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ABSTRACT

This manual was developed by the Community Resource Curriculum Development Project (CRCDP), a cooperative project to develop multi-disciplinary, multi-ethnic, multi-cultural science/social sciences teaching units based upon the Illinois State Goals for Learning and Chicago public school outcomes for a seamless fifth and sixth grade cluster. This manual contains six teaching units that include several experience-based activities using a constructivist teaching model and incorporating local resources. In these units, students approach each activity using skills gained from their own life experiences. Scientific principles and concepts are introduced following active exploration with hands-on models and investigations. Lessons are linked to information available in the local area and teachers are encouraged to utilize resources in their neighborhood communities whenever possible. The units include: (1) "Atoms and Atomic Structure"; (2) "Without Feathers: Discovering the Forces Behind Human Flight"; (3) "I Spy... Crystals"; (4) "Physics in the 5th Grade? Yes!"; (5) "Sound"; and (6) "Up Down and Around in Chicago: Weather in the Windy City." (JRH)

Community

Resource

Curriculum

Development

Grades 5-6

A Cooperative Effort Project

between

William H. Brown Elementary School
Galileo Scholastic Academy
Andrew Jackson Language Academy
Mark T. Skinner Elementary
National-Louis University
University of Illinois/Chicago
and
The Chicago Academy of Sciences

Spring, 1995

Community Resource Curriculum Development Project

Project Partners
Andrew Jackson Language Academy
Galileo Scholastic Academy of Math and Science
Mark T. Skinner Elementary School
William H. Brown Elementary School
National-Louis University
The Chicago Academy of Sciences
University of Illinois/Chicago

Community Resource Curriculum Development (CRCDP)
The CRCDP is a cooperative project to develop multi-disciplinary, multi-ethnic, multi-cultural science/social sciences teaching units based upon the Illinois State Goals for Learning and Chicago public school outcomes for a seamless fifth and sixth grade cluster. The project provided a team of teachers and principals with a learning experience in creating curriculum, resulting in these six teaching units. The units include several experienced-based activities, using a constructivist teaching model and incorporating local resources.

Teachers have their own individual styles and techniques of instruction. Students have their own individual experiences, understanding, and ways of processing and internalizing what they are to learn. Recognizing these differences in instruction and learning, CRCDP presents flexible yet effective lessons designed to help maximize the success of both teachers and students in their science/social sciences classes.

CRCDP is based on the belief that real learning happens more easily and thoroughly within the context of real life. In these units, students approach each activity using skills gained from their own life experiences. Scientific principles and concepts are introduced following active exploration with hands-on models and investigations. CRCDP provides a bridge between the abstractions of the school curriculum and the world (see Forward: Integrated Elementary Units, page 1).

The CRCDP learning model also focuses on the use of real, experience-based activities in the classroom. Lessons are linked to information available in the local area and teachers are encouraged to utilize ressources in their neighborhood communities whenever possible (see Community Resources, page 13).

The CRCDP project and materials have been funded through an Eisenhower grant. The writing teams created six different units. Copies of the units are available through The Chicago Academy of Sciences. Call 312/549-0606, Ext. 2047 for more information.

CRCDP Objectives

CRCDP units stand alone and are designed to provide ways to individualize existing science/social science instruction to help meet the many needs of the students. The multi-disciplinary nature of the program maximizes the impact of learning skills and the indicated outcomes. The specific objectives of the projects are:

1. to develop a network of resource agencies which can offer expertise, programs, and personnel to aid in the implementation of the State of Illinois Learning Goals;

2. to empower the local school communities by providing meaningful, hands-on knowledge in curriculum development, implementation, and evaluation to teachers and administrators at the local level; and

3. to provide an easily accessible directory of resources and curriculum units to aid the urban classroom teacher in teaching, and to give the academic direction and materials necessary to fulfill Illinois State Goals for Learning requirements at the fifth and sixth grade level.

D. *Physics in the 5th Grade? Yes!*
Unit Introduction........ D2
1. Physics From Past to Present........ D11
2. Mass and Measurement........ D16
3. Force and Motion........ D19
4. Time to Share Experiences........ D22
Student Data Sheet Masters........ D34

E. *Sound*
Unit Introduction........ E2
1. Sound Source........ E5
2. Let's Talk........ E7
3. Sound Travels........ E9
Student Data Sheet Masters........ E11

F. *Up Down and Around in Chicago:Weather in the Windy City*
Unit Introduction........ F2
1. What is Air?........ F10
2. What is Wind?........ F15
3. How are Clouds Formed?........ F23
4. What Types of Clouds are There?........ F28
5. What is the Water Cycle?........ F32
Student Data Sheet Masters........ F41

Table of Contents **Grades 5-6**

Forward.... 1

Community Resources.... 13

A. *Atoms and Atomic Structure*
- Unit Introduction.... A2
- 1. Getting a Grip on the Atom.... A5
- 2. Atoms: Setting the Table.... A7
- 3. Atoms: The Sturcture.... A9
- Student Data Sheet Masters.... A12

B. *Without Feathers: Discovering the Forces Behind Human Flight*
- Unit Introduction.... B2
- 1. Creating a Visual History of Flight.... B6
- 2. How Do They Stay Up There?.... B9
- 3. Cross Country Air Rally/Scavenger Hunt.... B13
- 4. By Design.... B15
- Final Evaluation.... B17
- Student Data Sheet Masters.... B19

C. *I Spy... Crystals*
- Unit Introduction.... C2
- 1. To Be or Not to Be.... C4
- 2. Crystals in the Rough.... C6
- 3. The Senses Have It.... C8
- 4. A Face is a Face.... C10
- 5. Supersaturated Solutions = Crystals.... C12
- 6. When is a Marshmallow an Atom?.... C14
- Assessment: I Spy a Crystal.... C16
- Student Data Sheet Masters.... C19

Forward

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As the 21st century approaches, new developments in science education will have far-ranging influences in both the science content in the curriculum and in the way science is taught. At the national level, new standards for science teaching and learning are being drawn up by the National Committee on Science Education Standards and Assessment, under the auspices of the National Research Council (NRC). The Standards, akin to the NCTM Standards in Mathematics, are intended to describe how content, teaching, and assessment are coordinated in classroom practice so that all students have an opportunity to learn science (NRC, 1993, p.10). The Standards follow in the footsteps of two influential national projects, Project 2061 of the American Association for the Advancement of Science (AAAS) and the Project Scope & Sequence of the National Science Teachers Association (NSTA) (Rutherford & Ahlgren, 1990; NSTA, 1990). These documents point the way in curriculum and instruction in science for practitioners at all levels.

Many school systems across the country are in the process of revising their curricula to be in tune with the recommendations of these documents. A group of teachers and administrators from four elementary schools in the Chicago Public Schools became engaged in collaboratively pursuing this course in 1993 as part of the Community Resource Curriculum Development Project (CRCDP), funded by the Illinois Board of Higher Education through the Dwight D. Eisenhower Program. In this project, educators from the schools involved-- William H. Brown Elementary, Galileo Scholastic Academy, Andrew Jackson Language Academy, and Mark T. Skinner Elementary-- worked to create integrated science and social sciences units, with assistance of a team of consultants which included this writer, Dr. Janice Schnobrich, former teacher at Skinner Elementary, Carol Fialkowski, Phil Parfitt and Ken Rose from the Chicago Academy of Sciences, Dr. Albert Larson of the University of Illinois, and Mary Nalbandian, former Director of Science for the Chicago Public Schools.

Such curriculum work at the local school level is needed now, as the Chicago Public School system no longer has a curriculum department. With the decentralization of the Chicago School District, the responsibility for curriculum development has fallen to the schools even though there was no provision for local professional education regarding this complex task. The major aim of the Community Resource Curriculum Development Project was to facilitate the professional development of these schools' professional staff in the area of curriculum writing.

To promote the objectives of this project, teams of two or three teachers and administrators, with diverse experience, worked on creating an integrated science-social sciences instructional unit. During the first year of the Eisenhower grant support, seven science-social sciences units were completed by the teams, each focused on one or more community resources, including Chicago's cultural institutions. The units were conceived in terms of the mandated Illinois State Goals for Learning for the kindergarten through six grade levels, and in terms of contemporary scholarship on teaching and learning. They include assessment, particularly alternate ways to measure student growth, such as through portfolios, projects and/or other performance measures. Each team wrote one unit, utilizing the Chicago Public School's *Objectives and Standards* and the state science and social sciences goals.

The unit writing workshop sessions offered by the CRCDP considered current scholarship in both the disciplines and in pedagogy. Most of the new national science programs are now being influenced to various degrees by an emerging understanding of the way children learn science (Shamos, 1989). The view now is that success in learning requires the student's engagement and effort. It also requires his or her attention to central ideas, the "conceptual themes" of science. Learning is seen to be a complex phenomena involving various learning styles. Nevertheless, what is learned is always a construction (Sigel, 1978). Because engagement with the content is so important, the affective domain, that is, the child's *attitude* and *interest*, is of foremost importance for learning success. Because connections are required between new and previous knowledge, the amount and quality of the child's *reflecting* also is important. Because knowledge realms ultimately connect and because discipline bound fragmentation can be narrow-mindedness, emphasis now is placed upon teaching science across the curriculum, on integrating instruction.

The whole language movement in the language arts and reading also emphasizes more integration.

Academics call the theory which now informs much work in science education "constructivism". The idea that we build or *construct* our meanings is the source of the label. It is a view still unfamiliar to many educators. To scholars, constructivism is an *epistemology*, a theory of knowledge, an explanation of how we as individuals, or as communities of individuals (the scientists), know what we know about the world.

Learning

Instead of being passive recipients of data from the outside, the child's memory and meaning are *constructions*, concepts which are influenced by prior knowledge and other factors. Incoming stimuli are processed by the child using beliefs, concepts, frameworks, which were created earlier. As the child solves problems, interacts with others, and adapts to circumstances in life, concepts-- models of the world and how it works-- are added and developed.

A child's prior knowledge about a natural phenomena influences his or her science learning (Ausubel, 1968). As Michael Watts (1991) puts it, "We come to understand things in terms of what we already understand; if we cannot lock new ideas into the ideas we have already generated, then new experiences become somewhat meaningless" (p. 54). In learning science, prior knowledge has been demonstrated to be powerfully facilitative or, the opposite, obstructive (Osborne & Freyberg, 1985; Driver, 1983; Watts, 1991). The science education literature is full of studies of children's naive science, their alternative conceptions (not *mis*conceptions, because no conception can be proven to replicate physical reality). From this work we can say that some of a child's prior conceptions are common among children of particular developmental levels, while others are idiosyncratic. Naive conceptions often are robust and resistant to change through construction, others are amenable to change (Conner, 1990; Watts, 1991).

For the child, as well as for us all, coming to understand something is a creative act. *Active participation* is a must (Watts, 1991). The various conceptual worlds represent, or model, the physical world (the 'real' world) and are always *interpretations* of some text, a written text or a text of nature. The constructions we make help us interpret experience (Kelly, 1955). Our models, like those of scientists, change in response to everyday 'reality testing' and may be replaced by those which work better.

Not all concepts function at the same level. Our conceptual worlds are organized in an hierarchy: some concepts overarch others, some ideas provide a framework for others. Particular ideas are key to understanding others. For example, Newton's concept of force is critical to understanding his mechanics (Hestenes, Wells, & Swackhamer, 1992).

As the child constructs his or her conceptual world, initial understandings often may be fragmentary and incoherent (diSessa, 1988). Conceptual coherence can develop in big jumps, as insight. A conceptual world can become completely reorganized after a particular insight or upon the resolution of a conflict. The key processes which lead to concept development are *reflection* and *problem solving*. Cognitive change includes aspects of *restructuring, invention,* and *directionality*. The child may *appropriate* the adult meaning (Newman, Griffin, and Cole, 1989).

Constructivism as a theory of knowing can be summarized in the following principles:

- Knowledge consists of past constructions-- the world is known through a framework that transforms, organizes, and interprets one's perceptions;

- Constructions develop through the processes of assimilation and accommodation, by which old concepts are adapted and altered to fit a logical framework;

- Learning is more an organic process of invention than a process of accumulation-- learning involves different frameworks of understanding which one produces in structural leaps in cognition made throughout development;

- Meaningful learning occurs through reflection and resolution of cognitive conflict, and this process brings coherence to earlier fragmented and incomplete understanding (Fosnot, 1989, 19-20; see also von Glasersfeld, 1989; Vygotsky, 1978; Howe & Jones, 1993).

The primary goals of science instruction should be, first, to encourage the child's willingness to learn ("feeling is first" as e.e. cummings said), and second, to facilitate *understanding* of the scientific concepts and models. The child should be enabled by instruction to construct facsimiles of scientists' ideas. The child should see that, at least in some circumstances, the scientists' view is better than his or her naive explanation, that is, more useful, or plausible, or intelligible (Abimbola, 1983). Teaching science involves *persuasion*. For change to occur, a student needs to become dissatisfied with the commonsense beliefs about the world and perceive scientific explanations as worthwhile. The child's prior knowledge provides the necessary bridge for understanding, but also can be an obstacle. Thus, for the teacher, "...effective instruction requires more than dedication and subject knowledge. It requires technical knowledge about how students think and learn" (Hestenes, Wells, & Swackhamer, 1992, p. 142).

Teaching for Conceptual Change

There is no recipe for constructivist science teaching, but the central goals are encouraging willingness to learn and facilitating understanding. For many students today, science lessons are characterized mostly by teacher talk and student note taking, with major emphasis on memorization, and often including meaningless activities and investigations. Science typically is isolated in the curriculum. Among both children and adults, scientific ideas are widely misunderstood, and student interest in science declines through the grades (Miller, 1989, Biddulph & Osborne, 1984). Even hands-on activities will not automatically lead to conceptual development-- significant teacher facilitation is almost always required.

The challenge for teachers is not so much in understanding the constructivist theory of learning, "...it is in discerning and acting on the teaching implications.. The challenge for teachers is helping children to ask the right questions, so that they examine their ideas, their observations, their findings, and develop more valid scientific understandings. It is about deepening and clarifying children's insights." (Smythe, 1993, 8). An old Deweyan ideal, child-centered teaching, now is back in fashion.

Teachers are likely to find useful a variety of strategies to foster concept learning. Examples of such strategies include the following:

1. Focus on significant representations (models, images, concept webs, maps, etc.);

2. Persuade students of the value of the scientific models;

3. Link instruction to students' past experiences and earlier lessons;

4. Use predictions and explanations to elicit students' prior knowledge;

5. Provide opportunities for students to test predictions, discover contradictory evidence, and consider alternate explanations;

6. Encourage several modes of representation-- writing, speaking, drawing, acting, etc.;

7. Summarize students' experiences, highlight and contrast alternative concepts, ask for evidence for different views, and discuss applications in children's lives (Neale, Smith, and Johnson 1990, p. 112).

Many other teaching methods are congenial to a constructivist stance. Brooks (1990) would add that the kind of strategies that are implied in constructivist theory would have teachers foster student autonomy, initiative, and leadership; use manipulative, interactive, and physical materials; use raw data and primary sources; allow student thinking to drive lessons (that is, teachers should alter content based on student responses). Brooks also suggests that teachers should cluster lessons around problems, questions, and situations regarding similar concepts, and that teachers should inquire about their students' concepts before they share their own.

Jay Lemke and those who follow Vygotsky encourage teachers to facilitate dialogue among students (Lemke, 1990; Newman, Griffin, & Cole, 1989). This can be done in a variety of ways, such as by asking open-ended questions and by posing contradictions to students' views then inviting responses. These teacher behaviors promote inquiry.

One of the more obvious and significant implications of constructivism is that teachers should encourage students to reflect on the content. Many strategies promote reflection, including allowing wait-time after posing questions and seeking elaboration of students' responses. Teachers have to be sensitive to the pace of instruction because if more student reflection is a priority, time will be required for the discovery of relationships and the creation of metaphors (Brooks, 1990).

Most fundamentally, constructivist methods are about getting children to *think*. Constructing/restructuring concepts is an effortful practice that is accomplished through reflective thought. To learn the scientists' views, children have to think about them (and that is why student motivation is so central a concern).

Constructivism as a View of the Nature of Science

Conceptual change is a phenomenon of individual growth and development, but conceptual change also occurs in cultural communities, like the communities of scientists. Constructivism is a theory, therefore, of the growth of knowledge in science. Science "...is a process that assists us to make sense of our world." (Lorsbach & Tobin, 1992, pp. 1-2).

Scientific knowledge is a complex of meanings continually negotiated in a community of workers. As Einstein himself states:

> Science is not just a collection of laws, a catalogue of unrelated facts. It is a creation of the human mind, with its freely invented ideas and concepts. Physical theories try to form a picture of reality and to establish its connection with the wide world of sense impressions (Einstein & Enfield, 1938, p. iii).

The other aspect of the typical definition of science is that it is a process of knowing. In many classrooms this process is still being communicated as "the scientific method," which is often described as a stepwise procedure of experimentation, beginning with either a question or a hypothesis and ending with a conclusion, the new knowledge. Students are taught Dewey's steps but without the context within which Dewey was speaking. Duschl (1988) calls this distortion of the nature of sciences *scientism,* which also includes the notion that there is a single right solution to every problem. We know now, however, that scientists don't follow any such steps in carrying out their work (although they often report their work in a format that reflects a stepwise procedure). What can be said with certainty about the scientific method is that scientists' work is *creative*. From a constructivist perspective, "the scientific method", if one is to be identified, is to create valid models of nature:

> The great game of science is modeling the real world, and each scientific theory lays down a system of rules for playing the game. The object of the game is to construct valid models of real objects and processes. Such models comprise the core of scientific knowledge. To understand science is to know how scientific models are constructed and validated. The main objective of

science instruction should therefore be to teach the modeling game (Hestenes, 1992, p. 732).

Constructivism has provided much insight into the nature of science, including its scope and limits. The latest view of science, however, is complex and challenging, and many issues remain unresolved. Nevertheless, implications for science teaching can be derived from constructivist philosophy of science (Duschl, 1990; Duschl & Hamilton, 1992).

One implication is that science activities in the classroom should be less like cookbook recipes. Student activities typically provided in textbooks follow a common pattern. First a problem is stated or a question asked. Then follow aims or objectives, then a list of materials and the procedures. At the end are questions about the results which guide students to the "right" conclusions. The "hidden" lesson is that correct conclusions are reached by this procedure (inductive reasoning) (Garrison and Bentley, 1990). Further, premises are rarely discussed and the results are assumed to confirm the hypothesis or prediction. Not only do cookbook-type activities model faulty reasoning, but students can successfully complete them without much thought (and thinking is what is required for students to construct concepts).

What can be done instead? Activities and investigations in the field and in the classroom can be less structured like recipes and more like the investigations of real scientific work. Instructional activities also can be designed to engage students in more student-to-student discussion and debate focused upon scientific ideas, and more collaborative group work (Lemke, 1990; Larochelle & Desautels, 1991). The computer can be used to engage students in a variety of scientific simulations, or 'microworlds' (diSessa, 1988). Further, students can be taught to be more aware of their expectations, their own theoretical biases, as they carry out investigations (Gowin, 1987). Lastly, exemplars of the creation and negotiation of scientific knowledge from the history of science can help students learn knowledge of science, as well as scientific knowledge (Matthews, 1987).

Conclusion

Science is valuable because it offers coherent explanations of the world which help us *interpret*, or make sense of our experience (Broudy, 1973). Ecosystem theory, for which helps us determine if and why we should pay any attention to such changes, or personally act to influence the situation.

In my own work in science teacher education, I encourage educators to consider the problems of science teaching and learning from the constructivist perspective. The present time is one in which the implications of this theory for classroom practice are beginning to be explored and evaluated. In this generative conception of science teaching, the teaching-learning process is regarded as a complex process, involving motivation and rapport, a variety of learning materials, and many factors outside the teacher's control. The process involves a dynamical negotiation of meaning between the learner and the environment. New software, better textbooks, and new materials are helpful, but the most sound way to improve schooling is to better educate teachers and to provide them with the tools and conditions they need to facilitate their students' learning. The Community Resource Curriculum Development Project is a step in that direction. Through the collaborative work involved in fashioning the following several units, the Chicago educators who participated further developed their own scientific concepts and pedagogical competence, while building a professional and community support network.

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Community Resources

compiled by Mary Nalbandian
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American Indian Center
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Balzekas Museum of Lithuanian Culture
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Chicago, IL 60629
582-6500

Brookfield Zoo
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708/485-0263 ext. 360

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Chicago Botanic Garden
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Glencoe, IL 60022
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Chicago, IL 60601
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708/655-8866

DuSable Museum of
African American History
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Environment, Department of, #600A
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Chicago, IL 60610
744-7607

Field Museum of Natural History
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East Roosevelt Road
at Lake Shore Drive
Chicago, IL 60605
922-9410 ext. 246

Forestry Bureau
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939-0490

Garfield Park Conservatory
300 North Central Park
Chicago, IL 60624
533-1281

Graceland Cemetery
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Chicago, IL 60613
525-1105

Harold Washington Library
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Chicago, IL 60605
747-4850

International Museum of
Surgical Science
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Chicago, IL 60610
642-6502

Kohl Children's Museum
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Wilmette, IL 60091
708/251-6950

Lincoln Park Conservatory
Fullerton and Stockton Drive
Chicago, IL 60614
294-4770

Lincoln Park Zoo
Ms. Judith Kolar
2200 North Cannon Drive
Chicago, IL 60614
294-4649

Little Red Schoolhouse Nature Center
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Willow Springs, IL 60480
708/839-6897

McKinley, Ada S.
Community Services, Inc.
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Chicago, IL 60607
544-0600

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738-1503

Mitchell Indian Museum
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Kendall College
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Morton Arboretum
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Museum of Science and Industry
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122 South Michigan Avenue
Chicago, IL 60603
431-4930

Polish Museum of America
984 North Milwaukee Avenue
Chicago, IL 60622
384-3352

River Trail Nature Center
3120 Milwaukee Avenue
Northbrook, IL 60062
708/824-8360

Rosehill Cemetery
5800 North Ravenswood Avenue
Chicago, IL 60660
561-5940

Sand Ridge Nature Center
15890 Paxton Avenue
South Holland, IL 60473
708/868-0606

Shedd Aquarium
Ms. Linda Wilson
1200 South Lake Shore Drive
Chicago, IL 60605
939-2426

University of Illinois
Cooperative Extension Service
25 East Washington, Suite 707
Chicago, IL 60602

Willowbrook Wildlife Haven
525 South Park Boulevard
Glen Ellyn, IL
708/790-4913

Atoms and Atomic Structure

Community Resource Curriculum Development Project

Developed by: Frana Allen

Atoms and Atomic Structure

Rationale
This unit is intended to meet the following Instructional Programs Objectives for the Illinois State Goals for Learning at the sixth grade level.

BIOLOGICAL AND PHYSICAL SCIENCES
Use appropriate scientific vocabulary.
Recognize the three parts of the Periodic Table,
Illustrate the parts of an atom.
Keep a journal.
Identify three different elements from the Periodic Table one solid, one liquid, and one gas.

SOCIAL STUDIES
Use a map of the United States of America to locate some of the elements found on the Periodic Table in their natural states.
Use a map of the world to locate where the "Father of the Periodic Table of Elements" was born.

MATHEMATICS
Using the Periodic Table, tell the total number of electrons on the rings of a specific atom (e.g. Carbon = 6 electrons; Nitrogen = 7 electrons).

Content Background
Everything in the word is made up of atoms. Students sometimes wonder why do white sugar and white salt taste so different? Why does white sugar dissolve in water while brown sugar does not? These things are different because the molecules are different?

To understand why molecules are different we need to look inside of them. Scientist have done this and what they have found were atoms. Every molecule in the world is made of one or more atoms. Molecules are like the words of the world, atoms are like the letters of the alphabet. With only twenty-six different letters, we can make every word in the dictionary. Molecules are different because they are made up of different combinations of letters. Salt molecules are different from sugar molecules because they are made up of different combinations of atoms. Dimitri Mendeleev, a Russian scientist published and arranged the first Periodic Table. This basic foundation has enabled scientists to add elements to the Table. Today, there are approximately one hundred and nine elements. The Periodic Table is written in the "letter-symbols" of elements.

Timeline for Unit
This entire unit consists of three main lessons and creative activities to summarize the study. This unit will last approximately four to five weeks and cover the size of the atom, interpreting the Periodic Table, and the atomic structure of an atom.

Evaluation/Assessment
Students will have regular assessments at the end of each main topic of study. These will consist of questions, hands-on activities, and games. In addition, they can demonstrate an understanding of all or most of the information presented in the background of this unit. Each class member will be able to give the correct answer to the teacher. Oral reports and constructed models of an atom will also be used for assessments.

Community Resources
Chemistry Workbook 1: Understanding Matter
Globe Book Company, Inc.
Englewood Cliffs, New Jersey
Copyright, 1988

Elements of the Week
A Descriptive Chemistry Technique
Published by Flinn Scientific, Inc.
P.O. Box 219
Batavia, IL 60510

The Usborne Illustrated Dictionary of Physics
Usborne Publishing Ltd.
20 Garrick Street
London WC2E 9BJ, England
Copyright, 1988

Chemistry of Matter
Prentice Hall
Englewood Cliffs, New Jersey
Copyright, 1993

Science World
D.C. Heath and Company
Copyright, 1955

The Book of Popular Science, Vol 2
Grolier, Incorporated
New York, New York

Glossary

ATOMIC NUMBER: the number of protons in the nucleus of an atom; the number of electrons in the outer shells is equal to the number of protons

ATOMIC WEIGHT/ATOMIC MASS: tells the number of protons, electrons, and neutrons in an atom

ELECTRON: a part of the atom that moves around the nucleus; it has a negative (-) charge

MATTER: solid, liquids and gases are the three parts of matter. Matter is the smallest part of an element

NEUTRON: a part of the atom found inside the nucleus; it has no electrical charge

PERIODIC TABLE OF ELEMENTS: a chart of elements in their natural state

PROTON: a part of the atom found inside the nucleus; it has a positive (+) electrical charge

SHELLS: the outer rings of the atom; electrons move around the nucleus in the shells

Lesson 1: Getting a Grip on the Atom

Lesson Introduction
All scientists believe that everything is composed of particles. Imagine that you are holding something made of gold, silver, or aluminum. Gold, silver, and aluminum are elements. If it were possible to dissect those elements down to the smallest particle you would have atoms. An atom is the smallest part of an element that has the chemical properties of that particular element.

In this activity, students will use an 8 1/2' x 11" sheet of paper to try to gain some understanding of the size of atoms.

Specific Lesson Objectives
The students will:
1. use appropriate scientific vocabulary.
2. record and compare results of experiments.
3. understand the structure of an atom.

Time Allotment
This lesson can be completed in one 40-minute session.

Materials
8 1/2 x11 piece of paper
pencil
large structure of the atom
student journals
copies of Student Data Sheet 1.1

Advanced Preparation
Students can do this on an individual basis or cooperatively.

Procedure

Tap Prior Knowledge
1. Ask the students the following questions:
   a. What do you think an atom is?
   b. How large do you think an atom really is?
   c. What does the term tiny or minuscule mean?

Hands-on Activity
2. Distribute a sheet of paper " 8 1/2 x 11" to each student. Have the students fold the paper in half and tear or, cut it in half. Set one half sheet of paper aside and continue to work with the other half.

3. Tear the half in half, again, set one half to the side. Work with the remaining half.

4. Continue this folding, tearing, and setting aside process until the paper is too small to be cut in half.

Introduce Principle/Concept

5. Tell the students that if they cut this paper in half sixty times they will have a piece of paper approximately the size of an atom. Discuss the terms "elements" and "atoms" and how they relate to each other. Ask the students to name other "tiny items" in their environment.

6. Discuss the structure of the atom. There are three parts: nucleus (which consists of protons, which has a positive electrical charge, and neutrons which have no electrical charge), and electrons (which are in the outer shells and have a negative electrical charge).

Relate Activity and Concept

7. Display a large structure of an atom. Have students copy and label the atom and its parts and place it in their journal.

Lesson Assessment

Use Data Sheet 1.1 to assess what each student has learned about atomic structure and place it in students' folders.

Lesson 2: Atoms: Setting the Table

Lesson Introduction
Dimitri Mendeleev, a Russian scientist, created the first chart of natural elements known as the Periodic Table of Elements. This is an international shorthand used by chemists all over the world. He is known as the "Father of the Periodic Table of Elements."

Specific Lesson Objectives
The students will:
1. use appropriate scientific language identify the Periodic Table of Elements.
2. identify the three parts of the Periodic Table.
3. locate and identify Russia as Mendeleev's homeland.
4. identify what the numbers found in each square of the Periodic Table represent.

Time Allotment
This lesson can be completed in one 40-minute session.

Materials
overhead projector
copies of the Periodic Table (one for the overhead and one for each student)
three different colored crayons: red, green, and blue
student journals
copies of Student Data Sheets 2.1 and 2.2

Advanced Preparation
The students will make a journal entry entitled "Atomic Structure."

Procedure

Hands-on Activity

1. Distribute Periodic Table to each student along with the red, green, and blue crayons. Place the Periodic Table on the overhead projector and point out the following information:
    a) The Periodic Table includes all the naturals elements known to humans at this time. There are elements that don't have names because scientists haven't agreed on a name.
    b) a Periodic Name has one or two letters that represent a given chemical element. For example:
        O - Oxygen
        Al - Aluminum
    c) The Periodic Table is divided into two main parts:
        Metals
        Nonmetals
    d) The Periodic Table is also divided into solids, liquids and gases.

e) The Periodic Table uses the terms Periods and Group:
Periods refer to the number of electron shells.
Group refers to whether the symbols refer to solids, liquids or gases.

f) The Periodic Table has numbers associated with each symbol.
The top number refers to the Atomic Number. The number in the bottom left refers to the Atomic Mass or Atomic Weight. The number in the bottom right refers to the number of Electrons on the Shell (outermost part of the shell of the atom).

2. Explain that today the students will focus on identifying the two parts of the Periodic Table- Metals, Nonmetals- and some of the solids, gases and liquids.

3. Using crayons or colored markers, have the students color nonmetals yellow and metals red on their Periodic Tables.

4. Distribute Student Data Sheet 2.1, and help students fill in information as they locate some of the solids, liquids and gases on the Periodic Table.
Sample page set-up:

Gases

Name of Element	Symbol	Type of Matter
Helium	H	Gas

Introduce Principle/Concept

5. Explain to students that the Periodic Table is a table of natural elements found on and around our Earth.

Lesson Assessment

Check students' journals. Use the Student Data Sheet 2.2, Setting the Table, to assess what the students have learned. Students can use the Periodic Table or they can rely on their memories.

