially in cold places, many animals quiet down. Some animals hibernate, living off the fat stored in their bodies.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Animals react differently to seasonal changes. | | 141-142 | |
| 2. Hibernating animals sleep in the winter and awake in the spring. | 100, 101 | | |
| 3. Mammals are warm-blooded and have fur or hair. | 94 | 131 | |
| 4. Reptiles are cold-blooded and have scales. | 95 | 132, 151 | |
| 5. Amphibians live in the water and on the land. | 96 | | |
| -- Frogs are amphibians. | | | |
| 6. Fish breathe air from the water through gills and have scales. | 97-98 | 20-25 | |

Chapter VII Weather Grade II

Main Concept: There is invisible water vapor in the air. When water vapor is cooled, it may condense.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Weather changes almost daily. | 104-105 | | |
| 2. We are affected by all weather changes. | | 133-134, 140 | |
| 3. Sunshine, temperature, wind, and moisture cause important changes in the weather. | | | |
| 4. The water cycle is continually taking place: | 114-115 | | |
| a. Water leaves the earth as vapor.<br>b. Water returns as precipitation.<br>c. Water travels the same cycle over and over again. | | | |
| 5. Water evaporates into the air and forms water vapor. | 105-107 | | |
| 6. Heat changes water to water vapor-- this is called evaporation. | 105-107 | | |
| 7. A fog is a cloud near the ground. | 108-109 | | |
| 8. If the temperature is low enough, clouds condense into snowflakes. | 113 | | |
| 9. There are many different kinds of clouds. | 107 | | |
| a. Cirrus.<br>b. Cirrocumulus.<br>c. Altocumulus.<br>d. Cumulonimbus.<br>e. Nimbostratus.<br>f. Cumulus.<br>g. Stratus. | | | |

Chapter VIII | The Big Round Earth | Grade II

Main Concepts: The earth is round. The earth turns (rotates) on its axis. The earth revolves around the sun. The earth receives heat and light from the sun.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Most living things need heat and light. | 130-131 | 92, 111 112 | 48 |
| 2. The sun is the center of our solar system. | | | |
| 3. The sun is a star. | 125-129 | | |
| 4. The sun is much larger than the earth. (About 100 times.) | 125-129 | | |
| 5. The sun is always highest in the sky at noon. | 127 | | |
| 6. The earth revolves about the sun in $365\frac{1}{4}$ day and night periods. | | | |
| 7. Earth completes a spin on its axis every 24 hours. | 125-126 | | |
| 8. We have daylight when our part of the earth faces the sun. | 125-126 | | 11,12 |
| 9. The earth, sun, and moon are approximately round. | 122-124 | | 3,4 |

Chapter IX — The Earth's Gravity — Grade II

<u>Main Concepts</u>: The earth pulls things down toward it. This is called the earth's gravity. <u>Down</u> is toward the earth. <u>Up</u> is away from the earth.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. If a satellite moves fast enough, it is not pulled down by the earth's gravity. | 140-141 | | 185-189 |
| 2. Gravity is a force. | 134-135 | 36-41, 44-47 | 105-115 |
| 3. Inertia is a force that keeps things that are at rest where they are. | | | 98-103 |
| 4. Inertia keeps moving things going. | | | 89-103 |
| 5. Friction is a force that helps make things stop moving. | | 26-41 44-47 | 105-115 |

Chapter X — Electricity — Grade II

<u>Main Concepts</u>: Electricity comes from such sources as batteries and generators. The electricity travels from the source through a wire.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Electricity returns to its sources through another wire. | 146-149 | | |
| 2. House electricity is powerful and can be dangerous. | 150 | | |
| 3. Electricity for most uses comes from a power house. | 151-152 | | |
| 4. Static electricity is caused by friction, (non-moving). | | | |
| 5. Current electricity is moving electricity. | | | |
| 6. Electricity is not carried or conducted by all materials. | | | |

Chapter XI　　　Work and Play With Magnets　　　Grade II

<u>Main Concepts</u>: Magnets attract (pull) things made of iron and steel. Magnets pull (attract) or push (repel).

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Magnets can be used to make other magnets. | 157-160 | | |
| 2. An electric magnet is made by winding wire. | 161-164 | | |
| 3. The earth has a magnetic field. | 165-170 | | 124 |
| 4. A compass is a magnet needle that can turn. | 165-170 | | |
| 5. Magnetism is a form of energy. (A force.) | | 34 | |
| 6. Magnets usually have two poles. | 157-160 | | 121-122 |
| 7. Magnets make work easier for us. | 165-170 | | 123 |

Chapter XII Animal Babies Grade II

Main Concepts: Most animal babies are born in the spring.
Many animal parents take care of their young.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Different animal babies have different ways of moving. | 176-177 | | |
| 2. Some animals are born from their mothers; others are hatched from eggs laid by their mothers. | 178 | | |
| 3. Amphibians are born from eggs hatched in the water. | 179 | | |
| 4. Some animal babies look like their parents. | 180-181 | | |
| 5. Human babies are born at any time of the year. | 182-183 | | |
| 6. Man is the highest form of animal life. | 182-183 | | |
| 7. Animals grow, move, and multiply. | 174-177 | | |
| 8. Most living things can be classified as plant or animal. | | | |
| 9. Most plants and animals are made of cells. | 145,146 149,154 | | |
| 10. All livings things need air, food, water and warmth. | 98 | 24-25 141 | 139-251 |

Chapter XIII | Plants and Soil | Grade II

<u>Main Concept</u>: Most plants grow best in a loose, rich topsoil. Rotted plant material and earthworms help to make topsoil.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Plants help build soil. | | | 75-77 |
| 2. There is solid rock everywhere under land, lakes, rivers, and oceans. | | | 80 |
| 3. Soil covers most of the rock of the earth. | | | 66-67 |
| 4. There are three basic kinds of rocks:<br>a. Igneous.<br>b. Sedimentary.<br>c. Metamorphic. | | | |
| 5. Topsoil contains bits of:<br>a. Plant material.<br>b. Sand and rock. | 186-189 | | 67-69<br>74-75 |
| 6. Topsoil is the darker colored top layer of soil. | 193-198 | | |

Chapter XIV　　Good Food, Good Teeth　　Grade II

Main Concepts: We need different kinds of food for good health. Food comes from many different places. Germs on food can cause illness.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Our teeth are tools that help us cut, tear, crush, and grind our food. | 205-206 | | |
| 2. Children lose their first set of teeth. | 207-209 | | |
| 3. A varied diet helps to keep us strong and healthy. | 210-211 | | |
| 4. Food is prepared in the body by digestion. | 212-213 | | 149-151 |
| 5. We get energy from food. | | | 139-144 |
| 6. Blood distributes digested food to all parts of the body. | 212-213 | | |
| 7. Minerals help teeth grow hard and strong. | 209-210 | | 154 |
| 8. We should rest after meals. | 214 | | |
| 9. Breakfast is an important meal. | | | 134-135 |
| 10. New cells are made from food you eat. | | | 145-146 |

## Science in the 3rd Grade

This outline provides for the following areas of major emphasis in the 3rd grade, as noted by an (*).

1. Living Things

    a. Plants*
    b. Animals
    c. Interdependence *

2. The Earth

    a. Structure and History*
    b. Air, Atmosphere and Weather*
    c. Conservation*

3. Space Beyond the Earth

    a. Sun and Other Heavenly Bodies*
    b. Space Exploration*

4. Matter and Energy

    a. Heat*
    b. Sound*
    c. Light
    d. Electricity and Magnetism
    e. Friction and Machines*
    f. Atomic and Nuclear Energy
    g. Composition of Matter*

5. The Human Body

    a. Structure and Function
    b. Health and Safety*

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This inventory of background would serve as the basis for selecting only those instructional materials, activities, experiments and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understandings, and generalizations in a different sequence, different grouping, or in correlation with other curriculum areas. This also will be dependent upon the background and special needs of the class. Likewise, this guide provides a <u>basic</u> framework for developing science understandings and generalizations. Classes or individuals with special interests and abilities could proceed beyond the scope of this outline.

Chapter I | Sound and Hearing | Grade III

Main Concept: Sounds are produced by vibrations which can travel through solids, liquids, and gases.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. There are many different kinds of sounds. | 1 | | 162-163 |
| 2. Vibrations are neces<sub></sub>sary to produce sound. | 2-6 | | 164-166 |
| 3. Frequency is the number of times a second an object vibrates. | 1-6 | 167-169 | |
| 4. The kind of sound we get depends upon how fast something vibrates. | | | |
| 5. Sounds can travel through many conductors. | 1-7 | | |
| a. Sounds can travel through air. | 8-10 | 175-177 | |
| b. The eardrum helps to conduct vibrations. | | 184-189 | |
| c. A stethoscope is used for better sound conduction by the doctor to listen to our hearts and lungs. | 11-13 | | |
| d. In the telephone, sound waves are changed into vibrations of electricity. | 14-15 | | |
| e. Hearing aids amplify sounds or conduct them through bones of the head. | 16 | | |
| f. Water conducts sound. | 17 | | |
| 6. Sounds travel as waves. | | | 176 |
| 7. Sound waves can be directed and reflected. | | | 178-179 |
| 8. Sound waves do not travel as fast as light. | | | 180 |
| 9. It is important that our ears be given proper care. | 8-9 | | 188-189 |

Chapter II Life in the Desert Grade III

<u>Main Concept</u>: Most desert plants and animals have special ways (adaptations) for living in a desert environment.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Living things move themselves, grow, and produce other things like themselves. | 21-22 | | 130-145<br>153 |
| 2. Reptiles, especially snakes, frequently live in the desert. | 22-24 | | |
| 3. Most reptiles hatch from eggs and take care of themselves as soon as they are hatched. | 22-24 | | |
| 4. Mammals are warm-blooded and suckle their young. | 25-27 | 113 | |
| 5. Mammals have fur or hair. | 25-27 | | |
| 6. Roadrunners and other desert birds have adapted to the desert environment. | 28 | | |
| 7. Most desert plants have waxy skins, fat shapes, and long roots. | 29-31 | 109 | |
| 8. A community includes many different kinds of plants and animals which depend on one another for survival. | 20-23 | | |

