DOCUMENT RESUME

ED 393 707 SE 058 291

AUTHOR	Smith, Janice, Ed.
TITLE	Super Science Connections.
INSTITUTION	Wisconsin Univ., Madison. Inst. for Chemical Education.
SPONS AGENCY	National Science Foundation, Washington, DC. Directorate for Education and Human Resources.
REPORT NO	ICE-94-009
PUB DATE	95
NOTE	242p.
AVAILABLE FROM	Institute for Chemical Education, University of Wisconsin-Madison, Dept. of Chemistry, 1101 University Avenue, Madison, WI 53706.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC10 Plus Postage.
DESCRIPTORS	Elementary Education; *Elementary School Science; Hands on Science; *Integrated Curriculum; *Science Activities; Science Process Skills; Scientific Literacy

ABSTRACT

This manual was developed to help K-3 teachers incorporate science and science activities as an integral part of their curricula. It integrates hands-on science activities with other curricular areas, particularly the language arts. The activities include science background information, science process skills, classroom management suggestions, extensions of the original activity, and connections to other relevant areas. The activities in this manual are correlated to specific benchmarks in "Benchmarks for Science Literacy." Topics covered include: color and light, insulation, pressure, surface tension, water and changing its state, and making connections. A bibliography, list of resources for science teachers, and list of suppliers for materials recommended are also included. (JRH)

Super Science Connections

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ICE Publication 94-009

ICE is funded primarily by the National Science Foundation, Directorate for Education and Human Resources. Materials distributed and views expressed are those of ICE and do not necessarily reflect the opinions or policies of NSF.

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Preface

The Institute for Chemical Education (ICE) has a major publications program to accompany its many workshops for pre-college teachers. This book, intended for K–3 teachers, has arisen naturally out of planning for workshops we call Super Science Connections. These workshops provide materials and training to help K–3 teachers incorporate science and science activities as an integral part of their curricula.

The Super Science Connections (SSC) program has resulted from efforts of a variety of individuals. Ronald Perkins, Assistant Director of ICE, had been interested for some time in creating a new program that would allow early elementary teachers to make effective use of the many activities that had been developed in ICE workshops for high school and middle school teachers and published by ICE in *Fun with Chemistry: A Guidebook of K–12 Activities, Volumes 1 and 2*, compiled and edited by Mickey and Jerry Sarquis. In 1991 Janice Smith applied to become an ICE Fellow to develop science materials that would be integrated with reading and math for early elementary grades. Her interest clearly matched Ron Perkins' idea, and she was appointed an ICE Fellow for the summer of 1992.

In order to have a program that would be easily incorporated into K–3 classrooms, we needed input from K–3 teachers who really know what will and will not work. ICE was very fortunate to be able to put together an SSC Board consisting of award-winning teachers whose enthusiasm for science was boundless and who were willing to work on this project without full compensation for their efforts. Celeste Bunting, Carol Colegate, Patricia McKean, Karen Perkins, and Linda Pils came to UW–Madison in July 1992 to meet with Ron Perkins, Janice Smith, Natasha Aristov, Glen Dirreen, and me. That meeting began a process of hard work and long hours for everyone concerned that has culminated in SSC workshops held at Sacred Heart University and UW–Madison, as well as this publication. Janice has detailed the contributions everyone has made to this publication in her introduction on page xvi, and so I will not repeat them here. Suffice it to say that a great deal of effort has gone into this publication and the accompanying workshop program.

I think I can speak for everyone involved when I say that the results have been well worth the effort. I hope that you, the reader, will agree. I also hope that you will pass along any suggestions you may have for ways that we could improve this program. You are invited to correspond with me at the address on the back cover.

John W. Moore, Director

June 1995

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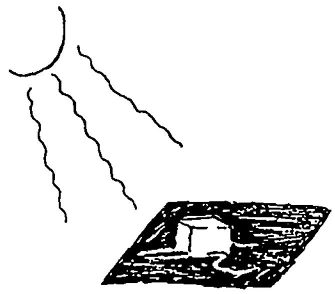
ICE,



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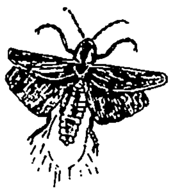

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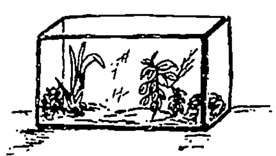

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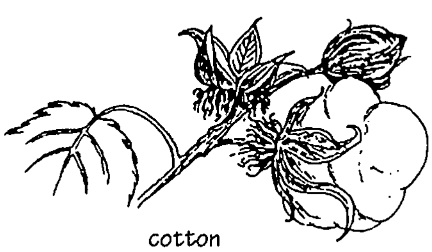

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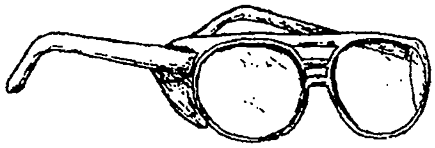


A Note about Safety

The measure of appropriate safety precautions is what would a reasonable person have done in the situation. We have taken a cautious, conservative view of "reasonableness" in the activities in SSC. We have included only those chemicals and procedures that we do in our own classrooms with confidence that we are not risking the safety of any of the students. The proper safety action if something is splashed into the eye is to wash the eye out with water for five or ten minutes. We are not recommending safety glasses for all of the activities, unless local policies require it. While one of the experiments uses vinegar, no family requires its children to wear safety glasses while using Italian salad dressing! We have not included reactions with ammonia at this age level, however, because a reasonable person would not have a child of this age using ammonia.

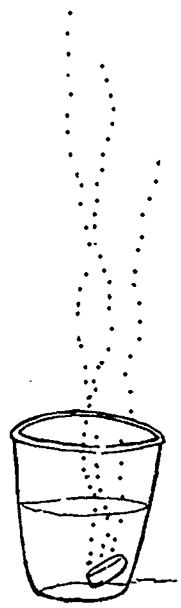
There are two activities where we suggest eye protection. One is "Seltzer Surprise" where the top of a film canister pops off, and there is a chance that the top could hit a student directly in the eye, if the student did not follow the directions to stand back. Try this experiment yourself to get an idea of the force of the reaction. The other experiment where we suggest eye protection is "Fabulous Fancy Fabric". This is because we are using plastic pipets which are similar to medicine droppers containing rubbing alcohol. These pipets are a great way to deliver small quantities of liquid to one spot. They can also be used as squirt guns, either accidentally or because one of your students just couldn't resist the temptation!

You will want to check with your local school district about specific regulations. Some require safety glasses for any science work. There are usually two justifications for this. One is that the district is responding to any potential liability by exercising extreme caution. The other is that wearing safety glasses is a way to model behavior that highlights that safety is an important consideration in a laboratory situation. That is, it doesn't matter what chemicals are being used, the goal is to reinforce that safety glasses should be worn in a science laboratory.

There are many sources of safety glasses. Two suppliers that have a smaller size for children are Laboratory Safety Supply, Catalog # VA-10035 and Delta, Catalog # 53-190-0030.

The Flinn Scientific Company catalog is a good reference for safety (1-800-452-1261). Also the National Science Teachers Association (1-800-722-NSTA) publishes a flipchart called "Safety in the Elementary Science Classroom" (~ $5.95, PBC30x) and we recommend this for your reference.

Introduction



Super Science Connections integrates hands-on science activities with other curricular areas, particularly the language arts. It is written for teachers of children in grades K–3. It encourages the kind of classroom where the teacher isn't sure how many hours in a day or week are spent on science, because the science is integrated and flows naturally with the other events throughout the day. The activities include science background information, science process skills, classroom management suggestions, extensions of the original activity, and connections to other relevant areas.

If this SSC publication meets its objectives, you will use it to begin wherever you are in your attitude and commitment to hands-on science in your elementary classroom and move in the direction of

- doing more science,
- emphasizing process skills as well as science content,
- including physical science as well as the life sciences, and
- connecting in context to other curriculum areas.

Super Science Connections activities are designed to help children develop science literacy as described in *Benchmarks for Science Literacy*. This book is a compilation of specific science literacy goals by grade level from the American Association of the Advancement of Science. The book emphasizes that "...when the benchmarks specify that 'Students should be able to do...' something, we take that to mean they will in fact do so when appropriate circumstances present themselves." (*Benchmarks*. 1993, p 28). That is, to be scientifically literate, students must learn both content knowledge and process skills. In addition, both the content and the process must be learned in context so that connections can be made appropriately. We have correlated the activities in *SSC* to the specific benchmarks in *Benchmarks for Science Literacy*. General benchmarks that relate to the nature of science and science process skills are listed in Benchmarks, at the end of this book. Specific science content benchmarks are included at the start of each unit. Consult the Contents.

In *Super Science Connections*, children do science. We quote Jeff G. Brodie, a fifth and sixth grade teacher at East Side Elementary in Edinburgh, IN

> Vocational education has always understood that if you want someone to learn to repair an automobile, you need an automobile to repair. If you want to teach someone to cook, you put them in a kitchen. Whoever heard of teaching someone to swim in a traditional classroom? Likewise, I do believe that we are learning that in order to truly teach science, we must 'do' science. (Haury and Rillero, 1992)

Celeste Bunting, a first grade teacher and SSC Board member, writes

> A hands-on approach to science in the classroom is the best way for students to learn. It is also one of the best ways to get children to love science and pursue further study in this area. Children who learn by doing and by being given the chance to actually experience the how and why behind a scientific principle will make it become a part of them. William James said 'People can alter their lives by altering their attitudes', and if we can alter our students' attitudes about learning science, they will begin to think of themselves as scientists as they explore the world around them.

For example, throughout the year, the teacher assigns one student at a time to bring in a mystery object in a bag and to write five clues about it. (A student page for this example follows this introduction.) The class responds by predicting what the object inside might be, using the five clues to draw a picture of what they think is in the bag. A poem that you might want to integrate with this activity is "What's in the Sack" from *Where the Sidewalk Ends* by Shel Silverstein.