Lesson 3: Atoms: The Structure

Lesson Introduction

Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. The outer electrons govern the chemical properties of the element.

Specific Lesson Objectives

The students will:

1. use scientific vocabulary.
2. recognize some of the elements and their symbols.
3. know where some of these natural elements are found in our environment.
4. construct a simple atom (e.g. carbon; nitrogen; oxygen).
5. calculate and illustrate the number of electrons, protons and neutrons on a specific elements.

Time Allotment

This lesson can be completed in three 40-minute sessions

Materials

overhead projector
magnetic rubber strips
posterboard (8 1/2 by 11)
Periodic Table transparency
hole punch
multicolored paper
two sets of student Periodic Table Sheets
copies of Student Data Sheets 3.1, 3.2, and 3.3

Procedure

Part One

Hands-on Activity

1. For classroom visual aids, use a piece of posterboard approximately 8 1/2 by 11.

2. Get a roll of magnet strips and cut three small pieces.

3. Using a magic marker or letter stencils, draw or paste them on the cardboard. Write the element letter symbols, e.g., "He". Write the full name of the element under the symbol, e.g. "Helium". Emphasize that the first letter must be capitalized.

4. Write the atomic number over the top of letter symbol. Write the atomic weight underneath the letter symbol.

5. Attach the magnetic strips to the back of the cardboard and attach to the metal chalkboard.

Part Two

Introduce Principle/Concept

6. Invite students to look at a picture of an atom on Student Data Sheet 3.1. Point out to the students that the center of the atom is called the nucleus. Have the students place inside the nucleus the letter P symbolizing a positive charge. Have the students place the letter N underneath the P symbolizing a neutral charge or no charge.

7. Point out to the students that outer part of the nucleus are called shells or clouds, or energy levels. These shells hold electrons. The electrons hold a negative charge. Each of the shells can only hold a certain amount of electrons.

8. Tell the students that they will learn about the first two shells. The first shell can only hold two electrons. The second shell can only hold eight electrons.

9. Using your hole puncher, punch out holes from three different colors of construction paper. The colors will represent the three parts of an atom. These little colored 'holes' will represent the protons, the neutrons, and the electrons.

10. Stick one colored circle next to the letter P. Stick another colored circle to the letter N. Use the remaining color as the electrons. Place the correct number of dots on the correct number of shells.

First shell-two dots
Second shell- eight dots

Part 3

Relate Activity and Concept

11. Review the three parts of an atom. Explain to the students they will be given a list of elements off of the Periodic Table. These elements are to be used in creating this particular element's atom. For example, in the element of Carbon, the proton, found in the nucleus has six dots (red), the neutrons have 12 dots (green), the electrons, (blue) are found on the outer of the shells. The first shell holds two electrons. The second shell will hold only four.

Element ----- Carbon	Symbol ---- C
Atomic Number -----6	Atomic Weight ----- 12

12. Give the students the following elements to calculate and construct atoms. Have them choose three. Neon, Helium, Nitrogen, Oxygen, Hydrogen, Calcium, Magnesium.

13. Remind the students that the number of protons and the number of electrons are always the same. Complete Student Data Sheet 3.2.

Lesson Assessment

Use the Student Data Sheet 3.3 to assess what the students have learned.

Matter and Atoms
Fact Finding Sheet for Students

1. Matter is all around us.
2. Everything you use and eat and touch is matter.
3. You and I are matter. All people, animals and plants are matter.
4. Air is matter.
5. Matter can be solid, or liquid, or gas.
6. Matter has mass and it takes up space.
7. Water is matter.
8. Water can be a solid matter. Ice is a solid matter.
9. Water can be a liquid matter. The water we drink is liquid matter.
10. Water can be a gas matter. Water vapor in the air is a gas matter.
11. Water has mass and water takes up space.
12. All matter is made up of tiny things called atoms.
13. There are 109 different kinds of atoms.
14. Matter made up of just one kind of atom is an element.
15. Iron is an element. Oxygen is an element. Gold is an element.
16. Iron is a solid matter. Gold is a solid matter.
17. Oxygen is a gas (or gaseous) matter.
18. Mercury is an element. Mercury is a liquid matter.
19. Each element has a letter symbol.
20. Scientists use symbols for each element.

Student Data Sheet Masters

Atoms and Atomic Structure
Students Data Sheet Master 1.1

Written Assessment

Name ______________________ Date ____________________

Circle the correct word:

1. What is the smallest part of an element?

matter atom particle

Match the words to complete the statements:

atom proton neutron electron

2. The ________ is the smallest part of an element.

The nucleus of an atom contains ____________ and ____________.

3. The __________ has a positive electrical charge.

The __________ has a negative electrical charge.

The __________ has no electrical charge.

Atoms and Atomic Structure
Students Data Sheet Master 2.1

Name ______________________ Date ____________________

Directions: Fill in the blanks

Name of Elements	Symbol	Types of Matter (Gases, Solids, Liquid)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Atoms and Atomic Structure
Students Data Sheet Master 2.2

Setting the Table

Name ______________________ Date ____________________

1. What is the name of the chemist who created the Periodic Table?

2. What are the two main parts of the Periodic Table?

___________________________ and _______________________________

3. Name three types of matter found on the Periodic Table

1 ____________________

2 ____________________

3 ____________________

4. Name a gas and its symbol

____

Name a solid and its symbol

____

Name a liquid and its symbol

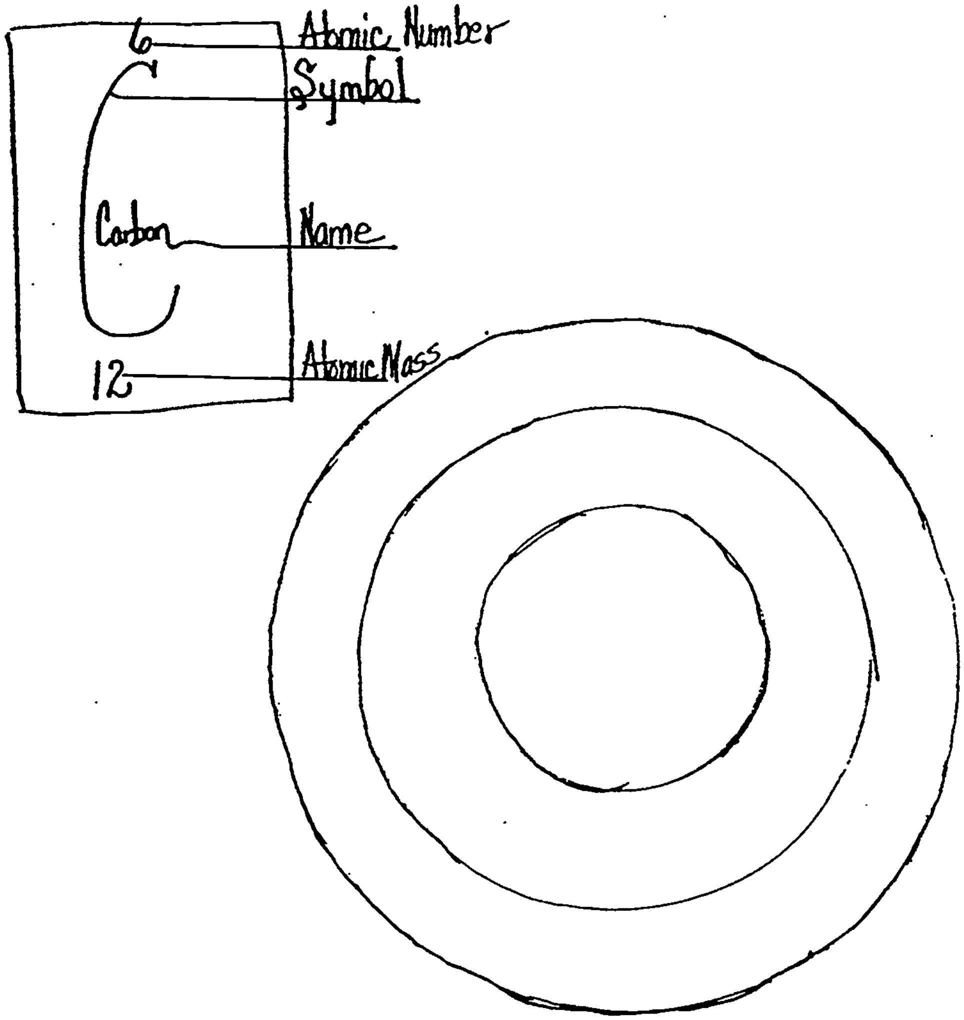
____

Atoms and Atomic Structure
Student Data Sheet Master 3.1

Atomic Structure

Name ______________________ Date ____________________

Use the diagram to reproduce the atom as instructed.



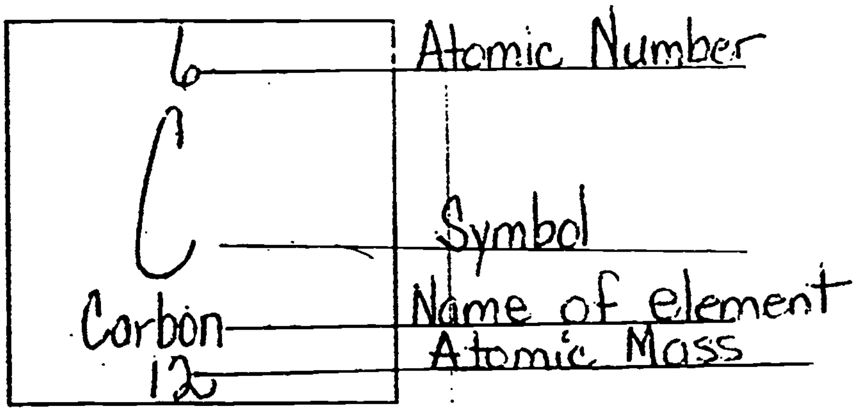
How many?
Protons ______________
Neutrons ______________
Electrons ______________

Atoms and Atomic Structure
Student Data Sheet Master 3.2

Directions:
Use the Periodic Table. Choose 3 metals and place them in the boxes marked "Metals"

Choose 3 nonmetals and place them in the boxes marked "Nonmetals"

Identify the following terms on each box like shown in the Sample Box.



Metals | Metals | Metals

Nonmetals | Nonmetals | Nonmetals

Atoms and Atomic Structure
Student Data Sheet Master 3.3

Name ____________________ Date ____________________

Atoms: The Structure
Answer the following questions
Use the Periodic Table to answer the following questions.

1. Name the two parts of the Period Table
   a.
   b.

2. What is the atomic number of the following elements
   a. Potassium-
   b. Neon-

3. What is the atomic mass of the following elements
   a. Mercury-
   b. Calcium-

Name____________________________Date________________________

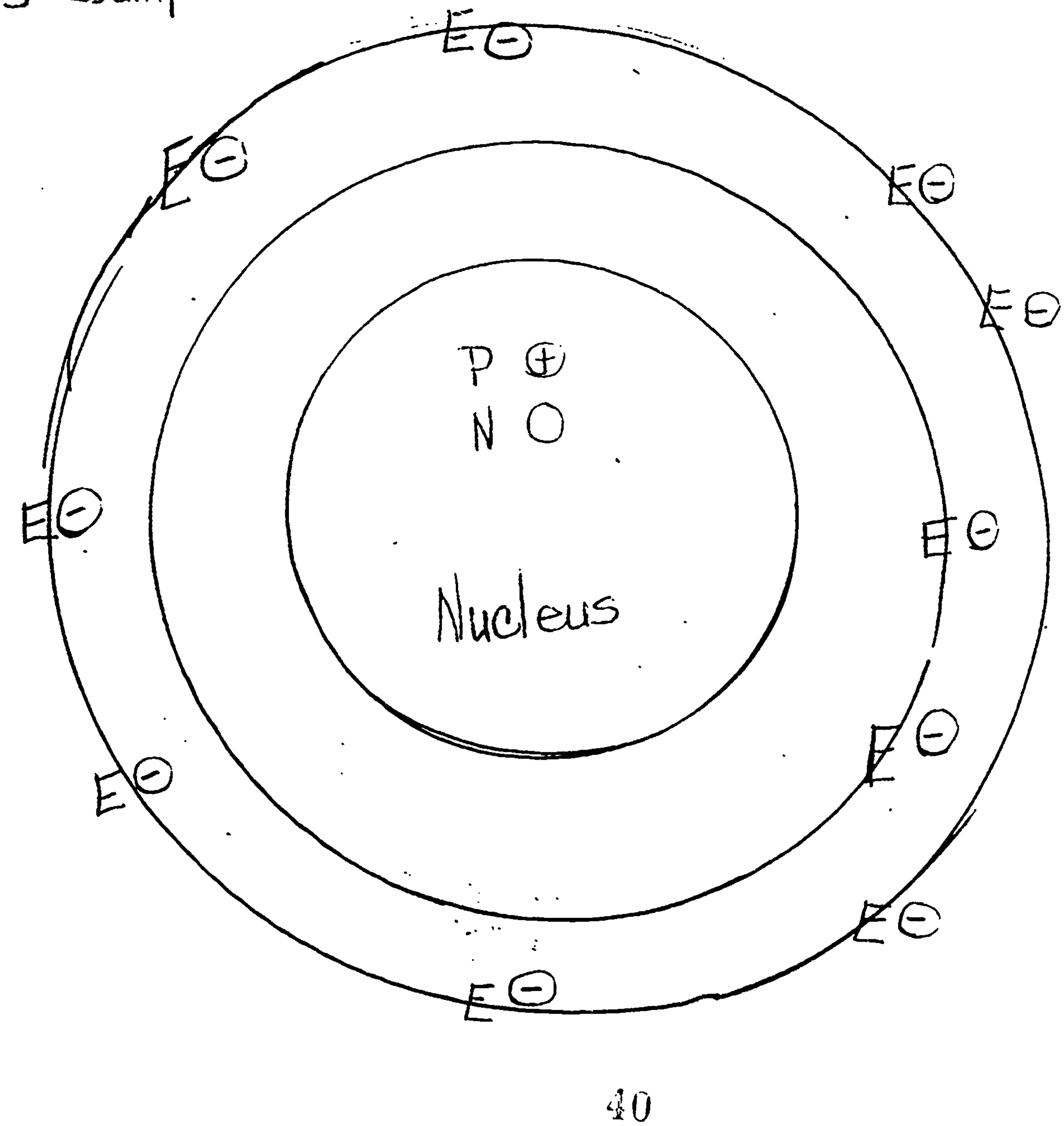
Atomic Structure

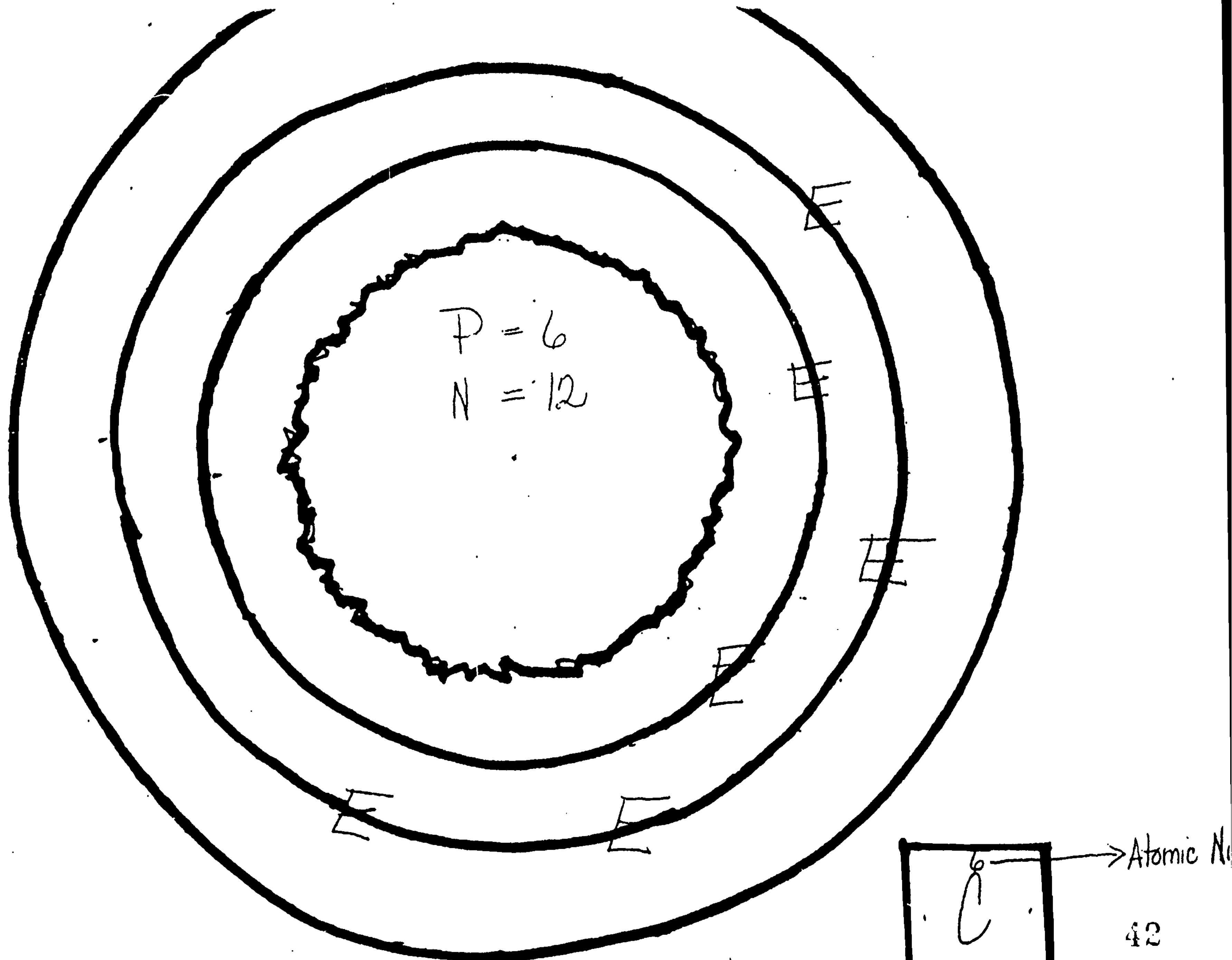
Worksheet #2

Directions

Use this diagram to reproduce the atom as instructed

Teacher's Sample





Remember: Protons and Electrons are always hold the same number.

THE PERIODIC TABLE OF THE ELEMENTS

METALS

Key:
- 6 — Atomic Number
- C — Symbol
- Carbon — Name
- 12 — Atomic Mass (rounded to the nearest whole number)
- L-4 — Number of electrons in outer shell; Outer electron shell

PERIOD	GROUP 1A	GROUP 2A	GROUP 3B	GROUP 4B	GROUP 5B	GROUP 6B	GROUP 7B	GROUP 8			PERIOD
1 Electron Shells K	1 H Hydrogen 1 K-1										
2 Electron Shells K-L	3 Li Lithium 7 L-1	4 Be Beryllium 9 L-2									
3 Electron Shells K-L-M	11 Na Sodium 23 M-1	12 Mg Magnesium 24 M-2									
4 Electron Shells K-L-M-N	19 K Potassium 39 N-1	20 Ca Calcium 40 N-2	21 Sc Scandium 45 N-2	22 Ti Titanium 48 N-2	23 V Vanadium 51 N-2	24 Cr Chromium 52 N-1	25 Mn Manganese 55 N-2	26 Fe Iron 56 N-2	27 Co Cobalt 59 N-2	28 Ni Nickel 59 N-2	4
5 Electron Shells K-L-M-N-O	37 Rb Rubidium 85 O-1	38 Sr Strontium 88 O-2	39 Y Yttrium 89 O-2	40 Zr Zirconium 91 O-2	41 Nb Niobium 93 O-1	42 Mo Molybdenum 96 O-1	43 *Tc Technetium 99 O-1	44 Ru Ruthenium 101 O-1	45 Rh Rhodium 103 O-1	46 Pd Palladium 106 O-1	5
6 Electron Shells K-L-M-N-O-P	55 Cs Cesium 133 P-1	56 Ba Barium 137 P-2	57-71 RARE EARTH ELEMENTS	72 Hf Hafnium 179 P-2	73 Ta Tantalum 181 P-2	74 W Tungsten 184 P-2	75 Re Rhenium 186 P-2	76 Os Osmium 190 P-2	77 Ir Iridium 192 P-2	78 Pt Platinum 195 P-1	6
7 Electron Shells K-L-M-N-O-P-Q	87 Fr Francium 223 Q-1	88 Ra Radium 226 Q-2	89-103 ACTINIDE SERIES	104	105	106	107				7

The names and symbols of these elements have not been assigned.

RARE EARTH ELEMENTS 57 - 71								
	57 La Lanthanum 139 P-2	58 Ce Cerium 140 P-2	59 Pr Praseodymium 141 P-2	60 Nd Neodymium 144 P-2	61 Pm Promethium 147 P-2	62 Sm Samarium 150 P-2	63 Eu Europium 152 P-2	64 Gd Gadolinium 157 P-2

ACTINIDE SERIES 89 - 103								
	89 Ac Actinium 227 Q-2	90 Th Thorium 232 Q-2	91 Pa Protactinium 231 Q-2	92 U Uranium 238 Q-2	93 *Np Neptunium 237 Q-2	94 *Pu Plutonium 242 Q-2	95 *Am Americium 243 Q-2	96 *Cm Curium 247 Q-2

* These elements have been made artificially

NON-METALS

PERIOD	GROUP 1B	GROUP 2B	GROUP 3A	GROUP 4A	GROUP 5A	GROUP 6A	GROUP 7A	GROUP 0	PERIOD
1								2 He Helium 4 K-2	1
2			5 B Boron 11 L-3	6 C Carbon 12 L-4	7 N Nitrogen 14 L-5	8 O Oxygen 16 L-6	9 F Fluorine 19 L-7	10 Ne Neon 20 L-8	2
3			13 Al Aluminum 27 M-3	14 Si Silicon 28 M-4	15 P Phosphorus 31 M-5	16 S Sulfur 32 M-6	17 Cl Chlorine 35 M-7	18 Ar Argon 40 M-8	3
4	29 Cu Copper 64 N-1	30 Zn Zinc 65 N-2	31 Ga Gallium 70 N-3	32 Ge Germanium 73 N-4	33 As Arsenic 75 N-5	34 Se Selenium 79 N-6	35 Br Bromine 80 N-7	36 Kr Krypton 84 N-8	4
5	47 Ag Silver 108 O-1	48 Cd Cadmium 112 O-2	49 In Indium 115 O-3	50 Sn Tin 119 O-4	51 Sb Antimony 122 O-5	52 Te Tellurium 128 O-6	53 I Iodine 127 O-7	54 Xe Xenon 131 O-8	5
6	79 Au Gold 197 P-1	80 Hg Mercury 201 P-2	81 Tl Thallium 204 P-3	82 Pb Lead 207 P-4	83 Bi Bismuth 209 P-5	84 Po Polonium 210 P-6	85 At Astatine 210 P-7	86 Rn Radon 222 P-8	6
7									7

65 Tb Terbium 159 P-2	66 Dy Dysprosium 163 P-2	67 Ho Holmium 165 P-2	68 Er Erbium 167 P-2	69 Tm Thulium 169 P-2	70 Yb Ytterbium 173 P-2	71 Lu Lutetium 175 P-2

97 *Bk Berkelium 249 Q-2	98 *Cf Californium 251 Q-2	99 *Es Einsteinium 254 Q-2	100 *Fm Fermium 253 Q-2	101 *Md Mendelevium 256 Q-2	102 *No Nobelium 254 Q-2	103 *Lw Lawrencium 257 Q-2

DRAFT

Without Feathers: Discovering the Forces Behind Human Flight

Community Resource Curriculum Development Project

Developed by: Kerry Bacia

Without Feathers:
Discovering the Forces Behind Human Flight

Rationale
This unit is intended to support the following Illinois State Goals for Learning and Chicago Public School performance outcomes for learning at the fifth grade level:

BIOLOGICAL AND PHYSICAL SCIENCES
The concepts and basic vocabulary of physical science and its application to the life and work in contemporary technological society
The social and environmental implications and limitations of technological development.

Outcomes
Show relationship between balanced and unbalanced forces and motion.
Evaluate the implications of technology in a variety of environmental and human contexts.
Interpret results and recognize when they are ambiguous.

SOCIAL SCIENCES
Understand and analyze events, trends, and personalities shaping history.
Demonstrate a knowledge of the basic concepts of the social sciences and how these help to interpret human behavior.
Demonstrate a knowledge of world geography with emphasis on that of the U.S.

Outcomes
Exhibit an understanding of the chronology and significance of major historical and economic events contributing to the growth and development of the U.S.
Use maps, globes, and other geographic tools and technology to identity the major physical and cultural features of the earth.
Examine the influence of technology and mass communication in our daily lives.

Content Background
There are four forces acting on a plane in flight: gravity, lift, thrust, and drag. The gravitational pull of the earth on a plane, expressed as its weight, is a downward force. Lift, its opposing upward force, is caused by the action of the air on the wings, lifting the plane into the air and keeping it there while it is flying. Thrust is the force that pulls the plane forward and is produced by a propeller or a jet engine. Drag is thrust's opposing force. It is a resistance caused by the friction of the plane's movement through air. In order for a plane to take off, the lift must be greater than the gravity, and the thrust greater than the drag.

Producing lift
A plane achieves lift because of the flow of air passing over the wing. Swiss scientist Daniel Bernoulli (1700-1782) discovered the scientific principle (named after him) which explains why this lifting effect takes place. Bernoulli's Principle says that when air moves faster across the top surface of a material than across the bottom surface, the pressure of the air pushing down on the top surface is less than the pressure of the air pushing up on the bottom surface.

The shape of an airplane wing makes use of Bernoulli's Principle. The front edge of the wing is curved, while the bottom is flat. As the plane moves, air flows over both surfaces, but because the top is curved, the air that flows over it must cover more distance than the air flowing over the bottom. Scientific tests have proved that all of the air both above and below, reaches the end of the wing at the same time. This means that the air flowing over the top must move faster than the air flowing over the bottom.

According to Bernoulli's Principle, because the air is moving faster over the top surface, the air pressure on the top of the wing is smaller than the air pressure underneath it, the greater pressure underneath the wing pushes up and produces lift. All of the above information leads to two other facts:

1. The bigger the wingspread, the more air passes over and under the wing, and the greater the lift will be.

2. The faster the speed of the plane, the faster the air flows over the wing, the smaller the air pressure pushing down, the greater the lift becomes.

Producing thrust
Thrust is the force that pulls the plane forward and, concurrently, makes air flow above and below the wings. British scientist Sir Isaac Newton's (1642-1727) third law of motion makes thrust possible. Newton's third law says, that for every action, there is an equal and opposite reaction.

Some planes produce thrust through the use of a propeller. The propeller is turned at a very high speed by an engine using gasoline as fuel. It bores into the air much like a screw going into wood, it's whirling blades adjusted to strike as much air as possible, to produce the greatest thrust. The faster the propeller is turned, the greater the forward thrust will be.

Other planes get their thrust from jet engines. The jet engine is a hollow cylinder that is open at both ends. Air entering the front and of the cylinder is compressed, then a fuel such as kerosene is sprayed into the cylinder. This mixture burns with intense heat, giving off hot gasses that expand, shooting out of the back of the cylinder with enormous force and speed. As the gases shoot out with a backward force, we get an equal but opposite forward force or thrust, that moves the plane forward at high speed. The faster the fuel burns, the greater the backward push of the hot escaping gases, and the greater the forward push on the plane.

Reducing drag

The friction of the air rubbing against the moving plane causes the air to resist the plane's forward motion. At high speeds, this resistance, or drag, can increase enough to slow down the plane. To overcome drag, planes are streamlined, which means that the plane is designed so that air flows past the plane smoothly. Scientists observe nature, copying the streamlined shapes of fish, birds, and tear drops when designing planes. Cars and trains which also travel at high speeds through wind resistance are also streamlined.

Timeline for Unit

This unit is divided into fifteen 40-minute sessions, or a period of approximately three weeks, and can be successfully accomplished at any time of the year.

Evaluation/Assessment

Assessment is discussed in every lesson in this unit and is accomplished in a variety of ways including oral discussion, written work, visual displays, map work, hands-on activities and logs. Having each child keep a portfolio would give an excellent picture of individual student growth in understanding the concepts introduced. It is recommended that the teacher take photographs for inclusion in the portfolio.

Community Resources

Museum of Science and Industry
57th street and Lake Shore Drive
Chicago, IL 60637
In addition to technological exhibits, the museum has collections of prized automobiles, racing cars, airplanes, locomotives and ship models (helpful to examine design improvements and streamlining).

Meigs Field
Lake Shore Drive at Roosevelt Road
Chicago, IL 60605
Small airport, centrally located, where students can observe small aircraft.

"Historical Perspective of Flight." *NASA's Discovery*. June 1994: 3-5.
Jennings, Terry. *Planes, Gliders, Helicopters, and Other Flying Machines*. New York: Kingfisher Books, 1992.
Smith, A.G. *History of Flight Coloring Book*. New York: Dover Publications, Inc., 1986.
Victor, Edward, Ph.D. *Science for the Elementary school* s 5th ed., New York: Macmillan Publishing Company, Inc., 1980.

Glossary

AILERONS: long, narrow movable flaps located near the wing tips at the rear of the wings which move up and down, and are used to steer the plane to the right or left

ANGLE OF ATTACK: the slant or angle at which the wing is set

BERNOULLI'S PRINCIPLE: when air moves faster across the top surface of a material than across the bottom surface, the pressure of the air pushing down on the top surface is less than the pressure of the air pushing up on the bottom surface

DRAG: the resistance caused by the friction of air rubbing against the moving plane

FUSELAGE: the body of the plane which carries cargo, passengers, crew, and fuel

GRAVITY: the pull of the earth which is expressed as the plane's weight

LIFT: a force produced by the flow of air over passing over the wing (see Bernoulli's Principle)

NEWTON'S THIRD LAW OF MOTION: for every action there is an equal but opposite reaction

STREAMLINING: designing in such a way that air flows past smoothly

THRUST: the force that pulls the plane forward, and at the same time, makes air flow above and below the wings

Lesson 1: Creating a Visual History of Flight

Specific Lesson Objectives
The students will:
1. understand and analyze events, trends, and personalities shaping history examine the influence of technology in our daily lives
2. exhibit an understanding of the chronology and significance of major historical and economic events contributing to the growth and development of the U.S.