Chapter III    A Pond Community    Grade III

<u>Main Concept</u>: Aquatic plants and animals are adapted to life in a watery environment. Aquatic plants and animals need food and oxygen to survive. They depend on one another for survival.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The pond community includes many different kinds of plants and animals which depend on one another. | 34-37 | | |
| a. Birds that have oily feathers and tool-like bills and feet live here. | 41-43 | | |
| b. Mammals of the pond community have made adaptations to the environment. | 44 | | |
| c. Birds, fish, and frogs eat insects, and insects feed on other insects and plants. | 45-46 | | |
| d. Mosquitoes lay eggs in the water which hatch and become pupae before they are full grown and leave the pond. | 46 | | |
| 2. Plants and animals need food and oxygen to survive. | 47-49 | | |
| a. Animals take in oxygen and give off carbon dioxide. | 47-49 | | 134-135 |
| b. Green plants use carbon dioxide in making food and give off oxygen (algae). | 47-49 | | 134-135 |
| c. Fish eat plants, take in oxygen, and give off carbon dioxide. | 57-63 | | |
| 3. Plants and animals are interdependent. | 45-46 | 125 | 136-137 |
| 4. Matter may change from one form to another, but in such changes the total amount of matter in the universe remains unchanged. | 50-56 | | |
| a. Dead plants and animals return materials to the soil. | 50-63 | | |
| b. Fungi and bacteria assist in the process of decay. | 50-63 | | |
| c. Mold, a type of fungus does not make its own food. It produces spores in place of seeds. | 50-63 | | |
| 5. An aquarium is a small community of water plants and animals. | 57-63 | | |
| 6. Nature tries to maintain a balance between plant and animal life. | 57-63 | 125 | 136 |

Chapter III (Continued) Grade III

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 7. Animals secure food and protect themselves in different ways. Some molds, yeasts, and bacteria produce changes useful to man. | | 108-127 | 130-144 |
| 8. All living things are made of cells. | | 141 | |

Chapter IV The Big Ocean Grade III

Main Concept: The ocean is a large part of the earth's surface.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The ocean is a large part of the earth's surface. | 66-91 | | |
| 2. Rivers carry salt and other minerals into the ocean. | 70-77 | | |
| 3. The ocean contains many valuable minerals. | 70-77 | | |
| 4. Many kinds of plants and animals live in the ocean and make use of its minerals. | 79-87 | | |
| 5. Ocean plants and animals are interdependent. | 79-87 | | |
| 6. Oceanographers are scientists who study the ocean. | 78 | | |
| 7. Ocean animals get the energy they need from eating other animals or plants, whose energy in turn can be traced back to the sun. | 79-84 | 124-125 | 137-139 |
| 8. Living things produce new living things like themselves. | 83-84 | | |
| 9. Animals secure food and protect themselves in different ways. | 81-82 | | 136-137 |
| 10. Ocean animals furnish us with many useful products. | 85-87 | | |
| 11. All animals depend directly or indirectly on plants as a food source. | 79-87 | | |

Chapter V | Plants and More Plants | Grade III

Main Concept: Seed plants may be grown from seeds, roots, stems, or leaves. New plants manufacture food and provide man and animals with a continuous supply. They also form fibers which provide many useful products.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. All living things are made of cells. | 141 | | 104-105 |
| 2. Plants need air, water, and food to stay alive. | | 16, 158 | 5,133-135 140-144, 152, 155 |
| 3. Plants produce many seeds, which are distributed in various ways. | 92-94 | | 151-152 155 |
| 4. Gravity, wind, water, man, and animals may carry the seeds. | 92-94 | | |
| 5. New plants may grow from roots, stems, or leaves of plants. | 95-100 | | 150-153 |
| 6. Seeds contain baby plants and a supply of food to start their growth. | | 151-152 155 | |
| 7. Each part of the plant helps it to live and grow. | | 151-152 155 | |
| 8. Each part of a tree has a special function. | 101-102 | | |
| a. Leaves make the food the tree uses. | 101-102 | | |
| b. Bark is the protective covering of the tree. | 101-102 | | |
| c. Water and minerals from the soil travel from the roots to the leaves through special tubes in the trunk and branches of the trees. | 101-102 | | |
| 9. Trees supply many useful products. Wood products contain wood fibers. | 103-105 | | |
| 10. Plants and their products are useful to man. | 106-110 | | 139-143 |
| 11. Trees grow an annual ring just inside the bark. | 105 | | |
| 12. Most trees are grouped as either hardwoods or softwoods. | 106-107 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 13. Green plants are the food factories of the earth. | 111 | 104 | 143 |
| 14. Only green plants can make their own food. | | 104 | 139, 142-143 |
| 15. Plants change with the seasons. | | | |
| 16. Most plants have roots, stems (trunks), leaves, flowers, and seeds. | 95-100 | 104 | 138-141 151-152 155,158 |
| 17. Animals depend on plants for their food supply. | 108-111 | | |
| 18, Forests provide food and homes for many animals. | 108-111 | | |
| 19. Plants and animals are interdependent. | 136-139 | | 104 |

Chapter VI Applied Science Grade III

Main Concept: A great variety of plant, animal, and synthetic materials are used in the manufacture of cloth and clothing.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Definition of applied science: Science used for the benefit of people, is called applied science. | 115 | | |
| 2. Cloth is made from threads woven of twisted fiber. | 114-119 | | |
| 3. Fibers of some animals used are: hair, fur and wool. | 114-119 | | |
| 4. Some moths have cocoons made of silk fibers, which can be unwound to make silk. | 120-121 | | |
| 5. Plant fibers are used to make cloth. The fibers in the seed pods of cotton provide cotton threads. | 122-124 | | |
| 6. Looms are used to weave thread into cloth. Automated looms are now being used to make cloth. | 125-127 | | |
| 7. Colors of cloth are made from dyes obtained from plants, coal, tar, and other substances. | 128-130 | | |
| 8. Chemists have found ways to make cloth out of wood, milk, coal, sand, straw, and beans. | 130-133 | | |

Chapter VII Heat Grade III

Main Concept: Heat travels by conduction, convection, and radiation. Some materials are good conductors of heat: some are good insulators.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Most clothing acts as a heat insulator. | 136-137 | | |
| 2. Poor conductors of heat are called insulators. | 138-147 | | |
| 3. Metals are good conductors of heat. | 138-147 | | |
| 4. Heat can be radiated and reflected. | 142-143 | | |
| 5. Shiny objects reflect heat. | 142-143 | | |
| 6. Fuel, heat, and oxygen are necessary in order to have fire. | 144-146 | | |
| 7. Heat is needed to start a fire burning. | 144-146 | | |
| 8. Oxygen is needed to keep a fire burning. | 144-146 | | |
| 9. Homes can be heated by conduction, convection and radiation. | | | |
| 10. Heat is conducted from inside the radiator, through the metal, to the air in the room. | 147-150 | | |
| 11. Heat travels from the furnace to the radiator by convection. | 147-150 | | |
| 12. Heat also warms the air in a room by convection. | 147-150 | | |
| 13. The heat from the radiator warms us by radiation. | 147-150 | | |
| 14. A fire can be put out by eliminating either fuel, heat, or oxygen. | 151 | | |

Chapter VIII Machines At Work Grade III

Main Concept: Most machines make work easier by increasing either force or speed.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Most simple machines change either force or speed. | 154-161 | | |
| 2. Levers can increase force or speed. | 156-161 | | |
| 3. There are three classes of levers. Each has:<br>a. A fulcru<br>b. A force .n.<br>c. A load arm. | 156 | | |
| 4. Gears are used in many devices to increase speed. The gears in the following machines increase speed:<br>a. Egg beater.<br>b. Hand drill.<br>c. Bicycle. | 162-165 | | |
| 5. A wedge increases force. | 166-169 | | |
| 6. A wedge cuts and spreads materials. | 166-169 | | |
| 7. Some tools have wedges that increase force. | 166-169 | | |
| 8. Some plants and animals also have wedges. | 168 | | |
| 9. Energy is required to move a machine. | 156-171 | | 142 |

Chapter IX Electricity at Work Grade III

Main Concept: Electric current has many uses. As it flows in a circuit, it produces heat as in a toaster, light as in a light bulb, and movement as in a vacuum cleaner.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Electric current is used to produce heat and light. | 172-177 | | |
| 2. Electricity makes a filament (thin wire) of a light bulb glow. | 172-177 | | |
| 3. A fluorescent bulb has a gas that glows. | 172-177 | | |
| 4. Electricity going through a thick wire gives more heat than light. | 172-177 | | |
| 5. Electricity can be used to produce motion. | 178-181 | | |
| 6. Electromagnets are used to move substances made of iron. | 178-181 | | |
| 7. An electric motor has electromagnets that make an iron wheel spin around. | 178-181 | | |
| 8. Electricity flows when there is a complete circuit. | 182-185 | | |
| 9. Switches are used to break a circuit of electricity. | 182-185 | | |