See page xvii.

As another specific example, develop a collection of buttons or buy some from Cuisenaire Company. Read *The Button Box* by Margarette S. Reid. Have students work in groups of four. Two of the students in the group choose a rule to use to classify the buttons and then divide the buttons into piles based on the rule. They do not tell the other two students what rule was used. Now the other two students work together to determine what rule was used to classify the buttons. This activity is easily adapted to the ability of the children depending on the number of criteria in the rule (color, size, number of holes, flat or rounded, etc.). Follow the discussion by writing about or drawing pictures of these buttons. (A student page for this example follows this introduction.)

See page xix.

See page xxi.

A third activity that emphasizes a science process skill is "Classifying Cards" in the Introduction, where students use a microviewer (x30 magnification) to identify a substance. (The complete unit, including student page, follows this introduction.)

These three activities will help to meet the following objectives of *Benchmarks for Science Literacy:*

- The Physical Setting benchmark of "by the end of 2nd grade, students should know that...
...objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (color, size, shape, weight, texture, flexibility, etc.)." (*Benchmarks.* 1993, p 76)

- The Habits of Mind benchmarks of "by the end of 2nd grade, students should be able to...
...describe and compare things in terms of number, shape, texture, size, weight, color, and motion. Draw pictures that correctly portray at least some features of the thing being described." (*Benchmarks.* 1993, p 296)

What if I don't have time or money?

Those of us involved with the *Super Science Connections* project are aware that teachers new to teaching science in a hands-on integrated way may feel that they do not have enough time, enough science background, or enough money. You can do the activities in this book with a little time, as much science background as you have, and with very little money!

The *Super Science Connections* Board members are classroom teachers themselves and understand that you do not have the time to spend an hour each morning preparing for an activity, an hour the night before gathering the materials, and an hour reorganizing and cleaning afterwards. As one of the participants in Carol Colegate's workshop wrote "these are teachers who really teach in the real world and know what we face everyday." The activities are easy to prepare, and use readily available materials. No treasure hunts; you don't need to know your local chemist—or even your high school science teachers! (A local science person can be a great resource, however.)

Little money is the reality in many school districts. For example, a first grade teacher in rural Pennsylvania told me that her school "had less than $50 to improve the science center K-6th grade this year." At a workshop in Connecticut I suggested a weekly letter home to the parents, and one of the teachers said that she would never be allowed to use so much paper! We are therefore acutely and painfully aware of the need to keep SSC materials at a cost that is minimal. No elementary science happens if the teacher is limited to just reading the catalog and wishing that he/she could buy the stuff! It is part of the mission of ICE to make quality materials for teaching of science available at low cost, and the activities in this book are faithful to that mission.

What if I don't know much about science?

Elementary teachers often perceive themselves as "not knowing enough" about the subject matter. This is particularly true of the physical sciences. We have provided science background information for you with the activities. Nevertheless, it is OK not to know the answer to a student's question! Actually, you can be an important role model illustrating how scientists experiment and explore to find out the answer to a question. All you have to say is "I don't know. How can we find out about this?" That is about the best definition of research that there is! SSC Board member Karen Perkins writes

> Once the teacher has become convinced that he/she doesn't have to know ALL the answers and can learn along with the children, teaching science in the primary grades can be an exciting and rewarding experience.

Science background information is included with each activity. It provides the teacher with background and is NOT intended to be science content taught to the student. Some of the activities have science content that is developmentally appropriate for grades K-3. Others are interesting and motivating activities that teach about being a scientist. As Laura Huber (an elementary school teacher and science coordinator who reviewed this book) writes, "Science education should be about teaching the kids how to be a scientist first and about science content second."

In judging what is appropriate science content for the elementary grades, *Super Science Connections* supports the view that "the 'what' of science is as interesting as the 'why' " (Gabel, 1989). Elementary science should provide a variety of concrete, hands-on experiences; focus on things from nature that can be observed; and emphasize the science process skills. Science taught in this way will build a basis of experiences and thinking skills that can be used with older children to begin to answer the 'why' questions.

As you begin to develop your own science units that connect with other curricular areas, I recommend the following:

• Each year the March issue of *Science and Children* (National Science Teachers Association) has a list of Outstanding Science Trade Books for Children.

• The Children's Cooperative Book Center (University of Wisconsin-Madison) publishes *CCBC Choices* each year. CCBC is a book examination center and research library that receives and reviews copies of almost all trade and alternative press books published in English in the US for children and young adults.

I would also encourage you to share what you have learned about the effectiveness of this kind of teaching and learning with other teachers. Pat McKean, an elementary science teacher and mentor as well as an SSC Board member) shares this definition of teaching: "a series of decisions that are made to increase the learning of a child." My efforts will be well rewarded if this publication helps you to make those decisions and, therefore, increase the learning of the children in your classroom.

Send me your comments and reactions and ideas. Perhaps there will be a *Super Science Connections II!*

Janice E. Smith
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York, PA 17405-7199
email: jsmith@yorkcol.edu; phone: 717-846-7788 ext. 1302

References

Benchmarks for Science Literacy. Project 2061. American Association for the Advancement of Science. 1993.

Gabel, Dorothy L. "Let Us Go Back to Nature Study." *Journal of Chemical Education*. 1989, 66 (9), pp 727–729.

Haury, David L. and Rillero, Peter. "Hands-on Approaches to Science Teaching, Questions and Answers from the Field and Research". ERIC Clearinghouse for Science, Mathematics, and Environmental Education, #ED349185. Ohio State University. 1992.

Reid, Margarette S. The Button Box. Dutton Children's Books. 1990. ISBN #0-525-44590-0

Silverstein, Shel, "What's in the Sack" from *Where the Sidewalk Ends*. Harper Collins Childrens Books. 1974. ISBN #0-06-025667-2.

Credits

Celeste Bunting, Carol Colegate, Karen Perkins, and Pat McKean have served on the ICE K-3 Advisory Board since it began in the summer of 1992. They are really the authors of this book in the sense that I put their expertise on paper.

John Moore, the director of ICE, has made it possible for us to collaborate as teachers and scientists, to meet and plan the *Super Science Connections* project, and to write these activities. Ron Perkins, the assistant director at ICE, helped to shape the vision.

Cynthia Dawes Smith in York, PA provided the art work. She says she learned science as she read the units and sometimes just had to stop drawing and actually do the activity to see what happened!

Margie Zimmerman joined us in the summer of 1994 and added the curriculum development expertise.

Laura Huber (an elementary school science coordinator and graduate student in Curriculum and Instruction) reviewed the draft for appropriateness of science content and concepts to the grade levels (K–3) of our audience, and I have incorporated many of her suggestions into this improved version.

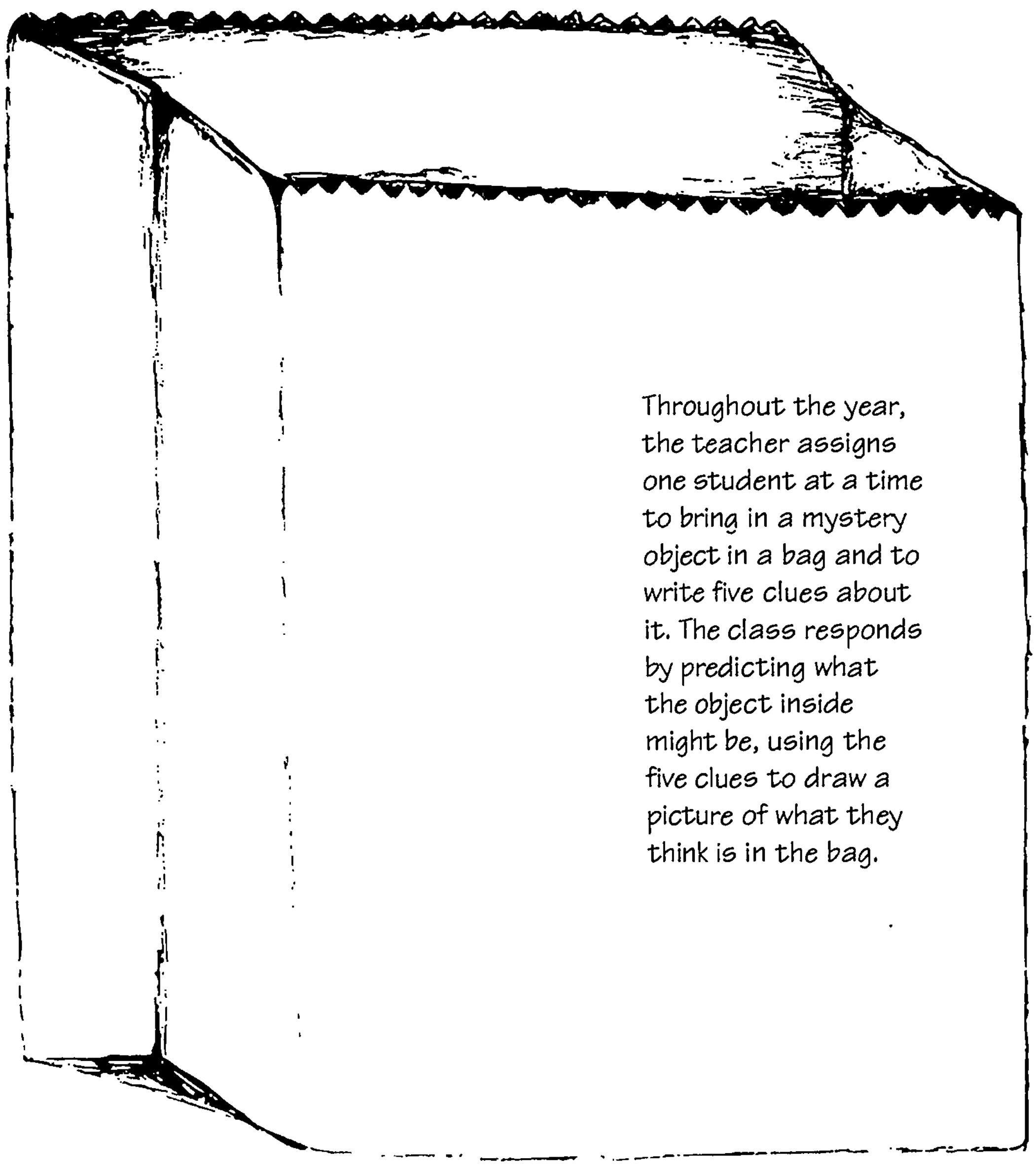
Jeanne Hamers reviewed the draft for scientific accuracy and clarity of explanations of the science concepts. She also checked the directions for carrying out each activity. I have incorporated many of her suggestions into this final draft.

