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Multisensory science activities for learning disability students kindergarten through third grade

Jacklyn M. Hester

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MULTISENSORY SCIENCE ACTIVITIES FOR LEARNING DISABILITY STUDENTS;
KINDERGARTEN THROUGH THIRD GRADE

A Project Proposal Submitted to
The Faculty of the School of Education
In Partial Fulfillment of the Requirements of the Degree of
Master of Arts
in
Education: Special Education Option
by
Jacklyn M. Hester
1984
To my husband and daughter, Joseph and Kasha who have been my inspiration and support each day of my life.
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INTRODUCTION

According to Cartwright, and others the term handicapped refers to "those children evaluated and diagnosed as being mentally retarded, hard of hearing, deaf, speech impaired, visually handicapped, seriously emotionally disturbed, orthopedically impaired, other health impaired, deaf-blind, or multihandicapped, or as having specific learning disabilities".¹

The National Advisory Committee's definition on the handicapped states in the federal regulations governing P.L. 94-142 is: "Specific learning disability i.e. (learning disability) means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, or mental retardation, or emotional disturbance, or of environmental, cultural, or economic disadvantage.".²

It is important to obtain a clear understanding of the differences between the terms a disability and a handicap. The term disability refers to an objective, measurable, organic dysfunction, or impairment, such as a loss of a hand or paralysis of speech muscles or etc. Handicap refers to environmental or functional demands placed upon a person with a disability in a given situation. A handicap is the effect a disability has on an individual's functioning in specific circumstances.

² Ibid., p 191 and 192.
Therefore, when the term learning handicap is used in this project it is in reference to the term learning disability.

Learning disabled children constitute a heterogeneous group with different degrees of disability. Three strategies for remediation are generally used: (1) task training, in which the emphasis is on sequencing and simplification of the task to be learned, (2) process (ability) training, in which the focus is on the remediation of a specific developmental disability or dysfunction, and (3) ability-process-task training, in which the first two approaches are integrated into one remedial program. Basically the content of a science program for children with special needs is the same as that learned by all other students. A strong science program should make provisions for students with special needs and should provide a multisensory approach rather than a textbook oriented program when teaching science education to the learning disabled child. Many sensory experiences of feeling, smelling, tasting, looking, and listening teach children to question conditions and events around them. By using all their senses, boys and girls develop an awareness, alertness and perceptiveness to possible answers for their many questions.

Historically, disabled children have received little or no science education in their special education curriculum. These students have deficiencies and cannot perform certain functions in the same manner as the non-disabled or in some cases cannot perform them at all. A large amount of educational planning and programming for the disabled has mainly focused on these deficiencies and what individuals could not do rather than on adaptive approaches to meet the individual's needs. Studies indicate that for all learning disabled children there is a significant potential and capability for learning. Furthermore, research also suggests


that early science experiences are valuable and important in the development of all learners but they are absolutely essential if learning disabled students are to achieve their academic and social potential.

Traditionally, science taught from commercial textbooks and unit kits is based on a reading prerequisite common to "normal" children. Students who are blind, deaf, mentally retarded, learning disabled, or emotionally disturbed are excluded. University curricula for teacher preparation in special education does not require courses in science teaching methods specifically; teachers of special classes do not teach subjects with which they are minimally familiar. This is clearly evidenced by the small number of disabled individuals currently pursuing careers in science, technology, or related areas (AAAS, 1980). Reasons ranging from "they cannot use the equipment", "read the thermometer", "get to the work bench", or "will hurt themselves" have been used implicitly to explain the lack of science education in the school careers of disabled individuals.

Because of the escalating advances of our society toward a more technologically sophisticated world, educators have been somewhat forced to re-evaluate curricular offerings in the public schools. "Science education is no longer only necessary and desirable for all students if they are to understand, to operate, and to survive in the complex industrial civilization." Public Law 94-142 and Public Law 93-380, Part VI B; Education of the Handicapped, state that "to the maximum extent appropriate handicapped children

7 Ibid, Herbert D. Their
should be educated with children who are not handicapped and that special classes, separate schooling and other mean of removal of handicapped children from the regular environment occurs only when the nature of severity of the handicap is such that education in regular class with the use of supplementary aids and services cannot be achieved satisfactorily. This process of mainstreaming (placing children back in the regular classroom of selected experiences) children is being urged because many educators and parents believe that the best education for many handicapped children will result if they are placed in an environment with "normal" children.

Teachers who have had experience with the problem of "mainstreaming" the learning handicapped suggest the following reasons why a science educational program would be beneficial to the student:

1. Learning handicapped children can often experience much needed success in science activities because many of these are "hands-on" experiences. These experiences involve doing and observing, and the activities can often be done with other children.

2. Science experiences are appealing to most children and learning disabled children respond positively to learning about pets, using magnets, growing plants, examining rocks and similar activities.

3. While many of the activities are group-oriented, emotionally disturbed children can often work independently with science materials when this seems advisable, as it sometimes does, since these children frequently prefer working alone.

4. For the learning disabled children science experiences are helpful as a therapeutic activity, making them more comfortable as they become involved in experimenting, observing and using their senses.

5. Science experiences are helpful in teaching most children to read. Especially when they read about what they have done, read the directions for doing something, or read to find answers.

6. Handicapped children have generally had very limited experience with science; thus it is a new field and sparks their interest.

In 1982, the California State Department of Education re-examined the status of science education in the schools and concluded that there was a definite need for an increase in the study of science for all children. Parents and educators are also showing renewed interest in science education, because they are beginning to recognize

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9 Glenn O. Blough and Julius Schwartz, Elementary School Science and How to Teach It (New York: Holt, Rhinehart and Whinston, 1979) p. 72-74
10 Ibid.
that science can be an effective and stimulating means of teaching basic skills. Capitalizing on youth's enthusiasm for science projects, teachers can make science a vehicle for instruction in reading, writing, mathematics, and other subjects. Science helps students develop skills in observation, rational inquiry, experimentation, deductive logic, and analytical reasoning.¹¹

Researchers and educators agree that science is best taught at the elementary school level as a hands-on subject, a doing instead of a textbook oriented activity. Simple materials are needed to provide interesting experiences while the setting provokes coherent thought about their meaning. The basic processes used in science, such as observing, describing, comparing, classifying, measuring, using numbers, interpreting evidence, inferring, predicting, experimenting, are fundamental skills that should be developed during the formative years in an activity based program.¹²

Composite results of studies reveal that using hands-on multisensory activities as the core for teaching science in a self contained classroom is a motivational force which promotes reading and arithmetic achievement for all students, particularly for the learning disabled child.

**SUMMARY:**

Learning handicapped students have disadvantages, which enable them to function in certain ways as the nondisabled. Significant legal and policy changes have brought about a more enlightened view of the learning handicap and their educational needs. Technological and scientific advances, especially in alternate modes of exploring and expressing one's ideas brought about by advances in computers and


¹²Hausman, *Choosing A Science Program For The Elementary School*, p. 11-44.
related fields, have accomplished a great deal in terms of minimizing the individual's disability and maximizing capabilities. Science education, which has its emphasis on experienced based guided learning, which ables the student to use all of their sensory mechanisms, can play a unique role in providing young learning handicapped children with information, understanding, and experience. This can help them develop competency and the self-confidence needed to benefit from the opportunities available to them through technology.
REVIEW OF THE LITERATURE

For many years the decline in high quality and well attended science education programs has been a source of concern to educators, parents, policy makers, and leaders of business and industry. These concerns apply to all citizens, whether disabled or not.

In the past, learning handicapped children have received very little science education in their educational programs. Federal, state, and local regulations and policies requiring equal educational opportunity of the disabled (P.L. 94-142 and others) have brought about many changes including mainstreaming and now many disabled individuals now have the same opportunity to study science as the nondisabled individual. Unfortunately for all, and especially in the case of the young learner, this still frequently means little or no science education in the elementary school. Early science experiences are valuable and important in the development of all learners, but they are absolutely essential if disabled individuals are to achieve their academic and social potential.

From a current review of science literature, it is evident that a minimum of information and materials are readily available for the regular classroom teacher who must adapt a curriculum for science to meet the needs of learning disabled children.

This project is concerned with the learning disabled student and their need for meaningful, successful, challenging and interesting learning experiences in science. Learning disabled students tend to be highly motivated to learn when an instructional experience is designed so that they can take part in it. They are motivated to become independent and are willing to work long and hard to master a skill or procedure. Learning disabled students, like all other individuals,
need motivating experiences that encourage them to explore and extend their own limits rather than have someone arbitrarily set limits based on what they believe a person with that disability can do. The purpose of this project will deal mainly with science activities the children take part in (multisensory) and do not require a lot of textbook reading on the part of the student which will enable the learning disabled student to gain critical information, ideas, and issues necessary to understanding a topic and contribute to their self-confidence and self-image.

Current trends and strategies for teaching science to the learning disabled student are limited. The author has chosen to concentrate on three areas of science: life science, physical science, and earth science. Most of the literature is geared toward the elementary level and can be easily adapted for junior or senior high school.

The materials presented in this project are to give teachers strategies and insight on how they can make science activities experienced based and to adapt readily available materials to accommodate the needs of this group of students.
Piaget, a Swiss psychologist, has influenced elementary science education in the United States. Piaget had carefully observed children's intellectual development. He concluded that younger children are qualitatively different from older children in dealing with problems. His explanation was that there are well-defined stages of growth through which a child must pass before being able to structure his perceptions in keeping with more mature understandings. Piaget concluded that abstractions cannot be expected of a child until he has reached the appropriate developmental stage. Reliance on verbal explanations at too early a stage is futile and can cause negative attitudes toward learning. This age block (K-3) is largely organization in character and correlates with Piaget's two stages of cognitive development: Preconceptual Stage (2-4 years); and the Stage of Intuitive Thinking (4-7 years). To an extent, the knowledge statements in this grouping are representative of concepts that may be symbolized by single word (e.g., bird, solid, stare, etc.). These Piagetian principles may be applicable to teaching some learning disabled students of various ages when considering the characteristics of their developmental domain in comparison with Piaget's developmental stages. There is no one set of characteristics or behaviors found in all children who have been identified as learning disabled. Some learning disabled children present patterns of disabilities primarily in the cognitive domain: relationships with others, self-concept, or inappropriate behaviors. Still other learning disabled children may have language domain problems and have trouble expressing themselves in oral or written form or processing language. Finally, many learning disabled youngsters show problems in the motor


14 Ibid.

domain either in gross motor skills, psychomotor or perceptual motor skills, or some combination. It is most common that one or more of the characteristics occur in different children.

In considering Piaget's principles and the characteristics of the learning disabled child in the (K-3) grade block, we can draw the conclusion that these children are qualitatively different and at a disadvantage academically from older children as well as "normal" developed children in the same age or grade block. In that the learning disabled child has not reached the well-defined stages of their growth as indicated by Piagetian principles and will not be able to structure their perceptions in keeping with more mature understanding and thinking until these limitations are overcome or some form of adaptive approach is developed to meet their special needs.
Hausman, a member of the Council for Basic Education, along with others, believed that all students except the severely retarded, should receive adequate instruction in the basic intellectual disciplines. His report states that in the early 1960's a movement began to offer elementary schools genuine alternatives to textbook science. Educators seemed to agree that children's first-hand experience with concrete objects and laboratory investigations were essential to achieve an adequate learning in science. Several groups developed entire science curricula organized around investigative inquiry, using material objects. They wanted to show that important ideas considered basic to scientific understanding could be translated into experiments suitable for elementary school children (K-6). They planned to show that coherent science programs of increasing depth could be devised from laboratory involvement at least as well as from a traditional textbook series, thus adding dimensions that textbooks seem unable to contribute.

In general, the projects emphasize the child's engagement in a task that is intrinsically interesting. As the children perform investigations from the various hands-on projects, they seem to be enjoying themselves. It is not aimless play and structure that have been build into the tasks in a sequence of activities. The students will master concepts, knowing them as only actual experience can demonstrate. Also, they will have the opportunity to exercise imagination, to seek evidence, to rely on observable data, and to explain the evidence of their senses.

With the formulation of the new science programs, the traditional student text was discarded. The report states that a new kind of text-teacher guides were designed with each program that describe the philosophy of the project and explains

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16 Ibid.
17 Ibid.
in detail each investigation together with its purpose.

Hausman further states that these project materials directed to teachers focus on appropriate strategies for teaching elementary science through inquiry. A child must have a chance to discover some simple relationships for himself. He must not be told everything. Inquiry must be genuine. Investigation must be carefully structured, walking through the paces. The child must be able to exercise thought processes other than through the paces. Responsibility for learning must visibly rest on the child. 18

Hausman exphasizes three new science programs in his study: Elementary Science Study (ESS), Science-A Process Approach (SAPA), and Science Curriculum Improvement Study (SCIS). He states that there is no science program that achieves its goal entirely. Each new science program has a unique approach that appeals to different ideas on how science should be taught. Within a school the administrators and educators decide which science program suits their style best in meeting the needs of all students.

James A. Shymansky, William C. Kyle, Jr., and Jennifer M. Alport studied the effectiveness of the hands-on science programs of the 1960's. These educators wanted to know why, in less than ten years, hands-on activity programs practically fade out after much time, money and effort were invested in developing them. They analyzed thirty-four studies to compare the performance of students in three new science classrooms. These science programs are the aforementioned stated in Hausman's study. The average students in ESS, SCIS, or SAPA classrooms performed better than the students in traditional classrooms across all performance criteria measured. 19

18 Ibid.

Shymansky, Kyle, Jr., and Alport also analyzed twenty-one studies, each comparing some aspect of student attitude toward the new science curricula with attitudes toward traditional programs. The studies approached the question of attitude in three ways: (1) attitude toward the new course, (2) attitude toward science, and (3) attitude toward self. In each of the categories, student attitudes were more positive toward the new programs than toward the traditional ones.  

The aforementioned researchers also analyzed thirteen studies that focused on process skills, (e.g., observing, inferring, interpreting data, and etc.) development in new curricula versus traditional classroom. Students who experience the new curricula scored higher than students who experiences traditional methods.

In a study on the development of related skills, reading, mathematics computation, and communication, thirty-one studies were compared in these areas to the traditional classroom. The composite results show students in SCISS and SAPA classrooms scored higher. No research data was found for ESS classrooms.

The authors of this report are not suggesting a return to new science curricula and they are not advocating abandonment of current programs. But what they are suggesting is that educators, coordinators, and curriculum committees re-examine the new science curricula for activities and teaching ideas, and consider incorporating them into existing programs.

The quantitative synthesis of the research clearly shows that students in new curricula programs achieved more, like science more, and improved their skills more than did student in traditional-textbook-based classrooms. In the best interest of

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20 Ibid.
21 Ibid.
children it is only fair that these program be given another critical look.\textsuperscript{22}

Glen Blough and Julius Schwartz report that children who may generally be considered as "slow learners" have often been know to respond well in science experiences. This may be due to the fact that there can be much learning through doing; through observing with the senses; through experimenting, constructing, and etc.\textsuperscript{23} Also their finding suggest that with the passage of Public Law 93-380 more and more handicapped children are being mainstreamed back into regular classrooms. This places a new responsibility on classroom teachers, many of whom feel, or actually are, ill-equipped to give these children adequate attention. Despite the plights of some teachers many educators and parents believe that the best education for many handicapped children will result if they are placed in an environment with "normal" children.

Blough and Schwartz did not deal with how to teach science to handicapped children in a regular classroom. They relied on teachers who had had experience with this problem who indicate reasons why science would be suited for inclusion in mainstreaming. In discussing their experiences with Blough and Schwartz, the teachers provided the following advice:

1. Familiarize yourself with the needs and care of the handicapped child.
2. Make use of the specially-trained personnel available to you.
3. Try not to be impatient when progress is slow.
4. Remember good teaching techniques are as appropriate to a handicapped child as well as any other child.
5. Observe the handicapped and try to discover how you can adapt science experience to their particular needs and limitations.
6. Use individualized instruction techniques.\textsuperscript{24}

\textsuperscript{22} Ibid.


\textsuperscript{24} Ibid.
Wallace and Kaufman believe that the initial and on-going instructional needs of the learning handicapped child should serve as the focus of a remedial program. Formal and informal assessment results must be used in planning programs and evaluating programs effectiveness. Successful remediation will depend on the selection of a wide variety of materials, techniques, and methods that are tailored to individual needs. Finally, "the difficult aspects of overcoming learning problems in children are directly related to the type of instruction provided for the child."25

Their describes and explains the unique and essential role early and continued science experience can play in enabling learning disabled individuals to develop their potentials to the fullest. He views science, with an exphasis on evidence and use of mathematics and natural language, that can provide unique opportunities for all students to use and develop their reasoning abilities. He further states whether this takes place or not is determined by the kind of science and the method in which it is taught. For example biology, he purport, can be another fo foreign language concentrating on the learning of new words to name and describe organisms and processes. It can also be an introduction to the wonders of life and all of the opportunities for analysis, synthesis and greater understanding and knowledge which becomes available with its study.

Their believes quality science teaching is experience bases. "The evidence collected by the learner is combined with the factual andprocedural input provided by the teacher and other sources in order to evolve knowledge, confidence, and interest necessary for effective decision making in the learner. This approach to science teaching includes the "rote" but emphasizes the "reasoning" aspect of

Finally, Their cites reasons why science instruction for the disabled at an early age and continued throughout their school career takes on added importance:

1. Hand-on experiences are essential in developing knowledge and understanding of one's environment and one's personal relationship to it.

2. Scientific and technological advances have provided computers, talking calculators, versa-braille hook-ups, and etc. Which can help to mitigate limitations. In order to effectively use these technological devices, disabled individuals need to first know about them. Which enables them experience to explore variables, using equipment and materials and generally getting over fear and apprehension regarding machines and related devices.

3. The computer will become an important part of many jobs in the future. Because of technological advances in alternate ways for individuals to use computers many of these jobs are available to the disabled with the necessary background and training, and more importantly, self confidence to seek the positions."

SUMMARY OF LITERATURE

Within the last several decades there has been many advances in science and technology. Each day our whole society is becoming more aware of and dependent upon these advances. We expect our citizens to make a wide variety of science and technology-based decisions in the world of work and life in general. Therefore, science has become extremely important in educational experience for all learners and especially for the learning disabled individuals.

Learning handicap children have disabilities that do not permit them to function in the same way as non-learning handicapped children. It is evident that certain provisions should be made to overcome these disabilities in order for these children to reach their maximum potential.

Ibid., Herbert D. Their, p. 198-199.
The field of science makes these special provisions for the learning handicapped student. Science provides many opportunities for necessary related learning experiences in fields such as mathematics, language, and application skills. Research and educators agree that science should be taught at the elementary school level using a hands-on instructional approach. Much of what children learn comes through their skin. Sensitive, active hands, feet, tongues, and tastebuds identify objects by unique characteristics. Research clearly shows that students in these programs achieved more, liked science more, and improved their skills more than did students in traditional textbook-based classroom programs.

All of the evidence seems to indicate that in many schools for the present time and into the foreseeable future, an emphasis on enrichment and qualitative science programs is needed. By providing meaningful, easy to use, hands-on instructional experiences for learners is a viable and effective way to improve the science education experiences for all learners, especially the learning handicapped.
PURPOSE

This project fulfills a need which at the present is not being met, to provide a multisensory rather than a textbook oriented approach curriculum for the learning disabled child functioning at the kindergarten through third grade level. The learning experiences will engage the student's five senses. The children will have the opportunity to engage in various science activities, opposed to only reading about them. The curriculum content will be designed from the most recent Science Framework For California Public Schools (K-3). This science curriculum will provide children with a literal feel for what they are supposed to be learning and help develop knowledge leading to interpretation of natural phenomena and a better understanding of the world around them.
STATEMENT OF OBJECTIVES

The objectives in developing a science curriculum for kindergarten through third grade learning handicapped students are as follows:

1. To provide a list of objectives applicable to learning disabled students with emphasis at the elementary grade level (K-3).

2. To develop a curriculum for elementary level learning handicapped children (K-3) in science that will help develop and improve their cognitive, affective, and psychomotor skills and develop a better understanding of the world around them.

3. To select typical activities from the various areas of science to give any teacher enough information to start a good program of science education with a feeling of confidence.

4. To design the curriculum to be used as a science-based enrichment interdisciplinary program.
PROCEDURE

Each instructor in a given school district who receives students identified as learning disabled will be given the opportunity to use the suggested science activity manual for their students. The suggested grade levels to use this program are the learning disability children who function at the kindergarten through third grade level.

This science manual will consist of three areas of study: life science, physical science, and earth science. Each lesson presented in the manual within the formentioned science areas will have two or more activities to be performed by the children. It is up to the instructor to make any necessary provisions to meet the needs of their particular children. There will also be included in each lesson four organizational categories: Objectives, Materials, Procedures, and Results. The materials are the supplies and equipment needed to perform the activity. The procedure is the step-by-step process in utilizing the materials. The results are the observed conclusions of the stated procedure which, incidentally, also serve as a double check for the inexperienced teacher.27

This science program could be administered in small groups of individualized settings, whichever is appropriate to meet the needs of the students. The science curriculum emphasizes the child's engagement in tasks that are practical as well as enriching. A challenge is posed, and the child has a chance to respond with appropriate materials at hand. The situation should be open enough for children to try without embarrassment, to make a mistake without penalty, and to try again.

TEACHING SUGGESTIONS FOR LEARNING DISABILITY CHILDREN

The following suggestions will assist a student in functioning in a science program:

1. Establish a rapport with the student and make his or her time studying science a pleasant part of the day.
2. Textbook and worksheet materials should be taped for those students who cannot read well enough to make it meaningful.
3. Students would benefit by working in small groups while carrying out the discovery activities.
4. Provide manipulative equipment for student use.
5. Some students have memory problems, both short and long term, which will prevent them from memorizing. Don't expect them to memorize.
6. Use a study guide prepared by the teacher. It will help to organize the material, aid memory, introduce vocabulary, and be helpful in reviewing.
7. When a new word is found, illustrate it with a drawing. Display the definition and the drawing on a classroom bulletin board so that the entire class will benefit.
8. Take advantage of opportunities for science field trips. Visit the planetarium, the high school science laboratory, and go to the out-of-doors for nature hikes.
9. A large number of films and filmstrips are available in the science area. Use them whenever they can reinforce science concepts. Transparencies should also be used.
10. Use displays of pictures and drawings to illustrate science concepts.
11. Curriculum Modification techniques from the mathematics and social science areas should be applied here for there is a relationship between these areas.
12. When possible, use a common name for scientific objects rather than scientific names.
13. Encourage each student to carry out a science project for himself, such as when seed germination is studied, plant seeds and observe them grow.

Herbert G. Cohen and others
MULTISENSORY SCIENCE ACTIVITIES
FOR THE
LEARNING DISABLED STUDENT

Course Outline: Multisensory Science Activities

Unit Content: Life, Physical, and Earth Sciences

Supplementary Material: Various follow-up, review, and parent involvement activities are included with each lesson.

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PART I  LIFE SCIENCE
LIFE SCIENCE

UNIT 1 SEEDS AND PLANTS

LESSONS

Lesson 1  Seeds ..............................................................
Lesson 2  Seed Parts ...........................................................
Lesson 3  When Seeds Grow ..................................................
Lesson 4  Scattering Seeds ...................................................
Lesson 5  Plants ..............................................................
Lesson 6  How Does Light Affect Plants ..................................
Lesson 7  Classifying leaves ................................................

UNIT 2 ANIMALS

Lesson 1  Animals (The study of animals in general) ..................
Lesson 2  Classification ....................................................
Lesson 3  Cages and Containers ............................................
SEEDS

OBJECTIVES - Students should be able to:

1. Compare the structure (physical characteristics—shape, size, color, and et al.) of different types of seeds.
2. Classify seeds on the basis of structure.
3. Define seed.

SCIENCE BACKGROUND

Seeds are the most important part of a plant. The roots, the leaves, the flowers, all exist so there can be seeds. And because each seed has been given the form that is best suited to produce its own kind of plant, there is great variety in their shapes, sizes, and colors.

Some seeds are round. Others are egg-shaped, triangular, circular, long and slender, curved, or coiled like a snail. Some seeds have horns, others have tails, and many have wings. Some are smooth, others are ridged. The color of the skin of the seeds varies also. It may be red, orange, purple, or any gay or dull color, striped or spotted, black or white. Many seeds look like beetles or pebbles in shape and color. In this way they escape seed-eating birds. The carrot seed is shaped like a hairy bug, the chickweed seed looks a little like a caterpillar, and the castor-oil seed resembles a shiny beetle.

The sizes of seeds vary almost as much as the different kinds of seed. Tobacco seeds are so tiny that one seed pod may contain as many as 40,000 seeds. Poppy seeds are only slightly larger. From those tiny particles they range up through almost every size to the large Brazil nut and white walnut. The seed of one kind of coconut tree is so large that it weighs about 22 pounds (10 kilograms).

The size of the seed has no bearing on the size of the plant that will grow from it. The tallest tree in the world, the California redwood, grows from a very small seed. The large seed of a watermelon will produce only a low vine.

Some plants, such as ferns and mosses, do not have seeds. They reproduce their kind by means of spores. Many plants which bear seeds also have another method of reproduction. Onions, daffodils, and lilies develop bulbs from which new plants sprout. Strawberries have stems that creep along the ground. A new plant grows from each joint of the creeping stem. Lawn grass is thick because it has stems that creep underground, and new shoots sprout from the many joints. Potatoes have "eyes," and each eye is a plant bud.

Most plants, however, depend upon seeds alone to continue their kind.

SCIENCE WORD

seed

MATERIALS

A wide variety of seeds small plastic bags
1 to 2 large poster sheets 1 large felt tip black marker

For further discussion the two activity sheets may be used which follow this lesson.

TIME ALLOTMENT: Allow one 30-minute science period plus the time needed to soak bean seeds the day or night before.
Lesson 1 continued.

INTRODUCING THE LESSON

Gather many types of seeds for display purposes. A wide variety of seeds will show students structural likenesses and differences which aid in seed dispersal, protection from animal consumption, and survival in harsh climates.

Display a variety of seeds. Have the students predict what kind of plant will grow from each seed. Plant some of the seeds to see if the predictions are correct.

TEACHING THE LESSON

1. Discuss the fact that there is a wide variety of seeds and why.
2. Ask the following questions:
   A. What are seeds? (Seeds are tiny plants with stored food.)
   B. Where are seeds found? (Seeds are found in flowers, caves, and in the ground.)
   C. What grows from seeds? (New plants grow from seeds.)
3. Distribute a variety of seeds to the students. Have them sort these seeds in any way(s) they wish. Some may wish to sort them by color, size, shape, use, texture, and etc.
4. Discuss the variety of seeds that people and animals eat. A wall display on this could be made by the students or one which names or identifies the various seeds collected by the students.
5. Point out that there are many poisonous seeds. Stress the importance of not handling or eating poisonous seeds. Entire plants and/or their seeds may be harmful.
Dear [Name],

I am studying seeds in school. I am learning that many seeds are good to eat and that many foods are made from seeds. Please help me complete this chart.

Thank you

<table>
<thead>
<tr>
<th>Seeds People Eat</th>
<th>Food Made From Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What is inside this apple?

Color them.

Then color the apple.
Most seeds grow inside fruits and vegetables. Here are some fruits and vegetables. Can you draw the seeds inside?
Lesson 2

SEED PARTS

OBJECTIVE - Students will be able to:

1. Observe and identify the common parts of a seed.

SCIENCE BACKGROUND

Seeds are produced by cone or flower bearing plants. There are many plants, however, such as the liverworts and ferns that do not produce seeds.

A bean seed has several important parts. Three of these parts should be seen by the students as they complete this lesson. The seed coat (testa) is a protective outer layer. It can be easily peeled off the bean seeds that have been soaked. The embryo is that part which will become a new plant. The cotyledon (endosperm) is the food supply for the embryo. A bean seed is a dicotyledon. This means it has two cotyledons. Some seeds of other plants have only one cotyledon. These seeds are called monocotyledons.

All seeds store food. Some, like willow and poplar seeds, store little food. They germinate very quickly and grow rapidly. Others, like squash and locust seeds, store more food. These seeds survive without germinating immediately. The stored food provides energy for the embryo during dormancy and for the germination process.

SCIENCE WORDS

embryo
stored food
seed coat

MATERIALS

Supply enough materials for each student to work alone.

2 bean seeds
metric ruler
water
plastic cup

hand lens
paper towel
pencil and paper

ACTIVITY

1. Have the students observe how the seeds look and feel. Have them measure and record the sizes of the two bean seeds. Have each student soak their seeds in a glass of water overnight.

2. After soaking the seeds overnight have the students measure and record the sizes of the two seeds again. Have them observe how the seeds look and feel.

3. Show the students how to carefully peel the seed coat off one of their seeds. Have the students observe this outside part of the seed with a hand lens.
4. Show the students how to carefully divide their bean into two halves in order to observe the halves with a hand lens.

5. Have the students find the tiny plant in the seed and observe the plant with a hand lens. Have the students draw what they see and write the parts of the seed on their drawing.

TEACHING SUGGESTIONS
- You may wish to have a labeled model of a bean seed for reference when discussing the activity.
- Ask students to tell the differences between the two soaked seeds and the two dry seeds.
- Discuss the function of each seed part.
- Show the parts of a seed on an overhead or opaque projector.

WHAT DID YOU LEARN? (Ask the following questions for review):

1. How did the seeds change after they were soaked? The soaked bean seeds got very soft. They also got bigger. The water made them soft.

2. How many parts did the seed have? The seed had three parts: the seed coat, stored food, and young plant.

3. Where was the tiny plant in the seed? The tiny plant was at one end of the seed between the two parts of the stored food.

4. What parts does the tiny plant have? The tiny plant has leaves and a stem or root (the stem and root appear as one part).

Note: Seeds are soaked to soften the seed coat and make it easier for them to grow. The outside part of a seed protects the rest of the seed.
Follow Up Activity

Name: ____________________

Make a Seed

1. Color the seed and the baby plant.
2. Cut out the seed and the baby plant. Be sure to cut on the dark lines.
3. Paste the baby plant on the dotted lines in the seed.
4. Fold the seed together.

Fold here

fold here
Lesson 3

When Seeds Grow

OBJECTIVES - Students should be able to:

1. Hypothesize which seeds will grow.
2. Measure and record the growth of the seedlings.
3. Infer that water is necessary for seeds to grow.
4. Define what would happen to seeds planted in a dry versus a wet place.
5. Hypothesize what happens when seeds are planted in places that have water but also have cold temperatures.

SCIENCE BACKGROUND

Seeds germinate when conditions are right to support the needs of growing plants. Most kinds of seeds do not sprout right after they are dispersed. Instead, they go through a dormant period. The dormant period may last a few weeks or many years. Scientists have found and germinated some seeds that were several thousand years old. Water, oxygen, and the proper temperatures are all necessary for seed germination. Water makes the seed swell and breaks the seed coat. It also causes chemical changes necessary for growth to begin. Large amounts of oxygen are used by the seed to burn the stored food and produce energy. The temperature needed by seeds to germinate varies with the specific type of seed. Some seeds (onion, pea) will germinate when the soil temperature is fairly cool. Other seeds (green bean) require much warmer temperatures.

SCIENCE WORDS

germinate  dormant  sprout  seedling

PREPARATION SUGGESTIONS

• You may wish to have milk cartons already filled with soil prior to the activity.
• You may want to poke two small holes in the bottom of the cartons to aid in drainage.
• You may want the students to practice measuring the height of plants from soil level to the tip of the main stem. Be certain they do not touch the plants and cause damage.
• Students with visual impairments can label their cartons and tray with the Dymo or Rotex label machine. Have sighted peer to assist them when ever necessary.

TEACHING SUGGESTIONS

• You may wish to have students work in pairs.
• Remind students to record their observations on the record sheet. Point out that record keeping is very important to scientists.
• Have students place their cartons on the foam trays before watering to avoid spilling of water.
• Ask students why they are covering the cartons with clear plastic wrap. You may wish to compare this to the use of green houses in raising plants.
If the seeds in NOT WATERED fail to grow into plants after one week, have the students dig out the seeds for observation.

You may want the students to keep their plants and use them for the next activity on how light affects plant growth.

**Activity**

*When Will Seeds Grow?*

Annotations for activity materials indicate quantities needed for:

**What to use:**

- 2 small milk cartons
- 60 scissors
- pencil and paper
- 60 labels
- potting soil
- 2 bags
- 6 soaked bean seeds
- water
- small paper cup
- clear food wrap
- foam meat tray
- metric ruler

**What to do:**

1. Cut the tops off both milk cartons. Label the cartons Watered and Not Watered.
2. Fill each carton with soil. Gently pack the soil with your hands.
3. Use your finger to poke three holes in the soil of both cartons. Put one seed in each hole and cover the seeds with soil.
4. Add water until the soil is moist to the carton marked Watered.
5. Cover both cartons with plastic wrap. Put the cartons on a tray by the window.
6. Take the plastic wrap off both cartons after the seeds begin to grow. Water the soil only in the Watered carton.
7. Use the ruler to measure any plants that grow. Record their height every day for two weeks.

Be sure to wash out the milk cartons before using them in the activity.
WHAT DID YOU LEARN? (Ask the following questions for review):

1. What happened to the seeds? The seeds in the WATERED carton grew. Most, if not all, the seeds in the NOT WATERED carton did not grow. Some may have started to grow because of the moisture already contained within the soil, but the lack of additional water prevented much growth.

2. How long did it take for young plants to appear? Some seeds may have started to germinate in two to five days after planting.

3. In which carton were the tallest plants? The tallest plants should be in the carton marked WATERED.

TIME ALLOTMENT: Allow one 30-minute science period for the initial activity. Continue with observation and measurement time of two weeks.
THE GREAT BEAN RACE

RECORD SHEET

NAME ________________________________

DATE ________________________________

ACTIVITY PAGE
AR PARENT: The class is studying some parts of plants. This activity will help your child learn to read the names of the parts.

PLANT PART NAMES

- leaf
- stem
- root
- fruit
- seed
- flower

Look in the window.

What plant part name do you see? How well can you read each name?

Take a walk outdoors. What plant parts can you find?
Dear ____________,

I am studying seeds in school. I am learning how seeds grow into plants. May I put these pictures in order, number them, and tell my story about seeds to you?

Thank you

A Story About Seeds

1

[Diagram of seed stages]
Jimmy plants some seeds.

He waters only one dish.

What happens?

Draw it. Color it.
AME

1. Write the names of these plant parts.

2. Color the fruits you eat red.
   Color the seeds you eat yellow.

Lesson 4

SCATTERING SEEDS

OBJECTIVE:

1. Children should be able to tell how seeds are dispersed.

SCIENCE BACKGROUND

Wind, water, and animals are the means by which seeds are dispersed. A seed's physical structure and its means of dispersal are closely linked. For example, poppy seeds are enclosed in pods. At maturity, the tops of the pods open. When the wind blows, the pods shake out seeds like salt shakers. Milkweed seeds have hairy tufts that are outgrowths of the seed coat. These tufts can be easily carried by the wind. Their seeds are dispersed as they roll over the ground.

Water may carry seeds for short distances without destroying their ability to germinate. Coconuts have seed coats that are imperious to water. They are carried from island to island by the ocean.

Barbs, hooks, bristles, and spines on some other seeds (beggar-ticks) easily cling to animal fur. Many other seeds are able to withstand the digestive juices of animals. They pass through the body unharmed.

TEACHING THE LESSON

1. To begin a discussion on seed dispersal, you may wish to pose some thought-provoking questions such as:

   1. What would happen if
      a. seeds from every plant fell off and landed directly below the plants? How many would grow? Why?
      b. seeds were planted by farmers at the wrong time of year?
   2. Why do animals eat only certain kinds of seeds?
   3. How do new kinds of plants grow on islands?

   Answers to these questions will vary. The questions are meant to motivate students to think about how and why seeds are scattered.

2. Introduce the term dispersal. Have the students use the term when discussing how seeds are scattered.

3. Discuss the foods people eat which come from plants. Students may want to make a list or chart of these foods.

OPTIONAL STRATEGY

1. Display several types of seeds that are used to grow crops. Your local hardware/garden supply store should have some available. Have students compare the size and appearance of the seeds with the plants they produce.

4. Discuss when students may have used seeds to plant flowers or grasses for lawns. Ask the questions When have you planted seeds? How else have you scattered seeds? Answers will vary.
5. Have some students bring in cockleburs, sticktights, and other sticky seeds. You may want students to view these seeds under a hand lens and draw pictures. Allow the students to handle the seeds and observe their textures.

6. Ask the students if they have ever had to pull cockleburs or sticktights off their pets or their own clothes after walking through a forest or a field. Tell them they helped in scattering the seeds of those plants.

7. Have the students name those birds that they think eat seeds. Make a list of the birds and the seeds they eat. Some examples might include crows eating corn, blue jays eating sunflower seeds, or chickadees eating berries. Ask and discuss the question. When might the seeds germinate? The seeds would germinate if they fell where conditions were right for them to germinate.

Have the students do the activities which follow this lesson. The students may do the activities individually or as a teacher directed activity.
Unit I  Seeds and Plants

How Are Seeds Scattered?

What to use:
scissors

What to do:

Part A

1. Look at each seed picture.
2. Below the picture, write how you think the seed is scattered.
Part B

1. Cut out the pattern on the left.

2. Cut down on the solid line as shown.
   Fold the two top halves in opposite directions.

3. Fold up the bottom part three times.
   Fasten a paper clip to the bottom.

4. Hold the paper spinner as high as you can. Let it drop to the floor.

What did you learn?

1. How was your spinner like some seeds?
   The spinner had "wings" on top like some seeds have.

2. How would your spinner seed be scattered? The spinner is scattered by the wind.

3. How can you tell which seeds are scattered by the wind? Seeds that have winglike parts or tufts are probably scattered by the wind.

4. How can you tell which seeds are scattered by animals? Seeds that have barbs which stick on hair or fur are probably scattered by animals.

ON YOUR OWN: When the Hawaiian Islands were first formed, they did not have any plants. Find out how coconut trees and other plants began growing on these islands. Draw a picture or mural showing what probably happened.

Students may also want to learn how animals began to inhabit the islands.
Follow-up Activity

Name ___________________________ Date _____________

Unit 1  Seeds and Plants

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What to use:
scissors

What to do:

Part A

1. Look at each seed picture.

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Part B: a

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What did you learn?

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2. How would your spinner seed be scattered by the wind?

3. How can you tell which seeds are scattered by animals?

4. How can you tell which seeds are scattered by animals?

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1. How was your spinner like some seeds?

2. Cut out the pattern on the left.

3. Fold up the bottom part three times.

4. Fasten a paper clip to the bottom.

Hold the paper spinner as high as you can. Let it drop to the floor.
How Seeds Travel

Draw a line from the seed to the way it travels.
OBJECTIVES

- To develop an awareness of the process of change that occurs as a plant grows
- To involve the children in some aspects of daily plant care
- To acquaint the children with different ways that plants can be grown
- To discover that food can be grown from seeds
- To demonstrate that some plants grow and develop differently than others

This unit is presented in two main sections: indoor growing activities and outdoor growing activities. It is divided this way so that the teacher can select appropriate activities without having to sift through all the cards in the unit. The activities lend themselves for use independently of one another. Either section can be used separately, as both series of activities are complete. The Exploratory Activity, nonetheless, is presented both at the outset and completion of the unit activities.

The teacher should note that it is not necessary to use the individual activities in any special order, but the outdoor activities naturally are limited by local winter conditions.

It is felt also that the activities included here are examples of things which are easily managed and flexible enough to meet the children's interests or to include other activities similar in nature.

When planting seeds for classroom projects, remember that some seeds may sprout at different rates than others. If you make a 2-3 week growth chart and nothing happens in that time, set the project aside, change your focus of activities, or start something different, but continue watering the planted seed. You may just have a slow sprouter and can turn the class's attention back to it when it does begin to grow.

Children will most enjoy plants with a fast growth habit so they can see some progress each day. Beans, popcorn, garlic, carrot tops, and sweet potatoes sprout quickly and show differences in a matter of days. Some plant materials can also be started in water for observation of roots and stem, such as carrot, sweet potato, garlic, and avocado pit.

A variety of seeds can be collected easily from common foods. For one week try to save every type of seed that goes through your kitchen. You may be surprised at the variety, even those sitting on the kitchen shelves.

When planting outdoors, determine how much preparation you will need to do, well ahead of the proposed planting time. It will help the activities to go smoothly.

Round up a few garden tools to prepare the soil, old tires or planks to make planting areas, and bags of yard clippings to use as mulch. You might also want to check the advice of a gardener friend, neighbor, or parent about specific needs of the soil with which you will be working. Regarding specific plants to use outdoors, the selection will be limited unless winters are mild in your area.

It is especially hoped that participation in the activities you choose will be enjoyable in itself. Don't hesitate to change your plan as the activities progress, so that enthusiasm can be maintained through the completion of the projects.

EXPLORATORY ACTIVITY

Materials:
- Mixture of many seeds from kitchen, garden, or seed packets
- Small dishes to hold "samples"
- 2 shoeboxes or large bowls, scoops
- Paper and pen for recording observations
- 3-4 sieves or strainers of different mesh sizes
- Nutcracker

Procedure:

Assemble a variety of types of seed to show the children. Many may easily be gathered, for example, in the kitchen: citrus seeds of all types, avocado pits, dried beans, sunflower seeds (raw, in the shell, if possible), apple seeds, tomatoes, garlic, grape seeds, poppy seeds, popcorn, melon seeds, apricot or peach pits. Garden plants, flowers, or grasses also yield seed at the end of their growing season. Wild bird seed has a good mixture of seeds, too.

Wash food seeds and allow them to dry thoroughly. Put the seed mixture in a large bowl or shoebox on a table where it is available to the children. Place the other materials on the table alongside.

Give each child or pair of children a small dish to sample seeds from the box or bowl. Let them examine the seeds freely.

Record the children's comments and actions as you observe them, even if nothing happens. You will want this information to refer to later when you again present this exploratory activity at the end of the unit.

Do the children handle and examine the seeds closely or strain them through their fingers? Do they scoop and pour the seeds, pick out the largest seeds or sort the familiar ones? Observe whether they show the seeds to one another or comment on something they recognize or discover. Note how long play continues with sieves, strainers, scoops, or nutcrackers. Write down specific children's interests.

Keep these notes for comparison at the end of this set of plant growth activities.
Plants

The usefulness in learning about plants through growth comes while watching the metamorphosis from seed to sprout to full-blown plant, and each stage can be observed as it changes.

The activities presented here are designed to provide concrete experiences. In this way the children are involved directly in the experiences and learn by discovering for themselves much of the information that is contained within the activities. Additional guidance can, of course, be offered to children who wish to pursue an interest in any of the specific projects.

Selected activities provide an opportunity to involve parents in a classroom project. Some activities also help the children relate classroom experiences to their home surroundings. Some growth projects offer the additional benefits of eating what has been grown.

Indoor activities

The indoor activities with plants can be used in different ways. You may want to use them individually to introduce plant growth and care to your class. Three of the growth projects could be started simultaneously to compare the appearance and rates of growth of different types of plants. In this case you can use the Individual Child Record Sheet #3, Growth Chart, so each child can keep an individualized observation sheet.

Use of a growth chart will illustrate that some plants grow faster or develop differently from others. How long did it take to see roots form on plants growing in water? Which plants had leaves first or grew long stems? How long does it take to grow tall?
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If the children start only one growth project at a time, be sure that one is completed before starting another. You can structure this by limiting the number of spaces you make on the observation chart, or by limiting the activity if no changes occur within two weeks. This is to keep the children from having to work with more than one chart at a time. If, however, someone brings in a pussy willow branch while the class is involved in observing a plant project with a growth chart, go ahead and treat it in the same way, but omit the chart. This will challenge the children to make the same type of chart observations independently.