Chapter X Planets and Stars Grade III

<u>Main Concept</u>: Our solar system is made up of the sun, nine known planets and their moons. The planets and moons receive heat and light as they move around the sun.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. It is considered possible that people will someday visit the moon in a rocket ship. | 188-196 | | |
| 2. A rocket ship to the moon must be aimed ahead of the moon in its orbit because of the distance of the moon from the earth and the movement of the moon. | 188-192 | | |
| 3. Rockets travel through airless space. | 193-194 | | |
| 4. Hot burning gases within the rocket engine will provide the push to send the rocket into space and back. | 193-194 | | |
| 5. Scientists believe that the moon lacks air and water and differs from the earth in other respects. | 195-196 | | |
| 6. People will have to prepare for these conditions when they go to the moon. | 197-201 | | |
| 7. The moon travels around the earth in about a month. | | | |
| 8. The sun shines on the moon. | 197-201 | | |
| 9. One side of the moon is always light. | 197-201 | | 36-37<br>40-47 |
| 10. Sometimes we see all the lit-up side; at other times we see only a part of it or none at all. These different shapes are called phases. | 197-201 | | |
| 11. There are nine planets in our solar system. | 202-205 | 32 | 68-71 |
| 12. Four planets are larger than the earth and four are smaller. | 202-203 | | |
| 13. A star is like the sun and shines by its own light. | 206-207 | | |

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 14. The brightness of the sun and sky keeps us from seeing the stars in the day time. | 206-207 | 46-57 | |
| 15. A constellation is a group of stars with its own shape. | 207 | 44 | |
| 16. The sun is a star. It is much larger than earth. | | 33 | 66-67 |
| 17. The sun is the source of most of our energy. | | 160 | 73 |
| 18. Many parts of the earth have four seasons. | | | 76-77 |
| 19. The amount of energy received by a section of the earth depends upon the angle at which the sun's rays strike the ground. | | | 78-79 |
| 20. It takes the earth a year to revolve around the sun. | | | 81 |
| 21. The axis of the earth is always pointed in the same direction. | | | 80 |
| 22. Rotation of the earth on its axis results in day and night. | | | 80-81 |
| 23. When the northern half of the earth is tilted toward the sun, there is summer in the north and winter in the south. When the southern half of the earth is tilted toward the sun, there is summer in south and winter in the north. | | | 82-85 |
| 24. Every action has an equal opposite reaction. | 193-194 | | |
| 25. Stars vary in size, brightness, and distance from the earth. | | 33,42 | |
| 26. The universe is made up of many star systems or galaxies. | | 34 | |

Chapter XI | The Earth's Surface | Grade III

Main Concept: The surface of the earth is made of bedrock. Bedrock is changed to rock and soil by temperature changes and by the action of water, plants, and animals.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The surface of the earth is bedrock. Other parts are covered with soil or water. | 210-214 | 72 | |
| 2. Bedrock is changed to rock and soil by temperature changes and by the action of wind, water, plants, and animals. | 210-229 | | |
| 3. The earth's materials are constantly changing. | 210-229 | | |
| 4. Many changes occur in cycles. | 210-229 | | |
| 5. Matter is anything that takes up space. Even though the form in which matter exists may change, matter itself cannot be destroyed. | | 62-65 67-69 | |
| 6. The earth's surface is always changing as rocks are changed to soil. | 214-215 | | |
| 7. There are many different kinds of rock. | 225-227 | | |
| 8. Many different kinds of soil are formed as different kinds of rocks are changed to soil. | 225-227 | | |
| 9. Running water changes the surface of the earth and may form canyons, valleys, and deltas. | 218-221 | | |
| 10. Some of the earth's surface is rocky; other parts are covered with soil or water. | 210-214 | | |
| 11. Soil contains tiny bits of rock. Soil was formed from rocks that once perhaps were part of mountains. | | 69, 120 | |
| 12. Rock is cracked and split by contraction and expansion caused by temperature changes. | 215-216 | | |
| 13. Contraction and expansion can be taken care of, as in sidewalks and train tracks, by spaces being left. | 217 | | |

Chapter XI

Grade III

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 14. Water in cracks of rocks expands when it freezes, thereby splitting the rocks. | 222-223 | | |
| 15. Some plants soften and crumble rocks as they grow on them. | 224 | | |

Chapter XII | Learning About Rocks | Grade III

Main Concept: Geologists can tell much of the history of a region by studying rocks and fossils contained in rocks. Sedimentary rocks are formed when sand or mud, plus other tiny particles, after being removed by running water to an undersea location, generally becomes layered and the particles stick together as rock because of pressure, weight, and chemical actions.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Rocks differ in many ways such as hardness, color, and texture. Identification and grouping is also dependent upon how they were made and where they come from. Hardness is a means of identification, and a scratch test is used which compares the hardness of rocks on a chartlike scale. | 230-235 | | |
| 2. Sandstone is a rock which is formed by the action of the wind, water, and ice on older rocks which become stuck together while under shallow seas. | 236-237 | | |
| 3. Sandstone, a sedimentary rock, varies in color according to the chemical materials which hold the sand particles together. Sandstone is used largely as a building material. | 236-237 | | |
| 4. Clay is a sedimentary material which may not have become rock. | 238-242 | | |
| 5. Clay has been used for making bricks, pottery, chinaware, and many other products. | 238-242 | | |
| 6. Clay, when heated, becomes hard and waterproof. | 240-242 | | |
| 7. Sedimentary materials are emptied or deposited in the sea by rivers. | 243 | | |
| 8. Large particles of sediment in the form of pebbles become stuck together to form a rock called puddingstone. | 244 | | |
| 9. Limestone is a sedimentary rock that varies in color, texture, and origin. The origin is mainly plant or animal marine life. | 244-245 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 10. Limestone can be identified by means of an acid test. | 246 | | |
| 11. Because of their formation, most sedimentary rocks are layered and layering yields much information to the geologist. | 230-235 | | |
| 12. Fossils are the remains or prints of former plant or animal life found naturally buried in rock. | 247 | | 69-90 |

Chapter XIII | The Water Cycle | Grade III

<u>Main Concept</u>: By studying the water cycle and the properties of water, people have obtained knowledge of how to conserve and use our water supply more wisely.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Water leaves the earth through evaporation and returns in some form of precipitation such as rain. This is called the water cycle. | 250-255 | | |
| 2. Water vapor, carried up by air as it evaporates may form clouds or fog. Clouds that touch the earth are called fog. | 254 | | 52-56 |
| 3. There are four different types of clouds:<br>a. The big fluffy clouds are cumulus clouds:<br>b. The dark storm clouds from which rain falls are nimbus clouds.<br>c. The cirrus clouds look like a little curl of smoke.<br>d. The flat clouds that spread across the sky are the stratus clouds. | | | 57-58 |
| 4. Water vapor in a cloud clings in tiny particles to specks of dust as it cools. | 254-255 | | |
| 5. Some of the moisture that falls on the land soaks into the ground and forms underground water, most of which returns to the sea by flowing into small streams and subsequently into larger rivers. | 252 | | |
| 6. Water can be stored for later use, or it can flow into irrigation ditches that carry water to plants. | 256-257 | | |
| 7. Irrigation helps crops to grow on land that would otherwise be barren. | | 213 | |
| 8. Water is transported from the principle source through large pipes called mains, and then through smaller pipes to most of our homes. | 258-263 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 9. Water mains carry the water from the source of supply to smaller pipes for distributing to people and factories. | 258-263 | | |
| 10. Pumps force the water through the pipes. | 258-263 | | |
| 11. The earth's materials are used over and over again. | 250-255 | 62-68 | 52-56 |

Chapter XIV | Cycle of a Mineral | Grade III

Main Concept: Calcium is needed by people for the formation of their bones and teeth, by sea animals for the formation of their shells and by plants for proper growth. The sedimentary rock is made up largely of calcium.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Sea animals make their hard shell homes out of lime, containing calcium, which is dissolved in water. | 266-271 | | |
| 2. People's teeth and bones require calcium, which we get from food, especially milk. | 266-271 | | |
| 3. Cows get their calcium from plants which in turn have received calcium from the soil. | 205-206 | | |
| 4. Limestone, containing calcium, is the rock from which most underground caves are formed. | 272-273 | | |
| 5. Water, flowing through limestone, contains carbon dioxide and forms a substance which over a long period of time, causes limestone to dissolve and form a cave. | 272-273 | | |
| 6. Calcium is a necessary element for plants. | 274 | | |
| 7. Limestone is crushed to form powdered lime for the type of fertilizer that returns calcium to the soil. | 276-277 | | |
| 8. Calcium undergoes changes within the earth's crust. | 276-277 | | |
| 9. Minerals of the earth are frequently used and reused. | 276-277 | | |
| 10. Calcium, like all other matter, can be neither created or destroyed; it is simply changed in form physically or chemically. | 274-277 | | |

## Science In The 4th Grade

This outline provides for the following areas of major emphasis in the 4th grade, as noted by an (*).

1. Living Things.

    a. Plants*
    b. Animals*
    c. Interdependence*

2. The Earth

    a. Structure and History*
    b. Air, Atmosphere, and Weather*
    c. Conservation

3. Space Beyond the Earth

    a. Sun and Other Heavenly Bodies*
    b. Space Exploration

4. Matter and Energy

    a. Heat
    b. Sound
    c. Light
    d. Electricity and Magnetism*
    e. Friction and Machines*
    f. Atomic and Nuclear Energy
    g. Composition of Matter

5. The Human Body

    a. Structure and Function*
    b. Health and Safety

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This inventory of background would serve as the basis for selecting only those instructional materials, activities, experiments and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understandings and generalizations in a different sequence, different grouping, in correlation with other curriculum areas. This also will be dependent upon the background and special needs of the class. Likewise, this guide provides a basic framework for developing science understandings and generalizations. Classes or individuals with special interest and abilities could proceed beyond the scope of this outline.