Betty Moore at ICE headquarters in Madison put all the pieces together—the art, the text, and the graphic style. It is amazing what can happen to a text file in her expert hands!

The following persons participated in the reviewing or development of this book or portions of it and I appreciate the expertise that each of them shared: Linda Pils, Rosemarie Kaminski Rung, Lynn Toft, Kim Sterner, Marie Dunstan. Gregory Fuchs did the computer drawings and also scanned, enhanced, translated, distilled, and generally kept track of all of the artist's sketches with the result that they appear to have been drawn on the printed page. Bill Tallon participated in the field testing of the first draft of the book.

Finally, thanks to my family, Greg, Jennifer, and Jeremy, who have made their summer vacations whatever they could do within driving distance of Madison while I worked on this project.

What's in the Bag?



Throughout the year, the teacher assigns one student at a time to bring in a mystery object in a bag and to write five clues about it. The class responds by predicting what the object inside might be, using the five clues to draw a picture of what they think is in the bag.

Directions to students and parents:

____ 1. Put your name on the bag. Place a small common object inside this bag. Fold down the top of the bag.

____ 2. On the form below, write or draw 3 to 5 descriptive clues about the object. Use as many of your senses as you can.

____ 3. Bring the bag with the completed form to school the next morning.

BE SURE TO KEEP THE OBJECT A SECRET!
Do NOT tell even your best friend!

At school we will try to guess what is inside the bag.

The object will be returned to you.

My name is: ______________________

Clues:

1.____________________________________

2.____________________________________

3.____________________________________

4.____________________________________

5.____________________________________

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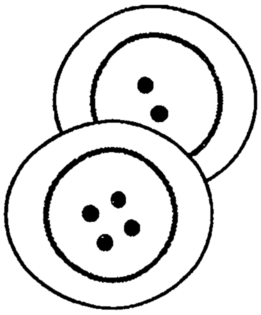
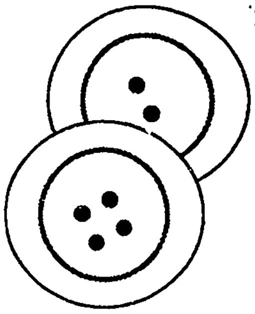


Buttons

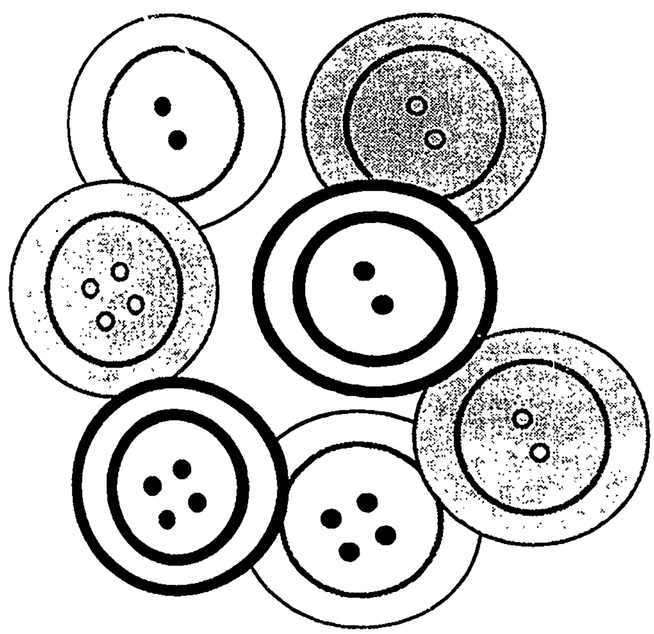
Directions to students and parents:

Develop a collection of buttons or buy some from Cuisenaire Company. Read *The Button Box* by Margarette S. Reid. Have students work in groups of four. Two of the students in the group choose a rule to use to classify the buttons and then divide the buttons into piles based on the rule. They do not tell the other two students what rule was used. Now the other two students work together to determine what rule was used to classify the buttons. This activity is easily adapted to the ability of the children depending on the number of criteria in the rule (color, size, number of holes, flat or rounded, etc.). Follow the discussion by writing about or drawing pictures of these buttons.

For younger students, make attribute cards for color, size, shape, texture, etc. Have one child select one of the attribute cards and then select the buttons that fit the attribute. The other children try to guess what attribute card was used. Attribute cards can be by word or by picture, depending on reading abilities.



Things we know about the group of buttons:



Names of the scientists:

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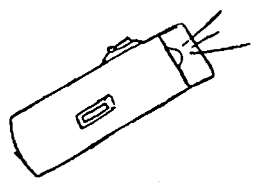
Classifying Cards



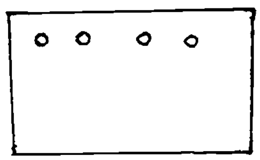
Can you identify the crystal?

Materials ✔ List	I NEED for my class:	I HAVE:
Microviewer* or pocket microscope	_____Microviewers	_____
"slide" or guide card of each substance (and classifying cards for students to identify)		
index card, 5 in. × 8 in. (13 cm × 20 cm.)	_____index cards	_____
clear tape	_____clear tape	_____
hole punch	_____hole punch	_____
black construction paper	_____sheets of black paper	_____
shaker containers of		
salt	_____salt shaker	_____
sugar	_____sugar shaker	_____
flour	_____flour shaker	_____
borax	_____borax shaker	_____
sand	_____sand shaker	_____
Epsom salts	_____Epsom salts	_____

*Available from: American Science & Surplus, Catalog # 23137, Delta, Catalog # 53-130-3280, or Edmund Scientific, Catalog # B35, 001.

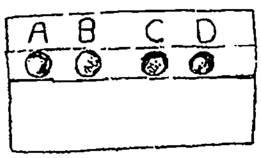
➲ SAFETY FIRST: Epsom salts and borax can cause illness if ingested. Emphasize to your students that materials used in activities should NOT be tasted. While tasting the sugur or salt won't harm them, they could easily mistake the harmful materials for those that can be eaten.

Directions for Making the Slides

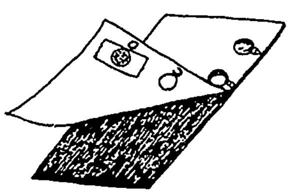


___ 1. Punch 3 or 4 holes in the 5 × 8 index card. Space them so that you can write the name of the substance next to the hole.

___ 2. Put clear tape on the back of one of the holes in the card. Sprinkle salt on the sticky side of the tape that is exposed through the hole in the card. Put another piece of tape on top of the hole in the card. Label as salt.



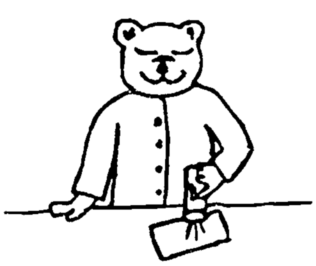
___ 3. Repeat with the other holes, replacing the salt with the other substances that are listed in the materials. There are six substances listed for you to choose three or four to put on the guide card. For this age level, we recommend no more than four substances.



___ 4. Tape or glue the card to a sheet of black construction paper.

___ 5. Punch 3 or 4 holes in each of the 5 × 8 index cards. Repeat step 2, but do not label the substance on the card. Instead, label as A, B, C, D. Make several of these and number as Card 1, 2, 3, etc.

Directions for Using the Slides and Microviewers



___ 1. The Microviewers require 2 size AA batteries. There is an off/on switch for the light and a knob that is used to focus. They magnify 30x.

___ 2. View each of the substances on the 5 × 8 card that is labeled. Put the microviewer directly on the object.

___ 3. Take one of the numbered classifying cards. View it. What substance is labeled A? Which one is B? etc.

Discussion

What are the shapes you see?

How are the substances different from each other?

ICE,

Connection

Read *Two Bad Ants* by Chris Van Allsburg.

References

The idea for classifying cards is from Carol Colegate and Karen Perkins, Personal communication.

Van Allsburg, Chris. *Two Bad Ants.* Houghton Mifflin. 1988. ISBN #0-395-48668-8

A looks like: ______________________________

B looks like: ______________________________

C looks like: ______________________________

D looks like: ______________________________

Names of the scientists: ______________________________

A looks like: ______________________________

B looks like: ______________________________

C looks like: ______________________________

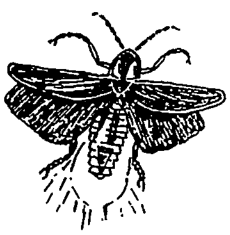
D looks like: ______________________________

Names of the scientists: ______________________________

Color and Light

Science Concepts

The activities in Color and Light include these science content concepts:



- Sunlight is made up of all the colors of the rainbow. The colors always appear in the same order when separated: red, orange, yellow, green, blue, indigo, and violet. We can separate sunlight into these colors in a variety of ways.
- Colors can be created from combinations of other colors.
- Combinations of different materials can be separated as they interact with other substances.

This content concept applies to the "Fly, Fly Butterfly" extension in this unit:

- Some animals have different stages and forms throughout their lifetime.

