HANDS-ON SCIENCE MANUAL:
ACTIVITIES AND EXPERIMENTS

MASTER'S PROJECT

Submitted to the School of Education
University of Dayton, in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education

by

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Approved by:

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Official Advisor
ACKNOWLEDGEMENT

Special recognition goes to my loving husband, Tony, who has been helpful and supportive throughout this whole endeavor. Thank you!
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CHAPTER I

As with most major institutions in the United States, public education is full of controversy and constant change. Trends in education have come and gone yet the movement toward a hands-on approach to teaching science seems to have proven its merits over the past thirty years. Science programs such as SCIS (Science Curriculum Improvement Study) and SAPA (Science - A Process Approach), which began the hands-on movement in the 1960's, showed that experiences form the basis of real learning. However, many teachers today still teach science using traditional textbooks and worksheets. In an age where the need for scientific and technological literacy is at its greatest, our students are becoming bored with science as they regard it as pages to cover and tasks to complete in each lesson.

While acquiring process skills, children learn how to learn. The process skills taught in hands-on science cut across subject-matter lines, equipping students with the potential to respond effectively to a wide range of intellectual challenges (Kepler, 1991). These skills, which include observing, classifying, predicting, and measuring, cannot be developed by simply reading about science. The hands-on approach is to science what soccer is to physical education or piano lessons are to music class (Katz, 1986). Teachers who still follow the traditional practice of lecturing about specified reading assignments from a textbook are teaching their students that science is a dry and arcane laundry list of facts and theories.
which are meaningless and unrelated to students' lives. Hands-on science reflects the investigative nature of science and its direct application to the students' lives. The goals of learning should mesh with personal goals (Kotar, 1988). Through science, children should learn how to make rational decisions and evaluate personal consequences, how science and technology help to resolve society's problems, and how to collect, organize, and interpret information (Kotar, 1988).

As we enter the 21st century, it is vital that our schools produce graduates who know how to reason, solve problems, and think critically. They must be literate in the application of scientific principles and processes. Adults who find themselves in the next century with such limited skills as rote memorization and regurgitation of meaningless facts will not only find their personal achievement limited but will also limit the advancement of our society as a whole.

Justification

The National Science Foundation recently disclosed a startling level of "scientific illiteracy" among American adults (Bennett, 1987). The trend is evident with American students. The National Assessment of Educational Progress (NAEP) conducted by the Educational Testing Service (ETS) found that the results of the second international science assessment, conducted in 1986, revealed that, at grade 5, the United States ranked in the middle of science achievement relative to 14 other participating countries. At grade 9, students in the United States ranked next
ETS also discovered that 11% of the third graders assessed in 1986 reported having had no science instruction at the time of assessment. One third of those who were receiving instruction said that they spent no time on homework. Approximately half of the teachers at grade three reported spending one to two hours each week providing science instruction. Is it any wonder that our students are failing the national report card in science when it is so obvious that science does not play a major role of importance in our schools?

This neglect of science can be attributed to a variety of factors including teacher anxiety about science, lack of materials and supplies, insufficient time to teach science, and inadequate funds to continually resupply materials used. Each of these factors plays a role in our nation's declining science literacy, yet the hands-on approach, when based on the needs, interests, and creative abilities of our children, can offer the positive alternative to negative statistics.

In its search for outstanding elementary school science programs, the National Science Teachers Association (NSTA) accepted nominations from schools all over the United States who felt they had an exemplary science program. The results showed that those schools that met the defined criteria often had well-developed hands-on science programs in place. In Renton, Washington, the K-6 science curriculum is based on a hands-on approach to science. Renton teachers want science to be a positive, practical, everyday experience (Penick and Bame, 1988).
The curriculum at Hillsborough County Schools in Tampa, Florida balances content with process. It emphasizes activities that build problem-solving and critical thinking skills while being consistent with research on teaching, learning, and childhood development.

The program in Douglas, Wyoming is designed so that students will be curious learners who willingly involve themselves in problem solving situations, show curiosity, and explore materials, experience each of the processes of science, and understand that some problems have more than one solution (Penick and Bame, 1988.)

In each of these schools, science plays an important role in all human activity. The curriculum must be based on the needs and creative interests of children. It should help children to think, to solve problems on their own, and to apply their solutions to everyday life. Students are actively involved in all aspects of these science programs. They emphasize science as a way of knowing and aim to develop a positive attitude toward science in the students and to prepare students to be scientifically literate as members of society.

The hands-on method provides experiences which involve students in the learning process and exposes them to the environment, not just to textbooks. Procedures of investigation such as observation, measurement, experimentation, and communication allow children to gain an understanding of natural phenomena. The most effective learners are those who are actively engaged in the learning process and accept
responsibility for their own learning.

Former Secretary of Education, William J. Bennett, observed that when the predominant method of teaching science is teacher-oriented with information presented in the format of a lecture, it is little wonder that children's natural curiosity about their physical world turns into boredom by the time they leave grade school and into dangerous ignorance later on? Bennett also observed that a hands-on adventure, guided by a knowledgeable teacher, could sweep children up in the excitement of discovery and illustrate the point that science is for everyone—not just scientists. Science is a way of thinking, a way of understanding the world (Bennett, 1987).

The support for hands-on science can be found in test results as well. In 1982, the National Science Foundation supported a project initiated by the University of Colorado to analyze 34 studies that compared the performance of students in traditional, textbook-based classroom with students in classrooms using new curriculum programs designed to teach hands-on science such as Science-A Process Approach, Science Curriculum Improvement Study, and Elementary Science Study. The average student in the SAPA, SCIS, or ESS classroom performed better than 62% of the students in traditional classrooms across all performance criteria measured (Shymansky, 1982). Students in the hands-on based curricula scored between 18 to 36 percentile-points higher in process skill development and 8 percentile-points higher on tests of reading and math skills. The results were consistent when either standardized or special
tests were used and no evidence of bias was found.

Assumptions

The creation and use of a hands-on lab manual for students to use in conjunction with their textbooks will greatly enhance their learning. Students will not simply be reading about science, they will be doing science. By acting as scientists and using the skills of observation, prediction, experimentation, and description, the students will have abundant opportunities to question data, to design and conduct real experiments, and to carry their thinking beyond information given by the teacher. The more actively involved students are in science, the more long-lasting and meaningful their learning will be.

Limitations

This manual will be developed to coordinate with the curriculum currently established by the Oakwood Board of Education for the fifth and sixth grades. It may not correspond with curricula used in other school districts or at other grade levels.

The author's school has a volunteer committee of mothers who work in the science lab. They are available to set up experiments for the teachers, gather unusual or needed supplies, and restock the supply of consumable materials out of an established fund set aside for the science lab. The lab manual will be developed with the knowledge that materials are either
already stocked in our lab or can easily be gathered by one of the volunteers. Schools that do not have a lab, volunteers, or funds may not find some of these activities appropriate in terms of time or money.
CHAPTER II
Review of Literature

The history of science as an organized part of the elementary school curriculum began in the mid-nineteenth century. Most students who attended school at that time were preparing for universities and future political and professional roles so teachers stressed the development of readiness for university training (Butts and Hall, 1975). The curriculum for "object study" required that students memorize information about the properties of selected objects of study, but nothing was done with the information since it was generally felt that children's minds were not developed enough intellectually to process it.

By the close of the nineteenth century, science curriculum was put into a textbook format so it was no longer necessary to rely on the knowledge and ability of the teacher alone.

The focus in science shifted from object study to nature study. By the 1900's, the emphasis was on encouraging young adults to stay in the rural communities rather than migrate to the cities (Butts and Hall, 1975). Liberty Hyde Bailey is associated with the movement toward nature study but it still did not go beyond observing and memorizing characteristics of objects of nature.

A profound and long-lasting influence on science teaching came in the 1920's with the work of John Dewey and Gerald Craig (Butts and Hall, 1975). Dewey believed that the method employed by scientists was vitally important. Craig felt that the affective part of science should be taught. He believed that
appreciations, interests, and attitudes were important aspects of science, and that laws, generalizations, and principles of science were relevant to all individuals as they interact with their environment (Butts and Hall, 1975).

There was still a heavy emphasis on the body of knowledge of science in the mid-1950's and having students read about science was deemed important. However, the launching of Sputnik in 1957 caused many people to voice a concern over the quality and quantity of science teaching in our schools. The government made more funds available and, by the 1960's, millions of dollars were being spent to develop new science curriculum materials. This led to the development of a variety of science curriculum programs such as Science - A Process Approach, Science Curriculum Improvement Study, and the Elementary Science Study. Many of these new curriculums stressed the importance of students becoming active, engaged learners of science and the importance of science being taught through the hands-on approach became evident.

The advantage of teaching science through a hands-on approach is discussed in a variety of books and journals. (See, for example, the July, 1990 issue of Science Education.) Discussions between American and Japanese educators about science teaching have been far reaching but have focused primarily on data comparing scientific reasoning abilities of seventh, eighth, and ninth grade students from the two countries (Takemura et al., 1985; Mattheis, Spooner, and Coble, 1986). A sample of 4397 Japanese students were randomly selected and 3291 American
students were randomly selected only from the state of North Carolina. The students were tested using a slightly modified version of the Classroom Test of Formal Reasoning. The Japanese students outperformed the North Carolina students on virtually all reasoning tasks at all grade levels. The most favored hypothesis about these results was that the Japanese school curriculum places greater emphasis on reasoning, problem-solving, open-ended questioning, hands-on experimentation, and argumentation, and less emphasis on recalling textbook facts. Researchers were almost unanimous in the view that hands-on approaches are the way science should be taught that makes the most difference. Japanese students have first-hand experience with real objects. Japanese science is taught with inquiry procedures and hands-on activities.

Gabel (1989) observed that hands-on activities should not only be used to clarify and to extend concepts, but also to teach children to think. Reading about a phenomenon in a textbook does not provoke the same level of conflict or curiosity as doing the same activity oneself.

Kotar (1988) noted that creative and interested teachers produce creative and interested students. When science is a first-hand experience, children not only learn science but also improve their other learning skills. They become better at reading, math, and even writing. By observing, comparing, describing and analyzing scientific phenomena, children can not help but develop intellectually (Kotar, 1988). The exemplary elementary school science program, one that uses the hands-on
approach, stresses the students' inquiry and decision-making processes. For the classroom to mirror the real world, the teacher should be an active model, spending less time on lecturing and more time engaging students in hands-on activities and asking open-ended questions (Goodlad, 1984).

Despite the many positive repercussions of the hands-on approach to teaching science, the majority of our schools are still not employing the hands-on method. Many teachers have fears about teaching science because, they feel they might give students wrong information (Duckworth, 1990). Many teachers are quite anxious about teaching science and they often unintentionally transfer their anxiety to their pupils either by science avoidance or by authoritarian presentations of science terminology and generalizations.

The obligation to reply to pupil's questions that teachers impose on themselves together with the fear of not being able to finish the course in time is often the basis of their "directive" attitude. They feel children must go "this way" because that is the way the teacher knows and with which the teacher feels secure and at ease. An emphasis is often placed on "mistakes" or failures in performance and students are harassed to complete work so they can go on to the next assignment regardless of present understanding. Teachers tend to pose questions only for which they have the answer (Piltz, 1968). However, teachers cannot be responsible for students' learning, as though it were a deliverable product, but they can and must monitor the processes students are using as they work (Duckworth, 1990). Unfortunately,
not enough teachers are committed to the belief that children's learning of science could best come through their own investigative activities when properly encouraged and supported.

The teaching of science must convey to students that science is not just the memorization of a body of knowledge, but that it also includes the excitement of using one's mind in conjunction with the body of knowledge of science to solve a problem (Butts, 1975). Too many teachers over the years have taken the excitement out of science for their students. Teachers have unknowingly clung to their empiricist traditions and theories which view the errors, failures, or difficulties of pupils as either their own responsibilities or as shortcomings of the method of instruction. In contrast, the teachers' tasks are to differentiate those that they have to correct and those that they have to respect because they result either from children's levels of development or from the progress teachers are making in the organization of children's knowledge (Duckworth, 1990). Teachers need to realize that children organize and interpret the world around them in an effort to explain it to themselves. Out of this process comes a body of theories, ideas, and beliefs. If we wish to enter this world constructed by children, we must learn to listen to them and to talk to them without imposing or even suggesting our adult conceptions of the world. The playfulness of the scientist, like the playfulness of a child, is intense, but permits the freedom to explore and try out a wide range of ideas with no fear of being wrong (Duckworth, 1990.)

Science is the subject in which teachers need to give their
students the freedom to learn through experimentation, observation, and problem-solving. Learning is not an efficient process that can be planned, structured, organized, and streamlined. Certain conditions can facilitate children's learning, such as the use of hands-on activities, whereas other conditions can render learning almost impossible as in the traditional textbook approach which emphasizes reading about science and rote memorization of facts.