Chapter I | The Insect World | Grade IV

<u>Main Concept:</u> Insects are the largest, most widespread group of animals. Adult insects have six jointed legs, three body parts, a hard exoskeleton and either three or four life stages. Ants, hornets and honeybees are social (group living) insects. Some insects damage crops.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Insects are the largest, most widespread group of animals because they can adapt to many varied conditions. | 1-3 | 53,54,73 | |
| 2. Adult insects have the following parts:<br>a. Six jointed parts.<br>b. Three body parts.<br>1. Head.<br>2. Thorax.<br>3. Abdomen.<br>c. Hard Exoskeleton. | 4-8 | | |
| 3. Various insects have different kinds of mouths used for:<br>a. Biting.<br>b. Chewing.<br>c. Sucking. | 6 | | |
| 4. Some insects have the following four life stages.<br>a. Egg.<br>b. Larva.<br>c. Pupa.<br>d. Adult. | 9-12 | | |
| 5. Some insects have the following three life stages.<br>a. Egg.<br>b. Nymph.<br>c. Adults. | 12 | | |
| 6. Insects have forms of communication:<br>a. Sounds.<br>b. Motions. | 14-15 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 7. Social insects are those who live together in colony and share the work.<br>a. Bees.<br>b. Ants. | 19-22<br>23-24 | | |
| 8. Many insects are protected by their color and their shape. | 16-18 | | |
| 9. Insects survive in great numbers because each kind lays many eggs in different places. | 13 | | 88 |
| 10. Insects can be both helpful and harmful to men. | 25-27 | | 83-87 |

Chapter II Plants and Seeds Grade IV

Main Concept: Flowering plants produce seeds made up of a tiny plant and some food. Seeds are scattered in a variety of ways and may grow into new plants.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Flowering plants produce seeds. | 31 | | |
| 2. Parts of a seed:<br>a. Covering.<br>b. Tiny plants.<br>c. Food for plant. | 40-41 | | |
| 3. The three most important parts of a flower:<br>a. Stamen, long tree like part with knobs at tip.<br>b. Pistil, base of flower petal containing ovary.<br>c. Petal, surrounds the seed-making part. | 32-33 | | |
| 4. Pollen is a powder found at the tip of the stamen. | 24-38 | | |
| 5. Ovules, the beginning of seeds, are found in ovary. | 34,37 | | |
| 6. Fruit is the scientific name for a ripened ovary. | 33,39 | | |
| 7. Ovules are fertilized by pollen in order to produce seeds. | 37 | | |
| 8. The methods of pollination:<br>a. Self pollination, when stamens are longer than pistils.<br>b. Cross pollination, when pollen comes from one flower and is carried to another by birds, insects or man. | 34-38 | | |
| 9. Two types of seeds:<br>a. Monocotyledons.<br>--Seeds with one part (cotyledon).<br>b. Dicotyledons.<br>1. Seeds with tow parts (cotyledon).<br>2. Flower parts in groups of 4 and 5. | 44-45 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 10. Seeds have properties that help them travel. | 46-47 | | |
| 11. Seeds are transported by:<br>a. Wind. c. Animals.<br>b. Water. d. Gravity. | 46-47 | | 77 |

Chspter III Molecules of Matter Grade IV

<u>Main Concept</u>: Molecules (smallest single particle of a substance) are always in motion. Each of three states of matter depend on the way molecules are held together. We use air molecules in the gaseous state. Differences in air pressure can make things move.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. All matter is made up of atoms and molecules. | 51-57 | 140-141 | 99-101<br>105-110 |
| a. A molecule is the smallest single particle of a substance. | 52-53 | | |
| b. Atoms are smaller particles found in molecules. | 52-53 | 141 | 105-106 |
| 2. The three states of matter are: | 58-59 | | 102-104 |
| a. Solid.<br>b. Liquid.<br>c. Gas. | | | |
| 3. Each of the three states of matter depend on the way molecules are held together. | 62 | | |
| a. In a solid, molecules hold their place. | 62-63 | | 117 |
| b. In a liquid, molecules roll and slide over each other. | 64-65 | 245,246 | 117-118 |
| c. In a gas, molecules are far apart. | 67-69 | 231,242<br>243 | 118-119 |
| 4. Heating or cooling can change molecules from one state to another. | 60-61,68<br>70-72 | | 115-123 |
| 5. The higher the temperature, the faster molecules vibrate. | 67 | | |
| 6. Air, the most useful gas, is composed of molecules of: | 74-77 | 231-233<br>242-243 | |
| a. Nitrogen.<br>b. Oxygen.<br>c. Traces of other gases. | | | |
| 7. Oxygen is necessary for breathing. | 74-75 | 102,104,<br>105,132,<br>137 | 244-245<br>253,269<br>274,286 |
| 8. Air pressure is the push of air molecules in all directions. | 78-81 | 231,242<br>243<br>254,255 | 245-246<br>270-271<br>286 |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 9. Compressed air is air pressed and squeezed into a smaller space. | 81-82 | | 166-167<br>277 |
| 10. Since compressed air pushes with more force than normal air, it is used in the operation of machinery. | 82-83 | 26-28 | 163-164 |

Chapter IV | Causes of Weather | Grade IV

Main Concept: The chief factors in weather are the sun's heat, the movement of air, and the movement of water. The temperature of the air depends mainly on the heating effects of sunlight. Differences in temperature bring about movement of air. Wind is air motion. Heat causes the evaporation of water into the air and loss of heat causes the condensation of water vapor.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The weather changes constantly because of the earth's surface. | 88-89<br>94-95 | 224-229<br>233-236 | |
| a. The sun heats the land and the water. | 88-89 | 234 | |
| b. Water heats up faster than land. | 95-97 | 234-237 | |
| c. Number of hours of sunlight determines the weather. | 90-91 | | |
| 2. The earth is covered by a blanket of air. | 94 | | |
| a. Temperature of the air depends on the heating effects of sunlight. | 98-99 | | |
| b. Sunlight heats the earth and the earth heats the air. | 98-99 | | |
| c. Warmed air expands and becomes lighter. | 101 | 237-239 | |
| d. Cooler air is heavier. | 101 | 237-239 | |
| 3. Air currents are movements of air. | 100 | 232-233 | |
| 4. Wind is air in motion. | 102-104 | 232 | |
| a. Winds are caused when cooler air displaces warmer air. | 102-104 | | |
| b. The force of wind depends on the difference in temperature between masses of warm air and cool air. | 104 | 242-245 | |
| c. Winds help even out the temperatures of the earth. | 105 | | |
| 5. Evaporation of water into the air is caused by heat. | 115 | 247-248 | |
| 6. Condensation of water vapor is caused by loss of heat. | 106 | 120-122 | 248-252 |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 7. Clouds are formed when water vapor collects high in the air. | 112-114 | | |
| a. Very cold clouds cause water. | | | |
| b. Fog is a cloud near the ground. | 107 | | |
| c. Dew is droplets of water formed on cool objects from water vapor in the air. | 106 | | |
| 8. The water cycle is water evaporating into the air and returning to earth in various forms. | 115 | 247-252 | 117-119 |
| a. Rain, drops of water. | 109 | 249 | |
| b. Snow, rapidly frozen water vapor. | 112-113 | 249 | |
| c. Hail, round pieces of ice formed in clouds. | 111 | 252 | |
| d. Sleet, frozen rain. | 111 | 252 | |
| 9. Breezes: | 102 | | |
| a. Seabreeze, cool air over water flows in and replaces warmer air, rising over land. | 102 | 232-238 | |
| b. Landbreeze, cool air over land flows out and replaces the warmer air rising over the water. | 103 | 237-238 | |

Chapter V Climate and Living Things Grade IV

Main Concept: Climate is the average weather of a region over a long period of time. Rays of the sun that are directly overhead heat the earth much more than slanting rays. Altitude and nearness to large bodies of water cause differences in climate. Climate is important to the way man, animals, and plants live in different regions.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Climate is the type of weather a place had over a long period of time. | 120 | | 83,87, 90-91 |
| 2. Polar climates exist in the Arctic and Antarctic regions. | 119-123 | | |
| 3 Polar climates have: | 125 | | |
| a. Night most of the time during winter. (24 hours of darkness) | 125,137 | | |
| b. Daylight most of the time during the short summers. (24 hours of sunlight) | 130,137 | | |
| 4. Polar regions receive less heat from sunlight because of the slanting rays of the sun. | 133-135 128-132 | | |
| 5. Dark things become warmer than light things in sunlight. | 138-139 | | |
| 6. Tropical climates exist in the areas between the Tropic of Capricorn and the Tropic of Cancer. | 150 | | |
| 7. Tropical climates have: | 150 | | |
| a. Equal hours of sunlight and darkness almost all year. | 150 | | |
| b. The sun is directly overhead at noon in the tropics. | 151 | | |
| 8. There are three main types of tropical climates which are determined by the amount of rainfall. | 152 | | |
| a. Rainforest Climate, hot and rainy the year around. | 152-153 | | |
| b. Savannas, a few months of heavy rainfall, the rest of the year is dry. | 154 | | |
| c. Desert, hot and dry. | 155 | | |

| Understandings to be developed | Heath | Macmillan | American |
| --- | --- | --- | --- |
| | (page) | (page) | (page) |
| 9. Middle latitude climates are found between the polar regions and the tropical regions. | 159 | | |
| a. Middle latitude climates have four seasons because the angle at which the sunlight strikes the earth differs from season to season. | 159 | | |
| b. Temperature is influenced by altitude and nearness to the large bodies of water. | 165 | | |
| 1. Heavy rain on the windward side of mountains. | 163-164 | | |
| 2. Desert climate on the lee side of of mountains. | 163-164 | | |
| 10. Animals adapt to their environment. | 140-143 | | |
| 11. Plants adapt to their environment. | 144 | | |