Time Allotment
This lesson can be completed in three 40-minute sessions.

Materials/Resources
butcher or other rolled paper suitable for a timeline
materials of your choice to illustrate time line (paint, crayons, colored pencils, etc.)
2 3"x5" index cards for each of your students
flight history research cards (teacher created--see below)
5 pre-drawn sections of time line (see below)
a folder for each group
cooperation/support of school librarian for one of the following:

1. A one half hour of assisted research in the library
2. A loaned classroom collection of books on aviation & reference

Advanced Preparation
Put students in groups of five or six. These should be permanent cooperative groups for the duration of the unit.

It is necessary for the teacher to prepare a number of flight history research cards. You will need a number equal to the number of students in your class. To create these cards, use colored index cards, cut in half. Each card should have the name of a person, myth, invention, etc. important to the development of flight. Possible Items for Flight History Research Cards:

Sir George Cayley's "Convertiplane", 1804
William Henson's "Aerial Steam Carriage", 1842
Albert and Gaston Tissandier's "Airship", 1883
Otto Lillenthal's "Biplane Glidee", 1895
Orville and Wilbur Wright's "Flyer", 1903
Leon Levavasseur's experimental "Antoinette", 1911
Anthony Fokker's "Fokker Dr-1 Triplane", 1917
"Curtiss Flying Boat *NC-4*", 1919
"Boeing 707", 1954
"Douglas World Cruiser", 1924
"Boeing 40A" (Mail Plane), 1926
Ryan NYP *Spirit of St. Louis"*, 1927
"Douglas DC-3", 1935
Vickers Supermarine "Spitfire", 1936

Frank Whittle's "Whittle Jet Engine", 1930
Bell X-1 (sound barrier), 1947
Concorde Supersonic Transport, 1969
Charles A. Lindbergh
Pegasus
Daedalus and Icarus
Kitty Hawk, North Carolina
Dr. Robert H. Goddard
Amelia Earhart
Octave Chanute
Lockheed 5-B Vega
Montgolfier Brothers
National Advisory Committee for Aeronautics (NACA)
Clement Ader

Using the butcher paper, prepare 5 fifty year sections of unlabeled time line covering the years 1750-2000. Label only the century and half century marks. In an activity below, the time lines will be joined together.

Procedure

Tap Prior Knowledge

1. In large letters, put the words human flight in the middle of the board. Ask students for words and phrases relating to the topic. Accept a broad range of answers including types of planes, hot air balloons, helicopters, names of people associated with flight, forces, mythological stories, ate. Feel free to ask questions about things you think they might know, and have not mentioned, but do not add any information yourself. (this should take approximately 20 minutes.)

Share with Group

2. Ask students to break into their groups and brainstorm how (they think) airplanes fly.

3. Before the end of this first 40-minute class period, students should choose a secretary for the day, (secretaries rotate with each activity), and complete the following adapted KWL activity. Secretaries should take a sheet of blank paper and fold it horizontally (like a letter) into three sections. Holding the paper sideways, like a brochure, each consecutive section should be titled as follows: What we think we know/What we want to know/What we learned. Secretaries should fill out the first column based on group discussion and consensus. This paper should be kept in the group folder when not in use as it will be part of the final evaluation.

Research/Hands-on Activity

4. At the beginning of your second 40-minute period, have students randomly draw a flight history research card from a container of your choice. Tell them that before they examine how flight works, they are going to create a visual history of flight. Each of them is to draw a picture of the person or item on their card and write a

short, (1 -2 paragraph), description of how they relate to the history of flight. Take students to the library for a half hour of research. Upon your return to class, have students take a few minutes to share found information in their groups.

5. Prior to your third 40-minute period, post time lines, connected and in order, on the wall of your room. At the beginning of class, pass out two index cards to each student and instruct them to transfer their drawing to one card and their information to the other. As each student finishes they are to place their items at the appropriate location on the time line and fill in the year. They may then take a brief look at other items on the line. (Allow about 20 minutes for this part of the activity--or, you could have them do the transfer of picture and info as part of the previous night's homework and leave more class time for the next part of the activity.)

Relate Activity and Concept

6. When all items are posted, encourage students to make general statements about the history of aviation based on items that they can see on the time line. Have each group make two lists:

1. General statements about aviation based on time line items.
2. Ways aviation has changed the life of people on this planet.

Lesson Assessment

Successful group completion of part one of the KWL activity and group compilation of lists 1 &2 in step 6. Successful individual completion of time line/research task. Teacher evaluation of individual participation.

Lesson 2: How Do They Stay Up There?

Specific Lesson Objectives
The students will:
1. show relationship between balanced and unbalanced forces and motion.

Time Allotment
This lesson can be completed in three 40-minute sessions.

Materials
Station 1 (to be set up for first session)
6 large square pieces of cardboard, (2 1/2 ft. x 2 1/2 ft.)
hallway outside of classroom or outdoor area

Station 2 (second session)
A (station must be near electrical outlet)
small fan with a long extension cord
several round pencils
flat board (fairly thin and lightweight)
instruction card
B
flat plastic bottle (shampoo?)
cork to fit this bottle
vinegar
baking soda
toilet paper
four round pencils
instruction card
C
6 long narrow balloons
6 6-inch lengths of string
6 straws
cellophane tape
string
2 chairs
instruction card

Station 3 (third session)
A
5 textbooks
30 sheets of 8 1/2 1 paper instruction card
B
10 large index cards 5 pencils instruction card
C
2 balsa wood glider airplanes (one large, one small)
instruction card

Advanced Preparation
Set up one station for each 40-minute period. For sessions two and three, each station has three activities. Each student or group is to perform at least 2 of the activities during the time period. (You may need to sat up a schedule.)

Each Station is set up with activities designed to exhibit a specific force related to flight. Station 1 --drag, Station 2--thrust, Station 3--lift.

Duplicate station instruction cards, 6 for each station. Information for Teacher-Created Instruction Cards:

Station 1
Hold a large piece of carddboard in ffront of you and run down the hall. What happened? How can you hold the cardboard so that you can run faster?

Teacher info: the resistance of the air against the cardboard will cause drag and slow down the student's forward motion. This drag can be minimized if the student runs carrying the cardboard under an arm.

Station 2
A
Place several round pencils under the flat board. Place the fan on top of the center of the board. Switch the fan on. What happens? Why?

Teacher info: the spinning blades of the fan produce a thrust that makes the fan move.

Station 2
B
Fill the bottle about one third full with vinegar. Place a teaspoon of baking soda on a small piece of toilet tissue and twist into a roll, drop into the bottlle, give the bottle one good shake to break up the roll, and push the cork into the bottle firmly, but not too firmly. Immediately place the bottle on 3-4 round pencils. What happened? Why did it happen?

Teacher info: in a very short time the cork will blow out of the bottle, and the bottle itself will move in the direction opposite to that of the cork. The baking soda reacts with the vinegar to form carbon dioxide gas, which pushes in all directions. When the force is strong enough, the gas blows the cork out of the bottle. As the gas shoots out of the bottle in one direction, you get an equal but opposite force that moves a shorter distance than the cork because it is heavier than the cork.

Station 2

C

Blow up a balloon and tie a string in a bow arounu its neck. Attach the balloon to a soda straw, using scotch tape. Run a long length of string through the soda straw and attach both ends between two chairs. Now untie the string so that the air can escape. What happens? Why does it happen?

Teacher info: when the balloon is filled with air and the string is tied around its neck, the balloon does not move because the air pressure inside the balloon is equal in all directions. When the string is untied and air begins to escape from the balloon, the air pressure inside the balloon becomes unequal. The air pressure is now greater on the surface opposite the neck of the balloon because the air pressure on the neck decreases as the air escapes, so the balloon moves in a direction opposite to that of the escaping air.

Station 3

A

Place one end of a sheet of paper inside a book so that the paper hangs downward (from the top of the book). Now hold the top of the book level wlfh your lips and blow over the top of the paper.

What happens? Why?

Teacher info: the sheet of paper will rise because the fast-moving stream of air across the top of the paper causes the air pressure on the top surface of the paper to be less than the air pressure underneath the paper (Bernoulli's Principle).

Station 3

B

Take a large index card and cut a strip lengthwise about 5 centimeters wide. Bend and staple one end of the strip about 2 1/2 centimeters from the other end. Gently pinch the rounded end of the strip until the upper surface is curved and the lower surface is straight. Slip a round pencil through the loop and blow across both the upper and lower surfaces at the same time.

Teacher info: a lift will be produced on the wing because the air moves faster across the upper surface than the lower surface, so the air pressure on top of the wing is less than the air pressure underneath.

Station 3

C

Test fly both airplanes. What is the difference in their flight? What causes this difference?

Teacher info: the greater the wingspread, the more air passes over and under the wings and the greater the lift will be.

Procedure

Tap Prior Knowledge

1. Have students review their KWL activity from their group folders. Give them 5 minutes to review what they think they know about flight.

Share with Group

2. When time is up, ask them to brainstorm questions that indicate what they would like to know about flight and write them in the second section of their KWL sheets. Give them an additional 10 minutes. Have them refile the KWL sheets.

Hands-on Activity

3. Set up Station 1. If the weather is good, set up 6 test areas outside, (one for each group), and have each group follow the instruction card. At the end of each activity students are expected to do the following:
    1. Draw a picture of themselves doing the activity.
    2. Describe what they did.
    3. Describe the results that occurred because of what they did.
    4. Explain why they think they achieved those particular results.

4. Second session. Set up station 2. You will need to set up three separate activity areas in the classroom. Set a group rotation schedule so that each group gets a chance to do activities at a minimum of two areas. Students are to go to their area and complete the activity by following the instruction card and doing their write up.

5. Session three. Set up station 3. Instructions are the same as the item above.

Introduce Principle/Concept

6. At the and of session one, explain to students that there are four forces involved in flight, and that they are: lift, gravity, thrust, and drag. Give a brief definition of each.

Relate Activity and Concept

7. At the end of each session, ask students to describe what happened in the activity they just did and to guess which of the forces they experienced during the course of the activity. Make sure they explain their answers. At the end of each activity, ask them if they think that the particular force would be a helpful one in flight, or something to be overcome. Ask for explanations. During the post activity discussion for Station 1, talk about resistance and designers' efforts to streamline airplanes to alleviate the ill effects of drag. Ask students to think of other common vehicles that are streamlined to combat wind resistance (ex. trains, cars, racing bikes, etc.)

Lesson Assessment

Assessment includes evaluation of oral participation during discussion, teacher evaluation of participation in Station activities, review of written activities pertaining to Station work, and part two of KWL activity.

Lesson 3: Cross Country Air Rally/Scavenger Hunt

Specific Lesson Objectives
The students will:
1. use maps and other geographic tools and technology to identify the major physical and cultural features of the earth.

Time Allotment
This lesson can be completed in three 40-minute sessions.

Materials
duplicated map of the continental U.S. including lines of latitude and longitude (enough copies for all students-laminated desk maps are ideal for this activity if they are available to you--map should also include a mileage key)
student worksheet (one for each student)
6 different rally/scavenger hunt flight plans (one for each group--teacher created--see sample in teacher help)
1 atlas for each group
prize(s) of your choice for the winning group (optional)

Advanced Preparation
Duplicate enough copies of a map of the continental U.S. (including latitude and longitude lines) and the student worksheet for all students. These will be used during your first 40-minute session.

Create 6 different rally/scavenger hunt flight plans based on the example in teacher help and using the 10 cities listed on the worksheet. These will be used for the race in your second 40-minute session.

Procedure

Tap Prior Knowledge
1. Ask students how planes know where they are going. How do pilots identity locations in their flight plans? Depending on their responses, you can briefly review the use of coordinates in math.

Share with Group
2. Ask students to get into their groups and brainstorm different situations in which using coordinates to locate something might be valuable or why someone might want to use coordinates to mark a place that they found something.

Hands-on Activity
3. Tell students that they will be using the coordinates of latitude and longitude to locate and identify 10 major American cities. They may work cooperatively in their groups to find the answers and they are to be as accurate as possible because tomorrow, they will be using their information in a race. Each student must complete a worksheet. (Pass them out. This should complete your first session.)

Answer key to latitude/ longitude activity

1. Chicago
2. St. Louis
3. New York
4. Boston
5. New Orleans
6. San Francisco
7. Dallas
8. Atlanta
9. Gallup
10. Salt Lake City

4. At the beginning of the second session, ask students to retrieve their worksheets from the day before. Tell them that they will be going on a cross country scavenger hunt, and that each group will be given its own flight plan to follow. The first group to return to the fearless leader, (you of course!), with accurate information, will be the winner! Pass out the flight plans, making sure that no group starts until you give the signal. Go for it! No matter who wins, allow all to finish.

Introduce Principle/Concept

5. Session 3. Return to student brainstorming activity, (#2), and discuss the importance of using geographic tools such as latitude and longitude, point out the fact that cities are cultural features of the earth.

Relate Activity and Concept

6. Discuss important institutions and cultural resources that one might find in cities. (i.e. , museums, universities, hospitals, libraries, government agencies that have jurisdiction over larger areas of the country, food and product distribution centers, transportation centers such as major airports, etc.) The variety of resources that these cultural features of our country contain make a strong case for an organized system of location for such riches.

7. What natural resources can be found in and around different geographical areas? (i.e., mountains, lakes, desert, etc.) Why would it be important to be able to locate specific areas? How could this relate to conservation of natural resources?

Lesson Assessment

Teacher evaluation of oral participation of individual students. Successful completion of latitude/longitude group activity. Successful completion of scavenger hunt.

Lesson 4: By Design

Specific Lesson Objectives
The students will:
1. formulate an hypothesis, plan an experiment, and present data.
2. interpret results and recognize when they are ambiguous.
3. recognize the preparation needed for a world of work.

Time Allotment
This lesson can be completed in five 40-minute sessions.

Materials
a ream of 8 1/2 x 11 duplicating paper
rulers
pencils
imagination

Advanced Preparation
Knowledge of how to make a basic paper airplanes- there are several books on this subject, my favorite being More Best Paper Aircraft, The Pinnacle of Paper Airmanship: 12 High Performance Fliers You Can Make in Minutes, by Campbell Morris, Perigee Books, published by the Putnam Publishing Group. This book includes folding tips and some more advanced designs (which are not necessary for this lesson, but might provide some additional fun for your class).

Procedure

Tap Prior Knowledge
1. Ask students to explain the four forces involved in flight to you as if you did not know how they worked. Be sure to ask questions intended to elicit more precise information as if you truly did not know. (You might ask for volunteers and allow others to add information in an orderly fashion.) When drag is being explained, be sure to ask how scientists or designers overcome this problem. (streamlining) When lift is explained, ask about which feature of the plane is most responsible for interaction with this particular force. (wing). And whether the size of the wing makes a difference (review background material on lift).

Hands-on Activity
2. Tell students that today, they are going to become scientists and designers. The first thing they are going to do is learn to fold a basic airplane. Make sure all students have a sheet of paper, then give instructions while demonstrating- tell them that each group represents a design company, and that you are going to give them a problem to solve. You are a major airplane producer for both the government and commercial airlines. You need a new design for the military that is faster than your basic modal (the plane that you just folded). You also need a model for your commercial airline contracts that will stay aloft longer, for passenger flights. The design company that can most efficiently meet these challenges, will get your billion dollar contract. The only tools they are

allowed to use are pencil, scissors, paper, and their imagination. They are required to work as a group and keep track of their trials and errors and/or their advances in design (save each successive model). They are to deep in mind what they've learned about the forces involved in flight. Lot them begin. Make sure students understand that the speed in which they finish their task is not a factor in whether or not they are awarded the contract. They must focus on meeting your specifications for the product to the best of their abilities.

3. Session 2&3. When a group feels they have their best model, in each category, they must develop a scientific way of testing it to see if it meets your specifications. They should use the basic model to coiled some baseline date. In order to meat your specifications. What must they know about the basic model? (how far it flies and how long it remains airborne.) How can they find this out? Is one trial enough? How many would give them a good idea? How will they collect and express their data? (chart, graph) should they use the same method of testing for their other models? Must conditions be exactly the same? (yes) Why? Since groups are likely to be working at different rates. These sessions should allow for teacher interaction with individual groups in order to facilitate the above. You may have to get them started or restart them with some of these questions. Make every effort not to give correct instruction. All testing should be done indoors (hallway, gym). Reasons will become apparent later.

4. Session 4. When all groups have completed and tested their designs and are confident that they have their best models, each group should give a presentation of its data and demonstration of its models for the whole class. The contract should be awarded to the team(s) that most closely mat your specifications. (there should be only one winner in each design category. It is conceivable that one team could win in both categories, but not absolutely necessary.)

Introduce Concept

5. Session 5. Encourage students to share their process of design with the class. What would this stage of their project be called in the working world? (research and development) What were some of the necessary elements included in the testing of their product to make the test unquestionably valid? What about the following section, when they designed a scientific way to test their product? (although this is still part of research and development, it also has elements of quality control.) Does the final product stand up under repetitive testing? Would their test results have been as clearly valid if they had tested outdoors? Why or why not? (no, because of the unpredictability of the wind.)

Relate Activity and Concept

6. Discuss how the activity in which the students have been engaged relates to actual work in the scientific and business communities. Emphasize the importance of team building in the work place.

Lesson Assessment

Successful participation in and completion of design project. Teacher evaluation of individual participation in class discussion and group activities.

Final Evaluation

(one 40-minute session)

Student: Have students complete final section of KWL activity individually. On a single sheet of loose leaf paper. Give students 5-10 minutes to list as quickly as they can, everything they can think of that they learned during the aviation unit. After the 10 minutes are up, ask them to write, in paragraph form, about what was most important, enjoyable, and interesting to them.

Teacher: Examination of group cumulative portfolios and individual assignments. Review of the final section of the KWL activity.

Student Data Sheet Masters

Without Feathers: Discovering the Forces Behind Human Flight
Student Data Sheet Master 3.1

Latitude/Longitude

Name the cities that you find at each location.

Latitude	Longitude	City
42 N	88 W	________
38 N	91 W	________
41 N	74 W	________
43 N	72 W	________
30 N	90 W	________
38 N	123 W	________
33 N	97 W	________
34 N	85 W	________
36 N	109 W	________
42 N	113 W	________

Without Feathers: Discovering the Forces Behind Human Flight
Student Data Sheet Master 3.2

Sample Flight Plan

You are to visit the following cities and pick up the items requested. You are to save fuel, so plan the order in which you will travel to these cities.

After you have planned your route, calculate the number of miles you flew. Then calculate how long the entire trip took you if your plane travels 200 miles per hour and takes 10 minutes for every take-off and landing.

Cities	Pick-up
Boston	25 live lobsters
Gallup	A Kachina doll from the intertribal ceremonial
Atlanta	The door knocker from Scarlet O'Hara's town house
Salt Lake City	Some briny water from the Great Salt Lake
Dallas	A Dallas cowboy cheerleader to teach you some new steps
New Orleans	A gator

DRAFT

I Spy... Crystals

Community Resource Curriculum Development Project

Developed by: Margaret Sommer

I Spy... Crystals

Glossary

ATOM: the smallest particle of an element that can take part in a chemical reaction

ALUM: bitter white powdered spice used in pickling

BORAX: laundry product

CRYSTAL: a solid that has flat sides and atoms arranged in a symmetrical pattern that is repeated over and over again

CRYSTALLIZE: become crystal

CRYSTALLOGRAPHER: a scientist who studies the arrangements of the atoms that make up crystals

DISSOLVE: to go into solution, to be absorbed, usually into a liquid

EVAPORATE: to change from a liquid to a gas

EPSOM SALT: a bath salt crystal

FACE: the flat surface of a crystal

GEMSTONES: minerals that occur in nature and are valued for their beauty, rarity, and durability

GEODE: a hallow rock in which crystals have formed inside the cavity

INTRINSIC PROPERTY: basic attribute or feature of something

LAVA: melted magma from beneath the earth's crust which is forced up through the cracks and pours forth from volcanoes; very porous rock

MINERAL: substance which was never alive, made of one or more elements

MOLECULE: the smallest particle of a compound that retains all chemical properties of that compound

PRECIOUS METALS: crystalline minerals but single crystals are rarely found; i.e. gold, silver, and platinum

ROCK SALT: crystal found near table salt and used in making ice cream

SALT: spice crystal that is cubelike, with flat sides or faces

SUBSTANCE: material of which something is made

SUGAR: cooking/baking crystal that is oblong and slanted sharply at either end

SATURATED: when a solution contains as much dissolved material as it can hold at that temperature

SUPERSATURATED: to cause a solvent to hold more of a solute than it normally could, usually by warming the solvent

SOLUTE: a substance dissolved in something else

SOLVENT: the dissolving substance of a solution, usually a liquid if the solution consists of a solid and a liquid

SOLUTION: a mixing of two or more substances so that the molecules of one are evenly dispersed through the others

SYMMETRY: balanced proportion either by a balance of halves on opposite sides of a line or by the balance of parts around a central point of axis

Lesson 1: To Be or Not to Be...

Lesson Introduction

A geode is a plain, seemingly ugly brown or gray rock. It feels rough to the touch and is usually light weight for its size. It may be found to have an oval or round shape. The secret is inside and exposed when it is split open to reveal a hollow center that is surrounded by beautiful purple, black, or colorless crystals. Geodes are usually found having a 2-6 inch (5-15 cm) diameter. They can be found in the South Western United States and Mexico, and other parts of the world.

Specific Lesson Objectives

The students will:

1. observe and describe a whole geode.
2. observe and describe a split geode.
3. illustrate and reflect on their observations.
4. color and label states and/or countries where geodes can be found.

Time Allotment

This lesson can be completed in one 60-minute session.

Materials

one whole geode for each group with location found
one split geode for each group with location found
one demonstration set (whole and split) of geodes
magnifying lens
scale
tape measure
copies of Student Data Sheets
United States maps to color

Advanced Preparation

Arrange students into cooperative groups.

Procedure

Tap Prior Knowledge

1. Hold a whole geode for the class to see. Ask "What am I holding?" Accept all answers.

Hands-on Activity

2. Pass out a geode (rock) to each group for a closer look. Let each group discuss their geodes (rocks) and contribute one description item to be listed on the board. List the locations where the rocks where found. Keep the suspense up by not telling the students they are observing "geodes". Call them *rocks* until now.

Introduce Principle/Concept
3. Ask students what they think is inside the rock (geode). Accept all answers then show one that has been cut or broken open. Explain that this is a geode. Inside a geode can be found crystals.

Relate Activity and Concept
4. Pass out a split geode to each group. Have them list a description of each geode on the board, along with its location.

5. Explain the data sheet and the types of data to be recorded. Give scale, tape measure, and magnifying lens to each group. Let the cooperative groups work together to gather data and fill out the individual work sheets.

Social Studies Connection
United States maps are colored and/or label to show where geodes can be found.

Books to Read
Be a Rockhound, by Martin Keen, Julian Messner, 1979.
Exploring Crystals, by James Berry, New York: Collier, 1969.
Gems and Minerals, by Susam Harris, Franklin Watts, 1980.

Lesson 2: Crystals in the Rough

Lesson Introduction

Rocks are not always what they seem to be. Inside some hollow rocks can be found beautiful crystal structures. Rocks are made up of two or more kinds of minerals. Minerals are non-living chemical substances that are found in nature. A geode has an accumulation of one mineral that has mixed with water to form solution and then evaporated to leave behind crystal formations. This process took place many times before the geode opened.

Specific Lesson Objectives

The students will:

1. mix a solution.
2. observe and record evaporation.
3. make a simulated geode.
4. use the scientific method.

Time Allotment

This lesson can be completed in one 60-minute session.

Materials

hot water
alum
small mixing containers (medicine cups of film holders, two for each student)
  a) to mix in
  b) dry on
spoons or sticks for stirring
measuring spoons
half of a nut shell per student (walnut or similar)
food coloring (optional)
copies of scientific method data sheets

Advanced Preparation

Arrange students into cooperative groups.
Arrange an area in the classroom that will remain undisturbed for the simulated geodes to crystallize.

Procedure

Tap Prior Knowledge

1. Ask the students "What did we find when we cracked open a geode?" The students will recall their experience with crystals.

Hands-on Activity

2. Show the groups pictures of geodes and have geodes for them to look at. Explain that today they will make a simulated geode. "What does that mean?" You will make something that resembles a real geode and observe the crystal formation.

3. Today's geodes will be made using half of a nut shell (walnut shells). The shell resembles the outside of the geode which is rough to the touch and light brown in color. The crystals will be made by mixing a solution of one tablespoon very hot water and about one tablespoon of alum. (Note: Add alum slowly using one teaspoon at a time until it is dissolved. Stop adding when no more will dissolve.) After it is mixed and dissolved, pour the solution into the nut shell. Set aside the simulated geode in an undisturbed location to be observed. Fill out the scientific method sheet.

Introduce Principle/Concept

4. A geode is a porous rock. Over time a mineral (non-living chemical substance) and water have seeped through the rock and eventually the water began to evaporate. As the water evaporated, it left behind crystal formations. This happened many times leaving layers of crystal formations that are exposed when the geode is cracked open.

Relate Activity to Concept

Each student or group collects supplies. Add one tablespoon of very hot water to container. Add one tablespoon of alum to water and mix until it is dissolved. Add slowly using only what is needed. Pour solution into shell. Place on film holder. Set shell aside and observe. Fill out the scientific method sheet.

Social Studies Connection

Talk about other countries where e geodes can be found. Using a world map point out the different locations. Compare how they might relate to the place in the United States where geodes are found. Color map showing locations.

Books to Read

Rocks and Minerals, by R.F. Synes, Eyewitness Books Series, Alfred Knopf, 1988, *The Curious World of Crystals*, by Lenore Sanders, NY: Prentice Hall, 1964.

Lesson 3: The Senses Have It....

Lesson Introduction
Scientists have found and use many ways to identify crystals. One way that involves no special equipment is by using your senses. The use of your sense of touch and sight will start your adventure in understanding and defining what a crystal is.

Specific Lesson Objectives
The students will:
1. learn the characteristics of a crystal.
2. find out what the Illinois State crystal is.
3. describe what the Illinois State crystal looks like.
4. locate where the Illinois State crystal can be found.
5. complete data sheet.

Time Allotment
This lesson can be completed in one 60-minute session.

Materials
one quartz crystal for each student
copies of Student Data Sheets

Advanced Preparation
Arrange students in cooperative groups.

Procedure
Tap Prior Knowledge
1. Ask "What do you know about crystals?" Group can discuss together, form a list, and each group can contribute to a list that is written on the blackboard.

Hands-on -Activity
2. Pass out a crystal that is contained in an envelope or bag to each student. Instruct students to hold the envelope but not to look inside of it. Ask students to close their eyes, take out the crystal and hold it. Tell them to concentrate o the crystal they are holding. Ask questions about the crystal. You need to decide if you want them to answer out loud or keep the answer for later.

Questions
1. When you squeeze on the crystal, does it feel cold, warm, or hot to you ?
2. When you squeeze the crystal does the shape change?
3. As you feel the surfaces of your crystal does it feel rough or smooth?
4. Do all the surfaces have the same shape?
5. Count the surfaces to see how many there are.

6. Feel the edges of your crystal. Are they sharp or are they rounded?
7. Did the edges of your crystal make points when they came together?
8. If your crystal made points, count them to see how many points.
9. Open up your eyes and look at the color of your crystal.

3. Complete data sheet using what was discovered about crystals in the above activity.

Introduce Principle/Concept

4. Review the following with the students:

Crystal temperature is cool or cold.

Crystal hardness can be soft like graphite and can be scratched with a fingernail, but most are hard.

Crystal form is solid.

Crystals have flat sides, but sometimes you can feel a texture that reveals the atomic structures.

Crystal surfaces appear in certain numbers that reveal the inner structure.

Crystals have five basic characteristics:

1. straight edges
2. clean angles
3. clear defined surfaces
4. a special hardness
5. a particular shape

Social Studies Connection

Read about Illinois to discover what the state crystal is. Describe it and draw a picture of it. Color in the places where it can be found on a state map.

Books to Read

Crystals, by Ian F. Mercer, Harvard University Press, 1990.

Millions and Millions of Crystals, by Rona Gans, NY: Crowell, 1973.

Lesson 4: A Face is a Face...

Lesson Introduction

Crystals are found all around us. They are an important part of our everyday life. The crystals we are using can be found in grocery, and drug or pharmacy stores everywhere. Crystals can be found in home especially the kitchen. Crystals grow in smooth plane surfaces. The surfaces are called faces.

Specific Lesson Objectives

The students will:

1. identify several forms of mineral crystals.
2. observe a crystal face.
3. make a saturated solution.
4. compare the "grown" crystal to the individual crystal faces.
5. complete data sheets.
6. discuss use of crystals.

Time Allotment

This lesson can be completed in one 60-minute session.

Materials

salt
alum
Epson salt
magnifying lens
very hot water
cups (small medicine cups or film canisters
petri dishes or shallow dishes
mixing spoons or stirrers
measuring spoons
transparent tape
overhead projector
cupric sulfate (optional for teacher)
sugar
rock salt
Note: Have in display boxes and open container for viewing

Advanced Preparation

Arrange students into cooperative groups. Heat water to boiling. Set up overhead projector.

Procedure

Tap Prior Knowledge

1. Display the various crystals in there containers and open dishes for observation. Ask "What do all of these containers have in common? Where can you purchase these? What are they used for ?" Look at the clear open

Lesson 5: Supersaturated Solutions = Crystals

Lesson Introduction

Mineral crystals come in different shapes and can be different colors. They have regular features: including straight edges, flat faces, and repeated shapes. The shape of the crystal depends on the type of mineral it is. Each mineral will always form the same crystal shape. The color of a crystal depends on the impurities of each mineral as it mixes.

Specific Lesson Objectives

The students will:

1. make a supersaturated solution.
2. find out how crystals form.
3. compare the "grown" crystals to the individual crystal faces.
4. complete data sheets.

Time Allotment

This lesson can be completed in one 60-minute lesson.

Materials

salt
alum
Epsom salt
very hot water
cups (small medicine cups or film canisters)
petri dishes or shallow dishes
mixing spoons or stirrers
measuring spoons
transparent tape
food coloring
copies of Student Data Sheets

Advanced Preparation

Heat water to boiling (very hot). Arrange students in cooperative groups.

Procedure

Tap Prior Knowledge

1. Ask "What happened last time when we added the mineral crystals to liquid (water)?" It dissolved and made a solution. We made simulated geodes.

Hands-on-Activity

2. Today we will be making a supersaturated solution. The first teacher demonstration of a supersaturated solution is a large batch of Rock Candy (Student Data Sheet 5.1). This can remain a surprise for the class to discover when it is ready to eat.

containers. Ask "What do these have in common ?"(i.e., color, texture, use) They are all crystals.