Outdoor activities

It is hoped that any class group can undertake an outdoor project. The directions here are adaptable to individual situations and present a simplified project so that the work will not outweigh the benefit.

The outdoor gardening, in fact, can be undertaken in either the spring or the fall, depending on the teacher’s familiarity with growing things and the use of other science units in the classroom schedule. Even if some class groups are not able to pursue a small garden project, some of the indoor activities are easily extended to take advantage of the outdoor growing season. If citrus or avocado seeds are sprouted or a branch of shrubbery forced, they can be potted, transplanted and maintained as container plants. The individual activities are written with suggestions for extending some indoor projects in this manner.

TEACHER’S NOTE on short season vegetables: Plants such as lettuce, spinach, and radish, are ideal, for early “research and discovery” planting. They can be planted while the weather is still very cool, and they grow rapidly. The children can see their growth to maturity and harvest by the end of the school term.

Other plants, such as tomato, bean, or cucumber, may show more impressive growth, but they take longer in producing their edible portion. Children’s interest may wane, or the project could end due to frost or summer vacation before those vegetables can be picked.

Radishes are especially rapid-growing; if you plant them two or three times, a week apart, you may even get to see the first planting flower and go to seed. The later plantings of radish can be watched along with the other plants and harvested at maturity for a garden salad snack. Check seed packets for days to maturity so everything is ready to eat at the same time. Send home any surplus with the children, and they can show off their produce.

Such plants are named specifically in the outdoor garden activities only as examples of what you can use. Don’t feel that you must limit yourself to the outlined activities. Take into account your seasonal variations or limitations, too.

Basic Facts that Teachers Should Know About Growing Plants Seeds

All seeds, however different they may look, contain the basic elements for a new plant, protected by a seed coat. The embryo of the seed has the beginnings of a stem, root, and the “seed” or cotyledon leaves of the plant. The pulp of the seed stores starch, sugars, fat, and protein to start the seed growing when conditions become favorable.

The different appearances of seeds (usually) function to scatter the seeds to potential planting areas. Seeds such as the maple and pine have wings which can
INTRODUCTION

Catch the wind. The dandelion and milkweed have soft hairs on their seeds which carry them in the wind like parachutes. Burr seeds have tiny hooks which catch on animal fur or clothing to carry them to new places. Some plants, such as touch-me-nots, have seed pods which pop open when the seeds are ripe, flinging the seeds away from the parent plant. The seed pod of the poppy acts like a salt shaker, and flings the tiny seeds away as the plant is jostled or blown in the wind.

Rates of growth in plants

Plants grow actively for a large part of the year, but their rate of growth is not always obvious. The change in a vegetable or flowering plant will be much more dramatic than the same season's growth of a tree or most shrubbery.

Many plants (annuals) go through a complete cycle from seed to plant to flower, to seed, and are killed by frost (petunia, for example) or shrivel and die when their seeds have dried out and can be picked (beans, for example). The growth of these annual plants is usually measured in days, as each day is a major part of their life.

Other plants with slower growth habits are measured in seasons or in years. Biennial flowers (hollyhock, for example) grow only leaves the first year and live through the winter to produce a flowering stalk the second season and thereafter. The onion and carrot grow in a similar manner, making a flower stalk and seeds in their second season, but they usually are picked for cooking after only one season. A tree is an even better example of growth in years, as some trees can grow for 20 years or more before reaching maturity. Fruit trees also may grow for several years before they produce any fruit.

This type of plant is obviously inappropriate for use in a classroom project except for watching it sprout and become a potted plant.

Perennial plants are a type which can be grown either from seed or from the division or cutting apart of a root clump. Top growth of these plants usually dies seasonally and renews top growth each year. Perennial food plants include chives, asparagus, rhubarb and parsley. Examples of perennial flowers include daylilies, lilies of the valley, pinks, peonies, chrysanthemums, and irises.

Faster growing plants are better to use in classroom experiences so the children can maintain an interest in projects by seeing results: food and flowers. The plants with the shortest growing days to harvest include those with edible leaves or roots, such as lettuce or radishes. Vegetable plants which produce a pod or fruit must first grow a certain size before flowering and maturing. Early varieties of certain cool-weather vegetables such as peas may possibly be grown within a spring session of school.

Parts of plants

All plants basically are the same: they have an underground portion, the roots, which we do not see; and an above-ground portion made up of stems, leaves, and flowers which produce a fruit, vegetable, or seed.

In many food plants, the fruit (or vegetable) that is produced from a pollinated flower is the part which is eaten. Common examples are tomato, cucumber, pea, bean, apple, peach, and strawberry.

Other plants that are used for food are picked before the plants flower. Of these plants, it is not always the same part which is eaten. Celery and rhubarb stalks or stems are eaten. Asparagus is another stem
INTRODUCTION
which is used in the bud stage. No leaves appear until the food harvest period is over and the shoots are allowed to grow.

Plants such as lettuce, spinach, mustard, collards and parsley are used for their edible leaves. The unseen root portion of plants such as the sweet potato, white potato, turnip, beet, and carrot are common food sources. Bulbous plants such as the onion and garlic also provide food from an underground part of the plant. This bulb portion is not a true root, nor is it a part of the plant stem. It actually is storing food for the plant to send up a flowering stalk in its second year, but it is harvested for use in cooking before that time.

Herbaceous plants are often harvested for their flowers or leaves, for seasonings and for teas. Examples of herbs used for these purposes are mint, rosemary, basil, oregano, lemon balm, and thyme. Such flowers as hibiscus, elderflower, jasmine, chamomile, and clover are frequently used in blended teas. The flowers of daylilies (hemerocallis) and squash plants are even sautéed and eaten by home garden enthusiasts.

The seeds of several types of plants are commonly used in cooking and for seasonings of foods. Dill seeds, cumin seeds, celery seeds, mustard seeds, poppy seeds, sunflower seeds, and millet seeds are some which are used in this way.

Planting media

The materials described in this section can be used alone or in combination with each other.

The planting medium serves to hold the seeds in place during germination and rooting, to supply and hold water available to the new plant, and to permit oxygen to reach the roots through the porous mixture. It must be as free of harmful diseases and insects as possible, to avoid stunting or killing the plants.

SOILS—Soils are composed of mineral and organic matter in various combinations. The mineral or inorganic part of soil is made up of broken, decomposed pieces of rock, air and water. The organic part of soil is made up of plant and animal residues broken down by fungi and bacteria. It is called humus and can be the product of one's own compost heap.

LOAM—This is a catchall word for good garden soil. It can be used alone or mixed with sand for germinating. It needs to be pulverized and sterilized.

PEAT—Peat is used as a covering for germinating seed, as a part of composts for seed and potting soils, and alone or mixed with sand as a germinating medium. Peat has a high percentage of organic matter since it is made up of plants that die, settle under water, and decay slowly. Peat has a high capacity for holding water and is relatively free from weed seeds. It is difficult to wet and has some nutrients.

PEAT MOSS—This is partially decomposed sphagnum moss. It is difficult to wet and forms a hard surface crust which repels water.

SPHAGNUM MOSS—This moss is renowned for its water-holding ability because of hollow cells which make up the stem and leaves. Ground-up or milled sphagnum moss is easier to handle than unmilled sphagnum. It is also difficult to wet at first (soaking and then squeezing out excess does it), and, if kept moist, it will not form a hard crust. It is naturally sterile.

SAND—Sand is important in a good mix to help provide drainage in the soil. Builder's
INTRODUCTION

or "sharp" sand grains are rough to the touch; "soft" sand is too fine to be useful. Sand should be well washed for use in potting mixes.

VERMICULITE—This lightweight material is expanded mica, often used for seedlings or to "lighten" the soil in potting mixes. It is sterile and holds water well, almost more than seeds demand. It has no nutrients, so some organic material must be added to the mix, or the seedlings watered with plant food if they are not to be transplanted when the first true leaves appear.

PERLITE—Volcanic rock is expanded by pressure heating to become lighter than sand. It has no nutrients and is too light to be used alone as a planting medium. Perlite can be used in place of sand to "lighten" the soil and provide aeration.

MIXTURES—In general, a light mixture such as sandy loam is good for germinating seeds. Mixtures such as one part soil, one part sand, and one part peat, by volume, are commonly used. Both these examples require sterilization. One combination that is sterile to start with is one-third milled sphagnum moss, one-third vermiculite, and one-third sand. This can be mixed at home or purchased in bags. It is very clean to use, but fertilizer solution must be used when true leaves appear.

STERILIZING—If garden soil is included in any mixture, it has to be sterilized. The moist mixture should be placed in a 250°F oven for at least two hours. This will kill fungus spores which cause "damping off" disease in seedlings. The disease causes seedlings to wilt and fall over, encouraged by the moist atmosphere of the planter.

Equipment

Just about any container will work that is over 2 1/2" high, can hold the planting mix, is fairly waterproof, and has holes in the bottom. Many items can be found around the home for this purpose: milk cartons, margarine tubs, disposable dell containers from the store, cup containers from yogurt or cottage cheese, eggshells or egg cartons, etc.

Other types of containers are available in garden centers, singly or in kits, such as:

Yellow trays—trays with high sides, made of compressed peat, wood fibers, or plastic.

Peat pots—round and square, are good for root cuttings or seeds to be transplanted. Sides should be slit open when repotting or planting in the ground, and the pot completely covered with soil since it will act as a wick and take water from the soil if left exposed.

Peat pot strips—peat molded into a double row of small pots, like an ice cube tray.

Jiffy-7's—individual planters made from compressed peat in plastic netting. They expand with added water so seeds can be planted. Roots grow easily through the open sides.

Ferticubes—one inch square blocks of compressed sphagnum moss, perlite, and vermiculite with added nutrients.

An eyedropper or small teaspoon is useful for watering small planters. Sometimes a well-washed detergent bottle with a push-pull nozzle cap works well if used carefully.

Some type of label will be needed for each planter or tray of seeds. Items such as popsicle sticks or tongue depressors can be stuck into the soil, or masking tape can be written on and taped to individual containers.

Planting seeds

Try to buy seeds early in the spring so they will be on hand. Older seeds (those packed for previous years) may still grow, but with a smaller percentage of germina-
INTRODUCTION

Older seeds may be tested at home by sowing a few in a wet paper towel to see how many do germinate before using in class.

Planting containers should be filled close to the top, leaving ¼” or less so air may easily circulate. The soil should be firmly tamped down and thoroughly wetted. Mild force in pouring the water will help settle the mix without splashing dirt about; the containers should drain well for at least an hour.

Use a folded paper to sow very fine seeds, tapping it gently to scatter the seed.

When the seeds are sown, cover the planter with plastic to retain moisture. It should not touch the surface. Hold up by a stick or pencil in the soil. At this time, the planter should be in a warm place but not be in the sun.

Germination

Three things are essential to the germinating seed: water, suitable temperature, and oxygen. Light is important once the seeds have sprouted.

Water softens the coating of the seed and causes the seed to swell so it can burst out of the softened seed coat. Water also helps to pass oxygen to the embryo plant for the growth process to begin.

The temperature required for many plants to germinate is 10-15°C (50-60°F); most houseplants require more warmth (18-27°C or 65-80°F).

Very small seeds must be planted near the surface of the soil so they do not crush themselves trying to push out toward sunlight.

Essentials for proper germination:
1) Water—the planting should never dry out.
2) Overwatering can deprive the seeds of oxygen and drown them.

3) A spray-mister or fine sprinkler can for watering will not disturb the seeds.
4) Seeds sown too deeply may germinate poorly.
5) Seeds should be kept out of direct sun until germination is complete.

Seedlings

When the young plant (or seedling) first emerges from the soil, it has no “true” leaves yet. The first pair of “seed” leaves that push up through the soil provide nourishment while the root system develops. At this point the plant can survive in a sterile growing medium such as peat moss or a vermiculite/perlite mix.

When the first green shoots have appeared, move the seedlings into direct sunlight. Turn the plants daily to keep them from growing in only one direction.

As the soil mix starts to dry, water the plants either from the bottom through the drainage holes or from the top with a mister or fine sprinkler can.

When true leaves appear, add fertilizer or transplant to fertile soil.

When to water plants

Different plants need watering at different times. The first thing to know about watering is how much water a plant needs: should it remain slightly moist between waterings or should the soil dry out before you water again?

Once the watering requirement of a plant is known, one must know how to tell when the plant needs watering. Test the soil by putting a finger into the dirt up to the first knuckle. If the soil feels loose and powdery and doesn’t stick to the fingertip, the soil has dried out since watering. If the dirt seems to stay stuck together and sticks to the finger, it is still slightly moist. A very moist soil will be obvious to the touch of a finger. Water the plant according to what
it needs. At first, plants should be checked every day, until the needs of each plant are apparent.
PLANTS
Activity (Spring field walk)

Materials:
- Potted plant or one of the growing class projects
- Sample of green to take outside

Procedure:
- Early in the spring, around the last week of March, plan a field walk to find the new growth of spring.
- Gather your group together to prepare for the walk. Present a potted plant or one of the projects that is growing in class. Ask the children if they know what it is; see if they can name the color.
- Tell them that there haven’t been too many green things outdoors all winter. Can they tell why? Most plants can’t grow outside in the winter; it’s too cold.
- Now that the weather is becoming warmer, we are going outside to see if anything has started to grow. It is possible to see several different “greens.”
- Tell the children to look for the green color of plants. Take along some examples of green for confirmation.
- Bring samples of green back to class.
- Upon returning to class, discuss observations. Were there many colors or many different plants? Did they look or feel alike?
- Ask if the children know of a place in the schoolyard or around the grounds where they could grow some things of their own.
- Suggest that the class try growing some plants outdoors. Emphasize choosing seeds that will still grow in the cool weather.
- Have the children ask their parents for ideas about what to plant. Someone may even be able to donate a root clump of chives to the class, or a perennial flower.

Good plants for this project include: lettuce, spinach, and radishes. These can all be grown from seed. Plant the cloves of a garlic bulb or potted chives which can usually be found at a grocery store.

Amaryllis, tulip, daffodil and narcissus grow quickly and are exciting to see with many leaves and lovely blossoms.

Record the outcome of the field walk: the children’s exploration, how each child became involved in the “hunt for green”, their comments and descriptions, the variety of items found, where the plants were discovered.

In discussing the growing of plants, note the variety of suggestions offered by the children and their questions.

Where the growing season is (very) long, this activity can be adapted for use early in the fall. The class can observe the many different growth habits of plants. Successional activities can then be planned to end before freezing weather.

The following Follow-Up Project may be used with this activity.
Have you ever looked carefully at a plant? When you do, you will find many interesting things. Choose a plant near your home or school. Look at it closely. Then answer as many of the questions on this page as you can.

1. Where is the plant growing? Is it in the light or in the shade? Is the soil wet or dry?

2. What does the plant look like? Draw a picture of it here.

3. Does it have flowers or fruits?


5. What kind of plant is it? You can ask your parents or your teacher, or look for it in a book about plants.

6. When you look at the plant later, has it changed? In what way?
**Activity**  *(Field trip to seed store for information about gardening)*

**Materials:**
- List of questions made by the class
- (Contact) Local seed store manager or garden “expert”

**Procedure:**
- Contact a local seed store manager or a gardening “expert” that you know. This could be a friend or neighbor who raises a garden. A seed store offers an array of seeds, garden supplies, and tools.
- After taking the field walk, look for spring growth, suggest to the class to try planting some things outdoors.
- Ask the children if they have ever gardened or watched their parents garden. Have them tell of their experiences with outdoor growing. Encourage all contributions.
- Have the children help compile a list of things needed or that need to be done to start a garden. Include questions for information on making a new garden: What is a good location? What plants could best grow now? Can they be harvested before school is out? What are the best growing conditions for those plants? Is there an easy way to make a small garden bed at school? How much care will the plants need? What is the best kind of dirt?
- Take this list of questions along on the trip, and see if the children will do some of the asking. Write down answers.
- Purchase seeds at this time for the outdoor project.
- The information gained on the gardening visit can be complemented as the project progresses by the printed information on the seed packets. Many basic gardening books are also available to confirm basic facts of garden care; check with your local librarian.

**Activity** *(Selecting a garden spot)*

**Materials:**
- Book on basic garden requirements or notes from class visit with plant care “expert”
- Seed packets of plants you will grow
- Paper of planting measurements
- List of needs to consider in choosing garden spot

**Procedure:**
- Ask the children if their parents know of any seeds that are planted in cool weather (see Activity 1). Tell them about the ones you found in the garden book.
- Show the garden book, pamphlet or notes about garden needs and care. Summarize information and also use the instructions on the seed packets.
- Determine the type of area the class should look for such as planting under the branches of a tree. Check with the school principal to see if there are any limitations.
- Go outside together and look for a spot around the school grounds where the class can plant some seeds. Choose a sunny spot, out of the way of major foot traffic. Remember to check details given for seeds on the packet.
**PLANTS**

**Activity (Caring for the garden)**

**Materials:**
- Bucket of water, "sprinkle" can
- Yard clippings or straw for mulch

**Procedure:**
- Check the planters each day. Sprinkle them with water if it hasn’t rained in the last few days. This can be done at the start of the class’s outside play time.
- Set up a garden growth chart like the one for indoor plant activities. Refer to the indoor growing activities.
- There may be plant seeds which sprout other than the ones planted. These are called weeds just because they are not wanted. Cover them with mulch to keep them from growing. The original seeds will be growing in a circle (tire) or a row marked by the sign.
- Parents may again assist the project by donating sacks of yard clippings for mulch. When class plants are identifiable from weed plants, it is time to **mulch** with straw or almost any plant material.
- Demonstrate with a handful of the mulch material how to spread it right up next to the circle or row of tiny plants. Let the children finish spreading a thick layer of mulch, taking care not to cover the plants they want to keep. Mark this activity on your garden calendar.
- Apply more mulching material, as it becomes dry and compacted, to make a thick layer and stop weeds from growing through. It also helps retain water. Once the plants are established, they may not need to be watered. Check under the layer of mulch and water only when dry.

If radishes are planted after having mulched, just pull back the mulch to expose the soil to plant your seeds. When the plants come up, cover any bare dirt with mulch again.

**Activity (Thinning the plants)**

**Materials:**
- Seed packet (for instructions)
- Spirit duplicator *11
- Scissors for each child
- Paper, one sheet for each child
- Paste

**Procedure:**
- When the plants have grown sufficiently so that the leaves are touching, it is time to thin them out. Explain that thinning the plants gives the remaining ones plenty of room to grow.
- Thin as directed on the seed packets. Let each child pull some of the plants and examine them closely. The children can then see the underground part of the plant. What do they think it is called?
- Are the roots of the different plants the same? What do they think the roots do? They help keep the plant in the ground and from falling over. They also take up water from the soil so the plant can grow.
- Put mulch material between the plants to retain moisture and keep weeds controlled.
- When the children return to the classroom, give each of them a copy of spirit duplicator *11. Have them cut out the pictures of the parts of the plant and paste them on paper to form the entire plant. These papers are used to diagnose the extent to which the children have learned the concept of plant growth.
What Do Seeds Need for Growing?

Here is a picture of a garden. Draw what the seeds need for growing. Color in your picture.
PLANTS

Activity  (Sprouting a sweet potato)

Materials:
- 8” square or round baking pan, medium bowl, or mayonnaise jar
- Water
- Medium-sized sweet potato
- Paper toweling
- Growth Chart
- Crayon
- String

Procedure:

Gather the materials and give the sweet potato to the children to pass around. See if anyone knows what it is.

A sweet potato grows in the ground, and it is eaten. It can also grow as a plant for the classroom.

Let the children pour some water into the container which you have provided. Plant the sweet potato, tapered end downward. Tell the children it should be about half covered. Let them add or remove water as needed. Use paper toweling for drips or spills.

Ask the children where they think the plant will come from. Point out the “eyes” of the sweet potato and let the children examine them.

Write the heading “sweet potato” at the top of each growth chart and give one chart to each child. (Unit IV—Activity 3)

Ask the children to mark an X in the first box to represent the start of the project. Tell them they can all check the sweet potato tomorrow and each day to see if anything has changed. Have the children mark lines across the boxes each day nothing new occurs.

On the day roots are sighted, have them draw “roots” in that box on the growth chart. Follow the growth each day. Watch for the roots to reach the bottom of the jar or the sides of the pan. Mark the box on that day with a star and accompany this mark with a simple drawing.

What do the roots make you think of when you look at their tangled growth?

When stem growth begins, ask the children to mark the day with a simple drawing. The children can note progress by counting the number of leaves as they appear, or by measuring.

To measure, tie a knot at one end of a length of string, about 2 feet or more in length. Choose one stem to measure. Have one child hold the knot against the sweet potato, and ask another child to pull the loose end of the string to the end of the growing stem. Mark this point with a fiber tip pen. Draw a “leaf” in the box for that day. Use green. Fasten the string to the growth chart with a paper clip or punch a hole in the corner and lace the string through it.

Continue measuring on the same stem each time a new leaf appears. Draw an additional leaf on the growth chart each time. See how long it takes for the vine to grow longer than the string.

Set the sweet potato project on a table in front of a bulletin board and pin the vines up as they grow. See how long it takes to grow taller than the teacher or higher than the bulletin board.

Set the plant on top of something and see how far down toward the floor the vines may dangle.

The growth charts may be used to diagnose the children’s observations and ability to record them.
Activity (Growing a carrot top)

Materials:
- Top end of carrot with ½"—1" of carrot left on
- Small container or bowl to hold carrot tops
- Small jar (bouillon cubes, baby food) or margarine container for each carrot
- Round toothpicks, 3 per carrot
- Water and pitcher
- Paper towel
- Growth chart, pen or pencil (optional)

Procedure:
This activity could arise in several ways: the teacher could bring carrot tops from home; the class could fix carrot sticks for snack sometime; the teacher could suggest top ends of carrots among items to bring from home to try growing.

Present the carrot ends to the children to look at. Ask if they think these pieces could grow. Tell them to check closely and guess where something might grow from the piece of carrot.

Ask the children how they might make carrots grow. See if they refer to other growing projects for ideas. Tell them to try putting the pieces of carrot into some water and see what happens.

Explain to the group that the carrot should not be covered over with water. Count 3 toothpicks and poke them in around the sides of the carrot near the top end. Set this on the mouth of the jar, then let each child take a carrot piece and 3 toothpicks and do the same thing.

For plastic containers, show how to stand the carrot piece on a toothpick tripod in the dish. The carrot must be below the rim of the dish so it will be in the water.

Fill the jars or dishes with water or let the children take the containers and fill them from the faucet, but not full. Next, put the carrots in the water. Help adjust the amount of water. Soak up drips or spills with paper towels.

Ask children what they think will happen next. Check each day to make sure the bottom of the carrot pieces are covered in the water.

You can use Spirit Duplicator #10 to record growth. Follow the procedures used for the birdseed and sweet potato in keeping this growth chart.

If the growing carrots are maintained and sustain the interest of the group or a few children who care for it, the carrot may flower.
Plants

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<th>4th Week</th>
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Follow-Up Activity

PLANTS

Activity (Sprouting an avocado seed)

Materials:
- Pint or quart-sized container
- Toothpicks or matchsticks
- Avocado seed from home
- Water, knife

Procedure:
Avocados sometimes take a while to sprout, but try it, for the stem and roots grow quickly and are easy to watch when started in water.

Let the seed dry for 3-4 days. Obtain a jar from instant coffee or mayonnaise to give the roots plenty of room.

Use 3 sturdy toothpicks or wooden matchsticks (shaved at one end) to poke into the narrow end of the seed; you may want to pierce the seed first with the tip of a knife.

Suspend the seed down into the neck of the jar, with the pointed end up, so that the broad end will always dip into the water which fills up the jar. First the root will grow down into the water, and soon the seed will spread open and a shoot will grow. Check regularly the amount of water and look for changes.

For the avocado to become a sturdy potted plant, follow its growth until the stem is 12" high, and then cut it off, almost right back to the seed. It will soon grow another, stronger stem which can support more leaf growth without bending over.
Activity

How Does Light Affect Plant Growth?

Time Allotment: Allow one 30-minute science period for steps 1-3. Students will need to check soil moisture content every other day for one week. At the end of each week, a 15- to 30-minute science period is needed to analyze results.

Objectives

1. Hypothesize which seedlings will grow best (in light or no light).
2. Analyze the conditions under which most plants grow best.
3. Compare the growth of the seedlings and communicate their findings.

Preparation Suggestions

- Use bean seedlings which have grown since previous activities or plant eight bean seeds per student or group two weeks prior to this activity.
- Find several tall boxes which will fit over each group’s seedlings to be grown without light. A large grocery bag could be used if the seedlings are placed in a very dark place.
- If there are no windows in your room, use a “grow light.” Caution students not to handle this light as a safety precaution.

Teaching Suggestions

- This activity could be performed by small or large groups. All of the seeds to be grown IN LIGHT can be grouped together on trays near a light source. Those seedlings to be grown in NO LIGHT can also be grouped together. Do this activity in the way most suited to your preference and classroom arrangement.

Meeting Needs: Allow your special students to work with a peer helper while completing the activity.

- Have students measure their seedlings the first day of the activity. Record the height on a chart. Display the chart in a prominent position in the classroom.
- Have one student from each group check the water needs of the seedlings. Students may wish to take turns. After watering, remind students to put the seedlings back in their proper position.
- After the first and second weeks, have students observe the seedlings. Have them measure the growth. Record the heights and compare them with the earlier measurements.
- Discuss the results of this activity. Students should be encouraged to tell what happened in their own words. The use of a control in an experiment is important; however, most students would not be able to understand this abstraction. However, you

ACTIVITY

How Does Light Affect Plant Growth?

Annotations for activity materials indicate quantities needed for 30 students in groups of 10 each:

What to use:

- 3 small milk cartons
- 15 bean seedlings
- labels
- 15 pencil and paper
- 9 paper cup
- potting soil
- 1 bag
- 2 tall boxes

Ask students to save their small milk cartons from lunch.

What to do:

1. Label one milk carton Light, one carton Some Light, and one carton No Light.
2. Plant three seedlings in each carton. Add water to each carton until the soil is moist.
3. Place a tall box over the carton labeled No Light. Put the other two cartons near a window.
4. Every day at noon, place the second tall box over the carton labeled Some Light. Remove the box each morning.
5. Check the soil in each carton every other day. Add water if needed to make the soil moist.
6. After one week observe the plants in each carton. Record any changes you observe.
7. Wait a second week. Observe and record any changes.
may still want to discuss what the control and variables were.

WHAT DID YOU LEARN?

1. How did the seedlings in each carton look at the start of the activity?
   All of the seedlings should look very similar at the beginning of the activity.

2. How did the seedlings in each carton look after two weeks?
   Answers will vary. The seedlings grown IN LIGHT should be tall and green.
   Those grown in SOME LIGHT should be shorter but still green (possibly a pale green).
   Those grown in NO LIGHT should be yellow (or brown), shorter yet, and limp.

3. Which carton of seedlings grew the best?
   The seedlings IN LIGHT grew the best.

USING WHAT YOU LEARNED:

1. Plants that need a lot of light to grow and produce food live in sunny places.
   Those that need less light live in shady places.

2. Water is a variable in this activity. If the plants did not receive equal amounts of water, the final poor condition of some seedlings might be due to lack of water, not lack of light.
Which plant was kept in a dark place?

Color it.

What does the plant need now?

Color it.
Write your answers in the blanks.

What is a seed? ________________________________

Identify the parts of this seed and tell what each part does.

a. _______________________________________

b. _______________________________________

c. _______________________________________

What does the word germinate mean? ________________________________

What two things does a seed need to germinate?

a. _______________________________________

b. _______________________________________

What three things does a seedling need to grow?

a. _______________________________________

b. _______________________________________

c. _______________________________________

Tell two reasons why these seedlings did not grow well.

a. _______________________________________

b. _______________________________________

What three things do plants need to make their own food?

a. _______________________________________

b. _______________________________________

c. _______________________________________

Tell how each seed might be scattered.

a. _______________________________________

b. _______________________________________

c. _______________________________________

Why are there many different ways that seeds are scattered?
Classifying Leaves

The ability to classify leads to a more useful arrangement of objects. Classifications built upon a single characteristic such as color, size, shape, or texture are not very useful. More useful classifications can be made after many experiences with several characteristics. In this lesson with leaves, the characteristics become more complicated and the combinations of variables are increased.

To increase the child's awareness of the similarities and differences in leaves.
To give children an experience in arranging and classifying leaves.

Bags in which to collect leaves, Chart on leaves
Round, sharp, long, pointed, green.

Make arrangements to take a nature walk around the school or to a nearby park to collect leaves. Give children large paper bags in which to place their leaves. Caution the young collectors against picking too many leaves at one time, for they dry out rapidly. Also caution them against damaging plants and property when collecting leaves.

Upon returning, display Chart and have the children examine and describe some of the characteristics of the leaves that they found. Call for volunteers to come to the chart and compare the pictures shown with real leaves. Have them note the edges of their leaves. Have them pay attention to the veins of the leaves. Ask the children such questions as: "Do all leaves have the same kind of edging or veins?" "Do both sides of the leaves look alike?" Ask the children to group similar leaves together. Some may group their leaves by shape, others by color, size, serration, or venation. Help children to group some of their leaves according to more than one variable (shape and veins or shape and edging).

Arrange the leaf collections on newspapers in a flat but natural position. Place a few sheets of another newspaper on top of each collection. These papers will absorb the moisture as the specimens dry. Place another collection on top of the second layer of newspapers. Continue this arrangement for several layers, then place flat boards upon the last layer of newspapers. These boards can be weighted down by stacks of heavy books. Make sure the weight is heavy enough to keep the specimens from wrinkling. If the specimens are very moist, the procedure may need to be repeated. An alternate method would be to place the layers of newspapers and leaves between two flat boards. The boards can then be clamped or strapped tightly together, pressing the leaves and papers between them.

After 24 hours the specimens can be mounted to fairly heavy sheets of paper by tape, glue, or staples.

The sheets may be prepared as scrapbooks or individually framed. All the specimens should be organized and appropriately labeled.
To help the children realize the differences in vein patterns and edging patterns, let them prepare various kinds of art prints. Suggestions for prints may be found on page ... Shadow prints, spatter prints, and blue prints emphasize leaf shapes and edging patterns (serration). Paint prints, transfer prints, and carbon prints tend to emphasize vein patterns (venation). Crayon prints and plaster casts emphasize both.

When the prints are finished, the children should group or classify their pictures by noticing similarities and differences.

The leaves shown in this chart differ in color, size, venation and serration. Use this variety of characteristics to elicit from the children how the leaves are alike and how they are different. Proceeding from the lower right hand corner of the chart in a clockwise direction the leaves are: White Oak, Black Gum, White Ash, Tulip Tree, Paper Birch, Sugar Maple, American Holly, Black Willow, and Red Oak.
Lesson 7 Cont.

Classifying Leaves

OVERVIEW

Most children like to look at leaves. They like to collect them and often let us know how much they appreciate them. It is fair to say that leaves are intrinsically motivating in themselves. For these reasons, leaves have been chosen as the basis for another lesson on classification that stresses similarities and differences in the properties of an object.

AIMS

To increase the child’s awareness of the similarities and differences in various leaves.
To further develop visual acuity in children.
To help the children classify leaves.

MATERIALS

Leaves of various kinds (showing differences in size, shape, color), construction paper, plastic tape, crayons.

ORAL VOCABULARY

Pointed, round, long, short, sharp, triangle, circle, other descriptive vocabulary that might apply to the physical characteristics of different leaves.

HOW TO BEGIN

Mount a variety of leaves on construction paper using cellophane tape and display them in front of the class. It would be preferable if leaves that have been brought in by the children are mounted in addition to the ones you select. If it is at all possible, have enough leaves to pass around to the children. This way, they can pick them up and examine them more closely.
Feeling, smelling, and observing the leaves at close hand is far more effective than having the children observe them from a distance.

PROCEDURE

Begin by asking the children if they notice anything new about the room. Since you have prepared these mounted leaves in advance, the children will be quick to respond to the display. Give the children a chance to express themselves about the leaves in their own way before guiding a brief discussion about the characteristics of the different leaves. Ask questions that tend to focus the attention of the children on those characteristics common to all of the leaves. “How are all of the leaves the same?” should give you responses as, “They all have a stem,” “They are all flat,” “They come from trees,” etc. When these characteristics are expressed, ask such questions as, “Who can tell us how the leaves are different?” Depending on the particular leaves that are available, the children should bring out the differences in color, size, and shape. You may have to guide their thinking to elicit the specific differences among the leaves.

A very effective technique is to isolate pairs of leaves that show “contrasting” characteristics. For example, you can display a round leaf and a leaf shaped like a triangle, and ask questions such as, “How are these two leaves different?” “Can anyone tell us another difference?”

Such questions as, “Which leaf is longer?” “Which of the leaves is rounder?” and “Which leaf is pointed?” will certainly help to reinforce the descriptive vocabulary.

One way to emphasize the shapes, colors, and sizes of the leaves would be to draw pictures on the chalkboard, exaggerating the qualities that show the similarities and differences. How much terminology that the children
Il depend on the degree to which you have worked with the children recognizing and identifying familiar objects earlier in the term.

Doodling simple outlines of the leaves, matching real leaves to outlines of the corresponding leaves, and other cutting and pasting activities serve to reinforce many of the important ideas of this lesson.

IDEAS FOR
GOING FURTHER
**Crayon Prints:** This kind of print may be done by placing a leaf flat on a hard surface with its vein side up. Place a sheet of thin paper over the leaf and stroke the flat side of a crayon across the paper in parallel motions. Over the entire leaf and the outline and veins of the leaf will show up clearly.

**Paint Prints:** Paint the veined surface of the leaf with water colors. Before the leaf dries, place it, painted side down, on porous sketching paper. Cover the leaf with another sheet of paper and press it with a hot iron. A hot crayon wax will print an image of the leaf on the lower sheet.

**Transfer Prints:** Rub the veined side of a leaf with a crayon. After coloring the entire surface, place the leaf crayon side down on paper or cloth. Remove the leaf with another sheet of paper and press it with a hot iron. A print will be made.

**Carbon Prints:** Place the veined side of a leaf against a sheet of carbon paper. Press the leaf with a warm iron, then place the leaf against a sheet of white paper, veined side down. Press the leaf again with the warm iron and a print will be made.

**Shadow Prints:** Place a leaf on a piece of thin paper, then place the paper against a window with the leaf between the pane and the paper. Outline and veins of the leaf can be traced lightly then darkened with tooth ink or crayon afterward.

**Spatter Prints:** Place a leaf on a sheet of paper and spatter ink or paint and the edge of the leaf. Some spray paints work well for this activity. Dip a tooth brush into a pan of ink or thin poster paint. Hold the brush sideways over the leaf. Scrape the bristles with a thin stick and the spatter will pattern around the edge of the leaf.

**Blueprints:** This kind of print requires a good deal of preparation and is best on sunny days. Carefully arrange on a sheet of glass the specimen to be blueprinted. Place blueprint paper greenish side down upon specimens. Place a second piece of glass on top of the blueprint paper. Expose the specimen side to the sunlight for 2 to 5 minutes (less bright light takes the longer time). Remove the blueprint paper and soak it in water for several minutes. Dry the paper between paper towels, and it will be dry flat.

**Plaster Casts:** These casts are made by coating the inside of a shallow cardboard box or cut-down milk carton with vaseline. Coat the veined side of the leaf also. Place the leaf in the box coated side up. Pour Plaster of Paris gently into the box and allow it to harden. The plaster will set in 10 minutes, but will take overnight to dry thoroughly. When dry,
We bring leaves for our science table.
Leaves grow on plants.
Some leaves are small.
Some are big.
In each line find two leaves that are alike.
Put an X on each one.

1.

2.

3.
Follow-up Activity

Leaves Are Not Alike

These leaves are alike  These leaves are different

Are they alike?

Yes  No

Yes  No

Yes  No

4
PART 1 CONTINUED - Unit II Animals
Lesson 1

OBJECTIVES

- To discover that animals are of many different sizes
- To discover that different animals eat different foods
- To discover that animals live in many different environments
- To develop responsibility in caring for animals in the classroom
- To develop an awareness of differences between similar animals

In this set of activities, the children make discoveries about animals through indoor and outdoor activities and by observing real animals where they live. The children participate in field trips and care of classroom pets. Some of the activities may overlap or extend information from a field trip to an indoor activity, or from outdoor observation and discovery to an indoor activity.

Those not familiar with caring for small animals can learn through contact with friends and neighbors who have pets. Feel free also to contact the managing personnel of a pet store, the local library, a high school biology teacher, or other expert who can provide details about specific animals. Preparation of this sort can give you confidence in handling a small animal should you choose one for the classroom.

Be aware that any classroom pets must be provided for over long weekends, holidays, and vacations. On weekends and short holidays, many pets can be supplied with extra food for the couple of days. The children can take turns keeping the animals at home over vacations. Friendly "experts", books, or pet store personnel can be consulted for more information about specific pets.

Picture books of varieties of animals or specific groups of animals, information for recording observations on a class project, or information that a child and parent can use for a project at home, offer excellent guidance to individual class members whose interests extend beyond the initial activities you present.

Activities with a high child interest level or eager participation can be repeated or adapted to fit the needs of the class as you use this science unit.

Observe the children during the exploratory activity. Record details on how each child acts or participates.

Repeat the recording of your observations when the exploratory activity is again used at the end of the unit. See if there is any apparent change in the behavior of each child. Children who have had some previous background experience with animals may have developed an investigative curiosity; a child who seemed disinterested at first may show increased observation skills through exposure to animals in these activities. The children may develop more interaction with one another from participating in activities together.

You can see each child's progress in relation to previous behavior, rather than comparing one to another when the background experiences may differ widely.

EXPLORATORY ACTIVITY

Materials:
- Pen and paper
- Assorted spoons and forks

Procedure:

Choose two or three areas outside to take the class to look for living things such as birds, squirrels, dogs, cats, or insects. Consider an area around a tree; another near residences which have pets.

Take the class outside to one of the above areas. Ask the children to find some living things. Challenge them to spend one or two minutes looking and see what they find. Initiate the activity by participating.

Have the children tell about what things they saw and where they were found.

Proceed to the next area and follow the same procedure. Look for one or two minutes and see what kinds of living things can be found.

Record on paper, as the activity progresses, the actions of the individual children. Observe how they approach the task of looking for various animals: do they look up among the leaves? examine tree bark? look at the ground? the sidewalk? or around the bases of plants? Some may examine the earth or want to dig into it. Are they having fun or are they at a loss and don't know what to do? Do they use the full time allotted for observations? Are they exchanging ideas or findings with friends?

Keep your notes to refer to again at the completion of activities from the Animals unit. This activity will be repeated in the same manner and notes made again on your observations of the children for comparative purposes.
it needs. At first, plants should be checked every day, until the needs of each plant are apparent.

Animals

A unit on animals often connotes zoo or circus games and many pictures of animals found in such places. In this set of activities, animals are treated in both a broader and more directly visible sense.

The unit here attempts to develop or broaden an awareness of many different types of animals in nature and the daily environment. “Animal” is expanded beyond cat, dog, bear, lion, and giraffe, to include worms, insects, fish, and others.

The activities are designed to increase the children’s observation skills so they can make discoveries about animals. Exploration and discovery of indoor and outdoor animal habitats provide personal experiences in the children’s own environment.

Observation of the outdoors finds the children actively seeking local insects or birds and observing their behavior. Field trip experiences are for information and for exposure to animals not common around the home or the geographical region.

Indoor activities expand outdoor and field trip experiences within the classroom setting. These experiences can provide an opportunity for the children to participate in routines of caring for an indoor pet.

For children to gain the most from their involvement, activities should encourage active participation wherever possible. In this way, each child can incorporate new information and observations and build on previous experiences.

Activities with a high child interest and participation level can easily be repeated during the course of the science unit.

Pets in the Classroom

Before a pet is selected to keep in the classroom, consider its needs as well as the conditions in the classroom. This will help to limit the possibilities to those animals which can adjust and function within your classroom environment.

There are many animals which are easily accommodated in the scheme of a classroom. Such an animal should have a simple routine of care in which the children can participate, and a feeding schedule which permits being left unattended for two or three days on the weekend. For vacation periods, make arrangements to keep the pet in someone’s home.

Basic Facts Teachers Should Know About Classroom Animals

Following is a list of some animals which are easily kept indoors including some facts concerning their care.

For more detailed information about these or other animals which you would like to keep as an indoor pet, consult your librarian, another pet owner, a high school biologist, or pet store for facts on their care.

Turtles—Keep turtles in a terrarium or a straight sided container of water with stones or an area on which the turtle can dry off. A flat rock makes a handy “bridge” from land to water. Turtles are cold-blooded, so they remain the same temperature as their surroundings and cannot stand long exposure to sun or cold. A small piece of plaster of paris in the water will help keep the shell hard.

A turtle eats vegetables and meat (plants and animals). Foods suitable for a turtle include edible greens (spinach, lettuce), worms, tadpoles, snails, fish, insects, hard-boiled or raw eggs, cheese, fruit, string beans, or commercially prepared turtle
food. Turtles do not digest fat, so any meats should be lean and raw. Feed the turtle once a day, removing the excess after one hour. Put a few drops of cod liver oil on the food occasionally. Turtles have no teeth. The jaw is sharp for cutting and chewing. To feed the little turtles, place them in a bowl of water. When the turtle has finished eating, return it to its home container. Raw foods should be offered in small quantities.

Periodically, wash out the turtle bowl and its contents. Use a sink which is not used for food preparation. Baby turtles bought in shops have been known to carry salmonella. Similarly, although turtles can stand much handling, the children should always wash their hands well after handling turtles.

Replace the water in the bowl with fresh water which has sat for 24 hours to allow the chlorine to escape.

Gerbils—The gerbil is a rodent resembling the mouse-rat family. It has a soft, furry tail and a broader face, like a squirrel, and longer hind legs adapted for leaping. They are curious and friendly animals which can be handled gently.

A glass or plastic cage with a wire cover makes a good home for a gerbil and will protect it from drafts. A leaky old aquarium is excellent, but a wire cage could suffice with a barrier around the bottom to keep cage materials inside. As a rodent, it gnaws, so a simple wooden tunnel is good for this as well as for playing and hiding. Cedar chips make the best material for the cage bottom. Cardboard and gravel can also be used, but needs to be cleaned out more often than cedar chips. The gerbil will shred materials such as paper towels, tissues, or terry towel scraps for a nest. An exercise wheel provides good exercise and is entertaining to watch.

Gerbils will eat almost anything. Mouse- or rabbit pellets are available commercially, or they can be fed lettuce, seeds, or pieces of fruit and vegetables. Food can be placed randomly in the cage, or pieces can be offered by hand. Use a water bottle that hangs to the side of the cage; refill it as it runs low. Gerbils are easily maintained in the classroom and can be left with enough food and water for almost a week, if necessary. This can be gauged by how much food and water are consumed daily or over a week of regular attention. A gerbil may be handled by children, in cupped hands, moving from one to the other.

Clean the cage every 1-3 weeks, depending on size of cage, number of animals, and material used in cage bottom. Gerbils enjoy a companion, but it should be noted that they will mate three times a year. It is feasible to keep a pair of the same sex.

Hamsters—Hamsters are furry burrowing rodents with a short tail and large cheek pouches for storing food. They can be handled gently but do have sharp teeth and are startled by quick movements.