<u>Main Concept</u>: Water, the most important liquid on earth, exists in three states and can dissolve many substances which are important for living things. Plants and animals cannot live without water. Plants obtain soil minerals dissolved in water. In animals, water is the basic liquid for transportation of substances to and from cells, and in some animals, is the liquid for the cooling system.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Water is the most important liquid on earth. | 169-170 | | 102-104 |
| -- Animals and plants cannot live without it. | | | 244 |
| 2. Water can be in the solid, liquid or gaseous states. | 171 | | 102-104 |
| a. Liquid state is most useful.<br>b. Liquid water can dissolve many substances. | | | |
| c. A solution is a liquid with something dissolved in it. | | | 136-137 |
| 3. All plants need water and are made up mainly of water. | 174 | 63-65 | |
| a. Plants get water and dissolved minerals from the earth. | 175 | 69 | |
| b. Plants use some water and all the minerals. | 175-176 | 70-72<br>77 | |
| 4. Living things use water as transportation system. | 177-178<br>180 | 91-95<br>136-137 | |
| a. Blood is mostly water with substances dissolved in it.<br>b. Blood carries dissolved substances throughout the body. | | | |
| 5. The heart, blood, and blood vessels are responsible for the transportation of materials in the body. | 188 | | |
| a. The heart is a pump which sends blood through the blood vessels. | 188-189 | | |
| b. The heart, arteries, veins and capillaries make up the circulatory system. | 189-191 | | |
| c. The pulse, the throbbing of blood moving through arteries, is caused by the heart beat. | 192-194 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 6. All living things are made up of cells. | 180 | 105-106 | |
| -- Cells require water and food. | 182-183 | | |
| 7. All living things need oxygen. | 187-195 | | |
| 8. The digestive system prepares food for use by the body. | 197 | | |
| a. Mouth.<br>b. Stomach.<br>c. Small Intestine. | | | |
| 9. The body has several ways of removing waste materials. | 198 | 104 | |
| a. Blood carries cell wastes to the kidneys, which form a solution called urine. | 198 | | |
| b. Some water and waste materials are taken from the blood by the sweat gland forming a solution called perspiration. | 198-199 | | |
| 10. The body keeps a steady temperature. | 201 | | |
| a. Around 98.6° F is normal body temperature.<br>b. Body temperature is kept steady with help from sweat glands and perspiration. | | | |

Main Concept: There are many ways of traveling -- on land, on water, and in the air. All involve the same three factors: a force, something to push against, and a resistance that is less than the force. In airplane flight, an additional force is required to produce lift. Friction is a resistance present in all motion. Friction can be reduced in various ways.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. All movement is the result of a force overcoming a resistance. | 207-210 | | 151-154<br>190 |
| -- Work is done when something is moved by a force. | | | |
| 2. Friction results when two surfaces rub against each other. | 211 | | 151 |
| a. The rougher the surface, the greater the friction. | 212 | | |
| b. The heavier the load, the more friction there is to overcome. | 217 | | |
| 3. Friction is resistance in all motion. | 211 | 44-46<br>48-49 | 280<br>248-249 |
| 4. Friction can be reduced by using: | 213<br>216-219 | | |
| a. Rollers.<br>b. Wheels.<br>c. Bearings.<br>d. Lubricants. | | | |
| 5. For every action there is an equal and opposite reaction. | 224-225 | 37-42 | 275-276 |
| a. A downward push causes an object to rise.<br>b. A backward push causes an object to go forward.<br>c. Examples. | | | |
| 1. Swimming. | 224 | | |
| 2. Flying. | 227 | | |
| 3. Boating. | 226 | | |
| 6. Thrust is the forward push of a boat or airplane produced by the action of its propeller. | 231<br>233-235 | | |

Chapter VIII Machines And Power Grade IV

Main Concept: Muscle Power was the first form of energy used by man to do work. Steam, moving air, flowing water, hot gases from a flame, and electricity have energy. Work is done when a force moves something. Power machines have lightened the work of getting food, shelter, and clothing.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Machines are designed to make work easier. | 266-267 | 24 | |
| 2. Work is done when a force moves something. | 258 | | |
| 3. A force is a push or pull. | 258 | | |
| 4. Wind, water, and steam can be used to do work. | 244-246 | | |
| a. The force of water is more dependable than the force of wind. | 244-299 | | 157 |
| b. Steam can push with greater force than wind or water. | 250-252 | 36 | |
| 5. Steam is water in a gaseous state. Force of steam can turn a large turbine. | 253 | | 168 |
| 6. Gasoline engines are used when lighter-weight engines that start quickly are needed. | 254-255 | | |
| 7. Diesel engines are used to pull heavy loads. | 256-257 | | |
| 8. Gas turbines are driven by hot gases from burning fuel. | 257 | 36-37 | 170-171 |
| 9. Energy can do work. | 258 | 22-25 | 163-167 |
| 10. Electricity can be generated in several ways and can be used in many ways. | 261-265 | | 182 |
| 11. Electric motors drive many kinds of machines. | 258-261 | 148-164 | 172-174<br>182 |
| a. An electromagnet is formed when electricity flows through a wire which is wound around an iron core. | 260-261 | 159-161<br>160 | |
| b. Each motor has an electromagnet. | 258 | 160 | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 12. An alternating current starts flowing in one direction, stops, and reverses direction many times per second. | 261-262 | 148-164 | |
| 13. An electric current flows from a generator through wires to many places. | 264-265 | 148-164 | 172-173 |

Chapter IX Earth, Moon, and Space Grade IV

Main Concept: The moon is a satellite of the earth. The planets of the solar system and their moons revolve around the sun in constant orbits in the same direction, but at different speeds. The year, month, and day are determined by the earth's and moon's motions. The moon's surface gravity is one-sixth that of the earth. It is believed that the moon has no atmosphere, no bodies of water, and no living things. The moon's gravitational attraction is the chief cause of tides.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Galaxies contain billions of stars. | 275 | | 202-204 |
| 2. There are probably billions of galaxies. | 276 | | 202-204 |
| 3. Our Solar system consists of nine planets and our sun. | 274 | | |
| 4. All satellites, natural or artificial, travel around the sun in fixed orbit. | 274 | | 195, 238 |
| 5. The earth is a natural satellite of the sun. | 271-272 | | |
| a. The earth's circumference is 25,000 miles. | | | |
| b. The earth is one of the nine planets that revolve around the sun in fixed orbits, in the same direction, but at different speeds. | 274 | | |
| c. The earth makes one rotation, called a day, on its axis in 24 hours. | 279 | | |
| d. The earth makes one revolution, called a year, in $365\frac{1}{4}$ days. | 278 | | |
| 6. The moon is a natural satellite of the earth. | 273-290 | | 259-267 |
| a. The moon's diameter is $\frac{1}{4}$ as large as the earth's diameter. | 280 | | |
| b. The moon has no atmosphere and can't support life as we know it. | 285 | | |
| c. Gravity on the moon's surface is one sixth of that of the earth's surface. | 285 | | |
| d. The moon is a sphere containing, plains, mountains, and craters. | 284 | | |
| e. The moon reflects the light of the sun. | 281 | | |
| f. One revolution of the moon around the earth is called a month. | 282 | | |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 7. The moon and the sun influence our tides. | 291 | | 196,208 228,286 |
| a. A high tide occurs on the side of the earth nearest the moon and on the opposite side farthest from the moon. | 291 | | |
| b. Low tides occur at the places between the two high tides. | | | 196,208 228,286 |
| c. Spring tides and extra high tides, occur twice a month. | 292 | | |
| d. Neap tide, a small high tide, occurs a week after spring tide. | | | |
| e. A tidal day is 24 hours and 52 minutes long. | 293-297 | | |

## Science in the 5th Grade

This outline provides for the following areas of major emphasis in the 5th grade, as noted by an (*).

1. Living Things

    a. Plants*
    b. Animals*
    c. Interdependence*

2. The Earth

    a. Structure and History*
    b. Air, Atmosphere, and Weather*
    c. Conservation*

3. Space Beyond The Earth

    a. Sun and Other Heavenly Bodies*
    b. Space Exploration*

4. Matter and Energy

    a. Heat*
    b. Sound
    c. Light
    d. Electricity and Magnetism*
    e. Friction and Machines
    f. Atomic and Nuclear Energy*
    g. Composition of Matter

5. The Human Body

    a. Structure and Function*
    b. Health and Safety*

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This invento of background would serve as the basis for selecting only those instructional materials, activities, experiments and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understandings, and generalizations in a different sequence, different grouping, or in correlation with other curriculum areas. This also will be dependent upon the background and special needs of the class. Likewise, this guide provides a basic framework for developing science understandings and generalizations. Classes or individuals with special interests and abilities could proceed beyond the scope of this outline.

Chapter I | The Weather Forecast | Grade V

Main Concept: Meteorologists (weather scientists) can predict weather conditions with a remarkable degree of accuracy by using special instruments and interpreting the information supplied by these instruments and other sources.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Weather is important. | 1-3 | | |
| 2. Winds are currents of air and are caused by differences in temperature and pressure. | 6-7 | 214-216 | 17-19<br>60 |
| 3. We can often tell about the coming weather by the kinds of clouds. | 19-21 | 216,240<br>241,258<br>356 | |
| 4. Cloud Shapes: | 19-20 | 231-258 | |
| a. Cirrus.<br>b. Stratus.<br>c. Cumulus. | | | |
| 5. Precipitation: | 26-29 | | |
| a. Rain.<br>b. Snow.<br>c. Sleet.<br>d. Hail. | | 233-235<br>241,356 | |
| 6. A combination of several special weather conditions can develop into a violent storm called a hurricane. | 32-33 | 251 | |

Chapter II Earth and Space Navigation Grade V

Main Concept: Sucessful navigations from one place to another, whether on land, at sea, in the air, or in space, is based on our knowledge of the earth and space beyond, and requires the use of specialized instruments.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. People explore for various reasons. | 36-38 | | |
| 2. The earth is a sphere. | 39-43 | | 242,274<br>5, 64<br>315 |
| 3. The heated air around the equator and the cold air near the poles causes the air to flow in huge circles. | 44-45 | 221-222<br>239,240 | 44-45 |
| 4. The heating and cooling of water sets up large and steady currents in the ocean. | 44-45 | 332-334 | |
| 5. Cold water sinks down and causes warm water to rise. | 46-48 | | |
| 6. A magnetic compass works because the earth is a magnet having two ends or poles. | 49-52 | 13 | 71 |
| 7. Between the earth's two magnetic poles is a magnetic field including the earth and the poles themselves. | 49-52 | | |
| 8. Parts to Newton's Law of Universal Gravitation:<br>a. Everthing has gravitation.<br>b. The more mass to a substances, the stronger its gravitation.<br>c. The greater the distance between two things, the weaker the gravitation between them. | 62-71 | 272,280 | |