Benchmarks

These benchmarks from *Benchmarks for Science Literacy* apply to this unit:

Some events in nature have a repeating pattern...
Chapter 4: The Physical Setting
Section B: The Earth Grades K–2, page 67

Benchmarks, continued

People use their senses to find out about their surroundings and themselves. Different senses give different information. Sometimes a person can get different information about the same thing by moving closer to it or farther away from it.

Chapter 6: The Human Organism
Section D: Learning Grades K–2, page 140

The sun is the main source of energy for people and they use it in various ways...

Chapter 8: The Designed World
Section C: Energy Sources and Use Grades 3–5, page 193

Similar patterns may show up in many places in nature and in the things people make.

Chapter 9: The Mathematical World
Section: Symbolic Relationships Grades K–2, page 217

This benchmark from *Benchmarks for Science Literacy* applies to the extension "Fly, Fly Butterfly" in this unit:

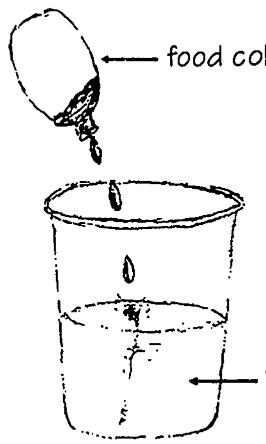
A lot can be learned about plants and animals by observing them closely, but care must be taken to know the needs of living things and how to provide for them in the classroom.

Chapter 1: The Nature of Science
Section C: The Scientific Enterprise Grades K–2, page 15

Topic: Color and Light

Is Black Really Black?

What is a way to make the color black?



Materials ✔ List	I HAVE:
one set of food coloring	____
one clear container	____
water	____

Directions

____ 1. Using suggestions from the students for the color and number of drops to use, add enough of the colors to make the color black. Count and record the number of drops of each color used.

____ 2. Repeat. Can you make black with a different combination of colors? Repeat as often as the class shows interest in exploring this question.

We suggest this as a whole class activity, not individual or student groups. Be sure to allow the students to make "mistakes" by adding too much of one color, etc.

Science Background

Many of the colors that we see are mixtures of two or more colors. The primary colors are red, yellow, and blue. Primary means that you can make all the other colors by mixing these three in some way. For instance, you can mix the red and yellow food colorings to get orange. The color black is made from a mixture of all colors. Your students may have discovered that there is more than one way to make black with the food coloring. Paints can be mixed in the same way to get different colors.

Mixing of light is different from mixing paints or dyes. For light, white is the combination of all colors. (See "Rainbows without Rain" in this unit for a way to separate white light into its colors.) When the light hits an object, it can be absorbed (taken in) or reflected (bounced back). If the object reflects all of the light, it looks white, like this page. The paper is reflecting all the light back to our eyes and not taking in (absorbing) any of the light. If the object absorbs all the light, it looks black, like the ink on this page.

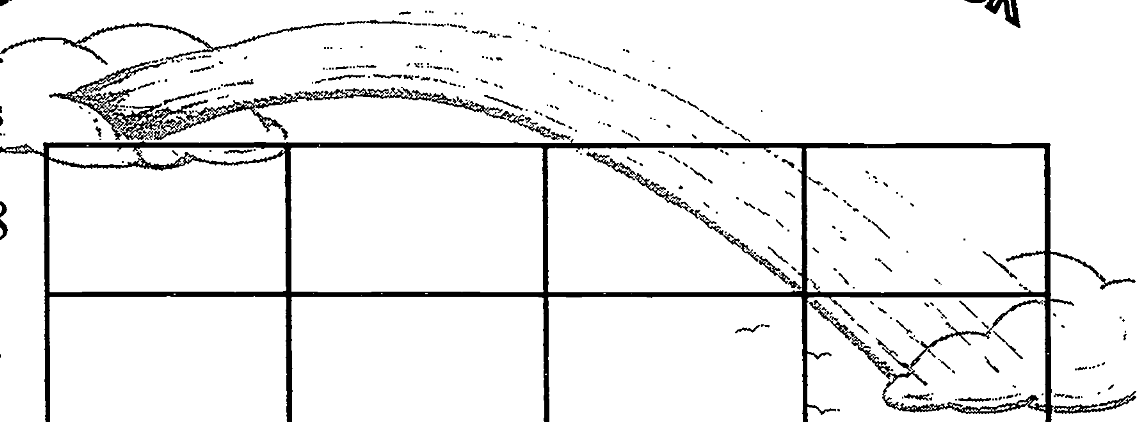
What about objects that have a color other than black or white? The color that we see depends on the color (or the wavelength) of light that reaches our eyes. We see the colors that are reflected (bounced back) by the object, and not the ones that are absorbed. A red apple looks red to us because red light is bounced back to our eyes and the other colors of light are absorbed by the apple.

Not all animals can see color. Humans can. So can some other primates, and some birds, fish, reptiles, and insects. Only some animals have eyes with the ability to interpret the different wavelengths of light into colors.

Connections

Make a bar **graph** titled "How we made the color black", using the worksheet on the next page. Use the number of drops of each color for the vertical axis and the colors for the horizontal axis. Younger students should color in one box when a drop of that color is placed in the cup. For non-readers, use a crayon or marker to color each of the color words on the worksheet with the appropriate color.

How we made the color black



Number of drops	Green	Blue	Red	Yellow
8				
7				
6				
5				
4				
3				
2				
1				

Names of the Scientists ______________________

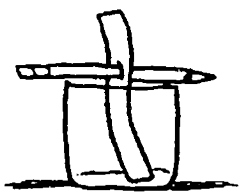
Topic: Color and Light

The Mystery Pen

How can you separate the mixture of inks in water soluble markers?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
5 or 6 coffee filters per group or absorbent paper towels (e.g. Bounty™)	_____ coffee filters or _____ paper towels	_____ _____
4 or 5 clear 12 or 16 oz. cups per group	_____ clear 12 or 16 oz. cups	_____
4 or 5 different brands of pens or markers—all black and all water soluble	_____ black water soluble pens or markers of DIFFERENT brands	_____
sharp pencil	_____ pencils	_____
water	_____ cups of water	_____
scissors	_____ scissors	_____

Directions



___ 1. Cut a 1 inch by 7 inch strip (2.5 cm × 17.8 cm) from the paper towels or coffee filters. The strips should be about 1 inch longer than the height of the cups.

___ 2. Put the strip in the cup, holding it so the bottom of the strip just touches the bottom of the cup. Poke the pencil through the strip, so the pencil will rest on top of the cup and the paper strip will hang in the cup, just touching the bottom.

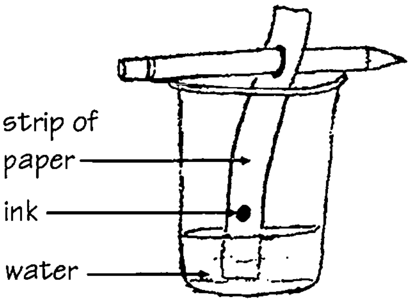
___ 3. Remove the strip from the cup. Put a spot of ink about 1/4 inch (0.6 cm) in diameter on the strip of paper about 1 inch (2.5 cm) from the bottom end.

Directions, continued

___ 4. Add enough water to the cup so that there is about 1/2 inch (1.25 cm) of water on the bottom.

___ 5. Place the strip in the cup with the pencil resting on the top of the cup. The spot of ink MUST be above the water level. If the water becomes colored because the spot of ink was too low, begin again.

___ 6. Observe the water level and the spot of ink. As the water moves up the strip, the ink separates into the colors that were used to make it.



___ 7. When the strip is wet all the way up to the pencil, remove it from the cup and allow it to dry.

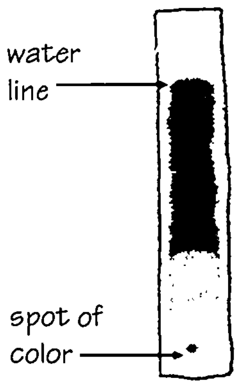
___ 8. Use one strip for each of the four or five pens that you choose to test. They must be water-soluble pens or markers.

___ 9. When the strips are dry, post them on a chart on the wall with the name of the pen next to the strip.

___ 10. Choose one of the pens you have on the chart. Tell the students it is a mystery pen. Do not tell them which one you have chosen.

___ 11. Separate the colors in the ink of that pen by the method described above. Ask the students to identify the mystery pen by comparing its color pattern to the chart on the wall.

Science Background



This method of separation is called chromatography. Scientists often use chromatography to separate mixtures of substances. Black ink contains a mixture of colored substances called pigments. In this activity, the filter paper and water are used to separate the pigments in the black ink. The water moves up the paper because of capillary action. As the water meets with the ink and moves up the paper, it brings the substances in the ink with it. Each different substance moves up the paper at a different speed. How fast each substance moves depends on its attraction to the water and to the paper. Those colors that are more attracted to the water than to the paper move up quickly. Those that are more attracted to the paper than the water move more slowly. The result is that the colored substances in the ink are separated.

Extensions

Use the same directions but **substitute colors** other than black. Try using several different colors. Some of the colors will be mixtures of several different colored inks. These will separate as the mixture interacts with water as described in the science background. Other colors in the marker set will consist of only one type of ink and these will not separate into bands of color.

Connections

Read *Hailstones and Halibut Bones* by Mary O'Neill.

Read *Rainbow Crow, a Lenape Tale* by Nancy Van Laan.

Read *Nate the Great* by Marjorie Weinman Sharmat. This is a mystery featuring Nate as a detective who helps people find things. In the story, Nate writes a note to his parents.

- ➢ Make a class list of the clues Nate used to solve the mystery in the story.
- ➢ Pretend you have a request for help from the principal. The principal has found a black marker in the book bag of a second grader and a note in black ink on a paper towel that says "School's Canceled!" on the office door. How could the class find out from the chromatography experiment if the ink came from the same type of pen? Could you prove the very same pen or just the same type? (The answer is that you could only find out the type or brand of ink—not a specific pen.) To find out, the class can do the experiment again with the "note and pen from the crime scene".
- ➢ As the teacher, choose to write the note with the same or a different pen as the one you give the class on a paper towel. Be sure that both are from water-soluble markers!
- ➢ Do the experiment again. For the note, cut out a piece of the note that has some of the writing near the bottom. For the pen, spot the ink on the strip of coffee filter.
- ➢ Compare. Is the ink from the same type of pen? **Write a letter** to the principal explaining how you solved the mystery.