A hamster cage should be small with screened sides and an exercise wheel. The floor should be covered with cedar chips. Hamsters also like straw or cut up newspapers for a nest, which should be changed often. Hamsters like to sleep in a 4" square box, fastened halfway up the cage, with a ladder to climb. Provide a box of sand for burrowing and hiding. They like to sleep or nap in the daytime and are very active at night.

Since the hamster is a nocturnal animal, feed it late in the day. Good foods include bread, raw vegetables, grains, seeds, edible greens, or even dog biscuits and milk. They need plenty of water in a bottle hung on the side of the cage. A few drops of cod liver oil should be added to the food twice a week.
Do not handle hamsters when they are first received. Allow them to adjust to their new surroundings and then handle them very gently and with slow movements. The cage should be cleaned weekly or bieweekly, as it seems necessary. The door of the cage should always be fastened securely, because a hamster on the loose can do great damage.

Guinea pigs—These animals are known for cleanliness and gentleness. They are affectionate and require little care to remain healthy. They are long or short-haired in a wide variety of colors. Their bodies are short and thick, with short legs, and a large head with a blunt nose.

A guinea pig is kept easily and cheaply in almost any light, airy, draft-free location. They are poor climbers and do not jump, so their home does not need a cover. A cage with a solid bottom should be cleaned at least weekly, or one with a wire mesh floor can have a tray of sand or litter underneath to catch droppings and can be changed more frequently. Supply cut or torn newspapers for a nest area.

Place food for the guinea pig in a heavy crockery feeding dish that will not tip over. A good balanced diet consists of fresh greens, hay, water, and salt, supplemented by commercially prepared pellets or chow. It will eat foods such as apples, tomatoes, carrots and tops, cauliflower, dandelions, green clover, lawn clippings, lettuce, celery tops, sugar beets, and corn. Feed grains with greens to avoid diarrhea. Rock salt should always be available.

Parakeets—These birds are available in blue, gray, white, yellow, and the original green color. They have long tail and wing feathers and a sharp pointed bill, somewhat like a parrot. They are wild in Australia and are available in the United States in pet stores.

Parakeets are kept in roomy cages, with perches near food and water containers which are attached from the outside of the cage. Provide bell toys and swinging perches which are available commercially. Bird cages have a slide-out tray on the bottom which pulls out for weekly cleaning. Cover the tray with brown paper cut to size and spread a layer of bird gravel. The birds eat some of the gravel to help digest their foods. Do not use newspaper because the parakeet will partake and the print is bad for the digestion. Gravel paper is available as a substitute.

Birdseed is widely available in supermarkets and pet stores. Parakeets also need grit or cuttlebone to sharpen their beaks and will eat fresh spinach, carrot or celery tops, or dandelion greens in addition to seed. Parsley or lettuce will make them sick. The birds must be supplied with fresh water daily. They chirp and sing and may imitate other bird calls or whistling.

Place a small pan of tepid water in the cage occasionally for the bird to take a bath. Parakeets need to have the cage covered at night to keep out drafts and light. You may handle them gently and often, allow them to perch on the finger or in the open hand. Movements should be slow and quiet to avoid alarming the birds, since they can peck with their bills and strike with their wings.
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Activity 1 (Outdoor feeding tray)

Materials:
Aluminum dish (recycled TV dinner tray, pie pan, etc.)
A rock for a weight
Collected nuts and seeds, other bits of food, or packaged wild bird seed; suet in winter
Crayon, marker, or gummed stickers
Paper for observation chart
Scraps of material, yarn, or string
(optional)

Procedure:
Collect items for a feeder tray to attract birds and squirrels. During field walks, search for acorns, black walnuts, buckeyes (horse chestnut), or other tree seeds. Seeds from the kitchen can include sesame, millet, sunflower, etc. Wild bird foods containing similar mixtures are easily purchased in bulk. Fruit parings or cores, crackers, or suet can also be offered.

Set the tray on a window ledge or under a nearby tree where it is easily seen from the classroom. Weight the tray with a rock so it doesn't blow away. Spread the nuts and seeds or food in the bottom.

Observe the tray regularly each day and at different times throughout the day.
Rule a sheet of paper into 2" squares and tape it near the window. Mark in one square each time someone sees a bird or squirrel visiting the feeding tray. Make a circle, an X, or some other line or symbol to stand for a visitor. Gummed stickers or stars can also be used.

Each day remind the children of the feeding tray and list. Choose a volunteer to add food to the tray when needed.

At the end of a week's time, discuss the project with the class. Encourage each child to take a look at the tray from time to time.

Look on the ground for signs of animal activity, such as broken hulls from nuts and seeds or food scraps which have been gnawed. If the weather is nice, open a window and listen for animal and bird noises.

Regular feeding of birds should continue throughout the winter. Animals will learn to depend on the food you provide, especially when there is snow on the ground and other food is scarce.

In the spring, set out strips of scrap materials, yarn, or string to see if any are taken by birds for nest-building.

Activity 2 (Bird pictures)

Materials:
Book of bird pictures
Feeding tray from previous activity
3 x 5 cards (optional)
Pencil and pens or crayons for bird sketch (optional)

Procedure:
Obtain a book of bird pictures. The library is a good resource. Look through the book and place book marks or clip index markers on the pages showing birds commonly seen in your area.

Show the book to the children. Tell them these are some pictures of birds which might visit the feeder. Show the first picture of a bird. Has anyone ever seen one of these birds?

Ask the children to describe the bird as they see it; the color or markings, where it is sitting, etc. Does anyone know if it makes a sound? See if they can name the bird, then tell them what the name of it is.
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Present each bird picture in a similar way. Encourage the children to talk about any experiences they have had in observing birds.

Show the children that markers are placed on the pages which show birds that are likely to be seen visiting the class's feeding tray. Say also that when looking through the book, they should leave the markers on the pages so that the next reader will know where to look.

Have one of the children place the book in the area where they watch the feeder tray or mark their observations. It will be readily available for the children to look at during free times throughout the day.

(Optional) Provide simple sketches of those birds which may frequent your feeder on 3 x 5 cards. They need not be fancy, just including the outstanding characteristics (color, head crest, body shape) which make the birds recognizable. Put the name of the bird at the bottom of the sketch. See below.

(Optional) Place the sketches near the chart of observations. When the children see a bird, they can readily compare and identify the card that matches what they see. The bird cards can accompany the book of bird pictures.
Problem: How do birds differ from other animals?

Materials:
1. Pictures of various birds
2. Chart paper to list the characteristics of birds
3. Bird books
4. Stuffed birds if available

Procedure:
1. Place pictures of birds around the room. Have the bird books on the library table. If stuffed birds are obtainable, display them also.
2. When a question arises guide the discussion so that the children will want to find out more about birds.
3. Have students study pictures, books, and specimens.
4. After the study period, list the characteristics of birds on chalkboard as students state them.
5. Have children notice that birds have feathers, wings, and beaks; lay eggs, have no teeth, etc.
6. The children should make a chart with the data they have discussed.

D. Result:
The children will learn some of the gross characteristics of birds.

E. Supplemental Information:
1. Birds are warm-blooded animals. They have special characteristics which adapt them for food searching, protection, and flight.
2. There are many good bird feeders and bird-baths which the students might want to build.

F. Thought Questions:
1. How do the bones of birds differ from the bones of other land animals?
2. Do birds need much energy for flight? How do they adjust to their energy requirements?
3. How are the wings of birds similar to the wings of airplanes? how different?
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Activity 3 (Learning to use a magnifier)

Materials:
   Hand-held magnifiers
   Tray; paper bag or box
   Assorted objects for close examination: yam, sandpaper, cracker, toy car, leaf, fabric scrap, small jar of dirt, torn paper, decorative buttons, feather, small jar of salt

Procedure:
   Present the tray with the magnifiers to the group. Allow the children to play with the magnifiers freely for several moments. See if they make any discoveries.
   Ask the children if they know what the magnifiers are called. Have them talk about their experiences with the magnifiers, after they have had a chance to play with them freely.
   Demonstrate how to hold a magnifier directly over the palm of a hand and move it closer to the palm while looking. Point out what is happening and what is seen. Let the children try it.
   When the children begin to imitate the procedure, point out the sequence that makes it successful: holding the magnifier over the object, then moving it closer to look. Stop when the object seems big and clear.
   Spread the assortment of objects on the tray or table. Have the children tell what they see without the use of the magnifier, just their eyes. Then, give each child an object. Ask the children to use the magnifiers and examine the assorted objects as they wish. Ask, "Are the objects bigger?"
   Other things which can be examined easily include fingers, shoes, clothes, and hair.
   As each child practices looking through a magnifying glass, keep on modeling or demonstrating what to do. Point out and describe what is visible.
   Ask the children to demonstrate to one another how the magnifiers work and in turn, they will learn from each other.

Activity 4 (Observing ants)

Materials:
   Hand-held magnifiers
   Bread crumbs, cake, or cracker crumbs
   Restaurant packet of sugar or jelly
   Stick

Procedure:
   Explore the outdoors in preparation for this activity. Find an area which has one or more anthills. Look for them in grass, in open soil, and even in cracks in the sidewalk or driveways. Take the children outside and look for ants. Find an ant hill by looking for the hole or hill itself, or by finding some ants and following them. Sometimes a large number of ants move along a pathway. Follow the ants in each direction to see where they have come from and where they are going.
   Have the children describe the anthills when they locate some.
   Observe what the ants are doing.
   Look closely at the ants, using hand-held magnifiers. Allow for plenty of turn-taking among the children if you have found only one or two hills.
   Put some food crumbs near some of the ants outside the hill or in their pathway as they walk.
   Sprinkle some sugar in front of or near some ants. Use a small stick or a finger to spread some jelly on the ground. See what the ants do. Then add a few drops of water to moisten the sweet.
   Have the children place objects in the path of a trail of ants. Use sticks, rocks,
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folded paper, wood, or whatever you can supply. Observe what happens.
Ants will flee their nest carrying eggs and larvae if they feel that danger is near. Take a stick and scratch around the anthill, disturbing or scraping away some of the dirt around the opening. Gently poke into the opening of the hill a few times. This should be enough alarm to cause them to evacuate the nest.
**Activity 5 (Indoor ant farm)**

**Materials:**
- Ants, nest soil, hand trowel
- Double grocery bag, stapler
- Newspapers, widemouth quart jar
- Slim (olive) jar with lid, to fit in quart jar
- Piece of nylon stocking
- Dark construction paper
- Rubber bands
- Piece of sponge, jam or syrup
- Flashlight
- Round or square metal baking pan, water
- Dropcloth, broom, dustpan (indoors only)

**Procedure:**
1. Locate a nest of medium or large ants outside. In preparation for the activity, dig into the nest and quickly transfer soil and contents into bag.
2. Avoid mixing soil from two nests. Fold top of bag several times and staple across the top. Keep in a cool place until needed.
3. Prepare ant farm outdoors if possible, otherwise spread newspapers or a dropcloth on the floor and have a broom and dustpan handy.
4. Have children center the closed thin jar inside the quart jar. Fold newspaper into funnel and insert in mouth of quart jar.
5. Open bag with ants and soil and gently transfer to jar while one child steadies the funnel. Set the jar in a pan of water to keep ants from leaving the ant-farm jar.
6. Have ready a piece of nylon stocking to cover the top of the jar and fasten with a rubber band.
7. Let children wet the sponge and place a dab of jam on it. Quickly put it in the jar and replace the stocking cover. Keep the sponge damp by daily dripping water through the stocking; renew jam once a week.

The children can also wrap the jar with the construction paper and fasten it with rubber bands. After a few days the paper can be removed for several minutes to watch the ants in their new home. Lift the jar to look at the bottom, too. Rewrap the jar after observing the ants.

Have the children report on what they see in the jar.

When interest in the project diminishes, empty the jar outside near where they were dug up.

**Activity 6 (Finding soil animals)**

**Materials:**
- Bucket or portable basin
- Shovel or spade
- Magnifying glasses or hand-held magnifiers
- Assorted spoons and forks
- Assorted small containers or bowls
- Newspapers or newsprint sheet for each child
- Scoop, container or small shovel
- Broom and dustpan, or sponge and bowl of water if done indoors

**Procedure:**
1. Take the children outside to dig up some dirt for examination. Try to choose an area where things are growing, not just trodden or gravelly soil. Close examination of the dirt can be done inside or outside.
2. When the soil is first dug and on the shovel, let the children look at it. Ask them if they see any insects. There may be an earthworm readily visible, or some ants or other bugs. Fill the bucket or basin with a gallon or more of dirt, and you will be ready to explore it more closely.
3. Seat the children in a semi-circle around the bucket or basin of dirt and give the children newsprint to spread on the ground as a work surface.
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Let each child take a “helping” of earth to use on the individual worksheets. Use hands, scoop, container or small shovel.

Ask the children what they think they might find in the soil. Tell them they can explore with their fingers or use forks and spoons to dig and pry. Set the utensils within reach of the children.

Pass out small containers (such as pie tins, margarine tubs, or cottage cheese cartons) for the children to use if something is found.

Encourage examination with the magnifiers. Set an example by using one as you look through the dirt for sticks, bugs, plant roots, or whatever is interesting. Then each child can do the same and put items that are found in an individual dish.

When everyone has had a chance to explore thoroughly in the dirt, put the dirt from the worksheets back into the basin or bucket. Pour the dirt back into the hole where it was obtained.

Let the children show one another what they found in the dirt. They will enjoy sharing and comparing their discoveries. See if they can name the things they found, whether insect, rock, stick, etc.
A. Problem: How do ants live?

B. Materials:
1. Twelve to fourteen ants
2. Large jar with screen
3. Loose soil
4. Water
5. Black paper
6. Small moist sponge
7. Honey or sugar
8. Magnifying glass

C. Procedure:
1. Fill the jar with loose soil.
2. Dampen soil lightly.
3. Leave sponge in jar.
4. Cover side of jar with black paper.
5. Place ants and small amount of sugar in jar.
6. Cover jar with fine wire screen.
7. Tie or scotch-tape a black paper around the jar. (Leave about an inch at the top of the jar without paper.)
8. Slip the black paper off for a short period each day to observe the ants at work.
9. It is necessary that ants have water daily. Caution—too much food will cause mold and odor in the colony.
10. Have students observe ants under a magnifying glass and draw a simple sketch of the ant's main body parts.

D. Results:
1. The children can see the progress ants make in building tunnels and storerooms.
2. Students will learn the major anatomical parts of ants.

E. Supplemental Information:
Ants work together to build homes and carry on life processes. They live in a specialized animal society; that is, some ants are "workers," some "royalty," and some "cows."

F. Thought Questions:
1. How do ants behave differently in their natural environment than they do in a classroom ant house?
2. What kinds of foods have you seen ants carry to their natural homes?
3. Are ants strong animals? How much weight in comparison with their body weight have you seen them carry?
4. Can ants see?
Insects

is an insect.

A

is an insect.

Insects are animals.
I see them everywhere.

A

is an insect.

Can you find the insects?
Draw a line under each one.
More Insects

These are insects, too.
Count each insect's legs.
Count the feelers.
The feelers are on the insect's head.

How are insects alike?

Insects have ____________________________ legs.

Insects have ____________________________ feelers.
activity

A. Problem: How do bees live?

B. Materials:
1. Class bee house
2. Dead bee
3. Large pictures of bees
4. Books containing information about bees
5. Magnifying glass
6. Honeycomb (or jar of honey if honeycomb is unavailable)

C. Procedure:
1. Interest is stimulated by bringing to class a bee-house, honeycomb or honey, and a dead bee.
2. The class should list its questions about bees and group them around broad areas such as “food,” “habits,” “structure,” etc.
3. The class should then attempt to find answers to its questions by observation and reading.
4. Observe a bee under a magnifying glass.
5. Pupils should draw a simple sketch of the main anatomical parts of a bee.

D. Results:
1. Children will learn about the community life of the bees.
2. Students will learn about the main body parts of bees.

E. Supplemental Information:
Life in a beehive is complex, orderly and interesting. Each bee has its own work to do for the welfare of the entire colony.

F. Thought Questions:
1. How does the society of a bee compare with that of an ant?
2. How are different flavors possible in honey?
3. What are the specific jobs of the specialized work of bees?
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Activity 7 (Looking for animals in pond or stream water)

Materials:
- Plastic basin or large glass jar or bowl (half-gallon or gallon size)
- Magnifiers
- Water from pond or stream

Procedure:
Survey your locale or ask the parents to try and locate a pond or stream where you can obtain a sample of water to examine in class.
Visit the area with the children and collect the water. Make other arrangements to have the sample brought to class if a visit is not possible.
Put the materials in a location accessible to the children, especially a table around which a group can gather.
Begin by looking closely at the contents of the jar or bowl. Ask the children if they can see anything in the water. Name something in the water.
Move away to make more room for children to look at the water. Ask them to describe things that they see.
Ask the children if anything is happening in the water. Can they see any movement?
Ask the children if they know a better way to see what's in the water. Suggest the use of the magnifier if necessary. The magnifier will allow the children to enlarge tiny animals and see more detail.
Set out a jar of water drawn from the tap for the children to observe. They can examine it and compare it to the pond water to see if any tiny animals appear or any other changes take place.

Activity 8 (Collecting caterpillars)

Materials:
- Empty 2-3 lb. coffee can, or shoe box
- 1-3 glass jars with lids (quart size or larger)
- Hammer, small nail
- Sheets or long fabric strips to wrap "cocoons" (optional)
- Spirit Duplicator #42
- Crayons

Procedure:
In preparation for this activity, go outside and locate some caterpillars. Look for a plant whose leaves are nibbled or shows other signs of being eaten. If you don't find any on the first try, keep looking at daily or weekly intervals. You may also find one crawling on the ground or up the stems of plants.
Prepare the display jars by making air holes in the lid with a hammer and a small nail.
Tell the children they will be going outside and hunting for caterpillars. Give them a clue as to where they can look; caterpillars eat leaves. See if they can extrapolate this information and look on the bushes, garden plants, etc.
Take the children outside to a location you have scouted. Be sure they carry along a can or box for bringing back specimens to class.
Along with any caterpillars that are found, bring back some leaves from the plant where it was found. Include a small branch or twig on which it can settle to build its cocoon.
After returning to class, put the caterpillars in separate display jars with leaves from the plants where they were found. They are often the only food that the caterpillar will eat.
Choose one or two children each day to

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ANIMALS

remove dead or dry leaves and animal droppings. Supply fresh leaves, the same type where the animal was found. The moisture necessary for the animal is contained in the fresh leaves it eats.

The caterpillars are harmless and can be allowed to crawl on hands and arms.

As the animal grows, it may go into its final molt or cocoon stage. The caterpillar spins a silken thread around itself or makes a shelter to crawl into. After this resting stage, a moth or butterfly may emerge.

Give each child a copy of spirit duplicator #12. Have the children identify the stages of caterpillar growth and then color the pictures so they remember observing them.
Animals

ME
activity

A. Problem: Do caterpillars change into butterflies?

B. Materials:
1. Live caterpillars
2. Pictures
3. Informational books

C. Procedure:
1. Have a brief, general discussion about caterpillars and butterflies.
2. Have the children who are interested form a study committee.
3. The committee should find live caterpillars and plan how they will care for them.
4. As the caterpillars pass through the different stages, the members of the committee can report to the class by showing the stages and telling what they have found.

D. Result:
The students will learn about each phase of the life cycle of a butterfly.

E. Supplemental Information:
Caterpillars eat specific types of food. If you are not sure about the food to feed the caterpillars, use the leaves or grass from where they were found.

F. Thought Questions:
1. How does the life cycle of a butterfly compare with the life cycle of other animals?
2. How are the caterpillars going to be kept in class to insure their health and safety?
3. What are the differences between a moth and a butterfly?
A. Problem: Do tadpoles become frogs?

B. Materials:
1. Frog in jar or terrarium
2. Tadpoles in class aquarium
3. Sketches of different stages of development on chalkboard
4. Books with pictures of frog’s development
5. Literature (booklets, pamphlets, etc.)

C. Procedure:
1. Let children observe tadpoles and frogs in science corner.
2. Have students read literature about frogs.
3. Have a question and answer period and pose such questions as:
   a. How far can a frog jump?
      Answer—20 times its own length.
   b. How many kinds of frogs are there?
      Answer—1700 different kinds.
   c. How long do they live?
      Answer—Many live as long as 30 years.
   d. What are the differences between frogs and toads?
      Answer—There are few visible differences, but the main ones are:

   **Frogs:**
   - Skin: Soft, moist, smooth.
   - Teeth: Small.
   - Movement: Fast
   - Habitat: Mostly in water.

   **Toads:**
   - Skin: Tough, dry with bumps (bumps give off a secretion which is harmful to animals).
   - Teeth: None.
   - Movement: Clumsy (short front legs that toe in).
   - Habitat: On land and water.

4. Ask children if they would like to study what happens to fishlike tadpoles.
5. Have children observe the changes that occur in the tadpoles.
6. As a culmination, the teacher and pupils might cooperate in the making of a chart entitled:

D. Results:
1. Children gain firsthand experience observing the various phases of metamorphosis.
2. Children learn the characteristics of frogs and toads.

E. Supplemental Information:
Frogs and tadpoles are within the experiences of many children. They can be watched as they develop in the classroom; they make interesting specimens for learning. If aquarium is kept in the classroom, be sure to change water frequently or the tadpoles will die. They can be fed fish food, lettuce, and bits of hardboiled eggs. If the children want to keep a frog at home they should dig a deep hole in the backyard in which is placed a large basin. Frogs should be fed live insects. All eggs are not fertile and those which are not die. Tadpoles sometimes eat each other.

F. Thought Questions:
1. How do scientists classify (group) animals?
2. Where would frogs and tadpoles be placed?
3. How many animals do you know that live in and around the water?
Frogs live on land.
Frogs live in the water, too.
Look at the frog’s back legs.
They help him jump.
Frogs eat insects.

Write the words.

Frogs eat ____________________________.

Frogs can ____________________________.

Some frogs live in ____________________________.
Activity 9 (Movement)

Materials:
None

Procedure:
Have a movement activity based on the observations of caterpillars.

Have the children take turns lying prone on the floor, arms' extended forward. They creep forward, first on feet or knees, then extend the front half of the body on hands or elbows. Have each "crawl" on leaves and stems and pretend to be eating leaves.

The children can use sheets or fabric strips to spin their own "cocoons", especially if they watched their own caterpillars do this. The "caterpillar" child should stand and hold one end of the sheet and turn around slowly. Other members of the group hold the fabric as it winds around to form a "cocoons." After a short waiting period, the moth or butterfly emerges to test its wings and fly away.

Have a "dance of caterpillars" as all the children participate in the movement activity.

Activity 10 (Farm or animal visit field trip)

Materials:
Pictures of animals to be seen on visit
Paper and pen
Spirit Duplicator #13
Crayons

Procedure:
Survey the classroom parents to find out if any of them keep animals, uncommon pets, or farm animals for the class to visit. Sometimes, the parents may have friends or neighbors who keep animals.

Arrange with the owner of the animals for your class group to visit, observe and learn about the animals. Ask if the children can help feed the animals, for example, or touch or closely observe the animal's actions.

For classroom preparation, obtain pictures of the animals you will be visiting from the library or other sources.

Ask the children to help in making out a list of questions to take along on the trip. What kind of things would they like to find out about the particular animal or animals? You may wish to leave space between the questions for filling in an answer. Use the list for discussing the field trip on your return to class.

Questions you may want to try and elicit can include: What do the animals eat? Where do they sleep? Can anyone keep one of these animals? Do they require special care? Can you play with them?

Before leaving on the trip, discuss guidelines to be observed while visiting: suggestions or cautions from the owner, examples of behavior to follow, etc.

You may find an animal owner who can transport a pet to class. In this case, the class can issue an invitation to bring the animal to class. The same behavior guidelines can be discussed and a list of questions prepared.

Give each child a copy of spirit duplicator #13 to be used to diagnose their observations. Have the children draw what they saw on the field trip and then color the scene as they recall it.
Farm animals

NAME_________________________
1. What do farm animals need? Draw lines.

2. Circle what we get from these animals.

3. Put an X on the animals that are not pets.

Answers on page T69A.
Can you put the young with its parent?

Draw lines. Then color the animals.
Color the pets yellow. Color the farm animals red.

How do we use these animals? Draw lines.

On the back, draw one way people care for pets.
Activity 11 (Pet store field trip)

Materials:
- Paper and pen

Procedure:
Contact a local pet store about a visit from your class group. Ask the manager if your group can have a “tour” and see the various animals the store handles. This activity is also a good introduction to caring for pets.

Prepare a list of questions with the children to take along to the pet store. Ask them what they would like to know about small pets. Give examples, such as turtle, gerbil, goldfish, white mice, or parakeet as well as cats and dogs.

Try to aim for some information pertaining to indoor care of pets in a school environment in addition to other interests expressed by the children.

This information might contribute to your decision about choosing a pet to keep in the classroom.

Activity 12 (Gerbil)

Materials:
- Gerbil; food (prepared pellets, fruit and vegetable pieces, seeds)
- Leaky aquarium or plastic, glass, or wire cage
- Wire cover for cage
- Exercise wheel, water bottle
- Wood scraps for simple tunnel; hammer and few nails
- Cedar chips, newspaper, or gravel for bottom of cage
- Cardboard, toweling, tissue to shred for nest
- Empty soup can

Procedure:
Introduce the cage with the gerbil. Ask the children if they know what it is: a gerbil, which can be kept in the classroom. Let the group examine the set-up for a short time. Place it in a location accessible to the children.

Begin discussion of gerbil care by asking the children to describe the cage and what it contains. Encourage exchange of questions and information by asking the children the uses of the objects they see in the cage. They may, in return, ask where the animal sleeps or why it looks a certain way.

Children should help to formulate rules for handling the gerbil so they will feel a shared responsibility for its well-being.

Discuss also duties to be fulfilled as a result of keeping the gerbil. Ask the children if they know some things that will be needed to keep the gerbil happy and healthy: what does it need? Water must be kept in the water bottle; food must be offered daily; the cage must be cleaned periodically.

The children can feed and water the gerbil once they are shown how it is done and have participated at least once in the activity. Extra food can be left in the cage for the weekend.

The children can offer papers, tissue, or toweling as nest material for the gerbil to shred. They will also enjoy watching the gerbil play in an exercise wheel or gnaw on objects placed in the cage.

Offer a tin can with both ends cut out and sharp edges removed for the gerbil to play and hide. A simple tunnel can be devised from wood scraps for climbing and gnawing. A piece of tree limb which fits in the cage can serve a similar purpose.

Similar animal care activities can be undertaken for such classroom pets as goldfish or guppies, turtles, etc.

Children may enjoy choosing names for classroom pets.
Activity 13 (Cleaning gerbil cage)

Materials:
- Gerbil and cage
- Large cardboard box
- Newspapers
- Cardboard or cedar shavings
- Paper or terry toweling, tissue for nesting
- Food, fresh water

Procedure:
Children can provide much assistance when the cage is cleaned weekly. The gerbil should first be removed to a large cardboard box where it can easily be watched without worry of escape.

Toys or permanent objects should also be removed from the cage and placed into the box. Set the water bottle aside in a safe place. Discard used cage filler, old food scraps and nest materials. Dump onto opened newspaper, roll up and throw away.

The children can fold or cut newspaper or cardboard to fit the cage bottom. Cedar shavings or chips can be used if they are available; they require changing less often (2-4 weeks).

Replace gerbil in cage; replace water bottle and toys. Offer materials to shred for a new nest: paper or terry toweling, cardboard, tissue, etc. Supply fresh food and the gerbil is ready to go again.

The children can gradually assume full responsibility for care of the gerbil after the routines are repeated several times. A different pair of children can be assigned each week to participate in these tasks. All of the children can contribute bits of food from home for variety in the gerbil’s diet. Some snacks may be shared with the gerbil, also.

Activity 14 (Zoo visit)

Materials:
- Transportation to zoo
- Pictures of zoo animals
- Sack lunches or packed snack for a picnic
- Spirit duplicator #44

Procedure:
If there is a zoo within moderate or long driving distance of your school, it may be most practical to pay a single extended visit rather than to treat it as a short activity. Use the trip to visit animals which easily fall into broad categories; for example, birds, fish, reptiles, felines, apes and monkeys, or rodents.

While viewing each group of animals, ask the children to describe what they see. What size is the animal’s body? What kind of body covering or skin does it have? How does it move around? Watch for several moments. Is it like any other animal we know?

As the children move from one animal group (cats, for example) to another (monkeys and apes), they can compare the characteristics of each group: monkeys and tigers both have long tails; monkeys sometimes use their front feet like hands and for walking; tigers walk on their four paws like a cat; a monkey can hang from its tail but a tiger cannot; tigers eat meat; monkeys eat fruit.

Listen for sounds the animals make. What kind of surroundings do the animals live in? What dominates the scene—water, trees, rocks?

After returning to school, or the next day, give each child a copy of spirit duplicator #44. Have each draw lines from the animals they saw at the zoo to the zoo scene. These worksheets may be used to diagnose the extent of the children’s observations.
A. Problem: How do we care for hamsters in the classroom?

B. Materials:
1. Male hamster
2. Female hamster
3. Two wire mesh pens, about 3' x 2' in area, with sides at least 6 inches high
4. Four pans for food and water

C. Procedure:
1. Select students for specific duties, such as feeding the hamsters, cleaning the pens, or recording observations.
2. Place the two hamsters in the same pen and allow them to mate.
3. Feed the hamsters a variety of foods such as greens, bread, milk, etc.
4. Keep fresh water in the pen at all times.

D. Results:
1. Students will learn about the care and feeding of hamsters.
2. Pupils will discover some of the elements of breeding and care of young animals.

E. Supplemental Information:
1. All life comes from life, and each species reproduces its own kind of living organism.
2. Life is dependent upon certain materials and conditions.
3. Most animals need food, water, exercise, fresh air, and sunshine.
4. Use caution in handling the female hamster for a short time preceding and following the birth of the litter.
5. If hamsters are not available, guinea pigs will work equally well.

F. Thought Questions:
1. How are hamsters similar to other pets?
2. What are some differences?
3. What is the natural habitat of hamsters?
Procedure:
The day after a zoo visit, review these experiences in class with a role play or movement game. Have the children recall the animals they saw at the zoo. Show a picture of each one that was seen. (optional)
Cooperate in describing how the animals moved around. Make up movements with the children for the whole group to perform.
Think of other animals encountered in science activities, and imitate the movements of these animals, etc.
Give each child a copy of spirit duplicator #15. Tell them to complete the picture.

Closing Exploratory Activity
Materials:
Pencils, one for each child
Assorted spoons and forks
Spirit duplicator #16
Procedure:
Choose two or three areas outside where you can take the class to look for living things such as birds, squirrels, dogs, cats, or insects. One area could be around a tree; another could be near residences which have pets. Take the class outside to one of the spots you have selected. Tell the children to look around to see what living things they can find. Set a one- or two-minute time limit and begin. When the time is up, ask if anyone saw some living things. Have the children share what things they saw and where they were. Move on to the next spot and do the same thing again: look for one minute or two minutes and see what kind of living things can be found.
Take notes as the activity is in progress and watch the children individually. Note how each one gets involved in the task: closely examining the environment, digging the ground, looking into shrubbery, exchanging findings or following an active classmate, looking all over or staying with one focus. Do they seem to be having fun? Do they use the full time allotted? Compare these notes with those from the exploratory activity at the beginning of the unit to see how the activities have changed their awareness.
On returning to the classroom, give each child a copy of spirit duplicator #16. Have them recall the animals they have seen, then look at the animal/insect pictures, count the number of legs on each animal and print the numeral beneath the animal. Have them compare the numbers.
See card no. 7865-77
activity

A. Problem: How do animals differ from plants?

B. Materials:
Any number of living and nonliving things such as frogs, grasshoppers, goldfish, plants, rocks, shells, sticks, kittens, white mice, etc.

C. Procedure:
1. Divide the living from the nonliving things and note the differences.

2. Divide the living things into plants and animals and note the differences between the two.

D. Result:
The pupils should recognize the differences between living and nonliving things and between plants and animals. They should understand that all living things are classified as either plants or animals.

E. Supplemental Information:
1. Living things are alike in some respects and different in others.
2. Nonliving things have very few characteristics of living things.
3. Living things are either plants or animals.

F. Thought Questions:
1. How do some nonliving things move?
2. What is the biggest living thing you know about? the smallest?
3. What is the largest nonliving thing? the smallest?
activity

A. Problem: What animal am I?

B. Materials:
1. A flannel board with blue background about 18” x 24”
2. Flannel cutouts: A white rabbit and other familiar animals; strips of brown for ground, strips of green for grass, and an orange-colored carrot topped with green leaves or original drawings of pictures from a picture book, mounted on cardboard and backed with strips of sandpaper or flocking to make them adhere to the flannel board

C. Procedure:
1. Place ground and grass strips on flannel board.
2. “Plant” carrot between ground strips.
3. Place rabbit near carrot on ground.
4. Have children learn the name of the animal, where it lives and what it eats.
5. Change the animal and its setting.
6. For each animal find out:
   a. where it lives
   b. what it eats
   c. what preys on it
   d. how it has its young (eggs, live births)
   e. how important it is to us

D. Result:
Children will learn to identify common animals, their habitats and their food.

E. Supplemental Information:
This activity can be used to integrate other subjects such as language arts or social studies by adding printed words on cards or including studies on farm, food, health, etc.

F. Thought Questions:
1. Can we get information about animals by their size? color? shape?
2. Can we get information about animals by where they live?
3. What information can’t we get by a flannel board study that we could get if we were to see the animal in real life?
Where does each animal live? Draw lines.

land

water

Circle the body part used to protect each animal.

Draw a group of these animals in the right pictures.

ers on page T125A.
R PARENT: The class has been studying wild animals. We have learned where they live, one way they are classified, and how they protect themselves and their young. We have also learned about animal groups. In this home activity, you will help your child learn about the foods wild animals eat. Have your child write the correct foods beside each animal.

WHAT DO THE ANIMALS EAT?

squirrel

caterpillar

spider

bird

raccoon

rabbit

Visit a zoo. Find out what other animals eat.

Answers on page T125A.
CHART TIME

Find the animals with each kind of covering.
Count the animals.
Color that many boxes in the chart.
Tell about your chart.

### Animal Coverings Chart

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A. Problem: How do we prepare an aquarium for the classroom?

B. Materials:
1. Glass tank and cover
2. Sand
3. Plants
4. Paper
5. Sprinkling can
6. Fish
7. Snails

C. Procedure:
1. Wash glass tank thoroughly. A tank with a rectangular metal frame and a slate or glass bottom is most satisfactory. It is less likely to break than an all-glass tank without a frame, is easily repaired when broken, provides a large surface area for oxygen absorption, and offers an undistorted view of the fish. A tank 10" x 10" x 16" or more is advisable, as it is difficult to keep a smaller tank in good condition. Globes or goldfish bowls prevent adequate observation of the occupants and do not provide enough surface on the bottom for the plant growth or the sand that is needed.
2. Wash sand till water is clear. Coarse sand is best for the aquarium.
3. Place a 2-inch layer of sand at the bottom of the aquarium. Large pebbles and rocks, as well as ornamental castles, sea shells, and the like should never be placed in the aquarium. Un-eaten food settles and decays under them, polluting the water. Living fish are sufficient ornaments.
4. If the tank is not already in its permanent position, place it there now. (Moving the aquarium after it is filled with water may cause a leak.) The tank should be placed in a position that ensures a liberal supply of diffused light. An ideal position is one with an exposure of one to two hours of direct sunlight daily. This will result in the active process of photosynthesis, in
which the plants use the carbon dioxide given off by the fish and release oxygen needed by the fish.

Too much light encourages growth of algae and weeds which crowd out cultivated plants. If kept in a window, the tank should have a dark paper pasted on the outer side to prevent the growth of algae on the glass.

5. The tank should not be placed near a radiator because a high temperature is injurious to most fish. Cold-water fish, including goldfish, thrive at temperatures from 59° to 65° F. Tropical fish require temperatures of 70° to 80° F.

6. Pour water from a sprinkling can into the tank, taking care to disturb the sand as little as possible. The slow pouring of water from a sprinkling can allows it to become aerated.

7. Disinfect plants by putting them in a salt solution (four ounces of salt to the gallon) for one minute, then washing them in fresh water. All plants, native or purchased, should be disinfected.

8. Put plants in sand. When the roots are long, they should be pruned. Roots should be spread and well covered with sand.

Plants should not be scattered over the whole aquarium but should be placed so as to leave an open space in which the fish can swim freely. Plants of like species are best grouped together. A planting plan of the bottom of the aquarium can be made on paper before the actual planting. Floating plants may be added later if desired. They are sometimes not recommended because they shut out light. Several kinds of plants are valuable as oxygenators. Sagittaria, Vallisneria, Elodea, Anacharis, Ludwigia, Myriophyllum and Cabomba are all suitable and ornamental and may be rooted in the sand. It is often possible to obtain native plants entirely suitable for the aquarium. Search in ponds and streams where minnows and other life are found and hunt for the small green plants under the water. Discover by investigation what plant life is at hand that will keep water pure, for the ponds grow their own aerating plants.

In the newly planted aquarium, algae may develop and fresh water may become cloudy. Even if cloudiness is considerable, the water should not be changed unless blue-green algae cover plants, sand, and windows with a dark slimy coat. Normally, blue-green algae will not disturb the aquarium. Soon the cloudiness dis-appears and an attractive light brown color replaces the crystal clear water of the newly planted aquarium.

When tap water is used, the tank should be allowed to stand at least 24 hours before putting in the animals. This allows the water to clear and become thoroughly oxygenated, the plants to take root, and any unwanted gases to dissipate.

9. After this time place fish and snails in the aquarium. The water in the aquarium should be approximately the same temperature as that from which the fish are taken. The fish should not be touched with the hands or dropped into the water, as this may injure their scales and lead to development of a fungus disease. They should be allowed to swim out of the container into the tank. A dip net may be used to transfer the fish from one container to another. Care must be taken that the size and species of the fish are such that the larger ones do not eat the smaller ones!

Freshwater snails are, for all purposes, the best scavengers. A snail to every gallon of water is recommended. Native species are usually preferred. They can be gathered from streams or ponds or bought. Certain small fish such as the "weather fish" and catfish are valuable in preventing food from settling to the bottom.

10. Feed fish sparingly. It is well to remember that prepared fish food is highly concentrated. Fish should be given only what they can eat within 15 minutes. If food remains at the bottom, too much has been given. Uneaten food should be removed.

Animals
Feedings should be regular. Twice a week is usually sufficient in cold weather — three times a week in warm seasons.

Prepared food can be obtained at aquarium supply stores, pet stores, five and tens, and grocery stores. This may be supplemented by occasional fresh foods such as scrapings of raw beef and chopped lettuce. Live food such as Artemia is also satisfactory.

11. Remove immediately any fish showing signs of illness. Overfeeding, insufficient oxygen, and sudden changes in temperature are the chief causes of sickness among fish. Congested reddish fins, white fungus on the body, or wobbly body movement are signs of illness.

Treatment with salt water has been found best for general use. For a weak bath, one teaspoonful salt to a gallon of water is recommended. For a strong bath, use one tablespoon salt to a gallon of water. A sick fish should be left in the weak bath for 24 hours. This treatment is continued with a new solution until the fish becomes healthy. The fish are left in the strong solution for only 15 to 20 minutes at a time. Saltwater treatment is not effective in all types of illness. Consult an aquarium book.

Gaping of fish at the top of the water may be due to an excess of carbon dioxide in the water or a lack of oxygen. If the water is oversaturated or undersaturated with oxygen, the excess or lack is quickly adjusted by exposure with the air above the water. However, since carbon dioxide passes from water to air and air to water very slowly, it takes much longer for an excess of carbon dioxide to pass off. It has been found that fish cannot take in oxygen at the gills if too much carbon dioxide is in the water. For this reason, fish can suffocate even when plenty of oxygen is present. Plants use carbon dioxide when actively engaged in photosynthesis and make the aquarium more habitable by reducing the amount of carbon dioxide in the water.

12. After fish have been placed in the aquarium, cover the aquarium with glass in order to prevent evaporation and the collecting of dust.

D. Supplemental Information:

The experience of making an aquarium and caring for live animals in the classroom is both interesting and educational. The types of tank, sand, animals, and plants selected all are factors to be considered. Aging and proper temperature of the water, and the daily care and observation of the animals and plants are also important items. The children become aware of the interrelationship between plants and animals. The oxygen needed by the animals is provided by plants and the carbon dioxide needed by the plants is provided by animals. When the oxygen-carbon dioxide relationship is well-balanced, it is unnecessary to change the water in the aquarium.

E. Thought Questions:

1. What are the little dots that form on the sides of the aquarium that look as if they were covered with thin cellophane?
2. Which type of green plants survive best?
3. What are the advantages of bushy type plants?
A. **Problem:** How can we preserve insects or make a butterfly collection?

B. **Materials:**
1. Insects collected on a field trip
2. Insect pins (size 2 or 3)
3. Forceps
4. Cardboard insect boxes
5. Glue
6. White card
7. Fine point pen
8. Spreading board, sheet of cork, or cardboard
9. Relaxing jar
10. Formalin

C. **Procedure:**
1. Insects must be mounted on insect pins.
2. Place older specimens in a "relaxing jar," a widemouthed jar with wet sand on the bottom. Add to this a few drops of formalin and place the insects in the jar on the sand and close the jar tightly. A small dish with sand may be substituted. The specimens will be soft enough to handle in a few days.

3. Hold the specimen between the fingers of one hand while putting the pin in vertically with the other hand. Push the specimen up toward the head of the pin three-eighths of an inch for grasping the pin with the fingers. Use forceps for pushing the insects upon the pin.
4. Put the pin through the center of the stoutest part of the body, but never through a joint that lies between two parts of the insect.

5. Beetles must be pinned through on one of the hard shell wings, just to the right of the midline down through where the two wings meet on the body.
6. True bugs will need to be pinned through the small, triangular piece that is attached to the hind end of the thorax.
7. Keep specimens in most natural position. Place those with slender abdomens low on the pin. Spread out legs and antennae and let dry, then push to proper place on the pin.
8. Some insects should have wings spread in mounting. To save space, sometimes the wings on one side are spread to save room in the insect box. A spreading board is best to use, but a sheet of cork can also be used.
9. Insects too small to pin are best glued to the tips of small cardboard points. Use a card as thick as a library card. Cut it into strips about \( \frac{3}{4} \) in width. Then make crosscuts across the strip at slight angles to make slender triangular points \( \frac{3}{4} \) long and about \( \frac{3}{4} \) wide at the base. These points can be made more quickly with a punch secured from an entomological supply house.
10. Now lay out the small insects on a clean sheet of paper so they rest on their right sides with their wings extending to your left, and with their heads toward you. Any other position will make it more difficult to examine the mounted specimen.
11. Put glue on the paper and pick up a cardboard point with the forceps, touch its smaller tip to the glue, and touch the point to the uppermost side of the insect. The insect will be fastened to the point with the right side up and its head away from you, when it is turned over. Put pin through the base of triangular point, letting the specimen extend to the left of the pin.
12. When labeling the specimen put a number on every insect pin. Make a label as small as it can possibly be made and still contain as much data as possible. Too many insect collections contain more paper labels than insects. Try making the labels as small as \( \frac{3}{4} \times \frac{1}{4} \) in.
13. Each specimen should be labeled with the locality, town and state, date, month, day, and year.
written for instance like 7.4.75 for July 4, 1975, and name of the collector. Add any other information you can as to the sort of place in which the insect was found, what it was doing, etc.