Teachers may also avoid science because the materials are either too expensive or too difficult to secure and maintain (Alport, 1982). According to the 1986 National Assessment Educational Testing Service, only about 46% of seventh or eleventh grade science teachers reported access to a general-purpose laboratory.

A solution to this problem may be found by looking at the science programs of schools recognized by the National Science Teachers Association to have exemplary science programs. These schools created kits for the classroom teachers' use which focused on simple, everyday materials wherever possible. The maintenance of these kits was the responsibility of a central office person, not the classroom teachers. Teachers were also given in-service training in the use of these kits and received support from the administration as well as encouragement to try new ideas and materials.

A stumbling block to good elementary school science teaching is the complaint of a lack of time. Elementary school teachers frequently need to prepare six or more different lessons a day
and they may be encouraged to "slight" science in favor of the "basics" of reading and mathematics (Glasgow and Carson, 1986). In response to this complaint, the National Science Teachers Association points out that the best programs integrate science with other content areas such as reading, language arts, and math. By combining the subjects in this way, time can be used more efficiently and students are given an education in which they are able to see the interrelationship between the subjects.

The problem of assessment also constrains the use of hands-on science. It is relatively easy to test children's knowledge when they have been asked to memorize lists of data from a text, but it is more difficult to design tests that measure learning derived from direct experience (Bennett, 1987).

Chittenden (1988) identifies three limitations of the multiple choice format for assessing pupil knowledge and higher level skills: (a) the selected-response mode (s-r mode) masks the nature of pupils' knowledge and understanding (they answer someone else's question using someone else's answer); (b) the s-r mode is extremely difficult to use for assessing productive thinking and problem solving; and (c) the s-r mode emphasizes a "best" or "correct" answer which is antithetical to goals of science education. He recommends the inclusion of free-response exercises or items as a required feature of a testing program in science. Some schools provide checklists of students' ability to perform experimental tasks.

There is no field of human knowledge that affords a greater outlet for creative activity than science; its very nature and
structure demand innovation and encourage original thought and action (Piltz and Sund, 1968). In a world where there are increasing numbers of jobs that require critical thinking and fewer jobs on which following directions blindly is expected, it is vital that we use the hands-on method to teach science. Science can and must begin with explorations of events in the everyday world so that students can learn how to investigate scientifically and thereby form the basis for later learning. As stated by Piltz and Sund (1968) "a page from the history of the advancement of mankind is a page from the history of science" (p. 168).

The need for curriculum reform is well documented. Our science curriculum must reflect modern content that teaches higher-order thinking, "learning to learn" skills, and the uses of science in human affairs (Hurd, 1991). Many writers and publishers of science curriculum are emphasizing critical thinking skills as well as the hands-on experience but teachers are developing their own themes for teaching science (Hurd, 1991). As teachers evaluate their courses of study, they collect a variety of hands-on activities and ideas that enhance their units.

Many science textbooks in use today are little more than dictionaries, but even if students were to know all the data ever discovered in the sciences, they would still be described as functionally illiterate. Scientific literacy is more than knowing a bag of facts (Hurd, 1991). This is why teachers are developing their own collections of hands-on activities. They
realize that the facts presented in textbooks must be made real and brought to life in order for students to develop an understanding and ability to apply the concepts to different situations.
Chapter III
Handbook

The hands-on lab manual will be designed to coordinate with the fifth and sixth grade science curriculum based on the course of study designed by the Oakwood City School system. As shown in Tables 1 and 2, the major areas covered will include life science, physical science, and earth science. Specific objectives have been identified for each grade level in each area of science. Activities and objectives have been designed to reinforce the objectives determined in each area.

The labs are organized so that each includes the concept being taught, the purpose for doing the activity, the amount of time that should be allotted for the activity, the materials that will be needed, the steps for the student to follow as a guide through the activity, a short evaluation, and extending ideas which add to the knowledge already gained through completion of the activity. At the end of each section is a description of other short activities which extend the concepts learned in that area and which can be implemented at the discretion of the teacher.
<table>
<thead>
<tr>
<th>Life</th>
<th>Physical</th>
<th>Earth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the classification of animals into vertebrates and</td>
<td>Recognize the basic units of matter in terms of atoms,</td>
<td>Understand the concepts of weathering and erosion</td>
</tr>
<tr>
<td>invertebrates</td>
<td>elements, compounds, and molecules</td>
<td></td>
</tr>
<tr>
<td>Recognize the six major groups of invertebrates</td>
<td>Develop the concept of physical properties of matter</td>
<td>Identify major types of environmental pollution</td>
</tr>
<tr>
<td>Recognize the five main groups of vertebrates</td>
<td>Conclude that matter can undergo physical changes</td>
<td>Understand the basic factors that cause and influence the weather</td>
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<tr>
<td>Understand the ecological relationship between the living and non-</td>
<td>Understand that electricity is a form of energy that results</td>
<td>Understand the nature of the universe beyond the solar system</td>
</tr>
<tr>
<td>living world</td>
<td>from the movement of electrons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Observe that current electricity is produced when electrons</td>
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<tr>
<td></td>
<td>move along a complete unbroken path</td>
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<tr>
<td></td>
<td>Understand how magnetism is used to produce electricity</td>
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</tr>
<tr>
<td></td>
<td>Identify sources of energy</td>
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## Objectives in Science Curriculum
### Sixth Grade

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<tr>
<th>Life</th>
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<th>Earth</th>
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<tbody>
<tr>
<td>Sixth grade students will:</td>
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<tr>
<td>Identify the three main kingdoms used</td>
<td>Recognize the diverse and varying forms of</td>
<td>Determine that the sun is the fundamental</td>
</tr>
<tr>
<td>for classification of organisms</td>
<td>matter</td>
<td>source of energy on earth and its energy</td>
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<tr>
<td>Classify plants into two groups, and sub-</td>
<td>Compare elements and compounds</td>
<td>influences climates</td>
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<tr>
<td>divide those groups by recognizing differ-</td>
<td>Explain that electricity is a form of energy</td>
<td>Identify why climates are different</td>
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<td>ences in structure and function</td>
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<tr>
<td>Recognize man’s position in the order of</td>
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<tr>
<td>life and the organization of the human</td>
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Overview of Activities

Life Science
Fifth Grade

<table>
<thead>
<tr>
<th>Concept</th>
<th>Activity Pages</th>
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<td>Vertebrates/Invertebrates</td>
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<tr>
<td>Plants/Ecosystems</td>
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Life Science
Sixth Grade

<table>
<thead>
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<th>Concept</th>
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<td>47 - 49</td>
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<tr>
<td>Diffusion/Mitosis</td>
<td>50 - 52</td>
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<td>Fungi/Protists/Monerans</td>
<td>55 - 62</td>
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<td>Plant Reproduction</td>
<td>65 - 70</td>
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Physical Science
Fifth Grade

<table>
<thead>
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<tr>
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Physical Science
Sixth Grade

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<tr>
<td>Compounds/Chemical Properties</td>
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Earth Science
Fifth Grade

<table>
<thead>
<tr>
<th>Concept</th>
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<tbody>
<tr>
<td>Weather</td>
<td>103-107</td>
</tr>
<tr>
<td>Solar System</td>
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Earth Science
Sixth Grade

<table>
<thead>
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<th>Activity Pages</th>
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<tr>
<td>Climate</td>
<td>119-122</td>
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Fifth Grade
Life Science

Objectives:

Understand the classification of animals into vertebrates and invertebrates.

Recognize the six major groups of invertebrates.

Identify the five main groups of vertebrates.

Experiments:

Comparing vertebrates and invertebrates
Watch earthworms mix soil
Observe snails and spiny-skinned animals
Determine what pond snails eat
Observe joint-legged animals
Observe fish
Compare reptiles and amphibians
Determine the best environment for cold-blooded animals
Compare and observe birds and mammals
Identify birds
Calculate wingbeats per minute for birds
Measure internal body temperature under different conditions
Monitor the breathing rate of fish

Sources:

Addison Wesley, 1989
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Vertebrates/Invertebrates

Purpose: To compare and contrast vertebrates and invertebrates.

Time: 40 minutes

Materials:

- live vertebrates (hamster, guinea pig, frog)
- live invertebrates (earthworm, snail, insect)

Steps:

1. Observe the animals and note the similarities and differences between the vertebrates and invertebrates. Take care with any animals that might bite. Wash your hands afterwards.

Extending Ideas:

Scientists classify living things, or organisms, according to the ways organisms are alike. The animal kingdom is divided into two large groups, vertebrates and invertebrates. All animals with backbones are vertebrates. Most animals do not have backbones and they are called invertebrates.

Elementary Science, 1980
Concept: Invertebrates

Purpose: To learn about and observe the behavior and living environment of an earthworm.

Time: 20 minutes

Materials:

- 2 jars with lids
- 2 earthworms
- dark soil
- light sand
- carrot scraps
- dark paper
- masking tape
- water

Steps:

1. Put a layer of dark soil about 2 cm thick in the bottom of each jar. Cover the soil with a layer of light sand. Add dark and light layers until the jars are almost full. Moist the soil.
2. Put the earthworms in one of the jars on top of the soil. Add the carrot scraps. Wash your hands with soap and water after handling the worms.
3. Cover the jars with a lid. Wrap both jars with a dark piece of paper. Put the jars aside.
4. Write down what you think will happen in the jars.
5. After three days, unwrap the jars.

Evaluation:

1. How can you tell which jar contained the earthworms? Describe the soil and the sand in the jars.
2. Which of the jars do you think would be a better place for a plant to grow? Why?

Extending Ideas:

The earthworm is one kind of segmented worm. Like other worms, segmented worms are found in many places such as soil, lakes, ponds, and salt water. Segmented worms are more complex than flatworms and roundworms and it's body is divided into ringlike segments.

Addison-Wesley, 1989
Concept: Invertebrates

Purpose: To determine the type of food a pond snail eats.

Time: 20 minutes

Materials:
- shallow dish
- pond water
- pond snail
- ruler
- celery leaves
- spinach leaves
- lettuce

Steps:
1. Add pond water to the dish. Place the pond snail in the dish.
2. Tear little squares off each of the leaves. Measure each square with your ruler. Record the type and size of each leaf square.
3. Place the leaf squares in the water with the snail. Place the dish in a safe place overnight.
4. The next day, note which leaf squares have been nibbled and how much was eaten.
5. Compare your results with your classmates.

Evaluation:
1. How much of each leaf was eaten? What was the favorite food of the snail?
2. Did the snails of your classmates prefer the same vegetable as your snail? Explain why you think this was so.

Extending Ideas:

The garden snail has a single foot on its lower body and a single, spiral shell. You may have seen one creeping along on its belly. This belly is actually a thick, muscular foot which it uses to crawl, dig, and catch food.

Addison-Wesley, 1989
Concept: Invertebrates

Purpose: To observe snails and spiny-skinned animals and describe their characteristics.

Time: 30 minutes

Materials:
- live snail
- spiny-skinned animal
- hand lens

Steps:
1. Observe the snail and spiny-skinned animal (starfish, sea urchin, or sand dollar) with a hand lens.
2. Notice the differences and similarities in their structure.

Evaluation:
1. Where do these animals live?
2. How do these animals look alike?
3. How are these animals different?

Extending Ideas:

Mollusks like snails have soft bodies with a tough outer covering called a mantle which protects them. Unlike mollusks, spiny-skinned animals have firm bodies. They get their name from the spines that cover their bodies.

Addison-Wesley, 1989
Concept: Vertebrates

Purpose: To become familiar with the features and characteristics of fish.

Time: 15 minutes

Materials:

- fish in a bowl or aquarium
- clock or watch

Steps:

1. Observe one or more fish in a fish bowl or aquarium. Look carefully at the external features of the fish. Notice the gills, fins, and scales.
2. Count the number of times the gills open and close in 30 seconds.

Evaluation:

1. Does the fish open and close its mouth each time the gills open and close? Why do you think this occurs?
2. How do fins help the fish move?

Extending Ideas:

Most of the earth is covered with water. The most common vertebrates in this environment are fish. The bodies of fish are covered with scales. Scales protect fish. Most fish also have fins. Fins help fish move through the water. Even the tail is a fin.

Elementary Science, 1980
Concept: Invertebrates

Purpose: To observe joint-legged animals and describe how they are alike and how they are different.

Time: 30 minutes

Materials:

- pill bugs
- insects
- spiders
- jars with lids
- hand lenses

Steps:

1. Search for various insects, spiders, and pill bugs. Punch holes in the lids of the jars and keep the animals in the jars since some of these organisms may bite or sting.
2. Observe the specimens with a hand lens. List in your journal how these animals are alike and how they are different.