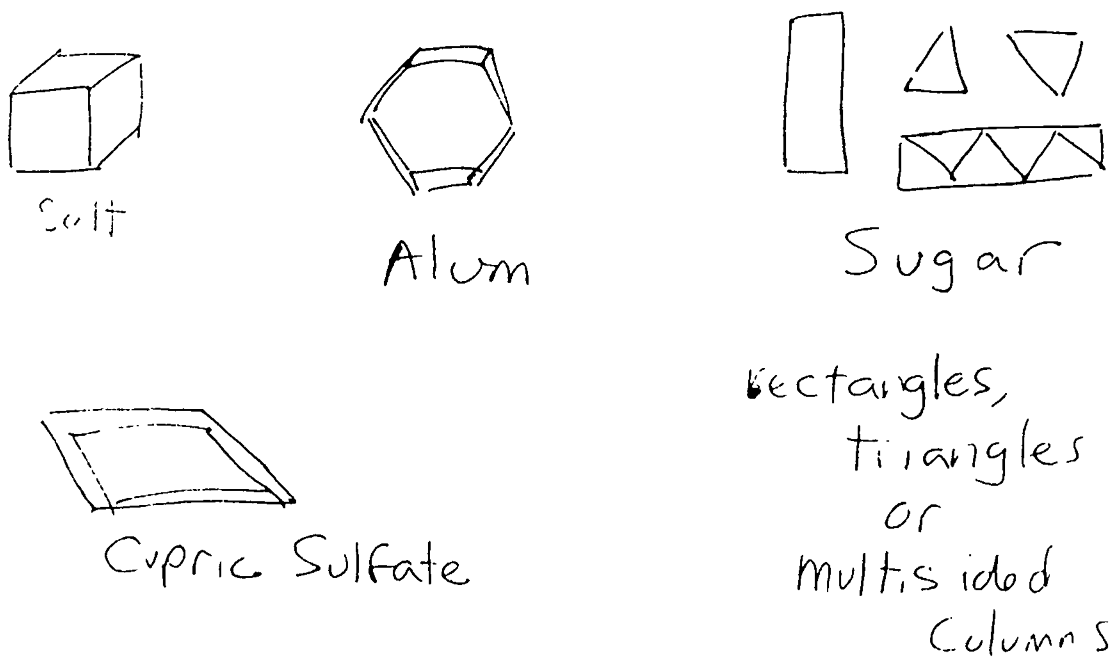
Share with Neighbor
2. Now we will closely look at a crystal. Place salt or other crystal on the overhead projector. Observe and discuss.

Hands-on Activity
3. Have each member of the group collect a crystal in a labeled container, magnifying lens, worksheet (the three members all have a different crystal so they can observe and share each others crystals). Tell students to put a pinch of crystal on the black sample section of their paper and examine it with a magnifying lens. They let them draw what they see on their paper. After drawing, tape the original sample down and label. Each proceeds to observe the crystals of the other members and completes their sheets.

Introduce Principle/Concept
Point out the smooth flat surface. This is the crystal face. Each crystal has special shape. Observe other crystals on the overhead to show different faces. Note: This is where cupric sulfate can be used/observed.

Social Studies Connection
Locate, read, and discuss various uses of crystals.

Books to Read
The Young Rockhound's Handbook, by W.R.C. Shedenhelm, G.P. Putnam and Sons, 1978.



Introduce Principle/ Concept
3. Explain that by using very hot water the crystals will dissolve faster. The hot water allows more crystals to dissolve then cooler water. A supersaturated solution is made when more crystals than usual dissolve in the water.

Relate Activity and Concept
4. After the surprise supersaturated solution is put aside and explain that each student will now make a small supersaturated solution. Add one tablespoon of water to the cup. Add one tablespoon of crystal mineral to the cup and stir. Continue adding more crystal mineral until no more will dissolve. You now have a supersaturated solution. Add a few drops of food coloring to the solution and stir. Explain that in nature crystals are colored by many chemical impurities when they mix into the solution. Pour the supersaturated solution into a petri dish, including any undissolved solids. Set the dish aside to evaporate and grow (ask" what is evaporation?)".

5. Observe and log observations. When completely evaporated do comparison and fill out data sheet (Student Data Sheet 5.2).

Social Studies Connection
Crystals are formed using different minerals and have many colors. Some minerals have more value than others. Through out history people have searched to find the locations of precious and semi-precious crystals. Now you can find a particular birthstone or gem that relates to each month of the year.

Things to do:
1. Find out what your birthstone is and draw and write about it.
2. Use a birthstone chart and complete it by finding or drawing pictures of the gemstone (Student Data Sheet 5.3)
3. Research the history of birthstones and find out how they are used or what is believed they can do.

Lesson 6: When is a Marshmallow an Atom?

Lesson Introduction

A crystal is a solid form of a substance. Crystals get their shapes from the way the atoms or molecules are arranged in an orderly pattern. This pattern is repeated over and over again throughout the whole crystal. The atoms (molecules) are like building blocks. Each crystal is made up of millions of them. They are stacked and layered on top of each other making a special pattern that becomes a crystal shape. There are seven standard crystal shapes which are called systems. A crystal of salt has the shape of a cube and is made of hundreds of millions of cube-shaped salt molecules. Atoms make up molecules. Molecules make up matter.

Specific Lesson Objectives

The students will:

1. make a model of a crystal shape.
2. compare their model to the ones they grew.
3. compare their model to the crystals Galena or Pyrite.

Time Allotment

This lesson can be completed in one 60-minute session.

Materials

miniature marshmallows (8 per student)
toothpicks
crystal samples grown in supersaturated solutions
pyrite or galena crystals (perfect cube crystals)
paper models (if using instead of marshmallow variety)
pictures or models of seven different crystal shapes

Advanced Preparation

Arrange students in cooperative groups.

Procedure

Tap Prior Knowledge

1. Ask "When you observed crystals using your magnifying lens did they all look alike? What shapes did you see?" Show pictures and/or models. "Did you see some crystals that looked like these?"

Hands-on-Activity

2. Students will collect materials and make cubes. Compare this cube to their supersaturated crystals. Which are the same? (salt) Compare to a crystal of Pyrite or Galena, they grow in natural cube structures.

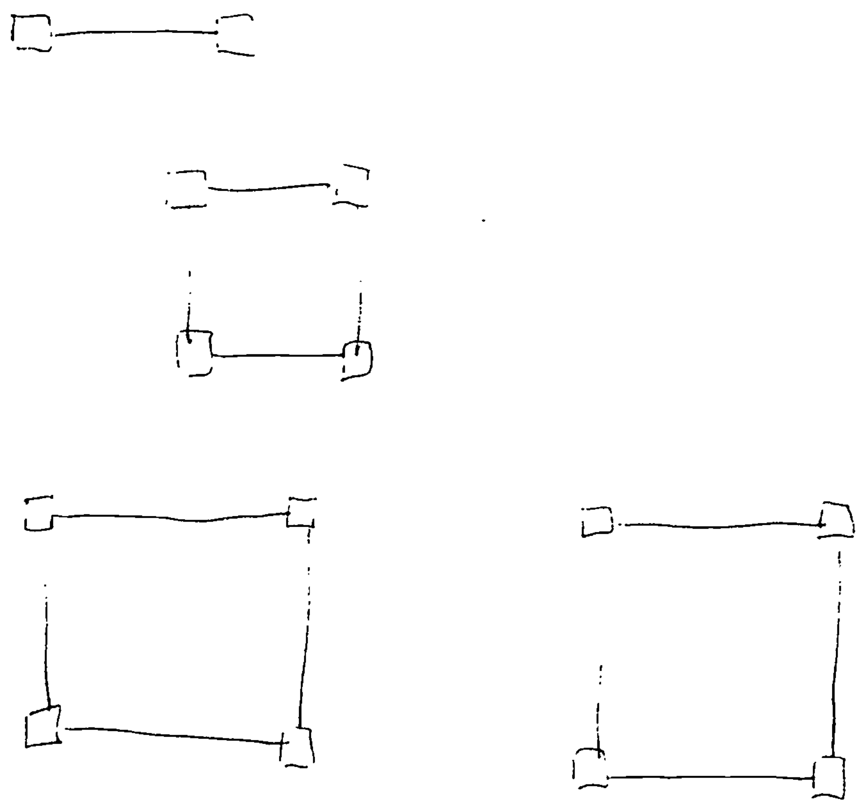
Introduce Principle/Concept

3. Crystals come in seven standard shapes which are called systems. Today you will build one in the shape of a cube. The shape comes from atoms which form together in an orderly pattern. This shape is called a system. This same pattern is repeated over and over again.

4. The marshmallows are like the atoms they will be connected by a toothpick. Make four structures of two marshmallows connected by a toothpick. (Drawing) Next connect two of these with two toothpicks to form a square. (Drawing) Make another square from the remaining toothpicks and marshmallows. (Drawing) Connect the two squares with toothpicks to make a cube.

Books to Read

Crystals and Crystal Gardens You Can Grow, by Jean Stangl, Franklin Watts, 1990.



I Spy a Crystal
Group Assessment

Lesson Introduction
This is a culminating class group lesson. It will incorporate the use of information learned from the proceeding lessons.

Specific Lesson Objectives
The students will:
1. pick out two different crystals using what they have learned about the characteristics of a crystal.
2. use lens to distinguish characteristics.
3. work cooperatively in a group.
4. complete worksheets.

Time Allotment
This lesson can be completed in one 60-minute session.

Materials
magnifying lens
sample labeled cards of salt, alum, Epsom salt, etc.,
sample cards of unknown crystals (2 types on each card)
data sheets

Advanced Preparation
Make labeled sample cards of each crystal being used. Make enough for each group to have a set. Make sample cards using two crystals mixed together. Each group also needs their own set of these. Arrange the students into cooperative groups.

Procedure
Tap Prior Knowledge
1. Discuss with students what they have learned that can help them tell crystals apart. Go over crystal characteristics.

Hands-on-Activity
2. Each group will be assessed on how well they work together as well as their worksheets. They will be observing mixed crystals and have to decide which two are on each sample card. Next they will complete the worksheets.

3. Each group gets a set of labeled sample cards. Each group gets sample cards of mixed crystals. Together they observe the mixed samples and decide on which crystals they are. After deciding on the crystals, they fill out the data sheets.

I Spy a Crystal
Individual Assessment

Lesson Introduction
While studying crystals and their formations many characteristics were discussed. Each activity introduced the use of the scientific method. As a final activity the students will construct their own experiment and "grow" crystals of their choice using the scientific method.

Specific Lesson Objectives
The students will:
1. conduct their own experiments.
2. record their own experiments using the scientific method.
3. explain their experiments and findings to class.

Time Allotment
This lesson can be completed in two 60-minute sessions. One session is for performing, another for explaining.

Materials
(Individual Materials)
small medicine cups
stirring stick
petri dish or shallow dish
data sheet

Supply Area Materials
labeled containers of salt, alum, and Epsom salt etc.
measuring spoons for each container
hot water

Procedure
Tap Prior Knowledge
1. Ask" What is the "scientific method?" and go over the steps. Ask "Why do scientists use this method?"

Hands-on Activity
2. They will be conducting an experiment of their own to make crystals. Each student will decide what they need to perform their experiment and they will record all their information on the "Scientific Method Sheet". During this experiment they will be working alone and not talking to anyone except their teacher. Everyone needs to concentrate on their own work and think about how they could later explain it is someone else.

3. Read over the scientific method sheet together and go over what is expected to be done. Show the supply area and how you will monitor it.

When they get their individual supplies and worksheet they can start working. Only after they have completed the procedure part can they start to get materials from supply area.

4. The completed experiments will be put aside for further observations. Recording can be made daily or whenever determined. Reports on experiments can be done orally at a later date.

Student Data Sheet Masters

I Spy... Crystals
Student Data Sheet Master 1.1

Crystals Observed

I Spy... Crystals
Student Data Sheet Master 2.1

Scientific Method Sheet

I Spy... Crystals
Student Data Sheet Master 3.1

Crystals Observed

I Spy... Crystals
Student Data Sheet Master 4.1

Crystals Observed

I Spy... Crystals
Student Data Sheet Master 5.1

Rock Candy Recipe

Ingredients and Equipment

2 cups of boiling hot water
4 cups of sugar
food coloring
large heat resistant measuring bowl or cup
Large plastic container (square 1.3 - gallon Rubbermaid or Tupperware)
Mixing spoon

Procedure

Add the sugar a cup at a time to the boiling water. Stir until each cup dissolves. Add food coloring and stir. Pour into the plastic container. Cool in a warm place so large crystals will form. In a few days crystals will begin to form on the surfaces. Push these crystals to the bottom of the pan to help the evaporation process. In about seven days the bottom of the container will have a thick layer of sugar crystals. Now you need to turn the container over in a sink or large pan to let the extra solution drain off. (about two hours) When the crystals are dry, push on the bottom of the pan and break the crystals into chunks. Let the chunks of crystals dry on waxed paper. Break them into enough pieces for the whole class to taste.

I Spy... Crystals
Student Data Sheet Master 5.2

I Spy... Crystals
Student Data Sheet Master 5.3

Birthstone Chart

January	Garnet
February	Amethyst
March	Aquamarine or Bloodstone
April	Diamond
May	Emerald
June	Pearl, Alexandrite, or Moonstone
July	Ruby
August	Peridot, or Sardonyx
September	Sapphire
October	Opal, or Tourmaline
November	Topaz
December	Turquoise, or Zircon

I Spy... Crystals
Student Data Sheet Master
Assessments

DRAFT

Physics in the 5th Grade? Yes!

Community Resource Curriculum Development Project

Developed by: Friedricka White

Physics in the 5th Grade? Yes!

Rationale

This unit is intended to meet the following Instructional Program Objectives for the Illinois State Goals for Learning at the fifth grade level:

BIOLOGICAL AND PHYSICAL SCIENCES

Use appropriate scientific vocabulary

Demonstrate the need to observe safety procedures while conducting experiments.

Differentiate between an observation and an inference.

Explain the organization of a data table.

MATHEMATICS

Estimate and measure the weight or mass of an object by using customary or metric units.

Write an equation for a situation involving multiplication or division.

Find the probability that an event will occur given the probability of its occurrence.

Explore problems and describe results using graphical, numerical, physical, algebraic and verbal math models or representations.

SOCIAL STUDIES

Distinguish between renewable and non-renewable natural resources

Identify ways in which the natural resources of a region influence the lifestyle of its inhabitants.

CHICAGO PUBLIC SCHOOL LEARNING OUTCOMES GRADES 4-8

BIOLOGICAL AND PHYSICAL SCIENCES

Demonstrate living and non living things are composed of different types of matter and have properties that may change.

Show relationship between balanced and unbalanced forces and motion.

Identify different energy forms and demonstrate the relationship between work and energy.

Discuss contributions of various cultures to present scientific knowledge.

Demonstrate how forces change speed and direction.

Apply formulas to solve problems in science.

Demonstrate and practice safe and laboratory techniques.

SOCIAL SCIENCES

Recognize the preparation needed for the world of work.

Demonstrate the ability to make informed choices to meet wants and needs.

BENCHMARKS FOR SCIENTIFIC LITERACY
By the end of 5th grade students should know:

Results of similar scientific investigations seldom turn out exactly the same.
Sometimes this is because of unexpected differences in the things being investigated, sometimes because of unrealized differences in the methods used or in the circumstances in which the investigations is carried out, and sometimes just because of uncertainties in observations.
Science is an adventure that people everywhere can take part in, as they have for centuries.
Clear communications is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.
Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.
Things on or near the earth are pulled toward it by the earth's gravity.
The earth's gravity pulls any object toward it without touching it.
Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect the given force will have.
How to keep records of their investigations and observations and not change the records later.
How to offer reasons for their findings and consider reasons suggested by others.

Content Background
There are five fields of study in science:

ASTRONOMY - The study of the planet we live on - earth and all our neighbors in space.
BIOLOGY - The study of the way living organisms behave and interact.
CHEMISTRY - The study of the way materials are put together and their behavior under different conditions.
EARTH SCIENCE - The study of the unique habitat that all known living creatures share- the earth.
PHYSICS - The study of energy and matter and the relationship between them. Physics has to do with all things around us and the energy they have. It is about why things get hot, what light is, how things move and make sounds. The main areas are light, heat, sound, mechanics, electricity and magnetism.

Our unit of study will concentrate on the mechanics of physics dealing with *force* and *motion*. Forces are all around us, from the force of gravity that holds us on earth to the force of fuel that sends rockets into space. Simply said, force is a push or pull.

In understanding more about forces, we will experiment with the meanings of matter and energy and learn to work a few problems using simple formulas used in the study of physics. Students will be introduced to simple experiments explaining Newton's three laws of motion and they will be able to tell which law is being used as they prepare an experiment of their own to present to the class. Sir Isaac Newton was a British physicist and mathematician who lived from 1642-1727. *Gravity*, which is the pulling force of the earth, was a kind of force that Newton discovered by asking the question - why do things fall to the ground? He realized the force acting on a falling body was the pull of gravity. He said it came to him when he saw an apple fall from a tree and the Standard international (SI unit) measurement, of which is used today in the study of physics, is called Newton, and is approximately the weight of an apple. Of course this is of one the legendary stories told about one of our most famous scientists. There will be other stories told about scientists of note such as Newton, that will attract the attention of the students but will enhance the interest of teachers as well.

It is also interesting to note at this point that one reason why physics is not taught at the elementary level at most schools is because the student's math skills are not developed enough to handle many problems which will occur during the learning of physics. Since physics is a method of computing the effects of the laws of nature by means of using mathematical equations, the 5th-8th grade students can be introduced to these fundamental laws, and a stronger interest will have developed their background and curiosity by the time they have reached high school and are introduced to algebra, trigonometry and chemistry.

Please remember, learning should be fun and that physic's main tool is in the use of math and which should be taught in the most interesting way as possible. Therefore, lots of stories, games, examples and experiments will be used as an aide to assist in your process of teaching this elementary unit of just one of the branches of physics. Allow children to express their own knowledge of the subject to be discussed. Develop, classify and construct meaningful explanations. Finally extend and enrich new understandings so that the students can relate to them.

Timeline for Unit

This unit contains work for a schedule of 15 days (3 weeks) which can be stretched out longer depending on the number of individual science experiments children will do on their own. The lessons are set up so that an introduction of physics history will be given, and an understanding made of the importance of physics study, conversions of units of measure, correlation of numbers to symbols, Newton's three laws and experiments demonstrating these laws. During the third week, the students will share their knowledge with other classrooms and parents. An end of unit celebration will be held with "Young Physicists" awards given. Journals and the "observation table" will be on display.

Evaluation/Assessment

There will be an end of unit example of an assessment rubric relating to the understanding of this unit. Teachers are asked to create their own rubrics for some of the lessons. There are also data sheets at the end and throughout the unit with matching and question and answer sheets. A sample for the student's self evaluation sheets is also given. Journals and Science Experiments that are explained by the students throughout the lessons will also serve for the teacher's individual evaluations of their students. Some students may also want to create their own rubric or self evaluation.

Community Resources and Other Information

LOCAL BOOK STORES:

Illinois Institute of Technology Bookshop
3200 So. Wabash Ave. Chicago, IL 312-567-3120
This university bookstore has new books in print on science and technology.

The Children's Bookstore
2465 Lincoln Ave, Chicago, IL 60614 312-248-2665

Museum of Science and Industry Bookstore and Shop
57th and Lake Shore Drive, Chicago, IL 60637 312-684-1414 (x780)
Has large display at main entrance within the museum. This store sells science books, toys and novelties.

GREAT BOOKS THAT ARE AVAILABLE:

Physics Experiments for Children." by Muriel and Mandell, Dover Publications, 180 Varick St, New York, NY, 1959
One of a series of books with experiments and activities. Others include biology, chemistry, electricity, and astronomy.

TEACHER REFERENCE BOOKS:

"Educators Guide to Free Science Materials" 35th Edition., 1994, Educators Progress Service, Inc. 214 Center St. Randolph, WI 53956-1497 414-326-3126 $27.95.
This book lists and describes free science materials including films, filmstrips, slides, audio tapes and printed materials by category of science subject area.

" Science 2001 Text Sets"
Contact Dr. Diane Schiller Loyola University, 6525 No. Sheridan Rd. Chicago, Illinois, 60626. 312-508-8383
Teachers can borrow sets of science books grouped by subject.

"Physics Curriculum and Instruction" 22585 Woodhill Dr., Lakeville, MN 55044 612-461-3470.
A 10 page catalog of physics demonstrations and concepts on video cassette and laser disc.

"Physical Science" (100 reproducible activities) by Joan DiStasio, Instructional Fair, Inc. 11994 Grand Rapids, MI
A valuable resource book introducing chemistry or physics to young students. The book contains activities and practice on metrics, graphing, motion, machines, periodic table, formulas and equations also much much more.

" 50 Nifty Science Experiments" by Lisa Melton and Eric Ladzinsky. Lowell House Juvenile, Los Angeles, 1992.

"Factbook of Science" Nimosa Books, 1993.

Physical Science" A Homework Booklet by Joan DiStasio- Instructional Fair, Inc. Grand Rapids, Mi. , 1995.

The Usborne Book of Science?" by Amanda Kent and Alan Ward.
Usborne Publishing LTD, London, England, 1990
An elementary book with introduction to biology, physics and chemistry.

"Force and Motion" (intermediate) (Hands on minds-on science) Teacher Created Materials, Inc. P. 0. Box 1040. Huntington Beach, CA 92647
This book has an extensive bibliography and many ideas and activities for extending this unit of study.

"Demonstrations Handbook for Physics" Second edition edited by Freir and Anderson American Association of physics teachers, One Physics College Park, MD. 20740-3845
301-209-3300
Book has apparatus and demonstrations that require only low cost everyday materials. $24.00.

SCIENCE PROGRAMS ON TELEVISION
Science Power
Chicago Cable Television Channel 21 by Dr. Diane Schiller Loyola University and Philip C. Parfitt, Chicago Academy of Sciences On Air, Sept.-May, on Wed. 7:30 - 8:30 p.m. Program allows students to phone and participate during live broadcasts about science.

PBS Station: WTTW, Chicago, Channel 11 and WYCC Chicago, Channel 20.

Classroom Contact - (Science 4-6)

PBS Elementary/Secondary Learning Series.
Braddock Place, Alexandria, VA 22314-1698. Call 800-228-4630. This PBS series is available in a special classroom edition and comes with an easy to use teachers guide. Price is $ 15.35.

STORES
American Science and Surplus Store
5696 Northwest Highway, Chicago, IL 60646
312-763-0313
Resource for inexpensive surplus science equipment.

Toy Station
270 Market Square, Lake Forest, IL 60045
708-234-0180
Sells different science kits including Educational Insights Science Kits.

Storehouse of Knowledge
2822 N. Sheffield, Chicago, IL 60657
312-929-3932
School Supplies and extensive section of books and materials on science.

MAGAZINE:
Superscience Blue Edition
Scholastic Inc. subscriptions, 2931 E. McCarty Street, P.O. Box 3710, Jefferson City, MO 65101-3710
800-631-1586
A classroom magazine for students grades 4-6, including science classroom activities. $6.75 per year for 10 or more.

TRIPS:
Museum of Science and Industry
57th street and Lake Shore Drive, Chicago, IL 60637-2093
Suggested exhibits that concern Force and Friction include Grainger Hall of Science, Communications Exhibit, Space Center, Gravity Well, Booster Rockets Steam Engines, Rocket Engines, Imaging. Also geared toward teachers and students grades 5-8, are the "Learning Labs" which emphasize peer to peer communication, problem solving, investigation and discovery. Teachers will be required to attend a workshop before bringing students to Learning Labs. Teacher Guides will be distributed at the workshop. For Learning Lab information, call the coordinator at 312-684-1414 x2440.
The educational department at the museum can tailor demonstrations for your particular needs. Call for group reservation 312-684-1414 x2290.
Fees: Demonstrations are free of charge to educators and museum visitors.
School/Public Program Information: 312-684-1414 x2429. Call Jane Peterson x2451 to get on the mailing list for museum NOTEBOOK, a publication for teachers that highlights different activities, programs and resources.

Six Flags Great America Physics Days
Contact Lisa Ignoffo, Special Events representative, Six Flags Great America, P.0. Box 1776, 542 N. Route 21, Gurnee, IL 60031
708-249-2133 x6439
This trip is set up for high schoolers but 5th and 6th graders can also be introduced to educational fun in a recreational atmosphere, on rides the students measure their acceleration, horsepower and centripetal force as they become part of the science experiment.

The Power House
contact Michael J. Radziewica, Commonwealth Edison 100 Shiloh Blvd., Zion, IL
708-746-7080
Mon.-Sat. 10am-5pm, Admission - Free.
Interactive hands on science museum. An educational experience where one can learn about energy. Includes a theater and educational resource center.

Science and Technology Interactive Center
18 W. Benton, Aurora, IL 60506
708-859-3434
Wed. Friday, and Sunday, 12-5.
Scientific exploration and experimentation. Has fun science toys and materials.

Career Connections
PHYSICISTS: Help design things like rockets and bridges, study properties of matter and decide what materials would be best used for building things, work with chemists and biologists to help make gains in the field of medicine, work with other scientists such as geologists to help find and pump oil. Physicists go to college mostly 5-7 years. Physicists can be found working in the field of nuclear energy and/or business organizations such as TV companies, etc.

ORE CONTROLLERS: Help locate the uranium underground. Learn about earth science during 2 years of college.

HEAVY EQUIPMENT OPERATORS AND MINERS: Remove uranium from the ground. Get on the job training.

SAFETY TECHNICIAN: At Nuclear Power Plants, makes sure plant is safe for workers. Checks amount of radiation inside and outside plant. Tests samples of air and water in environment. Four year training program.

RADIATION THERAPIST: Concentrates x-rays or other radiation on the diseased parts of cancer patient's body. Radiation might destroy or stop growth of cancer cells. Train at college or hospital for 2 years.

Glossary

ACCELERATION: a change in velocity, either an increase or a decrease

BALANCED FORCES: more than one force acting on a single object which cancel each other out, thus producing no change or movement

CENTER OF GRAVITY: the point about which an object will balance

CENTRIFUGAL FORCE: the force in a circle that wants the object to escape the circle in which it is traveling

CENTRIPETAL FORCE: the force that keeps an object traveling in circles

CONCEPT MAP: a visual method to see organized ideas and concepts

CONCLUSION: the outcome of an investigation

DISPLACEMENT: a change in position; the volume of fluid pushed aside by a body immersed in a fluid

EINSTEIN'S THEORY OF RELATIVITY: the only velocity that can be measured is velocity relative to some other body

ENERGY: whenever anything moves or changes in any way; the ability to do work

EXPERIMENT: a means of proving or disproving an hypothesis

FORCE: a push or pull showing active power or strength

FREEFALL: the falling of an object toward the earth with no forces pulling or pushing it except gravity

FRICTION: resistance to motion of surfaces that touch

FULCRUM: a pivot point; the support about which a lever turns

GALILEO: (1564-1642) known for his theory of a sun-centered solar system, he laid the foundation for our understanding of gravity; the father of the scientific method

G FORCE: force of attraction between 2 objects; a G- Force is produced by the earth's gravity

GRAVITATIONAL ATTRACTION: force of attraction between an object and the earth; referred to as weight

GRAVITY: a force that pulls objects on earth towards its surface; the direction of the pull is toward the center; the measurement of gravity is 32 ft. per second (9.8 meters per second) for every second of falling time

HYPOTHESIS: a guess as to what might happen when asked a question of problem in which you are trying to find the answer

INCLINED PLANT: a slanted surface

INERTIA: a property of matter which requires exertion of a force on a body to change its position or motion

INVESTIGATION: to observe something and then perform a systematic inquiry in order to explain what was originally observed

KINETIC ENERGY: energy due to motion of a mass

LIQUID: matter that has definite volum but no definite shape

MEASUREMENT: an amount obtained through the process of measuring something

NEWTON, SIR ISAAC (1642-1727): known for his three laws of motion, the law of gravitation and one of the inventors of a math called calculus.
1st law: A body at rest will remain at rest, and a body in motion will remain at constant velocity unless acted upon by an unbalanced force
2nd law: force equals mass times acceleration; F=ma
3rd law: for every action, there is an equal and opposite reaction

MATTER: anything that occupies space and has weight

PHYSICIST: scientist who studies force and motion; they also study cosmic rays, such as sub atomic particles, ultra high frequency sound, studies of molecules and atoms, the behavior of light, and the relationship of matter to energy

PROJECTILE: an object that can be thrown, hurled or shot in a forward direction

QUESTION: a formal way of inquiring about a particular topic.

SOLID: state of matter that has definite volume and definite shape

VELOCITY: a measure of a rate of motion in a particular direction

Lesson 1: Physics from Past to Present

Lesson Introduction

This lesson contains the following content ideas.

Physics is one of many branches of science.

Physics has an interesting historical background.

Physics has an influence on the way we live here in the U.S. and all over the world.

Physics study requires many scientific and mathematical explanations and laboratory work and experiments have great importance.

In this lesson, students will be given an explanation of the historical background and meaning of the word "physics." They will have an opportunity for asking questions, stating what they already know, and will begin to set up their classroom with a laboratory atmosphere. Students will be divided into groups and they will realize how working together will benefit their understanding of the lessons. As they begin to understand some of the physics principles in our everyday lives, they can compare how physics might be used differently in other parts of the world.

Specific Lesson Objectives

The students will:

1. learn how various cultures have contributed to present scientific knowledge.
2. prepare to practice and demonstrate laboratory techniques. They will be able to ask questions relating to what they have learned from the teachers' explanations.
3. recognize the preparation needed for the world of work. They will also understand the importance of being able to do research]and having their findings documented.
4. be able to see the importance of teamwork and begin to do appropriate research homework assignments.

Time Allotment

This lesson can be completed in one 50 to 60-minute session.

Materials

Some of the following items can be brought in to place on the observation table:

lab coat
safety goggles
spring weight scales
books for children to read
liter bottle
measuring cup
marbles
small airplane
ruler with metric measurement, etc.
(more items will be brought in as lessons continue

Advanced Preparation
Arrange students into cooperative groups.

On the first day of class, make up a chart such as this with these rules to keep on the observation table.

1. Follow classroom rules of behavior
2. Wear safety goggles when necessary for certain experiments
3. Listen carefully to instructions before trying any experiments
4. Dispose waste and recyclable materials in proper containers
5. Keep experimental area clean and good order

Procedure

Tap Prior Knowledge
1. Give students opportunity to discuss and tell about anything they may know about scientific history.