14. Specimens must be preserved in an airtight box (called a Schmitt box) if you hope to keep certain small beetles called museum pests from getting in and eating them up. You may want to keep a few specimens in a cigar box or some other such container, but you will surely be disappointed if you try to keep them for any length of time. If the school has Schmitt boxes for its collection, they will probably appreciate any gifts you care to make to them, and the classes for years to come will profit from your skill and care in mounting these specimens.

D. Result:
Students will learn common and scientific names of insects and proper collecting and mounting techniques.

E. Supplemental Information:
If these steps are used for mounting and preserving these specimens which have been collected, you will have a collection which you will be proud of and may keep safely for years to come.

F. Thought Questions:
1. Where would be the best locations to look for insects?
2. Is there a best time of day or season to try to collect insects?
3. What materials are needed to catch insects?

activity

A. Problem: How do we build a small, simple cage?

B. Materials:
1. Screen 3" x 3"
2. Widemouthed jar and open lid
3. Caterpillar or other insect
4. A little soil, leaves, and small twigs

C. Procedure:
1. Cut screen to fit jar lid; it replaces center of lid.
2. Place soil, leaves, twigs, and insect inside of jar and replace screen lid. Fasten securely.

D. Result:
A small, simple cage is created.

E. Supplemental Information:
Children have opportunity to participate in making cage and caring for insects. They can also watch various developmental changes which can be used as the basis for classroom discussions.
This type of cage is easily kept clean and is adapted to different insects. The all-around view gives children a clear observation of the insect. This cage is very easy to make, and the size of the jar can be varied according to the need.

F. Thought Questions:
1. What other small animals might be kept in such a cage?
2. What are some precautions that must be taken in order to keep the animals alive?
3. Could we test which foods these animals prefer to eat?
activity

A. Problems: How do we make a wire cage for small animals?

B. Materials:
1. Wire screen
2. Pie plate or large scotch tape can with lid
3. Plaster of Paris
4. Branch and leaves from shrubbery where animal was found
5. Wire cutters

C. Procedure:
1. Pull one piece of wire from the screen to use as a lace.
2. Shape screen into circle to fit the plate or can.
3. Weave wire lacing through screen where it overlaps.
4. Mix plaster of Paris and put in bottom of can.
5. Place branch in the desired position and let plaster dry.
6. Cover the plaster with leaves and the cage is completed.
7. The lid placed on top of the screen keeps the animals inside the cage.

D. Result:
A small wire cage is created.

E. Supplemental Information:
This is an easy method by which the children can build an inexpensive cage. It will be useful in their observations of small animals because it is easy to view. It is exceptionally fine for caterpillars. Measure the circumference of the can before cutting the screen so that it will not overlap more than 1". Any kind of a can with a lid will do for the bottom and the top of the cage.

F. Thought Questions:
1. What kind of animals can best be kept in such a cage?
2. What precautions should be taken to keep them alive?
3. What are some "natural" enemies of the animal that you have collected?

activity

A. Problem: How can we make a pet cage for medium-sized animals?

B. Materials:
1. Galvanized wire (about 1" or 2" mesh)
   a. 2 pieces 30" x 26" — (sides)
   b. 2 pieces 20" x 26" — (ends)
   c. 1 piece 21" x 31" — (top)
2. Wire-cutter pliers
3. %" plywood for floor (21" x 31" if desired)

C. Procedure:
1. Cut pieces of wire to specifications.
2. The sides can be fastened together by either one of the following methods:
   a. Use galvanized wire to tie corners together, spacing the ties about six inches apart. Wind wire around three times.
   b. When cutting sides of cage, leave one inch projections of wire on front and back sides.
These can be bent back around the wire of sides of cage.
3. The top is fastened in the same manner.
4. If a bottom is desired, bore four holes in the board to fit corner wires.

D. Result:
A sturdy, practical classroom cage is created.

E. Supplemental Information:
1. This cage is collapsible for convenience in storing and carrying.
2. The tying of the edges together allows for folding of the cage when not in use.
3. This cage can be used for any of the larger pets—such as rabbits, setting hens, or baby chicks in the classroom.

F. Thought Questions:
1. What kind of animals could be kept in this cage?
2. What modifications of this cage could be made that would make watering, feeding, and cleaning easier?
3. Could other types of animal storage be utilized?

activity

A. Problem: How do we make a terrarium for reptiles?

B. Materials:
1. Large terrarium
2. Plate glass cover
3. Adhesive tape
4. Sand
5. Small, dry twigs, rocks
6. Shallow dish or saucer
7. Reptiles
8. Electric light (heating element)

C. Procedure:
1. Fill the bottom of terrarium with two inches of sand.
2. Place saucer inside.
3. Add twigs, rocks.
4. Add water to saucer.
5. Tape corners to raise corner height so that when glass cover is placed on top air will be able to pass under cover to animal(s).
6. Place on cover.
7. Put animal(s) in tank.
8. Feed the reptiles with worms, live insects, and earthworms.
9. Place light over cover to maintain warm temperature.

D. Result:
Class will learn about reptiles and their care.

E. Supplemental Information:
1. Do not use poisonous varieties for classroom.
2. The best temperature is about 80°F.
3. Ants and flies are good food for lizards.

F. Thought Questions:
1. Are reptiles helpful to man?
2. What are some distinct characteristics of reptiles?
3. How do snakes shed their skins?
PART II  PHYSICAL SCIENCE
PHYSICAL SCIENCE

LESSONS

Lesson 1  My Senses: See, Feel, Smell, Taste
Lesson 2  Tangerines (sensory activity)
Lesson 3  Magnets
Lesson 4  Magnets and Magnetism
Lesson 5  Heat
Lesson 6  Light and Shadows
Lesson 7  Machines and Work
Lesson 8  Many Kinds of Matter
Lesson 9  Matter and its Changes
OBJECTIVES

• To associate each sense with its appropriate body part
• To learn to use the senses
• To learn which is the best sense to use for a particular situation
• To use as many senses as possible in daily observations and routines

Very often people go through life unaware of what is happening in their immediate environment. Although their senses are functioning properly, they never learned to use them to the fullest extent and to benefit from them. How many people never hear the chirp of a bird, the howling of the wind, or the sound of silence? How many people never smell the fragrance of spring! How many people never feel the softness of snow?

In this unit there is an attempt to help the children become aware of their senses so they can see, feel, hear and smell the beauties of nature; so they can benefit and better enjoy the world around them.

• Observe the children during the first observation activities.
• Record their behavior during these activities.
• Repeat the observational recordings at the end of the unit and see if there has been any apparent change in the children’s behavior.
• Note if they have become more aware of their environment.
• See if they are using their senses in their daily routines.

EXPLORATORY ACTIVITY 1

Materials:
None

Procedure:
Let the children explore the classroom (beginning of the year).
Ask them to find a table and stand by it; a chair; a closet; a bookcase; a toy shelf, etc. If more than one child is by the same object, ask the child to find another one (another chair, another desk, etc.).
Ask them to find something in the classroom that they don’t have at home.
Ask the children about things they have at home and don’t have in school.
Ask what helped them discover all these things (the eyes).

EXPLORATORY ACTIVITY 2

Materials:
None

Procedure:
Go outside with the children to see what they can discover. Look at the outdoor equipment (sandbox, jungle-gym) the trees, the grass, the flowers, the birds, the sky, the clouds, etc.

Note: Record the children’s observations, comments, and behavior during this activity. Are the children standing in one place or are they moving around? Are they using other senses than the sense of sight? (Are they smelling things? Are they listening to sounds? Are they touching and feeling things?) Keep your records and compare them with your records on the last exploratory activity.
Activity 1 (Sense of Sight)

Materials:
None

Procedure:
Ask the children to look at each other and discover new things about their friends: others, color of eyes, hair, special marks. Ask each partner to take turns describing features. Pair the children. Ask one of each pair to close the eyes and tell the color of the partner's hair, eyes, others. Change roles: ask each partner to close the eyes and attempt to tell details about the other child. Ask the children why they had problems telling about their partners' color of clothes, eyes, hair, etc.

Activity 2

Materials:
Red circular object

Procedure:
Ask the children to close their eyes. Hold a red circular object and ask the children to tell what you're holding and what color it is. After the children fail to answer correctly, ask them to open their eyes. Show them the red circular object and repeat your question. Ask the children why they couldn't answer your question the first time. Hide an object and let the children look for it. Ask what helped the children find the hidden object.

Activity 3 (Sense of Hearing)

Materials:
None

Procedure:
Ask the children to be very quiet and see if they can listen and tell about things in the classroom. Ask them to listen to the sounds in the classroom. Ask them to listen to the sounds that come from outside. Ask them to try and identify the sources of the sounds such as a bus, a plane, birds, the wind.

Let the children listen to the silence.

Let the children talk about pleasant and unpleasant sounds. Let each child tell about likes or dislikes of a particular sound. Allow for individual differences. Ask what helped in hearing all these sounds. Ask what sense was used.

Activity 4

Materials:
None

Procedure:
Let the children produce sounds with different parts of their bodies: hands, legs, tongue, teeth, whole body.

Ask the children to close their eyes. Produce a sound with one part of your body and ask the children to guess what part produced the sound heard.

Let children take turns producing different sounds for the others to guess (with eyes closed).
MY SENSES

Activity 5

Materials:
- Paper (2-3 sheets for each child)
- Tin cans, Wooden blocks, Sticks
- Jar or Glass, Plastic spoons and forks

Procedure:
Give each child a sheet of paper and ask the child to produce a sound with the paper. Ask the children to produce a different sound with their paper. Encourage the children to produce many different sounds with their papers (shake, fold, tear, crumple, etc.). Give the children as many sheets of paper as they need to produce various sounds.
Place the other materials on the table and let the children produce different sounds with them.
Ask the children to close their eyes. Produce a sound and have them guess what material produced the sound heard. (Use a different material each time.)
Let each child in turn produce a sound with a chosen material and let the rest of the children guess (with closed eyes) what material produced the sound.

Activity 6

Materials:
- 8-10 opaque small jars or 35mm film containers:
  - 2 half filled with rice
  - 2 half filled with sugar
  - 2 half filled with toothpicks
  - 2 half filled with beans
  - 2 half filled with nails or thumbtacks

Procedure:
Let the children listen to the sounds the containers make. (Use only one of each of the above.) Let each child shake a container, guess what’s in it, and then open it up to check the answer.

Introduce the second set of containers. Let the children play with this set until they discover that the two sets are identical. Ask the children to find pairs of containers that sound alike. Let the children check their pairs by opening the lids of the containers and looking inside. Start with four containers and increase the number as the children become proficient in matching the containers.

Activity 7

Materials:
- Blindfolds

Procedure:
Blindfold the children. (If any of the children refuse to be blindfolded, let them close their eyes.)
Stay about 6-7 feet away and in front of the children and ask “Where am I?”
Instruct the children to point with one hand in the direction of the sound and pull the blindfold off with the other hand to check their answer.
Repeat the game several times, each time from a different direction. Let a child ask “Where am I?”
Play the same game as above, but instead of asking “Where am I?” produce a sound like clapping, whistling, singing, jumping, etc. Let the children point in the direction of the sound and identify the sound.

Note: You could vary the game: Have children hide and take the blindfolded person near hidden people. Have one person say “Where am I?” at a time. If the blindfolded person points in the direction of the voice, that person is caught.
**Activity 8**

**Materials:**
- Blindfolds

**Procedure:**
Blindfold one child. Point to another child in the group and ask the child to say in a natural voice, “Who am I?” Ask the blindfolded child to guess who was speaking. Change roles. Try to give each child a chance to have a turn being blindfolded and a turn to say “Who am I?”

**Activity 9**

**Materials:**
- Tape recorder and tape

**Procedure:**
Tape sounds which are familiar to the children (bell ringing, telephone, walking, running, singing, etc.). Play the recording. Stop after each sound and ask the children to identify the sound heard.
Plug the children’s ears with some cotton or have them hold their hands tightly over their ears. Play the recording again. Stop after each sound and ask the children to identify the sound. Ask the children why they couldn’t identify the sound this time. Ask what helps us hear (our ears).

**Activity 10 (Sense of taste)**

**Materials:**
- 6-8 baby food jars:
  - A jar with sugar and a jar with salt
  - A jar with chocolate mix and a jar with cinnamon and sugar
  - A jar with baking powder and a jar with confectioners sugar
  - A jar with Koolaid and a jar with dry wine or vinegar of the same color

**Procedure:**
Place the jar with sugar and the one with salt on the table. Ask the children what’s in the jars. Ask them if the substances in the jars are the same. Ask them if they are sure. Ask how they can really be sure whether or not the substances are the same.
Let the children taste the sugar and the salt and discover whether they taste different even though they look the same. Ask what helped to discover this (the mouth and tongue). Ask what sense we used (the sense of taste). Follow the same procedure with the other substances.

**Activity 11**

**Materials:**
- 6-8 baby food jars:
  - A jar with pink lemonade and a jar with plain lemonade
  - A jar with brown sugar and a jar with regular sugar
  - A jar with lemon jello and a jar with lime jello

**Procedure:**
Place the jar with the pink lemonade and the one with the plain lemonade on the table. Ask the children what’s in the jars. Ask them if the drinks in the jars taste the same. Ask them how they can really be sure whether or not the drinks taste the same.
Let the children taste the pink lemonade and the plain lemonade and discover that they taste alike, even though they look different.
Repeat this activity each time with two other substances that look different but taste alike.
MY SENSES

Activity 12

Materials:
- Chocolate square (at least one per child)
- Lemon drops (at least one per child)
- Saltine crackers (at least one per child)
- Slices of lemon, sugar lumps
- Salt (in shaker or jar)
- Pepper (in shaker or jar)
- Cinnamon and sugar (in shaker or jar)
- Big plastic tray

Procedure:
Put all the materials on the tray and place in the center of the table. Let the children identify the things on the tray. Let them taste each of the things and relate what they feel each time they taste something. Encourage the children to talk about the things they like to taste and things they don't like to taste. Emphasize the right to be different and like things that others don't like, or dislike things that others like.

If all of the children, for instance, say that they don't like the taste of lemon, you can tell them that you happen to love it, and thus encourage children to tell about their likes and dislikes even if they don't coincide with the other children's preferences.

Let each child eat a cracker, a piece of chocolate and a lemon drop. Let those who want, eat a slice of lemon.
Note: Emphasize safety measures: We never taste unfamiliar substances unless an adult we trust tells us it's safe to do so.

Activity 13 (Sense of smell)

Materials:
- A set of smelling cups: (use paper or opaque plastic cups)
  - 1 cup with onion slices
  - 1 cup with peanut butter
  - 1 cup with peeled banana
  - 1 cup with lemon slices
  - 1 cup with cinnamon
  - 1 cup with black pepper
  - 1 cup with peppermint extract
  - 1 cup with vinegar
  - 1 cup with garlic
  - 1 cup with orange slices
  - 1 cup with cologne

(You don't have to use all of the cups. Use a few at a time).

Procedure:
Cover the cups with aluminum foil and poke small holes in the foil. Let the children guess what's in each cup. Ask questions like: What does it look like? Why can't you tell? What does it sound like? Can we tell by the sound what it is? How can we tell? Let the children smell each cup and say whether or not they like the smell. Let them suggest what's inside and check their answers by opening the cups and looking inside.

Ask what helped us find out what's in the cups (our nose).
Ask what sense we used (sense of smell).
MY SENSES

Activity 14

Materials:
Two sets of smelling cups each containing:
- 2 cups with onion slices
- 2 cups with peanut butter
- 2 cups with peeled banana
- 2 cups with lemon slices
- 2 cups with cinnamon
- 2 cups with black pepper
- 2 cups with peppermint extract
- 2 cups with vinegar
- 2 cups with garlic
- 2 cups with orange slices
- 2 cups with perfume

Procedure:
Cover the cups with aluminum foil and poke small holes in the foil.
Set 2 cups of onion slices and 1 cup of cinnamon on the table. Let the children find the two cups that are the same by smelling them.
Continue to play the game, changing odors each time.
Gradually increase the number of cups from which a child must select the like pair. For example, use two cups with bananas, one with cinnamon and one with lemon slices. Later use two cups with perfume, one with orange slices, one with pepper, one with garlic, etc.

Activity 15

Materials:
Crayons, Paper for drawing

Procedure:
Divide each child's paper in half. Ask the child to draw on one half of the page things that the child likes to smell and on the other half of the page, things that the child doesn't like to smell.
If a child has difficulties drawing likes and dislikes, ask the child to tell you what things are nice to smell and write those down on one half of the page. Next, ask the child what things aren't nice to smell and write those down on the other half of the page.
Or children can cut pictures from magazines and paste them in the appropriate columns.

Activity 16 (Sense of touch)

Materials:
An assortment of small objects of different textures:
- Sponge, Cotton ball, Sandpaper
- Piece of velvet, Ping-pong ball
- Plastic tray

Procedure:
Put all the objects on the tray and place the tray in the center of the table. Ask the children to look at the objects on the tray. Let each child tell everything about one of the objects on the tray by looking at it. Now, let each child pick up the object described and feel it.
Let each child tell what else was discovered about the object by feeling it. (Ask, "What does it feel like?")
MY SENSES

Activity 17

Materials:
Empty shoe box
An assortment of objects of different sizes, shapes and textures such as:
- Pencil, Ping-pong ball, Wooden block
- Plastic block, Spoon, Sandpaper
- Sponge, Cotton ball

Procedure:
On each side of the shoe box cut a hole large enough for a child to stick a hand. Put the assortment of objects inside the box. Let each child, in turn, stick a hand in the box, feel an object, and try to identify it. Let the child take it out to check the guess. If the child guessed correctly, ask how the child knew what it was. If the child's guess was wrong, ask why it was.

Ask what helped in guessing what the object was (our hands).
Ask what sense was used (the sense of touch).

Activity 18

Materials:
Small paper bag
Pencil, Marble, Small rubber ball
Wooden block (square), Sandpaper
Cotton ball, Piece of velvet
(or other objects similar to the above)

Procedure:
Make a surprise bag for each child. Put the above or similar objects in each paper bag. Ask the children to take out, without looking, a long object. Ask them to take out a round object; hard; square; soft; rough; smooth object.
Ask how they knew what object to remove from the bag.
Ask what sense they used.

Note: If the children seem to have problems identifying the objects without looking at them, take the objects out of the bag and ask the children to find a round, square, long, short, hard, soft, rough, smooth object. Replace the objects in the bag and repeat the activity.

Activity 19

Materials:
- Cup of ice water
- Cup of warm water

Procedure:
Put the two cups on the table and ask the children what's in the cups. Let the children guess and discuss it among themselves. Ask if the contents of the cups are the same. Ask if they are sure they are (or aren't) the same.
Ask how they can make sure whether or not the cups contain the same thing.
Let the children feel the water in both cups.

Activity 20

Materials:
- Pieces of velvet or silk (one per child)
- Pieces of sandpaper (one per child)

Procedure:
Ask the children about other ways (except for our hands) in which we can feel.
Let the children take their shoes and socks off and feel objects around the room with their feet. Let them tell what the things feel like (the floor, the rug, the chair, sandpaper, velvet, etc.).
Give the children a piece of velvet and let them put it against their cheeks and tell what it feels like. Let them put it on their arms, slide it along their legs, and tell each time what it feels like.
Repeat the same procedure with a piece of sandpaper.

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MY SENSES

Activity 21

Materials:
Blindfolds

Procedure:
Play a "Guess who" game. Blindfold a child and let the child guess who another child is by feeling: touching the head, the face, the clothes, etc.
Repeat the activity until each child has a chance to feel and be felt.
Ask questions like: How did you know who it was? What made you think it was

Activity 22

Materials:
Two identical sets of objects of different textures, such as:
- Pieces of velvet
- Pieces of sandpaper
- Pieces of cardboard
- Two rubber balls
- Two marbles
- Shoe box

Procedure:
On each side of the shoe box cut a hole large enough for a child's hand. Put the two sets of objects inside the box. Have each child reach in and take out two objects that feel the same.
If a child does not match a set, let the child try again until successful.

Activity 23 (All senses)

Materials:
- Red (or other color) ball (or other small object)

Procedure:
Ask the children to close their eyes. Hold up the red ball and ask them what you have in your hand. Ask them what color it is.
Let the children open their eyes. Hold up the red ball and repeat your questions. Ask the children why they couldn't answer your questions the first time.
Ask what sense helped them answer your question.
Ask what sense(s) did not help them.
Have the children close their eyes and let one child hide behind the door. Ask who's missing. Ask how we can be sure that is indeed the missing person. Ask the hiding child to say something and see if the children can identify the voice. Let the children look behind the door and see who's hiding.
Ask which sense(s) helped us and which one(s) did not.

Activity 24

Materials:
- 2 cups of lemonade; one with sugar and one without sugar
- 2 closed bottles or jars; one with cologne and one with colored water (the same color as the cologne)

Children's record

Procedure:
Put the two cups of lemonade in the middle of the table and tell the children that one cup of lemonade contains sugar and the other one does not, but you don't know which. Ask the children to help you find the lemonade with sugar.
Ask which would be the best sense to use.
Ask about each of the other senses: maybe our eyes can tell us which is which; maybe our ears, etc.
Let the children taste the lemonade and tell which one is sweet.
Put the two bottles on the table and tell the children that one bottle has cologne in it, but you don't know which one it is. Ask
**MY SENSES**

Ask them to help you. Proceed as in the previous activity. Let the children smell the bottles and tell which is the cologne.

Show the children the record and tell them you don’t know what’s on the record; a song or a story. Ask them to help you. Proceed as above. Play the record and let the children tell whether it’s a song or a story.
MY SENSES

Activity 25

Materials:
- Spirit Duplicators #4 and #5
- Scissors, Paste

Procedure:
- Give each child a copy of spirit duplicators #4 and #5.
- Have them cut out the pictures of objects on spirit duplicator #5.
- Ask the children to paste each one of their objects under a specific sense and tell why they put it there.
- Some pictures lend themselves to more than one sense (i.e. cookie: I smell it and I eat it; flower: I smell it and I feel it).
- It is not important under which sense a child puts his picture card as long as he has a valid reason for doing so.

Activity 26

Materials:
- A compopper with a glass or clear plastic top
- Popcorn

Procedure:
- Pop the corn.
- Let the children look at the corn pop.
- Let them close their eyes and listen to it pop.
- Ask them to smell the corn, feel it.
- Let them eat it.
- Ask questions such as: What do our eyes tell us about the popcorn? our ears, mouth, nose and hands?

Activity 27

Materials:
- None

Procedure:
- If possible, take the children to a bakery. Tell the children you're going to visit a bakery. Discuss with the children what a bakery is, what a person who works in a bakery is called, what things are baked.
- Ask the children to tell you what senses might help us discover things about the bakery.
- In the bakery, ask them just to try and find out what their nose can tell them about the bakery. Let the children taste some baked goods.
- When you return to school, let each child tell what was experienced in the bakery (the things smelled and the things tasted). Ask if any of the other senses helped us in the bakery:
  - What did our eyes tell us? (What did the bread look like? the cake? etc.)
  - What did our ears tell us? (What sounds did you hear in the bakery?)
  - Did our hands tell us anything? (How did the cake, bread, etc. feel?)
  - Did our body tell us anything? Was it hot or cold in the bakery?

Activity 28

Materials:
- None

Procedure:
- Go outside with the children to see what their senses can help them discover.
- Look at the outdoor equipment (sandbox, jungle-gym, etc.), the trees, the grass, the flowers, the birds, the sky, the clouds, etc.
- Note: Record the children's observations, comments, and behavior during this activity:
  - Are the children standing in one place or are they moving around?
  - Are they using other senses than the sense of sight? (Are they smelling things? Are they listening to sounds? Are they touching and feeling things?)
MY SENSES

Compare these records with your records of the first exploratory activities and note if there has been any apparent change in the children's behavior while observing their environment.
Our senses

<table>
<thead>
<tr>
<th>Nose</th>
<th>Mouth</th>
<th>Ear</th>
<th>Eye</th>
<th>Hand</th>
</tr>
</thead>
</table>

NAME ___________________________
Our senses

AME
Purposes:

1. To learn that living things have both similarities and differences.
2. To learn the sources and importance of Vitamin C in diet.
3. To provide opportunities to practice and develop computation skills.
4. To develop manual dexterity.
5. To observe shape, form, color, texture, and smell in natural objects.

Introduction:

Here is what may appear to be a very simple science lesson. However, as the lesson progresses, you will begin to see that it can become as complex as you wish to make it and your pupils can handle. This flexibility is one of the real beauties of this activity. It can be kept simple for the younger, slower child, or expanded for the older, more able student. Another feature of this lesson is that students perform their own "experiments" and actually work with something from their everyday environment, a tangerine!

This activity kit provides opportunities for learning in mathematics, science, art, and health. The mathematics implications will become evident to you as the activities progress. The health will have to be put into it as you feel the right time approaching. Talk about the importance of the different nutrients in our diet, especially vitamins. What vitamin do citrus fruits like tangerines provide? (Vitamin C) The main thrust for science in this activity is toward the realization on the part of your students that all living things have 2 great tendencies. They tend to resemble each other and they tend to differ from each other, both at the same time. This is a principle seen throughout nature. In addition to tangerines, point this out to pupils in both the plant and animal kingdoms, even among humans. As far as art is concerned, even the simple tangerine contains certain forms, symmetry, textures, and colors. Comparisons could be made with other fruits or other natural objects.
Materials:

Provided in kit:

Tangerines - 1 per pupil

Provided by the teacher:

Paper towels
Crayons (optional)

Advance Preparations:

1. Make ditto copies and/or overhead transparency of page 6.
2. Make sure you have sufficient paper towels.
3. Make sure you have enough tangerines and that they are not spoiled.
4. Check the supply of crayons if you intend to follow this lesson up with some art activities.

Procedure:

Have monitors distribute paper towels and tangerines to each student. Each pupil will need at least 3 paper towels. Have pupils look at the tangerine and study it for a moment. Discuss with them the differences and similarities between them, e.g. size, shape, color, etc. See how many ways they can find in which the tangerines are similar and different. Make 2 lists on the chalkboard, differences and similarities. You may want students to write these down and use them as vocabulary words.

Have pupils peel their tangerines carefully. You may have to demonstrate this for them. It may be difficult to start peeling if the skin is smooth. A small, shallow bite in the skin near the top will facilitate starting. During or after the peeling process, discuss with pupils the textures of the skin, inside and outside. This will provide additional vocabulary and sensory stimulation. This is a good time to discuss smell also. Have pupils wrap peelings in one of the paper towels and have a monitor circulate with the waste basket to pick them up.

Next have pupils carefully separate the sections of their tangerines. Write the word section on the board and discuss it. Have pupils line up their sections neatly on a paper towel and count them. They should write the number in the space by number 1. of their response page. Not all of the tangerines have the same number of sections. Ask them to guess whether all of the tangerines have the same number of sections. Ask for a show of hands to see how many had tangerines of 9, 10, 11, etc. sections. Write the number of each on the board and discuss this interesting revelation. Bring up the subject of similarities and differences. Are the sections all the same size and shape?
On the response page, under number 1., are printed the outlines of 3 sections of a tangerine, 2 solid and the 3rd dotted. Have pupils go over the dotted section and then draw enough more sections to represent the number they each had.

Now comes the part that's most fun. Ask pupils to eat each section of the tangerine, one section at a time, and keep track of how many seeds he finds in each section. Have each pupil draw the correct number of seeds inside the outline of each section under number 1.

Next have pupils draw the sections again under number 2. This time have them write the number of seeds inside each section.

Discuss with pupils the fact that tangerines have seeds in them. Ask them if they think each section will have seeds in it and if they think each section will have the same number of seeds. Then.....

After the sections have all been eaten and the seeds counted, make another tally on the chalkboard of how many sections had 0 seeds, 1 seed, 2 seeds, etc.

As you go around the room asking each pupil how many sections he had with 0 seeds, 1 seed, etc., have the class help you by adding the figures out loud. This will give them some practice in adding figures in their head.

There are many additional ways in which to exploit the math value of this activity. How far you go will depend on how far you wish to carry it and how able your pupils are. An additional idea would be to have pupils look for patterns in the seed count of each tangerine. Do the numbers of seeds occur in some uniform pattern within the sections or are they random? Another idea would be to see if all tangerines have the same number of seeds. Does the number of seeds vary with the number of sections?

**Vocabulary:**

Section
Seed
Peeling
Tangerine
Citrus
Vitamin

Also other key word as they arise during the course of the lesson.
Evaluation:

1. Answer the following questions orally or in writing:
   a. In what ways are tangerines alike?
      (1) General size, shape, color, sweetness.
      (2) Have seeds
      (3) Have skin
      (4) Divided into sections
   b. In what ways are tangerines different?
      (1) Different sizes
      (2) Different shapes
      (3) Different colors
      (4) Different numbers of sections
      (5) Different numbers of seeds
   c. In what ways are all trees alike?
      (1) Have trunks
      (2) Have branches
      (3) Have leaves
      (4) Need water and sunlight to grow
   d. In what ways are all trees different
      (1) Different sizes
      (2) Different shapes
      (3) Different numbers of branches
      (4) Different shapes of leaves
      (5) Different numbers of leaves
      (6) Different colors
   e. In what ways are all dogs alike?
      (1) 2 eyes
      (2) 2 ears
      (3) 4 legs
   f. In what ways are all dogs different?
      (1) Size
      (2) Color
      (3) Loudness of bark
   g. In what ways are you like the other pupils in your class?
      (1) 2 arms
      (2) 2 legs
      (3) 2 eyes
      (4) hair on your head
h. In what ways are you different from the other pupils in your class?

(1) Different heights
(2) Different weights
(3) Different color hair
(4) Different names

2. Recognize pictures of food items containing Vitamin C.

a. Oranges
b. Lemons
c. Grapefruit
d. Tangerines
e. Tomatoes

3. Question pupils to see how many had fruit today for breakfast or lunch.

4. Describe the shape and color of several fruits.

5. Count and write as a numeral:

a. The number of windows in the classroom.
b. The number of pupils in the classroom.
c. The number of tables in the classroom.
d. The number of papers on the biggest bulletin board in the classroom.
Lesson 3

Level - Primary

**Magnets**

**OBJECTIVE**

- To discover some of the qualities of magnets by handling, playing and experimenting with them

Magnets are fun.
Magnets are fascinating.
Magnets lend themselves to discovery; so allow your children to discover as much as they can about magnets through fun and play.

Observe the children during the first exploratory activity. Note how they are approaching the magnets; what they do with them; what they say; whether they are having fun; how long they play with the magnets.

Record what you have observed and keep your records for further reference.

This exploratory activity is repeated at the end of the unit. Record the children's observed behavior during the activity and compare it with the children's behavior at the beginning of this unit.

**EXPLORATORY ACTIVITY**

**Materials:**
- A large plastic tray
- Small magnets (one for each child)
- Nails, paper clips, safety pins
- Bottle caps, screws, matches, erasers
- Small squares of construction paper
- Small squares of aluminum foil

**Procedure:**
- Put all the materials in the plastic tray and place the tray in the center of the table.
- Give each child a magnet. Ask the children if they know what they have. If they don't, tell them they are magnets. Tell the children that magnets are fun things and that they can try and see how much fun they are by playing with the magnets and the objects in the tray. Let the children experiment freely with their magnets and objects for as long as they seem interested in the activity. Let the children wander around the room and experiment with their magnets.

**Note:** Record how the children approach the magnets.

1. What do they do with the magnets?
2. What do they say?
3. How long do they play with the magnets?
4. Are they having fun?
Magnets

We assume that this is the first exposure to magnets for most children. This unit, therefore, offers many opportunities to handle and manipulate magnets. Hope-fully, through play and manipulation, the children will discover some of the properties of magnets.

Magnets and magnetism is a very broad and fascinating field. Over the years the children will learn more about magnets. Limit yourself in this unit to only concrete explorations and manipulations with magnets.

The following background information is for the teacher only. It is not meant for the children.

Basic Facts That Teachers Should Know About Magnets

People have been familiar with magnets for centuries mainly through the use of compasses. Compasses are small bar magnets which can easily rotate until they point to the north-south directions.

When two bar magnets are brought to close proximity, they can either attract or repel each other. The end of each magnet, which if allowed to rotate will point to the north, is called the “N pole” (or “N-seeking pole”). The other end is called the “S pole” (or the “S-seeking pole”). Two like poles (N and N or S and S) repel each other. Two unlike poles (N and S) attract each other.

Magnets are known to attract some materials, mainly metals (like iron). Some materials, and even some metals (like aluminum or brass), are not attracted by magnets. When a bar magnet is brought close to a piece of iron (say a nail), the nail is attracted to the magnet. It will first align itself, pointing to the closest end of the magnet, and then it can start moving towards the magnet. We say that the bar magnet temporarily induced magnetism in the nail. If the N pole of the bar magnet is brought close to the nail, an S pole will be induced in the close-by end of the nail and an N pole will be induced in the other
end. If the bar magnet is removed, the nail loses its magnetism after a short while. Some materials, however, maintain their magnetization, and so they become magnets themselves.

Often, bar magnets are bent into horse-shoe shapes bringing the N and S poles closer together so that between them the effect (the so-called "magnetic field") is stronger.

When a bar magnet is broken into two pieces, the two new pieces become bar magnets. If each piece is again broken into two pieces you will have four magnets, etc. To date, scientists have not been able to isolate a single N pole or a single S pole.*

The ability of a magnet to influence other materials, to attract and even change them (permanently or temporarily) into magnets, is transmitted through space (air or vacuum). So it is not absolutely necessary to touch the other materials. Some "non magnetic" materials, such as paper or sheets of aluminum, when introduced between the magnet and the other material (like the nail above), do not show any appreciable effect between the magnet and other material. However, when intermediate magnetic materials (like other nails or sheets of iron) are introduced, they will have a great effect. The reason is clear. The intermediate nails also become magnetized so that the nail which we wished to affect now feels the effect of the intermediate magnet as well as that of the bar magnet.

If a bar magnet, like a compass, is brought near a wire which conducts electricity in one direction, the magnet (the needle) will align itself perpendicular to the wire. (A current in a wire flowing in one direction, a DC current, is achieved when a battery is used. The current which we get from our walls should not be used here since it is an alternating, or AC, current which changes direction 60 times a second, so that the compass will have to try to change its orientation 60 times a second—a chore too difficult for a compass needle.) So we see that (direct) currents affect magnets. If we twist our current—carry the wire into a loop and then continue twisting it, we get a coil. This coil, when it carries a DC current, attracts magnets, or magnetic materials like iron nails, just as a bar magnet placed on the axis of the coil would do. We call such coils electro-magnets because they are magnets whenever DC electricity flows in them. If we put magnetic materials ("cores") inside the coil, the electro-magnet becomes much stronger.

Electro-magnets are much more useful than bar magnets because they are much stronger and their effect (the magnetic field which they produce) is easily controlled by changing the current through them.

Scientists, like physicists, use magnets (usually electro-magnets) in practically all their research. Some physicists study the properties of magnets. Others use magnets to study other fields.

At home, we find magnets mostly in switches. For instance, in a dishwasher, when the cycles change (from wash to rinse, etc.), small electro-magnets close
and open new electric circuits. At certain points of the cycle a current flows through the electro-magnet coil. It becomes activated, that is, it becomes a magnet, and attracts a wire, which by doing so closes another circuit, like closing a switch, thus allowing current to flow through the new circuit.

The effect of currents on magnets is very basic and scientists explain the whole phenomenon of magnetism on the basis of current. The bar magnet itself has magnetic properties because in it small particles (atoms and groups of atoms) have circulating currents just like in a loop of DC current. When many such atomic loops are lined in the same direction, the effect is similar to the effect of a coil. Thus the bar magnet itself is, in a way, an electro-magnet. Clearly, the ability of different materials to have their small atomic-sized current loops align themselves, and not the size of the materials, determines the magnetic properties. Those which align themselves easily, like iron, become good bar magnets and good cores for electro-magnets. Those which do not align themselves cannot become magnets, are not good as cores, and do not affect the action of magnets on other materials when placed between them.

How are magnets produced?

Some weak magnets are originally found in nature. Usually, however, magnets are produced through the influence of other magnets on them. The best way to produce a magnet is to take a bar of iron, wrap wire around it in the shape of a coil, and pass a current in one direction (DC) through the coil. The bar of iron thus becomes magnetized and will usually retain its magnetism permanently.
**MAGNETS**

**Activity 1**

**Materials:**
- U magnets (one for each child)
- Two paper or plastic plates
- One large plastic tray
- An assortment of small objects which are attracted by magnets, such as: paper clips, scissors, nails, pins (straight and safety), screws, bottle caps
- An assortment of nonmetallic small objects which are not attracted by magnets, such as: buttons, erasers, paper, crayons, pencils, toothpicks, matches
- 2" pipe cleaners

**Procedure:**
- Put all the objects on the tray and place the tray in the center of the table. Put the two plates next to the tray. Give each child a magnet and a pipe cleaner.
- Make “magic rings” with the children by fastening a magnet to each child’s finger with a pipe cleaner. The end of the magnet should be facing away from the finger.
- Ask the children to use their “magic rings” to sort the objects into the two plates. Let them put all the objects that are attracted by magnets in one plate and all the objects that are not attracted by the magnets into the other plate.

**Activity 2**

**Materials:**
- Magnets (one for each child)
- String or twine (about 1 foot per child)
- Sticks (one foot long stick per child)
- An assortment of objects that are attracted by magnets (see Activity 1)
- An assortment of objects that are not attracted by magnets (see Activity 1)
- A plastic bucket or bowl
- Spirit duplicator #19
- Pencil for each child

**Procedure:**
- Make fishing poles with the children by tying their strings to the sticks and attaching their magnets to the end of the strings.
- Place both the objects that are attracted by the magnets and those that are not attracted by the magnets in the plastic bucket or bowl. Let the children fish out the objects that are attracted by the magnets.
- Ask what can be done to successfully fish for the other things with their poles. Allow the children to express themselves and test any suggestions they come up with. If the children don’t come up with a workable solution, suggest attaching paper clips to the objects in the bucket.
- Let the children fish for the remaining objects.
- Diagnose the children’s understanding of magnets by having them complete spirit duplicator #19. Have each child circle the objects that a magnet will pick up.
MAGNETS

Activity 3

Materials:
- Magnets (one for each child)
- An assortment of objects that are attracted by magnets (see Activity 1)
- Sheets of paper (one for each child)
- Plastic tray

Procedure:
- Put all the objects on the tray and place the tray in the center of the table. Give each child a magnet and ask each to pick up an object with the magnet.
- Distribute sheets of paper. Ask the children to cover their objects with the paper.
- Now ask the children whether they think the magnets will pick up their objects. Let them try and see what happens.
- Let the children repeat this experiment with other objects. (Remember: Let the children first pick up the objects with their magnets. Then, let them cover the objects with pieces of paper and try their magnets again.)
- Invite children from another class to come visit your class and play a “trick” on them. Let your children show the other children how they can lift pieces of paper with their magnets.

Activity 4

Materials:
- Magnets (one per child)
- Paper clips (one per child)
- Paper cups (one per child)

Procedure:
- Give each child a magnet and a paper cup with a paper clip in it. Ask the children to remove the paper clips from the cups without touching the cups or the paper clips with either their hands or bodies. Let the children try out any suggestions they might have. If the children do not come up with a workable solution, suggest that their magnets may help them. If this doesn’t help, demonstrate to the children how you remove the paper clip from the cup. Hold your magnet against the cup (near the side with the paper clip). Slowly move your magnet upward and watch the paper clip “follow” until it is removed from the cup. Let the children remove their paper clips from their cups using this technique.

Activity 5

Materials:
- A large glass dish or bowl
- 2 wooden blocks, paper clips, thumbtacks

Procedure:
- Fill half the glass dish or bowl with water.
- Set the glass bowl on the blocks on the table as illustrated below. Put paper clips and thumbtacks in the glass bowl. Ask the children what they think will happen if they move their magnets along the bottom of the dish.
- Let each child, in turn, move a magnet along the bottom of the dish and see what happens to the paper clips and thumbtacks.
- Ask the children if they can remove a paper clip or thumbtack from the glass bowl without touching the bowl with either their hands or bodies. Let the children try their suggestions. If no one suggests using the magnets, demonstrate to the children how you remove a paper clip from the bowl with your magnet. Let each child remove an object from the bowl with a magnet.

Note: If necessary, set up more than one glass bowl or dish.
MAGNETS

Activity 6
Materials:
- A large glass dish or bowl with water
- 2 wooden blocks
For each child:
- A cork
- A small piece of paper
- A large straight pin
- Thumbtacks
- A magnet
Procedure:
Set the glass bowl on the blocks on the table.
Give each child a cork, a small piece of paper, a straight pin and 2-3 thumbtacks, and show each child how to make a sailboat.
Show the children how to make a sailboat by putting a straight pin through the middle of a paper and sticking the pin into a cork. Put 2-3 thumbtacks into the bottom of each boat. Let the children put their boats in the water. Ask them how they could sail their boats. Let the children try out their suggestions. If no one comes up with the idea of using the magnets, ask the children if they think their magnets might help. If still nothing happens, show the children how you sail your boat by moving your magnet along the bottom of the boat.
Let each child in turn sail a boat in the above manner.
Take the thumbtacks off the boats and repeat the activity. Ask what happened and why.
Replace the thumbtacks. Pair children up and let each pair of children race their boats from one end of the bowl to the other end.
Note: If necessary, set up more than one glass bowl or dish.

Activity 7
Materials:
- Large plastic tray
- Small scraps of paper, heavy cardboard, plastic, cloth, aluminum foil, tin
- Screws (one per child), magnets (one per child)
Procedure:
Give each child a screw and a magnet. Put the scraps of the above materials on the tray and place the tray in the center of the table. Let the children pick up the screws with the magnets. Let each child cover up the screw each time with a different scrap of material and first guess if the magnet will pick up the covered screw or not. Let the child then check whether right or wrong by trying to pick up the covered screw with the magnet;
Let the children share their experiences. If there is disagreement, let them resolve their differences by trying to pick up the screws covered up with the materials in question.
MAGNETS

Activity 8

Materials:
- Large plastic tray
- Different kinds of magnets: bar magnets, circle magnets, U magnets, horseshoe magnets

Procedure:
Put all the magnets on the tray. Place the tray on the table. Ask the children what's on the tray. If they say that these are magnets, ask them how they can make sure that these are indeed magnets.

Let the children experiment with the materials and discover that they are all magnets.

If children don't experiment, suggest that they repeat the experiments with the paper, boats, fishing, etc., using all types of magnets.

Encourage the children to bring magnets from home (if they have any) and let them experiment with them in class. Let children, or parents, tell about magnets they have around the house and bring them to school if possible (pot holders, magnets for memos, etc.). Discuss with the children the use of these magnets.

Activity 9

Materials:
- A circle magnet
- A similar circular object that is not a magnet
- A U magnet
- A similar U object that is not a magnet
- A bar magnet
- A similar bar object that is not a magnet
- A horseshoe magnet
- A similar horseshoe object that is not a magnet

Procedure:
Put the circle magnet and the similar circular object that is not a magnet on the table. Ask the children what these things are. Whatever a child's response may be (both are magnets or one is a magnet and one is not), ask the child how to discover whether it is a magnet or not a magnet.

Let the children experiment with the two objects and discover that one is a magnet and one is not.

Let the children close their eyes. Move the magnet or the similar object around. Tell the children to open their eyes and find which one is a magnet.

Repeat this procedure with the U, bar and horseshoe magnets.

Note: If possible, provide a magnet of each kind and a similar object for each child.