Extending Ideas:

Arthropods are the largest group of animals and the largest group of invertebrates. They live in air, on land, and in water. They usually have pairs of jointed legs, segmented bodies, an exoskeleton, and antennas.

Addison-Wesley, 1989
Concept: Vertebrates

Purpose: To determine whether air or water maintains a more constant temperature and to infer whether it is easier for a cold-blooded animal to live on land or in water.

Time: 30 minutes

Materials:

- 4 thermometers
- 4 jars
- labels
- water
- pan
- ice

Steps:

1. Put a label on each jar. Number the jars.
2. Fill jars 2 and 4 halfway with water.
3. Place a thermometer in each jar. Measure and record the temperatures in a data table in your journal.
4. Place jars 1 and 2 near a sunny window. Place the other jars in a pan filled with ice.
5. Wait five minutes. Measure and record the temperatures of all four jars.

Evaluation:

1. Did the jars filled with water or air have a more constant temperature?
2. In which environment would it be easier for a cold-blooded animal to live?

Extending Ideas:

Cold-blooded animals have changing body temperatures. Their body temperatures are the same as the temperatures of their surroundings. Their blood is not really cold. Cold-blooded animals become less active when temperatures are too low or too high.
Concept: Vertebrates

Purpose: To observe reptiles and amphibians and describe how they are similar and different.

Time: 25 minutes

Materials:
- live amphibians (frog or salamander)
- live reptile (chameleon)

Steps:
1. Observe the reptile and amphibian in their aquariums for two or three days.
2. Describe in your journal the ways in which the two types of animals are similar and different. Draw a sketch of the animals.

Extending Ideas:

Amphibians and reptiles are two groups of cold-blooded vertebrates. Amphibians live part of their lives in water and part of their lives on land. Frogs and toads are amphibians. Most reptiles live on land. Lizards, snakes, and turtles are reptiles.

Addison-Wesley, 1989
Concept: Vertebrates

Purpose: To develop a check-off sheet for identifying birds.

Time: 20 minutes

Materials:

- journal
- pencil
- possibly a field guide for bird identification

Steps:

1. Create a check-off sheet for identifying birds that contains the following categories:
   - size
   - general shape
   - beak size
   - beak color
   - wing shape
   - feather color
   - type of feet
   - leg length
   - special features

2. Keep track of at least 4 different kinds of birds over the next few days and fill out the check sheet for each bird. You can later identify the birds by using the information on the check-off sheet and a bird identification book.

Extending Ideas:

Birds live on land, in trees, and on water. They are vertebrates and have skeletons adapted to their needs. Instead of front legs, birds have wings. Most birds use their wings to fly but some, like the penguin, do not fly.

Addison-Wesley, 1989
Concept: Vertebrates

Purpose: To examine live birds and mammals to determine how they are similar and how they are different.

Time: 30 minutes

Materials: variety of small live mammals and birds

Steps:
1. Observe one or more small mammals such as a hamster, gerbil, or mouse and a bird such as a canary, parakeet, or parrot.

Evaluation:
1. How are these animals similar and different?
2. How are mammals and birds different from reptiles or amphibians?
3. Do these animals feel warm or cold? Why?

Extending Ideas:

Penguins are birds with feathers and wings, but they do not fly. Seals are mammals covered with fur. Both animals are warm-blooded. Warm-blooded animals keep steady body temperatures. They can remain warm even when the outside temperature becomes cold.
Concept: Vertebrates

Purpose: To determine if internal body temperature remains constant when the body is exposed to a different environmental condition.

Time: 30 minutes

Materials:
- dishpan of ice water
- alcohol thermometer
- towel
- forehead thermometer

Steps:
1. Use the alcohol thermometer to measure the temperature of the ice water. Use the forehead thermometer to take your temperature. Record the temperatures.
2. Place your elbow in the water. After five minutes, remove your elbow from the dishpan. Quickly dry an area on your elbow. Use the alcohol thermometer to take the temperature of your skin. Record.
3. Repeat step 1. Compare your internal body temperature with your skin temperature.

Evaluation:
1. Did the cold temperature of the ice water cause a change in your internal temperature?
2. When you go outside on a cold day, what do you think happens to your body temperature? Why?

Extending Ideas:

You are a mammal. While you and other mammals are different, you have many things in common. For one thing, all mammals are warm-blooded vertebrates. Only mammals have hair or fur. Most mammals give birth to only a few young and they nurse their young with milk from glands.

Addison-Wesley, 1989
Concept: Vertebrates

Compare the number of times some birds beat their wings in one second:

<table>
<thead>
<tr>
<th>Bird</th>
<th>Wingbeats per Second</th>
</tr>
</thead>
<tbody>
<tr>
<td>crow</td>
<td>2</td>
</tr>
<tr>
<td>pigeon</td>
<td>3</td>
</tr>
<tr>
<td>chickadee</td>
<td>27</td>
</tr>
<tr>
<td>hummingbird</td>
<td>70</td>
</tr>
</tbody>
</table>

Calculate the number of wingbeats per minute for each bird.

Extending Ideas:

Birds' bodies are covered with feathers instead of scales. No other animal has feathers. A bird's large outer feathers help it fly. Short, soft feathers, called down, lie close to a bird's skin. Fluffing these feathers helps keep a bird warm.

Addison-Wesley, 1989
Concept: Vertebrates

Purpose: To observe if a fish’s breathing rate changes when the water temperature is lowered.

Time: 45 minutes

Materials:

- fish
- fish net
- water
- jar
- ice
- spoon
- thermometer
- clock or watch

Steps:

1. Add water to the jar. Let it sit overnight.
2. Gently put the fish in the water.
3. Measure and record the water temperature.
4. Observe the fish closely. Count and record the number of times the fish opens and closes its mouth in one minute.
5. Carefully add three ice cubes to the jar. Stir the water gently. Repeat steps 3 and 4.
6. After three minutes, repeat steps 3 and 4.

<table>
<thead>
<tr>
<th>Start</th>
<th>After adding ice</th>
<th>After 3 minutes</th>
</tr>
</thead>
</table>

Water temperature
Fish’s breathing rate

Evaluation:

1. How did the water temperature affect the fish’s breathing rate?
2. Predict what would happen if the water temperature increased. How would you change this experiment to test your idea?

Extending Ideas:

Fish need oxygen just as you do but they get their oxygen from water. When a fish appears to be swallowing water, it is usually taking in oxygen. Fish have featherlike structures called gills. Oxygen in the water is absorbed by the blood vessels found in the gills.

Addison-Wesley, 1989
Teacher Activity

Obtain at least one sponge specimen and one synthetic sponge. Ask students to examine both types of sponges. Have them explain how a real sponge and a synthetic sponge are similar and how they are different. Then have students examine the skeletal framework of the real sponges with a hand lens. Have them compare the skeleton of the real sponges with the fibers of the synthetic sponges.

Cooperative Learning Activity

Once the characteristics of mammals are learned, conduct a survey of all the mammals that you see in a two-day period. At the end of that time, form into groups of four. Compile your lists of mammals into a group list. Discuss the features of those animals and list the attributes of each animal related to the features of mammals. For example, list the type of hair or fur the animal has, the environment in which the animal lives, how many young that animal generally gives birth to in one litter, how long that animal might care for its young, and so on. Present your data and compare with other groups.

Teacher Activity

Obtain a whole fish from a local grocery or fish market. Let students examine the fish for the features learned in the lesson. Use a sharp knife to cut the fish apart. Let students see how the structure of the bones gives the fish its shape. You may want to point out the gills and the air bladder.

Teacher Activity

Ask students to go on a "mollusk hunt" in their neighborhood or on the school grounds. They will probably find garden snails and slugs by turning over dead logs, rocks, and leaves. Instruct them to put any snails or slugs in a jar that has holes in its lid and to bring them to class. Have students observe the snails and slugs with hand lenses. They might also conduct snail races.
Fifth Grade
Life Science

Objective:

Understand the ecological relationship between the living and non-living world.

Experiments:

Identifying limiting factors
Testing for carbon dioxide
Looking for signs of succession
Making an aquarium

Sources:

Addison Wesley, 1989
Hooka on Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Plants

Purpose: To demonstrate that limewater is a test for carbon dioxide.

Time: 20 minutes

Materials:
- elodea plant
- 2 jars
- limewater
- soda straw

Steps:
1. Choose one of the following hypotheses:
   a. Limewater is used to test for oxygen.
   b. Limewater is used to test for carbon dioxide.

2. To test your hypothesis, fill one jar with limewater. Place the elodea in the jar.
3. Put the jar in a sunny place. Observe the jar carefully for several days. Record any changes in the limewater.
4. Add limewater to the other jar. Using the soda straw, gently blow into the jar. Observe and record any changes in the limewater.

Evaluation:
2. Did your results support your hypothesis? Why or why not?

Extending Ideas:

The foodmaking process in a plant is called photosynthesis. The word comes from two Greek words. Photo means light. Synthesis means putting together. Leaf cells need light to put carbon dioxide and water together to make food.

Addison-Wesley, 1989
Concept:  Plants

Purpose:  To identify limiting factors in radish seed growth.

Time:  20 minutes

Materials:

- 2 plastic foam cups
- 10 radish seeds
- soil
- spoon
- salt solution
- water

Steps:

1. Label one cup A and the other cup B.
2. Fill the cups with soil about two centimeters from the tops.
3. Plant five radish seeds in each cup. Make sure the seeds are not too deep in the soil.
4. Put three spoonfuls of water in cup A. Put three spoonfuls of salt solution in cup B.
5. Put the cups in a sunny spot. Check them daily. Add water to cup A or salt solution to cup B when the soil looks or feels dry.
6. Record any results you observe.

Evaluation:

1. What were some limiting factors in this activity? Which factors did you control?
2. What plants live near the ocean’s shore? What limiting factors must these plants adapt to?

Extending Ideas:

Plants need three things from their environment to make food: sunlight, water, and air. Foodmaking usually occurs in the leaf cells of plants. The things needed to make food must be transported to these leaf cells. Special cells in a plant’s roots, stems, and leaves do this.

Addison-Wesley, 1989
Concept: Plants
Purpose: To look for signs of succession in a grassy area.
Time: 30 minutes
Materials:
  string    plastic knife
Steps:
1. Look for places in the schoolyard where there is grass. Choose a place where there is also a dandelion plant or other large weed.
2. Place a circle of string on the ground around the dandelion and its leaves. Use the knife to carefully dig up the dandelion.
3. Record the number of grass plants that are growing inside the circle.
4. Lay the same string in a circle on the grass where there are no dandelions. Count and record the number of grass plants inside.
Evaluation:
1. Did the number of grass plants inside the two circles differ? Explain.
2. How does this activity explain what happens during succession?
Extending Ideas:
A change in the kind of organisms that live in a place is called succession. Ecosystems are always changing. Sometimes changes happen suddenly. A natural disaster such as a fire, flood, mudslide, or earthquake, may kill living things or change the environment. Change can also happen slowly such as when a pond slowly fills in and becomes a forest.
Addison-Wesley, 1989
Concept: Ecosystems

Purpose: To make an aquarium to see how plants, animals, and nonliving things interact.

Time: 45 minutes

Materials:

<table>
<thead>
<tr>
<th>4-liter jar</th>
<th>sand and gravel</th>
<th>water</th>
<th>snails</th>
</tr>
</thead>
<tbody>
<tr>
<td>water plants</td>
<td>guppies</td>
<td>guppy food</td>
<td></td>
</tr>
<tr>
<td>labels</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Steps:

1. Work in a group. Add sand and gravel to the jar. Slowly add water to fill the jar three-quarters full. Leave the jar uncovered for three days.
2. Add water plants, guppies, and snails to the jar. Make sure your aquarium gets the nonliving factors it needs. Also keep in mind the energy pyramid that will work in your jar.
3. After you have set up your aquarium, feed the guppies. Feed them each day. Label your jar.
4. Observe your aquarium every school day for two weeks. Record your observations of the following factors: condition of plants, condition of animals, condition of nonliving factors.

Evaluation:

1. How did the living things affect the nonliving things in your ecosystem?
2. Did your ecosystem have what it needed to survive? How do you know?

Extending Ideas:

The living things in a community depend on many nonliving things in their environment. Air, moisture, soil, and light are just a few nonliving things in an environment. A community and its nonliving things are called an ecosystem. An ecosystem can be large or small.

Addison-Wesley, 1989
Teacher Activity

Take students outside on a brief nature walk. During the walk, have them identify and record all the living and nonliving things they observe. Back in the class, help students make a list of living things and a list of nonliving things on the chalkboard, compiled from the observations of each of the students.