Activities to Introduce Scientific Principle
2. Read story of past scientists, giving history of physics and the reasons why it is so important for our beginning studies.

STORY: "FROM OLD DAYS TO NEW WAYS"
(A history of physics)

A long time ago, there were men who were curious and wanted to know what was happening around them. They did not understand and they made up myths to explain things. They said everything that happened was caused by good and evil spirits. They did no experiments and had no tool or instruments, but they did observe and discuss what they saw.

These Greek philosophers also asked the question, " What is everything in the
universe made of?" The conclusion they came to was that everything in the universe was composed of 4 elements that were Earth, Fire, Air and Water. We know now that anything we can touch, see, smell, taste, or feel is called matter, and that matter is anything that takes up space.

These men also stated that the planet Earth was the center of the universe and the sun, moon and stars revolved around Earth. Centuries later, instruments such as the telescope were invented so that the actions of the planets could be viewed more closely. The philosophers and men now called Alchemists were searching for only one element that everything was made of. As this search started the battle began as to who was right about our Earth and the Universe.

It was later discovered by using the telescope, that the Earth was not the center of our universe, but indeed the Sun was. Also at this time,

observations were assigned symbols and numbers and from that point on, everything that relates to science was quantified (everything can be computed or explained by numbers).
Aristotle, one of the early philosophers, refused to accept the fact that the sun was not the center of the earth and probably set back scientific discoveries a few years.

Remember, alchemists were trying to find only one element and many many years were spent trying to turn metal into gold. Much later, theories were explained as to how atoms are composed in every element and everything because atoms cannot be seen with the naked eye, this discovery was accepted. Also, alchemists were now called scientists.

A division of scientific theories was now developed from which 5 distinct sciences evolved: Astronomy, Biology, Chemistry, Earth Science and Physics. Two important facts were developed then and still hold today. They are:
Reductivism (Everything can be reduced to a smaller level) and
Mechanism (Everything is quantified and assigned a number and/or symbol).

One man in particular named Isaac Newton discovered and formulated 3 laws of nature that explained what the past philosopher, alchemists, and scientists had been trying to put together for many centuries. This man created a new branch of science in physics called mechanics.

Newton was a secretive man and how he arrived at his formulas is not known. His laws obey the nature of all things on our earth. One of these days a different set of laws may be discovered by a yet unknown scientist that will not only apply to our earth but to the entire universe.

It is because of Newton's 3 laws, that other branches of physics have been developed. One of our newest branches is Nuclear Physics. One of our most famous scientists by the name of Albert Einstein was responsible for the formula that was the basis for the atomic bomb. He urged that atomic energy be put to peaceful use.

There are more than 100 million babies born each year compared to 30 million deaths. Here is a time table to compare:
2000 years ago--- 250 million inhabitants on earth
Year 1000 --- 50 million
Year 1800 --- 1 billion
Year 1900 --- 1 billion-650 million
By Year 2000 --- Estimated 6 billion people on earth

Scientists all over the world will have to pool resources to help build, plan for food, etc. to help undeveloped countries. Consider the fact that more than 50 million children work all over the world now and most of them don't go to school.

Because there are unequal resources, unequal development, and because many countries depend on favorable climate conditions, soil fertility, richness of mineral resources, the United States is rich in all these elements and will probably be called above and beyond the call of duty for providing services. We are also rich in natural resources like rivers and harbors that make movement of materials easier. Using machinery in America, and scientific methods of farming, it now takes less than 10% of the population to feed the rest of our nation.

Whatever science a student wishes to take up, some manner of physics must be studied and our country wants its citizens to be ready to answer the call for scientific knowledge that might be needed.

3. Have children choose their titles in each group as explained below:
   Project Leader: Scientist in charge of reading directions or setting up equipment.
   Physicist: (could be more than one) Scientists in charge of carrying out directions.
   Secretary: Scientist in charge of recording the information.
   Spokesperson: Communicates the findings of the group experiment to the rest of the class or works the mathematical solution on the board.

4. Set up and explain observation table.

5. Play the Great Debate. Assign each group one of these topics: air, earth, fire, water. The group will discuss why its topic was the most important element. After 10 minutes, a spokesperson for the group is chosen and represents the group in the Great Debate. The 4 students will be seated in the front of the class. Keep a tally chart running on the board with a mark made every time a good point is made. After 20 minutes, ask students to give or write their final conclusions.

Connect to Everyday Examples

6. In order to survive, human beings have adapted to many geographical environments. These influence the economy, habitats, food, clothing and technology. Even though there has been technological progress and improved communications, some difficulties still remain and adaptation is not always possible.

7. Each of these famous scientists were from another country. A report from your group will be due by the end of the week.

1. Albert Einstein from Germany (1879-1955). Famous for theories on relativity.
2. Isaac Newton from England. (1642-1727). Discovered law of universal gravitation and laws of motion.
3. Galileo from Italy (1564-1647). Laws on failing bodies.
4. Nicholas Copernicus from Poland (1473- 1543). Founder of modern Astronomy.
5. Aristotle from Greece (384-322 BC). Believed every event had logical explanation and conclusions could be formed from investigation and observation.

8. Have students record their thoughts on their personal reports. Students will experiment and document their notes and discoveries which will be kept in daily journals. Journal sheets may be passed out with instructions given for keeping notes up to date. (each student may have individual books or work on loose sheets day by day so that they can be stapled together later.

My Personal Record

Date
Subject
Book or materials used
What did I think would happen?
What actually happened
The main thing I learned
What more would I like to know about this subject?

Group Self Evaluation

Date
Problem or assignment for group
Was the question answered and understood?
Did we encourage and cooperate with each other?
Who was the spokesman chosen to discuss this assignment?

Home Activity/Parent Involvement
Each student will ask parents to help them find some items from the kitchen at home with metric measurements on them so they might share them with the class on the observation table and for experiments.

Lesson Assessment
Each group member shows active participation and teamwork during discussions and role play. Journals are started in a proper manner after examination by teacher. Students are able to express their ideas clearly and ask logical questions. The important end to the story is that while there were many other scientists from many countries who had good ideas, they were never published. This should be in the journal entries in some form.

Lesson 2: Mass and Measurement

Lesson Introduction

This lesson contains the following content ideas:

The need for making accurate observations.
How and why we measure things.
The different methods and conversions of units of measurement.

In this lesson, students will learn about the early ways used to measure items. The meaning of mass and weight and different forms of matter will be reviewed before going on the heart of our unit which is force and motion and ways of measuring movements. Students will also learn that a scientific method of observing things will give more accurate information. A story will be read on the historical background of measurement. Children will understand that we must have standards of measuring but before these standards were developed a system of counting was necessary.

Specific Lesson Objectives

The students will:

1. demonstrate how living and non-living things are composed of different types of matter and have properties that may change.
2. estimate and measure the weight or mass of an object by using customary and metric units.
3. be able to correlate numbers to symbols.
4. be able to communicate to others what they observe.

Time Allotment

This lesson can be completed in one 50 to 60-minute session, although you may need an additional day if the play is to be used.

Materials

copies of data sheet 2.1, "a play on the history of early measurements"
pictures of different types of measurement devices and actual samples set out on table for measuring experiments
regular and metric measuring bottles and container
scales
rulers
ice cubes
balloons
hot plate

Procedure

Tap Prior Knowledge

1. Give students opportunity to discuss and ask questions about measurement and tell about what they may already know.

Activities to Introduce Scientific Principle

2. Explain how even in "cave man" days, people needed to use some form of measurement. Numbers were not in use but words were used to develop common measurement. Demonstrate the following and have children imitate.

Cubit: Distance from point of elbow to tip of middle finger.
Span: Distance from tip of thumb to tip of little finger spreading out the hand.
Palm: The width of four fingers held together.
Digit: The width of a finger.
People during biblical days probably used these terms. (Egyptians-Babylonians)

3. Later, the Romans gave us units of measure we can recognize.
Mile: 1000 paces
Foot: Length of man's foot
Inch: Width of thumb

4. Now with the metric system of measurement we have a standard system that does not depend on the length of one's hand or foot which never really gave accurate measurements. The standard meter bar is kept in a laboratory in Sevres, France. A copy of this bar is in the National Bureau of Standards in Washington, D.C.

5. Read the play found on Data Sheet 2.1 so that children may choose to role play the " History of Physics".

6. See data sheet 2.2 for measurement details and comparisons of standard and metric measurements. Problems will be found on this sheet to be given at the teacher's discretion.

7. Demonstrate different sizes of matter and ways it can change form.

8. Groups will decide on an experiment to demonstrate before the class, the principles of mass and measurement. After deciding on a topic, spokesperson will follow these guidelines:

BEFORE DEMONSTRATION: Ask these questions.
1. What will happen if
2. Call on children to predict.

AFTER DEMONSTRATION:
1. Say - This is what happened
2. Ask -- What else would you like to find out about this?

Connect to Other Everyday Examples

9. Student understands that if he travels outside the U.S. anytime, he or she can buy items or use transportation with clear understanding of the metric system. The U.S. is already beginning to made changes from our system to the metric system by using liter bottles of milk and sodas, and putting weights on packages of food.

10. When different people measure the same object they may not get the same results. Students will understand that the more carefully measurements are made, the more likely they will probably agree with the results and sound conclusions can be drawn from them.

Home Activity/Parent Involvement

Have student ask a parent's weight in lbs and review how this weight can be converted to kilograms. Share the answers of this assignment at the next class meeting.

Lesson Assessment

After this lesson, students will be asked to define matter and compare characteristics. They can identify solid, liquid and gaseous forms and describe how matter changes. They can also demonstrate how we measure length, volume and mass.

The spokesperson for each group (after conferring with team members) will demonstrate one of the following:

1. Show 3 objects of matter.
2. Demonstrate a matter changing form.
3. Show which items on the table will measure volume.
4. Demonstrate in chart form on the blackboard the answers.

Extension Activities

Books to Read

Mr. Wizard's Experiments for Young Scientists, by Dan Herbert, Doubleday and Co., Garden City, NY, 1959.

Lesson 3: Force and Motion

Lesson Introduction

This lesson contains the following content ideas.

- Meanings of force and motion.
- Understanding of Newton's laws that govern motion.
- Relationship of force to gravity and inertia in dealing with motion.
- Relationship of force to acceleration, speed, and direction.

In this lesson, students will learn about the meaning of force and motion and find out how forces interact. Forces are all around us, from the force of gravity that holds us on earth, to the burning of fuel that could propel us in a rocket past gravity. Students will also understand more about the energy that is needed to be expended for work or play and they will learn to make a better connection with the way things are happening around them.

Specific Lesson Objectives

The students will:

1. use appropriate scientific vocabulary.
2. show relationship between balanced and unbalanced forces and motion.
3. demonstrate how forces change speed and direction.
4. identify different energy forms and demonstrate the relationship between work and energy.
5. write an equation for a situation involving multiplication and division.

Time Allotment

This lesson can be completed in three 50 to 60-minute sessions.

Materials

The materials needed will be listed before each activity or found on the data sheets.

Procedure

Tap Prior Knowledge

1. Tell the story of Galileo and the Failing Bodies activity.

This is an "interest getter" and will probably fascinate students who have not been introduced to this concept before.

GALILEO'S STORY AND FALLING OBJECTS ACTIVITY

Review something about the following words before beginning the story: Mass, inertia, Galileo, and Newton, vacuum, and gravity

The story is that Galileo wanted to disprove Aristotle's theory that objects fall with speeds according to their weights. It is said that he climbed atop the leaning tower of Pisa in Italy in 1589 and dropped 2 balls with different masses. (One heavier than the other.) The 2 balls fell and hit the ground at the same time. Galileo also stated that an object tends to remain at rest because of its *Inertia.* Once an object begins to move it tends to keep moving because of its Inertia. Objects tend to resist change.

Newton summed up how things behave with his first law of motion.

NEWTON'S 1ST LAW
An object at rest remains at rest and an object in motion in a straight line continues in motion unless acted on by an unbalanced force.

Activities to Introduce Scientific Principle
NEED: softball, golf ball sheet of balled up paper.
DIRECTION: Stand up on a table and drop two of the objects at the same time.
WHAT WILL HAPPEN? Both balls will hit the ground at the same time even though the golf ball is lighter.
WHY? The force of gravity pulls on all bodies the same, regardless of shape or size.
TRY THIS! Take two sheets of paper and ball one of them up. Drop them from standing on top of table or chair both at the same time.
WHAT WILL HAPPEN? In this case, the crumpled piece of paper will fall faster.
WHY? The resistance of air against the falling bodies slowed the flat piece of paper down.
NOTE: A feather and a heavy ball would both fall at the same time if they were in a vacuum where no air could reach them- Also if two balls are used and one is dropped, and one is thrown, they will both hit the ground at the same time even though one was moving horizontally.

These activities will be set up on data sheets at the end of this lesson. They may be used according to the concept being taught for the day.

Share with Neighbor
Groups will be asked to choose activities, and will begin to demonstrate them for the rest of the class.

Connect to Other Everyday Examples
When we work we use force to move or stop something from moving. Machines are sometimes used to make our work easier. Friction comes about when things are rubbed together and this can be a problem when doing work but it can also be helpful.

Summary:
We have found that forces are caused by a push or pull and can be observed and measured. The changes that are brought about by the movement and the way things move is influenced by gravity. Matter or objects that have mass are

involved in our everyday life. We notice the changes of some of the objects and their movements by the way they accelerate and gain momentum.
Two very important scientists of the past who helped explain these meanings were Galileo and Isaac Newton and today, we are able to send rockets and satellites into space for explorations because they made clear some of the necessary understandings to make to make this possible.

Home Activity/ Parent Involvement
Students will begin preparing their own experiments at home as well as doing the group work at school. They may elicit help from parents and report to class if they have received any additional information from patents or library help..

Lesson Assessment
Children are able to demonstrate activities by following directions. Journals are being kept in logical order. Rubric assessments can be made.

Sample rubric
Assignement: Choose one of Newton's Laws and demonstrate an experiemtn using this law.
Criteria: Use appropriate vocabulary and make a clear demonstration of experiment.

1	2	3
unclear vocabulary no vocabulary or inappropriate	concept is emerging vocabulary is used, but is not consistent	carries out demonstration with clear explanation uses good vocabulary appropriately

Have students research the following topics on machines and prepare a written report about each on of these: Inclined Plane, Wedge, Screw, Level, Wheel and Axle and Pulley. Students can begin preparing own science projects. (Can use activities we have done, or do own research from classroom activity books and library).

Extension Activities

Books to Read
Science Experiences: Motion and Gravity, by Jeanne Bendick, Franklin Watts, NY, 1972. This book discusses motion of objects and about different forces Friction.
Story of Energy, by Paul Blackwood, McGraw

Lesson 4: Time to Share Experiences

Lesson Introduction
This lesson contains the following content ideas.
Review of past physics history lesson and an introduction into modern physics.
Explanation of good scientific method of presenting a science project.
A chance to experience classroom presentations to invited guests and celebration of completed unit of work.

In this lesson, students will review Newton's 3 laws of motion and each group will be asked to demonstrate one of the 3 laws with an experiment they have chosen as a group. On the first day, every group will given a time to decide on a topic and choose a spokesman who will report to the class at the end of the period.

During the next 3 days, students will demonstrate group or individual projects along with written reports. They will complete journals and write out invitations for inviting guests for "end of unit day" celebration.

Specific Lesson Objectives
The students will:
1. be able to differentiate between an observation and an inference.
2. explore problems and describe results using graphical, numerical, physical, algebraic and verbal math models or representations.
3. explain organization of a data table.

Time Allotment
This lesson can be completed in five 40 to 50-minute sessions.

Materials
students will have their group or individual presentations ready for
will have chosen their own materials to be used
copies of Student Data Sheets found at the end of this lesson will be of use

Procedure

Activities to Introduce Scientific Principle
1. Science demonstrations will be given each day as if at a regular science fair.

2. One group of students may want to prepare for "measurement play" to be presented.

3. Spokesman for class will be able to explain items on observation table to visitors.

4. Teacher will pass out individual "young physicists" certificates on celebration day.

5. Group and individual experiments will be shared with other classrooms, parents and principal.

Extension Activities

Books to Read

Physics Alive, by Peter Warren and John Murray
Physics for All, by J. J. Wellington
Physics for You 1 and 2, by Keith Johnson Hutchinson

NOTES ON *GRAVITY.*

Galileo climbed to the top of the Leaning Toweer of Pisa in Italy. He dropped different things of different weights to the ground. He wanted to see how long it would take for 2 objects that weighed differently , to hit the ground.
What do you think happened? (give students time to comment).

When you drop large thing and small things together from the same height they hit the floor at the same time.
WHY? Gravity is the reason.
Ask the following questions about gravity.

1. What does up and down mean?
2. What does weight mean?
3. What does gravity do to falling things?
4. How can gravity help us or make us work harder?

Give children time to discuss these questions. Tell them:
1. When we say things go "up" we mean they go away from the earth (which is the force pulling everything toward it) When we say "down" we mean it comes toward the earth
2. To find out what weight means, have student step on bathroom scale. Whatever the weight of the person is, that is , it means gravity is pulling the person down with the same amount that he weighs.
Different objects may weight more or less .
Some objects are heavier because they have more mass

EXPERIMENT:

NEED Dinner plate and paper plate that are the same size.
QUESTION: Which one will weigh the most when they both are the same size?
PROCEDURE: Hold the dinner plate in one hand and the paper plate in the other.
Which one feels heavier?(The dinner plate)
WHY? Even though they are both the smae size, the material or mass of the dinner plate is greater and it will weigh more.

CAN GRAVITY WORK FOR US?

Wind moves soil- gravity pull the soil down to new places. Gravity makes water run downhill. We build dams and make waterfall on turbines. The turbines turn electrical generators making electricity for our homes, factories and cities.

Some uses of gravity?

Paper weights keeps us on ground, brings water into our homes, anchors boats, helps us load iron, ore, grain, etc. onto ships quickly and easily.

Why are we not pulled into the sun?
Because on earth, the gravitational pull is stronger than sun and keeps us from flying off. All objects in the universe are subject to pull of gravity and inertia.(opposite of gravity) It makes objects keep moving in a straight line unless stopped. The earth's gravitational pull keeps the moon from flying off in straight line into space. The balance of gravitational pull and inertia keeps our sun's family in their places. The pull of the sun and the planets keeps each in its own orbit.

Inertia keeps each planet from being pulled into the sun's gravitational pull. Inertia keeps planets moving in a straight line.

Rockets have to travel 25,000 miles an hour to escape earth's gravity.

The center of mass is also called *center of gravity.*

EXPERIMENT

NEED: 7 BOOKS (SAME SIZE) TABLE.

DIRECTIONS: Stack books neatly on edge of table. Slide top book over edge until it begins to tilt. (this is almost halfway). Push it back until it begins to tilt. Working from top down, adjust each book over the edge of table.

When you reach bottom, top book will be completely over the edge of table. Top book can be moved further The next book is moved less because its center of gravity is affected by the book above it. The third book is moved less because it has 2 books affecting its center of gravity.

WHY? Each movement of a book as you work to the bottom is affected because the center of gravity of the books is affected by each book above it.

FORCE AND MOMENTUM

- Can make an object at rest start moving.
- Can stop a moving object.
- Can speed up or slow down a moving object
- Can change direction of object in motion.

Force doesn't always change an object's motion. If one pulls a heavy chain and it does not move, the chain stops at rest because gravity is stronger than you are and holds the chain in place. The force needed to stop a moving object depends on both its mass and its velocity. An object's mass multiplied by its velocity produced a quantity called *momentum.* (An indication of the strength of an objects motion). It takes more force to stop the motion of a car than to stop that of a bicycle. A moving car has more momentum than a bike moving at the same speed because the car has more mass. When moving objects collide, momentum can be transferred from one object to another.

Example: The cue ball hits a ball on a pool table. The cue ball stops but the ball that is hit rolls with the same speed that the cue ball had.

GRAVITY

Is the attractive force or pull between earth and all objects on earth.When you throw a ball up in the air, the force of gravity slows it down, stops it and accelerates it back to earth. An attractive force called gravitational attraction exists between bodies in the universe. When the ball is thrown in the air, the earth and the ball exert an attractive force on each other. The mass of the earth is much greater than the mass of the ball so what goes up has to come down. The moon's gravitational pull has a small effect on the earth. This pull causes *tides in large bodies of water. (Students can do research on tides as an extension activity).*

INERTIA

Inertia is the tendency of anything to resist a change inits motion and is related to Mass. Inertia has to be overcome to get an object moving and once moving it has to be overcome again to stop it moving

ENERGY

we are concentrating on motion energy which is necessary for any work to be done. Some objects that are used to help with the energy doing work are: lawn mowers, cars, power tools, etc. The amount of energy an object has depends on how fast it is moving and how much mass it has.Some kinds of energy are: electric, heat and light.
Stored energy from matter such as food(for body), fuel (heat), batteries and motors (power).
Activity: Write sentences on what happens when stored energy is released.
Potential energy: Stored energy that can be used to make things move.
Kinetic energy: That which is used when things are moving.
Extension activity: Class can make up an acrostic poem using the words that are energy sources.
Example:
F fuel for the body
O ranges would be good to eat.
O lives good in the salads
D onuts good for a snack.
Energy can sometimes be wasted by the force of friction.

FRICTION

.Friction is a force that occurs when 2 things rub together. Another kind of force acts only when objects are in motion and it always acts to slow motion. It is caused by contact with the medium in which an object is moving or with the surface on which it is moving.

MOMENTUM

An overall force acting on an object thereby increasing or decreasing its velocity. (The resulting acceleration or retardation will depend on the size of the force and on the mass of the object. Momentum is the mass of a body multiplied by its velocity.

WORK

Is the result of force moving an object through a distance along the same line as the force's direction. Work is done when force moves an object through a distance. The direction of force and distance must be along same line. You can change the amount of work you do by changing the amount of force or the amount of distance.

NEWTONS THREE LAWS OF MOTION

FIRST LAW: *An object at rest remains at rest. An object in motion continues in motion along a straight line unless acted on by an unbalanced force.(An unblaanced force is a force that is not cancelled out by some combination of other forces.)*

SECOND LAW *When an unbalanced force acts on an object, the change in motion of that object is proportional to and in the same direction as the unbalanced force.*

THIRD LAW *Forces occur in pairs. For every force (action force), there is an equal and opposite force (reaction force). The action and reaction forces act on different bodies.*

INERTIA EXPERIMENTS.

PURPOSE: Demonstrate how an object remains stationary due to inertia.
NEED: scissors, ruler, typing paper, unopened can of soda.
PROCEDURE: Cut out strip of paper
Lay paper on clean dry table
Put can on one end of paper
Hold other end of paper and push it up close to the can.
Quickly snap the paper away from can in a straight line.
WHAT HAPPENED? If paper was quickly pulled, it moved from under the can, but the can remained upright in the same place.

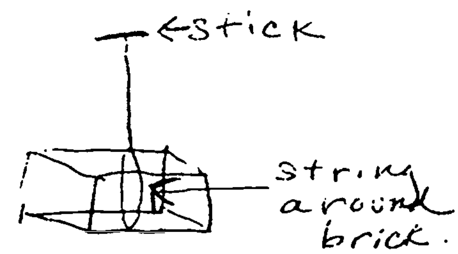
WHY:? Inertia is resistant to any change of motion. An object that is stationary remains that way until some force causes it to move. The can is not attached to the paper and because of the can's inertia, it remains stationary even though the paper moves foward.

Try this out.

PURPOSE: Demonstrate how object continues to move due to inertia.
NEED: 5 books, chair or cart with roller.
PROCEDURE: Stack books on edge of chair seat.
Push the chair foward then quickly stop chair.
WHAT HAPPENED? The books move foward and fall to the floor.
WHY? Inertia is resistant to any change of motion. A moving object remains in motion until some force stops it. The books are moving at the same speed as the chair.They are not attached to the chair, therefore, when the chair stops the books continue to move forward in the air until hitting some object. The force of gravity pulls them down to the floor.

Try this out.

PURPOSE: WILL THE STRING BREAK?
NEED: Short stick, length of light string, brick.

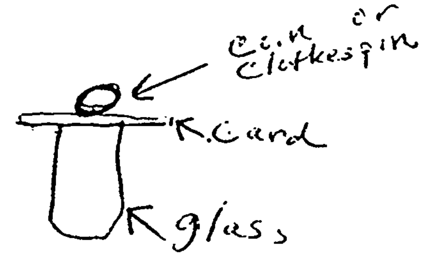


PROCEDURE: Tie an end of thread around the middle of the brick and the middle of the stick. Using stick for handle, slowly raise it a few inches from the ground. Lower the brick back to the ground then jerk the string upwards. The string will then break.
WHY: The law of inertia states that anything at rest tries to stay at rest while, when a body in motion will move in a straight line until affected by some outside force.
It took a larger force to make the body at rest move abruptly than if done gradual. The brick resisted the sudden change and the thread could not hold up to the greater force.

Try this.

PURPOSE: WILL IT FLY IN SPACE?
NEED: 4 FT. OF STRONG STRING, 1 TENNIS BALL.
PROCEDURE: Tie one end of string around tennis ball. Start ball swinging in circle around your head. As long as the string is held and you continue to swing, the ball will travel in an orbit around your head.(This illustrates how earth and other planets continue to orbit the sun.). *Momentum (going faster and faster)* make it try to pull away from the center of its orbit. If the string breaks or we turn it loose, the ball will fly away.
WHY: ? The string is created another force that tries to pull the ball toward the center of the orbit. This is called *centripetal Force. It is balanced against the inertia and keeps the ball in orbit.*

Try this.



PURPOSE: MAGIC WITH INERTIA.
NEED: Drinking glass, index card, penny or other
PROCEDURE: Put the index card over the top of glass.
Put coin on top of the card.
Quickly and forcefully thump the card foward with your finger.
May have to try this a few time and can use other small object beside coin (clothespin).
WHAT HAPPENED? The coin will fall into the glass.
WHY? Your finger applies the force to the card. It moves so quickly it gives very little force to the coin.
Note: If you use a clothespin, it wil flip over to the other side sometimes.

NEWTON,S SECOND LAW

PURPOSE: HOW WILL I MOVE?
NEED: Person with skates on.
PROCEDURE: The person with the skates on, throws out the ball.: Throw the ball out.
WHAT HAPPENED? The ball will go forward, while the person on the skates, rolls back.
WHY? When you throw the ball in one direction, this was *action*. When the ball pushes back,as you throw , it made you move, this is *reaction*.

An unbalanced force on an object causes object to accelerate in the direction of the force. The greater the force applied to given object, the greater its acceleration. For a given force, the greater the mass of an object, the smaller its acceleration.

Example: An empty truck picks up a load. It is fully loaded and it takes longer to reach the same speed as before when the truck was empty. When the truck is full, it accelerates slower because it has more mass. Trucks with large mass needs more distance to stop than trucks with smaller mass.
There is the formula to find out how much force is being used. ($F = ma$) Force equals mass times acceleration.

NEWTON'S THIRD LAW

Example:

ACTION: A rocket forces hot gases in one direction

REACTION The hot gases force the rocket to move in opposite direction. The reaction makes the unbalanced force greater than the rocket's weight. The unbalanced force makes the rocket move up. Action and reaction move astronauts.

WHY:? Inertia is resistant to any change of motion. An object that is stationary remains that way until some force causes it to move. The can is not attached to the paper and because of the can's inertia, it remains stationary even though the paper moves foward.

Try this out.

PURPOSE: Demonstrate how object continues to move due to inertia.
NEED: 5 books, chair or cart with roller.
PROCEDURE: Stack books on edge of chair seat.
Push the chair foward then quickly stop chair.
WHAT HAPPENED? The books move foward and fall to the floor.
WHY? Inertia is resistant to any change of motion. A moving object remains in motion until some force stops it. The books are moving at the same speed as the chair.They are not attached to the chair, therefore, when the chair stops the books continue to move forward in the air until hitting some object. The force of gravity pulls them down to the floor.

Try this out.

PURPOSE: WILL THE STRING BREAK?
NEED: Short stick, length of light string, brick.

PROCEDURE: Tie an end of thread around the middle of the brick and the middle of the stick. Using stick for handle, slowly raise it a few inches from the ground. Lower the brick back to the ground then jerk the string upwards. The string will then break.
WHY: The law of inertia states that anything at rest tries to stay at rest while, when a body in motion will move in a straight line until affected by some outside force.
It took a larger force to make the body at rest move abruptly than if done gradual. The brick resisted the sudden change and the thread could not hold up to the greater force.

Try this.

PURPOSE: WILL IT FLY IN SPACE?
NEED: 4 FT. OF STRONG STRING, 1 TENNIS BALL.
PROCEDURE: Tie one end of string around tennis ball. Start ball swinging in circle around your head. As long as the string is held and you continue to swing, the ball will travel in an orbit around your head.(This illustrates how earth and other planets continue to orbit the sun.). *Momentum (going faster and faster)* make t try to pull away from the center of its orbit. If the string breaks or we turn it loose, the ball will fly away.
WHY: ? The string is created another force that tries to pull the ball toward the center of the orbit. This is called *centripetal Force. It is balanced against the inertia and keeps the ball in orbit.*

CONCEPT. Energy must be applied to produce an unbalanced force. Unbalanced forces changes the motion of objects.

Note: Equal forces cancel each other.
Example: Tug of war Games.
Two children the same weight pull on a rope to try to see who will cross a line. Neither can be pulled across because they both weight the same and their force of pulling is the same. If someone else come to help one of the girls pull, he has added an unbalanced force and the one girl will be pulled across the line.

FRICTION

To compare friction on different surfaces-- you will NEED: sandpaper, cardboard, waxed paper.
Pull an object across each surface and note the effort or energy exerted on each surface.

Try this.
PURPOSE: BALL BEARINGS REDUCE FRICTION.
NEED: 2 empty paint cans with grooves on top of each. 1 book.
PROCEDURE: Put marbles in grooves of one of the cans.
. Invert the other can on top so that its groove is over the marbles.
. Put the book on top of the can and turn the can..
WHAT HAPPENED? It is easy to turn
WHY? Because rolling friction is much is less than sliding friction. Ball bearings (marbles) are hard and little contact is made with the surface. The balls are rollers and they are not limited to direction of the rotation.
Note: Take the marbles off and try the same experiment with the top can and book and see if the can and book turn.

USING THESE FORMULAS, EACH GROUP WILL WORK OUT THE PROBLEMS.
(Write the problems on board. Teacher will have answers on this sheet.)