Activity 10

Materials:
- Magnet
- Paper plate (for each child)
- 10 paper clips (for each child)

Procedure:
Line up the individual paper plates on the table. Line up the children so that each child faces a paper plate. On the floor next to each child, put 10 paper clips. Put the magnets on the table. Let the children have a race to see who can be first to move the paper clips from the floor to the paper plates on the table. Tell the children they can do it any way they wish, with or without magnets. Compare the results of children who used their magnets with those who used their hands.

If all the children chose one way (either hands or magnets), set up another race where some of the children would be using their magnets while others would be using their hands. Compare the results.

Change roles. Let the children who used their hands use the magnets this time, and let those who used their magnets pick up the paper clips with their hands. Compare the results.
**Activity 11**

Materials:
- Use materials from Activity 2

Procedure:
- Pair the children. Put the objects that are attracted by magnets into the plastic bucket or bowl. Give each child a magnet “fishing pole”. Let each pair of children fish together. Let them play until their magnets attract each other.
  - If this doesn’t happen through play, put only one object in the bucket and let two children fish together to see who can retrieve it. It’s most likely that this time the magnets will stick.

**Activity 12**

Materials:
- Long nails (one per child)
- Magnets (one per child)

Procedure:
- Tell the children that since they enjoyed working with magnets, you think each one should have a magnet.
  - Tell them that they can actually make their own magnets. Demonstrate to the children how to magnetize a nail. Rub the nail on the magnet about 40 times. Rub in one direction only and move the magnet away from the nail after each stroke.
  - Help the children make their own magnets.
  - Let the children play with their new magnets and then take them home.

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**Activity 13 (see Exploratory Activity)**

Materials:
- Large plastic tray
- Magnets (one per child)
- An assortment of objects that are attracted by magnets and some that are not (see Exploratory Activity)
- Spirit duplicator #20
- Crayons

Procedure:
- Put all the materials in the plastic tray and place the tray in the center of the table.
  - Give each child a magnet.
  - Let the children experiment freely with their magnets and objects for as long as they seem interested in the activity.

Note: Record the children’s approach to the magnets.
1. What do they do with the magnets?
2. What do they say?
3. How long do they play with the magnets?
4. Are they having fun?
- Compare with your records on the Exploratory Activity and see if any apparent change in the children’s behavior occurred.
  - Give each child a copy of spirit duplicator #20. As the children are coloring the magnets, go to each one and ask what they are coloring. Have them identify the various kinds of magnets pictured.
Kinds of magnets

AME
Our Biggest Magnet

You cannot hold the biggest magnet in your hands.
You cannot see the whole magnet at one time.
You see part of the biggest magnet every day.
It has a North and a South pole.
You walk on it.
You live on it.

What is the biggest magnet?

Color the North Pole blue.
Color the South Pole red.
EAR PARENT: Your child is studying magnets. This home activity will help your child discover the everyday uses of magnets. Your child will also learn what objects are attracted to magnets.

PULL! PULL! PULL!

Look around your house. Find some objects that have magnets in them. Make a list of the objects you find.

List objects here:


Bring some small object from home or us to test. We will see which objects are attracted by magnets.
Follow-up Activity

Name

Which one will lift the paper clip?

Color it.

Which things will a magnet pull?

Color them.
What do these words mean? Draw lines.
- attract
- repel
- poles

Write the names of the poles on this magnet.

Draw a line from each magnet to its shape.
- bar
- ring
- horseshoe

Magnets have many uses. Color each use.

Circle the words that tell what magnets do.
- fight
- repel
- run
- attract
- play
Get these objects.

Use a magnet.
Circle what the magnet attracts.
Circle the objects magnets attract.

Circle the objects magnets can attract through.

Write attract or repel.

Put an X on the bar magnet.

Circle the words that tell what attract means.

Circle the words that tell what repel means.
Lesson 4

ACTIVITIES IN SCIENCE

MAGNETS AND MAGNETISM

(A Discovery Kit)

Level

All Elementary Grades

Objectives

After completing the activities in this Kit, the pupil will be able to:

(Primary - Intermediate)

1. Demonstrate that some materials will stick to a magnet and some will not.
2. Demonstrate that some rocks are magnetic.
3. Understand that a magnet attracts (pulls to it) materials that contain metal, usually iron.
4. Demonstrate that magnets can pull toward each other or push away from each other.
5. Show that the two ends of a magnet are different.
6. Understand that magnets can have different shapes but they always have this difference at their ends (poles).
7. Demonstrate that two magnets push away from each other (repel) when their like poles face each other; two magnets pull together (attract) when their unlike poles face each other.

Introduction

Man has been attracted by the strange force that we call magnetism, since early civilization began. (See the legend about Magnes the shepherd boy, on page 2.) Even though we cannot fully explain magnetism, we make use of it every day.
Magnetism is a force, or more properly, a form of energy. Energy is defined by the physicist as "the ability to do work or cause motion." When your pupils feel the push or pull of magnets attracting and repelling each other, they will be experiencing this energy. This will excite them. Capitalize on this excitement and enthusiasm in every possible way as you use this activity Kit.

Children love to play with magnets. Since magnets and the other materials in this Kit are so interesting, you will need to caution pupils to handle the magnets very carefully and you must check to be certain that all are replaced after use. This Kit will contain about $45.00 worth of high quality "Alnico" magnets made of an alloy of aluminum, nickel, iron, and cobalt. (Alnico is the acronym formed from the names of these metals.) This particular alloy tends to be rather brittle and the magnets will shatter if dropped on a hard surface. While we realize that there will be some "wear and tear" and some losses, please make every effort to keep them to a minimum.

Magnes (MAG-neez), a shepherd boy who lived near the city of Magnesia in Asia Minor, was out tending his sheep one day. While walking across the fields, he noticed something very strange. In certain places, as he walked, he could feel something hold his sandals to the ground. He dug into the ground at one of these places and found some hard pieces of rock. He noticed that these pieces of rock stuck to his sandals. But, they seemed to stick to his sandals only where there was an iron nail. Because of this strange power, from then on, people believed that these rocks could cure many diseases, even toothaches. We call this kind of rock a lodestone.

Materials

Nine sets of materials packed in clear plastic buckets (two pupils share a set), each set contains the following items:

- 4 magnets, Alnico, cylindrical, 3"
- 2 large metal washers
- 10 large paper clips
- 2 bolts, 1/4 x 3"
- 2 nails, size 16D, with blunt points
- 2 wood blocks
- 2 styrafoam cubes
- 2 pieces of rubber tubing
- 2 large corks
- 2 copper wires

In addition:

- 9 horseshoe magnets
- 9 pieces of lodestone (natural magnetic iron oxide)
- 9 compasses
- 9 batteries, Size D
- 18 pieces of copper magnet wire, Formex insulated (sprayed, plastic-coated)
- 18 1" square pieces of fine sandpaper

Materials to be Collected by the Teacher

String
**ACTIVITIES IN SCIENCE**

**Advance Preparations**

Check sets to be sure they are all complete.

Run off copies of all pupil response pages you plan to use.

Make any overhead transparencies you will need.

Collect and post items and/or pictures for bulletin boards or related displays.

Try each suggested activity yourself, before you work with your pupils, especially hanging the magnet on a string so it points north and south. Doing activities yourself prior to having pupils do them will allow you to see what will happen and what, if any, pitfalls and problems may arise. You will also do a better job of helping and guiding pupils when they work.

**Procedures**

A good approach is to begin with those activities involving assorted materials in the sets. Do those activities involving only the magnets, last. In this way, you can have pupils put all materials back into the sets and just leave out the magnets. They won't mind putting the rest of the things away if they understand that they are still going to do more activities with the magnets.

At the end of a lesson, it may be difficult to have them put magnets back in the sets. One technique that works is to say, "Now comes a very difficult part of the lesson." Tell them how the long magnets must fit into the buckets with all the rest of the items. Make it a real challenge to pupils to see if they can replace the magnets correctly. As they achieve this, praise them orally and/or list the pupils' names (by pairs) on the chalkboard as soon as they are successful (and you collect their set!).

End lessons by asking individuals to name one thing each learned about magnets. You should get quite a variety of answers. Use this as a review/clarification activity.

**Lesson 1 (Primary - Intermediate)**

Before distributing the sets, remove two magnets from each so pupils who are sharing will get only one magnet apiece.

Before pupils open the sets, have them read the numbers on the lids aloud, then write that number in the upper left corner on their papers. This will give them practice in reading and writing numbers and will reinforce the concepts of left and right.

Ask pupils to open their sets and carefully pour the contents out on the table.

(Caution: Magnets tend to be brittle.)

Have pupils divide the contents of their sets between partners. Each pupil should get 1/2 of the contents. This will be a valuable experience in strengthening the concept of 1/2. (Each pupil should have five paper clips and one each of the other eight items, plus a magnet.)
At this point, allow pupils to "play" with the objects and see what they can do with them for a few minutes. They may try to construct something. Allow them this experimental period, no matter what odd activities happen!

You can now recapture their attention by stimulating an impromptu contest, "See who can pick up the largest number of things with a magnet!"

Have pupils count the total number of objects each has and write the numeral in the box on pupil's page 8.

Ask pupils to divide their items into two groups: all items that the magnet will pick up, in one group, and all items that the magnet will not pick up, in the other group. (The magnets pick up only items made of iron or steel.)

Read sentences 2-10 on pupil's pages 8, 9 with pupils. Have pupils identify each item from their sets by holding it up and saying its name aloud, as you show each item to them. Then they should fill in the blanks to complete the words on pages 8 and 9. Answers are given at the bottom of page 9, but not in order.

Distribute a piece of lodestone to each pupil. Ask them to try to pick up things with it. Its magnetism is not as strong as their magnets but will pick up light objects like paper clips. Tell them the legend of Magnes and his "discovery" of magnetism. Make a transparency or ditto master of page 7.

Lesson 2 (Primary - Intermediate)

Distribute sets, one set for every two pupils. Sets should each have four magnets, two per pupil.

You may review or repeat with pupils any of the activities listed in Lesson 1.

Distribute copies of pupil's page 10, "What Do Magnets Do?" Lead students in performing the four simple experiments. They will discover that magnets sometimes attract each other and sometimes repel each other (pull together and push apart).

Discuss this attraction and repulsion (pulling together or pushing apart) with the class. Try to get them to state that each end of a magnet must somehow be different from the other. Otherwise, why do they behave differently when reversed?

Distribute the horseshoe magnets, one per pupil. Before distribution, take off the keeper bars and put them aside so they will not be lost. Keeper bars should be kept on the magnets to delay the loss of magnetic properties while they are stored.

Allow pupils to "play" with the horseshoe magnets and other materials of their sets for awhile.

Have each pair of pupils try to put the poles of their horseshoe magnets together. Also have them reverse one magnet and try again. The same things should occur as in paragraph 4 (of this lesson). Lead pupils to make comparisons.
Magnets

1. How many things are in my set?

2. This is a n____ l.

3. This is a b____ t.

4. This is a w_______ r.

5. This is a paper c____ b.

6. This is a c____ k.

7. This is a rubber t____ e.

8. This is a piece of copper w____ e.
9. This is a piece of \_\_d.

10. This is a piece of \_\_\_\_\_m.

- wire
- tube
- cork
- clip
- styrofoam
- wood
- washer
- bolt
- nail
What Do Magnets Do?

1. Put your two magnets on the table like this.

![Image of magnets on table]

Draw a picture to show what happens when you push them together.

2. Turn one magnet around. Draw a picture to show what happens when you push them together.

3. Put your two magnets on the table like this.

![Image of magnets on table]

Draw a picture to show what happens when you push them together.

4. Turn one magnet around. Draw a picture to show what happens when you push them together.
AN OVERVIEW
What is heat?

BASIC CONCEPTS
1. Matter is composed of particles (molecules) that are in constant motion.
2. Energy exists in a variety of forms that can usually be converted from one form to another, such as mechanical energy to heat energy.
3. Matter exists in a variety of forms (solid, liquid, gas, and plasma) that can be converted from one form to another.

SCIENCE BACKGROUND
This unit is concerned with heat as a form of energy, how it is obtained, what it does to materials, and how the temperature of materials is measured. It is also concerned with fire, the conditions needed for burning, and the conditions needed for putting out fire.

The first section deals with heat as a form of energy. Heat is the energy of moving molecules (called kinetic energy or the energy of motion). Heat energy can be obtained from other forms of energy. Heat energy can be obtained from electrical energy, mechanical energy, chemical energy, radiant (solar) energy, and nuclear energy. The faster the molecules in a material move, the more heat energy the material has, and the hotter the material becomes. In general, heating causes materials to expand and cooling causes materials to contract. Heating or cooling can also change the state, or form, of materials.
### MATERIALS FOR THE UNIT

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>balloon</td>
<td>oil, olive</td>
</tr>
<tr>
<td>baking soda</td>
<td>pans, metal</td>
</tr>
<tr>
<td>bottle, with spray top</td>
<td>paper, white</td>
</tr>
<tr>
<td>bottles</td>
<td>pencil</td>
</tr>
<tr>
<td>candles</td>
<td>pot, Pyrex</td>
</tr>
<tr>
<td>clay</td>
<td>rod, wooden</td>
</tr>
<tr>
<td>food coloring</td>
<td>rubber band</td>
</tr>
<tr>
<td>freezer</td>
<td>rubber stopper,</td>
</tr>
<tr>
<td>frying pan</td>
<td>one-hole</td>
</tr>
<tr>
<td>hot plate</td>
<td>screw, large</td>
</tr>
<tr>
<td>ice cubes</td>
<td>screw eye, large</td>
</tr>
<tr>
<td>index card</td>
<td>sharpener, pencil</td>
</tr>
<tr>
<td>jars</td>
<td>spoon, metal</td>
</tr>
<tr>
<td>lens, hand, or magnifying</td>
<td>thermometer, laboratory</td>
</tr>
<tr>
<td>glass</td>
<td></td>
</tr>
<tr>
<td>marking pen, wax-glass</td>
<td>toaster</td>
</tr>
<tr>
<td>match box, with striking</td>
<td>trough, cardboard</td>
</tr>
<tr>
<td>surface</td>
<td>tube, plastic or glass</td>
</tr>
<tr>
<td>matches</td>
<td>vinegar</td>
</tr>
<tr>
<td></td>
<td>water</td>
</tr>
</tbody>
</table>
FOR ENRICHMENT

Books for the Teacher

Books for the Children


Films
Fire (Gateway)
10 min. b&w. c. Shows what is needed for fire, what it does for man, how it is controlled, and what it can do when it gets out of control.

Heat—Its Nature and Transfer (Encyclopedia Britannica Films)
11 min. b&w. c. Illustrates the nature of heat and how it is distributed. Shows practical applications of heat in home and industry.

Measuring Temperature (McGraw-Hill Text Films)
11 min. b&w. c. Shows how thermometers are constructed. Explains the principle of expansion and contraction by which thermometers work.

Nature of Heat (Coronet)
10 min. b&w. c. Shows that heat is the energy of molecular motion. Demonstrates how heat is transferred.

This is Heat (Cenco)
12 min. b&w. c. Describes sources of heat, expansion and contraction, thermometers, conductors and insulators. Shows how heat works for us and helps us in many ways.

Transfer of Heat (McGraw-Hill Text Films)
11 min. b&w. c. Shows and explains how heat can be transferred by conduction, convection, and radiation.

Understanding Fire (Coronet)
11 min. b&w. c. Shows the three basic requirements for fire: fuel, heat, and air.

Filmstrips
Cause and Nature of Heat (Jam Handy)
39 fr. si. c. Describes the sources of heat. Shows that heat is a form of energy and describes how heat causes change in states of matter.

Experiments with Thermometers (Society for Visual Education)
43 fr. si. c. Compares the molecular activity of solids, liquids, and gases. Describes how different types of thermometers operate and are used.

Finding Out About Heating Solids, Liquids, and Gases (Society for Visual Education)
43 fr. si. c. Describes where we get heat. Shows how solids, liquids, and gases act at different temperatures.

How Heat Causes Expansion (Jam Handy)
37 fr. si. c. Explains the principle of expansion and contraction of solids, liquids, and gases. Describes how liquid thermometers use this principle.

How Heat Travels (McGraw-Hill Text Films)
50 fr. si. b&w. Explains how heat travels by conduction, convection, and radiation. Describes how man benefits by this knowledge of the different ways that heat can travel.

Story of Fire (McGraw-Hill Text Films)
24 fr. si. c. Describes how fire was discovered and shows how fire helps us. Discusses careless practices in the use of fire.
DISCOVERING IDEAS

Materials
large screw  candle  clay
large screw eye  matches
two wooden rods  cold water

Conceptual Statements
1. In general, objects expand when heated.
2. In general, objects contract when cooled.

Objectives and Process Skills
1. Experiment with heating and cooling a metal screw.
2. Observe and describe screw and screw eye apparatus before heating screw, after heating screw, and after cooling screw.
3. Compare screw and screw eye apparatus before heating screw, after heating screw, and after cooling screw.
4. Infer that most materials expand when heated and contract when cooled.

Procedure
Another form of the screw and screw eye apparatus can be made by obtaining a large nail and a metal washer that fits tightly into the nail. Hold the nail near the head with a wood spring-type clothes pin.

Ask the children why it is necessary to provide small spaces at regular intervals in railroad tracks. Metal rivets used in construction are hammered tightly into place when they are red hot. This is done so that when the rivets cool, they will contract and pull the parts together with great force.

Results
After the screw is in the flame for several minutes it will no longer pass through the screw eye. The screw expanded when it was heated.

After the screw is dipped into the glass of very cold water it will again be able to pass through the screw eye. The screw contracted when it was cooled.

Materials
ice cubes  hot plate
metal pie pan  water

Conceptual Statements
1. In general, solids change to liquids when they are heated.
2. In general, a liquid changes to a gas when it is heated.

Objectives and Process Skills
1. Observe and describe what happens when ice cubes are heated.
2. Infer that when a solid is heated it changes to a liquid.
3. Observe and describe what happens when water is heated.
4. Infer that when a liquid is heated it changes to a gas.

Procedure
The children probably have had some experience with making and melting ice cubes, boiling water, and observing steam condensing. In most cases they will be able to make fairly accurate inferences and predictions on the effects of heating and cooling water.

Children (and many adults) infer that the white cloud that may form above the pot of boiling water is a gas. They call it steam, but it isn't. The water vapor formed when water boils is an invisible gas. Scientists call this invisible gas steam. When steam rises and meets colder air, some of it cools and condenses as a fine white cloud of water droplets.

Results
When ice cubes are heated they melt, change to a liquid. Ice cubes change from a solid to a liquid when they are heated. Most solids change to liquids when they are heated.

When water is heated it evaporates and changes to a gas called steam. A liquid changes to a gas when it is heated.
Materials
Pyrex pot   hot plate   metal pan
water       cold frying pan   freezer

Conceptual Statements:
1. A liquid changes to a gas when it is heated.
2. A gas changes to a liquid when it is cooled.
3. A liquid changes to a solid when it is cooled.

Objectives and Process Skills
1. Observe and describe what happens when water boils.
2. Observe and describe what happens when water vapor (steam) is cooled.
3. Infer that a gas changes to a liquid when cooled.
4. Observe and describe what happens when water is cooled.
5. Infer that a liquid changes to a solid when cooled.

Procedure
The children should observe the movement of the bubbles in the boiling water. The bubbles are escaping water vapor. Can they see “steam” rising from the boiling water? Remind them that the visible steam is condensed water vapor. This “visible” steam condenses even more when it strikes a cold object.

You might note that water is an exception to the rule of expansion and contraction from the temperature range of 39°F (4°C) down to 32°F (0°C). Above 39° water expands when heated and contracts when cooled. However, below 39° water expands when cooled. When water freezes it expands.

Results
The bubbles coming from the boiling water are water vapor. Some of the water has changed to a gas. Water droplets form on the bottom of the cold frying pan. Then water vapor condensed, or changed to a liquid.

When water is left in a freezer overnight it changes to ice. Water changed from a liquid to a solid when cooled.

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DISCOVERING IDEAS

Materials
pita

Conceptual Statements
Heat energy comes from other forms of energy.

Objectives and Process Skills
1. Describe what happens when they place their hand over a toaster that has been turned on.
2. Infer that heat energy can be gotten from electrical energy.
3. Describe what happens when they rub their hands together very fast.
4. Infer that heat energy can be gotten from mechanical energy.
5. Observe and describe what happens when sunlight passes through a hand lens onto a piece of paper.
6. Infer that heat energy comes from radiant energy—the energy of the sun.

Procedure
Conduct each part of the investigation described on this page. As a precautionary measure, you may wish to do the activity with the magnifying glass yourself.

If the children are curious as to what causes heat in the toaster you can explain that there are thin wires inside a toaster. These wires resist the flow of electric current through them. The resistance of the wires to the flow of electricity produces heat.

Results
When you place your hand over a toaster that has been turned on you can feel heat, electrical energy changed to heat energy. When you rub your hands together very fast you can feel heat, mechanical energy changed to heat energy. When you allow sunlight to pass through a hand lens onto a piece of paper, the paper will begin to char and burn, radiant energy changed to heat energy.
SYNTHESIZING IDEAS

In this section the children learn about and receive practice in formulating models. You may wish to raise the question, what do you think matter might be like since matter can change from a solid to a liquid and from a liquid to a gas? Matter can expand and contract! Allow the children to speculate on the nature of matter. After the discussion, proceed to the Building Ideas.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations
1. Have the children bend a thick wire back and forth quickly several times. Why does the wire get hot? What kind of energy changed to heat energy?
   Bending the wire back and forth makes the molecules in the wire move faster. The faster the molecules, the more energy they have, and the hotter the wire becomes.

2. Tell the children to place a glass of cold water and a glass of hot water side by side. They should then add two drops of red food coloring to each glass. In which glass does the water become red all over first? How does the theory of heat and moving molecules explain this?
   The molecules of hot water have more energy and are moving faster than the molecules of cold water. The faster-moving molecules hit the molecules of red food coloring harder and spread the coloring more quickly through the glass.

3. Ask the children what they think would happen if both the screw and the screw eye were heated at the same time. Why?
   If both the screw and the screw eye were heated at the same time, they both would expand. The screw would still be able to pass through the screw eye after both were heated.
Which water changes faster? Color it.

Which dry faster? Color them.
AN OVERVIEW
Light and Shadows

BASIC CONCEPTS
1. Events in the natural environment are characterized by universality and change.
2. Events in the natural physical environment can be observed, measured, and explained.
3. When objects and systems interact, evidence of these interactions can be observed as changes in position, color, temperature, form, and phase.

SCIENCE BACKGROUND
Light is a form of energy. It is radiant energy. We can see objects because, like a burning candle, they give off light or, like this book, they reflect light. During the day, objects are illuminated by light from the sun. Children sometimes think that light comes out of our eyes and is reflected back to us by various objects. The light, of course, comes from such sources as the sun or light bulbs and is reflected by objects to our eyes. In the first section of this unit, the children will learn that a light source is necessary in order to see objects.

Light energy passes through certain kinds of materials, such as clear glass or clear plastic. Such materials are called transparent. Light energy does not pass through other materials, such as wood or metal. These materials are called opaque. We can see through transparent materials; we cannot see through opaque materials. Through experimentation, the children will classify objects as transparent or opaque.

Since light cannot pass through opaque materials, the area behind an opaque object such as a stick will be in shadow; i.e., there will be little or no light in this area compared with surrounding areas. If light strikes the surface of an opaque object at a right angle, the shadow cast by the object will have the same shape as the object. Of course, the shadow will be two-dimensional rather than three-dimensional. The children will experiment to find out whether they can always identify an object by the shape of the shadow it casts.

Light travels in a straight line. For example, if holes are cut in three pieces of opaque cardboard, and these holes are lined up, light will pass through the three holes, and we will therefore be able to see through them. If the holes are not lined up, light will not pass through the three holes (since light usually cannot turn corners) and so we will not be able to see through the three holes at once.

Actually, a straight line is usually defined operationally in terms of light. We talk about "line of sight." A farmer makes certain his fences are straight by sighting along the posts. He is using the property of light that it travels in a straight line. A straight line can also be defined in terms of a taut string. When the children have lined up the holes in the three pieces of cardboard, they can stretch a string through the holes to determine whether they are in fact in a straight line.

The position of the sun in the sky can be studied by studying shadows and how they change. Children should be cautioned against looking directly at the sun. The sun is a very bright object, and anything more than a fleeting glance at it can lead to serious injury to the eyes. Do not look directly at the sun.

Shadows, however, indicate the position of the sun. For example, children can see that the sun is in the opposite direction to that of the shadow cast by an opaque object. When the sun is in the east, the shadow will extend in a westerly direction. When the sun is low in the sky, the shadow will be long. When the sun is high in the sky, the shadow will be short. By studying shadows, the children can learn about the position of the sun and how it changes in relation to the earth. The changing positions of a shadow are used in the sundial: the children can construct to tell time.

The color of sunlight changes during the day. In the morning and late afternoon, sunlight has to pass through more of the atmosphere than at noon. As a result, more of the long-wavelength red light in sunlight will penetrate the atmosphere than the short wavelengths that make up sunlight. This can cause very beautiful sunrises and sunsets, especially if some of this light is reflected by clouds. The children might also be interested to know that, because more sunlight can penetrate the atmosphere at noon, noon is a time when we are more likely to get a sunburn.

MATERIALS FOR THE UNIT
ball
box, cardboard, large
cardboard, pieces of clay, modeling coping saw (or scissors if cardboard is used instead of plywood for the sundial)
DISCOVERING IDEAS

Materials
3 pieces of cardboard
3 small pieces of wood

Conceptual Statements
Light travels in a straight line.

Objectives and Process Skills
1. Observe and describe what happens when the holes in the three pieces of cardboard are not aligned.
2. Observe and describe what happens when the holes in the three pieces of cardboard are aligned.
3. Compare what happens when the holes are aligned with what happens when the holes are not aligned.
4. Infer that light travels in a straight line.

Procedure
Have the children cut holes in the centers of three pieces of cardboard. Use three pieces of cardboard the same size. To find the exact center of each piece, draw diagonal lines across the cardboard from opposite corners. The point where the lines cross is the center of the cardboard.

Have the children try to run a string through the three holes after they are lined up. Have them pull the string taut. Can the taut string be held so that none of the string touches any side of any of the holes?

Results
Light travels in a straight line. When the holes in the three pieces of cardboard are lined up, the children will be able to see through the three holes at once by the natural light in the classroom. When the holes are not aligned, the children cannot see through the three at once because the light that they need in order to see does not turn corners.

Materials
flashlights
yardsticks or metersticks
pencils

Conceptual Statements
There is a shadow in places where there is less light.

Objectives and Process Skills
1. Observe and describe the shadow created when a light shines on an upright pencil.
2. Observe and describe the way the shadow moves when the light source is moved.
3. Infer that the position of the shadow depends on the position of the light source.

Procedure
Divide the children into groups. Give each group a pencil, a flashlight (pen flashlights are best for this activity), a yardstick or meterstick, some clay, and a sheet of paper. Have the children set the pencil upright in a dab of clay. Set the pencil and clay on the sheet of paper. Have the children shine the light from the flashlight on the pencil. Then have them trace a line along the edge of the shadow of the pencil. Have them extend this line in the direction of the flashlight using the yardstick or meterstick. How are the shadow, the pencil, and the flashlight lined up?

Now have the children move the flashlight to the left or the right. What happens to the shadow when the light is moved? Compare the position of this shadow with the position of the first shadow which was drawn on the paper.

Results
The shadow, the pencil, and the flashlight are shown to be all in a line with the help of the yardstick or meterstick. When the flashlight is moved, the shadow also moves.
SYNTHESIZING IDEAS

On this page, the basic idea that light travels in a straight line is developed. Make certain that all the children understand that you can see through three holes when they are lined up in a straight line.

A shadow of a pencil is formed because the light from the pen flashlight travels in a straight line. A line drawn along the edge of the shadow and extended toward the flashlight should pass through the light of the flashlight. Since light does not usually curve, it cannot fill the space behind the pencil. Some child might wonder why the area behind the pencil is not completely dark. Point out that there usually are other sources of light in the classroom than the pen flashlight. Some of this light often comes from the outside through the windows and is reflected by the walls. There also may be other sources of light that help fill up the space behind the flashlight. However, there is a shadow because there is less light shining on the area behind the pencil than there is in adjacent areas.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations
Hang a white sheet across the classroom. Place a bright light behind it. Darken the classroom and turn on the light behind the sheet. Have two children stand behind the sheet and in front of the light. Their shadows will fall on the sheet. The children can shadowbox or pantomime any actions they choose. If one child stands close to the sheet and the other close to the light, the shadow of the child close to the light will look like a giant. The watching children can guess what the shadows portray.

Materials
- cardboard
- small blocks of wood
- tacks
- scissors

Procedure
This activity can be used to check whether the children can line up objects in a straight line and whether they can describe what a shadow is.

Have the children work in groups of two or three. Have them cut out narrow strips of cardboard and tack these strips to small blocks of wood, as shown in the illustration.

Now, one child in each group should line up the strips of cardboard so that they are in a straight line between him and the child opposite him. Can he see the child opposite him? Why not? (The cardboards should block his view.) Then each of the other children in the group should check to see whether the strips of cardboard are in a straight line. You might want each child to line up the cardboard strips and have the other children check them. Have the children stretch a string alongside the three strips of cardboard. Is the string in a straight line? Are the pieces of cardboard lined up in a straight line?

Results
When the three cardboard strips are lined up between the eyes of two children, the children will not be able to see each other. The opaque strips block the line of sight.
Activity

Materials
flashlights
pieces of cardboard
pieces of transparent glass or clear plastic

Conceptual Statements
Shadows are cast by opaque objects.

Objectives and Process Skills
1. Observe and describe what happens when light shines on opaque objects.
2. Observe and describe what happens when light shines on transparent objects.
3. Compare what happens when light shines on opaque objects with what happens when light shines on transparent objects.
4. Infer that opaque objects block light.
5. Infer that transparent objects allow light to pass.
6. Observe and describe what happens when light shines on transparent objects held sideways to the beam of light.

Procedure
Have the children shine light from the flashlights onto various kinds of materials, including transparent materials such as clear glass and clear plastic, and opaque materials such as cardboard. Which materials cast shadows?

Have the children hold the transparent material on edge toward the flashlight. Is a shadow formed? Some materials are opaque if held on edge toward the flashlight, especially if the material is not too thin. However, the material is transparent in the other direction.

Results
Light passes through most transparent objects, although in some cases pale shadows might be formed because all the light from the flashlight might not pass through the object. Light does not pass through opaque objects so shadows are formed.
Which shows a sunny day? Color it.

Where will the shadow be? Draw it.
AN OVERVIEW
Machines Help Us
Levers at Work

BASIC CONCEPTS
1. Energy exists in a variety of forms that can usually be converted from one form to another.
2. When objects and systems interact, evidence of these interactions can be observed as changes in position, color, temperature, form, and phase.

SCIENCE BACKGROUND
Machines are devices that we use to help us do work. In some cases, machines make it possible for us to do work that we could not do without them. For example, we could not send spacecraft into space without the rocket, a very complex machine. In other cases, we use machines to make it more convenient to do certain kinds of work. It would be possible, for example, to climb up a flagpole every morning with a flag, but it is easier to raise the flag with a pulley system.

Many of the machines and tools in use today have been constructed on a small scale for children. Toy automobiles, tractors, trucks, stoves, sweepers, and brooms are available and quite commonly found among most groups of children.

Almost as long as children can remember they have known about machines and played with toy models of them. Probably few children are aware, however, that the purpose of machines is to help us do different work more easily and more efficiently.

An important generalization involved in the use of machines is that we always have to put more energy into a machine than the useful energy we get out of the machine. For example, a simple lever can be used to exert sufficient force to raise a heavy object, but we have to exert the force over a considerable distance in order to raise the heavy object a short distance. There is always a certain amount of friction that the machine has to overcome. Some of the energy we put into the machine is taken up by the machine to overcome this friction.

In working with machines, children come into contact with some of the most basic principles of science. They might not be able to articulate these principles, but they will be able to make use of them. Most of the machines considered in this unit are simple machines such as levers or pulley systems. These have a simplicity that makes it easier for children to see general principles involved in machines. Later, of course, the children will consider more complex machines.

Whenever possible, actual machines should be used to illustrate the principles on which machines operate. It would be desirable to have many simple machines available in the classroom. The six simple machines (the lever, the pulley, the wheel and axle, the inclined plane, the wedge, and the screw) can be classified into two broad groups: those like levers and those like inclined planes. Simple machines are used to increase force, change the direction of a force, or increase the speed or distance an object is moved.

The study of the unit can be introduced by asking the children to find as many machines as they can in the classroom. In most classrooms there are a large number of machines ranging from the knob on the door to the pulleys on the curtains or blinds. As they do this, children will tend to become more aware of the wide variety of machines to be found all around them.

MATERIALS FOR THE UNIT

apple, or other object
block, wood, triangular
boards, wood
books
box, cardboard or wood
cam, spring
clip, paper
cork
crow bar, or stick
drill, hand
egg beater
eraser, chalkboard
eraser, rubber
gear system
hammer

meterstick, or yardstick
nails, various sizes
nut cracker
nut, metal
plates, pie, small pulley, clothesline
rubber band, large ruler
spools, wooden, large and small sticks, different lengths
string
support bar
wagon, toy wedge
wrench

FOR ENRICHMENT

Books for the Teacher

**Books for the Children**


**Films**

How Machines and Tools Help Us (Coronet) 10 min. b&w. Shows how man has devised ways of making work easier with the aid of simple tools and machines.
How Strong Can You Be? (Journal Films) 10 min. b&w. c. Energy sources; how man uses them to make work easier and to better his standard of living.
Machines (Gateway) 8 min. b&w. A film for very young children illustrating uses of the wheel-and-axle, lever, inclined plane, pulley, wedge, and screw.
What's So Important About a Wheel? (Journal Films) 10 min. b&w. c. Science readiness film for primary and intermediate grades—principles of the wheel and its many applications in our everyday life.
You and Machines (United World Films) 13½ min. b&w. c. How machines help us do work by increasing force, increasing speed, changing direction of motion, or transmitting energy. Students see the operation of all the fundamental machine devices, and learn how they influence their daily activities.

**Filmstrips**

Simple Machines Help Us Work (Jam Handy) 6 filmstrips. si. c. Levers, wheels and axles, pulleys, ramps, screws and wedges are shown to be part of the child's everyday life, as well as the basic, later use for advanced technology.
Whys of Elementary Science II (Filmstrip House) 4 filmstrips. si. c. Simple machines: levers, wedges, wheels, inclines, screws, shown by stick diagrams.
DISCOVERING IDEAS

Materials
crow bar or stick to be used as a lever
box books.

Conceptual Statements
1. A lever is a simple machine.
2. A lever can be used to move an object.
3. A lever makes work easier.

Objectives and Process Skills
1. Observe and describe how a lever can be used to move an object.
2. Compare lifting objects with and without the use of a lever.

Procedure
Discuss the picture on page 101. What is the boy trying to do? How is he using the stick? Will this help him to move the rock? How can he lift the rock? The lever helps the boy to lift the rock. The boy would not be able to push the rock without the use of the lever. The lever makes it possible for the boy to exert more force (push).

Have the children experiment with levers. Try to find a long stick, crow bar, or broom. Put a few books into an empty box. Have the children try to lift the box. Now have them try to lift the box using a lever. Be careful so that the children do not break the handle of the lever. The children can compare the difficulty of lifting the box with a lever and lifting it unaided by the machine.

Results
The children experiment by lifting objects with and without the use of a lever. They find that they can lift heavy objects more easily with a lever than without one. When they push down on the lever the object is lifted up.

Materials
wood boards books
toy wagon

Conceptual Statements
1. A ramp (inclined plane) is a simple machine.
2. A ramp can be used to move objects up and down.
3. A ramp makes work easier.

Objectives and Process Skills
1. Observe and describe how to use a ramp to lift heavy objects.
2. Compare lifting objects with and without the use of a ramp.

Procedure
Discuss the picture on page 102. Explain that the boy on the ground wishes to lift his bicycle onto the platform where the other boys are. How can he do this? Some of the children may suggest that he lift his bicycle onto the platform. Lead the children to suggest that the boy walk his bicycle up the ramp.

To illustrate the advantage of using a ramp, have the children try the following investigation. Put several books in a box. Place the box on the floor near a table. Get a long board and a shorter board. Ask the children how they can move the box and books to the table. Can they use the boards to make lifting easier? How? They can make lifting easier by using a board as a ramp. Which ramp makes it easier? By experimenting with the boards they will find that the longer ramp reduces the steepness even though it increases the distance from floor to table.

Make sure that the board is held so that it does not slide.

Results
The children use ramps to lift objects. They conclude that ramps help us move objects up to a higher place and down to a lower place.
Activity

DISCOVERING IDEAS

Materials
wedge   hammer

Conceptual Statements
1. A wedge is a form of inclined plane. It is two ramps back to back.
2. A wedge is a simple machine used to split things.
3. A wedge is used to make work easier.

Processes
1. Observe and describe how wedges can be used to cut an object.
2. Identify wedges in different objects.

Procedure
Before discussing the picture on page 103, show the children a wedge. You can borrow a wedge from a carpenter or cut one from wood. First have the children look at only one side of the wedge. What do they see? Have them look at the other side. What do they see? They should be led to understand that a wedge is really two ramps back to back.

If possible, bring in an ax. The blade of an ax is a wedge. There are wedges in the log shown on page 103. The wedge is a machine used to split things.

Demonstrate how a wedge can be used to push things apart. Place the thin end of a wedge under the leg of a heavy table. Tap the blunt end of the wedge with a knife. When the blunt end of the wedge is tapped, the table is raised.

Tell the children that wedges go through something; they cut, split, and push apart things. Show the children a picture of a boat. What part of the boat is a wedge? The prow of a boat acts as a wedge, cutting through water.

Results
The children investigate wedges. They find that wedges are used to cut, split, and push things apart.

In this section the children become acquainted with a variety of simple machines. They learn about wheels, pulleys, levers, ramps, and wedges. In working with machines, children come in contact with some of the most basic principles of science. They may not be able to articulate these principles, but they will be able to make functional use of them. When they slide back and forth on a seesaw in order to balance, they show that they have a functional understanding of a basic law of science. Similarly, they show their understanding when they use a long lever or pry to lift a heavy object.
FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations

1. In order to give the children further experience and broaden their understanding of wedges, have them try the following investigation. Get two sticks. One stick should be sharpened so that it comes to a point at one end. The other stick should have a flat end. Get a bucket of hard soil or go outdoors to the playground. Have the children examine the pointed stick and then try to push it into the ground. Next, have them examine the flat stick and try to push this stick into the ground. Which stick was easier to push into the ground? Why?

   The children will find that the pointed stick will work better than the stick without the wedge end. The wedge makes it easy to push the stick into the ground.

2. Help the children understand the importance of roundness in wheels. Ask how wheels are shaped. Gather some materials for a science table display. You might display pencils, marbles, balls of various sizes, a flashlight, a banana, an apple, and a pear. Let the children roll these objects in various ways.

   Ask the children to test and compare the objects, discuss which objects rolled best. Help them to realize that a very smooth object will roll farther than an object that is not so smooth.

APPLICATION OF THE IDEAS

Materials
- pulley
- spatula
- knife
- can opener

Procedure

Try to obtain the objects listed so that the children can examine them. Have the children identify each object. What kind of simple machine does each object represent? How are the objects used? The clothesline pulley is used to pull clothing toward and away from the person who is pulling. This is easier than walking back and forth along the length of the line in order to remove or hang articles. The spatula and the knife are wedges. The spatula is used to separate food from the sides of a bowl. The edge of a knife is a wedge. It is used to cut things. The can opener is a lever. The pointed end of the opener cuts a hole in the metal top of the can. An upward force is applied to the flat end of the opener. The edge of the can acts as a fulcrum and the pointed end of the opener pushes down into the top of the can.

Results

The children identify a variety of simple machines in household objects. They examine a clothesline pulley, a knife and spatula (wedges), and a can opener (lever).
INTRODUCING THE SECTION

If you have a seesaw in the school playground, use it to illustrate the principle of the lever. Show the children the place in the center of the seesaw where the board turns or pivots. This is known as the fulcrum.

If a seesaw is unavailable, you can make one from a ruler and a small block of wood. Have the children put the ruler on top of the wood so that it balances.

SECTION OBJECTIVES

Conceptual Statements
1. Levers help us to push or pull harder.
2. Levers help us to push or pull farther.
3. When using a lever we must push or pull farther or push or pull harder.
4. We can lift heavy things more easily with a long lever than with a short one.

Processes
After completing this section, the child will be able to:
1. Experiment with a variety of levers of different lengths.
2. Experiment with balancing objects on an equal arm balance.
3. Infer that the lighter weight must be a greater distance from the fulcrum (pivot) of the balance in order to balance a heavier weight.
4. Observe that a long lever lifts heavy things more easily than a short lever.
5. Observe that a lever enables a small push or pull to apply a larger push or pull. The push or pull must move through a larger distance in order to apply the larger push or pull.

DISCOVERING IDEAS

Materials
- 3 spring clips
- wood support
- 2 small pie tins
- meter or yardstick
- chalkboard eraser
- string
- long nail
- hammer
- cork
- paper clips

Conceptual Statements
1. The equal arm balance is a lever.
2. When the weight (force or pull) on one side of the balance is greater than the weight (force or pull) on the other side of the balance, the lever will not balance.
3. By moving the heavier weight toward the fulcrum (pivot) of the lever you can balance it.

Objectives and Process Skills
1. Observe what happens when unequal weights (forces) are placed on either side of a balance.
2. Measure the number of paper clips that will level a balance with a cork or other object on the other pan.
3. Measure the number of paper clips that will level a balance with a chalkboard eraser on the other pan.
4. Experiment with moving the heavier object (eraser) varying distances from the fulcrum in order to level the balance.
5. Infer that the closer an object is to the fulcrum (pivot) of a lever, the less force is needed to balance the object.
Procedure

Have the children investigate the number of paper clips needed to balance a cork or other light object on the balance. Discuss how the balance is like a seesaw. Both are levers.

Have the children find the number of paper clips needed to balance some heavier object, such as a chalkboard eraser. When this is done, instruct the children to remove some of the paper clips. What happens? The balance moves up on the side of the paper clips. Now, ask the children to try to balance the lever without adding any more weights. Encourage them to slide the spring clip on the heavier side along the arm of the balance. Can they level the balance? How? Have the children note the distance the spring clip on the eraser side is from the fulcrum. Compare this with the distance the spring clip on the other side is from the fulcrum.

Results

The children experiment with a balance. They conclude that more paper clips are needed to balance an object far from the fulcrum than are needed to balance the same object when it is closer to the fulcrum.
A BALANCE

Where is the fulcrum?
Where are the pans?
DISCOVERING IDEAS

Materials
sticks of different length
box books

Conceptual Statement
1. It is easier to lift an object with a lever when you push down at the far end of the lever than at a point closer to the object.
2. It is easier to lift heavy objects with a long lever than with a short one.
3. You must push a longer distance when using a long lever than when using a short one.

Objectives and Process Skills
1. Compare lifting a box using a short lever and a long lever.
2. Infer that it is easier to lift a heavy object when using a long lever than when using a short one.

Procedure
Discuss the pictures on page 110. Why is the boy having more difficulty in lifting the lid of the box than the girl? To answer the question have the children perform the following investigation. Fill an empty box with books. Have the children try to lift the box using a short lever. Have them lift the box using a long lever. Which lever made it easier to lift the box? (The long lever.) Did they have to push a greater distance when they used the long lever? (Yes.) Have them experiment by pushing down on the long lever at different points. Is it easier to lift the box when they push on a point near or far from the box?