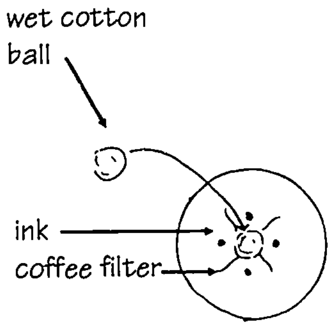
Connections, continued

➢ Discuss what other information the principal might need to know if the person who owned the book bag wrote the note. Some possibilities are:

Did anyone else take the book bag from the owner?
Does anyone else in the class have a pen of the same brand?
Do any of the teacners have a pen of the same brand?
Who was in the area of the office door?
About what time was the note posted?

More Connections

Make an **art project**—make a butterfly or flower or turkey or heart using the chromatography of the water soluble markers as described below.



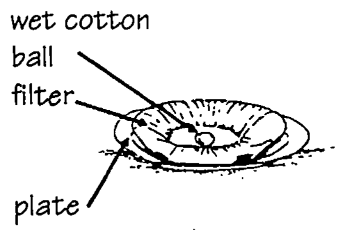
top view

___ 1. For each student you will need a Styrofoam plate or a "coated", water resistant plate, a cotton ball, and a coffee filter.

___ 2. Put a design with markers—dots, lines, etc., near the center of the coffee filter. The students can use any color of water-soluble markers for this.

___ 3. Place the coffee filter on the Styrofoam plate.

___ 4. Dip the cotton ball in water. Squeeze out most of the water. You will have to experiment a bit to get just enough water, and not too much water, on the cotton ball.



side view

___ 5. Touch the cotton ball to the center of the coffee filter. The water will spread out and separate the colors in the inks. If you have too much water, the colors will all gather at the edge of the filter.

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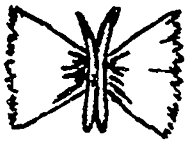
ICE,

More Connections, continued



Butterfly:

Pleat the filter paper when it is dry and put a clothespin in the center of it to make a butterfly. You may want to add eyes and/or a pipe cleaner antennae to the clothespin. Dabs of colored glue work well for adding details. You may want to glue a magnetic strip on the back and send the project home as a refrigerator magnet. You may also want to display the butterflies in the classroom as a mobile.

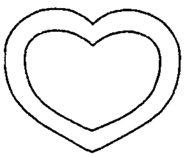
We suggest an extension about the life cycle of a butterfly. The information for this extension is included as "Fly, Fly Butterfly" in this unit.

Flower:

You can also make flowers by gathering the center of the filter paper together and adding a stem.

Turkey:

Use the pattern on the next page to make a turkey for a poster or card at Thanksgiving time.



Heart:

Cut out a frame of a heart from red paper. Trim the coffee filter as needed and glue it to the back of the heart.

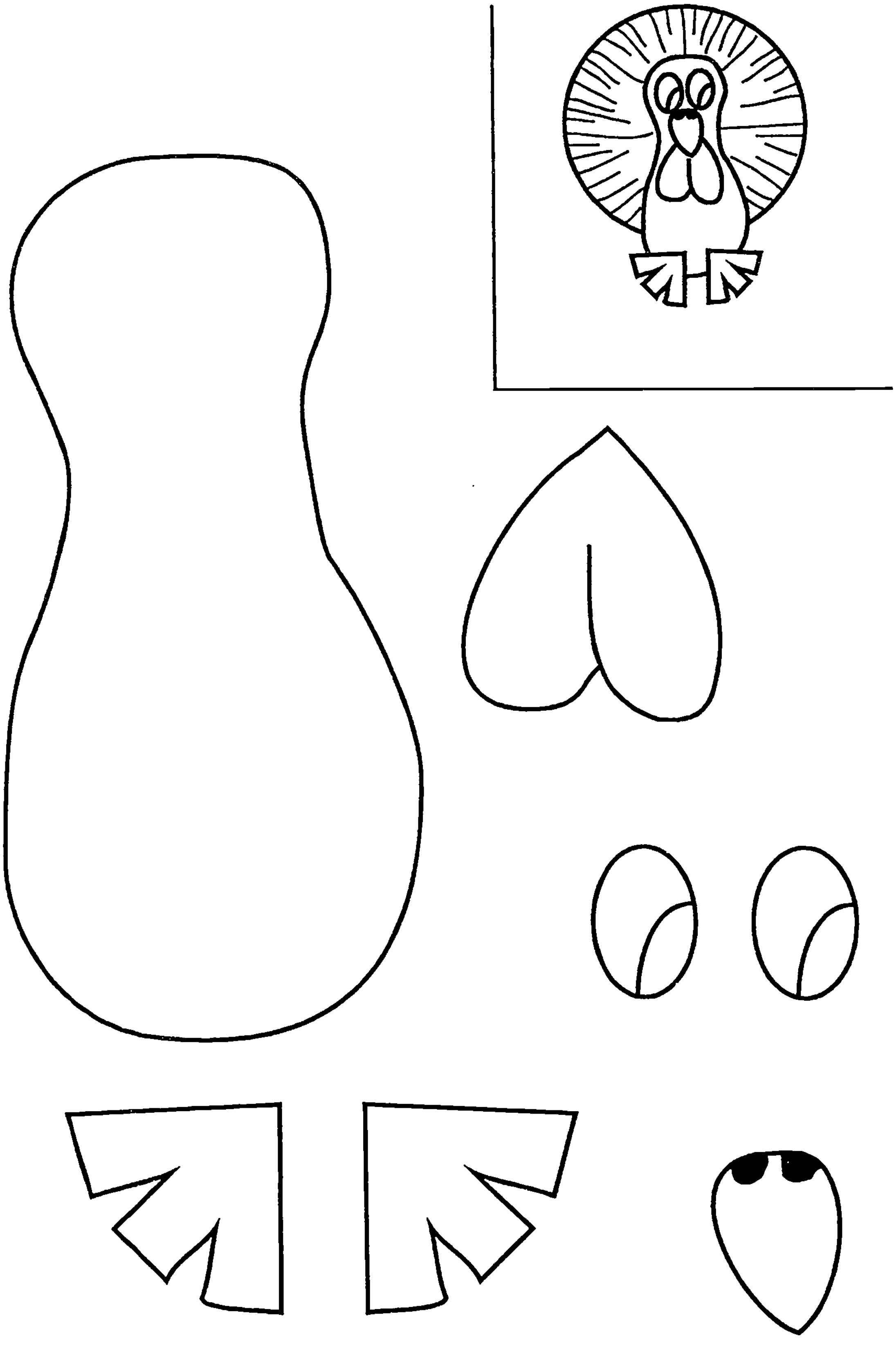
References

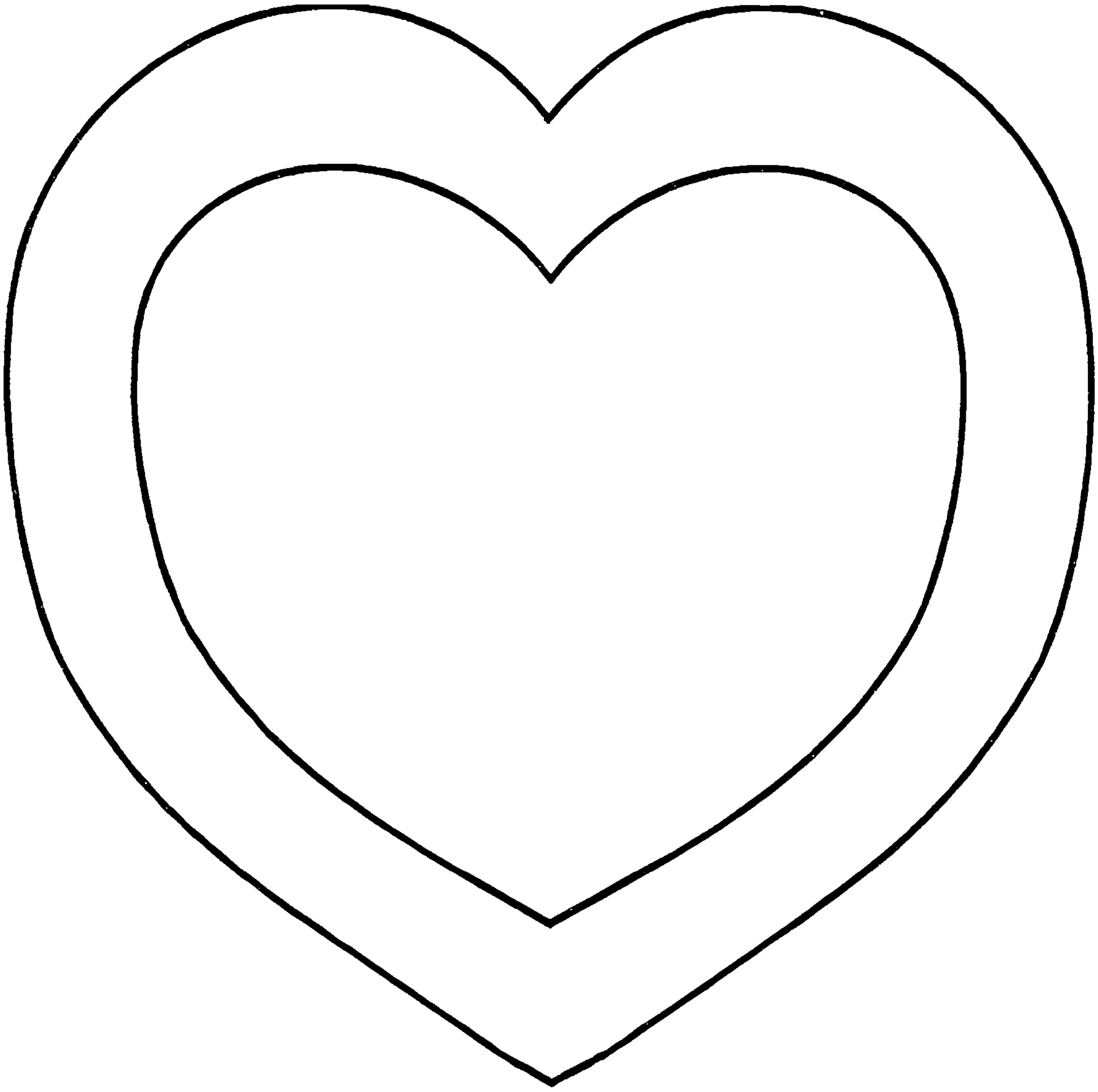
O'Neill, Mary. *Hailstones and Halibut Bones*. Doubleday Book for Young Readers. 1990. ISBN #0-385-41078-6

Sarquis, Mickey and Sarquis, Jerry. *Fun with Chemistry: A Guidebook of K-12 Activities*, Vol. 2, Activity #54, Institute for Chemical Education. University of Wisconsin-Madison, 1993.