Main Concept: Energy is the capacity to do work. In order to do work, a form of energy must be transferred into another form or from one place to another place.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Energy is the ability to do work causing something to move. | 74-80 | | |
| 2. Forms of Energy:<br>a. Mechanical.<br>b. Heat.<br>c. Chemical.<br>d. Electrical.<br>e. Light. | 74-80 | | 194-199<br>221-227<br>237 |
| 3. The amount of input energy is always equal to the amount of output energy. | 74-80 | | |
| 4. The Law of Conservation of Energy states:<br>"Energy cannot be created or destroyed, it can only be transferred from one form to another." | 74-80 | | |
| 5. Matter is the name given to everything that has weight and takes up space. | 81-83 | 170,356 | |
| 6. Atoms are composed of protons, neutrons, and electrons. | 81-83 | 191,206<br>356,6-7<br>196-204 | 68,70<br>72,81<br>110 |
| 7. When different kinds of atoms are combined, the substance is called a compound. | 81-83 | 192,206<br>356 | 70-71 |

Chapter IV Mechanical and Heat Energy Grade V

Main Concept: When the molecules of a substance, whether in a solid, liquid, or gaseous state, move together as a group they produce a form of energy called mechanical energy. Mechanical energy is usually the result of energy transfers. The terms heat and temperature have different meanings. Temperature is a measure of the average speed of molecules; heat is the total amount of energy, due to temperature, possessed by the molecules of a substance.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. When molecules of an object move together as a group, the result is mechanical energy. The molecules may be in any of the three states of matter, solid, liquid or gas. | 92-96 | | 316-317 |
| 2. Pushing, pulling, lifting, shoving, turning, twisting, cutting, pressing, and drilling are examples of work done by the output of mechanical energy. | 92-96 | | |
| 3. Mechanical energy is measured in units called foot-pounds. One foot-pound is the amount of work done in raising a one-pound weight a distance of one foot. | 92-96 | | |
| 4. The molecules of most substances when heated move faster and farther apart, causing the substances to expand or become larger. When these substances lose heat energy they contract. | 97-99 | | 72-81<br>85-86<br>101,102 |
| 5. Rapidly moving molecules have a higher temperature than slowly moving molecules. | 100-105 | | |
| 6. Heat has to do with the total amount of energy of the molecules. | 106-108 | | |
| 7. One of the most useful ways of getting warm from heat energy is to transfer it to mechanical energy. | 109-113 | | |

Main Concept: Most substances are a combination of atoms of two or more of the 103 known elements. A chemical change (a change in the internal structure) is produced when atoms are separated, combined with other atoms, or shifted from one molecule to another. Scientists have discovered ways of releasing the energy contained in the nuclei of certain kinds of atoms. In nuclear fission and fusion, matter is changed into heat, light, and other forms of energy.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Many of the substances we use everyday were made by chemical energy. | 116-121 | | 194 |
| 2. Atoms of some substances are held together by a force called a chemical bond. | 116-121 | | |
| 3. The combining of oxygen with any substance is called oxidation. | 121-122 | | 80, 119 |
| 4. The process by which plants make food is called photosynthesis. | 123 | | |
| 5. The energy we get from the nuclea is called nuclear energy. | 124-128 | | |
| 6. Nuclear energy can be released in two ways.<br>a. Fission.<br>b. Fusion. | 124-128 | | |
| 7. The law of conservation of mass-energy states that mass-energy can neither be created nor destroyed; it can only be transferred from one state to another. | 128-131 | | |

Chapter VI Electricity Grade V

<u>Main Concept</u>: Electrical energy is one of the most convenient, important, and perhaps most widely used form of man made energy. It can be transferred into other forms of energy: mechanical, heat, light, sound, and etc.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. All matter is made of atoms. All atoms have a small inner part called a nucleus and on outer part having electrons. | 134-136 | 199-206 | 117,148 174,179 |
| 2. Whenever two different substances are rubbed against each other, electrons are rubbed off one and piled up on the other. | 136-140 | 191,199 206 | |
| 3. This pile of electrons (which is stationary) is called static electricity. | 136-140 | 196-199 | 179-192 |
| 4. A machine that produces an electric current is called a generator. | 144-146 | | 178,210 194-199 207,236 |
| 5. A generator usually has two parts: | 141-146 | 13 | |
| a. A magnet.<br>b. A coil of wire around the magnet. | | | |
| 6. Large electric generators have huge special magnets called electromagnets. | 141-146 | | 223-238 |
| 7. Two wires are needed for an electric circuit: one from the current source to the device, and another wire from the device to the source. | 149-154 | | 212-215 |
| 8. Good conductors. | 155-157 | | 98, 207 211,216 229,236 |
| 9. Poor conductors. | 155-157 | | 98, 207 211,216 229,236 |
| 10. Fuses. | 155-157 | | 213-214 217,237 |
| 11. Circuit breakers. | 155-157 | | 208-210 213,215 218,219 227,229 234,236 |

Chapter VII Your Body And Growth Grade V

<u>Main Concepts</u>: The human body is composed of several systems. These body systems work together.
a. Circulatory.
b. Digestive.
c. Skeletal.
d. Muscular.
e. Respiratory.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Bones are the framework of the body. | 162-165 | 36<br>96-98<br>118,165 | 123,236<br>138,174 |
| 2. Ball and socket joints. | 162-165 | | |
| 3. The white and red cells are carried by the liquid part of the blood, the plasma. | 165-168 | | 124-125 |
| 4. There are hundreds of body muscles both large and small. | 168-169 | 36,108<br>37,38,40<br>96,118,<br>165 | 125-126<br>123,174 |
| 5. Carbohydrates are usually found in foods from plants and are useful as fuels. | 180-182 | | |
| 6. Sugar is a carbohydrate. | 180-182 | 34,40,94 | 72, 164 |
| 7. Starch is a carbohydrate found in every food made from plants. | 180-182 | | |
| 8. Fats are a fuel food. | 180-182 | | |
| 9. Proteins are useful for cell growth and repair. | 182-183 | 28-29 | 34, 40 |
| 10. Foods rich in minerals are needed for bones, teeth and red blood cells. | 183-184 | 34. 40 | 160,161<br>163 |
| 11. Calcium and phosphorus are needed for the development of bones, teeth and red blood cells. | 183-184 | 116,34,<br>40,190<br>191,65<br>154,124 | |
| 12. Vitamins. | 184-185 | | |
| 13. Glands. | 189 | 115-116<br>118,165 | |

Chapter VIII Animals on Our Planet Grade V

Main Concept: Animals found on the earth are classified according to the body structure.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Animal likeness and differences. | 192-194 | 100,101 33,49-50 80,81,83 | 131-146 |
| 2. Plants are like animals. | 192-194 | 33-56,59 61,72 | 115-122 |
| 3. Five groups of vertebrates: a. Fish. b. Amphibians. c. Reptiles. d. Birds. e. Mammals. | 195-216 | | 131-137 174 |
| 4. Invertebrates. | 217-223 | | 138-142 174 |
| 5. Protozoan. | 217,218 | 127,138 | 132 |
| 6. Arthropods. | 222,223 | | 136,137 |

Chapter IX Plants On Our Planet Grade V

<u>Main Concept</u>: There are thousands of different kinds of plants on the earth. Plants have been classified into many groups according to their structure, methods of reproduction, etc.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Plants are classified into two groups: Those that make seeds and those that do not make seeds. | 228-231 | 35,56-59 54,61,72 | 147-157 |
| 2. Dicotyledons. | 232-237 | | |
| 3. Monocotyledons. | 232-237 | | |
| 4. Conifers. | 238-239 | | |
| 5. Ferns and Mosses. | 239-242 | | |
| 6. Algae and Fungi. | 243-249 | | 151,174 |
| 7. Bacteria. | 249-251 | 131,129 160,132 133,152 153,269 | 84,88, 89,116 147 |

Chapter X Geology: Earth's Forces Grade V

Main Concept: The earth's surface is constantly being changed by two forces: Destructional forces that wear down the earth's surfaces, and Constructional forces that build up the earth's surfaces.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The earth's crust is made of several layers of rocks composed of minerals. | 254,255 | | 44,46,51 53,60,61 |
| 2. The earth's surface is always changing. | 254-261 | | 5-64 |
| 3. Volcanoes. | 262-266 | 334 | 2,28-31 42,61 |
| 4. Magma. | 262-279 | | |
| 5. Earthquakes. | 268-274 | | 45-52 61 |
| 6. Quartz is a common mineral. | 275-279 | | |
| 7. Obsidian is a dark, glassy, igneous rock formed from magma. | 275-279 | | |
| 8. Rocks and soil are worn down and carried away. | 280-281 | | |
| 9. Sediment. | 282-285 | | |
| 10. Metamorphic rock. | 286-289 | | |
| 11. Marble is formed from limestone. | 286-289 | | |

Chapter XI　　Conservation: Soil and Water　　Grade V

Main Concept: In order to maintain our natural resources, everyone must help through the conservation of soil and water.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. To conserve something means to use it wisely without wasting it. | 292-294 | | |
| 2. Growing plants and dead leaves help to protect soil from erosion. | 295-297 | | 5, 8-11<br>17-19<br>23, 60 |
| 3. Good soil conservation practice also includes:<br>a. Growing plants like the kudzu vine on eroded hilly land.<br>b. Planting trees to replace those burned out by a forest fire.<br>c. Growing cover crops to keep topsoil from blowing away. | 295-299 | | |
| 4. Flood water can cause great damage. | 303-304 | | 84. 123<br>154-155 |
| 5. Most of the earth's usable water supply comes from rainfall and snowfall. | 305-309 | | 231-233<br>235-238 |
| 6. The highest point of underground water is called the water table. | 305-309 | | |
| 7. When water is not clean and pure, we say it is polluted. | 310-311 | | |
| 8. Water that has been filtered through sand ar gravel may appear clean and yet contain harmful germs. | 310-311 | | |

Chapter XII Geology: Earth's Minerals Grade V

Main Concept: Valuable minerals -- coal, oil, uranium, iron, etc. were formed many thousands of years ago and are used by man to maintain and improve his way of life.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Ore is a mixture of rock materials which contain one or more useful minerals usually containing metals. | 314-319 | | |
| 2. Places where ore is found are called fields, beds, pockets, veins, and lodes. | 314-319 | | |
| 3. Uses of coal include:<br>a. Dyes<br>b. Drugs<br>c. Perfumes | 314-319 | | |
| 4. Petroleum is a mixture of substances having different weight densities. | 320-323 | | |
| 5. Nuclear fuels begin as uranium ore. | 324 | 199,206, 29,33,40 164 | |
| 6. Particles of gold from placer deposits may be washed into streams where they settle near the bottom of the stream beds. | 325-329 | | |
| 7. Iron ore may have been formed by the chemical action of bacteria. | 325-329 | 190,191 244,179 174 | |

## Science in the 6th Grade

This outline provides for the following areas of major emphasis in the 6th Grade, as noted by an (*).