Results
The children experiment with levers of different lengths. They find that it is easier to lift a box with a long lever than with a short one. They also discover that it is easier to lift a box when you push down at the end of the lever farthest from the box.

NOTE: With a long lever we can move heavier objects than with a short lever.

Which way is better? Who pushes farther?

CONCEPT: If we increase the distance over which we apply a force, we can use less force. The law of conservation of energy holds in all these activities: the force times the distance equals the work.
ACTIVITIES IN SCIENCE
Lesson 8

MANY KINDS OF MATTER
(A Discovery Kit)

Level
All elementary grades

Objectives
After completing the activities outlined in this Kit, the pupil will be able to:

1. Describe matter as anything having weight and taking up space.
2. Describe matter as existing in three states: solid, liquid, and gas.
3. Explain how matter can change from one state to another.
4. Observe a variety of objects and processes accurately and describe them.
5. Describe different kinds of materials by their properties.

Introduction
Everything in the universe can be divided into two groups, matter or energy. Since most forms of energy are invisible (heat, sound, chemical, mechanical, magnetic, electrical, etc.), they are not usually as noticeable to us. With matter, we tend to identify it as "things" (solids), ignoring its other forms—liquids and gases.

Energy is defined as "the ability to do work or to cause motion" while matter is "anything that has weight and takes up space." In nature the two are constantly interacting, yet we usually think of matter when we study the natural things around us. To prove this, you might want to precede these lessons by asking your pupils to name some things in nature that they know about or in which they are interested. By and large, you will get objects and "things": dirt, trees, air, rocks, etc., (matter) for most answers, not heat, light, sound, electricity, magnetism, etc., (energy).

This Kit is concerned with matter and some of its properties. One of the main purposes of the lessons is to develop pupils' skills in observing and describing what they see. This should increase both their awareness of the nature of things around them and their descriptive vocabulary. Items are provided in the Kit for pupils to use all five senses for observation and description.

Materials
For pupils to observe by seeing and touching (for lessons 1 and 2), 9 sets of objects, each containing:

<table>
<thead>
<tr>
<th>Aluminum foil</th>
<th>Vial of blue colored water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear plastic square</td>
<td>Rubber tube</td>
</tr>
<tr>
<td>Wooden dowel</td>
<td>Styrofoam cube</td>
</tr>
<tr>
<td>Tissue paper</td>
<td>Empty vial</td>
</tr>
</tbody>
</table>
ACTIVITIES IN SCIENCE

The teacher's demonstration materials:

- Ringstand
- Iron ring
- Wire gauze
- 150 ml beaker
- Alcohol burner
- Alcohol (for burner)
- Funnel

For pupils to observe by smelling (for lesson 3), 20 vials containing a wad of cotton and an odorous substance, numbered for identity:

- 5 containing oil of peppermint - marked "1"
- 5 containing vanilla extract - marked "2"
- 5 containing garlic oil - marked "3"
- 5 containing perfume - marked "4"

For pupils to observe by hearing (for lesson 4):

- 1 box containing a bell - marked "A"
- 1 box containing a large metal washer - marked "B"
- 1 box containing dried beans - marked "C"

For pupils to observe by tasting (for lesson 5):

- 2 shakers of sugar
- 2 shakers of salt
- 1 package of coffee beans

Materials to be Collected by the Teacher

- 3 lemons (enough for each pupil to taste a slice)
- Small container of pepper or hot sauce (optional)
- Paper towels
- Matches (to light alcohol burner)
- Egg carton tops (to use as trays)

Advance Preparations

Lesson 1 (Seeing)

Prepare enough ditto copies of Page A for each pupil.

Prepare a bulletin board and/or specimen display depicting living and non-living things.

Prepare a bulletin board and/or specimen display of objects depicting solids, liquids, and gases.

Get ice cubes.
Practice making smoke with a wet paper towel. Roll the towel up and wet the center. Light one end. As it burns toward the wet part, a good deal of smoke should be generated. Shaking the towel slightly will also produce puffs of smoke.

Assemble the ringstand and other items as shown in the diagram on Page 4.

Fill alcohol burner about 1/2 full of alcohol. Wick should extend about 1/4" above metal tube in cap.

Get matches.

Check to make sure that each of the 9 sets has all of the materials. Check vials and group them according to their odors.

Prepare ditto copies of Pages A, B-1, and B-2 for each pupil.

Prepare a bulletin board of pictures and/or actual samples of several different kinds of materials: fabrics, paper, foil, yarn, etc., of different colors and textures. Include labels such as "Heavy or Light?" "What Colors?" "Rough or Smooth?" etc.

Lesson 2 (Touching)

Prepare ditto copies and/or transparencies of Pages C-1 and C-2 if you plan to use them.

Lesson 3 (Smelling)

Prepare additional vials of other smells if you wish to expand the lesson.

Prepare bulletin board and/or display of objects: "What Do These Smell Like?"

Lesson 4 (Hearing)

Prepare additional sealed boxes with other objects inside them if you wish to expand the lesson.

Prepare bulletin board and/or display of objects: "What Do These Sound Like?"

Lesson 5 (Tasting)

Prepare ditto copies and/or transparencies of Pages D-1, D-2, and E if you plan to use them.

Prepare samples of other substances for tasting if you plan to expand the lesson.

Prepare bulletin board and/or display of objects: "What Do These Taste Like?"
Lesson 1 - Seeing

Begin with the idea that matter (objects/things) can be divided into two groups, living and not living. Use your bulletin board and/or display of actual materials to help put this across. You might play a game called "Live Or Not Alive?" (for very young children). Point to pictures or hold up objects and ask each pupil to say whether it is live or not alive (living or not living). Pupils might also think of things and ask each other which (classification) they fit. You could also have the pupils take turns pointing to pictures or holding up objects. Specimens such as leaves, insects, stuffed animals, etc., even though they are presently "dead" should be put into the "Live" category as should things like fur, leather, etc., since they formerly were part of a living object/thing.

After having "nailed down" the concept of living vs. non-living matter, the next step concerns the three conditions or "states" of matter. Non-living matter exists in three states: solid, liquid, and gas. Your pupils are familiar with the term 'solid state' as used with radios, television, phonographs, etc. This means that the electronic circuitry consists entirely of transistors and other parts made of solid materials rather than the old tubes that contained a vacuum. Again use bulletin boards and/or actual objects to demonstrate solids, liquids, and gases. In the small sets are pieces of wooden dowel (solid), vials of water (liquid) and "empty" vials (gas-air). Let pupils handle these objects as you lead the discussion. Let pupils open the "empty" vials. Ask them, "What is in the vial?" Have them name other things that are solids, liquids or gases. It may be difficult for them to name many gases. Make some smoke with a wet paper towel. This could symbolize a gas. Fog, smog, and steam are three other examples. Most gases, like air, are colorless.

Assemble the ringstand, ring, wire gauze, beaker, and alcohol burner as in the diagram on the right. Put an ice cube in the beaker and ask pupils, "What is the state of matter?" Light the alcohol burner and heat the ice cube until it melts. Ask pupils, "What is now its state of matter?" "Is it still the same substance?" (Yes). Continue heating until the water boils and you can see steam. "Is it still the same substance?" (Yes). "What state of matter is it in, now?"

Have pupils complete the response page (Page A).

Lesson 2 - Touching.

Begin by reviewing living and non-living matter and the three states of matter. This lesson directly involves your pupils in feeling, observing, and describing seven common objects that are provided in the sets (or more if you wish to expand the experiences). Use a bulletin board and/or display of actual objects and substances to begin a discussion on the properties of some materials and some of the common words used to describe things. This activity should result in building a vocabulary of many descriptive words. Stress ways to describe shapes, sizes, weights, colors, textures, and other special properties such as flammable, non-flammable, transparent, etc.
ACTIVITIES IN SCIENCE

Have pupils take materials out of the sets and observe them. They should also have these materials to use when they complete the response pages (Pages B-1 and B-2).

Lesson 3 - Smelling

Use the vials that have cotton inside soaked with the odorous substances. Five vials of each odor are supplied in the set so three or four pupils can work together. The vials are numbered: "1" for oil of peppermint, "2" for vanilla extract, "3" for garlic oil, and "4" for perfume. Let pupils smell one odor at a time and tell you what it smells like.

The forms for two different response pages are included. They are numbered C-1 and C-2. Use these to make ditto masters and transparencies on the thermal copier and run off copies for your pupils. Page C-1 is designed for pupils to circle the correct answer. For page C-2, list on the chalkboard all words that will be needed for answers (out of order) so spelling will not be a problem. You can include a few words as distractors (water, chocolate, milk) if you wish.

You may easily expand this lesson or have subsequent lessons that include many other smells. Use old pill containers, small jars, etc., instead of vials. Put in a wad of cotton and saturate it with any familiar odorous substance.

CAUTION! One very important part of this activity should be to teach children the dangers in smelling unknown things or harmful substances. Also teach them the technique of smelling unknown substances. Open a container and hold it about 12" away from the nose. Using one hand, create a draft from the open container towards the nose. Sniff this draft to pick up the odor. If no odor is smelled, slowly move the container closer to the nose and continue to create a draft until the odor can be smelled. The author had the experience of carelessly smelling a bottle of ammonia in the chemistry lab, as an undergraduate student, and was knocked almost unconscious Caution pupils not to deliberately inhale odors and vapors that may seem pleasing but are very harmful, e.g., gasoline, solvents like acetone (in some fingernail polish removers) and toluene (in some paint removers and brush cleaners), benzene (in permanent ink felt tip markers), cleaning fluids, glues (in some model airplane cements), and pressurized hair sprays with fluorocarbons.

Lesson 4 - Hearing

Use the three small sealed boxes that have objects inside. Gather pupils around you and shake one box at a time. Box A contains a little bell. Pupils should be able to recognize the sound. Box B contains a large, heavy, metal washer. It will be more difficult for pupils to name this object. Let them describe what they think it sounds like or what kind of sound it is making. Box C contains some dried beans.

Again, it will be simple for you to expand this activity by making additional boxes with other items inside. Use shoe boxes, greeting card and jewelry boxes, etc. Pupils might try to guess the size of the object inside or how many objects they think are inside.

Lesson 5 - Tasting

As in the lesson on smelling, caution children not to taste unknown things. There is, of course, the constant danger of poisons. Today there is also the danger of
CTIVITIES IN SCIENCE

rugs - prescription or illicit drugs. Children should be taught not to eat things offered by strangers; not to eat strange, unknown things from their own friends or schoolmates; not to eat pills, capsules, powders or liquids without the approval of their parents or guardians, and in the approved quantities for such substances.

Ince the four basic tastes are salty, sweet, sour, and bitter, materials with these tastes should be used in this lesson. Three of these are provided in the Kit: salt, sugar, and coffee (bitter). The other taste, sour, is found in acid foods. It is suggested that the teacher provide two or three lemons for this taste experience. A diagram of the tongue is included that shows the areas on the tongue that are sensitive to these four tastes. All other tastes are combinations of two or more of these tastes. Make pupil copies of pages D-1, D-2, and E for this lesson.

In addition, the tongue is also sensitive to temperature. Some substances create a feeling of hot or cold (pepper). You may wish to provide some pepper or hot sauce as well as other substances to expand this part of the activity.
1. Draw a picture of something that is a solid.

2. Color the bottle to show how much soda pop is in it. Is the pop a solid, a liquid, or a gas?

   The soda pop is a__________

3. Draw the smoke that would come from burning wood.
Name

Draw a circle around the correct answer for each question. Write the answer on the line beside it.

1. Pick up the aluminum foil. The aluminum foil is:
   shiny               dull
   light               heavy
   thick               thin

2. Pick up the piece of plastic. The plastic is:
   round               square
   rough               smooth
   clear               not clear

3. Pick up the wooden dowel. The dowel is:
   round               square
   shiny               dull
   rough               smooth

4. Pick up the piece of tissue paper. The tissue paper is:
   thick               thin
   clear               not clear
   round               square
Pick up the bottle of water. The water is:

- solid  liquid
- clear  cloudy
- blue   green

Pick up the rubber tube. The rubber tube is:

- solid  hollow
- hard   soft
- shiny  dull

Pick up the Styrofoam cube. The Styrofoam is:

- rough  smooth
- light  heavy
- round  square
What Does It Smell Like?

Draw a circle around the word that tells what smell is in each bottle:

Bottle 1.  Peppermint  Vanilla  Garlic

Bottle 2.  Garlic  Vanilla  Perfume

Bottle 3.  Perfume  Peppermint  Garlic

Bottle 4.  Peppermint  Perfume  Vanilla
Tell the Smell

Which bottle smells like perfume? No. ___
Which bottle smells like peppermint? No. ___
Which bottle smells like vanilla? No. ___
Which bottle smells like garlic? No. ___

Bottle 1 smells like ____________________________

Bottle 2 smells like ____________________________

Bottle 3 smells like ____________________________

Bottle 4 smells like ____________________________
ACTIVITY

Use your tongue.
How do they taste to you?
What Does It Taste Like?

Draw a line under the correct answers:

1. The salt tastes
   sweet salty sour

2. The coffee tastes
   bitter sour salty

3. The sugar tastes
   sour bitter sweet

4. The lemon tastes
   sweet bitter sour
How Does It Taste?

Choose the right answer for each sentence and write it on the line:

sweet   salty   sour   bitter

1. The sugar tastes__________________________

2. The coffee tastes_________________________

3. The salt tastes___________________________

4. The lemon tastes_________________________
Which places on the tongue are sensitive to which tastes?
MATTER AND ITS CHANGES
(The Ways Things Change)

AN OVERVIEW
Objects Change
Water Changes
Living Things Change
Moving and Change

BASIC CONCEPTS
1. Events in the natural environment are characterized by universality and change.
2. Events in the natural physical environment can be observed, measured, and explained.
3. When objects and systems interact, evidence of these interactions can be observed as changes in position, color, temperature, form, and phase.

SCIENCE BACKGROUND
Many events in the world around us are characterized by change. Organisms grow and change position; objects change in state, position, and outward appearance. The children are probably aware of the many ways things in their environment change; this unit will help them organize what they already know and use their knowledge for further exploration.

Materials can exist in three states: solid, liquid, or gaseous. Some materials can change from one state to another. For example, water can exist in a solid form (ice), a liquid form (water), and a gaseous form (water vapor). The agent of change in this case is temperature. A change in temperature can change water to ice or ice to water, and water to water vapor or water vapor to water. The children have probably observed the changes that take place when a material that is solid at a lower temperature changes to one that is liquid when the temperature increases. They know that water outside freezes when the weather is very cold during the winter, and that ice melts when the weather becomes warmer in spring. The first section of this unit helps the children to explore the way a change in temperature can change the state of a material. The second section explores the changes that take place in water when it is subjected to different temperatures.

Force is also an agent of change. The outward appearance of objects can be changed by the application of a force. For example, the outward appearance of a piece of paper can be changed when it is subjected to enough force to crumple. Tearing, bending, crushing, and denting are examples of the ways the application of a force can change an object.

A force is required to move an object from place to place. Motion is relative; i.e., we know that an object has moved when its position has changed relative to other objects in its environment. In the last section of this unit, the children will classify the forces acting on various objects as pushes or pulls and will be introduced to the idea that an object has moved when its position has changed relative to the objects around it. The children are familiar with the fact that an object that is dropped falls "down," i.e., toward the center of the earth. You can lead them to the realization that, since the object has changed in position, a force must have acted on it. This force is gravity. Gravity pulls all objects on earth toward the center of the earth.

Living things also change. Growth leads to the addition of new matter, and death leads to the destruction of matter. Adult animals grow older. Seeds sprout stems and roots; seedlings grow bigger until they look like the parent plant. Living things require certain things to grow and change. These include air, water, food, warmth, light, and a place to live. In the third section, the children will have a chance to grow seeds and observe the changes that occur in growing plants and animals.

MATERIALS FOR THE UNIT
- balloons
- balls
- blackboard
- chocolate
- containers, aluminum foil
- freezer
- hammer
- hot plate
- ice cubes
- jar, glass
- jars, Pyrex, two large

FOR ENRICHMENT
Books for the Teacher
May, Julian, A New Baby Comes, Creative Educational Society, 1970.

Books for the Children
Atwood, Anne, The Wild Young Desert, Scribner's, 1970.
Cosgrove, Margaret, Eggs and What Happens Inside Them, Dodd, Mead, 1966.
May, Julian, They Turned to Stone, Holiday House, 1965.


Films
How Materials Change (Coronet)
11 min. b&w. c.
Spring Brings Changes (Churchill)
11 min. b&w. c. Two children plant a vegetable garden as farmers plough their fields and other signs of spring are seen. A similar companion film is Fall Brings Changes. Children in Autumn (Encyclopedia Britannica Films)
11 min. b&w. c. Two children watch summer change into autumn; they watch changes in the habits of various animals and feel the weather grow colder.
Materials of Our World (United World Films)
14 min. b&w. c. Concerned primarily with developing new knowledge and awareness of characteristics and properties of some of the materials of the world. All materials are in three states; solid, liquid, or gas. Temperature changes can cause one state to change to another.

Filmstrips
All Matter Has Three Forms (McGraw-Hill Text Films)
43 fr. b&w, Elementary Science, set 3 series. Discusses and illustrates basic scientific concepts with laboratory demonstrations and models.

Heat Changes Things (Jam Handy)
34 fr. c. First Experiences with Heat series. Presents the basic concepts of heat. Visualized situations, experiences familiar to children, and simple experiments demonstrate the various aspects of heat.

How Things Change (Popular Science)
45 fr. c. Examines the continual physical and chemical changes that take place at varied paces—changes because of weather, heat, and wind. Notes the processes of change evident in growth, evaporation, and erosion. From the primary grades series.
DISCOVERING IDEAS

Materials
- glass jar
- wood shavings
- balloons
- aluminum foil containers
- paper
- hot plate
- pot
- baking chocolate
- matches

Conceptual Statements
1. Materials sometimes change when they are pushed.
2. Materials sometimes change when they are heated.

Objectives and Process Skills
1. Observe and describe what happens when certain materials are subjected to a force (push).
2. Observe and describe what happens when certain materials are heated or burned.
3. Compare the appearance of the materials before the experiment with their appearance after the experiment.
4. Infer that force and heating or burning can change objects.

Procedure
You can demonstrate how the materials shown have been changed. If you break glass, place it inside a container such as a plastic or paper bag and either drop it or hit it with a hammer. Be careful that no one handles the broken fragments of glass because they are sharp. Small pieces of wood can be placed in a used aluminum container and burned. Have the children compare the appearance of the objects before and after they have been subjected to force or heat.

DISCOVERING IDEAS (continued)

If possible, give every youngster the opportunity to push on inflated balloons. Here, one of the generalizations is that the form and shape of objects is sometimes changed by applying force to the material. Have the children see what different shapes they can form from the inflated balloons.

When paper and aluminum containers are crumpled, their shape is also changed by the application of force. Have the children find other examples of materials that have been changed in shape when they have been pushed.

In some cases, changes in the physical shape of materials take place when they are heated. Place a few blocks of chocolate (baking chocolate works very well) in a pyrex pan or other container. Have the children describe the properties of the chocolate blocks with special attention to their shapes. Then place the container on a hot plate and heat the chocolate. Have the children describe the changes that take place in the chocolate blocks and compare the appearance before and after heating.
DISCOVERING IDEAS (continued)

Stick a wooden match into a piece of clay or support it in some other way. Have the children describe its properties. After the match is well described, place the match in its support into a container such as an empty aluminum pan and ignite the head of the match. Have the children describe what happens. Also, have them describe the material as it appears after the burning has been completed. This is an example of a chemical change in which the nature of the material changes as a result of the interactions that take place.

Results
The shape and appearance of some objects and materials can be changed by force or by heating or burning. Force breaks glass, crumples paper and aluminum, and changes the shape of balloons. Burning alters the appearance and shape of wood. Heat melts butter and chocolate.

Materials and objects can be changed when a force or push is applied to them. They can be changed by heating and burning. The pictures on these two pages show examples of how objects and materials can be changed. Have the children decide which of the pictures show a force at work and which show a change in temperature. How is the original appearance and shape of the objects changed each time?

An interesting example of change takes place when popcorn is popped. Have the children describe the properties of popcorn. Then place some kernels along with some cooking oil in a pan. Put a lid on the pan and heat it on a hot plate. When the corn starts to pop, keep the pan moving so that the popcorn will not be burned. Before the children eat the popcorn, have them describe its properties and the changes that have taken place in it. (By the way, the popping of the corn is largely due to heating of the water in corn. When the water is changed to steam it expands and the kernel explodes.)
FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations

An interesting change takes place when eggs are heated. Carefully break open an egg and allow the contents to fall into a pan. Have the children describe the raw egg. Let them touch it to find out how it feels. Heat the pan on a hot plate and have the children observe and describe the changes that take place in the egg. When the egg has cooled, let the children touch it and compare how it feels and looks now with its texture and appearance before heating.

Materials
- Ice cubes
- Large Pyrex jars
- Water
- Hot plate

Conceptual Statements
1. Ice changes to water when it is heated.
2. Water goes into the air as water vapor when it is heated.

Objectives and Process Skills
1. Observe and describe how ice changes into water when it is heated.
2. Observe and describe how water changes into steam when it is heated.
3. Infer that the change in temperature changed the ice into water and the water into steam.

Procedure

Undertake these investigations as demonstrations. Have the children observe the liquid water and the ice before the heat is applied. Be sure that the children note how much water and ice there is. You might mark on the container the level of the water and ice.

Ask the children to describe the changes that they see taking place in the ice and water. What part of the ice cubes melt first? What happens to the ice as it becomes warmer? Is the water the same shape as the ice cube? Heat the water until it boils. Have the children describe the boiling. After the water has boiled for a while, turn the heat off. When the water has stopped boiling, is there as much water in the container as there was before?

Results

Ice melts and becomes water when it is heated. Water changes to water vapor when it is heated.
DISCOVERING IDEAS

Materials
hot plate     ice cube tray
2 pots       freezer
ice cubes    water

Conceptual Statements
1. Water condenses out of the air when the air is cooled.
2. Water changes to ice when it becomes very cold.

Objectives and Process Skills
1. Observe and describe what happens when the steam rising from boiling water is cooled when it comes in contact with a pan of ice cubes.
2. Infer that the change in temperature of the hot air had something to do with the appearance of water drops on the bottom of the pan of ice.
3. Observe and describe what happens when water is subjected to freezing temperature.
4. Infer that the change in temperature changed the water to ice.

Procedure
Do the demonstration that is shown. Support a shiny metal pan filled with ice above a pan of water that is being heated on a hot plate. A tea kettle can be used, and in this case, the pan should be supported above the spout. Have the children watch for drops of water forming on the pan. Watch to see how large the drops get. Sometimes the drops can be observed dropping off the pan. In a sense, this represents rain.

If possible, also have the children observe water as it freezes. What part of the water freezes first? Is the ice clear? (Usually water has air dissolved in it, and this makes the ice whitish in color rather than clear.) What changes take place in the water as it freezes?

DISCOVERING IDEAS (continued p. 83)

In places where it is very cold the water can be frozen by putting it outside the window. The children can then observe the freezing through the window.

Remove the water from the freezer or the window sill when it is partly frozen. Have the children observe the ice that has formed and note its appearance and location.

Results
Water drops will form on the bottom of the cold pan. When the air comes in contact with the cold pan, it is cooled. Cool air cannot hold as much water as warm air. The water vapor condenses out of the cool air and forms drops of water on the pan.

When water is subjected to freezing temperatures, it freezes and becomes ice.

SYNTHESIZING IDEAS

This is the culminating page of this section. It can be used as an appraisal device to check on the children's competency to describe and demonstrate some of the changes that take place in water as the temperature is changed.

Have the children describe and demonstrate how water can be made to go into the air; how ice can be changed to water; how water can be changed to ice; and how water vapor can be changed to water.

Have the children look for or give examples of changes they see in water or ice in the world around them. Discuss rain and snow (rain forms when warm air is cooled; this precipitation falls as snow when temperatures are low); what happens to puddles; what happens when snow melts; dew on grass and plants; drops of water on window panes, windshields, and cold drinks; and so on.
FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations
1. Other materials also change when they are subject to changes in temperature (melting of butter, stiffening of oil, etc.). Have the children find and give other examples of changes that take place as a result of changes in temperature.

2. Fill a shiny metal can with warm water. Why do no drops form on the outside of the can? The warm water does not cool the air around the can so no water vapor condenses.

APPLICATION OF THE IDEAS

Materials
ice
colored water
glass jar

Procedure
Have the children wipe a blackboard with a damp sponge. Ask them to note the color of the wet board. What happens as the water on the board evaporates? Where does the water go?

Put some ice cubes into some colored water in a clear glass jar. What forms on the outside of the jar? How can the children tell that the water drops on the outside of the jar were not formed by the water inside the jar? Where do the water drops come from?

Results
As the water on the board evaporates, the board returns to its original grayish color. It feels dry. The water goes into the air as water vapor.

Drops of water condense onto the jar from the cooled air around the jar. The children should realize that these drops were not formed by the water inside the jar because the water inside is colored and the drops are clear.

DISCOVERING IDEAS

Materials
2 sheets of glass
pan
string
glass jars

Conceptual Statements
Plants change as they grow.

Objectives and Process Skills
1. Observe and describe how plants change as they grow.
2. Infer that living things change as they grow.

Procedure
If possible, each child should have a chance to carry out this investigation. To do this, give each child a clear glass jar or drinking glass. Put a cylinder of paper towel in each jar. Push corn seeds down between the paper and the side of the jar. Put a little water in the bottom of the jar. The water will move up the paper and moisten the seeds.

To make the set up shown for the class, put a piece of paper towel on a glass plate. Arrange the corn seeds on the paper and cover it with the other piece of glass. Tie the glass together with string. Set up the plates in a pan so that one edge is immersed in water. The water will move up the paper and moisten the seeds.

Have the children observe and describe the changes that take place as the seeds sprout. They could make sketches of the seeds at various stages. When roots have developed, the seedlings can be planted in soil.

Results
The corn seeds will sprout. The stem grows up and the roots grow down. The roots develop root hairs. The stem develops leaves.
SYNTHESIZING IDEAS

In this section, the children learned that living things grow and change. Ask the children to describe the different stages in the life cycles of the three organisms pictured. If possible, observe a cat with kittens, a dog with puppies, mice or other small animals with young. Have the children note the characteristics of the babies and compare them with the adult animals. Over a period of several weeks, observe the young animals to see how they change.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations

1. Get some tadpoles from a pond or biological supply store. Put them in a large glass jar with sand or gravel and some water plants. Have the children watch to see how the tadpoles change.
   
   Tadpoles hatch from frog eggs. As they grow, hind legs develop. Then front legs and lungs develop and the shape of the mouth changes. The tail disappears. Adult frogs are amphibians; i.e., they live on land and in water, although they cannot breathe underwater. Tadpoles are water animals; they can breathe underwater.

2. Make some cuttings of ivy, pussy willow, coleus, or begonia plants. (Cut off a long piece of stem that has several leaves growing on it.) Put the cutting in a glass of water and cover the outside of the glass with black paper to encourage root development. Have the children observe the roots as they develop. When the roots are large enough to support the plant, plant it in a pot of soil.

DISCOVERING IDEAS

Materials

balls

Conceptual Statements

1. Objects can be moved from place to place.
2. An object has been moved when its position is changed relative to the objects around it.
3. A force is needed to move an object.
4. Objects fall toward the earth.

Objectives and Process Skills

1. Experiment to find out how a ball can be moved.
2. Observe and describe balls moving.
3. Infer that a force is needed to move a ball.
4. Observe that objects fall toward the earth.

Procedure

Take the children outside to experiment with the way balls can be made to move. If possible, they should use the variety of balls and toys shown. Ask them whether they are using a push or a pull to move the ball. (When a ball is thrown, a push is used. When it is whirled around at the end of a string or elastic band, a pull is used.) What happens when a ball is dropped? Ask the children to think of an explanation for this phenomenon. They should infer that a force is acting on the ball to make it move. The concept of gravity will be explored in the following investigation.

Supplement these experiences with other activities that involve pushes and pulls. The children can push and pull wagons, ride bicycles, roller skates, and so on. In each case, ask them what makes them or the objects move. How do they know that they or the objects have moved?

Results

A force is required to move an object. We know that an object has moved when its position is changed relative to the objects around it. When objects are dropped, they fall toward the earth.
DISCOVERING IDEAS

Materials
objects that can be dropped

Conceptual Statements
1. When an object is dropped, it falls toward the earth.
2. An object has been moved when its position is changed relative to the objects around it.

Objectives and Process Skills
1. Observe and describe what happens when an object is dropped.
2. Infer that a force acts on the object to move it.

Procedure
How do the children know that the nut dropped by the squirrel has moved? Which way did the nut fall? Let the children drop various objects. Which way do the objects move? What is needed to make an object move? Ask them if they are exerting a force when they drop an object. Are they pushing the object? Are they pulling the object? They should realize that they are not exerting a force to move the object so therefore the force must be exerted by something else. Lead them to the understanding that the earth is exerting the force. The pulling force of the earth is called gravity. Gravity pulls objects toward the center of the earth. Get a globe of the earth and tape paper dolls on it at the top, the sides, and the bottom. The feet of the dolls should in all cases be on the surface of the globe. Point out to the children that the pulling force of gravity keeps people and objects on the earth no matter where they are.

Results
The children know that the nut dropped by the squirrel moved because it has changed position relative to the squirrel, the tree, the children, and other objects around it. The nut was pulled to the ground by the force of gravity.
Which ice cube will change faster?

Color it.

Which ice cube will change faster?

Color it.
Follow-up Activity

Name

Which one changes water to ice?

Color it.

Where is ice changing to water?

Color the right one.
PART III  EARTH SCIENCE
LESSONS

Lesson 1  Weather and Seasons ..................................................
Lesson 2  Air ........................................................................
Lesson 3  Rocks .....................................................................
Lesson 4  Classifying Rocks ...........................................................
Lesson 5  Earth's Forces and Moving Objects ............................
Lesson 6  The Changing Earth ....................................................
Lesson 7  The Moon .................................................................
Lesson 1

Weather and Seasons

OBJECTIVES

- To establish a regular pattern of observing the weather to note how it is the same and different
- To participate in outdoor exploration activities
- To actively explore the local environment
- To perceive changes occurring in a familiar location
- To become aware of changes in daily activities due to seasonal transitions

The weather observation activities are introduced one at a time to the whole group of children to familiarize them with a basic skill or technique. For example, when the children are familiar with reading the thermometer, turn the activity over to the children to perform as part of a short daily routine in recording the weather.

The children can begin a daily routine with the informal reporting of outdoor conditions as they arrive at school. They can then gather together as a group before other class activities begin to assemble the weather information gathered by individual members. Appoint one child for the week to report the temperature, another to observe and report on wind activity, and another to look for weather clues at the window and make a simple drawing for the weather calendar. These “monitors” can gather the specific information for the use of the whole group in a short discussion guided by the teacher.

At the end of each week, review the number of days of sunny, cloudy, rainy, or snowy weather. Count the number of days in each temperature range. The days may all have been similar or they may show a wide difference with each day. At this time select monitors for the upcoming week.

The weather observation activities (class tree, weather hunts, field walks) and the seasonal posters or scrapbook are used on an intermittent basis. Repeat the activities several times in a season and then introduce them again as part of each new season. In this way, the class may compare the similarities and differences between the seasons.

An exploratory activity precedes the weather observation routines. Before these routines are even introduced, use the initial Exploratory Activity to record the children’s reactions and exploration. Look at how they approach the environment: by looking up, down, and around; by touching and feeling; by calling out observations and sharing their finds; observing from a distance; covering a wide area; or staying mainly in one spot.

When repeating the Exploratory Activity at the end of the unit, make the same kind of notes for each child as when you first began: specific actions, comments, and involvement of each child. You may not see changes in each child with each single activity, but wait until you compare your own notes on the children to see their development.

Look also at their own drawings of field walks or other outdoor activities and how they describe their pictures. They may be richer in thought and detail as the children learn more about ways of observing the outdoors. Keep a few drawings from early in your science activities to refer to at the end of the year, after many science experiences.

EXPLORATORY ACTIVITY

Materials:
None
(optional) soap for blowing bubbles

Procedure:
Take the children outside to “find the weather”, or gather together for a “weather hunt” before returning indoors from outside play.
Tell the children specific places to look to discover the state of the weather: look at the trees to find the wind; look for clouds in the sky; etc.
All stand in a sunny or open spot and tell how it feels: move to different open and sheltered spots and compare how they feel.
Other clues which may help the children to observe the weather conditions: what happens to loose hair in the wind? Do you feel different when the sun goes behind a cloud? Drop a handful of fallen leaves to the ground or toss them in the air to see what happens. Blow soap bubbles; see if they go up, down, or otherwise. Look at the type of clothing other people have on. See if the sun makes any shadows.

Note: Record children’s participation in the activity; how the children go about observing outdoor conditions. At the end of this season or of the weather unit, record their approach to observation again and see what kinds of changes have occurred with each child.
WEATHER AND SEASONS
Weather Observation Activity 1
Materials: None
Procedure:
"Weather hunts" are a simple, direct way of getting the children to observe their environment. When you go outside as a group, ask the children for specific information. Give them clues about where to look and what to look for to "find" the weather.
Tell them to look up at the sky and ask what they see. Are there clouds? Are they moving? Where is the sun? Feel the air; see if you can find ice or a puddle. Look at the people on the street; what are they wearing?
On days of inclement or severe weather, many of these clues can be observed by looking out the window.
On a daily basis, children will soon know what clues to observe for a description of weather conditions.

Weather Observation Activity 2
Materials: None
Procedure:
Take short walks to observe details of each season. In the same way as observing the weather, encourage the children to make statements about details by asking them specific questions.
Have the children look closely at bushes and trees: touch them; run fingers over the branches; feel the leaves. Run fingers through the grass. Ask the children what colors they see. Look for new plants or seedling trees.
What do you find on the ground: seeds, nuts, leaves, flowers? Have the children close their eyes and use their noses. Can they smell the grass, flowers, rain, dirt? Listen for noises of birds; squirrels. Stand in an open area and feel the sun. Move into a shaded area. Does it feel the same?
Touch the ground with an open hand in different places: concrete, asphalt, grass, pebbles or gravel, dirt. Does it feel the same?
Which way is harder? Color it.

Which way is harder? Color it.
DISCOVERING IDEAS

Materials
books  string  2 blocks of wood
pencils  table  sandpaper
mirror  oil

Conceptual Statements
1. Friction occurs when two objects rub against each other.
2. Friction can slow down and stop a moving object.
3. There is more friction between rough objects than between smooth objects.
4. Rough objects can be made smooth to decrease friction.
5. Some substances, such as oil, can be used to decrease friction between two objects.

Objectives and Process Skills
1. Observe and describe what happens when a book is pushed across a table.
2. Compare the force needed to pull three books across a table with the force needed to pull one book.
3. Infer that three books press harder on the table than one book.
4. Observe and describe what happens when pencils are placed under a book and the book is pulled.
5. Infer that the pencils made it easier to pull the book by decreasing friction between the book and the table surface.
6. Experiment to find out how friction can be decreased.

Procedure
Start a discussion about situations that involve friction. Why do door hinges squeak sometimes? Why are tools with moving parts, such as scissors, sometimes hard to work? Why are nuts and screws that have been in wood for a long time sometimes hard to work? Why is it hard to hold or turn things when your hands are soapy or oily? Why is it hard to walk on floors that have been freshly waxed? Why is it easy for a person to slide or skate on ice? Why is it so easy to move a sled across snow? Why is it easy for someone to slip when he steps on a banana peel or piece of fruit on the sidewalk? Have the children infer what makes it hard or easy for the objects or persons to move.

Try to get them to infer that there must be a special kind of force involved in these situations. When the force is present, it is hard for objects or persons to move, and moving things tend to stop moving. When the force is absent or reduced, it is easy for objects to move and hard for them to stop moving. When something is moving and slowing down, there must be a force pushing in the opposite direction of the moving object to slow it down. This force is friction.

Get a tube of powdered graphite, which is usually used to lubricate car locks and metal door catches. Try the graphite on a door latch that sticks. How does it affect friction?

Once the children understand the nature of friction, you might ask them to describe and discuss the types of friction they are familiar with. They may have used friction to stop a wagon. They might describe the use of rubber soles in their gym shoes. Another example they might give is their roller skates. The brakes on a bicycle or car are another example of using friction to stop a moving object. As the children give examples of how friction is produced by rubbing, ask them to demonstrate and explain their examples.

Results
Friction slows down and stops moving objects. The heavier an object is, the greater the friction between it and another object. Putting pencils or rollers under an object decreases friction between that object and the surface over which it is moving. Smoothing the surfaces of some objects and oiling others can decrease friction.
SYNTHESIZING IDEAS

As you cover more and more examples in class, the children will begin to realize that friction is a part of everyday life. It is both a helpful and a necessary part. Try to get them to imagine what life would be like without friction. How safe would it be to drive a car if there were no friction? Have the children make a list of the helpful effects of friction.

Once the children agree that friction can be helpful and necessary, it is time to ask if it is always good to have more friction. Is friction always helpful? Can it also be of no help? Can it ever be harmful? How can we cut down friction?

Develop the understanding that friction can be harmful. Ask the children what would happen to many machines at home if oil were not applied to them. In many cases the machines would be ruined. As the parts rub against each other, they get rougher and rougher, and there is more and more friction. The parts will begin to wear away. If there is too much friction, the whole machine might stop operating since there is not enough force to overcome friction. Rub some steel wool rapidly across a piece of metal. Have the children feel the metal. Develop the understanding that parts of machines can rub together and produce unwanted heat. If the parts become hot enough, a fire might start.

Some of the children may have been running in the gym, then slipped and fell, sliding across the floor and producing floor burns. The burns are the result of friction when their legs rubbed against the floor.

Discuss re-entry of spaceships into the atmosphere. The spaceships travel very fast and the friction of the air rubbing against the spaceship can produce heat. This can make the nose of the ship so hot it may burn up. To prevent this a protective plastic cone is put over the spaceship's nose. As a result the protective cone, rather than the ship, becomes hot and burns up, leaving the spaceship intact.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations
1. Get some cotton wool. Rub a piece of the wool over a smooth surface, such as a linoleum floor or table top. Rub a piece of wool over a rough surface, such as a rough wooden board. Which surface catches the most cotton wool? Why?
   The rougher the surface, the greater the friction will be, and the more cotton will rub off and catch on the surface.

2. If you strike a piece of steel sharply against some stone, you might notice some sparks. Rub the wheel of a cigarette lighter that has no fuel and note the sparks. The steel wheel rubs hard against the flint, which is a stone. Note that there is so much friction in this case that a great deal of heat, in the form of sparks, is produced.

3. Have some of the children bring roller skates to class. Let the children go outside. Have the children with roller skates skate quite rapidly, and let everyone feel the wheels on the skates. The wheels will feel quite hot from the friction between the wheels and the pavement.
   Place a roller skate on its side, slip a loop of string around the skate, and pull the skate along the floor. Feel the force of friction. Now place the skate upright so it is resting on its wheels and repeat the experiment.

4. Make a crayon mark on a metal pan and try to rub the mark off with a smooth cloth. Let the children examine some scouring powder. How does it feel? Does it feel scratchy? What is it used for? Pour some scouring powder on the smooth cloth which has been dampened. Try to rub the crayon mark off how. Point out that you get more friction with the rough scouring powder than with the smooth cloth.
Which ball will roll farther?

Color that picture.

Which box is harder to slide?

Color that picture.
Which one is for sliding? Color it.

Which wagon is stopping? Color it.
DISCOVERING IDEAS

Materials
toy truck board

Conceptual Statements
1. Gravity is a force.
2. Gravity pulls everything on earth toward the center of the earth.
3. Gravity can make objects move or stop moving.

Objectives and Process Skills
1. Observe and describe what happens when a toy truck is pushed up a slanted board.
2. Infer that some force made the truck stop moving up the board and move in the opposite direction.
3. Observe and describe what happens when a toy truck is placed at the top of a slanted board.
4. Infer that some force made the truck move down the board.

Procedure
Have the children carry out the investigation as described.

This is a good time to let the children discover that the weight of an object is a measure of the earth's pull of gravity on that object. Get a large, strong rubber band and suspend one end from a hook. Make a mark at the bottom of the band. Tie a string around a wood block and attach the string to the other end of the rubber band. Note how the rubber band stretches, and let the children make a mark at the bottom of the rubber band. Now get a second identical block, tie both blocks together and attach them to the rubber band. Note how much more the rubber band is stretched. Make a mark at the bottom of the rubber band again. When you compare the distances from the bottom of the free rubber band to the bottom where the blocks are attached to the band, you will find that the distance was twice as far for the two blocks as for the one block. The earth's pull of gravity was twice as great for the two blocks as for the single block. Since both blocks are identical, the two blocks are twice as heavy as the single block and weigh twice as much.

You can show the weight is double by repeating the experiment, this time using a spring balance with a hook on it. Have the children examine how much the spring stretches when one block, then two blocks, are suspended from the balance. Let them compare the weights (in ounces) of one block, then two blocks. Now ask each child how much he weighs, using this special form of question, "How many pounds of force does earth's gravity pull on you?"

Results
Gravity affects the movement of the truck. Gravity and friction acting together stop the truck on the floor. The force of gravity makes the truck stop moving up the board. Gravity pulls the truck down the board when it is placed at the top.

SYNTHESIZING IDEAS

From a discussion of gravity go on to the forces that can be exerted by moving air (wind) and moving water. Develop the understanding that all moving objects have energy, and this energy is capable of exerting a force that can make stationary objects move. Have the children look for evidence of objects being moved by the wind. What makes the clouds move? Discuss the effect of the wind's force on objects during a moderately windy day, a very windy day, and a very stormy day. Show pictures of the action of tornadoes and hurricanes on trees and homes.

Read the story of Isaac Newton, the scientist, and how he discovered gravity when he saw an apple drop from a tree. This story can be found in encyclopedias and in children's books on gravity. Newton knew that a force
is needed to make things move and he realized that there must be a force pulling on the apple. He found out how the earth pulls on apples and on every other object on earth. He called this pull the pull of gravity.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations


   The book stops falling because it hits the floor, which exerts a force on the book and makes it stop. The toy car will stop moving when it runs on to a flat surface and gravity and friction act on it to stop it. It might keep moving until it hits a wall or other surface that exerts a force to stop the car.

2. Ride a bicycle. Start, go faster, go slower, turn, and stop. What forces were used each time? Is a force needed to make moving objects turn?

   A force is needed to start the bicycle, make it go faster or slower, and to make it turn. If a force were not used to turn the bicycle, it would continue to move in a straight line.

3. Put a small toy car on a table. Try to make the car move without touching it. If you blow on the car or tilt the table, are you making the car move without pushing or pulling? Can you make the car move without using force?

   It is impossible to make the car move without using force. Blowing air pushes the car. Tilting the table is the same as pushing the table against the car. The force of the push makes the car move. Gravity also pulls the car down the slope toward the center of the earth.

APPLICATION OF THE IDEAS

Materials
pencil    large rock
small rock    string

Procedure

These investigations are simple explorations of the effect of gravity on objects. Remind the children that gravity exerts a force on an object proportional to the object's mass. This is demonstrated by the two rocks. The larger rock feels heavier and is harder to lift because gravity is pulling on it with more force than on the smaller rock. Sometimes a small object can have more mass than a larger object. Repeat this experiment with a small piece of lead or iron and a larger but lighter object such as a rubber ball or a block of wood. Ask the children why the smaller object is harder to lift. (It has more mass than the larger object so gravity exerts more pull on it.)