Cooperative Learning Activity

Divide the class into groups of four. Identify a social skill such as following directions. Take the groups to a natural setting to study a small ecosystem. Have each group measure one square meter of ground and mark its boundaries. Then each group should take a survey of the different living and nonliving things within the boundaries of the small ecosystem. Each group should decide how to record its survey findings and what procedures to use to make sure the survey is thorough. Have groups share results of their surveys with the class.

Outside Activity:

Take students outside to look for plants growing in the cracks of concrete or blacktop. Point out any ivy growing on the sides of buildings or fences. If an old sidewalk is evident, show how soil and grass have crept over the edge to cut down on the width of the walkway. Have students speculate on how the area would look in a few years if no upkeep were done. Have them imagine what the area would look like in 100 years if people deserted the area.

Cycles in Ecosystems

Teacher Activity

Purpose: To be able to observe a model of the water cycle.

Time: 15 minutes

Materials:

- heat-resistant beaker
- hot plate
- water
- ice cubes
- oven mitt
- large heat-resistant clear glass pot with lid

Description:

As students watch, fill the pot halfway with water and cover it with the lid. Heat the water until it boils. Put ice cubes into the beaker and, using the oven mitt, place the beaker on top of the pot and hold it there if necessary. Have students observe what happens. Water vapor will condense on the pot lid because the ice will have cooled that surface. As more and more vapor condenses, the water will begin to drip (precipitate) back into the pot.
Objective:

Recognize the position of humans in the order of life and the organization of the human body.

Experiments:

Observe cork cells under microscope
Cell concentration game
Comparing plant and animal cells
Make a cell model to observe diffusion
Predict the effect of diffusion on raisins
Observe cell division in yeast cells

Sources:

Addison Wesley, 1989
Hooked on Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Cell Structure

Purpose: To observe cork cells under a microscope.

Time: 30 minutes

Materials:
- cork
- microscope
- razor blade
- water
- microscope slide
- coverslip

Steps:
1. Cut very thin slivers off a bottle cork using a razor blade.
2. Place a sliver of cork on the slide and add a drop of water.
3. Place a coverslip over the cork and water.
4. Examine the slide under a microscope using the lowest power lens.

Evaluation:
1. Draw a sketch of the cork cells in your journal.
2. Write a description of what you see in terms of shape, color, and structure.
3. If you were the first person to see this or anything like it, what would you conclude about cork?

Extending Ideas:

Robert Hooke discovered that living things are made of cells. While looking at a thin slice of cork under a microscope, he saw little compartments that reminded him of small rooms, which he called "cells."

Addison-Wesley, 1989
Concept: Cell Structure

Game: Cell Concentration

Purpose: To learn the cell parts and their functions

Time: Varies

Materials: 12 index cards, pencil

Steps:

1. Find a partner.
2. Using the 12 index cards, write the names of the six different cell parts on separate cards and the function of each of those parts on the other six cards.
3. Shuffle the cards and place them face down on the floor or desk.
4. Take turns turning over 2 cards at a time to see if the cell part matches the function.
5. If it is a match, you keep the cards. If it is not a match, the cards are turned face down again.
6. Continue playing until all cell parts have been matched with their functions.

Extending Ideas:

The cells of all organisms have certain parts in common. If you look carefully, you can see that there are two important differences between plant and animal cells. One way plant cells are different is that they are surrounded by a cell wall that supports and protects the plant. The green color is caused by a substance called chlorophyll which is not present in animal cells. Chlorophyll traps energy from sunlight.

Addison-Wesley, 1989
Concept: Cell Structure

Purpose: To compare plant and animal cells.

Time: 30 minutes

Materials:
- microscope
- microscope slide
- coverslip
- onion
- eye dropper
- toothpick
- iodine
- water

Steps:
1. Use the edge of an unused toothpick to gently scrape the inside of your mouth (cheek.)
2. Put the scrapings on a microscope slide. Add a drop of iodine solution. Place a coverslip over it.
3. Gently pull a very thin piece of onion skin from between the layers of a piece of onion.
4. Put the onion skin on a second slide. Add a drop of iodine solution. Place a coverslip over it.
5. Look at both slides under a microscope.

Evaluation:
1. Draw a sketch of each slide in your journal.
2. Write a description of what you see in terms of shape, color, and structure.
3. Describe the similarities.
4. Describe the differences.

Extending Ideas:

Plants and animals are both living organisms so they are made of cells. These two types of cells are both similar and different in many ways.

Addison-Wesley, 1989
Concept: Diffusion

Purpose: To observe diffusion in a cell model.

Time: 15 minutes over a period of 2 days.

Materials:

| unflavored gelatin | zip-lock bag | jar | water | perfume | starch | clay | iodine |

Steps:

1. Add 1 package of unflavored gelatin to 1 cup of boiling water. Stir until dissolved.
2. Add 1/2 cup of cold water and 1 teaspoon each of perfume and starch to the gelatin.
3. Pour the mixture into a zip-lock bag. The mixture represents the cytoplasm and the bag represents the cell membrane.
4. Add a small round ball of clay to represent the nucleus.
5. Seal the bag and let it sit overnight.
6. The next day, fill a jar about 1/3 full of warm water.
7. Add iodine until the water is golden brown. Place the cell model in the jar.

Evaluation:

1. Describe the color of the mixture in the bag after a few minutes.
2. After a few hours, remove the bag from the jar and smell the water in the jar. Explain how you think the iodine and the perfume got through the bag.
3. What does this activity tell you about the cell membrane?

Extending Ideas:

When materials pass through the cell membrane, it is called diffusion. Materials always move from places where there is more material to places where there is less material.

Addison-Wesley, 1989
Concept: Mitosis

Purpose: To observe cell division taking place.

Time: 45 minutes

Materials:
- microscope
- small jar
- eye dropper
- microscope slide
- dry yeast
- coverslip
- warm water

Steps:
1. Fill a small jar with warm water.
2. Add 1 teaspoon of sugar and stir until dissolved.
3. Stir in 1 teaspoon of yeast. Keep the mixture warm for about 1 hour.
4. Describe in your journal any changes that you observe.
5. Place a few drops of the yeast mixture on a glass slide and put a coverslip over it. Examine under a microscope.

Evaluation:
1. Draw a sketch of the yeast cells in your journal.
2. Write a description of what you see in terms of shape, color, structure, and the stages of mitosis.

Extending Ideas:

   During mitosis, a single cell splits into two new cells. The new cells grow until they also divide. Before it divides, a cell must make copies of the chromosomes which are found in the cell nucleus. Chromosomes are ribbon-like structures that carry important cell instructions.

Addison-Wesley, 1989
Concept: Diffusion

Purpose: Students will observe and predict how diffusion changes cells.

Time: 60 minutes

Materials:
- jar
- hot tap water
- clock or watch
- seedless raisins
- straight pin

Steps:
1. Fill a jar half full of hot tap water.
2. Predict in your journal what will happen to a seedless raisin when you put it in water.
3. Put the raisin in the jar. Observe and draw the raisin.
4. Record changes in the raisin every 15 minutes for a total of 45 minutes.
5. Remove the raisin. Poke a hole in it.

Evaluation:
1. After 45 minutes, how is the raisin different?
2. What caused the difference?
3. How do you think the cells of the raisin changed?
4. What happened when you poked a hole in the raisin?

Extending Ideas:

- Food and oxygen are constantly brought to the cell where they are used up to produce energy. The cell is always producing waste as it converts food to energy.

Addison-Wesley, 1989
Objective:

Identify the three main kingdoms used for classification of organisms.

Experiments:

Observe mold growth on various foods
Dissect a mushroom to observe its parts
Make mushroom prints
Observe the organisms found in pond water
Observe bacteria found in yogurt
Grow bacteria found on and in the body
Determine the chemicals that help or harm yeast growth

Sources:

Addison Wesley, 1989
HBoxed On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Fungi

Purpose: To observe the growth of mold and infer the conditions that make mold growth possible.

Time: 20 minutes

Materials:
- plastic knife
- piece of fruit
- piece of cheese
- paper
- 3 plastic bags
- slice of bread
- water
- hand lens
- eye dropper

Steps:
1. Cut the fruit into small pieces. Put them in a plastic bag and add a few eye droppers of water.
2. Repeat step 1 with the bread and the cheese.
3. Store the bags at room temperature.

Evaluation:
1. Observe the bags each day for 5 to 7 days. Draw a sketch of what you see happening to the foods.
2. Describe the molds in terms of color, texture, and shape.
3. Are all of the molds the same? Explain why or why not.

Extending Ideas:
Molds, mildews, yeasts, and mushrooms are the four main kinds of fungi. Fungi are plantlike organisms that do not contain chlorophyll so they cannot make their own food.

Addison-Wesley, 1989
Concept: Fungi

Purpose: To examine the structure and parts of a mushroom.

Time: 25 minutes

Materials:
- mushroom
- plastic knife
- pencil
- journal
- hand lens

Steps:
1. Examine the mushroom with a hand lens. Describe its characteristics in your journal.
2. Carefully cut the mushroom in half lengthwise. Examine.
3. Draw a sketch of the cut mushroom. Describe what you see.
4. Carefully pull the cap off the cut mushroom. Look for the spore-producing parts called gills. Draw a sketch of what you see and write a description.

Extending Ideas:

Mushrooms are the largest fungi. They are many-celled and reproduce by spores which are single cells that grow into new organisms.

Addison-Wesley, 1989
Concept: Fungi

Purpose: To prepare mushroom prints to observe the spores produced by a mushroom.

Time: 15 minutes

Materials:
- mushroom
- white paper
- hand lens
- plastic bowl

Steps:
1. Carefully remove the stalk from a large mushroom with dark gills. The gills are the slits on the underside of the mushroom cap.
2. Place the cap, gill side down, on a sheet of white paper.
3. Turn the bowl upside down over the cap and paper.
4. Remove the bowl the next day. Carefully lift the mushroom cap off the paper.
5. Observe the print on your paper with a hand lens.

Evaluation:
1. What did you see on the paper?
2. Why do you think there are so many spores?
3. How does the number of spores compare with the number of seeds produced by plants?
4. How are spores spread from place to place?

Extending Ideas:
You may have seen mushrooms growing on decaying wood or springing up from grassy ground on a wet morning. Mushrooms grow on living trees and on dead matter in soil.

Addison-Wesley, 1989
Concept: Protists

Purpose: To observe different types of organisms found in pond water.

Time: 30 minutes

Materials:

- microscope
- coverslip
- slides
- pond water
- decaying grass
- tap water
- eye dropper

Steps:

1. Put a few pieces of decaying grass and a drop of tap water on a microscope slide. Place a coverslip on top.
2. Look at the grass under a microscope. Draw what you see in your journal.
3. Put a drop of pond water (including some of the scum on top) on a microscope slide. Place a coverslip on top.
4. Look at the drop under a microscope. Draw what you see in your journal. Compare with the grass slide.

Evaluation:

1. What kinds of organisms did you see?
2. How are these organisms different?

Extending Ideas:

Protists are one-celled or many-celled organisms that have cell nuclei. Some protists are like animals and some are like plants. They are classified in a separate kingdom because they are different from plants and animals in some ways.

Addison-Wesley, 1989
Concept: Monerans

Purpose: To observe the types of bacteria found in yogurt.

Time: 30 minutes

Materials:
- yogurt
- water
- methylene blue
- slide
- coverslip
- microscope

Steps:
1. Mix one part yogurt with ten parts water.
2. Put a drop of methylene blue stain on a slide and allow it to dry.
3. Add a drop of the diluted yogurt on the slide.
4. Examine the slide under a microscope. Look for rod-shaped bacteria and chains of round bacteria.

Evaluation:
1. Draw a sketch of the different types of bacteria you observe in your journal.
2. Write a description of what you see in terms of shape, color, and structure.

Extending Ideas:

The simplest of all organisms are monerans. They are one-celled but they do not have a cell nuclei. Instead, material that is enclosed in the nuclei of other cells is scattered throughout moneran cells.

Addison-Wesley, 1989
Concept: Monerans

Purpose: To help students understand that they have bacteria growing on and in them.

Time: 10 minutes per day for 3-6 days

Materials:
- sterile jar of agar
- sterile throat swab

Steps:
1. Gently wipe the sterile throat swab against the back of your mouth.
2. Open the jar of agar and brush the swab over the right side of the agar.
3. Gently press a finger on the left side of the agar.
4. Close the jar and label it with your name.
5. Dispose of the jars when observations are finished.

Evaluation:
1. Draw a sketch of the bacteria you observe growing in your agar each day for 3-6 days. Describe the differences you see day by day.
2. Describe what you observe in terms of shape and color.

Extending Ideas:

Bacteria are on you and in you. They are also in the bodies of most other organisms, in the air, in the water, and in the soil. In fact, they are just about everywhere. They are so tiny that thousands of them would fit on the dot above the "i" in their name.