1. Living Things

   a. Plants*
   b. Animals*
   c. Interdependence *

2. The Earth

   a. Structure and History*
   b. Air, Atmosphere, and Weather
   c. Conservation

3. Space Beyond the Earth

   a. Sun and Other Heavenly Bodies
   b. Space Exploration

4. Matter and Energy

   a. Heat
   b. Sound*
   c. Light*
   d. Electricity and Magnetism
   e. Friction & Machines*
   f. Composition of Matter

5. The Human Body

   a. Structure and Function*
   b. Health and Safety

Prior to the beginning instruction in any one of these areas, it would be natural to determine the extent of background that the children have. This inventory of background would serve as the basis for selecting only those instructional materials, activities, experiments and experiences that are appropriate for the class.

The teacher may find it necessary to develop the basic knowledge, understandings, and generalizations in a different sequence, different grouping, or in correlation with other curriculum areas. This will also be dependent upon the background and special needs of the class. Likewise,this guide provides a basic framework for developing science understandings and generalizations. Classes or individuals with special interests and abilities could proceed beyond the scope of this outline.

Chapter I Basic Chemistry Grade VI

Main Concept: Materials exhibit physical and chemical characteristics that enable us to classify and study them in an organized way.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Many chemical changes are helpful and others are harmful. Chemical changes are involved in almost everything we do. | 1-2 | | |
| 2. All matter is made of tiny moving particles called molecules, which in turn are made of the smaller fundamental particles called atoms. | 4-8 | 29-43 | |
| 3. The degree of motion of the molecules in a substance determines whether the substance is a solid, a liquid or a gas. (The three states of matter.) | 4 | 44-45 | |
| 4. An atom is made of small particles, the basic ones being the protons and the neutrons which are found in the nucleus of the atom, and the electrons which revolve around the nucleus. | 7-8 | 102-103<br>109-113 | |
| 5. The atoms of the molecules in a compound are held together by the force of chemical bonds. | 11-20 | | |
| 6. Materials having only one kind of atom are called elements (103 now known), and these elements can be chemically combined to form compounds. | 8-9 | | |
| 7. Compounds differ in their properties from the elements of which they are composed. | 11 | | |
| 8. Compounds can be taken apart as well as put together. | 14,15 | | |
| 9. The state of matter may be changed by the addition or removal of heat. | 4-5 | | 53-54 |
| 10. Different kinds of molecules require different amounts of heat energy to change their state. | 4-5 | 44, 45 | 53, 54 |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 11. Matter may be changed: | 6, 11-20 | 44, 45 | 53, 54 |
| a. Physically, if there is a change in the motion or position of the molecules. | | | |
| b. Chemically, if there is a change in the structure of the molecules and a new material is formed. | " | " | " |
| 12. In every chemical change, there is an energy transfer in which energy is either given off or absorbed. | 20 | | 2, 34 |
| 13. The three basic types of chemical changes: | 14-19 | | |
| a. Combining elements into a compound.<br>b. Separating compounds into elements.<br>c. Rearranging compounds into new compounds. | | | |
| 14. Various groups of tests may be used to analyze unknown substances. | 21-36 | | |
| 15. Each of the elements gives off its own color (or mixture of colors) of light when heated sufficiently. | 37-39 | | 70-71 266 |
| 16. Research in chemistry has helped to make life better for all of us. | 39 | | 96, 319-329 |

Chapter II Sunlight and Life Grade VI

Main Concept: In green plants, substances which are not food combine with the energy of sunlight to form food.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Through the process of photosynthesis, plants which contain chlorophyll, (green plants) make food for all animals on earth. | 44-59 | 236 | 96 |
| 2. The water and minerals needed for photosynthesis enter the plant through the root hairs and are conducted up through tubes in the stem to the leaves. | 45-47 | 237 | |
| 3. The carbon dioxide needed for photosynthesis usually enters the plant through stomata in the leaves. | 48-49 | 237 | |
| 4. In the food-making process, green plants convert low energy substances into high energy substances. | 51-57 | 238-239 | |
| 5. All living things require food, water, air and sunlight to carry on the life processes. | 58-59 | | |
| 6. Some plants do not contain chlorophyll and therefore do not make their own food but use dead plant material for their life process. Bacteria and fungi are examples of such parasites. | 62-66 | 244 | |
| 7. Raw materials needed for the food-making process will not be depleted for they are parts of an endless cycle. The processes of nature are complimentary. | 60-66 | 244 | |

Chapter III | Prehistoric Life | Grade VI

Main Concept: Scientists can use fragmentary remains and other traces in studying plants and animals of the past. Organized and classified, the knowledge of such plants and animals is useful in explaining the geological history of the earth.

| Understanding to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The earth is very old and through extremely slow changes ancient life has developed into modern life. | 82-93 | | |
| 2. The geological history of the earth can be divided into long periods of time during which many different types of life evolved?<br>a. Precambrian Era, simple soft-bodied sea creatures.<br>b. Paleozoic Era, Many more complicated sea creatures, first vertebrates developed - fishes and amphibians; also green plants developed on land.<br>c. Mesozoic Era, reptiles were the dominant form of life; first bird-life creatures developed.<br>d. Cenzoic Era, mammals developed and became the dominant form of life. | 82-89 | | |
| 3. Preserved remains of past life are found as fossils. | 71-79 | | |
| 4. Modern science has made it possible to arrive at the approximate age of a fossil through various methods. The most recent of which is the measurement of decay of radioactive materials. | 80,81 | | |
| 5. Man is a comparative newcomer to the earth. | 90-93 | | |
| 6. Mammals have certain characteristics which easily identify them from other types of animals. Most noticeable of which are that mammals are warmblooded and have hair on their bodies. | 88 | 229-237 | |
| 7. Early man's change from wandering and hunting to an agricultural life helped to develop early civilization. | 90-93 | | |

Chapter IV Sound Waves Grade VI

Main Concept: Sounds are caused by vibrations which are transmitted through matter in the form of waves. The properties of particular sounds are determined by the energy of the source and properties of the material which vibrates.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. Sound waves are only one kind of the many invisible waves which surround us and possess the properties of amplitude, frequency and speed as do the other types of waves. | 93-113<br>121 | | |
| 2. The amplitude, and therefore the volume, of a sound depends upon the amount of force of the vibrating source. | 101-103 | | |
| 3. There are some sounds too high and some sounds too low for the human ear to hear. | 106 | 363-366 | |
| 4. The frequency is also related to the length, weight and tension of a vibrating object. | 107-113 | | |
| 5. We usually use our voice box (Larynx) to communicate by sound. | 114-115 | | |
| 6. Sound vibrations may travel through solids, liquids and gases. | 116-120 | 195 | |
| 7. Sound vibrations travel in a wave motion in all directions from the source. | 116-121<br>167 | | |
| 8. An echo is reflected sound. | 122-123<br>328 | | 184-188 |

Chapter V Sound And Communication Grade VI

Main Concept: We can communicate by using sound vibrations to control electric vibrations in such instruments as the telephone. The electric vibrations then control mechanical vibrations which reproduce the sound.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. People have a definite need for communication. | 127 | | |
| 2. To fill the need for improved communication, a wide variety of instruments have been developed for the reproduction of sound waves. | 127-145 | | |
| 3. The telephone uses three main parts to transmit messages:<br>a. The transmitter, which changes sound vibrations to the electric impulses.<br>b. The conductor, which carries these impulses.<br>c. The receiver, which changes the electric impulses back to sound vibrations. | 128-131 | 133 | |
| 4. A public-address system uses the same principles as a telephone,with the addition of an amplifier. | 132 | | |
| 5. The basic function of a switch is to provide efficient and prompt connection of one telephone to another. | 133-135 | | |
| 6. A telegraph uses two main parts:<br>a. The key.<br>b. The sounder, which sends coded messages usually by means of an electric current. | 137-140 | | |
| 7. A phonograph involves the use of a method of storing sound vibrations as grooves on a record. | 141-144 | | |
| 8. Tape recordings involve a method of storing sound vibrations on a magnetized tape. | 144-145 | 133 | |