S = speed   d = distance   t = time . V = velocity   a = acceleration.

(S = d/t)   (a = at/2)   (d = VT)   (V = d/t)

Distance - length of actual path traveled.
Speed - distance an object moves in given amount of time
Velocity - Speed in a definite direction.
A change in velocity in a period of time is called acceleration.

Dropping an object from the top of a building, the velocity increases during the fall.
Objects in free fall on the earth is 9.8 m/s . This means each second the speed of the ball will increase by 9.8 m/s. (
m = meters) (s = seconds.)
After 2 seconds it will be 19.6 m/s
What will it be after 3 seconds? (98.0 m/s)
In 10 seconds it will be? (98.0 m/s)

1. If you walk 50 miles in 8 hrs., what would your average speed be? (6.2 miles per hr.)

2. What is the velocity of a plane that travels 3000 miles from N.Y. to Calif in 5.0 hrs. (600 miles per hr.). (V = d/t)

3, A car traveled 400 miles for 5 hrs. What was his average speed? S = d/t S = 400 miles/5 hrs. (71 miles per hr average speed)

4. A train traveled 270 miles in 4.5 hrs. How fast did it go? V = d/t V = 270 mi/4.5

5. How far did the train go in 7 hrs.?

6/. At the same speed, how long did it take to travel 300 miles? T = d/v
(Use problem 4 to work on 5 and 6)

Student Data Sheet Masters

Physics in the 5th Grade? Yes!
Student Data Sheet Master 2.1

HOW FAR DO I GO?
An introduction to measurement play by Keena Thompson.

CAST OF CHARACTERS:. Narrator, 2 scientists, 2 kings, tailor and builder.

PROPS: a 12-inch piece of string, 2 chairs, 2 paper crowns with England printed on one and France printed on the other.

Narrator:
An English King living in the 13th century may have bad trouble determining how far his kingdom extended. He couldn't tell the tailor in another village what size he wore and if he wanted to have another castle built just like the one he lived in at the time, it was impossible. You see, at this time, there existed no ruler, yard stick, or tape measure to help anyone judge distances. One scientist might build a tool and tell another how he did it, but when the person he told tried to build the same tool, it did not work. When the two tools were compared, the sizes were different.

One day, 2 scientists walk over to the King to solve a problem.

(2 scientists go over to the English King sitting on his throne/chair)

Scientist 1: Your Lordship, we have got to figure a way to unify distances.

King: I know, the tailors also have asked me to help them with the problem of telling what sizes are correct for making their clothes.

Scientist 2: Did you know that home builders are having trouble building houses too?

King: Yes, I know of this. It is time for us to create a method judging distances.

Scientist 1: I've got it! Lets call the method of judging distances *measurements*.

Scientist 2: That is fine, but what will we use to create this measurement?

Scientist 1: We will use the king! After all, the king is the most powerful man we know. Who will dare say that his way of measuring is wrong?

King: Sounds good to me, Let's get started. First, if I wanted to know how far away it is to the door what would I do?

Scientist 1: King, hold up your foot. I will take a piece of string and cut it to your foot size. We will call this string a foot.

Scientist 2: Good! That will work. Give me the piece of string we called a foot and lets cut lots of string the same size. Let's see... it takes twenty of these foot strings to get to the door. We will say twenty feet to the door. (The king and scientists have pretend to do these measurements).

King: Wonderful! Now made sure everyone knows about this string called a foot.

Scientist 1: From the tip of your nose to the tip of your outstretched hand, we will call a yard.

Scientist 2: The distance between the knuckles of your middle finger will be called an inch.

King: Good! Make sure everyone knows of this. From now on these measurements shall be used. That is the law.

Narrator: Time went on. Everyone knew of these measurements and used them. Many more measurements were added as the years passed, but problems with the measuring system still existed.

Tailor: The king need his clothes by tomorrow and I lost my foot string. I can't finish his clothes without my foot string! What will I do? I know, I'll use my own foot. After all, my foot is just about the same size as his.

Narrator: In another country, we see a builder with a few bricks.

Builder: Lets see, a step to a door should be four inches, The king says that an inch is the distance between the knuckles of the middle finger. I wonder if my hand is as big as his? Oh well, I'll use my hand.

King of France: Who does the English king think he is? My foot is just as good as his even if it is bigger...

Narrator: With all the different variations of sizes, the scientists knew something had to be done. They held a meeting in England. At this meeting, it was decided that a foot would be measured with a piece of wood called a ruler. It was then that the yardstick was made. Other measurements were developed also, such as time being seconds, and weight being pounds. The foot was to abbreviated as ft. Time as sec. and Pound as lbs. These methods of measurement had standard meaning so that everyone all over the world were to use them with no exceptions. This was to be called the British System of Measurement.

Every scientist had to sign a document stating that they would only use this system of measurement. Children and adults alike were only being taught this system.

By the year 1960, a meeting was held in France. it was then a new system of measurement was adopted by the International System. it was decided that this new method should be used to measure distances and weight more accurately. Again all the scientists there signed a document stating that this method would be used.

Some schools today, especially in the USA are still teaching the British System (they are beginning to use both) but in order to become a scientist and communicate with others who are in the science field, one must know the SI system or the Metric System of Measurement.

THE END.

Physics in the 5th Grade? Yes!
Student Data Sheet Master 2.1

Measurement notes of interest

The standard meter bar is kept in a laboratory in Sevres, France
A copy of this bar is in the National Bureau of Standards in Washington, D.C.

The metric system is based on multiples of 10. The English System is based on 12.

To change a length in inches to feet, divide by 12.

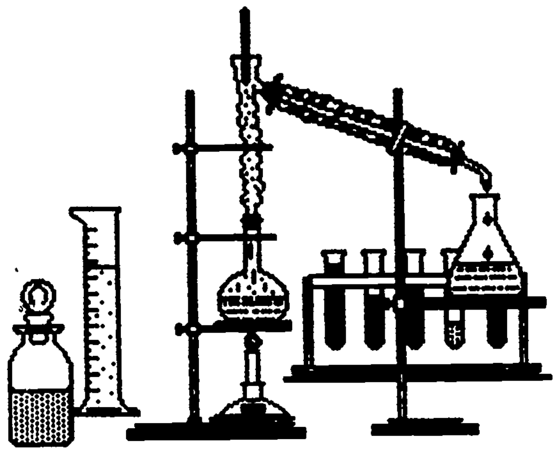
If you change length of feet into yards, divide by 3 (the number of feet in a yard)

Problem 1
Groups will make up 2 problems each to present to class - change these problems from one system to the other.

Problem 2
Measure the length of your text book in Metric and convert to English.

OUR PHYSICS OBSERVATION TABLE

classroom physicist



physicist ____________________

made super science discoveries
congratulations

____
classroom teacher

dated ______________

QUESTIONS TO ASK MYSELF.

WHAT DID I KNOW BEFORE LESSON?

WHAT DID I FIND OUT?

DRAFT

Sound

Community Resource Curriculum Development Project

Developed by: Denise Hetherington

Sound

Rationale
This unit is intended to meet the following Instructional Program Objectives for the Illinois State Goals for Learning at the fifth grade level:

BIOLOGICAL AND PHYSICAL SCIENCES
Use appropriate scientific vocabulary.
Demonstrate the effect of air pressure.
Demonstrate the difference between an observation and an inference.

SOCIAL SCIENCES
Recognize contributions of diverse cultural groups.

MATHEMATICS
Explore problems and describe results by using graphical representations.

Content Background
Many body parts are used in the creation and reception of sound. Lungs are used for every speech sound. Our lungs provide us with the air required when speaking. The diaphragm is a stomach muscle. The lips, teeth, tongue and palate are anatomical structures used to generate speech sounds. The /m/, /n/, /ng/ phonemes require sound transmission through the nose. The brain, lungs and diaphragm are always utilized.

Vocal cords provide vibration essential to sound production. Vocal cords are not used for all speech sounds. Some are voiced (ex. /b/) and some are voiceless (ex. /p/). Ears enable us to hear sounds and language for communication. We need to hear others as well as ourselves. It is important to hear ourselves so we can monitor the content and quality (pitch, volume) of our oral productions. Vibrations travel through the ear canal to the eardrum which vibrates. The cochlea turns vibrations into nerve signals which are transmitted to the brain.

Understanding sound creation and its effects is essential to an individual's awareness of the influences in his or her environment. Except in the presence of speech or hearing disabilities, the automatic and grand processes involved in creating and receiving, as well as the importance, of sound are often taken for granted.

Timeline for Unit
This unit consists of a total of seven 40-minute sessions, divided into three lessons.

Evaluation/Assessment
Using higher-order thinking skills, students will express opinions and factual information through oral discussions, physical participation, oral and written reports and completion of diagrams and charts. Data sheets will be reviewed by students. Oral discussions will be charted on the board by students.

Resources
The Book of Sound Therapy by Olivea Dewhurst - Maddock

The Talking Drums

Sound

Glossary

ACOUSTICS: the study of sound

DECIBEL: a unit of measure for loudness of sound

DIAPHRAGM: a large muscular membrane inside the body that separates the chest from the abdomen; when inhaling, these muscles expand the lungs, drawing air into your nose and mouth, and down your windpipe

FORCE: a push or pull that can produce a change in the motion of something

FREQUENCY: the number of times a certain action happens within a given time

HERTZ: a unit of measure for each cycle in a vibration

LARYNX: enlargement of the upper part of the windpipe that in man and most mammals contains the vocal cords

PALATE: the roof of the mouth; the bony front part is the hard palate, and the fleshy back part is the soft palate; the soft palate lowers during production of the /n/, /m/ and /ing/ phonemes, which require resonance in the oral and nasal cavity

PITCH: the lowness or highness of sound

PHONEME: the smallest structural unit of a speech sound, which can distinguish one word from another; the phoneme /m/ distinguishes "mat" from "at"

TRANSMIT: to carry from one person, place or thing to another

VIBRATION: periodic back and forth movement

VOLUME: the loudness of a sound

Lesson 1: Sound Source

Lesson Introduction
In this lesson, the students will learn what sound is, how sound is created, and the effects of force and frequency of movement on sound.

Specific Lesson Objectives
The students will:
1. use appropriate scientific vocabulary.
2. develop an understanding of air movement and its relationship to sound.
3. take data on pitch and volume occurrences.

Time Allotment
This lesson can be completed in three 40-minute sessions.

Materials
glass bottles or jars
rubber bands varying in length
water
tissue boxes varying in size
paper
metal or plastic containers
tapes of different musical instruments
illustrations of wavelengths
copies of Student Data Sheets 1.1 and 1.2

Advanced Preparation
Study literature on the development of sound relative to vibration, pitch and loudness. Examine diagrams to assist with the explanation of how sound is generated in people and objects.

Procedure

Tap Prior Knowledge
1. Ask students "What is sound?" "How do you make sounds?" "Where do sounds come from?" "How are sounds different?" Write responses to the questions on the board.

Share with Neighbor
2. Divide students into groups (a) to make sounds with different parts of their bodies; (b) to make sounds with different objects such as plastic , metal, glass containers, a paper bag, aluminum foil, empty, partially-full and full containers; (c) to make sounds with whatever musical instruments are available; (d) blindfold listeners who will identify the source of the sound and how it made. Stress that whenever you hear a sound, there is something moving. The movement is called vibration.

Hands-on Activity

3. Divide students into groups. Provide yarn, popsicle sticks, bottles, containers that are empty, partially-full and full, rubber bands different in length and thickness, and different-size tissue boxes. Allow students to make different instruments. Play the instruments. Students should record in a journal how they created different sounds.

Introduce Principle/Concept

4. Identify similarities and differences in relation to sounds heard and the structure of their source. Discuss vocabulary items.

5. Introduce volume as the amount of force applied to the movement and pitch as the speed of frequency of movement. Show pictures from books of wavelengths of different sounds.

6. Play a tape of sounds made by musical instruments. Ask the children to decide whether each sound is loud or soft in volume or high or low in pitch.

Home Activity/ Parent Involvement

Ask students to listen to the voices of three family members or friends and chart their pitch and volume on Student Data Sheet 1.1.

Lesson Assessment

Have students identify pitch and volume changes during a story telling activity by checking the appropriate column on Student Data Sheet 1.2.

Lesson 2: Let's Talk

Lesson Introduction
In this lesson the students will learn about speech sound production with focus on voicing and phonemes.

Specific Lesson Objectives
The students will:
1. use appropriate vocabulary.
2. identify anatomical structures of the speech and hearing mechanism.
3. identify usage of speech and hearing mechanisms in regards to phonemic production.

Time Allotment
This lesson can be completed in two 40-minute sessions.

Materials
cards with words written on them
cards with phonemes on them
books with pictures of the speech mechanism and auditory system
copies of Student Data Sheet 2.1

Advanced Preparation
Select literature on speech or language production. Prepare to label and discuss how our brain helps us to learn and utilize the speech and language we produce by enabling us to attend, process, recall and give information. Read the content background for the unit and share with students.

Procedure

Tap Prior Knowledge
1. Ask students "How do we talk?" "What parts of the body do we use to help us talk?" List responses on the board.

Share with Neighbor
2. Divide students into pairs. Give each student a word written on a card. Instruct students to take turns saying their word to their partners. Instruct the listener to write down his or her observations of how the word is produced.

Hands-on Activity
3. Recall the relationship between sound and vibration. Discuss the significance of vocal folds to speech production. Provide each student with a phoneme (/s/ or /z/). Placing their hands over the vocal folds ask each student to say the sound. /s/ should sound like a hiss; /z/should sound like a buzz. Then ask the students to tell whether they felt vibration. Vibration should have occurred on the /z/ phoneme only.

Introduce Principle/Concept

4. Show a picture of the speech mechanism and auditory system. Discuss each component of the speech and auditory mechanism and use during speech production and reception. Parts of our body are connected to our brain by nerves. These nerves transmit information from our brain to different parts of our body. This information tells our body parts what to do. For example, a student desires to answer a question by raising his right hand. In order to do this, the brain sends appropriate messages through the nerves and then to the right hand to tell it to move. If the student desires to raise his hand but cannot, then there is something wrong with the brain, nerves or body structures. Likewise when desiring to speak, the brain helps the student to think about what they want to say, how to say it and then sends the messages to the appropriate body parts that will be orally used to say the words.

Relate Activity and Concept

6. List components of the speech mechanism on the board. Give each student a phoneme on a card. Tell student to say the sound and check off each body part used when producing the sound.

Home Activity/Parent Involvement

Invite students to observe the oral structures, throat, and abdominal areas of a family member or friend while they are talking.

Lesson Assessment

Using data sheet 2.1, students will use a check mark to identify anatomical structures used during oral production of given phonemes.

Lesson 3: Sound Travels

Lesson Introduction
In this lesson, students will increase awareness of the effects of sound on our bodies and emotions.

Specific Lesson Objectives
The students will:
1. develop an appreciation for sound.
2. use sound to make changes in feeling.
3. be introduced to sound therapy.

Time Allotment
This lesson can be completed in two 40-minute sessions.

Materials
tapes of different types of music: Jazz, African, Blues, Reggae, Classical, Country Western. Students can also listen to sounds in nature or sounds of animals.
cassette player, CD player, or radio
copies of Student Data Sheet 3.1

Advanced Preparation
Select literature on sound therapy and the usage of sound and/music in different cultures. For example, *The Talking Drums* is a story about the different uses of drums in Africa. Dinka musicians from Sudan use percussion instruments along with their breath to produce sounds for health, communication and celebration. Sounds and music are used in ceremonies, worship and meditation. Variations in vocal quality during the spoken word can express and cause many feelings such as joy, sadness, enthusiasm and depression.

Procedure

Tap Prior Knowledge
1. Tell a story stressing anger, happiness, humor, sadness, fear, pain, defiance etc. Ask students to identify these feelings by listing them on a sheet of paper.

Share with Neighbor
2. Separate students into groups. Give each group a statement such as "I am sick". Students should take turns saying the statement with different emotions. Discuss the differences.

Hands-on Activity
3. Have students listen carefully to music selected (jazz, nature, classical). While listening to the music, the students will attempt to draw impressions

in visual form. Discuss and display the pictures in the classroom. (This activity was adapted from Celebrating Diversity with Art.)

Introduce Principle/Concept

4. Sound is energy moving back and forth through air. Variations and combinations in frequency of movement and intensity can affect how we feel mentally and physically. Contrast the feelings of the students when listening to fast vs. slow, loud vs. soft, high pitched vs. low pitched sounds or music.

5. In the field of science, the energy from sound has been used to break up kidney and gall stones in the body. Research by sound therapists and biologists have demonstrated strengthening affects of particular sound frequencies on particular parts of the body. For example, the note F was found to have an influence on the lungs.

Relate Activity and Concept

6. Select one person at a time or perform in unison. Ask students to sit quietly and listen to or feel their own breathing or heart beat. Using a drum or desk, the students should use their hands to drum to that tempo. Discuss feelings afterwards. (This activity was derived from *The Book of Sound Therapy* by Olivea Dewhurst.)

Home Activity/Parent Involvement

The students will identify different sounds and expressions at home. Describe how they make them feel (happy, sad, tense, relaxed, tired, energized etc.).

Lesson Assessment

Match notes to body parts.

Student Data Sheet Masters

Sound
Student Data Sheet Master 1.1

Family Sound Inventory
Directions: Watch three family members or friends. Place a check mark in the appropriate column to describe their pitch and their volume.

	High Pitch	Low Pitch	Intense Volume	Normal Conversational Level	Whisper
1.					
2.					
3.					

Sound
Student Data Sheet Master 1.2

Lesson Assessment: Story Telling Inventory

High
Pitch

Low
Pitch

Loud
Volume

Soft
Volume

2 or < 4 6 8 10 or >
Frequency of pitch and loudness occurrences

Sound
Student Data Sheet Master 2.1

Lesson Assessment

	lips	teeth	tongue	palate	jaw	vocal cords	lungs	diaphragm	nose
b									
d									
f									
g									
h									
j									
k									
l									
m									
n									
p									
q									
r									
s									
t									
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Up, Down, and Around in Chicago

Weather in the Windy City

Community Resource Curriculum Development Project

Developed by: Ken Rose

Up, Down, and Around in Chicago
Weather in the Windy City

Rationale
This unit is intended to meet the following AAAS Benchmarks for Scientific Literacy, as well as the following CPS Outcomes and Instructional Program Objectives for the Illinois State Goals for Learning, at the fifth-grade level:

BENCHMARKS
FOR SCIENTIFIC LITERACY
- When liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water. Clouds and fog are made of tiny droplets of water. (page 68)
- Air is a substance that surrounds us, takes up space, and whose movement we feel as wind. (page 68)
- Places too cold or dry to grow certain crops can obtain food from places with more suitable climates. Much of the food eaten by Americans comes from other parts of the country and other places in the world. (page 185)

CPS GRADE 8
EXIT OUTCOMES
- Analyze patterns of change in biological, physical, chemical, and geological systems.
- Analyze the interdependence of Earth systems (water cycle) and organisms.
- Use appropriate technology, such as computers, microscopes, calculators, and models.
- Use charts, maps, and other geographical tools to create, compare, and contrast geographical regions.
- Demonstrate an understanding of how climate and topography affect the way people live.

INSTRUCTIONAL OBJECTIVES:
BIOLOGICAL AND PHYSICAL SCIENCES
- Use appropriate scientific vocabulary.
- Match clouds with weather conditions.
- Explain evaporation, condensation, and precipitation phases of the water cycle.
- Summarize the effects of weather on the environment.
- Cite the reasons for presenting data in the form of tables, charts, or graphs.
- Record on a chart the factors that influence weather.

INSTRUCTIONAL OBJECTIVES:
SOCIAL SCIENCES
- Identify ways in which the natural resources of a region influence the lifestyle of its inhabitants.
- Analyze information obtained from maps focused on political boundaries, products, resources, land use, or climate.

"If you don't like Chicago's weather, wait a minute."
-Anonymous

Content Background

We live at the bottom of an ocean of air. This ocean affects our daily lives because it affects the weather, or the conditions of the atmosphere outside at any given time. In order to understand the weather, it is necessary to know about the air- ...what is it? ...how does temperature affect it? ...how is air movement, or wind, related to air pressure? ...what factors in the air will affect the formation of clouds? ...how do all of these things relate to the ongoing water cycle? We will try to answer these questions as we go through this unit, *Up, Down, and Around in Chicago.*

The atmosphere is composed of a mixture of gases. Nitrogen makes up about 78% of the mixture, oxygen about 21%, water about 0-4%, and carbon dioxide and inert gases (such as argon, neon, helium, krypton, xenon) less than 1%. These gases exert a force on the surface of the earth at sea level of nearly 15 pounds per square inch. The atmosphere is composed of several layers, but our direct experience is within the Troposphere. It is here that the weather conditions with which we are familiar take place. The movement of the air, and the form which water takes in its cycle (i.e., rain, snow, fog, clouds, sleet, dew, vapor), are dependent upon the atmospheric conditions at the time of observation.

The sun provides the heat energy that keeps the weather changing. The cause of wind, basically, is the unequal heating and cooling of the earth's surface. Differences in heat create differences in air pressure, and these differences in pressure make the winds blow (the air masses move) from one place to another. It is important to realize that the sun's heat is not distributed evenly across the surface of the earth. There are many reasons for this. Because the earth is a sphere, only a portion of the surface receives the energy at any given time. Having a day and night is therefore responsible for creating on-shore and off-shore breezes. The earth also receives light at different angles. The tilted axis of the earth and the yearly revolution cause variations in the amount of heat at different times of the year, resulting in seasons for some parts of the globe and causing seasonal variations to the winds.

Geography modifies the wind's behavior as well. Land and water affect breezes because they do not heat up or cool off at the same rate. Water heats up more slowly than land does and its heat-holding capacity is greater. Therefore, it absorbs and releases heat much more slowly than land does. The air temperatures, and resulting air pressures of the air masses influenced by these surfaces, are destined to be different. This concept is key to understanding the mechanics of wind, and the changing weather patterns.

Since the earth is hottest at the equator and coolest at the poles, the global wind circulation consists of cool air going from the poles to the equator at the surface of each hemisphere, and warmer air moving up at the equator and moving toward the poles in the upper levels. These winds are then steered into different belts by the rotation of the earth. This deflects the winds to the east and the west, rather then leaving them simply north and south. In the United States, our winds move predominately from the west to the east.

The water cycle involves three important processes: evaporation, condensation, and precipitation. At the surface of the earth, water enters the air by evaporation. (It can also enter by transpiration, when plants take in water and put water vapor into the air from their leaves, but evaporation is the bigger source.) The sun's energy warms this air and carries it and the water vapor upward. As air rises in the atmosphere, it cools. When the rising air is cooled to its dew point, condensation may occur. Drops of water are formed when enough molecules of water vapor accumulate around, and become attached to, a particle of dust in the atmosphere. Billions of tiny droplets of water form the weather phenomena we call a cloud.

All matter on earth is in the form of a solid, a liquid, or a gas. Matter in any one of these forms can change into another. Water can, of course, change from a liquid to a gas and it will still be water. The molecules in water vapor are the same as the molecules in the liquid water. How do these tiny particles control the properties of a substance? The molecules of a substance do not stay in one place. They move around. They bump into other molecules and move away from each other and also have a certain amount of attraction for each other. The state of a substance depends on how fast its molecules are moving and on how much the molecules attract each other.

In other words, gas molecules, such as water in its vapor state, move very quickly. They are spaced far apart and attract each other very little. As a result, they move away from each other and spread out. This is why vapor does not have its own shape. A gas takes the shape of its container.

Molecules in a liquid are closer to each other than those in a gas. They pull on each other strongly enough to give liquids a size, but not a shape. Liquids, like liquid water, spread out and take the shape of their containers like gases, but they do have a specific volume.

The molecules in a liquid move faster than the molecules in a solid. The molecules in a solid, like ice, are so closely packed together that they do not seem to move around much. They move very slowly, or vibrate, in place. The attraction between molecules in a solid is very great.

Water vapor in air plays an important role in determining the weather we experience. In addition to being instrumental in the formation of clouds and storms, water vapor causes our sensations of being warm or cool as it is evaporated from our exposed skin. Heat is transferred during the evaporation process. In colder temperatures, this is referred to as wind chill.

Clouds have been classified by meteorologists according to their appearance from the ground by two factors: height and form. The three basic cloud forms are cirrus, cumulus, and stratus. Cirrus are like wispy, feathery curls, and they are composed of ice crystals. Cumulus are like cotton balls. They are very dense and tend to cast shadows on the earth. Stratus are layered clouds, composed of water or ice, and give an overall gray appearance. The word nimbus w .en attached to a cloud form, means precipitation.

Water in the atmosphere is returned to earth in a variety of ways. Some of it leaves the atmosphere as a result of condensing on the earth's surface. Much of it leaves by first condensing in the atmosphere and then falling to earth as precipitation. Both processes play central roles in the water cycle and nourish the earth with water.

The water that we use today has been around since ancient times, recycled again and again through the water cycle. The water used to wash your face this morning could have been part of a cloud floating over South America last week. Our water is constantly recycled, and cleansed, as it changes forms from a liquid to a gas and back to a liquid through the phases of the water cycle.

By the way, the city of Chicago is nicknamed the Windy City, but it has nothing to do with the weather. The fact that it is often very windy here (69 mph is the fastest wind gust on record, set on April 29, 1984) is just a coincidence; it is by no means the windiest city in America. The name came about when Chicago was applying to become the site of the 1893 World's Columbian Exposition, and its chief rival was New York City. Newspapers in each city tried to present well-reasoned arguments to convince people that theirs was the city that should host the event. *New York Times* editor Charles Dana, portraying Chicagoans as self-promoting blowhards, told his readers to pay no attention to "the nonsensical claims of that windy city. It's people could not hold a world's fair, even if they won it." (This information was adapted from the *Chicago Sun-Times Metro Almanac*, 1993.)

This *Up, Down, and Around in Chicago* unit is just the foundation for your students' study of weather and weather phenomena. The entire story of the weather and all its interesting concepts cannot possibly be included in five introductory lessons, and students should be encouraged to do further investigating if their interests are piqued. Indeed, they can make a career out of learning more. Meteorologists, the men and women who study the weather, are always revising their ideas and developing new technological skills to carry out their work. They began just like your students, and now use many exciting, specialized tools to gather measurements from all over the world. They take these data continuously to get an accurate picture of the state of our atmosphere as it continues to change.

Have fun with these lessons. Take advantage of the fact that weather is a fascinating subject for everyone. After all, it is relevant to every student, and the concepts learned in these lessons can be immediately applied. Besides, every body likes to talk about it... Enjoy!

Timeline for Unit
This unit contains five lessons, which can b taught over the course of one month. Two of the longer lessons (Lesson Two and Lesson Five) each contain two distinct parts so that they can be taught in separate sessions if desired, depending upon teacher, students and availability of time.

It does not matter what time of year the subject is presented. However, if done early in the school year, the unit can be extended by having students obtain and record weather data throughout the year.

Evaluation/Assessment
Two of the lessons in this unit include examples of assessment rubrics, which relate directly to the CPS outcomes stated above. Several others lend themselves to authentic assessments easily. Teachers are encouraged to adapt the examples and make their own scoring sheets, as necessary.

Community Resources and Other Sources of Information
People/Places to Call
Atmospheric Education Resource Agents
National Weather Service Chicago Contact
Jim Allsopp
815/834-0651

Ted Lucas, Resource Agent, American Meteorological Society,
Project ATMOSPHERE. Will do classroom visits.
312/808-0100

Tom Skilling, WGN-TV
312/883-3132

Weather Channel Weather
800/525-6000

Places to Visit
Romeoville Weather Station
The National Weather Service
333 University Avenue
Romeoville, IL 60441
815/834-0673

The Nature Museum of the Chicago Academy of Sciences
Opening soon (1997) in Lincoln Park
Features an interactive lab for exploring weather and weather phenomena.

Internet Connections
Internet Activities Using Scientific Data: A Self-Guided Exploration
National Oceanic and Atmospheric Administration (NOAA)
S. Froseth and B. Pope, 1995.

PBS K-12 Learning Services Newsletter
e-mail k12@pbs.org

The Weather Underground
A network linking the atmospheric science community with pre-college age school children and their teachers. Contact Perry Samson, University of Michigan, Ann Arbor, MI 48109-2143 or e-mail samson@umich.edu for details.

Television/Video
Bill Nye, The Science Guy (Buena Vista Productions)
A half-hour show of science learning and entertainment, funded by NSF, to stimulate and encourage the curious interest of youngsters in science and technology. Check local listings.

Science Power!
A live, cable-access science show in Chicago. Wednesdays, 7 -8 PM, Channel 21. Selected shows are produced by the Chicago Academy of Sciences on a variety of science topics, and focus on the scientific method and careers in science. Viewers are invited to call in and participate from home!

The Active Atmosphere Video Tape Series
Focus Media, 839 Stewart Avenue, PO Box 865, Garden City, NY 11530.
The phone number is 800/645-8989

Books to Read

Abbott, Marti, and Polk, Betty Jane. 1991. *Clouds, Rain, Wind, and Snow*. Fearon Teacher Aids: Simon & Schuster Supplementary Education Group.

Braus, Judy. 1985. *Ranger Rick's Nature Scope: Wild About Weather*. National Wildlife Federation.

Emmons' Deighton K., Jr. 1988. *Weather Forecasting: Teacher's Guide*. Delta Education, Inc.

Geer, Ira W., Director. 1987. *The Everyday Weather Project*. State University of New York College at Brockport. The Research Foundation of State University of New York.

Graf, Mike. 1989. *The Weather Report*. Fearon Teacher Aids.

Kim, Hy. 1988. *Fascinating Science Experiments with Bottles and Jars*. To obtain a copy, write: Hy Kim, 427 Ewing Road, Bordman, OH 44512.

Lehr, Paul E., Burnett, R. Will, and Zim, Herbert S. 1987. *A Golden Guide to Weather*. Western Publishing Company.

Lockhart, Gary. 1988. *The Weather Companion: An Album of Meteorological History, Science, Legend, and Folklore*. John Wiley & Sons, Inc.

Roberts, Allene. 1992. *The Curiosity Club: Kid's Nature Activity Book*. John Wiley & Sons, Inc.

Rubin, Sr., Louis, D., and Duncan, Jim. 1989. *The Weather Wizard's Cloud Book*. Algonquin Books of Chapel Hill.

Suzuki, David. 1988. *Looking at Weather*. New Data Enterprises.

VanCleave, Janice. 1991. *Earth Science for Every Kid: 101 Easy Experiments that Really Work*. John Wiley & Sons, Inc.