Addison-Wesley, 1989
Concept: Fungi

Purpose: To determine which chemicals help or harm yeast growth

Time: 45 minutes

Materials:

- yeast
- 6 jars
- water
- beef broth
- spoon
- vinegar
- tape
- sugar water
- salt water
- apple juice
- spoon

Steps:

1. Label each jar with one of these liquids:
   - water
   - beef broth
   - sugar water
   - vinegar
   - salt water
   - apple juice

2. Fill each jar halfway with the warm liquid that matches its label.

3. Put a spoonful of yeast in each jar.

4. Let the jars stand at room temperature for 15 minutes.

5. Record your observations in a data table like the one shown:

<table>
<thead>
<tr>
<th>Jar contents</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td></td>
</tr>
<tr>
<td>beef broth</td>
<td></td>
</tr>
<tr>
<td>sugar water</td>
<td></td>
</tr>
<tr>
<td>vinegar</td>
<td></td>
</tr>
<tr>
<td>apple juice</td>
<td></td>
</tr>
<tr>
<td>salt water</td>
<td></td>
</tr>
</tbody>
</table>

Evaluation:

1. What do yeasts need to live and grow?
2. Why did yeasts not grow in all substances?

Extending Ideas:

Yeasts are tiny, round fungi that live in colonies. You probably know that yeasts are used to make bread. The yeasts use sugar in bread dough for food. They break down sugar into carbon dioxide gas, which causes the bread to rise.

Addison-Wesley, 1989
Activity

Use modeling clay to demonstrate how an ameba gets food. Tear a small piece of clay to represent food and place it on a table top. Then form the rest of the clay into the bloblike shape of an ameba. Pull on the outer edges of the clay to form pseudopods. Then stretch the "pseudopods" until they surround the "food." Show how the food is taken into the cell by incorporating the food into the clay ameba.
Sixth Grade
Life Science

Objective:

Classify plants into two groups, and subdivide those groups by recognizing differences in structure and function.

Experiments

Growing plants from plant parts
Observe the three phases of plant reproduction
Seed classification
Observe pollen under a microscope
Identify parts of a lima bean and cause it to germinate
Dissect a flower

Sources:

Addison Wesley, 1989
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Asexual Reproduction

Purpose: To observe asexual reproduction in bulbs, leaf cuttings, and potato buds.

Time: 15 minutes

Materials:

| plant bulb | ivy cutting | plastic knife | soil |
| plant pot | jars | water |

Steps:

2. Put a leaf cutting in a jar of water. When roots appear, plant the cutting in soil.
3. Get a potato with at least three buds, called eyes, on it. Place the potato in a bag. Put the bag in a dark place. Wait until the buds begin to grow. Then cut them off the potato. Plant the buds in a pot of soil.

Evaluation:

1. Which plant grew the fastest?
2. What part of a plant was used for each planting?

Extending Ideas:

There are two main types of reproduction. In one type, only one organism is needed to produce a new organism. This is called asexual reproduction. Most other types of reproduction require two organisms, a male and a female. This is called sexual reproduction.

Addison-Wesley, 1989
Concept: Plant Reproduction

Purpose: To observe three phases of plant reproduction: flowers, seeds, and germination

Time: 15 minutes

Materials:

- hand lens
- self-lock plastic bags
- paper towels
- 2 or 3 different flowering plants (some in bloom and some that have developed seeds)

Steps:

1. Examine the plants that have flowers in bloom and those that have developed seeds.
2. Put a folded, moist paper towel in a plastic bag.
3. Remove some of the seeds from the plants and place them on the paper towels in the bags.
4. Seal the bags and observe the seeds each day for two weeks.

Evaluation:

1. Draw a sketch of what you see happening with the seeds in your journal every other day.
2. Write a description of what you see.

Extending Ideas:

You may think that if you want a new plant you just plant a seed. But where do seeds come from? A plant has to make seeds. Making seeds is how many plants reproduce.

Addison-Wesley, 1989
Cooperative Learning Activity - Classifying Seeds

1. Have students collect seeds from home and outdoors.
2. Combine all the seeds and distribute them to students.
3. Divide the class into groups of four. Identify a social skill such as responding to ideas.
4. Group members will sort their seeds by size, then by shape, then by any other criteria the group determines.
5. Each group should display its collection of seeds, sorted into categories, by taping or gluing them on poster board.
6. Have the students share their information and discuss how they grouped their seeds. Remind them that, although there is a great diversity of seed types, each seed is formed by the same procedures of pollination and fertilization.
Concept: Plant Reproduction

Purpose: To observe pollen under a microscope.

Time: 15 minutes

Materials:
- small paintbrush
- pollinating flower
- microscope
- microscope slide
- coverslip

Steps:
1. Remove the pollen from a flower using a small paintbrush.
2. Place the pollen on a microscope slide and cover with a coverslip. Observe under a microscope.

Evaluation:
1. Draw a sketch of what you observe under the microscope.
2. Describe what you see in terms of color, size, and structure.

Extending Ideas:

Before seeds can be made, the sperm in the pollen must get to the eggs in the ovary. Pollination is the transfer of pollen from a male part of a flower to a female part.

Addison-Wesley, 1989
Concept: Plant Reproduction

Purpose: To identify the parts of a lima bean and discover the effects of water on seeds.

Time: 20 minutes

Materials:
- dry lima bean
- soaked lima bean
- metric ruler

Steps:

1. Measure the length, width, and thickness of a dry lima bean in millimeters. Record your data in your journal.
2. Carefully pry open the bean seed and identify the plant embryo. Sketch what you see.
3. Measure the length, width, and thickness of a lima bean that has been soaked in water overnight. Record your data.
4. Carefully pry open the soaked seed and identify the plant embryo. Sketch what you see.
5. Write a description of the similarities and differences you observed between the dry lima bean and the soaked lima bean.

Extending Ideas:

When the seed is planted in moist soil, it absorbs water. With water and warm temperatures, the young plant inside the seed begins to divide and grow. The young plant uses the food stored in the seed. In time, it grows large enough to break through the seed coat. This sprouting of a new plant from a seed is called germination.

Addison-Wesley, 1989
Concept: Plant Reproduction

Purpose: To examine the parts of a flower by dissecting a perfect flower.

Time: 30 minutes

Materials: flower straight pin hand lens

Steps:
1. Examine a flower. Identify these parts: petal, pistil, stigma, style, ovary, stamen, filament, anther.
2. Touch the tip of the stamen with your finger to collect pollen grains. Use a hand lens to look at the pollen grains.
3. Now look for pollen grains at the tip of the pistil. Look at them with a hand lens.
4. Carefully remove the pistil from the flower. Use a straight pin to cut open the ovary. Using a hand lens, find the ovules.

Evaluation:
1. How many pistils are in the flower? How many stamens did you find?
2. What shape and color are the pollen grains?
3. Draw a sketch of your flower. Label all the parts.

Extending Ideas:

The female part of a flower is the pistil which is made of three parts: the stigma, style, and ovary. The male part of a flower is the stamen which is made of the filament and the anther.
Fifth Grade
Physical Science

Objectives:

Recognize the basic units of matter

Understand that a compound is made up of two or more different kinds of atoms

Develop the concepts of physical properties of matter

Conclude that matter can undergo physical changes

Experiments:

Inferring structure without observation
Create models of atoms and compounds
Demonstrate solutions and suspensions
Predict how water levels are affected by solutions and suspensions

Sources:

Addison Wesley, 1989
Chemistry For Every Kid, 1989
Protecting Our Planet, 1991
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Matter

Purpose: To make models of combinations of atoms to discover how the same atoms can combine in different ratios to make different compounds.

Time: 20 minutes

Materials:
- 2 long bolts
- 2 short bolts
- 2 wing nuts
- 2 hex nuts

Steps:
1. Use the following symbols for each nut and bolt:
   - Long bolt-Lo
   - Wing nut-Wg
   - Short bolt-Sh
   - Hex nut-Hx

2. Place a hex nut on a long bolt. Use the symbols to write a formula for this "molecule."
3. Now add another long bolt to the combination you just made. Write a formula for this molecule.
4. Continue making molecules using different nuts and bolts. Write formulas for each molecule.

Evaluation:
1. What was the formula for your nut and bolt combination in Step 2? In step 3?
2. How many different combinations did you make?
3. How are your formulas similar to the formulas used by scientists for molecules and compounds?

Extending Ideas:

Elements are made up of very small particles called atoms. Each element has its own type of atom. Atoms are the smallest particle of an element that can exist and still keep the element's chemical properties.

Addison-Wesley, 1989
Concept: Matter

Purpose: To learn how to infer structure without direct observation.

Time: 35 minutes

Materials:
- box
- pencil
- 4 straws
- 3 washers

Steps:
1. With your pencil, carefully punch two holes in each side of the box. Make sure the holes on opposite sides line up.
2. Place four straws through the holes as shown in the picture.
3. Close your eyes. Have someone put the straws through the washers and close the lid.
4. Open your eyes and study the box. Move it but do not open the lid! Draw a diagram of where you think the washers were places on the straws.

Evaluation:
1. Was your diagram accurate? Why or why not?
2. What clues helped you guess where the washers were?
3. Compare this activity to the way a scientist makes a model of an atom.

Extending Ideas:

You live in a world made of matter. Your desk is probably made of wood. The classroom windows are made of glass. Wood and glass are types of matter. All matter has mass and takes up space. Each kind of matter is called a substance.

Addison-Wesley, 1989
Concept: Matter

Purpose: To make samples of a solution and a suspension and predict how water levels are affected.

Time: 15 minutes

Materials:
- 2 jars with lids
- Masking tape
- Salt
- Sand
- Water
- Spoon

Steps:
1. Use the tape to mark a line half way up the jars.
2. Fill each jar with water to the top of the tape.
3. Predict what will happen to the water level if you add three spoonfuls of salt or sand to each jar. Record your predictions.
4. Add three spoonfuls of salt to one jar and three spoonfuls of sand to the other jar.
5. Replace the lids. Shake each jar to make mixtures.
6. Observe the water levels.

Evaluation:
1. How did the water levels change? Explain your observations.
2. Were your predictions correct?
3. Which mixture was a solution? A suspension? Explain your answers.

Extending Ideas:

A mixture contains two or more different substances that are not chemically joined. The properties of mixtures depend upon the properties of the substances found within them. A mixture changes according to the amount of each substance present.

Addison-Wesley, 1989
Concept: Matter

Purpose: To demonstrate the difference between a solution and a suspension.

Time: 25 minutes

Materials:
- 2 plastic cups
- laundry starch
- spoon
- water
- sugar

Steps:
1. Fill one cup two-thirds full of water. Mark the outside of the cup to show the water level.
2. Add a spoonful of sugar. Stir it 20 times. Notice the level of the mixture. In the table below, record your observations.
3. Fill the other cup two-thirds full of water. Mark the outside of the cup to show the water level.
4. Add a spoonful of laundry starch. Stir it 20 times. Notice the level of the mixture. Record your observations.
5. Let both cups sit for five minutes. Record your observations.

Recording Data

<table>
<thead>
<tr>
<th>Events</th>
<th>Water and sugar</th>
<th>Water and starch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in level after mixing and stirring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What mixture looked like after stirring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What mixture looked like five minutes later</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation:
1. Which mixture is a solution? Which is a suspension? Explain.
2. Describe two differences you observed between the solution and the suspension.

Extending Ideas:

In a solution, the different parts mix together evenly. They do not easily separate from each other. The substances in a suspension usually remain mixed for only a short time. They do not dissolve.

Addison-Wesley, 1989
Activity

Students will separate a mixture of sugar and sand and also make a solution of sugar and water.

Have each pair of students take one spoonful of sand and one of sugar and mix the two substances in a bowl, stirring with the spoon. Direct students to fill one cup three-fourths full of water, pour the mixture of sand and sugar into it, and stir vigorously. Students should set the mixture aside for 15 minutes. The sand will settle out, leaving a solution of sugar water. Give each pair a large piece of aluminum foil. Have the students place the foil in the sun or near a heat source and then spoon a small portion of the sugar water onto the aluminum foil. After about five minutes, the water on the aluminum foil will have evaporated and left a white powder, which is the sugar.

Activity

Give each student a cup and a spoon. Tell students to make a mixture of things they have nearby. They could put into the cup marbles, pencil erasers, toothpicks, paper clips, coins, and so on. Tell students to put water in the cup and stir vigorously for one minute. Then ask them to observe their mixtures. Has anything become chemically combined? How would you go about separating this mixture? Explain that they each made a mechanical mixture, one that can be separated by mechanical means.

Activity

Food coloring is a mixture of various compounds and can be separated through chromatography. Cut a strip of paper towel about 2 inches wide and 9 inches long. Place a drop of food coloring at about the middle of the strip, about 3 inches from one end. Place the short end of the strip in a bowl of water, and have students observe the towel absorb the water. The spot of food coloring will separate into constituent parts, each with a slightly different color. Explain that chromatography is widely used in chemical analysis. The separation occurs because some molecules are more attracted to the water than others, and the ones more attracted move farther with the water along the towel.