Chapter VI Light Waves Grade VI

<u>Main Concept:</u> Light is a form of energy that show characteristics of both waves and particles.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. There is no apparent medium to carry light waves in space. | 154 | 194-195 | |
| 2. In every light source, there is some form of energy transformed to light energy. | 155-156 | | 17 |
| 3. It is possible to measure the amplitude, frequency and speed of light waves. | 157-165 | | |
| 4. Amplitude in light waves is referred to as brightness which is related to the amount of energy involved and the distance from the source. | 157-158 | | 80 |
| 5. Frequency of light waves determines the color of light. | 158 | | 20-21 |
| 6. Different materials obstruct light in varying degrees. (Transparent, translucent, and opaque.) | 169-170 | | 27 |
| 7. Some light is of too low frequency to see. (infra red) | 162-163 | | 23 |
| 8. Light travels at the approximate speed of 186,000 miles per second. | 164 | | 18 |
| 9. Light usually travels in a straight line. | 167 | 196-197 | 4-5 |
| 10. Light can be reflected from surfaces with or without being scattered. | 171-174 | 201-209 | 5-6 |
| 11. Color can be subtracted from white light by filters and absorption. | 175-179 | | |
| a. Surfaces reflect light of their own color. | | | |
| b. Absorbed light is transferred to heat energy. | | | |
| c. Dark-colored objects become warmer in sunlight than light-colored objects. | | | |

Chapter VII Optical Instruments Grade VI

Main Concept: Instruments are made which control light so that images can be changed in size or stored for future viewing.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. All optical instruments are extensions and modifications of the sense of sight. | 183 | | |
| 2. Lenses and mirrors can be used in optical instruments to control the size of an image and to focus light. | 184-201 | | |
| 3. Images formed by a convex lens are inverted. | 184-185 | | 26 |
| 4. Measurements can be organized to reveal relationships (direct and inverse) among them. | 187 | | |
| 5. Light energy can cause chemical changes. | 190-191 | | |
| 6. Photography uses light energy to change the chemicals on photographic film. (A "negative" result.) | 191 | | |
| 7. A positive photographic print may be made by exposing light through a negative to change the chemicals on special photographic paper. | 191 | | |
| 8. A refracting telescope uses two convex lens to enlarge images. | 193-196 | | 247 |
| 9. A microscope works on the same principles as the refracting telescope. | 196 | | |
| 10. A reflecting telescope uses a concave mirror to enlarge an image and focus it on a convex eye-piece lens. | 198 | 248 | |
| 11. A camera attached to a telescope can gather more light than using only the eyes with a telescope, for a camera can take a time exposure. | 201-202 | | |
| 12. Radio telescopes are not optical instruments, for they are receivers of radio waves, not light waves. | 202-203 | 180-181 | 242, 246<br>250, 255 |

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 7. Lift is an upward force working against the downward pull of gravity. | 236-237 | | |
| 8. Propellers compress air and push it backward. | 227-228 | | |

Chapter VIII Radio And Television Grade VI

Main Concept: Messages can be transmitted without wires by the use of electromagnetic waves. Such waves are used for both radio and television.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. The flow of an electric current through a material sets up a magnetic field around that material. | 208, 209 221 | | |
| 2. A moving magnetic field can set up a flow of electric current in some materials. | 210 | | |
| 3. Invisible radio waves are produced at a radio station by changing sound waves to electric waves and then to electromagnetic waves. In a radio the procedure is reversed, for electromagnetic waves are picked up, changed to electric vibrations which are changed back to sound vibrations. | 211-213 | | |
| 4. Radic waves can pass through many substances. | 213 | | |
| 5. The ideas of many inventors were used to develop the radio. | 214-215 | | |
| 6. A television works on the same principle as a radio, but in a television, electric vibrations are also changed to light waves. | 216-220 | | |

Chapter IX | The Nervous System | Grade VI

Main Concept: We learn about the world from stimuli received, transmitted, and interpreted by our senses and the entire nervous system.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. The main senses of sight, hearing, smell, touch, and taste are constantly employed as a means of knowing about our environment and investigating it. | 225 | 307 | 149 |
| 2. Learning results from the use of our senses and our nervous system. | 225<br>262 | 307 | |
| 3. The ear is a complicated organ which changes sound vibrations into nerve impulses. Its main parts are:<br>a. Eardrum.<br>b. Ossicles (hammer, anvil, and stirrup).<br>c. Oval Window.<br>d. Cochlea.<br>e. Auditory nerve. | 226-229 | | 159-161 |
| 4. The function of the semicircular canals is to control balance. | 228-229 | | 160 |
| 5. The eye is a complicated organ which transfers sound vibrations into nerve impulses; its main parts are:<br>a. Cornea.<br>b. Iris.<br>c. Pupil.<br>d. Lens (convex).<br>e. Retina.<br>f. Optic Nerve. | 320, 243 | 314 | 155-158 |
| 6. Eyeglasses help the lens to focus a sharper image on the retina. | 240-241 | | |
| 7. The nerve cells in the skin interpret anything that touches you and sends a message to the brain, along with impressions of pressure, temperature and pain. | 244-247 | 316-317 | 164-165 |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 8. The senses of taste and smell are closely related, for both the mouth and the nose are involved in the tasting process. | 248 | | 162-163 |
| 9. There are specific regions of the tongue that have cells that react only to sweet, salty, sour and bitter taste. | 249-250 | | 162 |
| 10. There are three main parts of the central nervous system: a. Sensory. b. Associative. c. Motor. | 252-253 | | 150 |
| 11. The nerve cell (neuron) is the basic unit of the nervous system, and is the only body cell that can conduct messages. | 254-255 | | 149 |
| 12. The brain is the central unit of the nervous system and has three main parts. a. Cerebrum. b. Cerebellum. c. Medulla. | 256-261 | | 153-154 |

Chapter X　　Astronomy: Time and Space　　Grade VI

Main Concept: Patterns in position and motion of celestial bodies have been of help to man in understanding the universe and measuring time.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. By studying the sky, scientists have found that there are changes from day to day which follow an orderly and predictable pattern. | 267-269 | 144-145 | |
| 2. The repeating pattern of the moon's phases is caused by the moon's position in relation to the earth and the sun as it revolves around the earth. | 269-270 | | |
| 3. The earth's rotation causes the apparent motion of the sun, moon, and stars across the earth. | 283-286 | 144-147 | |
| 4. The repeating pattern of the seasons is caused by the tilt of the earth's axis and the revolution of the earth around the sun. | 270-274 | | |
| a. The earth revolves in an orbit around the sun in $365\frac{1}{4}$ days. (1 year)<br>b. The earth rotates on its axis in 24 hours. (1 day)<br>c. The heating effect of sunlight depends upon the angle at which the sun's rays strike the earth's surface. | | | |
| 5. Eclipses occur when the sun, moon, and earth are on a straight line in space. | 277-282 | | 66 |
| a. A solar eclipse occurs when the moon casts a shadow on the earth as it passes between the sun and the earth.<br>b. A lunar eclipse occurs when the earth casts a shadow on the moon as the earth passes between the sun and the moon. | | | |
| 6. The sun is a nearby star that is the center of a large system of heavenly bodies that revolve around it. | 278 | 152-157 | 68-69 |

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 7. All planets travel at different speeds in different paths (orbits) around the sun and do not remain at constant distances from the earth or in the same direction from the earth. | 283-286 | 166-169 | |
| 8. The amount of time it takes for a planet to complete one revolution depends upon that planet's distance from the sun. | 288-290 | 166-169 | |
| 9. The method of triangulation is used to measure distances, sizes, and speeds in space. | 293-297 | 164-174 | |
| 10. A light year is a convenient unit to measure distances in space; it is the distance light travels in one year. | 297 | 176 | 19 |

Chapter XI | Theories of Astronomy | Grade VI

Main Concept: Scientists, after centuries of careful observation and record keeping, feel they understand the motions of bodies in the universe. They have conflicting ideas about how the universe and solar system began, however.

| Understandings to be developed | Heath | Macmillan | American |
|---|---|---|---|
| | (page) | (page) | (page) |
| 1. There is apparent order in the universe. | 301-303 | | |
| 2. An understanding of the principles relating to gravity and motion enables man to predict relationships of moving bodies in the universe. (Laws of gravitation and laws of motion.) | 308-312 | 69-87<br>93 | |
| 3. Planets, planetoids (asteroids), moons, comets, and meteors are all part of the sun's family. (The solar system) | 305-306 | 88-90<br>145-157 | 69 |
| 4. A given motion can be interpreted in different ways according to frames of reference. | 313-317 | | |
| 5. Scientists differ in their theories about the origin of the solar system. | 318-319 | | 84-87 |
| 6. Our solar system is part of the milky way galaxy, a tremendcus grouping of stars, which is only one of many galaxies. | 321 | 182-186 | 68-69 |

Chapter XII    Oceanography And Engineering    Grade VI

Main Concept: Knowledge gained in scientific study can be used to make life better for all men. One of the latest examples of this is in the rapidly developing field of oceanography.

| Understandings to be developed | Heath (page) | Macmillan (page) | American (page) |
|---|---|---|---|
| 1. Oceanography deals with the study of the ocean and involves several basic sciences. | 328-333<br>341 | | |
| 2. The ocean takes on increased importance as man looks to it as a source of food, fresh water, and minerals for an expanding world population. | 328-340 | | 233 |
| 3. Most of the life in the ocean depends upon microscopic plants and animals called plankton.<br>a. Phytoplankton are microscopic green plants which make food through the process of photosynthesis.<br>b. Zooplankton are microscopic animals which feed on phytoplankton and are in turn eaten by larger animals. | 336-338 | | 219-220 |
| 4. An engineer applies the discoveries of other scientists in many fields in practical and useful ways. | 341-342 | 373-374 | |
| 5. Ocean currents are influenced by difference in density and temperature of the water. | 339-340 | | 207-200 |
| 6. All characteristics of materials used must be considered by engineers, for all structures change under the influences that bear upon them. For example: The change in size of materials when materials are heated and cooled. | 341-356 | 51-54 | |
| 7. The depths of the ocean are now being charted and have been found to have formations similar to those on land. | 329 | | 182,185<br>204-205 |
| 8. Many animals that live in the depths of the oceans could not live at the upper levels, for their bodies are accustomed to high water pressure. | 333 | | |
| 9. Sea water is composed of many different elements and compounds. | 332 | | 213-214 |