Williams, Jack. 1992. *The Weather Book*. USA Today, Vintage Original, Division of Random House.

Career Connections

Careers in meteorology and related fields require many different abilities and interests: scientific, social, mechanical, technological, etc. They all require high school completion, plus either college/university or technical school training. Graduate work is necessary for some positions. Careers related to the study of weather include:

Meteorologist: keeps people informed of what kind of weather to expect

Navigator: plans courses for water craft and needs knowledge of weather

Meteorological Researcher: uses new technologies and studies trends in climates

Teacher: helps others learn about weather and weather phenomena

Agricultural Researcher: develops new plant types and determines soil conditions

Agricultural Engineer: designs irrigation systems

Water or Air Quality Engineer: studies sources and effects of acid rain

Hydrogeologist: develops, controls, and helps protect water supplies

Public Interest Specialist: promotes awareness by communicating with public

Glossary

AIR: a substance that surrounds us, takes up space, and whose movement we feel as wind

AIR PRESSURE: the weight or strength exerted by air molecules

BAROMETER: an instrument which measures air pressure

BEAUFORT SCALE: an observation-based classification system for wind force

CLIMATE: an overall pattern of weather conditions

CONDENSATION: part of the water cycle; changing from a vapor state to a liquid state

DEW: condensation of the water vapor in atmosphere due to drop in temperature at the end of the day

EVAPORATION: part of the water cycle; changing from a liquid state to a vapor state

FOLKLORE: the traditional beliefs, legends, customs, of a people

FORECAST: using observations to predict the future weather conditions

FRONT: the zone between air masses; where two masses meet

HUMIDITY: water vapor in the air

METEOROLOGIST: a person who studies and/or reports the weather

PRECIPITATION: part of the water cycle; rain, sleet, snow, hail, etc.

THERMOMETER: an instrument used to measure temperature

VACUUM: an enclosed space from which matter (especially air) has been partially removed

WATER VAPOR: water in the form of a gas

WIND: the movement of air caused by changes in temperature and pressure

WIND VANE: a tool used to show direction from which wind blows

Lesson 1: What is Air?

Lesson Introduction

This lesson contains the following content ideas:

Air takes up space which nothing else can occupy at the same time.
Air has weight.
Air exerts pressure in all directions.

In this lesson, the students will be discussing and witnessing the properties of a substance which many people take for granted. They will begin to understand the importance of air and of air pressure in the world around us, and see how it affects our daily lives. The students will be working cooperatively in pairs, with a single set of materials which must be shared, to gain experience in pro-social learning skills.

Specific Lesson Objectives

1) Following a class demonstration showing that a piece of tissue paper remains dry in the bottom of a jar when the jar is lowered downward into a bowl of water, each student will explain, in a journal entry, that air takes up space in the jar and that nothing else, including the water, can occupy the same space at the same time.

2) Given a meter stick or an empty wrapping paper roll, some string, scissors, and two empty cardboard milk cartons, the students will work in pairs manipulating the balance and imbalance of containers containing different amounts of air to illustrate the concept that air has weight.

3) Given a paper cup and a pencil or pen, each student will carry out a simple investigation to demonstrate the idea that air exerts pressure, and when asked, will correctly explain that an increase in pressure inside the cup would result in an exploding cup, while a decrease in pressure inside the cup would result in a collapsing cup.

Time Allotment

This lesson can be completed in one 60-minute session.

Materials

1 see-through plastic or glass jar
1 medium bowl
water
1 small piece of tissue paper
weather journals, one for each student
meter sticks or empty wrapping paper rolls, one for each pair of students
empty cardboard milk cartons, two for each pair of students
string
scissors
pencils or pens

1 drinking glass
1 square piece of cardboard
paper cups, one for each student
chalkboard and chalk

Advanced Preparation
Instruct the students to save milk cartons for the activity prior to the day of the lesson. Rinse them out and set them aside until you are ready for them.

Arrange students into cooperative pairs.

Procedure

Tap Prior Knowledge
1. Show the students in the class an empty jar. Ask them "What is inside?" There is something inside it, after all. Point out that "You cannot see it, or taste it, or smell it, but it is there." They will eventually reply that there is air inside the jar. "What is air?" Write this question on the chalkboard. Ask "What is air like?"

Share with Neighbor
2. Invite the students to "Think about how we can prove that air is inside, taking up space inside the jar?" Let them talk in pairs and then offer their ideas and develop some strategies as a class. They might mention that if air is in the jar taking up space then nothing else could take up that space. Draw their attention to this idea.

Hands-on Activities/Introduce Scientific Principle
3. Have one student help you by taking a small piece of tissue paper and packing it down inside the jar. Ask the class "How much air is now in the jar?" They will answer that there is a little less than before.

4. Ask a couple of students to fill a medium bowl about half full of water. Pose the question "What will happen if I lower this jar downward into the water?" They may offer some answers about the level of the water which, though accurate, are not directly related to this demonstration. Direct their attention to the question "Will the tissue get wet?" What do they guess will happen? Encourage predictions before going on with the demonstration.

5. Lower the jar downward onto the water as the students watch. Allow the students to react with disbelief and offer the chance for them to repeat the process themselves. The towel will stay dry. The first property of air, therefore, is that *AIR TAKES UP SPACE*. Write this on the chalkboard below your original question. Ask the students to summarize and explain the results of this class investigation in their weather journals. Give them a few minutes to complete this.

6. Next, take out two empty cardboard milk cartons and say "I wonder what is in these empty cartons." The students should respond based on the last demo that air is inside of them. Ask them "Does air weigh anything?" Once again, let them

suggest methods of investigation for this problem. You are merely directing their inquiry and guiding them in their search for a solution.

7. Distribute to each pair of students one meter stick or empty wrapping paper roll, some string, scissors, and two of the empty cardboard milk cartons. Show them how to set up a balance with the meter stick by tying a piece of string to the center and connecting one milk carton to strings at each end. Once each pair has its equipment balanced, ask "How might you take all of the air out of one of the milk cartons?" The easiest way is to squish it and make the carton flat. Instruct them to carefully squish one (only one!) of their milk cartons.

8. Encourage the students to guess what will happen when they try to balance the flat milk carton now. "Which will be heavier?" If air has no weight, it will still be balanced. If air has weight, it will no longer be balanced. Note how important it is not to disturb the way the balance is set up. The distance from the middle, the amount of tape, etc. should remain the same. The only variable you want to change is the amount of air in the carton. This investigation will show that the carton with air in it will be heavier than the squished carton with no air in it. From these results, write the second property of air on the chalkboard as *AIR HAS WEIGHT*. Give students time to record in their weather journals.

9. Next, develop the idea that since air takes up space and has weight, there is a third property called air pressure. This allows air to take on the form of winds, storms, hurricanes and tornadoes, etc. Invite the students to imagine being at the bottom of a large pile of bed pillows. Explain that "We live at the bottom of an air ocean which rests its weight and its force on the earth. What keeps our bodies from collapsing under all this pressure?" The pressure is the same on both sides of our bodies, inside and outside.

10. To demonstrate this idea, have one student fill a drinking glass with water. Take a small square of cardboard and put it over the top. Ask the students "What do you suppose will happen when the glass is tipped over? Will the air pressure be greater on the outside or inside?" In other words, will the cardboard stay on or will the water push it off? Do it to see what happens. It will stay on due to the air pressure outside.

Relate Activity and Concept

11. "What keeps a paper cup from collapsing?" As with our bodies, the pressure is the same on the inside and outside. Tell the students that "If we added more pressure to the inside of a paper cup, then the pressure would become greater on the inside than it was on the outside, and it would explode. If we decreased the air pressure inside of a cup, then the pressure would be less inside than it was on the outside and it would collapse. Let's try it."

12. Pass out paper cups to each student and instruct them to poke a small hole in the bottom with a pen or a pencil. Demonstrate, if necessary. When everyone has done

this, tell them to "Blow into the cup and feel the air coming out of the hole. Why is it doing that?" The reason is because the air pressure is increasing inside the cup and it escapes to an area with lower pressure. "What would happen if you put your finger over the hole?" It would explode. "Now, decrease the pressure inside the cup by exhaling, putting the cup to your mouth and breathing in. What happens?" "If you cover the hole?" It collapses. Supply them with the term 'vacuum' and discuss the uses and implications of manipulating air pressure in this way.

13. The third property of air to add to the list on the board is that *AIR EXERTS PRESSURE IN ALL DIRECTIONS*. Give students time to record in their weather journals. Air presses down upon the earth's surface at sea level at 15 lbs. per square inch. Here in Chicago, with an elevation of between 577 and 900 feet above sea level, that is very nearly the pressure we experience. It would be different if we were much higher or lower. Circulate around the room while the students are involved with this investigation and ask each student to explain the result of increasing and/or decreasing pressure in the cup to be sure they understand the relationship.

Connect to Other Everyday Examples

14. Prepare the students for the next lesson by telling them "Next time, we will be doing more with air pressure, the third of air's properties. Tonight, go home and keep thinking about what we did. Make sure you have these three properties listed in your journals. Also, try to come up with one or two examples of how air affects us every day, such as making our running faster or slower, making it possible to use a drinking straw, or holding automobiles up by tires."

Summary/Background for Activity

Air is not a solid or a liquid so many people think of it as nothing. It is indeed something and this is what is to be impressed upon students. The important things to know for the study of weather is that air takes up space, therefore it has weight, and therefore it exerts pressure.

Clean-Up

Dispose of the water in a nearby sink, or if you can, leave the bowl out on a counter top so that students will have the opportunity to observe evaporation and perhaps ask some questions about what happened to the water. Don't mention it to them; rather, let them notice.

Home Activity/Parent Involvement

Tell the students to try with their families at home at least one of the many air activities they tried during this lesson. The next day, during general classroom discussion, go around the room and ask each student for a simple sharing report. This will hold them accountable for the assignment.

Lesson Assessment

This introductory lesson has no formal assessment. Each student will summarize the results of the classroom demonstration in his or her journal. The journals can be reviewed to determine their comprehension of how "air takes up space that nothing else can occupy at the same time." That phrase, which is the main point of the demonstration, should be included in some form in their journal entries.

Each student will participate in the classroom investigation. Their active participation can be noted as part of the assessment.

Extension Activities

Books to Read

Kim, Hy. 1988. *Fascinating Science Experiments with Bottles and Jars*. To obtain a copy, write: Hy Kim, 427 Ewing Road, Bordman, OH 44512.

Lehr, Paul E., Burnett, R. Will, and Zim, Herbert S. 1987. *A Golden Guide to Weather*. Western Publishing Company.

Additional Activities

Some students may want to know more than these basic properties about air. For example, the atmosphere is composed of a mixture of gases. Nitrogen makes up about 78% of the mixture, oxygen about 21%, water about 0-4%, and carbon dioxide and inert gases (such as argon, neon, helium, krypton, xenon) less than 1%. These gases exert a force on the surface of the earth at sea level of nearly 15 pounds per square inch.

The atmosphere is composed of several layers. Our direct experience is within the Troposphere. Some of the more advanced students may want to find out about the other layers. Students who have difficulty with the classroom experiments may benefit from further hands-on experimenting. Mae and Ira Freeman's *Fun with Science* is recommended.

Lesson 2: What is Wind?

Lesson Introduction

This lesson contains the following content ideas:

A barometer is an instrument which measures air pressure.

Changes in air temperature affect measures of air pressure.

The sun heats the earth unevenly: land absorbs and loses energy more quickly than water.

Wind is caused by changes in temperature and air pressure.

The Beaufort Scale is one way to describe the force of wind.

In this lesson, the students will gain confidence in experimenting, making graphic representations, and interpreting data. They will complete these tasks as a class before they are required to do any of them independently. They will take on more responsibility for choosing the format of an assignment and will learn to rely less on authority figures to dictate how they are able to express their own ideas. As in all the lessons of this unit, they will be working cooperatively in pairs or in small groups, with a single set of materials which must be shared, to gather data from an assigned sample and share the results with the entire class.

Specific Lesson Objectives

1) Given a small glass jar, a balloon, a small stick and some glue, each student will construct a functional barometer and will explain, in a journal entry, that cooler air results in lower pressure while warmer air results in higher pressure.

2) Given containers of soil or of water, the students will work in small groups using thermometers to measure changes in the temperatures of these materials over a period of time, and will record their data together to focus a class discussion of wind.

3) Following an explanation of sea and land breezes, each student will draw a diagram in his or her journal clearly demonstrating how temperature differences create air pressure differences which create these shore breezes.

4) Following the lesson, each student will choose two maps which are appropriate for a discussion of onshore/offshore breezes, and will list three similarities and three differences between the regions shown on the maps.

Time Allotment

This lesson can be completed in two 60-minute sessions.

Materials

small glass jars, one for each student
balloons, one for each student
rubber bands, one for each student
glue
small sticks (coffee stirrers), one for each student

sample home-made barometer
bowl of warm water and bowl of cold water, one for each group
index cards, one for each student
medium plastic containers, one for each group
thermometers, one for each group
soil, at room temperature
water, at room temperature
sunlight, or heat lamp if sun is unavailable
copies of Students Data Sheet Master: Beaufort Scale
weather journals, one for each student
access to maps of many different regions, including Chicago
chalkboard and chalk

Advanced Preparation
Find a thermometer in the school that your students can check to monitor outside temperature. Ideally, this thermometer will be placed outside the window of your classroom, but that is not always possible. At the very least, try to find access to one.

Arrange the students into cooperative groups.

Procedure

Tap Prior Knowledge
1. Engage students in a discussion of the three properties of air discovered in the previous lesson by asking them to review their journals. They should know that air takes up space, has weight and exerts pressure in all directions. Give them some time to clarify and ask questions about these properties before going on.

Share with Neighbor
2. Tell the students the story of the 10-meter long barometer:

> There is a legend that a man placed a glass tube over 10 meters long upright in a pan of water. He filled the tube with water and sealed the top. The water dropped a few centimeters, but came to rest at about 10 meters above the pan of water. All of the people in town could see this because the tube was attached to the front of his building. It was the only place he could support a tube three stories high.
>
> The water level did not stay at the same place every day. In fact, it would drop just before a rain storm or a hurricane. The townspeople thought the machine brought the bad weather, and they blamed the man. They chased him out of town because they thought he was a witch.

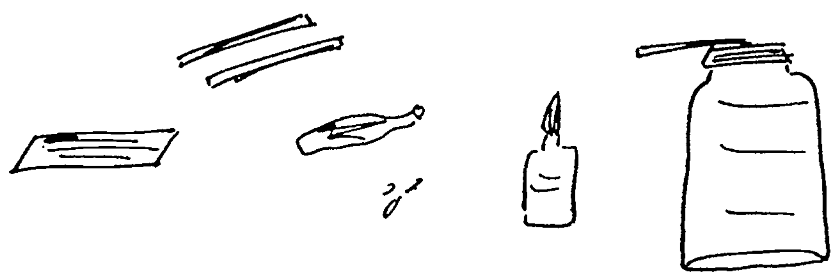
3. Initiate a discussion by asking "What kept the water up in the tube? Why did the water level move? Was the man practicing witchcraft? Did the machine bring bad weather?"

Hands-on Activities/Introduce Scientific Principle

4. Tell the students that it is simple to make one of these instruments. Show the students your home-made barometer. Have each student construct a barometer. Give them each a small glass jar, a balloon, a rubber band, and a small stick. Follow these steps:

a. Place a thin layer of glue around the mouth of the jar.
b. Stretch the balloon over the mouth.
c. Hold it in place. Fasten it with a rubber band.
d. Place a small drop of glue on the balloon, in the center.
e. Attach the small stick to the center.
f. Gently hold in place until it dries.

5. Pass out containers of cold water to each group of students. Tell them to watch the stick to see what it does when they place their instruments in the water. The pressure is lower as the air is cooled inside the jar, and the balloon goes in. As a result, the stick rises.



6. Ask the students "What do you think will happen when we place our jars into warm water?" The pressure will increase as the air is warmed inside the jar and the balloon will go up. The stick will go down. Distribute warm water to the groups, and try it out. Be sure the students understand and can explain the reactions. It would help to have them imagine air molecules bouncing off of each other. The warmer it gets, the harder they bounce, and the higher the pressure.

7. Set up an index card to mark changes from low to high pressure. Give the students a few minutes to write in their journals, explaining what happens to air pressure when the temperature rises and falls. If you haven't already used the word "barometer," be sure that you introduce the term to them now.

Part 2 (if you are doing the lesson in two sessions)

8. Ask the class "What makes the difference in air temperature that causes the differences in air pressure?" The sun is the cause. Yet "How could we have differences in temperature if the source of heat energy is shining equally on everything?"

9. Tell the students a story about burning your feet at the beach, in the summer. "Is the sand as warm or as cool as the water?" No it isn't. Tell the students "We are going to do an experiment to see whether soil or water absorbs heat faster."

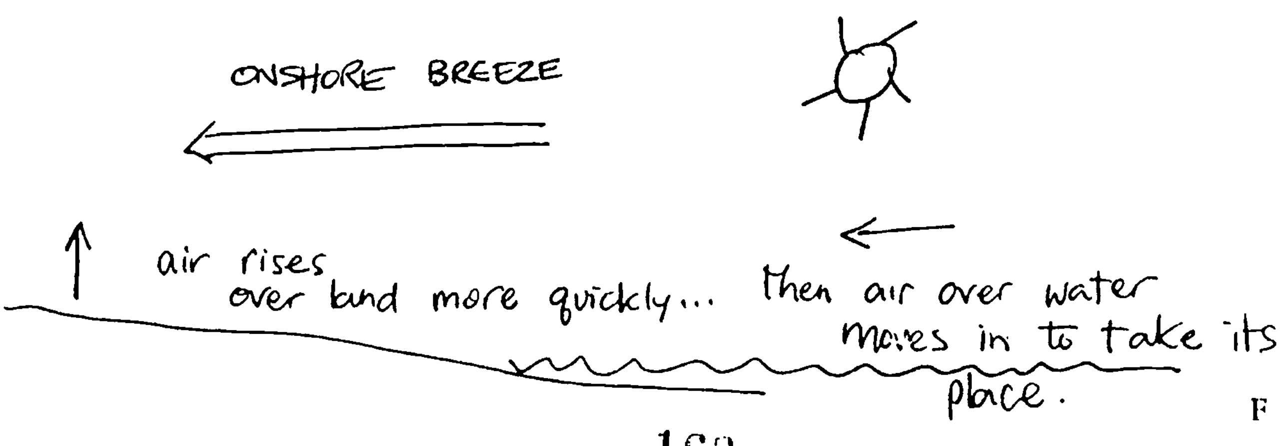
10. Pass out a container to each group. Give half soil and the other half water of the same base temperature. Give each group thermometers, and instruct them to place just the tip into the soil or the water. All of the containers will be placed in the sunlight and measurements will be taken every three minutes for about 15 minutes. Make sure the thermometers remain near the surface of both materials.

11. Have the students help you record the data on the chalkboard so that they gain the experience in data collection. Encourage them also to keep track of the entire class' results in their individual journals because information such as this is meant to be shared. The conclusions you can draw from this is that sunlight heats up darker-colored substances and objects faster than lighter-colored. Light, shiny objects reflect the sun's light and heat, taking longer for them to warm. Once taken out of the sun, the containers of soil will also cool faster than the containers of water.

Relate Activity and Concept

12. Clean up the materials from the experiment. Ask the students "What happens when they open the refrigerator door at home?" The cool air drops out of the bottom and you can feel it on your feet. "Which is warmer, your attic or your cellar?" The attic, usually. Warm air goes up and cool air goes down. Warm air is always lighter. The little molecules we mentioned earlier are bouncing around more when they warm up, so there's more space between them. When warm air rises, cooler air rushes in to take its place, and it gets warmed in the process. There is a continuous flow of air above a source of heat. This is wind.

13. "A good example of how this works is at the seashore, like on the shore of Lake Michigan here in Chicago. Heat from the earth warms the air in the same way that a radiator heats air in a room. As the earth's land and water warm and cool, the air also warms and cools. On a warm day, when there are no large scale winds, we know from our experiment that the air above the beach (land) gets warmer than the air above the water. It rises and cool air comes in from the water to take its place. This is called an onshore breeze." Now ask "What happens at night, when the land and water cool?"



14. Allow the students to make some educated guesses. "The land, once again, cools off more rapidly and to lower temperatures than the water, and the breeze goes the other way. Some days, the same area gets an onshore and an offshore breeze." Have the students draw a diagram in their journals clearly showing how temperature differences create air pressure differences at the seashore. Let them have a great degree of freedom in choosing the type of diagram they make. All of the students should be able to express the reasons for presenting data in the form of tables, charts, or graphs.

15. Each student should choose two maps which can be used to demonstrate the unequal heating of the earth's surface (review with them that the maps should have some land and some water). One of the maps can be of the Chicago area, but the other should be a novel example. In their weather journals, have each student write down three things that are similar and three things that are different about the regions, in terms of the development of onshore and offshore breezes.

Connect to Other Everyday Examples

16. "The greater the difference in air pressure, the faster the wind will blow. Storms and hurricanes, which we have all experienced, are caused by this." Have students look outside now and describe the wind. Is it calm or strong? Introduce the Beaufort Scale as one way of measuring wind speed, using observation of everyday objects like trees and flags. "In 1805, Admiral Beaufort of the British Navy developed the scale to estimate wind speeds from their effect on sails. Today, by international agreement, most nations use knots. We will use his scale, our school or classroom thermometer, and our new barometers, as well as other things we will find out about during this unit, to monitor the weather conditions from our classroom."

Summary/Background for Activity

The sun provides the heat energy that keeps the weather changing. The cause of wind, basically, is the unequal heating and cooling of the earth's surface. Differences in heat create differences in air pressure, and these differences in pressure make the winds blow (the air masses move) from one place to another. It is important to realize that the sun's heat is not distributed evenly across the surface of the earth. There are many reasons for this. Because the earth is a sphere, only a portion of the surface receives the energy at any given time. Having a day and night is therefore responsible for creating on-shore and off-shore breezes. The earth also receives light at different angles. The tilted axis of the earth and the yearly revolution cause variations in the amount of heat at different times of the year, resulting in seasons for some parts of the globe and causing seasonal variations to the winds.

Geography modifies the wind's behavior as well. Land and water affect breezes because they do not heat up or cool off at the same rate. Water heats up more slowly than land does and its heat-holding capacity is greater. Therefore, it absorbs and releases heat much more slowly than land does. The air temperatures, and resulting air pressures of the air masses influenced by these surfaces, are destined to be different. This concept is key to understanding the mechanics of wind, and the changing weather patterns.

Since the earth is hottest at the equator and coolest at the poles, the global wind circulation consists of cool air going from the poles to the equator at the surface of each hemisphere, and warmer air moving up at the equator and moving toward the poles in the upper levels. These winds are then steered into different belts by the rotation of the earth. This deflects the winds to the east and the west, rather then leaving them simply north and south. In the United States, our winds move predominately from the west to the east.

Safety

Students should be extra careful if working with heat lamps.

Clean-Up

Reuse the water and the soil you used in the experiment, if possible.

Home Activity/Parent Involvement

Have students bring their barometers home and keep track of the pressure in one place in the house over a couple of days. Bring the data back to school. Compare class data. Compile class averages. Was there a change in pressure? Was there a change in weather? Note: Keep one barometer, most likely the sample one that you made, in the classroom for ongoing measurements.

Student Data Sheet Master

Beaufort Scale

Lesson Assessment

Each student will construct a barometer from the materials provided. They can repeat the experiment with warm and cold water independently or in groups to see if their instruments work correctly. They will summarize the results in their journals. The journals can be reviewed to determine their comprehension of how temperature changes affect measures of air pressure.

Each student will participate in the classroom experiments and discussion about wind. This active participation can be noted as part of the evaluation.

Each student will draw a diagram of the onshore and offshore breeze in his or her journal, correctly identifying air temperatures and air pressures. They should specify that the wind will blow from high pressure to low and from warmer air to cooler. The type of diagram should be left up to the student.

Each student will choose two maps which are appropriate for a discussion of onshore/offshore breezes, and will list three similarities and three differences between the regions shown on the maps.

Sample Assessment Rubric

CPS Outcome: Analyze patterns of change in biological, physical, chemical, and geological systems.

Criterion: patterns of physical change

In a journal entry, the student:

Indicators:	1	2	3
	makes no relation between temperature of water or air and pressure in the description of activity	says that cooler or warmer water or air made stick go up and down but does not mention air pressure	says that cooler air results in lower pressure while warmer air results in higher pressure

CPS Outcome : Use charts, maps, and other geographical tools to create, compare, and contrast geographical regions.

Criterion: choosing appropriate maps

When given access to maps, the student:

	1	2	3
Indicators:	does not select two different maps i.e., both of Chicago	selects two maps but they are not appropriate for a discussion of shore breezes (no water and land)	both maps show both land and water

Criterion: comparing and contrasting geographical regions

In a journal entry, the student:

Indicators:	1	2	3
	lists one similarity and/or one difference	lists two similarities and two differences	lists three similarities and three differences

Extension Activities

Books to Read

Roberts, Allene. 1992. *The Curiosity Club: Kid's Nature Activity Book*. John Wiley & Sons, Inc.

Suzuki, David. 1988. *Looking at Weather*. New Data Enterprises.

VanCleave, Janice. 1991. *Earth Science for Every Kid: 101 Easy Experiments that Really Work*. John Wiley & Sons, Inc.

Additional Activities

More advanced students may wish to further investigate, with a globe, the unequal heating of the earth's surface. How do direct rays compare with indirect rays? How does amount of land compare with water? How does the rotation affect the air currents? Colored water can be dropped from an eye dropper onto the globe to illustrate this. The students might want to discover more about the prevailing winds of the earth.

All of the students need not have this much detail as long as everyone understands how temperature affects pressure. Less advanced students may benefit from books such as Jeanne Bendick's *The Wind* and Nina & Herman Schneider's *Let's Find Out about the Weather*. The experiments in these books will help children if they are having trouble grasping the concepts in class.

Additional Community Resource Excursions
Take a trip to the shore of Lake Michigan, if possible. There, the students can explain in their own words the dynamics of an onshore-offshore breeze. During a typical summer, cool breezes blow off the lake thirty to forty days, reducing the lakefront temperatures by 4 or 5 degrees. In winter in Chicago, the lake creates a slight warming effect because the water is warmer than the air.

TIMEOUT
Current Event Science Connection: The Greenhouse Effect

The Greenhouse Effect describes the warming of the earth's atmosphere by an increase in natural gases in our atmosphere, which prevent heat from escaping. They act as a greenhouse does, which is where the trend gets its name.

Carbon dioxide (CO_2) is responsible for about 50% of this warming trend. The main sources of CO_2 include burning fossil fuels like coal, oil, and natural gas, as well as the destruction of forests when they are cut or burned down. Other sources include Chlorofluorocarbons (CFCs), methane, nitrous oxide, and ozone.

As an activity, have your students analyze the interdependence of earth systems and organisms by allowing the students in each group to pick one of these greenhouse gases and research its sources and effect(s) on the environment. Then, invite them to report/share their findings with the other students in their groups.

Lesson 3: How are Clouds Formed?

Lesson Introduction
This lesson contains the following content ideas:

Air contains water which has evaporated (water vapor).
Warm air can hold more water vapor than cold air.
Clouds are formed when air cools and water vapor condenses on dust, smoke or salt particles.

In this lesson, the students will experience a sense of awe when they witness investigations involving evaporation because, like air, water vapor is something they cannot actually see and do not usually conceptualize. They will see the rationale for establishing a control in an experimental situation. As usual, they will be working together as a class to carry out a procedure, each contributing equally to the overall outcome.

Specific Lesson Objectives
1) Following a class demonstration showing the effects of heat and air movement on the evaporation of water, each student will summarize, in a journal entry, that water enters the air more quickly when heat is applied and when the air around it moves.

2) After listening to several examples of evaporation and condensation given in class, each student will offer a novel example of these processes from his or her own experience.

3) When asked to name the three elements involved in cloud formation, each student will correctly state evaporation of water into warm air, condensation of water once the air cools and the presence of dust, smoke or salt particles in the air.

Time Allotment
This lesson can be completed in one 60-minute session.

Materials
wet sponge or cloth
heat lamp
fan or stiff piece of paper
cotton balls
small jars or glasses, one for each group
colored water
large jars with lids, one for each group
water
ice cubes
matches
weather journals, one for each student
chalkboard and chalk

Advanced Preparation
Arrange the students into cooperative groups.

Procedure

Tap Prior Knowledge

1. Initiate a discussion about the last lessons, stressing what air is and how temperature and pressure differences cause wind. Then, wipe a damp sponge or rag across the chalkboard. Tell the students to "Watch closely for changes in the wet spots!"

Share with Neighbor

2. Ask "What happened?" They will say that the wet spot has disappeared. "Where did it go?" Encourage discussion in the groups and have the students think of a way we can speed it up. Accept their ideas. Be sure to include the suggestions of heat and air movement.

3. Tell them "OK, let's see how heat affects the disappearing water." Have students help you wipe two marks on the board and use a heat lamp on one. While you are waiting ask "Why are we only using the heat lamp on one?" They should answer that it is because we want to see the difference between one with heat and without. You can introduce the concept of a control but it isn't necessary to use the term. "What happened to the wet mark?"

4. "Now let's see if moving air, our other idea, affects the disappearing water." Again have some students make wet marks on the board and let someone fan one of them. "What happened?" Ask the students to summarize the results of these experiments in their weather journals.

Hands-on Activities/Introduce Scientific Principle

5. Take a cotton ball and a bottle of water and put a dab on each child's hand if they need further demonstration of this. Let them witness evaporation first-hand. Explain that "Water is in the air in vapor form. When water is heated, it changes from liquid to gas (just as when it is frozen it changes from liquid to solid). Play around with these words until they understand, and they can use them in their own explanations. Introduce the word 'evaporation'. The changing of a liquid to a gas is called evaporation.

6. Give each group a small jar and fill it with colored water. Have the students watch it closely for a minute. Ask the students to examine the outside of their jars. "What is on the outside? Feel it. Is it wet or dry?" It is dry?

7. Now, go around the room and add a few ice cubes to the jars and wait one minute. Have students repeat their examinations. There are water droplets forming on the outside of the jars. "Does the water come from inside?" No,

because it is not blue. The jars don't have any holes. It comes from the air. Water is in the air.