Activity

Give each pair of students two small cups, a spoon, access to sugar, and access to hot and cold tap water. Have one student in the pair fill a cup with cold water, add one spoonful of sugar, and stir until the sugar is completely dissolved. The partner will determine how long it takes for the sugar to dissolve. Then have partners switch roles and repeat the process using hot water. Explain that the sugar dissolved faster in hot water because the molecules of hot water are farther apart, allowing the sugar to mix in more rapidly.
Activity

Display a bottle of oil and vinegar salad dressing that has been left undisturbed for a while. Why is this substance a mixture? Because each substance retains its own chemical properties. Shake the bottle and have students watch as the oil and vinegar are mixed. What do you think will happen if the bottle is left alone for an hour? The oil and vinegar will separate. Explain that, because gravity will separate the parts of the mixture, oil and vinegar is a suspension.

Concept: Elements

Purpose: To classify elements according to various characteristics.

Time: 20 minutes

Materials:
copper wire  gold-plated object  charcoal briquet
iron skillet  aluminum foil  chrome fixture
quarter  mercury thermometer

Description:
Place examples of elements on a display table and allow students time to examine and handle these elements. Explain that each is a special type of substance. In a class discussion, list characteristics of each on the chalkboard. If possible, bring a helium-filled balloon to class, and release the gas while students observe.

Game:
Find a periodic table of the elements. Have students make flashcards of elements with the symbol of an element on one side and the name on the other. Play Around-the-World with the class or have students play other flashcard games in small groups.

Activity

Refer to the three models of the atom and remind students that no one has ever seen an atom. Therefore, information for these models are obtained from complex scientific equipment. Have pairs of students work through a process to show the difficulty of gaining this information. Have one student describe a magazine photograph, never telling exactly what the photograph is, while the other student, with paper and pencil, draws a picture according to the verbal description. The students will then compare the drawing to the photograph to see how accurately the drawing represents the photograph. Students may then switch roles, using a new photograph chosen by the second student.
Activity

Have students in small groups make models of a few atoms, using paper plates for backing, cotton for electron clouds, light and dark beans for protons and neutrons, and glue or tape to construct the models. Students may use reference books to determine the number of protons and neutrons in each element. The electron cloud of the models should increase in size as the nucleus increases in size.

Activity

In this activity, students will observe that the ratio of elements in a compound remains constant.

Cluster students in threes, but have them work individually. Place a box of large paper clips and a box of small paper clips within reach of each student cluster. Explain that each small paper clip is a hydrogen atom and each large paper clip is an oxygen atom. Tell students that water is formed when two hydrogen atoms attach to one oxygen atom. Give them one minute to make as much water as possible by attaching two small clips to one large clip and putting it in a pile.

After one minute, each student should separate the pile into large and small clips, counting the number of each. Write the number of clips on each table on the chalkboard. When all the numbers are compiled, show students that in each case there are exactly two hydrogen atoms for every one oxygen atom. Point out that no matter how much water is made, the ratio of two to one remains constant.

Activity

Divide the class into small groups, and give each group a clear glass of water. Direct students to add a drop of food coloring to the water but not to shake or otherwise disturb the glass. As the food coloring spreads throughout the glass of water, explain to students that they are watching molecules of one substance spread through molecules of another. Point out that, eventually, the molecules of the food coloring will slip between the molecules of the water to color the whole glass of water.
Activity

Put some fine steel wool into a clear glass jar, half-filled with water. Add three spoonfuls of liquid bleach and one spoonful of vinegar, and set aside. Explain that the bleach and vinegar help cause a chemical reaction. The red substance forming on the steel wool is rust, or iron oxide. The iron comes from the steel wool and the oxygen comes from the water.

Activity

Pour some vanilla extract into a balloon, quickly blow it up, and tie it. Then shake the balloon for about a minute. Allow students to smell the outside of the balloon. How can you smell vanilla through the rubber of a balloon? The vanilla molecules are small enough to slip between the molecules of the balloon to the outside.
Sixth Grade
Physical Science

Objective:

Explain that electricity
is a form of energy

Experiments:

Observe generated electricity by using a compass
Observe magnetism from an electric current
Make and run an electric motor
Show the increase in television sets
Learn how to change the strength of an electromagnet

Sources:

Addison Wesley, 1989
Chemistry For Every Kid, 1989
Protecting Our Planet, 1991
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Electricity

Purpose: To generate electricity and observe its generation by using a compass.

Time: 25 minutes

Materials:
copper wire   bar magnet   compass   tape

Steps:
1. Wind copper wire into a coil that has about ten loops. The coil must be large enough so that the magnet can fit inside.
2. Twist the two loose ends of the coil together.
3. Place a compass under the single wire with its needle parallel to the wire. You may want to tape the wire on either side of the compass.
4. Insert the magnet halfway inside the coil of wire and quickly pull it out.
5. At the same time, observe any changes in the compass needle.

Evaluation:
1. Explain any movement in the compass needle.
2. How could you get the compass needle to show more movement? State your hypothesis.

Extending Ideas:

In 1820, a scientist named Hans Christian Oersted was teaching a science class. He placed a compass near a wire carrying an electric current. The compass needle moved. Since a compass needle behaves like a magnet, Oersted concluded that electric currents produce magnetism.

Addison-Wesley, 1989
Concept: Electricity

Purpose: To observe magnetism from an electric current.

Time: 25 minutes

Materials:
- insulated copper wire
- 9-volt battery
- iron filings, iron dust, or steel wool

Steps:
1. Place the iron filings (or substitute) on a piece of paper.
2. Connect one bare end of the wire to the battery and arrange the other bare end so that it falls into the iron filings.
3. Record what happens in this setup.
4. Connect the bare ends of the wire to the terminals of the battery so that a current flows through the wire (making a circuit.) The wire should be looped through the iron filings. Quickly lift the wire and observe the iron filings.
5. Disconnect one end of the wire and observe what happens to the iron filings.

Evaluation:
1. Describe what happened at each stage of this experiment.
2. How do you know that the current produced the magnetism?

Extending Ideas:

In 1831, Michael Faraday showed that magnetism can produce electricity. He discovered that if a coil of wire is rotated between the opposite poles of a magnet, an electric current is generated in the wire.

Addison-Wesley, 1989
Concept: Electricity

Purpose: To make and run an electric motor.

Time: 60 minutes

Materials:

- enameled copper wire
- sandpaper
- 2 paper clips
- wood block
- battery
- modeling clay
- 2 wires
- bar magnet

Steps:

1. Scrape the enamel off the ends of the copper wire with sandpaper.
2. Coil the wire 10 times. Shape the coil into a square.
3. Bend the paper clips to make small loops. Insert the ends of the coil through the loops.
4. Stand the paper clips up on a wood block with clay.
5. Scrape the insulation off the ends of two more pieces of wire. Use the wires to connect the paper clips to the battery terminals.
6. Place the magnet so that one of its poles is close to the loop. Start the motor spinning with your finger.

Evaluation:

1. Why did the wires get warm?
2. What is the armature in this activity? The stator? The commutator?

Extending Ideas:

Motors convert electric energy to motion. This motion is known as mechanical energy. The mechanical energy produced by motors is used to make something move. In this way, motors are used to do work.

Addison-Wesley, 1989
Concept: Electricity
Purpose: To make a graph to show the increase in the number of television sets over a 20-year period.

Time: 30 minutes

Materials:
- graph paper
- ruler

Steps:
1. Make a bar graph to show numbers of television sets in various years.
2. Complete the bar graph with the data from the paragraph below:

The number of color television sets in the United States has increased rapidly since 1965. At that time, there were three million sets. In 20 years, there were 75 million more. The number increased steadily during those 20 years. In 1970, there were 21 million sets. In 1975, there were 47 million sets. By 1980, there were 63 million sets.

Evaluation:
1. When was the largest increase in numbers of sets?
2. When was the smallest increase?

Extending Ideas:

Television broadcasts are sent and received over radio waves. The signals, however, contain information about both pictures and sounds.

Addison-Wesley, 1989
Concept: Electricity

Purpose: To learn how to change the strength of an electromagnet.

Time: 40 minutes

Materials:
- 1 meter of insulated wire
- large nail
- sandpaper
- box of paper clips
- battery (1.5-volts)

Steps:
1. Remove the insulation from the ends of the wire with sandpaper.
2. Make an electromagnet by winding the insulated wire around a nail 20 times. All windings must be in the same direction. Make sure that both ends of the wire are free.
3. Connect the bare ends of the wire to the terminals of a battery.
4. Record the number of paper clips the electromagnet picks up. Predict what will happen if you increase the number of turns of wire.
5. Wind 20 more turns of wire. Repeat step 4.

Recording Data

<table>
<thead>
<tr>
<th>Wire turns</th>
<th>Predicted</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation:
1. How was the strength of the electromagnet affected by the number of turns of wire?
2. What would happen if you removed the nail from the coil?

Extending Ideas:

Electromagnets are very useful because they can be turned on and off. When the electricity is turned off, the electromagnet no longer acts like a magnet.

Addison-Wesley, 1989
Activity

These materials are needed to set up this demonstration: a radio, two lengths of insulated wire (with ends exposed,) a 1.5-volt battery, and a metal file with a wooden handle. Use one wire to connect the battery’s negative terminal to the narrowest part of the metal file. The other wire should be attached to the battery’s positive terminal and left dangling. Place the radio about one meter from the file and turn the radio on at a place on the dial where there is no station. Turn up the volume. Now scrape the exposed end of the dangling wire down the file. This will cause electromagnetic radiation (radio waves) that will be picked up by the radio. Point out that the radio waves sent out by radio transmitters are similar but much more controlled.

Activity

This demonstration will show students how sound that is changed into electricity can make a small light flicker. Set up a circuit with these materials: four pieces of bell wire, a transmitter from a telephone, a 470-ohm resistor, a light-emitting diode, and a 9-volt battery. (You can get a telephone transmitter from most telephone mouthpieces; just unscrew the mouthpiece and take out the disk.) The other materials can be obtained from most local electronics stores. Make the circuit in this order: negative terminal of battery to resistor, to transmitter, to diode, to positive terminal of battery. The wire can be attached to the transmitter with tape.

Once the circuit is complete, the bulb on the diode should react (flicker) to sounds received by the transmitter. Let each student speak into the transmitter to make the light flicker. Emphasize that the transmitter is changing sound vibrations into an electric current.

Activity

Copy an electric bill to give to each student. Write the following headings on the chalkboard: meter readings (previous and present,) period of service (number of days,) kilowatt-hours used, and total cost. Ask students to study the bill to find information pertaining to each of the headings listed on the board. Have them record this information. Then discuss the bill with the class.
Activity

Show students how a simple electromagnet can be made with dry cell batteries, an iron bolt, and about 3 meters of copper wire. Use a short piece of wire to connect the negative terminal of battery 1 to the positive terminal of battery 2. Connect one end of the rest of the wire to the negative terminal of battery 2, coil the wire many times around the bolt, and connect the other end to the positive terminal of battery 1. Demonstrate how the electromagnet can pick up objects such as pins.

Activity

Take apart an old motor from a blender, a fan, or some other discarded household appliance. Have students try to identify some of the parts. Even though much will be unidentifiable, students will nevertheless benefit from seeing the parts of a motor.
Sixth Grade
Physical Science

Objectives:

Recognize the diverse and varying forms of matter

Compare elements and compounds

Experiments:

Demonstrate how to make compounds
Demonstrate oxidation
Cause a reaction between iron and copper sulfate
Model how hydrogen and oxygen combine to form water
Observe expansion caused by gaseous products
Classify acids and bases using an indicator

Sources:

Addison Wesley, 1989
Chemistry For Every Kid, 1989
Protecting Our Planet, 1991
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Compounds

Purpose: To understand and demonstrate how to make compounds.

Time: 30 minutes

Materials:
- funnel
- 2 soda bottles
- vinegar
- measuring cup
- dish and spoon
- paper towels
- baking soda
- 2 balloons
- goggles
- water
- lemon juice

Steps:
1. Put the funnel on a bottle.
2. In the dish, mix a spoonful of vinegar with 125 ml of water.
   Pour the liquid into the funnel.
3. Rinse and dry the spoon with paper towels.
4. Put a spoonful of baking soda onto the middle of a tissue.
   Wrap the tissue, then push it into the bottle.
5. Quickly cover the opening of the bottle with the balloon.
   Watch to see what happens.
6. Repeat steps 1 to 5 with lemon juice in place to the vinegar.