Results

When dropped, the pencil falls to the ground because of the pull of gravity. The larger rock is harder to lift because its mass is greater than the small rock and therefore gravity pulls on it with more force. Two forces acted on the rocks: the child's muscles pulled the rocks up and gravity pulled them down.
Follow-up Activity

Name _______________________

Which way does gravity pull?

Color that one.
Which ones are pushing against gravity?

Color them.
Which ones are using more force? Color them.
The Changing Earth

AN OVERVIEW
How is land built up?
How is the surface of the earth changed?
How do people change the earth’s surface?

BASIC CONCEPTS
1. Events on the earth are characterized by change.
2. Events on the earth can be observed and explained.
3. Developments in science and technology bring about changes in the natural environment.

SCIENCE BACKGROUND
The earth’s crust or surface is made up of layers of rock. These layers vary in thickness from 3 to 20 miles under the ocean beds to 20 to 40 miles under the continents. Although the earth’s surface appears to be solid and permanent, it is always changing. These changes are generally too slow for us to see, but sometimes they can be very dramatic, as when volcanoes form and earthquakes occur. Since the earth’s beginning, mountain ranges have been built up and worn down, glaciers have come and gone, and oceans have covered the land and receded. All these occurrences have left their marks on the earth’s surface. By studying the rocks of the earth, geologists can learn its history.

Forces inside the earth help build up the crust of the earth. Great masses of rock are forced up to form mountains. Mountains are of four different types, depending on whether the masses of rock were folded, tilted, shaped into domes, or built up from volcanic materials. Earthquakes occur when layers of rock slip suddenly along a crack or fault in the rock layers of the earth’s surface. Volcanoes are formed when molten rock, called magma, erupts through cracks or weak spots in the earth’s surface. When the magma pours out of volcanoes, it is called lava. The material inside the earth is no longer believed to be molten. Geologists believe that the rock material under the earth’s surface is kept from melting by the great pressure exerted on it by the weight of the rock above it. They believe that the material is thus kept in a semiplastic condition. When pressure is released by cracks or weak spots in the earth’s crust, the hot semiplastic material becomes molten and is forced up through the earth’s crust. When it cools, it forms minerals and igneous rocks.

The process of breaking down the rocks of the earth’s surface is called weathering. Running water, freezing water, changes in temperature, wind, glaciers, plants, and animals can cause weathering. Carbon dioxide gas in the air dissolves in water to form carbonic acid, which breaks up limestone. Lichens growing on rocks give off an acid that crumbles the rocks.

Erosion moves soil and the products of weathering from place to place. The chief forces of erosion are water, wind, and ice. Water falling in mountains helps break up rocks there. Pieces of rock and soil are carried by the water into streams. The streams join into rivers that eventually run into the sea. The streams and rivers carry rocks and soil along with them. If the water is moving with enough force, it can carry large boulders. The rocks rub against the sides and bottom of the streams and river beds, wearing them away and freeing more material to be carried to the sea. In time, this erosion of the stream and river beds cuts valleys and canyons in the surrounding rock. The Grand Canyon is an example of this kind of erosion. The streams and rivers slow down as they reach the sea. The soil and rocks can be deposited as deltas or in the ocean beds. This helps build up the land.

This movement of materials from place to place upsets the balance of pressures on the earth’s surface. When pressures are increased by added weight, earthquakes can occur in surrounding areas.

Oceans both erode and build up the earth’s surface. Slow moving glaciers and wind move soil and rocks from place to place.

Soil erosion can be prevented by contour plowing, terracing, strip cropping, planting of ground cover and shelter belts of trees. People can cause and prevent erosion. Irrigation of dry areas allows plants to grow, thus preventing wind erosion of those areas. Overgrazing or badly planned farming can leave land open to erosion by removing the ground cover, in the first case, and by rendering the soil unsuitable for growing plants, in the second. Strip mining and clear cutting by lumbermen leaves the soil open to erosion. Good planning and thoughtful use of the soil ensures that future generations will inherit fertile, productive land, and not a desert.

MATERIALS FOR THE UNIT
bags, plastic
balance, platform
blocks, wooden
box, cardboard
burner, Bunsen
cans, large
clay, modeling,
    various colors
fan, electric
freezer
grass
gravel or pebbles
hammer
hot plate
ice cubes
jars, glass, various
sizes with caps
marbles
oil or vaseline
pail
pans, aluminum, various sizes paper, wax paper, white pin plaster of Paris rocks, soft and hard sand sandpaper sandstone scissors seeds, bean seedlings, bean soil spoon tongs towel, paper toothpaste, full tube watch or clock water wrap, plastic

**FOR ENRICHMENT**

**Books for the Teacher**

**Books for the Children**

**FOR ENRICHMENT**


**Films**

*Erosion: Leveling the Land* (Encyclopedia Britannica Films) 14 min. b&w. c. Shows the surface pressures of weathering, erosion, and deposition of the eroded material.

*The Earth in Change: The Earth's Crust* (Encyclopedia Britannica Films) 16 min. b&w. Shows how the earth's crust is constantly being changed by the action of forces inside and outside the Earth.

*The Meaning of Conservation* (Coronet) 11 min: b&w. c. Shows man's efforts in conservation by building dams for flood control, planting trees, and developing new farming methods.

*Understanding Our Earth: How the Earth's Surface Changes* (Coronet) 11 min. b&w. c. Explains the manner in which the earth's surface has developed and changed over the centuries, and how these changes occurred.

*Understanding Our Earth: Soil* (Coronet) 11 min. b&w. c. Shows how soil is formed, its composition, and the kinds of soil found in various parts of the country.

**Films**

*Changing the Face of the Earth* (Society for Visual Education) 41 fr. si. c. Shows the constant struggle between land-building and land-eroding forces.

*Mountains* (Society for Visual Education) 46 fr. si. c. Shows how mountains are formed, how they appear and disappear, and how they reveal the history of the earth.

*Rivers of Water and Ice* (Society for Visual Education) 43 fr. si. c. Shows how rivers start, how waterfalls are formed, and the effects of water erosion on the earth.

*The Soil* (Eye Gate House) 66 fr. si. b&w. Shows how soil is made, points out its importance, and shows how soil erosion can be prevented.


*Volcanoes and Earthquakes* (Society for Visual Education) 40 fr. si. c. Describes volcanoes, lava, hot springs and other volcanic phenomena. Shows how earthquakes are formed and detected.

*Wind and Waves* (Society for Visual Education) 42 fr. si. c. Describes the action of wind in carving rocks and forming dunes. Shows how waves shape coastlines and beaches.
DISCOVERING IDEAS

Materials
3 or 4 colors of modeling clay

Conceptual Statements
Tremendous sideward forces, caused by great temperature and pressure in the earth, cause horizontal layers of rock on the earth’s surface to fold.

Objectives and Process Skills
1. Experiment with clay and pressure to show the effects of pressure on the layers of clay.
2. Observe what happens when the clay layers are pushed from each end at the same time.
3. Describe the appearance of the clay layers after pushing.
4. Infer that the pushes, or pressure, on each end of the clay layers made the layers fold.
5. Compare the appearance of the clay with the folded rocks in the photo.
6. Infer that pressure is needed to make rock layers fold.

Procedure
The layers of clay represent layers of horizontal rock. A child puts one hand at each end of the layers of clay and pushes in toward the middle. This pushing represents the pressures inside the earth that act on layers of rock. After the layers of clay have been pushed inward toward the middle, have the children look at the picture of folded rock layers and compare their formation with that of the clay. Note that the folding may produce a whole range of mountains.

Results
The pressure of the children’s hands on each end of the clay layers will cause the clay layers to fold. If the layers are thick enough, the clay may crack as the children keep pressing on the ends. This will show how some faults are formed when rock layers are folded under pressure.

Materials
none

Conceptual Statements
Pressure makes rock layers slip along a fault.

Processes
1. Observe and describe what happens when the knuckles are pressed together and sideward.
2. Infer that pressure made the knuckles slip past each other.
3. Infer that pressure would make rocks slip and move along a fault.

Procedure
Ask the children if they have ever felt the ground underneath them shake, especially when a large truck or a train passed by. The moving wheels made the ground vibrate, and these vibrations spread out in all directions. The vibrations were strongest at the point of origin, but became weaker as they spread out. Relate this on a much larger scale to the vibrations produced by an earthquake.

Have the children carry out the experiment as described in the text. As the knuckles interlock, compare them with layers of rock pushing against each other along a fault in opposite directions. When enough pressure builds up in the crust of the earth, the sides of the layers along the fault suddenly slip past each other, causing an earthquake. If you push one fist higher than the other, still keeping the knuckles interlocked, the children will see how fault mountains may be formed.

Results
The children’s interlocked knuckles will slip past each other as they press their hands in opposite directions. This demonstrates how rock layers, under pressure, slip and move along a fault.
DISCOVERING IDEAS

Materials
full toothpaste tube      pin

Conceptual Statements
1. The hot semi-liquid material under the earth's surface is under great pressure.
2. When the pressure is released by a crack or weak spot in the surface, the material becomes liquid and breaks through the surface, forming a volcano.

Objectives and Process Skills
1. Observe and describe what happens when pressure is applied to a full toothpaste tube with a pin hole in it.
2. Infer that pressure forces the toothpaste through the pin hole in the tube.
3. Infer that pressure forces lava out of the earth, thus forming a volcano.

Procedure
Have the children observe the volcano in the picture. The opening at the top of the volcano is called the crater. Point out that, contrary to popular opinion, lava does not usually come out from the crater, but is more likely to emerge from cracks in the sides of the volcano or even at the base. Also point out that scientists call the hot material below the earth's surface magma, but then call it lava after it has become liquid and broken through the surface.

Help the children classify volcanoes as (1) active volcanoes, which are erupting or have recently erupted, (2) extinct volcanoes, which have not erupted for a long time and have no sign of activity, and (3) dormant volcanoes, which have not erupted for some time but still show signs of some activity.

Results
Pressure on the toothpaste tube makes the toothpaste squeeze out of the tube. Pressure makes hot liquid rock squeeze out of the earth through cracks and weak spots, thus forming a volcano.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations
1. Have the children look for layers of rock in the side of a cliff, a quarry, or along the side of a road cut through a hill. Are the layers folded? Are there any cracks in the layers?

Rock layers can easily be seen on sides of cliffs and quarries, and also when roads have been freshly cut through a hill. If there is any folding, it will not be as pronounced as those in the picture. Be sure to look for vertical cracks in the layers, even if they are small or narrow. They will help the children understand faulting later on.

2. Show that there are really two kinds of fault mountains. One kind is formed when there is a single fault between rock layers and one layer is pushed up higher than the other along the fault. Sometimes there are two faults in the rock layers, and only the section of rock layers between the two faults is pushed up, while the rock layers on each side remain at the same lower level. A mountain formed this way is called a block mountain.

3. Have children read and report on how earthquakes can be detected and located by a seismograph.

When an earthquake occurs, it produces vibrations that travel as waves through much of the earth. The seismograph detects and records these vibrations as wavy lines. By looking at these wavy lines scientists can tell when the earthquake started and how long it lasted. By comparing their information with the
information recorded by scientists at other places on earth, they can also find out where the earthquake took place.

4. Point out that there are three main types of volcanoes. Shield volcanoes, like Mauna Loa and Kilauea in Hawaii, are usually formed from quiet eruptions. The lava spreads out to form a broad base and gentle slopes. Cinder cone volcanoes, like Paricutin in Mexico, are usually formed from explosive eruptions. They have a fairly narrow base and steep slopes. Composite volcanoes, like Fujiyama in Japan and Rainier in the United States, are usually formed from eruptions that have had alternate quiet and explosive periods. Consequently, they have alternate layers of lava and ashes or cinders, which are steeper than shield volcanoes but gentler than cinder cone volcanoes. Some volcanoes do not build mountains at all, but pile flows of lava one on top of the other to form plateaus. Central Oregon and adjacent portions of Washington, Idaho, and California are all part of a lava plateau. Similar ones can be found in Argentina, India, and Iceland.

5. Explain how dome mountains are formed.
Sometimes the hot melted rock pushes up toward the earth's surface without bursting through. It pushes up the layers of rock to form what is called a dome mountain. The Henry Mountains in Utah, the Black Hills in South Dakota, and the Adirondack Mountains in New York are dome mountains.

6. Describe the life history of mountains as they pass from youth to maturity to old age.
During their youth, mountains are high and rugged, with steep slopes, rushing streams, and narrow valleys. Many of them have snow on their tops all the time. At maturity the action of water, ice, and wind wear away the mountains, lowering their peaks and making the slopes more gentle. Sometimes trees grow to the top of the mountains. The streams flow more slowly and the valleys become much wider. At old age the mountains have been worn down until they are almost level.

Materials
platform balance
2 small pans of soil and pebbles
same size
spoon

Procedure
Put water in one pan and pebbles and soil in the other. Put the pans on each side of the platform balance. Balance the pans evenly by removing or adding water or soil and pebbles to the respective pans. The pebbles and soil represent the earth's land surface. The water represents the ocean. When the pans are evenly balanced, have a child remove a spoonful of soil and pebbles from the pan and put it in the pan of water. Relate this to the fact that rivers carry soil and rocks to the ocean.

Greater weight causes greater pressure. This change in pressure is graphically demonstrated by the way the platform balance moves as soon as the spoonful of soil and pebbles is taken from the pan. When the spoonful of soil and pebbles is put in the water, the pan of water presses downward with even greater force. Accumulation of rocks and soil washed into the oceans by rivers can change the balance of the earth's surface this way.

Results
The balance between the two pans on the platform balance will be upset, demonstrating how pressure changes when materials are moved from one place to another.

In “Whither the Weather,” an article that appeared in Science Activities magazine, February 1970, Barbara Ford noted that:

In Denver, chemical wastes pumped into an underground reservoir between 1962 and 1966 apparently led to a series of quakes in an area where few, if any, seismic disturbances had been recorded in the previous 70 years. The three biggest quakes caused slight damage in Denver.
Materials
soft rock (sandstone or limestone)
hard rock (granite or basalt)

2 sheets white paper
sandpaper
small cake pan

Conceptual Statements
Wind often carries soil or sand with it. When it blows the soil or sand against a rock, it can wear away the rock.

Objectives and Process Skills
1. Observe and describe what happens when sandpaper is rubbed over hard and soft rocks.
2. Infer that hard rocks do not wear away as quickly as soft rocks.
3. Infer that rocks on the earth's surface might also be abraded.
4. Observe and describe how the wind created by the fan picks up and blows soil.
5. Infer that wind carrying soil or sand might abrade rocks on the earth's surface.

Procedure
If you are doing the investigation with the fan and the soil in the classroom, put newspapers on the floor. Be sure the fan is close enough to the soil to blow it away. Use dry soil or dry sandy soil for best effects.

Results
The sandpaper will wear away more of the soft rock than the hard rock. The hard rock may not be worn away at all. The soft parts of a rock wear away before the hard parts, which is why some wind-eroded rocks have odd shapes.

The fan blows the soil out of the pan and some distance away, depending on the strength of the fan and its proximity to the soil and on the type of soil used.

DISCOVERING IDEAS
Materials
shale, slate, or granite rock
gas flame (Bunsen burner)
cold water

Conceptual Statements
Changes in temperature can break up rocks.

Objectives and Process Skills
1. Observe and describe what happens to a heated rock dropped in cold water.
2. Compare the appearance of the rock before it is heated and dropped in cold water with its appearance after it has been heated and dropped in the water.
3. Infer that a sudden change in temperature can break a rock.
4. Infer that rocks on the earth's surface can also be broken up by changes in temperature.
5. Infer that the cracks in roads and sidewalks could have been caused by changes in temperature.

Procedure
For this experiment any coarse-grained porous rock will do. Even sandstone or commonly found conglomerate (which consists of pebbles and cemented sand grains) can be used. The important thing is to get the rock as hot as possible. Consequently, do not use a hot plate or a candle flame. If you use an alcohol lamp, keep the rock in the flame for a long time.

Let the children examine the rock before you heat it. How does it look?

Results
When the heated rock is plunged into cold water, the sudden contraction of the cooled rock will cause bits of rock to break or flake off and drop to the bottom. Look for small pieces of rock in the bottom of the jar. Lift out the rock with the tongs to examine it. How does it look now?
Activity

Materials
sandstone hammer
bowl of water jar with cap
plastic bag water
freezer timer (watch or clock)
soft rock (shale, sandstone, limestone)

Conceptual Statements
Water can erode rocks in two ways: (1) by getting into cracks in rocks and freezing, thus expanding and breaking the rock; (2) rivers carry rocks and rub them against each other, thus wearing them down.

Objectives and Process Skills
1. Observe and describe the sandstone before it is put in the water, after it is put in the water, after the water has frozen, and after the ice has melted.
2. Compare the appearance of the rock before the experiment with its appearance after the experiment has been completed.
3. Infer that the freezing water cracked the rock.
4. Observe and describe the pieces of rock after breaking with the hammer.
5. Observe and describe the pieces of broken rock after shaking them in the jar of water.
6. Compare the appearance of the pieces of rock after shaking with their appearance before shaking.
7. Infer that the pieces of broken rock rubbed against and wore away each other when the jar was shaken.

Procedure and Results
The porous sandstone will absorb water overnight. When the water in the rock freezes, it expands and cracks the rock. This will show up most clearly when the ice has melted.

After being shaken in the jar of water for 15 minutes, the pieces of soft rock will have smoother edges than they had before. When they were shaken, the pieces of rock rubbed against and wore away each other.
AN OVERVIEW
How do objects fall?
How is the moon an earth satellite?
What is the earth-moon-sun system?

BASIC CONCEPTS
1. The properties (time, position in space, motion, etc.) of objects can be viewed from several frames of reference.
2. Events in the natural environment are characterized by universality.
3. Events in the natural environment can be observed, measured, and explained.

SCIENCE BACKGROUND
The moon and other orbiting earth satellites can be considered to fall around the earth. As a consequence, anyone in an orbiting earth satellite has the sensation of falling.

Near the earth, an object tends to fall toward the center of the earth when dropped. However, if the object is given a forward push, it will tend to fall in a curved path. Theoretically, if an object were given a strong enough push, it would fall around the earth. In the text, the famous analogy of the cannonball being fired from the top of a mountain is used to explain this concept. With the help of powerful rocket engines, that can give an object a very strong forward push, we are able to put artificial earth satellites into orbit around the earth.

The moon is the earth’s only natural satellite. We see the moon because it reflects sunlight to us. Actually, about half of the moon’s surface is always in sunlight. Because the moon revolves around the earth, the amount of the illuminated part that we see changes. We see these changes as phases of the moon. The classic demonstration of the phases of the moon is presented in the text. The children should be able to see "phases of the ball" as it is carried around them.

Since the moon revolves around the earth, the moon sometimes comes between the sun and the earth. When this happens, the shadow of the moon falls upon the earth and this is seen on earth as an eclipse of the sun. At other times the earth is between the sun and the moon, and the shadow of the earth is seen on the moon. This is seen on earth as an eclipse of the moon.

The gravitational attraction between the moon and the earth causes tides in the larger oceans. Newton explained the production of tides as an effect of the difference in the gravitational attraction of the moon for the solid earth and its ocean waters. The ocean waters on the side of the earth facing the moon are nearest the moon and are therefore attracted most strongly. The waters on the far side of the earth, 8,000 miles farther away, are attracted least. The solid earth is attracted at its center of gravity, which is halfway between the two halves of the ocean.

According to Newton the moon attracts the ocean waters on the near side more strongly than it attracts the solid earth, causing the waters to bulge under the moon in a "high tide." On the far side of the earth the moon's attraction for the waters is less than for the solid earth. Here the waters bulge away from the surface in an indirect or opposite high tide. Halfway between the high-tide points, two areas of low tide are formed by the withdrawal of water to the high-tide locations.

It is important to capitalize on the topical interest of this unit. You may wish to plan to teach the unit when some space venture is scheduled. It would be advantageous to have the children watch television programs dealing with space, visit exhibits at local museums or planetariums, and view some of the excellent films available.

The study of earth satellites involves some concepts that are relatively foreign to our experiences here on earth. Sometimes, however, children seem better able to comprehend these concepts than adults. Throughout the text liberal use has been made of analogies that help children relate strange new concepts to more familiar ideas.

It is important to involve the children in experiments and demonstrations. While many activities are described in the text, additional suggestions are provided in the Column Guide.

MATERIALS FOR THE UNIT
ball, shiny mirror
balls, rubber paper
binoculars or small pencil
  telescope
  pillow, soft
  rocket, water
  rubber band
  scissors
  tape
  weight
  (metal washer)

FOR ENRICHMENT
Books for the Teacher

Books for the Children


Films
*Rockets and Satellites* (United World Films) 13½ min. b&w. c. Historical account of man’s conquest of the sky. Demonstrates in elementary terms concepts underlying rocketry.
*Man in Space* (Encyclopedia Britannica Films) 35 min. b&w. c. Traces rocket development from ancient Chinese weapons to modern missiles.
*Earth Satellites—Explorers of Outer Space* (Encyclopedia Britannica Films) 17 min. b&w. c. Illustrates principles on which satellites operate. Discusses how we use them to study the earth and the universe.

- *First Men into Space* (Encyclopedia Britannica Films) 16 min. b&w. c. Deals with some of the problems involved in surviving in space.
- *Action and Reaction* (Film Associates) 13 min. c. The basic principle on which rocket engines are based.

Filmstrips
*The Changing Moon* (Jam Handy) 69 fr. si. b&w. The changes that we see taking place in the moon as we observe it throughout a month.
*Conditions in Space* (Jam Handy) 45 fr. si. c. On the conditions in space where the earth satellites orbit.
*The Moon* (McGraw-Hill Text Films) 42 fr. si. c. Presents the physical aspects of the moon, its motions, phases, and eclipses.

Visual Aids
Moon Orbit Demonstration Program. 16-inch globe kit, $65. 12-inch globe kit, $45. Denoyer-Geppert Co., 5325 Ravenswood Ave., Chicago, Illinois 60640
DISCOVERING IDEAS

Materials
- mirror
- paper
- flashlight
- pencil

Conceptual Statements
1. We can see the moon because it reflects sunlight to us.
2. The apparent shape of the moon changes during the month.

Objectives and Process Skills
1. Observe and describe what happens when no light shines on a mirror in a dark classroom.
2. Observe and describe what happens when a flashlight beam shines on a mirror in a dark classroom.
3. Infer that the mirror reflects light from the flashlight to your eyes.
4. Infer that the moon reflects light from the sun to your eyes.
5. Observe and describe how the moon's shape appears to change over a month.
6. Record the apparent changes in the shape of the moon over a month.

Procedure
In the first investigation have the student holding the mirror turn the mirror in different directions so that all the children see the light reflected by the mirror.

For the second investigation, ask the children when they cannot see the moon. (during the new moon phase).

Results
If there is no light in the classroom the children cannot see the mirror. When light from the flashlight is shined on the mirror, the mirror reflects light to the children's eyes.

When observing the moon for a month the children will record the different phases of the moon. (See illustration page 81.)

Conceptual Statements
1. The moon is an earth satellite.
2. Apparent changes in the shape of the moon are caused by the moon moving around the earth.
3. The part of the moon you can see is the part that is in sunlight.
4. You cannot see the moon when it is between the earth and the sun.

Objectives and Process Skills
1. Observe and describe how much of the lighted part of the ball is seen as the ball is moved around the children representing earth.
2. Observe and describe how much of the lighted part of the ball can be seen when the ball is between the children and the light.
3. Compare how much of the lighted part of the ball can be seen when the ball is at various places around the children.

Procedure
On pages 78-79 the classic investigation of the phases of the moon is described. It is important that all the children take part in this investigation and that they relate the observations that they have made to the apparent changes in shape of the moon during the month.

The demonstration will be most effective if the classroom can be darkened. A shiny ball painted with aluminum paint works very well for this demonstration. Place a projector or other source of light at one end of the room. Have a child stand at the other end of the room and hold the shiny ball in his outstretched hand. A white volleyball can also be used for
SYNTHESIZING IDEAS

Many children think that the moon actually gives off light, like the sun. Through a discussion, introduce the concept of reflection. How do we see objects in our environment? Actually, we see most of the objects in our environment because they reflect light to our eyes. The moon may be considered an object in our environment, and we see it because it reflects sunlight to our eyes. The investigations involving reflection, including the investigation of the phases of the moon, make the point that objects can be seen even though they do not give off light by themselves.

You may wish to repeat the demonstration of the phases of the moon given on pages 78 and 79. Have someone stand near the projector and have him note how much of the ball is illuminated as it is being carried around the children representing the positions of the earth. Half the moon is always in sunlight. An observer near the sun will always see a “full moon.” However, on earth the same observer cannot always see all of the illuminated half of the moon.

Introduce the concept of phases of the moon. Phases of the moon are the different shapes that the moon appears to take during the course of a month.

Note that there is a time during the month when the moon is between the sun and earth. At that time, we cannot see the moon because we can see no part of the illuminated half of the moon. This phase is called the new moon. Soon after the new moon we can see a very thin sliver of light in the western sky soon after sundown. Have the children look for this phase of the moon following new moon.

this demonstration, although a ball painted with aluminum paint will be more effective.

Have the two or three children representing the earth stand at the end of the room opposite the light. Have the student holding the ball carry the ball around these three children. The child carrying the ball should stop at various points in his orbit around the three children so that they can describe the apparent shape of the lighted part of the ball. It may be necessary to have someone manipulate the projector so that the light continues to shine on the ball as it is carried around the three children.

Repeat the demonstration so that all of the children have a chance to see the lighted ball and how the shape of the lighted part of the ball changes as it is carried around them.

The children who have the ball carried around them represent the earth. The projector, of course, simulates the sun. The ball simulates the moon.

Have the child carrying the ball stop at four places in his journey around the children. Have the children describe how much of the ball is illuminated at each of these positions. For example, how much of the ball is illuminated when it is on the opposite side from the projector? How much is illuminated when the ball is between them and the projector?

Relate their observations of the lighted ball to their observations of the changing shape of the moon. Do they see any relationships?

Results

The children will observe that the shape of the moon does not change. Rather, the moon’s phases are a result of the different amounts of the moon’s lighted surface that can be seen as it revolves around the earth. When the moon is between the sun and the earth, the lighted part is not visible on earth. This is the new moon. When the earth is between the moon and the sun, all of the lighted part is visible on earth. This is full moon.
Activities

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations.

1. There have been many romantic notions about the moon throughout the ages. The dark areas of the moon, the mares, were at one time actually thought to be seas. The "man in the moon" has been seen and talked about for millennia. You may wish to have some of the children research these and other folk myths about the moon.

2. Have the children try to find out about the names and number of satellites that revolve around other planets in our solar system. (See some of the books listed in this Teacher's Guide.) From an almanac or such journals as Natural History, find out when and where the planet Jupiter can be observed. With a small telescope, or binoculars, some of Jupiter's moons can be seen as white dots near the planet.

3. The moon often appears to change color during the night. Have the children observe the full moon as it rises. Often, it is reddish-orange in color. This is because moonlight has to pass through more of the earth's atmosphere when the moon is near the horizon than when it is more nearly overhead and only reddish light can penetrate. Pollutants in the air also help to screen out all but the reddish light. Have them observe the moon again, just before going to bed. At that time the light of the full moon will probably be much whiter in color. When the moon is higher in the sky the moonlight passes through less of the atmosphere and less light is screened out.

FOR INDIVIDUALIZATION  (continued)

4. In order to demonstrate how craters are formed you may wish to have some children perform this activity. Fill a pie plate or other flat container with loose sand. Then, have children drop marbles into the sand. What happens when the marbles strike the sand? What happens to the sand that was in the hole? Some of the sand is compressed in the hole, while some is flung out. Wet the sand slightly. Now, have the children again drop marbles into the sand. What happens to the sand?
Materials
bright light
ball
globe

Conceptual Statements
1. An eclipse of the sun takes place when the moon is between the sun and the earth.
2. When the moon is between the sun and the earth, part of the earth is in the shadow of the moon.

Objectives and Process Skills
1. Formulate a model of an eclipse of the sun.
2. Observe and describe what happens when a ball is moved between a light and a globe.
3. Infer that during a solar eclipse, the moon passes between the sun and the earth, thus eclipsing the sun.

Procedure
To simulate a solar eclipse move the ball between the projector and the globe so that a shadow of the ball falls on part of the globe. Have the children describe what they see on the globe. How much of the globe is covered by the shadow? You may wish to point out that only a small part of the earth’s surface is in the shadow of the moon during the eclipse of the sun.

Spin the globe. As the globe spins the shadow of the ball appears to move across the surface of the globe. Similarly, the spin of the earth makes the shadow of the moon seem to move across the surface of the earth.

Results
When the ball is moved between the globe and the bright light, the ball casts a shadow on the globe. An individual standing on the side of the globe facing the ball would see the ball eclipse the bright light.

DISCOVERING IDEAS

Materials
bright light
ball
globe

Conceptual Statements
1. An eclipse of the moon takes place when the earth is between the sun and the moon.
2. When the earth is between the sun and the moon, the moon is in the shadow of the earth.

Objectives and Process Skills
1. Formulate a model of a lunar eclipse.
2. Observe and describe what happens when a ball is moved so that a globe is between the ball and a light.
3. Infer that during a lunar eclipse, the earth is between the sun and the moon, thus eclipsing the moon.

Procedure
To simulate a lunar eclipse hold the ball behind the globe so that the ball is in the shadow of the globe. Ask the children to make believe that they are on the surface of the globe. How would the ball appear from a point on the globe?

If the ball is moved slowly into the shadow of the globe, it may be possible to see the curved edge of the shadow of the globe. This simulates the curved edge of the earth’s shadow as it moves across the moon.

Results
When the ball is moved so that the globe is between the ball and the light, the globe casts a shadow on the ball. An individual on the globe would see the shadow of the globe falling upon the ball, eclipsing it.
BIBLIOGRAPHY


ARTICLES


SCIENCE KITS
1. Los Angeles County Schools, Suggested Activities in Science and Reading, (Los Angeles City Schools Instructional Planning Division 1975)
WEATHER AND SEASONS
Weather Observation
Activity 3
Materials:
- Drawing paper
- Crayons, water colors, fiber tip pens

Procedure:
When the group has returned to the classroom from a "weather hunt" have the children tell what things they saw or discovered outside. Encourage each child to contribute; prompt them to think by repeating questions asked outdoors.

Point out specific clues if the children offer a general or brief list: shadows, tree branches moving, the mail carrier in a heavy hat and scarf, hair blowing in the wind, a gray sky. Maybe the children saw puddles or someone wearing boots.

Ask the children how many of the same things they can observe by looking out the window. Point out that one can still find out about the weather without having to be outside.

Pass out drawing materials for each child to draw a "weather report" of something observed outside.

As the daily routine of looking and recording becomes established, one or two children may be chosen or choose to be "weather reporters" for the week, providing a picture each day for the weather calendar (see calendar activity).

Involve the whole group in drawing pictures when there is something really new, like the first snow or the first spring rainstorm. All the children should be eager to express themselves at that time.

Weather Observation
Activity 4
Materials:
- Spirit Duplicator #6
- Cards cut to fit the columns on the spirit duplicator
- Paste

Procedure:
To help in establishing a daily routine of recording weather observations, give each child a copy of the spirit duplicator #6—the weather calendar.

Encourage the children to report at the start of class on weather conditions experienced or observed on their way to school by drawing a picture of the conditions outside on the small cards. They will have a chance to express independent observations which can be prompted by questions such as: "How did your coat get wet?" "Why did you wear those big boots today?" or "Where's your coat?" Have them paste the picture under the appropriate day. Have them continue this activity for two weeks.

Fridays are a good time to review the week of weather. Count the number of sunny, rainy, windy, snowy days seen on their weather calendars.

When this routine has been established, you may want to make a large weather calendar for the classroom. Each day you may assign a different child to draw the weather report and tack it on the weather calendar under the appropriate day.
Weather and seasons

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Twee card no. 7865-36
OBJECTIVES

- To establish a regular pattern of observing the weather; to note how it is the same and different
- To participate in outdoor exploration activities
- To actively explore the local environment
- To perceive changes occurring in a familiar location
- To become aware of changes in daily activities due to seasonal transitions

The weather observation activities are introduced one at a time to the whole group of children to familiarize them with a basic skill or technique. For example, when the children are familiar with reading the thermometer, turn the activity over to the children to perform as part of a short daily routine in recording the weather.

The children can begin a daily routine with the informal reporting of outdoor conditions as they arrive at school. They can then gather together as a group before other class activities begin to assemble the weather information gathered by individual members. Appoint one child for the week to report the temperature, another to observe and report on wind activity, and another to look for weather clues at the window and make a simple drawing for the weather calendar. These “monitors” can gather the specific information for the use of the whole group in a short discussion guided by the teacher.

At the end of each week, review the number of days of sunny, cloudy, rainy, or snowy weather. Count the number of days in each temperature range. The days may all have been similar or they may show a wide difference with each day. At this time select monitors for the upcoming week.

The weather observation activities (class tree, weather hunts, field walks) and the seasonal posters or scrapbook are used on an intermittent basis. Repeat the activities several times in a season and then introduce them again as part of each new season. In this way, the class may compare the similarities and differences between the seasons.

An exploratory activity precedes the weather observation routines. Before these routines are even introduced, use the initial Exploratory Activity to record the children’s reactions and exploration. Look at how they approach the environment: by looking up, down, and around; by touching and feeling; by calling out observations and sharing their finds; observing from a distance; covering a wide area; or staying mainly in one spot.

When repeating the Exploratory Activity at the end of the unit, make the same kind of notes for each child as when you first began: specific actions, comments and involvement of each child. You may not see changes in each child with each single activity, but wait until you compare your own notes on the children to see their development.

Look also at their own drawings of field walks or other outdoor activities and how they describe their pictures. They may be richer in thought and detail as the children learn more about ways of observing the outdoors. Keep a few drawings from early in your science activities to refer to at the end of the year, after many science experiences.

EXPLORATORY ACTIVITY

Materials:
None
(optional) soap for blowing bubbles

Procedure:
Take the children outside to “find the weather”, or gather together for a “weather hunt” before returning indoors from outside play.

Tell the children specific places to look to discover the state of the weather: look at the trees to find the wind; look for clouds in the sky, etc.

All stand in a sunny or open spot and tell how it feels; move to different open and sheltered spots and compare how they feel.

Other clues which may help the children to observe the weather conditions: what happens to loose hair in the wind? Do you feel different when the sun goes behind a cloud? Drop a handful of fallen leaves to the ground or toss them in the air to see what happens. Blow soap bubbles; see if they go up, down, or otherwise. Look at the type of clothing other people have on. See if the sun makes any shadows.

Note: Record children’s participation in the activity; how the children go about observing outdoor conditions. At the end of this season or of the weather unit, record their approach to observation again and see what kinds of changes have occurred with each child.
WEATHER AND SEASONS

Weather Observation Activity 1

Materials: None

Procedure:
"Weather hunts" are a simple, direct way of getting the children to observe their environment. When you go outside as a group, ask the children for specific information. Give them clues about where to look and what to look for to "find" the weather.

Tell them to look up at the sky and ask what they see. Are there clouds? Are they moving? Where is the sun? Feel the air; see if you can find ice or a puddle. Look at the people on the street; what are they wearing?

On days of inclement or severe weather, many of these clues can be observed by looking out the window.

On a daily basis, children will soon know what clues to observe for a description of weather conditions.

Weather Observation Activity 2

Materials: None

Procedure:
Take short walks to observe details of each season. In the same way as observing the weather, encourage the children to make statements about details by asking them specific questions.

Have the children look closely at bushes and trees: touch them; run fingers over the branches; feel the leaves. Run fingers through the grass. Ask the children what colors they see. Look for new plants or seedling trees.

What do you find on the ground: seeds, nuts, leaves, flowers? Have the children close their eyes and use their noses. Can they smell the grass, flowers, rain, dirt? Listen for noises of birds, squirrels. Stand in an open area and feel the sun. Move into a shaded area. Does it feel the same?

Touch the ground with an open hand in different places: concrete, asphalt, grass, pebbles or gravel, dirt. Does it feel the same?
WEATHER AND SEASONS

Weather Observation Activity 5

Materials:
- Outdoor thermometer
- Household or utility thermometer
- 2 bowls, ice cubes, warm water
- Spirit Duplicator #7 or 8
- Red, orange, green, blue, violet crayons

Procedure:
Set up the outdoor thermometer so that the children can see it from inside the classroom. If it is portable (on a hook or ledge near a window which is easily opened), so much the better, since it can be used for both classroom demonstration and reading outdoor temperatures.

Look at the thermometer with the children and point to the indicator column. Explain that when the temperature goes up, the indicator rises. Also explain the effect of cold.

You can compare this procedure to how we react to warm and cold air. When it gets cold, we draw our arms and legs close to our bodies to stay warm; the thermometer column shrinks. When it’s warm, we stand up tall and extend our arms and legs to feel the warmth. Demonstrate with your body. Have the children explore this idea with their own body movements.

If possible, show the thermometer indoors, then outdoors, and see if the indicator changes. Then use a bowl of ice water and one of warm water so the children can watch the indicator as it changes. Let the children take turns moving the thermometer from one bowl to the other.

Name the color range the indicator falls within as you demonstrate the thermometer. Read the words describing the temperature range too. Next to the weather calendar, have a matching “key” showing the identical color strip with the descriptive words for each range of temperature.

Give each child a copy of the temperature chart. Each day have the children look at the outside thermometer and then draw a color line on their thermometer to have it look just the same.

Note: Keep an envelope of the matching color strips near the thermometer or the weather display. Have the children help select one that matches the range within which the indicator falls.

Weather Observation Activity 6

Materials:
- 2 soda or ketchup bottles
- Pinwheel or 4” x 6” square of heavy paper and a new pencil or 12” of ¼” dowel rod
- 3”-6” lengths of yarn or string
- Thumbtacks, sand, water

Procedure:
You can set up a simple weather station for observing the wind. It includes a pinwheel to see how strong the wind blows and lightweight strings or yarn tacked on a stick to see the wind’s direction.

Use a commercial pinwheel or make your own and pin it into the eraser end of a new pencil.

To make a pinwheel, mark the center of a square of sturdy paper (card stock works well). Cut from each corner toward the center mark. Stop cutting about ½” or more from the center. Insert the thumbtack from the back so the point is sticking through the paper. Fold one point from each corner to the center, covering the thumbtack point, and push onto the tack. When all four corners are in the center, push the pencil eraser onto the thumbtack as it lies on the table to secure the pinwheel. Pick it up and blow.
WEATHER AND SEASONS

Ask the children what it is and let them examine it to see if they can figure out how it works. Let children make pinwheels if materials are available and children are capable.

Use 3 or 4 strands of yarn or lightweight string and tie them together in a knot at one end. Put a pin or thumbtack through the knot and into the end of a dowel stick (¼", one foot long) or the eraser on a new pencil. Give this simple instrument to the children as you did the pinwheel and see what they have to say. With it they will be able to tell which way air is blowing. Have someone blow on it to demonstrate.

Use narrow-necked bottles (soda, ketchup) as a base. Fill them almost to the neck with sand to weight down the bottle for use outside.

Plunge the pencils or dowels into the sand and work them down as far as you can, close to the lip of the bottle. Pour some water into the sand to add more weight.

Set your weather station outside and either watch it there or put it where it can be seen from a window. Let the children make observations as the wind blows. Use a cardboard carrier from pop bottles for ease in carrying your weather station.

To prompt more specific observation, you can ask if the strings are always moving. Do they only move one way? All together? When do they fall limp? How do you tell when the wind speeds up?

Once the children are familiar with these two simple instruments and how they operate in a wind, you may want to move them to different places around the schoolyard. Experiment with this as a separate activity during a period of windy weather. Is the effect of the wind different under a tree than it is in the center of the grounds or in the corner of a fence?

Put the wind indicators near a hedge or a row of bushes and see what happens; move it near a corner of the building.
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Temperature chart for Fahrenheit scale.
## Weather and Seasons

**Temperature Chart - Celsius**

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WEATHER AND SEASONS
Weather Observation Activity 7

Materials:
- Paper, crayons, pen
- Camera (Polaroid, if available)

Procedure:
Choose a nearby tree or small landscaped area for regular close-up investigation by the class. Make regular visits to the spot on field walks, to become familiar with its appearance. Explore for details, perhaps staying to read a story, sing some songs, or have a simple snack. Every two or three weeks, take a snapshot of the children grouped in the same spot, if a camera is available.

With the children, write the observations they make with each visit. Examine the bark closely: look for bugs; turn over rocks; look for seeds or flowers; look and listen for birds.

Have the children draw pictures of the tree, or things they have noticed about the area. Be sure to discuss the walk so they will have ideas for their drawings. As the seasons progress, the children will be noting the changes as they occur and will have a photographic or drawn record to which they can refer. On each child's drawings, write the child's description of the picture.

Post this picture essay on the bulletin board or some other display area as it is made. Later include photos or drawings in a class book of the seasons or in individual scrapbooks that the children can keep.

This regular visit to explore an environment can also include a testing of the earth. Use a heavy duty spoon, child’s shovel, or small garden trowel to dig a small hole (3”-4” across, 2”-3” deep) so that the earth may be examined. Does the dirt stick to the fingers, or is it dry and powdery? Is it easy to dig into the soil, or is the ground rocky? Record the test, with the date for the class scrapbook. Put the dirt back in the hole. See if you can find any bugs or worms. Repeat this exercise on regular visits to the area. The class may note different degrees of moisture in the soil, and perhaps different types of plant and animal life as well. As the weather turns cold, it will gradually become more difficult to dig as the ground freezes. It may be impossible to try digging a new hole or even to remove dirt again which was previously dug out and refilled.

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WEATHER AND SEASONS
Weather Observation Activity 8

Materials:
- Seasonal catalog and magazine pictures
- Paper, tape or glue
- Construction paper for cover, stapler
- Posterboard or large construction paper
- Crayon or marker, thumbtacks or tape

Procedure:
Have the children make a scrapbook of the seasons. As you incorporate the seasons into class activities, provide a variety of magazine pictures, catalog pages, old greeting cards, or pictures of all types showing scenes, equipment, and activities which relate to the current season.

Each child or pair of children can select pictures of the season for a simple collage, which can be displayed and then used as pages in a scrapbook. Ask the children what clues they can look for in choosing pictures. This will put to use the information they have gained from weather observation and taking field walks.

You may want to have the children draw their own scenes of winter or a favorite outdoor activity. These, too, can first be used for display and then put into the season's scrapbook. Feel free to make individual books as the children collect their work, or just let them take the pictures home.

If the children like the scrapbook idea, include records of other seasonal activities. Include drawings and descriptions of events or trips the class participates in or observations of special note. The "class tree" and other short field trips can provide material for the scrapbook, too.

For posters of the season, use larger construction paper or posterboard if it is available. Use pictures featuring clothing, equipment, etc., appropriate to all the seasons, or at least to a mixture of two. Present the pictures for the children to examine, letting them name the articles they have themselves. Tell the children to make a poster of the things which would be most useful, comfortable, or fun to play with at this time of year. Ask them to state a few characteristics of the season or what things they can do now, so they'll have some clues to look for in selecting pictures for the poster.