Sharmat, Marjorie W. *Nate the Great*. Putman Publishing Group. 1986. ISBN #0-698-20627-4

Van Laan, Nancy. *Rainbow Crow, a Lenape Tale*. Knopf Books for Young Readers. 1989. ISBN #0-394-89577-0





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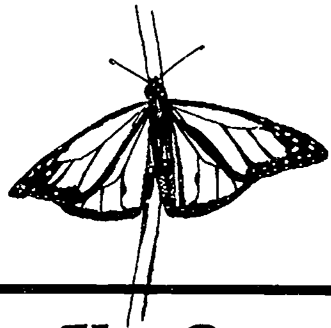
Topic: Color and Light



Extension: Fly, Fly Butterfly*

What is the Life Cycle of a Butterfly?

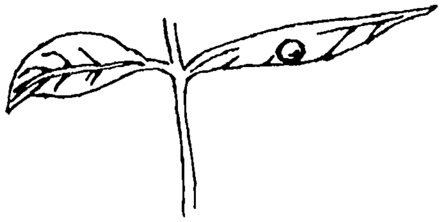
(*An extension of the Butterfly Art Project from the "Mystery Pen" Experiment)

Materials ✔ List (per student or group)	I HAVE:
caterpillar for monarch butterfly and milkweed plant*	______
books about butterflies (the reference section lists several that are recommended)	______
journal for daily observation—these can be notebooks or handmade from sheets of paper stapled into a construction paper cover	______

* Available from:
Biophilia, Randall Korb
For ~ $18 , a check or money order, Mr. Korb will ship throughout the continental U.S. from April through October.

Directions

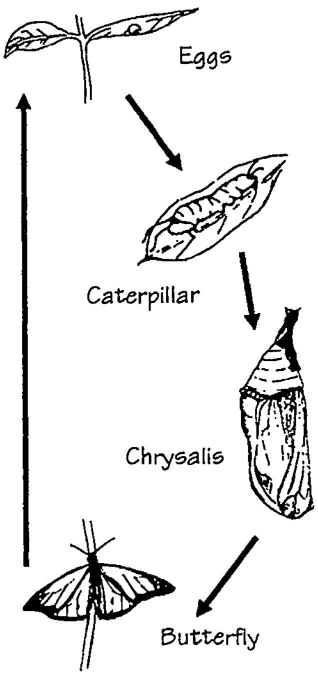
___ 1. Enjoy observing the chrysalis each day. Ask each student to keep a record of the observations each day in a journal. Be sure to release the butterfly outside!



Directions, continued

___ 2. If you have a microviewer, and a dead butterfly specimen, you can observe the tiny scales on the butterfly wings.

Science Background



Butterflies lay eggs to reproduce. The eggs hatch into caterpillars. Some kinds hatch in three days. Some take a year. The butterflies usually lay the eggs on leaves or stems that will be food to the caterpillar when the egg hatches. A caterpillar is called the larval stage of the life cycle. The caterpillar sheds its skin and grows a new one several times as it grows. Caterpillars eat many leaves. They have to eat for their own growth and to store food for the next stage when they are not able to eat. A grown caterpillar forms a chrysalis. This is called the pupa stage of the life cycle. Inside the chrysalis, a butterfly grows. Then the butterfly comes out of the chrysalis. In an hour or two the wings unfold and the butterfly is ready to fly.

This changing from an egg to a caterpillar to the chrysalis to the winged butterfly is called metamorphosis. It is a Greek word. The change from caterpillar to butterfly takes about 8 to 10 days for a monarch butterfly.

More Butterfly Connections

Find out how butterflies and moths are alike and how they are different.

Write stories or poems (example, cinquain) about butterflies. Make the stories or poems into a class book.

Put a milkweed seed inside a clear **Christmas ornament.** Tie with a ribbon. These make great gifts!

Read *The Very Hungry Caterpillar* by Eric Carle (for younger grades).

Build a butterfly tower.

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Materials ✔ List (per student or group)	I HAVE:
2 16-in. (41 cm) deli trays (you can also use a smaller size)	____
1 6-ft by 6-ft (180 cm × 180 cm) piece of nylon netting*	____
string, 3 pieces each at least 1 ft (30 cm) long	____

* Available from a fabric store

Directions to Build a Butterfly Tower

___ 1. Roll the netting into a cylinder shape. Overlap the ends by at least 6 inches (15 cm).

___ 2. Tie a knot in both ends of the netting or gather the ends and secure with a rubber band.

___ 3. Slide a deli tray into one end.

___ 4. Punch 3 holes equidistant in the other deli tray and tie a piece of string into each hole.

___ 5. Slide the punched tray into the top of the cylinder. Pull the strings out through the netting. Knot the strings together to form a hanger.

___ 6. Hang from the ceiling of your classroom.

___ 7. You can reach into the tower by reaching through the open side. where the netting is overlapped.

___ 8. Butterflies may be kept in your butterfly tower for up to three days. Feed them by soaking cotton balls with sugar water and putting them in a dish on the bottom tray. You can also put a plant on the bottom tray.

References

Burnie, David. *How Nature Works: One Hundred Ways Parents and Kids Can Share the Secrets of Nature.* Reader's Digest Association. 1991. ISBN #0-89577-391-0

Carle, Eric. *The Very Hungry Caterpillar.* Putnam Publishing Group. 1991. ISBN #0-399-22049-6.

Cutts, David. *Look—A Butterfly.* Troll Associates. 1982. ISBN #0-89375-663-6

Lavies, Bianca. *Monarch Butterflies: Mysterious Travelers.* Dutton Children's Books. 1993. ISBN #0-525-44905-1

Lepthien, Emilie U. *Monarch Butterflies (New True Books).* Children's Press. 1989. ISBN #0-516-41165-9

"Millions of Monarchs". *Life.* August, 1993. page 50.

Morris, Dean. *Butterflies and Moths.* Raintree Children's Books. 1987. ISBN #0-8172-8204-4

"Shimmer and Shine". *Ranger Rick.* National Wildlife Federation. July, 1988. page 21.

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Topic: Color and Light

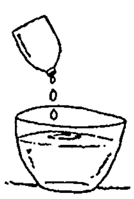
Gels of Color

What happens when you mix colors?

Materials ✔ List (per student or group)	I HAVE:
food coloring	____
cornstarch or Clear-Jel™ *	____
water	____
plastic zipper bags—sandwich size	____
stove or microwave oven for heating, prior to class	____

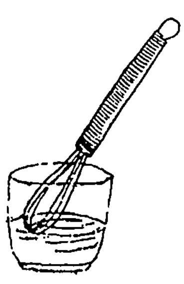
* Available from a cake and candy specialty shop or Educational Innovations, Catalog # SS-14.

Directions for Making the Gels



___ 1. Add a few drops (6 to 10) of food coloring to 1 cup of water (236 mL).

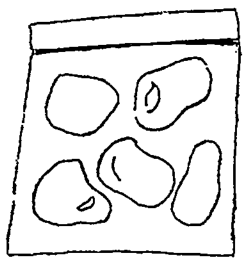
___ 2. Measure 2 tablespoons (30 mL) of cornstarch or Clear-Jel™ and add to the water. Stir with a wire whisk and heat in the microwave oven until a thick paste forms. Or heat on the stove while stirring constantly! Cornstarch does not give as clear a color as Clear-Jel™.



___ 3. Cool and store in a plastic bag.

___ 4. Repeat with any other colors you wish to make. Be sure to include the primary colors of red, yellow, and blue.

Directions



___ 1. Choose two colors that you will mix.

___ 2. Predict what the color will be when the two colors of gel are mixed.

___ 3. Pinch off a small portion of the gel of each color. Put the gels in a zipper plastic bag. Seal the bag. Use your fingers to mix the gels together or to create a picture.

___ 4. Choose another combination of colors.

___ 5. This activity works well with several stations where each has the directions to produce a certain color. Include directions to make a scary, pretty, angry, etc. color for at least one of the stations.

Connections

Decorate a window. Tape the gels in the zipper bags to a window. Add black paper strips as a border and make a "stained glass" window.

Make rainy day pictures. On a rainy day, sprinkle powdered tempera paint of the primary colors of red, yellow, and blue on a sheet of paper. Put the papers in the rain for a few minutes. Bring them inside to dry and look at what happened to the colors.