Evaluation:
1. What kind of compound (solid, liquid, or gas) did the baking soda form with the vinegar? With the lemon juice?
2. How were the reactions the same? How were they different?
3. Were the reactions physical or chemical changes? How do you know?

Extending Ideas:

A compound is made up of two or more different elements that are chemically combined in definite amounts. The number and arrangement of atoms determine a compound’s properties.

Addison-Wesley, 1989
Concept: Chemical properties

Purpose: To demonstrate that rusting is a form of oxidation by showing that oxygen is used when a piece of steel wool rusts.

Time: 50 minutes

Materials:

- steel wool
- metric ruler
- foil pie pan
- jar
- graph paper
- 2 tongue depressors

Steps:

1. Soak a piece of steel wool in water. Place the steel wool in a small jar. Turn the jar upside down on the tongue depressors in a pan. Pour water into the pan to a depth of 2 cm.
2. Measure and record the height of water in the jar in millimeters. Do this for three days.
3. Draw a right angle. Label the vertical line, Height of Water (mm). Mark spaces on this line from 0 to 10. Each mark should be 1 cm apart. Each mark is 1 mm. Label the horizontal line, Time (days). Mark spaces on this line from 0 to 3. Each mark should be 2 cm apart. Each mark is one day.
4. Plot the height of water for each day. Connect the points for a line graph.

Evaluation:

2. What caused the change in water level? Why?

Extending Ideas:

Chemical properties describe the way one compound will react with another. When compounds react, they produce a new substance with different physical and chemical properties.

Addison-Wesley, 1989
Concept: Chemical properties

Purpose: To model how hydrogen and oxygen combine to form water.

Time: 15 minutes

Materials:
- 4 toothpicks
- 2 marshmallows
- 4 gumdrops

Steps:
1. Pretend that marshmallows are oxygen atoms, gumdrops are hydrogen atoms, and toothpicks are chemical bonds.
2. Attach a marshmallow to both ends of a toothpick. An oxygen molecule has two atoms of oxygen for each molecule.
3. Attach a gumdrop to both ends of a different toothpick. Make two of these models. Hydrogen molecules also have two atoms for each molecule.
4. Take the three molecules apart. Build two molecules of water. No atoms are lost in the process. The total number of atoms is the same.

Evaluation:
1. How many chemical bonds are formed in each water molecule?
2. How many atoms of hydrogen and oxygen would you need to form five molecules of water?

Extending Ideas:
Elements and compounds are composed of atoms. In an element, all of the atoms are of the same kind. Compounds contain atoms of two or more different elements. The atoms are chemically joined together, forming molecules.

Addison-Wesley, 1989
Concept: Chemical properties

Purpose: To observe the reaction of iron with copper sulfate.

Time: 20 minutes

Materials:
- 2 iron nails
- copper sulfate
- jar
- water

Steps:
1. Stir a spoonful of copper sulfate into a jar of water.
2. Put 2 nails into the solution and wait a few minutes.
3. Observe the substance that forms on the nails.

Evaluation:
1. Has a chemical reaction occurred? How do you know?
2. What reaction occurred?

Extending Ideas:

In air or in water, oxygen reacts with many other substances. This type of chemical change is called oxidation. If oxygen atoms react with only one other element, an oxygen compound called an oxide is formed. This is what happens when oxygen reacts with the element iron and the compound iron oxide is produced, better known as rust.

Addison-Wesley, 1989
Concept: Chemical properties

Purpose: To classify seven substances as acid or base, using an indicator.

Time: 20 minutes

Materials:
- cabbage juice
- 7 small jars
- white vinegar
- spoon
- baking soda
- soap flakes
- grapefruit juice
- antacid
- ammonia solution
- lemon juice
- goggles

Steps:
1. Pour the cabbage juice into each jar. The juice will be your acid-base indicator. Acids will make it red. Bases will make it blue.
2. Add one spoonful of white vinegar to one of the jars. Record your observations in a data table like the one below.
3. Repeat step 2 for each substance listed in the data table. Use a different jar for each substance.

Recording Data

<table>
<thead>
<tr>
<th>Substance</th>
<th>Indicator color</th>
<th>Acids, bases, or neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>White vinegar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baking soda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grapefruit juice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soap flakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lemon juice</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation:
1. What is the strongest acid you tested? Explain.
2. What is the strongest base? Explain.

Extending Ideas:

Acids are compounds that will combine with baking soda, producing carbon dioxide gas. Bases are compounds that can cancel an acid’s chemical properties. The pH scale describes the strength of a solution containing an acid or base.

Addison-Wesley, 1989
Concept: Chemical properties

Purpose: To observe expansion caused by the gaseous products of a chemical reaction.

Time: 20 minutes

Materials:
- plastic soda bottle
- balloon
- yeast
- sugar
- warm water
- spoon
- rubber band

Steps:
1. Fill a plastic soda bottle half full of warm water.
2. Open a fresh packet of yeast. Add it to the warm water.
3. Measure a heaping spoonful of sugar. Add this to the contents of the bottle.
4. Cover the bottle and gently swirl the contents.
5. Use a rubber band to fasten a balloon over the mouth of the bottle.
6. Wait ten minutes, then record what you observe.

Evaluation:
1. What could have caused the changes?
2. Why was warm water used? What would happen if you used cold water or very hot water?

Extending Ideas:
During chemical changes, substances with new physical and chemical properties are produced. Chemical changes happen through events called chemical reactions. In a chemical reaction, substances known as reactants undergo a chemical change which results in the formation of new substances called products.

Addison-Wesley, 1989
Activity

In this activity, students will observe the chemical and physical changes that occur when matches are burned. Give each student a shallow dish, a match, tongs, paper, and pencils. Ask students to carefully examine the match and write down their observations. Circulate to each group and perform the following while students observe: hold the match over the petri dish with the tongs, light it, allow it to burn out, and then place the burned match in the petri dish. Use care when working with matches. Students may handle the match after it has cooled.

Have students note the characteristics of the match before and after burning (physical changes) as well as the changes that occur while the match is burning (chemical changes.) They should note that the chemical changes are the release of energy as heat and light, and the release of carbon dioxide.

Activity

Put a tablespoon of sugar in the center of an aluminum pie tin. Place a clear glass jar upside down over the sugar. Set the tin on a burner and heat the sugar over low heat until it turns black. Then remove the tin from the burner and allow it to cool. Once everything is cool, allow students to taste the liquid and the black substance under the jar.

Does the liquid taste sweet? (No)
Does the black substance taste sweet? (No)

Explain that heating the sugar reduced it down to carbon (the black substance) and water (the liquid.)

Cooperative Learning

Arrange the class in groups of four. Identify a social skill such as sharing work. Divide each group into pairs. One pair in each group will mix plain flour, sugar, and water to make a dough. The other pair will mix self-rising flour, sugar, and water. Bake the doughs and have the group members compare them. Group members will discuss the differences they observe and will write a single explanation, reached by consensus. (Self-rising flour contains baking soda and baking powder, which react to form carbon dioxide, causing the dough to rise; the other dough had no reaction so it did not rise.)
Activity

Obtain ammonium nitrate granules from a scientific supply company. Dissolve the granules in a jar of water and have the students note how cold the jar becomes. Students should feel the outside of the jar before and after the granules are mixed into the water. Discuss the result of the chemical reaction: the reaction causes a drop in temperature.

Activity

Have students test an enzyme at work. Provide each student with two test tubes. Have them put a piece of starch (such as bread or potato) in the bottom of each test tube, then add enough water to cover the starch. Have students put some saliva in one of the test tubes. Leave the test tubes in a warm place for a few days, then have students put a few drops of iodine in both test tubes. What happened when you added iodine to the test tubes? Explain that iodine is an indicator that turns blue in the presence of starch. Have students attempt to explain the difference in intensity of the blue color in the test tubes.
Objective:

Understand the basic factors that cause and influence the weather.

Experiments:

Determine dew point
Make a cloud model
Make a model of a cold front
Make a model of a wind vane

Sources:

Addison Wesley, 1989
Protecting Our Planet, 1991
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Weather

Purpose: To observe how clouds are formed by making a model of a cloud.

Time: 25 minutes

Materials:
- clear plastic bottle
- self-lock bag
- hot water
- cone incense
- 2 ice cubes
- foil pie pan

Steps:
1. Heat the bottle by immersing it in hot water for a few minutes. Do not let water enter the bottle.
2. Place the ice in a self-lock bag. Seal the bag.
3. Place a piece of incense in the pie pan. Ask your teacher to light it.
4. Turn the bottle upside down. Let some smoke from the incense rise into the bottle.
5. Turn the bottle right side up and quickly place the bag of ice cubes over the mouth of the bottle. Observe what happens in the bottle.

Evaluation:
1. What caused the cloud to form?
2. How does your model compare with how clouds form in the air?

Extending Ideas:

The cooling of warm, humid air causes clouds to form. As warm air cools, water vapor gathers on bits of dust in the air and changes to liquid. The bits of dust and water form tiny water droplets. Millions of these water droplets join to form clouds.

Addison-Wesley, 1989
Concept: Weather

Purpose: To be able to determine dew point.

Time: 30 minutes

Materials:
- aluminum cup
- water
- ice cubes
- paper towels
- thermometer
- stick for stirring

Steps:
1. Clean the outside of the cup with paper towels. Fill the cup two-thirds full of water.
2. Put the bulb of the thermometer in the water and hold it so that the bulb does not touch the sides or bottom of the cup. After one minute, read the thermometer.
3. Put one ice cube in the water. Hold the thermometer in the water as you did in step 2. With your other hand, use the stick to gently stir the water. Do not hit the thermometer.
4. Watch the outside of the cup. When moisture first begins to appear on the outside, read the thermometer. This temperature is the dew point. Record your answer for question 1 below.
5. Repeat steps 1-4 three more times. For the final dew point temperature, find the average temperature of all the readings.

Evaluation:
1. What was the dew point temperature the first time? The second time? The third time? The fourth time?
2. If there were more moisture in the air today, would the dew point be higher or lower? What makes you think so?
3. Why is it a good idea to take more than one reading and to find the average dew-point temperature?

Extending Ideas:

To understand the weather, scientists study four things: temperature, wind, moisture, and air pressure. These four conditions produce weather changes.

Addison-Wesley, 1989
Concept: Weather

Purpose: To make a model of a wind vane

Time: 30 minutes

Materials:
- poster board
- tape
- large eraser
- compass
- scissors
- pencil w/ eraser
- soda straw
- metric ruler
- index card
- push pin
- straight pin

Steps:

1. Tape a piece of poster board to your desk. Put the large eraser on the poster board. Draw a circle around it. Use a compass to find north, east, west, and south on the circle. Label these points.
2. Push the pencil into the eraser.
3. Use the scissors to cut a slit three centimeters long at one end of the straw. Fold the index card in half lengthwise. Place it in the slit.
4. Use a push pin to make a hole through the middle of the straw. Stick the straight pin through this hole and into the pencil end. Make sure the straw can spin.
5. Move around the wind vane and blow on it. Observe the direction it points. Record your results.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Direction from which wind blows</th>
<th>Direction wind vane points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation:

1. What does a wind vane tell you about the wind?
2. How can a wind vane help you predict a change in the weather?

Extending Ideas:

The sun provides the energy that heats the earth’s surface. The heated surface of the earth warms the air above it. But the sun does not heat all of the earth’s surfaces evenly. Some places become warmer than others. The differences in air temperature cause wind.

Addison-Wesley, 1989
Concept: Weather

Purpose: To make a model of a cold front using ice cubes.

Time: 20 minutes

Materials:
- red food coloring
- ice cube tray
- warm water
- dropper
- jar of water
- large, clear jar

Steps:
1. Add fifteen drops of red food coloring to the water. Stir until the food coloring dissolves. Make sure the water is a deep red. Add more food coloring if you need to.
2. Fill an ice cube tray with this colored water. Put the tray in a freezer.
3. When the cubes are frozen, fill a large jar halfway with warm water.
4. Gently drop an ice cube into the warm water.
5. Watch what happens in the water for the next five minutes.

Evaluation:
1. After step 4, what happened to the ice cube? To the warm water?
2. Although you are observing water and not air, describe how this helps explain what happens when a cold air mass meets a warm air mass.

Extending Ideas:

When cold air pushes into a region where there is a mass of warm air, a cold front forms. The cold air pushes under the lighter, warm air. This forces the warm air up.

Addison-Wesley, 1989
Demonstration:

Tape thermometers at various heights along the walls of the classroom. Record the temperatures on the chalkboard. Put a large container of ice and a fan in one corner of the room. Turn on the fan for one half hour. Take temperature readings again and record them on the board. Which location showed the greatest temperature change? Why?