When each child has glued a picture onto the poster, ask the children why they chose the pictures. Label the poster with the name of the season and hang it up for display.
Weather and seasons

AME

Winter:
- Coat
- Hat
- Mittens
- Boots
- Gloves

Spring:
- Sun
- Flowers

Summer:
- Shirts
- Shorts
- Sandals

Autumn:
- Trees
- Leaves
- Umbrella
WHAT IS THE WEATHER TODAY?

Air and water are parts of weather, too.

Cut out the weather clock.

Use a 📝.

Put your weather clock together.

Show today's weather on your clock.
SEASON TIME

Read each word in the tree.

What season do you think about?

Write the word by the season.

Fall  Winter

Spring  Summer

What season do you like best?

On the back, draw a picture of that season.

Show what you like to do.
AN OVERVIEW
What is air?
What is air made up of?
What is air pressure?

BASIC CONCEPTS
1. Events in the natural physical environment can be observed, measured, and explained.
2. When objects and systems interact, evidence of these interactions can be observed as changes in position, color, temperature, form, and phase.

SCIENCE BACKGROUND
We live at the bottom of an ocean of air that extends upward for hundreds of miles. Air is all around us; it can be found in porous materials and dissolved in water. Air is a mixture of many gases. About one-fifth of air is oxygen and four-fifths is nitrogen. Together, these two gases make up almost 99% of air. The remaining one percent is made up of carbon dioxide gas, hydrogen gas, and such inert gases as helium, neon, argon, krypton, and xenon. Air also contains water as a gas called water vapor, and changing amounts of dust, pollen, and waste gases given off by factories.

The gases that make up air are colorless. Although air is invisible, it is real. It takes up space and has weight. One cubic foot of air weighs about 1 1/4 ounces. Like all gases, air has no shape of its own, but takes the shape of the container it fills. When heated, air expands and rises; when cooled, air contracts and sinks.

The ocean of air around the earth is called the atmosphere. The earth's gravity holds the atmosphere to the earth's surface.

Scientists divide the atmosphere into five principal layers: troposphere, stratosphere, mesosphere, ionosphere, and exosphere. Almost all the water vapor, hence all weather conditions, are found in the lowest layer, or troposphere. The atmosphere prevents the absorbed sun's heat from leaving the earth. It also absorbs most of the harmful ultraviolet rays that come from the sun.

Because air has weight, it has pressure. At sea level the pressure of the air in the atmosphere is about 15 pounds per square inch of surface. Air presses equally in all directions. The higher we go, the less air there is; thus air pressure is less. A barometer is an instrument that measures air pressure. There are two kinds of barometers commonly used: a liquid barometer, usually filled with mercury, and a barometer without liquid, called an aneroid barometer. This barometer measures air pressure in terms of the number of inches of mercury it will support when the mercury is standing in a glass tube.

Air pressure can be increased or decreased. When air pressure is increased, the air can lift or move objects. It can be used to fill hollow objects. When the air pressure is decreased, the air will make objects stick to walls or else move from the direction of the greater to the smaller air pressure. Differences in air pressure cause wind, which is moving air.

A simple, but intriguing way to introduce this unit is to pose a riddle to the children, titled "Who Am I?" Make up your own riddle, which could go something like this: "You can't see me, but you can see what I can do. I take up lots of space. I am found in low places and in high places. The higher up I go, the lighter I become. Sometimes I am clean, and sometimes I am dirty. You can't taste me or smell me, but you can live without me. Who am I?"

The study of air lends itself very well to the processes of observing, describing, inferring, and predicting. As a result, there are an unusually large number of experiments and investigations that can be conducted. Give the children free rein to do these experiments, and encourage them not only to design their own experiments but to investigate further whatever interests them or catches their imagination. This unit leads quite easily to the study of either weather and climate, or the study of planes, rockets, and space travel.

MATERIALS FOR THE UNIT
aquarium, fish bowl or large jar
bags, paper, plastic balloons
bottles, glass, various sizes, narrow-necked, and baby bottle
bowl candles cans, tin cardboard clay
colored water compass drill funnel
glass hammer hot plate
ice cubes jars, glass, some with caps
limewater matches
milk carton nails
napkin, paper pans
paper paper, tissue paste
pencils rubber bands
rubber tube ruler
saucer saw


**FOR ENRICHMENT**

Books for the Teacher

Books for the Children
- Friskey, Margaret, The True Book of Air Around Us, Children’s Press, 1953.

**Films**

*How Air Helps Us* (Coronet)
11 min. sd. b&w. c. Shows that air exerts pressure, carries sound, helps birds fly, provides oxygen for living things, and disperses plant seeds.

*Air All Around Us* (Encyclopedia Britannica Films)
11 min. sd. b&w. Uses everyday life problems to explain contraction and expansion of air, work of compressed air, air has weight, and other concepts related to air.

*Nothing But Air* (Encyclopedia Britannica Films)
11 min. sd. b&w. Illustrates the properties of air, showing that air has weight and occupies space, that air is all around us, and that air in motion can be both useful and destructive.

*The Air Around Us* (Cenco)
12 min. sd. b&w. c. Describes the atmosphere, wind, properties of air, and shows that air can be compressed so that it can be used to do a variety of tasks for us.

*Air and What It Does* (Encyclopedia Britannica Films)
11 min. sd. b&w. c. Demonstrates how air moves, expands and contracts, exerts pressure, is essential to living things, and is useful in many everyday activities.

**Filmstrips**

*The Air* (Encyclopedia Britannica Films)
38 fr. si. c. Introduces the children to the atmosphere, the properties of air, and the effects air can produce.

*Air and Its Properties* (McGraw-Hill)
44 fr. si. b&w. Describes the properties of air, the pressure air exerts, and the effects of increased and decreased air pressure.

*Air Around Us* (Society for Visual Education)
38 fr. si. c. Describes the sky, winds, and clouds. Explains the rudiments of weather.

*Earth's Blanket of Air* (Society for Visual Education)
61 fr. c. record. Describes the atmosphere, where air is found, its pressure, and its effect on living things.
DISCOVERING IDEAS

Materials
a large cardboard sheet  2 jars of water
plastic bags  soil

1. Air is all around us.
2. You cannot see air but you can feel and see what it can do.
3. There is air in water and soil.

Objectives and Process Skills
1. Describe how air pushes against a large cardboard sheet when carrying it and running.
2. Observe and describe how air fills a plastic bag and takes its shape.
3. Observe and describe the bubbles that form on the inside of a jar of water that is allowed to sit.
4. Observe and describe the bubbles that rise from a lump of soil when it is dropped in water.
5. Infer that air pushes against the cardboard and fills and takes the shape of the plastic bag.
6. Infer that the bubbles that form on the jar and float up from the soil are air bubbles.
7. Infer that air is all around us.

Procedure
First have the children run without holding the cardboard. Have them note how fast they can run. Now let them take turns running while holding the cardboard sheet. Is it harder to run fast now? What do they feel pushing on the sheet? Have two children run together, one holding the cardboard. Which child runs fastest? Have them try it without the cardboard. It there a difference?

A person has to push air out of the way when he walks or runs. When he runs without holding the big piece of cardboard in front of him, he has comparatively little air to push out of the way, so he runs quite fast. But when he holds the big piece of cardboard in front of him, he has to push a lot of air out of the way, and this slows him down.

Have the children scoop up some air in a plastic bag and trap it inside the bag. Let them try to see the air. Develop the concept that something is inside the bag because the bag is bulging. When they push up on the bottom of the bag they will feel the air resisting.

When conducting this investigation, it might be a good idea to first press the plastic bag completely flat, in order to show the children that there is nothing in the bag. When you pull the open end of the bag quickly through the air, the bag will fill up with air and bulge quite noticeably. As long as you hold the neck of the bag tightly, the children will not be able to flatten the bag again. Something invisible is inside the bag. Hold the mouth of the bag near a child's face, put your hand at the base of the bag and push, releasing your hand around the neck of the bag at the same time. The child will feel the air on his face as the air is being pushed out. The children should infer that what you scooped into the bag is air, which is all around them.

Results
The children will feel air pushing against the cardboard sheet when they run. They push the air out of the way as they move. Air fills the plastic bag. When the children press on the air-filled bag, they will feel the air inside. Bubbles of air form on the inside of the jar of water. When the soil is dropped in water, bubbles of air will float out of it and up to the surface.
**DISCOVERING IDEAS**

**Materials**
sheets of paper

**Conceptual Statements**
Wind is moving air.

**Objectives and Process Skills**
1. Observe and describe what happens on a windy day.
2. Observe and describe what a paper fan does.
3. Infer that wind is moving air.

**Procedure**
Take the children outside on a windy day. What do they feel? What do they see moving? Make lists of the things they see.

Fold paper in accordion pleats to make paper fans. Gather the paper together at one end and fasten it with tape, paper clips, or staples. Have the children fan their faces. What do they feel? How does the fan make the wind they feel on their faces? (It pushes the air and makes it move.)

**Results**
With moderate winds you can see clouds moving, leaves rustling, flags flying, clothes swaying on the clothes line, and smoke being blown as it leaves chimneys. With strong winds you can see branches and bushes swaying, paper and leaves being blown about, and clouds moving quickly through the sky.

The paper fans push the air and make it move, creating a miniature wind.

**SYNTHESIZING IDEAS**

Start a discussion about where air can be found. Is there air around the school and the children's homes? Is there air around hills and mountains? Is there air in the desert? Is there air over ponds, lakes, and oceans? What makes the clouds high up in the sky move? Is there air above the clouds where jet planes fly? How high up does air go? Is there air in outer space where space ships go? (No.)

Let the children discuss what would happen if there were no air.

Since most children take the air for granted, they are not particularly concerned with how high up the air extends. Consequently, the first step in developing an understanding of the atmosphere is to convince the children that air covers the entire earth. Once this is established, the children can be led to conjecture about the extent of the atmosphere.

**FOR INDIVIDUALIZATION**

**Suggestions for Additional Activities and Investigations**
1. Take the children outside and let them observe the atmosphere. Point out that clouds are really relatively close to the earth. Even planes fly in the lower part of the atmosphere. Military rocket planes fly higher than commercial planes, yet they are still in the lower layers of the atmosphere. Some of our earth satellites orbit the earth yet are still within the limits of the atmosphere.

2. Show the children pictures of the layers of the atmosphere, together with how high each layer extends. Point out how the air in the atmosphere becomes progressively thinner until it fades out into outer space where there is no atmosphere at all.
DISCOVERING IDEAS

Materials
- paper napkin
- narrow-necked bottle
- glass
- aquarium or fish bowl
- clay
- funnel
- water

Conceptual Statements
1. Air takes up space.
2. Two objects cannot take up the same space at the same time.

Objectives and Process Skills
1. Observe and describe what happens when a glass containing a paper napkin is pushed upside down into water.
2. Infer that air in the glass kept the napkin dry.
3. Observe and describe what happens when water is poured through a narrow hole into a bottle.
4. Infer that air in the bottle could not get out so the water could not get in.
5. Infer that air and water cannot take up the same space at the same time.

Procedure
When pushing the glass with the paper napkin into the aquarium filled with water, be sure to hold the glass absolutely vertical. Any tilting of the glass will allow some of the air to escape and water to take its place, thus wetting the napkin. When you withdraw the glass from the water, wipe the sides and edges of the glass dry before turning the glass right side up, so that no water will drop into the glass and wet the napkin.

Be sure to pack the clay tightly between the funnel and the neck of the bottle so that no air can escape. Have the children pour a fairly large stream of water into the funnel. If the water flows in a small trickle, air may be able to escape through the funnel opening.

Results
The paper napkin in the glass remains dry because the air could not escape and therefore the water could not get into the glass. Water will not flow through the funnel into the bottle because air cannot escape from the bottle. Air and water cannot take up the same space at the same time.

DISCOVERING IDEAS

Materials
- 2 balloons
- string
- ruler

Conceptual Statements
Air has weight.

Objectives and Process Skills
1. Observe and describe how two balloons the same size and filled with the same amount of air can be balanced.
2. Observe and describe what happens when one of the balloons is emptied.
3. Infer that air has weight.

Procedure
When the balloons are blown up the same size, tie them with one end of a string and tie the other end of the string to one end of a ruler. Move the strings back and forth on the ruler until the balloons are balanced.

When the balloons are balanced, mark the exact location of both balloons on the yardstick. Then remove one balloon, let the air out, tie it again and replace it on the ruler. The end of the ruler that has the blown-up balloon will go down.

Results
The balloon filled with air will pull the ruler down at its end. This shows that the balloon filled with air weighs more than the empty balloon. Air has weight.
DISCOVERING IDEAS

Materials
2 aquaria or large glass jars
corks
small rocks

Conceptual Statements
1. Small objects that are heavy will sink in water.
2. Small objects that are light will float in water.

Processes
1. Predict and describe what happens when the children release small, heavy objects in water.
2. Predict and describe what happens when the children release small, light objects in water.

Procedure
Have the children fill the containers with water. Now, have them hold a small rock in the middle of the water. Ask them what they think will happen when they release the rock. Have them release the rock. Ask them to describe what happened.

Now, have them hold a cork halfway between the top and bottom of the water. What will happen when the cork is released? Have them release the corks and describe what happens.

Results
You may wish to point out that many heavy objects will float in water. For example, ocean-going ships are much heavier than the rocks. Yet, the ships will float on the water. It is the density of the objects that is critical. Objects that are more dense than water sink. Objects that are less dense than water float. Therefore, small objects that are heavy will sink in water.

DISCOVERING IDEAS

Materials
pebbles balloons

Conceptual Statements
1. Small objects that are heavy will fall in air.
2. Small objects that are light will float in air.

Processes
1. Predict and describe what happens when the children release small, heavy objects in air.
2. Predict and describe what happens when the children release large, light objects in air.

Procedure
The children hold a small rock as high as they can above the ground or floor. Ask them to predict what will happen when they release the rock. Then, have them describe what actually does happen when the rock is released. Have the children inflate balloons. Then have them hold the balloon as high as they can above the ground or floor and ask them to predict what will happen when the balloons are released. Have them describe what happens when the balloons are released.

Results
Air is a fluid. It is, of course, a much lighter fluid than water. However, objects that are less dense than air, such as balloons filled with helium, will float in air. Objects that are more dense than air will sink.

Actually, objects of the same size and shape will fall at the same rate regardless of their weight. However, the balloons will usually fall slower than the pebbles. This is because balloons are larger in size and more resistance is offered by the air. However, if there were no air, the balloons would fall at the same rate as the pebbles.
FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations

1. If possible, inflate a balloon with helium. Helium can sometimes be obtained in pressure cans from scientific supply houses. Have the children feel the balloon. Then, hold the balloon as high as you can over your head and ask the children to predict what will happen when you release the balloon. Have them describe what actually did happen when the helium-filled balloon was released.

2. Have the children repeat the experiments of dropping pebbles and balloons. This time, have them pay attention to the rate at which pebbles and balloons fall or rise in the air.

3. Freon gas can often be purchased in pressure cans at home appliance stores. Freon is much heavier than air and helium. Fill a balloon with Freon gas. Have the children hold the Freon-filled balloon and ask whether they see any difference between this balloon and the others. Then, hold the Freon balloon above the ground or floor. Ask the children to predict what will happen when it is released. Release the balloon. Have the children describe what happens to the balloon. Does this balloon fall in the same way as the balloon filled with air?

APPLICATION OF THE IDEAS

Materials
balloons
such gases as helium and Freon (if available)

Procedures
The illustration shows a vendor of balloons filled with helium. Since helium is less dense than air, these balloons will float away. At fairs, circuses, beaches, carnivals, and in zoos, there are sometimes vendors of helium-filled balloons. If possible, try to obtain some of these balloons. Or try to obtain a canister of helium and fill some balloons with the light gas.

Have the children experiment with popping balloons that are filled with gases such as air from their lungs, helium, and Freon.

You may wish to mention to the children that such vehicles as dirigibles, weather balloons, and the balloons that have been used to explore the upper atmosphere are filled with helium. They are lighter than air and therefore they will float up into the atmosphere. If possible, show them pictures of such vehicles.

Results
The children should be able to explain that helium balloons float because helium is lighter than air.
DISCOVERING IDEAS

Materials
2 candles (same size) matches large glass jar

Conceptual Statements
1. Air is made up of gases.
2. Oxygen is needed for burning.

Objectives and Process Skills
1. Observe and describe what happens when a jar is put over a burning candle.
2. Infer that the candle under the jar went out because there was something lacking in the air in the jar.

Procedure
The investigation here is designed to show that there is something in the air (oxygen) which is needed by the candle to continue burning. Since oxygen is invisible and cannot be isolated under ordinary classroom conditions, the children must infer that a special part of air is needed for burning. Point out that the gas remaining in the jar is mostly nitrogen, the other main constituent of the air.

When an object burns, it combines quickly with oxygen, giving off heat and light. This is called rapid oxidation. Many objects combine slowly with oxygen, and this is called slow oxidation with no flame produced. The formation of rust when iron combines with oxygen is a slow oxidation.

Results
When the jar is put over the candle, the candle will go out.

DISCOVERING IDEAS

Materials
1 jar cover
2 small jars (same size)

Conceptual Statements
1. There is a gas called carbon dioxide in air.
2. Limewater becomes milky when exposed to carbon dioxide.

Objectives and Process Skills
1. Observe and describe what happens to the open jar of limewater.
2. Infer that something in the air makes limewater milky.

Procedure
Limewater can be obtained in many drugstores.

Ask the children if they can think of any gases other than oxygen that might be in the air. If they are at all familiar with the process of body respiration, they will know that the body breathes in oxygen and breathes out carbon dioxide. Let them do the investigation described in their text which is designed to test for the presence of carbon dioxide in the air. Tell them that limewater becomes milky when exposed to a gas called carbon dioxide.

Point out that the amount of oxygen and carbon dioxide in the air remains the same because of the carbon-oxygen cycle. Green plants constantly take in carbon dioxide from the air to make food, and give off oxygen as a waste product. Man and animals breathe in oxygen to digest their food, and give off carbon dioxide as a waste product.

Results
The limewater in the open jar will turn milky, showing the presence of carbon dioxide in the air.
DISCOVERING IDEAS

Materials
simple kite construction kits (kite construction sets can often be obtained from dime stores, hardware stores and toy stores)

Conceptual Statements
1. Kites are held in the air by moving air.
2. Moving air is called wind.

Objectives and Process Skills
1. Predict when a kite can be launched.
2. Describe how to assemble a simple kite.

Procedure
Obtain several kite construction kits. If possible, obtain kits for the construction of different kinds of kites. The simplest kites do not need a tail. However, it may be desirable to have at least one kite with a tail. In older versions of kites, the tail was necessary to keep the kite in such a position that the wind would blow against the kite’s surface.

Have the children construct the kites. Then, have them fly the kites on a windy day. Have them describe how the kites fly. How high can they get the kites to fly? In what direction do the kites fly? What surface of the kite is in the direction of the wind?

Results
Kites are usually launched by running into the wind so that the wind will blow against the kite’s surface and lift it into the air.

Materials
1 sheet of paper for each child

Conceptual Statements
1. A sheet of paper will be lifted by a stream of air that moves across the top of the paper.
2. Airplanes are lifted by air that moves across the top of the wings.

Objectives and Process Skills
1. Observe and describe how a sheet of paper can be lifted by blowing air across the top of it.
2. Infer that airplanes are lifted by air that moves across the top of the wings.

Procedure
Give each child a piece of paper. Ask him to hold it on a desk or small table top at one corner of the paper. The paper should be held so that it bends downward away from the child. Then ask the children to blow as hard as they can across the top of the paper. They should watch the stream of air. Ask them to observe where the air moves. How is the paper moved?

Results
The blowing of the paper will result in the paper being lifted. The children will be able to observe the currents of air that flow both above and underneath the sheet of paper and cause it to move upward.

In the diagram on the bottom of page 134 the cross section of an airplane wing is shown. In this case, the same forces are involved as with the piece of paper. The air streams move both over and under the wing and cause it to lift up.
SYNTHESIZING IDEAS

Airplanes are lifted into the air by the flow of air over the top of the wing. The wing is lifted in the same way that the sheet of paper is lifted when you blow across the top of it.

A simple, but excellent, way to demonstrate the effect of air blowing across the top of a wing is shown in the illustration. A simulated airplane wing can be constructed by stapling the end of a manila file folder as shown in the illustration. Then, suspend the manila file folder which has been bent so that it has a curved upper wing surface with two strings. The strings can be supported by either four ringstands or chairs. Then, set up an electric fan so that a stream of air blows across the top of the manila file folder wing. What happens to the folder wing when a stream of air blows across it?

Have the children experiment by placing pieces of cardboard in such a position as to prevent the air from blowing across the top and then the bottom of the manila folder wing. How does this affect the flight of the wing?

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations
1. Have the children experiment with the fan and the manila folder set up as on page 135. Let them try adjusting the speed of the fan and observing the differences in the way the paper moves. Direct the fan at the paper from different angles and then try the same thing.

2. Have the children compare pictures or models of old airplanes with some new, modern ones. Ask them to observe the differences in wing structure and shape. Discuss with them which ones are better able to fly faster and longer. Ask why they think the modern structures are more efficient for flight travel.

DISCOVERING IDEAS

Materials
everal models of simple airplanes

Conceptual Statements
1. Moving air can move a plane up and down.
2. Moving air can make a plane move right or left.
3. Airplanes have moving parts on their wings that enable them to direct the wind to move them up or down and right or left.

Objectives and Process Skills
1. Observe and describe how moving air moves a plane up and down.
2. Observe and describe how moving air moves a plane to the right or to the left.
3. Observe the moving parts on the wing of a model airplane and infer their function.

Procedure
Have the children bring in model airplanes or supply several types that can be obtained in the local dime store. Let the pupils examine the parts and try flying them. It would be preferable to do this out-of-doors, if possible. Let them experiment with the moving of the rudder, elevator, and ailerons. They should observe which way they move to make the plane move up and down and right and left. Let them test these parts until they can draw definite conclusions by stating how the plane moves up and down and right and left.

Results
The children will be able to observe that when they move the elevators up, the plane will go up when it is thrown in the air. When the elevators are down, the plane moves down.

To have the plane turn to the right, the rudder is turned to the right and the aileron on the left wing is depressed while the aileron on the right wing is raised. These directions will be reversed when the plane turns left.
A PINWHEEL

Pinwheel Construction

You will need:

1 Straw

1 Pin

1 Pinwheel pattern

1. Cut out the pinwheel pattern.
Cut only on the dotted lines.
Do not cut into the circles.
2. Bend dark corner 1 to the center.
3. Push the pin into corner 1.

(continued) activity page
4. Bend dark corner 2 to the center.
5. Push the pin into corner 2.
6. Bend corner 3 to the center.
7. Push the pin into corner 3.
8. Bend corner 4 to the center.
8. Bend corner 4 to the center.

(activity page) (continued)
8. Bend corner 4 to the center.
10. Push the pin into the middle.
11. Pin the wheel to the straw.
12. Cover the point with tape.
AN OVERVIEW
What kinds of rocks are there?
What kinds of minerals are there?

BASIC CONCEPTS
1. Objects can be classified in a variety of ways.
2. Classification systems are man-made systems that are used to bring order and unity to observations of objects and phenomena.

SCIENCE BACKGROUND
In this unit we can begin to help children to an understanding of some ways that things are classified in science. The basis of classification is grouping together objects that are alike. In the study of rocks and minerals, children can learn how objects can be grouped.

One possible way to group things is on the basis of where they are found. If children bring in rock samples, the ones found in the western part of the community can be grouped together, as can those found in the eastern part. However, as the children look at these rocks, they will probably see that there are many differences between the rocks. Also, how could they tell someone who does not know the community about a particular sample of rock? See if the children can think of weaknesses in the method of grouping rocks by where they are found.

Usually, rocks are classified on the basis of such physical characteristics as color and hardness. In fact, physical characteristics are the bases for most systems of classification in science. As children begin to group together rocks that are alike, they are beginning to use the system of classification that is used throughout the sciences.

Another important goal in this unit is to give youngsters some understanding of how various kinds of rocks have been formed and changed. It is believed by many scientists that all rocks are formed from hot, molten rock materials. These molten rock materials harden to form fire-formed, or igneous rocks.

As soon as rocks are exposed at the surface, wind and water begin to wear them away. Eventually, the particles of sand and soil that are worn off are carried to the sea by rivers and streams. Here they are dropped, and the particles settle to the bottom. As layer on layer of sediment is deposited, pressure becomes very great, and the sediment is pressed into sedimentary rocks such as sandstone and limestone. Sometimes we can see streaks in these rocks which resulted when layers of sediment were piled on each other. Mixed in with the sediment are the remains of plants and animals, usually plants and animals that lived in the sea. These remain are called fossils. Children are usually keenly interested in fossils. Have them try to picture the kinds of living things from which they were formed.

Within the earth there is sometimes great heat and pressure. This heat and pressure can change the nature of rocks; rocks that are changed in this way are called metamorphic rocks.

Rocks are made up of one or more minerals. For example, granite is made up of quartz, orthoclase feldspar, and one other mineral such as mica or hornblende. Minerals form when molten material from inside the earth cools. A mineral is a solid element or compound of inorganic (nonliving) origin found in nature. An element is a substance that cannot be broken down into simpler substances by ordinary chemical means. A compound consists of two or more elements chemically combined. Minerals have various characteristics such as luster, hardness, color, streak color, reaction to acids, cleavage, fracture, specific gravity, and crystalline formation. The children will investigate some of these characteristics and classify minerals accordingly.

Soil is an important part of our environment. The children will learn the composition of soil and the properties of different kinds of soil. Plants, animals, and rocks break down and form soil.

In rural areas or in areas that are less densely populated, the children have probably had many experiences with soil. If the children in your class come from a densely populated metropolitan area, it is conceivable that these children will have little understanding of the work of the farmer or the importance of soil. These children are probably not aware of the different kinds of soil. If a field trip is not possible, show them magazine pictures that depict soil. Pictures of deserts, the Grand Canyon, and other unusual areas can be used effectively. There are many good films and filmstrips that can be shown.

MATERIALS FOR THE UNIT
- cans, tin, same size
- containers, various
- copper penny
- cups
- earthworms
- flower pots, same size
- glass, flat
- hammer
- hand lens
- hot plate
- kitchen knife
- jars, glass, some with caps
- leaves
- masking tape
- milk carton
- minerals, assorted
- nail
- pan
- paper, black
- pebbles
- pencils
- plaster of Paris
Materials
- a variety of rocks
- hand lens
- dull kitchen knife
- copper penny
- piece of flat glass
- vinegar
- unglazed white porcelain tile

Conceptual Statements
1. There are many kinds of rocks.
2. Individual rocks can be classified according to shape, color, texture, luster, streak color, and hardness.
3. Some rocks contain carbonate.

Objectives and Process Skills
1. Observe and describe different kinds of rocks.
2. Compare different kinds of rocks.
3. Classify different kinds of rocks according to their characteristics.

Procedure
A handbook of rocks and minerals is a basic necessity for this unit. See the bibliography for suggested references. If the school does not have a labeled rock collection, you might be able to get one from a local hobby shop, a museum lending library, or a supplier. You will need a variety of specimens of about the size of those on pages 34 and 35. Rocks are made of minerals; however, do not discuss minerals at this point, and do not give the children specimens of pure minerals to look at now. First let the children explore the rocks, using the questions on page 35 as a guide. Let them try to classify the rocks according to different characteristics the rocks have in common.

DISCOVERING IDEAS (continued)
Rocks can be classified according to hardness. A hard rock will scratch the blade of a kitchen knife and a piece of flat glass. A softer rock will be scratched by the knife blade, a copper penny, and a nail. The softest rocks can be scratched by a fingernail. Have the children make a chart as shown and write the names of the rocks on it. If you do not know the names of the rocks, number them and use the numbers to distinguish them.

<table>
<thead>
<tr>
<th>SCRATCH</th>
<th>ROCKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fingernail</td>
<td></td>
</tr>
<tr>
<td>Penny</td>
<td></td>
</tr>
<tr>
<td>Knife</td>
<td></td>
</tr>
<tr>
<td>Glass</td>
<td></td>
</tr>
</tbody>
</table>
FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations

1. Limestone, chert, and gypsum are precipitated sedimentary rocks. They are formed when rock materials precipitate from solutions. To show how this happens, dissolve as much salt as possible in a half cup of water. Put the solution in a shallow bowl. As the water dries up (evaporates), what happens? Where is the salt? Precipitated sedimentary rocks such as limestone are formed in much the same way.

As the water evaporates, the salt precipitates. It is visible at the water's edge.

2. Compare different kinds of sedimentary rock such as sandstone, conglomerate, and shale. How are they different from each other? Which has the largest grains? Rub the sandstone with a penny. What comes off?

Shale has the finest texture; conglomerate has the roughest. When the sandstone is rubbed, grains that look like sand come off it.

3. Have children collect and examine soil, which is made up of tiny pieces of rock. If your school is in an area near beaches, have the children bring in some sand. If not, get some from a sandpile or aquarium store. Let the children examine the grains under a magnifying glass or microscope. They will see that the sand is made up of tiny pieces of rock. They may note that sand is made up of different colored grains. You can show how this happens by rubbing different colored rocks with sandpaper. Collect the rubbings on white paper. They will look like the colored grains of sand. Explain that waves wear away rocks, thus producing sand.

Clay soil is made up of very fine particles of rock. It can be dug up, observed, felt, and compared with modeling clay. If samples of soil are shaken up in a jar of water, the clay particles will settle at the top. They can then be removed and observed. During dry weather, clay soil will become very hard and crack. Have the children observe this and feel its hardness.

Top soil or loam soil is made up of particles of rock and bits of decayed plant and animal matter called humus. Humus makes the soil fertile.
DISCOVERING IDEAS

Materials
shale, slate, or
gas flame (Bunsen burner)
granite rock

Conceptual Statements
Changes in temperature can break up rocks.

Objectives and Process Skills
1. Observe and describe what happens to a heated rock dropped in cold water.
2. Compare the appearance of the rock before it is heated and dropped in cold water with its appearance after it has been heated and dropped in the water.
3. Infer that a sudden change in temperature can break a rock.
4. Infer that rocks on the earth's surface can also be broken up by changes in temperature.
5. Infer that the cracks in roads and sidewalks could have been caused by changes in temperature.

Procedure
For this experiment any coarse-grained porous rock will do. Even sandstone or commonly found conglomerate (which consists of pebbles and cemented sand grains) can be used. The important thing is to get the rock as hot as possible. Consequently, do not use a hot plate or a candle flame. If you use an alcohol lamp, keep the rock in the flame for a long time.

Let the children examine the rock before you heat it. How does it look?

Results
When the heated rock is plunged into cold water, the sudden contraction of the cooled rock will cause bits of rock to break or flake off and drop to the bottom. Look for small pieces of rock in the bottom of the jar. Lift out the rock with the tongs to examine it. How does it look now?

Materials
sandstone
bowl of water
plastic bag
freezer
soft rock (shale, sandstone, limestone)

Conceptual Statements
Water can erode rocks in two ways: (1) by getting into cracks in rocks and freezing, thus expanding and breaking the rock; (2) rivers carry rocks and rub them against each other, thus wearing them down.

Objectives and Process Skills
1. Observe and describe the sandstone before it is put in the water, after it is put in the water, after the water has frozen, and after the ice has melted.
2. Compare the appearance of the rock before the experiment with its appearance after the experiment has been completed.
3. Infer that the freezing water cracked the rock.
4. Observe and describe the pieces of rock after breaking with the hammer.
5. Observe and describe the pieces of broken rock after shaking them in the jar of water.
6. Compare the appearance of the pieces of rock after shaking with their appearance before shaking.
7. Infer that the pieces of broken rock rubbed against and wore away each other when the jar was shaken.

Procedure and Results
The porous sandstone will absorb water overnight. When the water in the rock freezes, it expands and cracks the rock. This will show up most clearly when the ice has melted.

After being shaken in the jar of water for 15 minutes, the pieces of soft rock will have smoother edges than they had before. When they were shaken, the pieces of rock rubbed against and wore away each other.
We like to look at rocks.
Some are very big and heavy.
Some are little and not so heavy.

Tell about a rock that you found.
Draw a line to the words that tell.

The rock was

big
pretty
little
brown
red
black
heavy
Classifying Rocks

OVERVIEW

The making of a collection is an extension of the child's natural desire for making order out of chaos. When collections are arranged in various groupings according to a system of classification, they are most easily studied and more clearly understood. In this lesson the children continue to work with collections as they attempt to classify rocks.

AIMS

To discover that rocks, although alike in many basic characteristics, are dissimilar in many ways too (weight, size, shape, color, texture, etc.).

MATERIALS

Assorted rocks, stones, Chart on rocks

ORAL VOCABULARY

Rock, stone, pebble, brick, cement, concrete, rough, smooth, hobby, set, collection, other descriptive vocabulary.

HOW TO BEGIN

Take the children on a walk to gather rocks, stones, pebbles, etc. If weather or surroundings do not permit such a walk, have boxes of rocks on hand.

PROCEDURE

Display Chart and give each child a number of rocks. Let the children compare some of the rocks they have found with those shown on the chart. Permit each child to sit by himself. Suggest that the children sort and place the rocks in any way they wish. Some children will sort by size, others by shape, others by color, surface texture, etc. When all the children have finished, each child should be asked to describe how and why he sorted his own rocks. Rocks can then be grouped again into larger sets.

At this time, discuss with the children the possibility of setting aside a specific area in the room for the display of other collections. Some or even many of the children might be familiar with stamp or coin collections that their parents or older siblings have as hobbies. It would be fun for the class to consider their classroom collections as hobbies also. Ask them to find out about the hobbies their brothers, sisters, and parents have, and to tell about them in class. Some of the children may be able to bring in some of these collections. Being exposed to a great variety of possible collections will reinforce the need to group and classify. The children will become increasingly aware that anything can be grouped according to one rationale or another. (Some suggestions for housing rock collections may be found on page .)

IDEAS FOR GOING FURTHER

Visit mineral collections in a museum.

If possible, visit a vacant lot or building site to look for rocks and rock formations. The children can be asked to collect a few samples for their classroom collection.
ROCKS: Small rocks can be housed in shallow cardboard boxes or wooden boxes such as cigar boxes. The base of the box should be lined with a white or light colored paper, and marked off into squares so that specimens may be glued within each square. The squares should also have room for labels—not necessarily for the name of the specimen but for the heading of a classification decided upon by the child. If many specimens are gathered, one box might be labeled: "Red Stones." Another box might be: "Green Stones." Sub-classifications might be labeled within a box.

If the stones are quite large, containers such as fruit boxes should be used. Specimens may then be fastened to the bottom of the boxes with thin wires which extend through the wood and fasten on the back of the box.

It is recommended that a basis for classification be only tentative until a fairly large number of specimens are collected. With the classification label, a title such as "Rocks Found In My Backyard" would add more meaning to the collection.

Egg cartons can make excellent containers for small rock collections because of their separate compartments.
AN OVERVIEW
What is force?
How do forces act?

BASIC CONCEPTS
1. Events in the natural physical environment can be observed, measured, and explained.
2. Events and properties of objects (time, position in space, size, etc.) can be viewed from several frames of reference.
3. When objects and systems interact, evidence of these interactions can be observed as changes in position, color, temperature, form, and phase.

SCIENCE BACKGROUND
We live in a world of moving objects. Children come to school having already witnessed and experienced a variety of conditions involving forces and motion.

A force is needed to make things move or stop moving. A force is a push or a pull. Gravity and magnetism are forces. A force can be produced by moving air, moving water, electricity, steam, burning gasoline, chemical reactions, the sun's rays, springs, and muscles.

All too often the terms force, power, energy, and work are used interchangeably. This is wrong. Each term has a specific scientific meaning which is different than the others. A force is a push or pull— that's all. Energy is required to exert a force on an object, but energy itself is not a force. Energy makes it possible to exert a force. Energy is usually defined as the ability of matter to move other matter or to produce chemical changes in other matter. When we talk about machines, work. Energy is never used up, but instead it is changed from one form to energy in another form.

Work, according to scientists, is produced whenever a force makes an object move through a distance. No matter how much force is exerted on an object, if the object does not move, then—scientifically—no work has been done. Power is simply the rate, or speed, of doing work. If one machine can do the same or more work than another in a shorter time, then this machine provides more power than the other machine.

In this unit, the children learn that forces are necessary to make objects move, turn, and stop moving. Different kinds of forces affect motion. These forces include gravity, friction, wind, moving water, magnetism, muscles, and springs.

The connection between rubbing and friction is developed with a number of activities. The children learn how to increase and decrease friction and how friction can be helpful and unhelpful. They learn that friction generates heat.

Gravity is a force that pulls everything on earth toward the center of the earth. Gravity can make objects move slower or faster. It can make objects move or stop moving.

Inertia is the tendency of a body at rest to stay at rest and of a body in motion to stay in motion, unless outside forces affect these conditions. With the use of simple and familiar situations the children are led to understand inertia, although the term does not appear in the text.

All forces work in pairs. Forces can be the same direction as the strongest force acting on it.

MATERIALS FOR THE UNIT
- balloon
- blocks, wood
- board, wood
- books
- doll
- jar caps
- marbles
- mirror
- oil
- paper
- pencils
- rocks, small and large
- sand
- sandpaper
- shovel
- string
- table
- tin cans
- toy cars
- toy truck
- wagon
- wind-up toy

FOR ENRICHMENT
Books for the Teacher

Books for the Children
Pine, Tillie S., and Joseph Levine, Gravity All

**Films**

*Force of Gravity* (Gateway)
10 min. sd. b&w. Explains the theory of gravity and its observable effects, using every-day applications.

*Forces* (Encyclopedia Britannica Films)
14 min. sd. b&w. c. Beginning with a tug-of-war, it shows that forces can affect objects, then takes up the forces of gravity, magnetism, and electricity.

*Making Things Move* (Encyclopedia Britannica Films)
11 min. sd. b&w. c. Shows examples of forces that make things move, forces that keep things moving, and forces that make things more difficult to move.

*What Is A Force* (Coronet)
11 min. b&w. s. Shows that a force can cause an object at rest to move, and a moving object to go slower or faster, or change direction.

*Wind and What It Does* (Encyclopedia Britannica Films)
11 min. b&w. s. Shows what wind is, what it can do, and how it affects man and his surroundings by doing work and causing destruction.

*Filmstrips*

*Foggy and Windy Days* (McGraw-Hill)
40 fr. si. c. Explains in simple terms to the primary grade student the nature and effect of foggy and windy days.

*Friction at Work* (McGraw-Hill)
46 fr. si. c. Explains how friction helps and hinders us in our daily life. Shows the cause of friction.

*Gravity* (McGraw-Hill)
46 fr. si. c. Develops a clear understanding of gravity and its force, using everyday applications.

*Reducing Friction on Land* (McGraw-Hill)
50 fr. si. c. Uses the overcoming of friction to show different kinds of transportation.

*Water and Its Work* (McGraw-Hill)
44 fr. si. b&w. Shows how water helps grow things for food, and describes how moving water can do work for us.

*The Physical Environment* (American Book Company)
6 full-color animated motion slides. Grades K-3. Forces and Motion: What are some familiar forces? (Gravity; Friction; Magnets). What is a magnetic force? (Law of Magnets; Magnetic Lines of Force; The Earth Is a Magnet).
DISCOVERING IDEAS

Materials
wagon

Conceptual Statements
1. A force is a push or a pull.
2. A force can make an object move.
3. A force can make an object move faster or slower.
4. A force can make an object stop moving.

Objectives and Process Skills
1. Observe and describe what happens when a wagon is pushed or pulled.
2. Infer that a push or a pull can make an object move.
3. Compare the effects of a hard pull on the wagon with the effects of a pull that is less hard.
4. Infer that the amount of force exerted on an object can affect the speed with which the object moves.
5. Observe and describe what happens when a wagon that is moving is pushed or pulled in the opposite direction.
6. Infer that a force can make an object move slower or stop moving.

Procedure
If possible, take a wagon out to the playground and let the children explore the different ways in which they can make it move. How can they make it move faster? How can they make it move slower?

Develop the idea that forces can differ in magnitude. In playground activities see which child can throw a ball the farthest. Also, develop the idea that forces can be exerted in different directions by having the children roll, bounce, or throw objects up, down, and to all sides.

It might be a good idea to show that a large force can be exerted on an object, yet the object still will not move. Let a child try to pull open a locked door or try to push the classroom wall down. No matter how much force the child exerts, this force is not large enough to produce motion. According to scientists, no work has been done in this case. For work to be done, a force must move an object through a distance, no matter how small the distance is.

Once the children have developed the concept that force is needed to make things move, lead them into a discussion of what they would have to do to make these things stop moving. Develop the understanding that a force is necessary to stop a moving object, but this force must be applied in a direction opposite to the direction of the moving object. Let them experiment with the wagon to find out how they can stop it when it is moving.

Results
By exerting a force, either a push or a pull, on the wagon, the wagon can be made to move. The harder the force, the faster and longer the wagon moves. A force exerted on the moving wagon in the opposite direction can slow down the wagon or make it stop moving, depending on the magnitude of the force exerted.
Which two boxes are moving?

Color them.
SYNTHESIZING IDEAS

Remind the children that we need energy to work and play. Making an object move is work. Have a child lift a book. Where did the force come from that moved the book? When the children respond by saying that the child’s muscles or arm or hand exerted the force to move the book, ask where the muscles or arm got the energy to exert this force. Review the concept (studied in Foods and You) that our bodies get energy to work and play from food. Our bodies need energy to exert a force. The terms “force” and “energy” are not interchangeable. Energy is needed to produce a force that makes objects move or stop moving, but energy itself is not a force.

Ask the children to describe how the force of magnetism can exert a push or a pull (see the unit Magnets).

Get a long spring from a porch door. Stretch the spring and let one end snap back. Stretching the spring gives it energy, and when it moves back it can exert a force that can make objects move. Have the children infer how, when a porch door with a spring is pushed open, the door springs back by itself.

Obtain a spring alarm clock that has been allowed to run down. Remove the back of the clock and let the children observe the spring. Now wind the spring, noting how tight the spring becomes. Energy from the muscles of your fingers exerted a force on the spring, winding the spring up and giving it energy. Now the spring begins to exert its own force as it begins to slowly unwind, so that the wheels inside begin to turn and the watch begins ticking.

Spring action can also be shown by holding one end of a rubber band in your hand and placing a short pencil inside the loop. Keep twisting the pencil until the rubber band is tight, then let go of the pencil. As the stretched rubber unwinds, it exerts a force and makes the pencil spin.

FOR INDIVIDUALIZATION

Suggestions for Additional Activities and Investigations

1. Crumple up a piece of paper into a ball. Put the ball of paper on a table. Blow on it. Why does the paper ball move? What force is acting on it? How can you make the paper ball move faster?

Blowing air on the paper ball makes it move. Moving air can exert a force that can make objects move. Point out that moving air has energy, so it can exert a force. The harder you blow, the greater the energy the moving air will have, and the stronger the force exerted will be. This greater force makes the paper ball move faster.

2. Watch a game of baseball. What makes the ball move? Where do the players get the energy to make the ball move? How is the ball stopped? When must a player use greater force to stop the ball? Why does a baseball catcher wear a glove with thick padding?

A force is used to set the ball in motion. This force is exerted by a player’s arm. The player gets the energy to exert the force from the food he eats. Another force is needed to stop the ball. The greater the force used to throw the ball, the greater the force that will be needed to stop the ball. The catcher wears a padded glove so his hand will not be hurt when he exerts a lot of force to catch a ball that is moving with great force.

3. Finally, have the children make a list of all the forces they can think of that make objects in school, at home, or in the streets move. Let them group the objects by the forces that made them move.