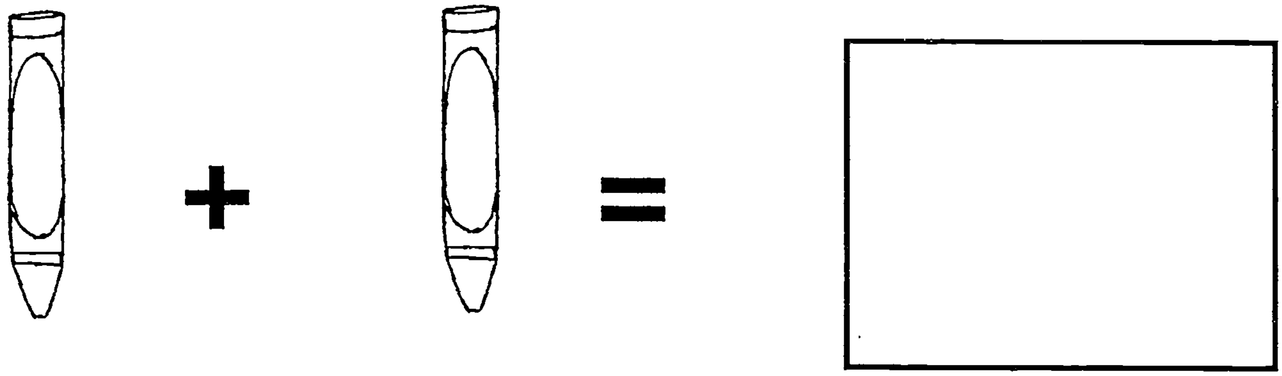
Read *Marianna May and Nursey* by Tomie de Paola.

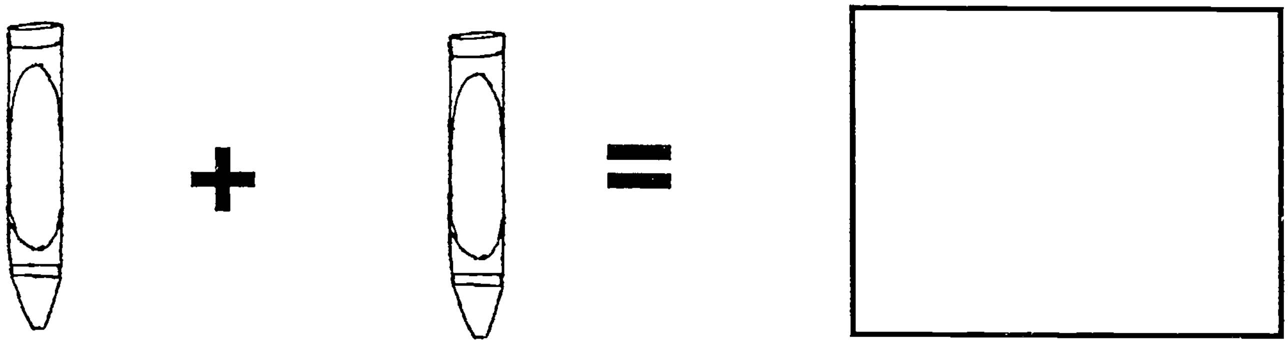
Read *Mouse Paint* by Ellen Stoll Walsh.

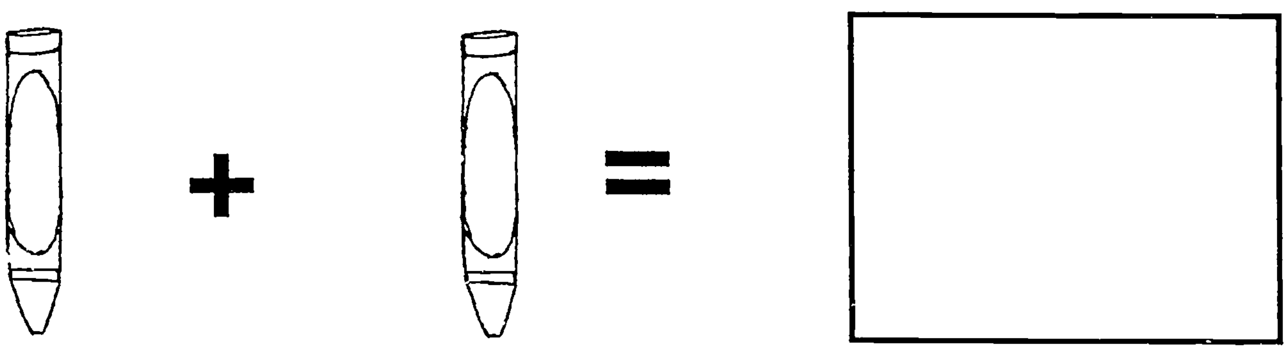
References

de Paola, Tomie. *Marianna May and Nursey.* NY: Holiday House. 1983. ISBN #0-8234-0473-0

Walsh, Ellen Stoll. *Mouse Paint.* Harcourt, Brace & Co., 1989. ISBN #0-15-256025-4







Names of the scientists ____________________

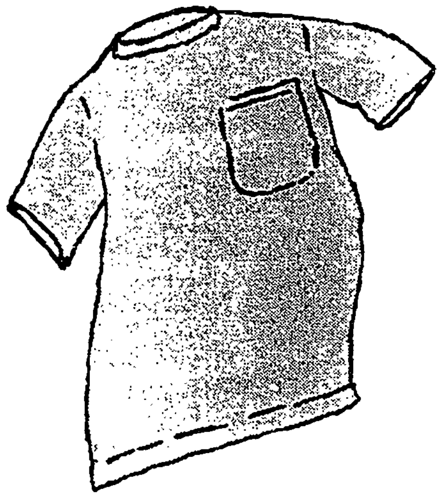
This is what we think will happen...

This is what happened...

This is what we learned...

Names of the scientists:

Topic: Color and Light



Fabulous Fancy Fabric

Will rubbing alcohol separate colors?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
Permanent markers—fine or broad tip in a variety of colors	_____ permanent markers	_____
White fabric—muslin, handkerchiefs, painter's caps, white tennis shoes, T-shirts, etc.	_____ fabric selections	_____
container with a plastic lid—size depends on the size you want the design to be—e.g. margarine container, 5 qt. (4.7 L) ice cream pail	_____ container	_____
Medicine droppers or pipets*	_____ droppers or pipets	_____
Rubbing alcohol	_____ containers for rubbing alcohol (small opening)	_____
Safety glasses**	_____ safety glasses	_____

Available from:

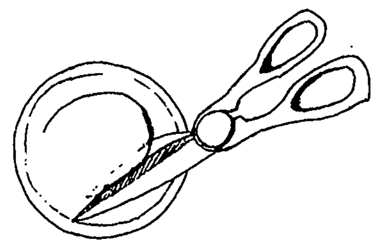
* Flinn, Micromole Scientific, Educational Innovations, or Wren Enterprises.

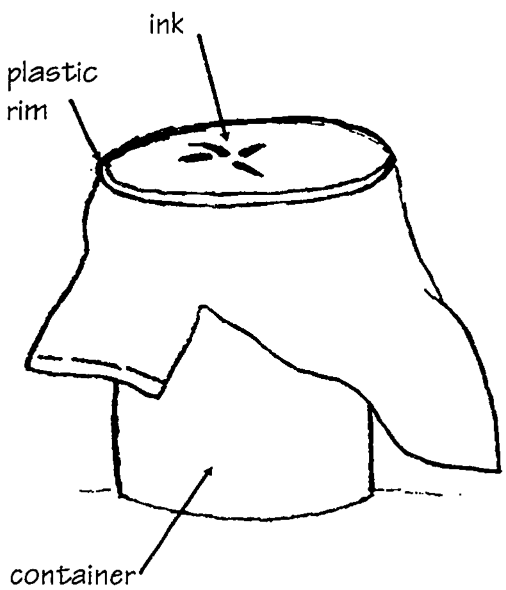
** Lab Safety Supply, Catalog #WA-10035, or Delta, Catalog # 53-190-0030.

Directions

___ 1. Prewash the fabric for best results. If the students bring fabric from home, be sure that it has been washed and dried. Draw a design of dots with permanent markers on the fabric. Keep the dots small.

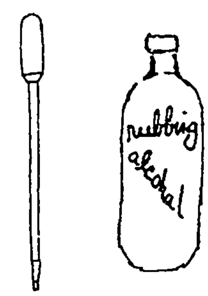
___ 2. Cut out the center of the plastic lid of the container, leaving a rim of about 1/2 inch (1.25 cm).



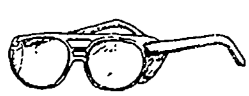


___ 3. Put the fabric over the container and use the lid to hold it in place. For the caps or sneakers, just use the fabric without positioning it with the plastic ring.

___ 4. Put on the safety glasses. These are recommended because some child in your class may accidentally use the pipet as a "squirt gun".



___ 5. Put the pipet or dropper into the rubbing alcohol.



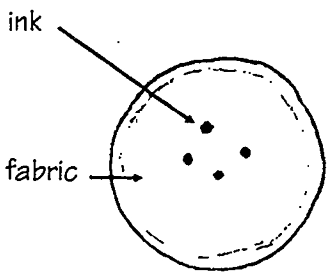
➲ SAFETY NOTE Be sure to use the alcohol in a well ventilated area since it evaporates quite easily. Use containers that have small openings for the alcohol so less evaporates while you are using it. If your classroom is not well ventilated, or you are not sure if it is, do this activity outside. Rubbing alcohol is also flammable, so be sure there are no flames in use! Avoid eye contact. If any is splashed in the eye, rinse with water for 15 minutes.

___ 6. Put a few drops of alcohol at the center of the design. Repeat as necessary. The colors will spread out and separate as the alcohol flows onto the fabric.

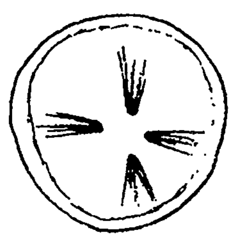
Directions, continued

___ 7. Allow to dry. Then move to a new area of the fabric to decorate if you wish.

Science Background



before alcohol



after alcohol

This is the same concept as "The Mystery Pen", using permanent markers and alcohol instead of water-soluble markers and water.