Relate Activity and Concept

8. When water vapor changes back into a liquid it is called 'condensation.' Introduce the word to the students. "Condensation needs a helper. Can you think of what it is?" If the students cannot come up with an idea, suggest "What did we add to the jars? What did this do to the water? What did it do to the air around the jar? What happened to the water vapor in the air when it cooled? What must happen in order for condensation to take place?" Discuss these questions with the students. Give some examples of evaporation and condensation from the world around us (water in a teapot, a puddle after a rainstorm, dew, bathroom mirror). Have each student offer a novel example from his or her own experience.

Connect to Other Everyday Examples

9. One of the important ideas to leave with the students is that warm air can hold more moisture than cold air. We touched on this in the investigations above. Ask them now to think of the summers and the winters in Chicago. Ask "When do we feel the water vapor in the air?" During the summer, we often feel the humidity. This is because the warmer summer air can hold more water vapor. Ask "Why are winters in Chicago more dry?"

10. Next, engage the students by saying "Look outside the window. Do you see any clouds up in the sky? We can try to make a cloud similar to the way one is made outside." Distribute materials. Ask students to fill their large jars with hot water. Let them stand for two minutes. While waiting, review what is happening to the water. The heat is causing evaporation and water is entering the air. What do you observe that let's you know this is happening? Have students empty their jars and quickly replace the cover. Ask the students to predict "What will happen if ice is placed on top?" When it cools the air won't be able to hold as much moisture. Exactly. Try it. "What happens?" Nothing.

11. Repeat the experiment, but this time after the students have emptied the water from their jars, go around and quickly drop a lighted match in the jar. Have students replace the lid and add the dish of ice. Observe for 30 seconds. "What happened this time?" A small cloud was formed. When asked, each student should name the three things necessary for cloud formation: water vapor, cooling, and dust, smoke or salt particles in the air for the water droplets to cling to.

Summary/Background for Activity

At the surface of the earth, water enters the air by evaporation. (It can also enter by transpiration, when plants take in water and put water vapor into the air from their leaves, but evaporation is the bigger source.) The sun's energy warms this air and carries it and the water vapor upward. As air rises in the atmosphere, it cools. When the rising air is cooled to its dew point, condensation may occur. Drops of water are formed when enough molecules of water vapor accumulate around, and become attached to, a particle of dust in the atmosphere. Billions of tiny droplets of water form the weather phenomena we call a cloud.

All matter on earth is in the form of a solid, a liquid, or a gas. Matter in any one of these forms can change into another. Water can, of course, change from a liquid to a gas and it will still be water. The molecules in water vapor are the same as the molecules in the liquid water. How do these tiny particles control the properties of a substance? The molecules of a substance do not stay in one place. They move around. They bump into other molecules and move away from each other and also have a certain amount of attraction for each other. The state of a substance depends on how fast its molecules are moving and on how much the molecules attract each other.

In other words, gas molecules, such as water in its vapor state, move very quickly. They are spaced far apart and attract each other very little. As a result, they move away from each other and spread out. This is why vapor does not have its own shape. A gas takes the shape of its container.

Molecules in a liquid are closer to each other than those in a gas. They pull on each other strongly enough to give liquids a size, but not a shape. Liquids, like liquid water, spread out and take the shape of their containers like gases, but they do have a specific volume.

The molecules in a liquid move faster than the molecules in a solid. The molecules in a solid, like ice, are so closely packed together that they do not seem to move around much. They move very slowly, or vibrate, in place. The attraction between molecules in a solid is very great.

Water vapor in air plays an important role in determining the weather we experience. In addition to being instrumental in the formation of clouds and storms, water vapor causes our sensations of being warm or cool as it is evaporated from our exposed skin. Heat is transferred during the evaporation process. In colder temperatures, this is referred to as wind chill.

Safety
It depends, of course, on the level of the students, but generally students should not use matches on their own. During the cloud investigation, an adult can walk around and quickly drop a lighted match in each container. Inviting parents into the classroom to assist with this lesson is a good way to get them involved.

Clean-Up
Dispose of the water in a nearby sink.

Home Activity/Parent Involvement
Encourage students to try the cloud-making demonstration at home, with parents and family members. Once again, tell them to have adult supervision with the

matches. Tell them to explain the cloud formation process to their audience(s). Class discussion can focus on: What questions did their families ask? What problems did they have? Did the demonstration work? if not, why not?

Lesson Assessment

Each student will write a summary of the experiment on evaporation in his or her journal. The journals can be reviewed to determine their comprehension of how heat and air movement affect the rate of evaporation.

Each student will offer novel examples of evaporation and condensation from his or her everyday experiences. This participation in the classroom discussion can be noted as part of the evaluation.

Each student will be asked to name the three elements involved in cloud formation. They should be able to verbally state the following: evaporation of water into warm air, condensation of water once the air cools and the presence of dust, smoke or salt particles in the air.

Extension Activities

Books to Read

Rubin, Sr., Louis, D., and Duncan, Jim. 1989. *The Weather Wizard's Cloud Book.* Algonquin Books of Chapel Hill.

Williams, Jack. 1992. *The Weather Book.* USA Today, Vintage Original, Division of Random House.

Additional Activities

A more technical explanation of evaporation and condensation may interest some of the students, although it might not be appropriate for all. Water vapor enters the earth's atmosphere when individual water molecules gain enough kinetic energy to be ejected from liquid. This is evaporation. They then travel around freely among the gas molecules of the atmosphere. Nearly 80% of the earth's surface is covered by oceans, lakes and streams. Thus, there is ample opportunity for evaporation to take place on a large scale. Evaporation also takes place over land masses where moist soil and living plants yield large amounts of water vapor to the atmosphere.

More advanced students who have grasped this idea may enjoy doing another experiment on their own. They can take two containers, one shallow and wide the other deep and narrow. After putting the same amount of water in both, see which one evaporates first. The more surface area you have, the more opportunity for evaporation.

Lesson 4: What Types of Clouds are There?

Lesson Introduction

This lesson contains the following content ideas:

There are three general categories for classifying cloud formations: cumulus, cirrus and stratus.

Some clouds are reliable predictors of future weather conditions.

Prior to the availability of modern weather instruments, people relied on observable factors such as cloud formations to predict the weather (folklore).

In this lesson, the students will compare different primary source materials and see that forecasts differ slightly. They will learn that a source is important to consider when gathering information. The students will also appreciate the ways people forecast weather in another era as they gain satisfaction by expressing themselves through art.

Specific Lesson Objectives

1) Following a discussion of cloud formations, each student will correctly identify clouds as cumulus, cirrus or stratus when looking at the sky or at a photograph.

2) Given an index card, each student will make his or her own cloud recording chart, using the same cloud coverage symbols used in newspaper weather reports:

3) Given a selection of weather folklore, each student will choose one of them and use a variety of art materials to illustrate it for the class bulletin board.

Time Allotment

This lesson can be completed in one 60-minute session.

Materials

photographs of clouds
various newspapers
large index cards
construction paper
markers and crayons
other art materials
weather journals, one for each student
chalkboard and chalk

Advanced Preparation

Arrange the students into cooperative groups.

Procedure

Tap Prior Knowledge

1. Begin the lesson by comparing today's weather with yesterday's. Are there any clouds in the sky? Review how clouds are formed: the condensation of water vapor in warm humid air as the air cools. Allow students to consult their journals if necessary.

2. Ask the students "why don't all clouds look the same if they are all formed the same way?" It depends upon the conditions when the clouds are formed. They may be made of ice crystals, water or both. They may look white and feathery, large and puffy, or black and ominous.

Share with Neighbor

3. Talk with the students about the kinds of clouds they have seen. Ask some of them to describe them fully or draw them on the board. Let them express themselves in a variety of ways.

Hands-on Activities/Introduce Scientific Principle

4. Give each group many photographs of clouds and ask the students to work together to classify them into groups.

5. Examine their classifications with them. Tell them that scientists have been using three main groups. Clouds that look like feathers or thin curls are cirrus clouds. They are found high in the sky. They are made up of ice crystals. Sometimes meteorologists use  as a symbol for them. Clouds that look like puffy cotton balls in patches are cumulus clouds. Sometimes they have flat bottoms. Their symbol is . Clouds which spread in layers over the sky are called stratus clouds. They are like stairs in the sky. Near the ground, stratus clouds give us fog. Their symbol is ____.

Relate Activity and Concept

5. Pass around several newspapers. Have the students take a look at several newspaper weather reports for the same day. Pick out the symbols used to show cloud coverage. Draw them on the chalkboard. Ask "Do all of the forecasts in these newspapers agree?" They rarely are exactly alike, and it is important to know from where your information comes.

6. Hand out large index cards and tell the students "We are going to make Cloud Recording Charts so we can keep track of the clouds every day." Draw a model on the board or make a sample chart to pass around.

Cloud Recording Chart

date	type of cloud	coverage

Connect to Other Everyday Examples

7. Tell the students that "Different types of clouds are usually associated with certain kinds of weather. Cumulus clouds are seen when the weather is fair. Cirrus clouds are formed when the air is cold. Stratus clouds give us gray days. Also, the word 'nimbus' when attached to a cloud name refers to rain. Nimbostratus clouds are usually accompanied by rain or snowy. Cumulonimbus are big, thick and gray clouds usually associated with thunderstorms."

8. Read to them some common Weather Folklore. There are some examples below. Ask "Have you ever heard your parents or grandparents say they knew it was going to rain or be nice tomorrow?" Explain how people used to rely on these sayings to plan on future weather. Tell them "People who lived long ago, especially farmers and sailors, did not have instruments like we do today. They learned to observe the things associated with weather. How reliable do you think they were?"

9. As an activity, each student will pick one saying and illustrate it to put up on the bulletin board. To avoid too many duplicate choices, write each saying on a single piece of paper and have the students choose the pieces of paper. In this way, all of the choices will be illustrated at least once.

Weather Folklore
What weather will tomorrow bring?
Cold wind follows when wind shifts to the north.
A sign of a long hard winter is a furry caterpillar with an extra long thick coat.
Birds sit in their nests before a storm.
A storm is likely when there is a halo around the moon.
Six more weeks of winter if a ground hog sees its shadow on February 2.
If squirrels store a lot of nuts, we will have a cold winter.
Cumulus clouds mean nice weather.
Rainbow in the morning, sailors take warning.
Cold weather follows when a south wind changes to a west wind.
When dew is on the grass, rain is not likely to come to pass.
Red sky in the morning, sailors take warning.
Red sky at night, sailors delight.
A storm is likely when smoke moves downward.

Summary/Background for Activity

Clouds are classified according to two factors: height and form. The three basic cloud forms are cirrus, cumulus, and stratus. Cirrus are like wispy, feathery curls, and they are composed of ice crystals. The name is Latin meaning "to curl." Cumulus are like cotton balls, heaped up. The word is similar to accumulated. They are very dense and tend to cast shadows on the earth. Stratus are layered or sheet-like clouds, composed of water or ice, and give an overall gray appearance. The word nimbus when attached to a cloud form, means precipitation, or rain cloud.

Home Activity/Parent Involvement
Have students watch a variety of weather reports on television with their families. Tell them to keep track of the reports in their weather journals, and respond to the following questions: How do different stations show storm patterns? Do they use satellite pictures, photos, animation, etc. Which symbols do you recognize? Which method is the most effective? Least effective?

Lesson Assessment
Each student will be presented with actual clouds (if available outside) or with photographs of clouds. They should correctly identify at least one of each of the three general cloud types: cumulus, cirrus or stratus.

Each student will make his or her own cloud recording chart. These can be examined to be sure all students have included the cloud coverage symbols reviewed in class.

Each student will produce an illustration of weather folklore. Completing this activity should be part of the evaluation and can be noted as such, but as always, the individual artistic choices made by the students should not be subjected to correction by the teacher.

Extension Activities

Books to Read

Abbott, Marti, and Polk, Betty Jane. 1991. *Clouds, Rain, Wind, and Snow.* Fearon Teacher Aids: Simon & Schuster Supplementary Education Group.

Braus, Judy. 1985. *Ranger Rick's Nature Scope: Wild About Weather.* National Wildlife Federation.

Lockhart, Gary. 1988. *The Weather Companion: An Album of Meteorological History, Science, Legend, and Folklore.* John Wiley & Sons, Inc.

Additional Activities
More advanced students might want to investigate independently the frontal systems which occur where two air masses meet. Thunderstorms, hurricanes, typhoons and tornadoes are exciting weather phenomena which can stimulate interest in learning. Some students may want to learn more about combinations of the three basic types of clouds. There are several which they can read about on their own.

Lesson 5: What is the Water Cycle?

Lesson Introduction

This lesson contains the following content ideas:

Precipitation results after water evaporates and condenses and this is known as The Water Cycle.

Precipitation can have many forms depending upon conditions.

The climate of a particular area is a general state of the weather conditions in that area over time.

Meteorologists study, monitor and predict the weather.

In this lesson, the students will understand that we live in just one climate, and that there are many others. They will understand how climate affects lifestyle choices and become more tolerant of those who are different. The students will appreciate the training, job skills, and importance of the career of meteorology after listening to a guest speaker share his or her experience. Finally, the students will be working cooperatively in small groups to develop and design their own weather stations using all of the information they have learned. The emphasis will be on sharing and making collective decisions on what is best for the group's project.

Specific Lesson Objectives

1) When presented with the Water Cycle Game, each student will play successfully, answering questions correctly to review the information learned this week.

2) Following a discussion of climate, each student will demonstrate an understanding of how climate and topography affect the way people live.

3) Given all of the information they have learned, the students will work in small groups to design their own weather stations. They will use instruments and scales they have constructed so they can monitor weather from our classroom. Each station should include a place to record a measure of temperature, wind force, air pressure, cloud formation, and type of precipitation.

Time Allotment

This lesson can be completed in two 60-minute sessions.

Materials

diagram of the water cycle
Water Cycle Game
guest speaker (meteorologist)
individual instruments and scales constructed throughout the unit
raw materials (cardboard, construction paper, markers, crayons, glue, etc.) for projects
chalkboard and chalk

Advanced Preparation

Arrange the students into cooperative groups.

Procedure

Tap Prior Knowledge

1. Tell the students "We know what happens when water evaporates and condenses. It makes a cloud up in the sky." Stimulate their memories from the previous lessons. Ask "What happens then?" Their replies may range from simple to complex, but water droplets become large and fall to the ground. Introduce the word 'precipitation'.

Share with Neighbor

2. In their journals, let them write down as many ways as they can in which this might happen. Have them brainstorm individually or in groups. Compare them with each other when they are finished. Include rain, snow, sleet and hail as forms of precipitation. "What are some of the atmospheric conditions which lead to these differences?" Record on a chart, or on the chalkboard, the factors that influence weather. Mention to the students that lake effect snow happens more in Michigan and Indiana than it does here in Chicago. Why is that? Because the winter wind usually blows from the northwest, it picks up moisture as it crosses the lake and dumps snow on the eastern shore. In a typical winter, the eastern shore gets 60 to 200 percent more snow than the western shore.

Hands-on Activity/Introduce Scientific Principle

3. Show the students the Water Cycle Game. Tell them "In this game, you will be water droplets and you will move through the water cycle yourselves. You will take turns rolling the die and following the instructions on the spaces. Each water droplet is going to try to get fifty points. You can answer the questions on the cards to earn extra turns, while you gain your points for making good weather or for doing good water deeds and lose points for making bad weather. The rules are printed here. Take a minute later in the day to read them over. I will leave the game here in our room for us to use. I invite you and your friends to play quietly at the corner table whenever you have some extra time."

Connect to Other Everyday Examples

4. Now engage the students in discussion. Ask "What is our weather like most of the time?" Get some answers from the students. They mentioned some types of precipitation before. Direct their attention to what we usually experience during our seasons. Ask "Has anyone ever lived somewhere else?" Some places are dry, some are hot, some are rather wet, etc. "Think about Gilligan's Island or The North Pole." Use other examples they might know easily.

5. Once they see the differences, tell them "The overall pattern of weather in a particular place has a name. We call it a climate." Write this word on the chalkboard. "Can you think of ways, any ways, where a climate might affect the way you live? How would you come to school? Would you walk, wait for a bus? What would you eat?" Take a while to let them discuss how weather affects our lifestyles. Places too cold or dry to grow certain crops can obtain food from places with more suitable climates. Much of the food eaten by Americans comes from other parts of

the country and other places in the world. It is important for them to see the reasons why some cultures dress, eat, and behave differently from what they are used to. Following the discussion, have them list in their journals one novel example each of another culture's clothing choices, food choices, and behavior which directly relate to climate. For example, people in hot climates sometimes wear many layers of clothing because layers keep them cool.

6. Introduce the guest speaker. "A meteorologist is a person who studies the weather. I am sure you have seen weather reports on television news programs. We even looked at some reports in the newspapers here in class. Remember? Well, today (insert name here) will tell us about this fascinating job. You should listen closely now and give your best attention and you will find out how the weather is monitored daily and how we can know what the weather may be in the future."

Part 2 (if you are doing the lesson in two sessions)
7. When the presentation is over, ask the students "What tools do we now have for monitoring the weather?" They should have no trouble remembering since these tools are concrete and are located around the room. We have made an instrument for measuring air pressure (barometer) and there is an instrument for measuring temperature outside the window (thermometer). We have the Beaufort Scale for measuring wind force, our cloud recording charts for noting cloud formations and our lists of the types of precipitation which we can observe with our eyes."

8. Now instruct them to put it all together in a weather station. Have them work together in groups of three. Each person is responsible for contributing something to the group, but each group only needs to use one instrument or scale of each type so they will have to collectively decide what to include.

Summary/Background for Activity
The first two important processes involved in the water cycle, evaporation and condensation, are explained in more detail in previous lessons, in the development of cloud formations. Precipitation is the final process.

Water in the atmosphere is returned to earth in a variety of ways. Some of it leaves the atmosphere as a result of condensing on the earth's surface. Much of it leaves by first condensing in the atmosphere and then falling to earth as precipitation. Both processes play central roles in the water cycle and nourish the earth with water.

The water that we use today has been around since ancient times, recycled again and again through the water cycle. The water used to wash your face this morning could have been part of a cloud floating over South America last week. Our water is constantly recycled, and cleansed, as it changes forms from a liquid to a gas and back to a liquid through the phases of the water cycle.

Home Activity/Parent Involvement
Invite parents to come into the classroom for the daily weather report on the weather station.

Lesson Assessment
Each student will be playing the Water Cycle Game to review the material during their leisure time. The students grasp of the material can be evaluated by observing them answer the questions contained in the game.

Following a discussion of climate, each student will demonstrate an understanding of how climate and topography affect the way people live.

The weather stations which the students develop will be evaluated in two ways. Individually, each student will construct the weather instruments and scales throughout the week and their knowledge/understanding of these tools can be judged informally by circulating about the room and asking for verbal explanations. Collectively, each group will put these elements together in their final products. Evaluations should be based not only on content, but also on aesthetic arrangement, quality of motor skills, and students' ethical use of every group member's input instead of relying on one person's work.

Sample Assessment Rubric
CPS Outcome: Demonstrate an understanding of how climate and topography affect the way people live.

Criterion: clothing

In a journal entry, the student:

	1	2	3
Indicators:	does not offer an example of clothing and its relation to climate	offers an example of clothing and its relation to climate, but it is not novel	offers a novel example of clothing and its relation to climate

Criterion: food

In a journal entry, the student:

	1	2	3
Indicators:	does not offer an example of food and its relation to climate	offers an example of food and its relation to climate, but it is not novel	offers a novel example of food and its relation to climate

Criterion: behavior

In a journal entry, the student:

	1	2	3
Indicators:	does not offer an example of behavior and its relation to climate	offers an example of behavior and its relation to climate, but it is not novel	offers a novel example of behavior and its relation to climate

Extension Activities

Books to Read

Emmons' Deighton K., Jr. 1988. *Weather Forecasting: Teacher's Guide*. Delta Education, Inc.

Graf, Mike. 1989. *The Weather Report*. Fearon Teacher Aids.

Geer, Ira W., Director. 1987. *The Everyday Weather Project*. State University of New York College at Brockport. The Research Foundation of State University of New York.

Additional Activities

Use The Weather Underground, a system of software, curriculum development, teacher training, technical support, and networking to create a network linking the atmospheric science community with pre-college age school children and their teachers. Contact Perry Samson, University of Michigan, Ann Arbor, MI 48109-2143 or e-mail samson@umich.edu for details.

Additional Community Resource Excursions

Take a trip to the Chicago Academy of Sciences. The museum is opening a new Weather Laboratory, an interactive lab for the exploration of weather and weather phenomena. Plans are to open the lab in January 1997.

TIMEOUT

Current Event Science Connection: Acid Rain

Acid rain is a serious problem in some parts of the world. Sulfur and nitrogen oxides, released by coal-burning power plants or motor vehicles, are put into the atmosphere every day. These pollutants combine with water vapor in the air to make sulfuric nitric acid. They return to earth as acid rain or acid snow.

pH is a measure of the acidity of a substance. It is actually a measure of the hydrogen ion concentration (H+). Almost every biological process is pH dependent, so that a small change in pH will result in a large change in the rate of the process. Most organisms cannot tolerate changes in pH outside their optimum range.

Acid precipitation lowers the pH of surface waters and destroys plant and animal life in streams and ponds. It also damages buildings, especially those made of a basic substance like limestone. Water Tower, downtown in Chicago, is an example of a building affected by acid precipitation. A change in pH also influences the solubility of metals, and metals, once dissolved, will often get into the gills of fish.

Ask students to think about: "How would driving less help?" Cars give out 34% of the nitrogen oxides. "How would electricity conservation help?" Electric utilities put out 65% of the sulfur oxide emissions. What else can we do?

Water Cycle Game
Instructions

For 2, 3, or 4 players

Materials

game board, 20 question cards, 4 water droplet playing pieces, 1 die, paper and pencil for adding up points

Object of the Game

Be the first water droplet to earn 50 points by going around the board adding and subtracting points to your score.

How to Set Up

Shuffle the question cards and place them on the marked square on the game board. Choose a playing piece of a certain color; these pieces represent water droplets. Roll the die to see who goes first-- the lowest roll begins, then players take turns to the left.

Playing the Game

Begin on START. Roll the die and move the number of spaces shown on the die.

Follow the arrows always. When you come to a ↑ or ⟶ space, you can decide which way to go. You must land on all the other spaces in order to do what they say to do.

Special spaces:

1. GOOD WEATHER - When you land on a good weather space, you are rewarded with 5 points. Add them to your score.

2. BAD WEATHER - When you land on a bad weather space, you must subtract 5 points from your score.

3. ★ PICK A CARD - The spaces allow you a chance to continue your turn by answering a weather question correctly. Have another player ask you the question. If it is answered correctly, you go again. If not, your turn ends, and the next player rolls the die.

4. ⑩ GOOD DEED SPACES - As a water droplet, you have done many good deeds. Each time you land on one of these spaces, add 10 points to your score.

5. MOVE AHEAD, GO BACK, LOSE 1 TURN - If you land on a space which says to move ahead or to go back a certain number of spaces, do it, then do whatever that space says to do. If the space says to lose 1 turn or wait here, your turn ends, and you don't take the next one.

When a water droplet gets 50 points, the game ends.

Have fun!

Water Cycle Game
Sample Questions for Cards

How does temperature affect air masses? (warm air rises cool air moves down)

What provides the energy that keeps the weather changing? (the sun)

Explain the basic cause of wind.

What are three properties of air? (air takes up space, has weight, and exerts pressure)

Which heats up faster-- water or land? (land)

Name the three main processes in the water cycle. (evaporation, condensation, and precipitation)

True or false: clouds are made up of water vapor in the sky. (false: the water vapor has condensed and is in its liquid state)

Name at least two ways water is returned to the earth. (dew, snow, rain, etc.)

Can air be weighed? (yes)

What does a barometer measure? (air pressure)

Give an example of a common weather folklore.

Winds are classified according to what observational scale? (Beaufort Scale)

Describe condensation.

Describe evaporation.

How much of the earth's surface is covered by oceans, lakes, and streams? (80%)

What does a meteorologist do?

Fog is made up of what type of cloud?

Draw the symbol for cirrus clouds.

Describe a cumulus cloud.

Give at least 2 examples of how climate affects behavior.

Give at least 2 examples of how climate affects food.

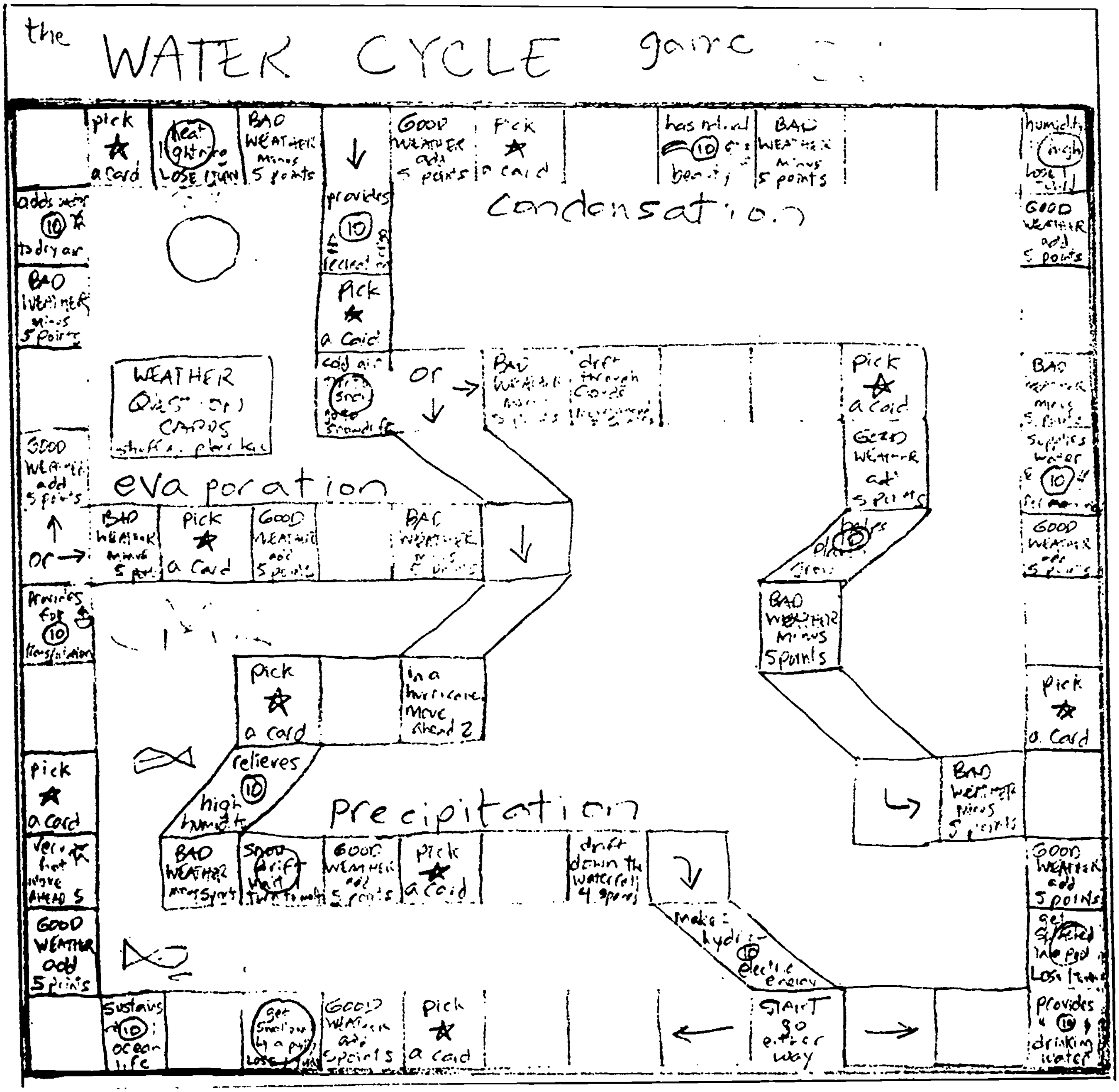
Give at least 2 examples of how climate affects clothing.

Discuss the problem of acid rain.

Discuss the greenhouse effect.

Would you expect more clouds on a winter day or a summer day? Why?

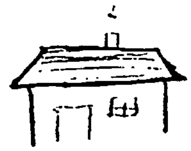
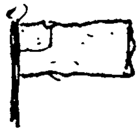
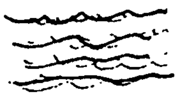
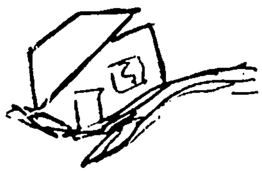
Water Cycle Game
Sample Game Board



Student Data Sheet Masters

Up, Down, and Around in Chicago
Student Data Sheet Master 2.1

Beaufort Scale

CALM	0		smoke rises straight up. less than 1 mile per hour.
LIGHT AIR	1		smoke drifts; weather vanes still. 1-3 miles per hour.
SLIGHT BREEZE	2		leaves rustle and weather vanes move. 4-7 miles per hour.
GENTLE BREEZE	3		leaves and small twigs in constant motion; light flag extended. 8-12 miles per hour.
MODERATE BREEZE	4		dust, dry leaves, loose papers raised; small branches move. 13-18 miles per hour.
FRESH BREEZE	5		small trees in leaf start to sway; crested wavelets form on inland waters. 19-24 miles per hour.
STRONG BREEZE	6		large branches in motion; umbrellas hard to hold; telephone wires whistle. 25-31 miles per hour.
MODERATE GALE	7		whole trees in motion; walking against the wind difficult. 32-38 miles per hour.
FRESH GALE	8		twigs break off the trees. 39-46 miles per hour.
STRONG GALE	9		slight building damage. 47-54 miles per hour.
WHOLE GALE	10		seldom happens inland; trees uprooted; much damage. 55-63 miles per hour.
STORM	11		very rare; much general damage. 64-72 miles per hour.
HURRICANE	12		anything over 73 miles per hour.

Please Return

Community Resource Curriculum Development

Evaluation Form

Name______________________________School______________________________

Address____

City______________________________State___________________Zip _________

Grade level(s) taught: ____

Subject area(s) taught: ____

Which unit/lesson(s) did you teach?

Describe the overall effectiveness of the activities:

Were the materials lists complete?

Did the lessons fulfill the stated objectives?

Were the directions/steps clear?

Were the Student Data Sheet Masters helpful for your students?

What activities did the students enjoy most? Least?

What suggestions do you have for the revision of the CRCDP curriculum?

Thank you for your help in evaluating our curriculum. We are planning to revise the materials for distribution to other teachers so your input is extremely valuable to us. Please return your evaluation to:

Community Resource Curriculum Development Project
The Chicago Academy of Sciences
2060 North Clark Street
Chicago, IL 60614