Cooperative Learning

Divide the class into groups of five. Identify a social skill such as contributing ideas. Students will observe the clouds and the weather and record observations at least twice a day for several days. Group members should decide together which weather conditions they will observe and when these observations will be made. Each group member should be responsible for at least two observations. After the observations have been completed and recorded, the group should form conclusions about the types of clouds that may be associated with particular kinds of weather. Have each group present its findings to the class, in the form of either an oral report or a pictorial report.

Activity

Have each student choose a city and locate it on a map of the United States. Each day for a week, bring in the national weather data from the newspaper. Have students draw in weather fronts on their maps and record the temperature and weather for their cities. At the end of the week, ask students to write reports about what happened to the weather in their cities during the week.
Fifth Grade
Earth Science

Objectives:

Understand the nature of the universe beyond the solar system.

Experiments:

Construct a sundial
Model solar and lunar eclipses
Observe and plot the progress of the moon

Sources:

Addison Wesley, 1989
Protecting Our Planet, 1991
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Solar system

Purpose: To use a model to show how solar and lunar eclipses occur.

Time: 10 minutes

Materials:

flashlight globe rubber ball

Steps:

1. Darken the room. Have someone shine the flashlight on the globe so that the light falls evenly on its surface.
2. Imagine you live on the moon. Predict what you would see on the moon during a lunar eclipse.
3. Move the rubber ball around the globe, like the moon orbits the earth. The rubber ball should be closer to the globe than to the flashlight. Observe the shadows that form on the globe and ball.

Evaluation:

1. Where did the "moon" cast a shadow on the "earth"? What would someone in this area see?
2. What happened when the earth was between the "sun" and the moon? What is this called? What would someone on the moon see?

Extending Ideas:

Two or five times a year, the earth, sun, and moon line up together. The earth gets between the sun and the moon. When this happens, the moon enters the earth’s shadow. When the moon moves through the earth’s shadow, a lunar eclipse occurs.

Addison-Wesley, 1989
Concept: Solar system

Purpose: To construct a sundial and infer that the earth is revolving around the sun.

Time: 20 minutes

Materials:
- pencil
- clay
- tape
- paper
- ruler

Steps:
1. Place a pencil upright in a lump of clay.
2. Find a window that gets sunlight all day. Tape a piece of paper on the window sill. Set the pencil and clay on the paper near the window pane.
3. Draw a half circle around the pencil.
4. Draw a line on the paper where the pencil’s shadow falls. Draw the line from the clay to the circle. Label this line with the time of day.
5. Every hour, mark the shadow’s position. Label each mark with the time of day. Do this for one full day.
6. Use this sundial to tell time the next day and one week later. Compare the sundial’s time with a watch.

Evaluation:
1. Was the sundial time the same as the watch each time you compared the two? Explain.

Extending Ideas:

During the earth’s yearly trip around the sun, we experience different seasons. The seasons are not caused by the distance the earth is from the sun. Instead, seasons are caused by the tilt of the earth’s axis.

Addison-Wesley, 1989
Activity

Have students put an object on their desks to represent the sun and use their pencils as the earth's axis. Students should hold the pencils inclined toward the sun and move the pencils in orbit. Remind them to keep their wrists locked so the pencils do not change orientation. As they move the axis in orbit, emphasize that sometimes the axis points toward the sun and that other times it points away.

Demonstration

Take a globe outside on a sunny day. Put a toothpick into a small clay ball and place it atop your state. Rotate the globe so your state is facing due south. Then tilt the glove to make the toothpick's shadow parallel to students' shadows. This simulates the earth's orientation in space.

Move another toothpick around the globe until you find the spot where it casts a shadow on the globe that points north. Explain that in this time zone, it is now noon. Now move the toothpick along the globe latitudinally and point out that there are places where the noon shadow points south and other places where there is no shadow.

Activity

Use a slide or filmstrip projector lamp placed slightly above head level as a light source, and a table tennis ball to represent the moon. Have students stand in front of the light, one at a time, hold the ball at arm's length, and orbit the ball around themselves. Explain that when they hold the ball in front of the lamp it represents a new moon. As they move the "moon" counterclockwise from the new moon phase (to the left of the lamp), students will see it waxing until it is in the full moon position (when the student is between the ball and the lamp.) Explain that after it is a full moon, it will wane. Now the ball is to the right of the lamp.

Demonstration

Move a circular object to different distances and positions in front of a slide projector lamp. Point out that when the object is near to and right in front of the lens, no light (total eclipse) reaches the wall. As the object is moved off center, point out that some light (partial eclipse) hits the wall. If the object is centered at a point farther away from the lens, an annular eclipse (some light in a ring around the object) strikes the wall.
Concept: Solar system

Purpose: To observe the moon for a month and plot its progress on a model.

Time: 20 minutes

Materials:
- cardboard
- calendar
- yellow modeling clay
- brown modeling clay
- blue modeling clay

Steps:
1. Draw a circle on the cardboard. Divide the circle into 28 equal sections.
2. Mold the clay into three round balls. Make the yellow clay represent the sun, the blue clay the earth, and the brown clay the moon.
3. Place the "earth" in the center of the circle and the "sun" outside the circle. Put the "moon" on the circle between the sun and earth as shown. This is your model of the moon's orbit.
4. Wait for a new moon. Draw what the moon looks like on a calendar like the one below.
5. On your model, write the date next to the clay moon. Then move the clay moon one section counterclockwise along the circle.
6. Watch and draw the moon each night. Repeat step 5 until the moon completes its orbit on the model.

Recording Data

<table>
<thead>
<tr>
<th>Sun</th>
<th>M</th>
<th>T</th>
<th>W</th>
<th>Th</th>
<th>F</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>etc.</td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

Evaluation:

1. Why did you move the moon one section each night?
2. At what phases were the sun, moon, and earth in a straight line?

Extending Ideas:

Like the sun, the moon appears to move across the sky. This motion is not caused by the actual movement of the moon. Instead, as with the rising and setting sun, the moon's motion is caused by the earth's rotation.
Activity

Display calendars that show the phases of the moon: new moon, first quarter moon, full moon, last quarter moon. Point out that sometimes the moon is full and other times it is not. Explain that the calendars show a sequence of events concerning the moon. Have students list on a piece of paper the dates of all the new moons, first quarters, full moons, and last quarters during the year. Discuss the sequence that the phases always take. Have students count the days between full moons, new moons and so on. Also have them determine the number of full moons in the year.

Activity

Have two students demonstrate how the moon rotates once on its axis for each revolution around the earth. Assign students to play the earth and the moon. Ask the "earth" to stand still. Have the "moon" move counterclockwise around the "earth" and always face it. Point out that the "moon’s" counterclockwise rotation on its axis causes the "moon’s" feet to point north, west, south, and east. Explain that this is what happens when the moon orbits the earth. Have the "moon" revolve around the "earth" again; this time tell the "moon" to keep his or her feet pointing in the same direction. Point out that now a different side of the "moon" faces the "earth" at different times because this time the "moon" is not rotating.

Activity

Go outside or to the gym to illustrate the different motions of the earth. Designate students to be the sun, earth, and moon. Have the moon orbit the earth while earth orbits the sun. Surround the sun, earth, and moon with the other students, representing stars in the Milky Way galaxy. All the stars (including the sun) should move around the center of the galaxy. All students should perform their movements at the same time. Replay this drama until students can perform it smoothly and all interested students have had a chance to play the sun, the moon, or the earth.
Demonstration

Tape a few pieces of yellow paper at various places the students know about on a globe. Dim the lights and use a strong flashlight to represent the sun. Slowly rotate the globe and point out how parts of the earth move into and out of the light.

Activity

Take students where the sun is shining directly into the building and put a piece of masking tape on several windows. Have students observe the tape's shadow. Ask students to place a small object where they think the shadow will be in four minutes (the time it takes the earth to rotate 1 degree on its axis.) Then have them predict where the shadow will be in 60 minutes. Check to see which predictions were correct.
Sixth Grade Earth Science

Objectives:

Determine that the sun is the fundamental source of energy on earth and its energy influences climate

Identify why climates are different

Experiments:

Determine areas on the earth with similar temperatures
Construct a model of a rainforest
Determine temperature changes as one moves from the equator to the poles

Sources:

Addison Wesley, 1989
Protecting Our Planet, 1991
Hooked On Science, 1991
175 Science Experiments to Amuse and Amaze Your Friends, 1988
Hands-On Science, 1989
The Whole Cosmos Catalog of Science Activities, 1977
Concept: Climate

Purpose: To identify areas of the earth with similar temperatures and discuss the types of organisms that can live there.

Time: 15 minutes

Materials:
   map of the world or a globe

Steps:
1. Identify places on the map that are cold all year long.
2. Identify places that are warm all year long.
3. Point out areas in which the weather changes seasonally.

Evaluation:
1. How does the temperature of each region affect the types of organisms that can live there?

Extending Ideas

The earth is divided into a number of large regions. Each region differs from the others. The temperature and rainfall, as well as the kinds of plants and animals, are similar in all parts of the region. Each of these regions is called a biome.

Addison-Wesley, 1989
Concept: Climate

Purpose: To construct a model of a rain forest to study the features of this biome.

Time: 45 minutes

Materials:
- 2-liter plastic soda bottle
- small pebbles
- potting soil
- plastic wrap
- moss
- charcoal
- water
- small plants

Steps:
1. Cut the top off the bottle.
2. Place a layer of small pebbles in the bottom of the bottle. Cover these with charcoal.
3. Carefully add a layer of potting soil. Cover it with a layer of moss. Wet the soil thoroughly, but do not make it soggy.
4. Plant the small plants. Spread them out so they have space to grow.
5. Tape plastic wrap over the "rain forest." Put it in a place where there is light, but not direct sunlight. Observe the rain forest for two weeks. Record any changes you see.

Evaluation:
1. Why did you not have to water the rain forest?
2. What animals could you add to your rain forest? Could they live without help from you?

Extending Ideas:

Heavy rains during the entire year and strong sunlight form a forest rich with plants called a tropical rain forest. The temperature in a tropical rain forest stays warm and it is always moist. Over 400 different kinds of trees grow in the rain forest as well as many types of animals.

Addison-Wesley, 1989
Concept: Climate

Purpose: To determine how temperatures change on earth as one moves from the equator toward the poles.

Time: 30 minutes

Materials:
- 2 thermometers
- tape
- globe
- lamp without shade
- metric ruler
- clock or watch

Steps:

1. Make a data table like the one shown below.
2. Tape a thermometer on a large globe at the equator. This is 0 degrees latitude. Tape thermometer horizontally.
3. Directly above the first thermometer, at 40 degrees north latitude, tape another thermometer.
4. Shine the lamp’s light at the equator, 15 centimeters from the globe. Take temperature readings of the two thermometers every 5 minutes for 15 minutes. Record the data.

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Start</th>
<th>After 5 minutes</th>
<th>After 10 minutes</th>
<th>After 15 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 degrees</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 degrees N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation:

1. Which thermometer had light shining more directly on it? Which thermometer recorded the higher temperature?
2. What caused the differences in temperatures?
3. How does this activity show in part why there are different biomes on the earth?

Extending Ideas:

Of all the factors that affect climate, temperature and moisture are most important. The temperature of a biome is determined by the amount of sunlight it receives.

Addison-Wesley, 1989
Cooperative Learning

Divide the class into six groups and assign each group a biome found in the United States. Identify a social skill such as staying on task. Have each group choose a major city within the assigned biome (such as Phoenix, Arizona, for a desert biome) and find its average weather conditions. To obtain this information, students can use reference books or local newspapers found at the library. Be sure all groups report conditions from the same time period. Ask each group to present information to the class and explain how the weather during that period is typical or atypical for the climate of the biome.

Activity

Fill a small pan halfway with soil and add enough water to completely moisten it. Pack down the soil. Place the pan in the freezer for four hours. Remove the pan from the freezer, and pour one or two spoonfuls of water on the frozen soil. Discuss with students that this is how the tundra looks in the summer. The water from the thawed topsoil is unable to drain through the permafrost and creates ponds and marshes.

Activity

Display a collection of branches and cones from various conifers. Also display samples of mosses and lichens. Explain that these organisms represent the climax vegetation of the taiga. Let students examine the specimens with a hand lens. Have them list some of the characteristics of each specimen.

Activity

Display one or more small cactus plants and another type of plant, such as a geranium. Let students examine the plants. Encourage them to carefully touch the plants. Caution them about touching cactus spines. Have them describe how the plants differ. Ask students to explain how the cactus is adapted to live in the desert. Then have them explain why many other types of plants, such as the geranium, could not survive in the desert.

Activity

Provide pairs of students with equal amounts of sand and loam. Have them place each soil type in a separate funnel with filter paper and pour equal amounts of water over them. Ask students to determine which soil type retains more water. Discuss how this demonstrates the properties of the soil found in a desert biome.
SELECTED BIBLIOGRAPHY