The inks in permanent markers will not dissolve in water—they are permanent in water. However, they do dissolve in other liquids, like rubbing alcohol. The inks are usually a mixture of dyes, and each of the dyes interacts with the alcohol a bit differently. Some of the dyes travel as fast as the alcohol as it spreads across the fabric; others don't travel as fast. With a bit of time, these different travel rates allow the alcohol to separate the mixture of inks and some interesting patterns result.

If water soluble markers are used here, they would not interact with the alcohol because they do not dissolve in it.

References

Becker, R.; Ihde, J; Cox, K.; Sarquis, J. L. "Making Radial Chromatography Creative Chromatography". *Journal of Chemical Education.* 1992. 69. 979-980.

Sarquis, Mickey and Sarquis, Jerry. *Fun With Chemistry: A Guidebook of K-12 Activities, Volume 2.* Activity #58, Institute for Chemical Education, University of Wisconsin–Madison, 1993.

Topic: Color and Light

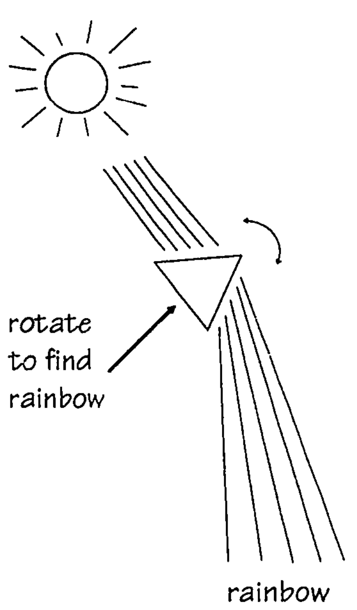
Rainbows without Rain

What are the colors in sunlight as shown by a prism?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
flashlight or a sunny window	_____flashlights	_____
prisms—at least 2*	_____prisms	_____
OPTIONAL magnifying lens	_____magnifying lens	_____

*Plastic prisms are available from:
Delta Education, Catalog # 58-160-4129, or Edmund Scientific, Catalog # B52, 451.

Directions

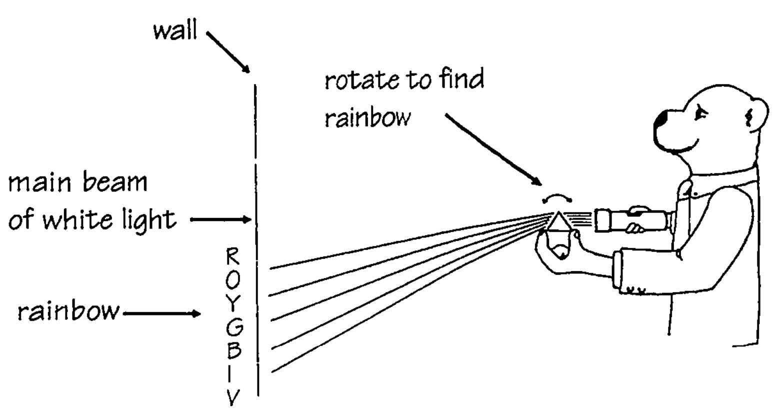


___ 1. You can use either sunlight or a flashlight as a source of light to create the rainbow. Sunlight provides a sharper rainbow, but you need a direct beam of sunlight coming through the window. In both cases, it may help to dim the room lights and close most of the window shades (except, of course, for the one through which the sun beam is entering).

___ 2. To get the rainbow from sunlight, hold the prism in the path of a sunbeam as shown in the picture. The prism has two triangular sides (one on each end) and three rectangular sides. The sunbeam should be striking one of the rectangular sides. The path of the light will bend in the prism and the light will exit through another rectangular side. Rotate the prism back and forth as indicated in the picture to find the rainbow. Be careful not to block the sun

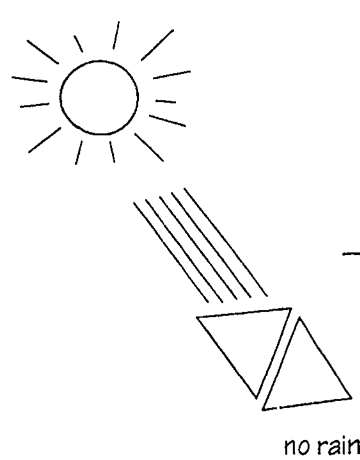
Directions, continued

beam with your fingers. You may have to look all over to find the rainbow—on the floor, wall, ceiling, or window ledge—depending on how you are holding the prism. If you arrange the prism like in the picture, the rainbow should appear lower than the prism. You might find a second rainbow higher than the prism, because of reflections within the prism. It may help to have a student hold a large piece of white paper or poster board in the area that you expect the rainbow to appear.



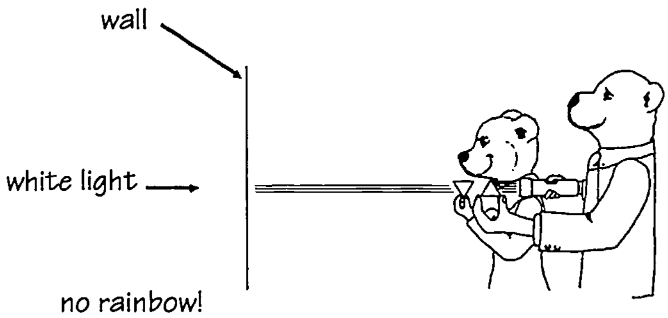
___ 3. To get the colors of the rainbow with the flashlight, stand about five or six feet from a white (or pale colored) wall or screen, facing the wall. Hold the flashlight in one hand and point it at the wall. Hold the prism in the other hand in the path of the light, close to the flashlight, so that the light is entering a rectangular side of the prism. You will see the beam of the flashlight directly in front of you on the wall.

Now rotate the prism back and forth (see picture) and look for the rainbow on the wall. If you hold the prism as in the picture, the rainbow will appear either on the wall below the main flashlight beam or on the floor. The rainbow will be curved because of the shape of the flashlight bulb and lens. You can try to make the rainbow sharper or clearer by moving the prism and/or flashlight. If you stand too close to the wall, the colors blend together and cannot be seen.



___ 4. Once you have found the rainbow from either sunlight or the flashlight, see if you can make the rainbow disappear using a second prism. Arrange the second prism to "catch" the light that is separated into the colors.

Directions, continued



If doing this with the flashlight, have one person hold the flashlight and the first prism and another person hold the second prism. It is important to hold the flashlight and the first prism steady. You could lose the rainbow just by changing the angle of the flashlight or first prism, without even using the second prism!

___ 5. Explore other interesting things you can do with a prism. Use a magnifying lens in the beam of light, before or after each prism.

___ 6. When finished, hang the prisms in a window.

Science Background

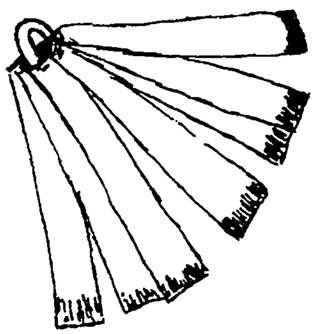
Light from the sun and from the flashlight appear white to us. White light is made up of light of many different colors or wavelengths. When the light is separated into its different wavelengths (by a prism, for example), we see the colors of the rainbow. These colors are red, orange, yellow, green, blue, indigo and violet. Each different color in the rainbow has a different wavelength and the color that we see is determined by the wavelength of the light that reaches our eyes. White light is a combination of all colors (or wavelengths); black is the absence of light.

A prism is a triangular block of material that you can see through—glass or clear plastic. In 1666, Sir Isaac Newton did a famous experiment with light and a prism. People had known for a long time that a prism would produce a rainbow of color from light. Sir Isaac took a second prism and showed that the rainbow of colors would recombine to form white light. He proved that the colors were in the light before it entered the prism and were not made in the prism.

When the white light from the sun or flashlight passes through a prism, it is bent—it changes direction slightly. The amount of bending (or the angle of bending) depends on the wavelength of the light. Because each wavelength is bent a different amount, the light becomes separated by wavelength (or color). A similar thing happens when a rainbow appears in the sky after a rainstorm. In this case, it is the drops of water in the air (instead of a prism) that cause the bending of the light.

There are some books listed in the reference section that will help your students learn about light and color.

Extensions



This visual aid can be used to help explain what happens when light goes through the prism. Cut seven strips of tag board and color the ends with red, orange, yellow, green, blue, indigo, and violet. Fasten the other ends together with a metal brad. Now the strips open out like a fan. This helps the students to visualize how the light bends and your eyes can see the different colors.

Connections

Read *Rainbow Crow*, a Lenape Tale by Nancy Van Laan.

References

Ardley, Neil. *Science Book of Color*. Harcourt, Brace, Jovanovich, Inc. 1991. ISBN #0-15-200576-5

Jenkins, Jessica. *Thinking About Colors*. Dutton Children's Books. 1992. ISBN #0-525-44908-6

Taylor, Barbara. *Over the Rainbow—The Science of Color and Light*. NY: Random House. 1992. ISBN #0-698-82041-8

Van Laan, Nancy. *Rainbow Crow, a Lenape Tale*. Knopf Books for Young Readers, 1989. ISBN #0-394-89577-0

This is what we think will happen...

This is what happened...

This is what we learned...

Names of the scientists:

Topic: Color and Light

Rainbow Grid and Goggles

What are the colors of sunlight as shown by color filters and rainbow glasses?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
Rainbow glasses*	______rainbow glasses	_____
Colored sheets of transparency plastic red, blue, yellow: 2 in. by 6 in. pieces (5 cm × 15 cm). Two of each color	______ colored sheets	_____

You can use colored plastic sections cut from report covers instead of transparency plastic if you can see through the plastic

Available from:
* Edmund Scientific, Catalog #B42,319, Rainbow Symphony, Inc., or Educational Innovations, Catalog # PG-1.

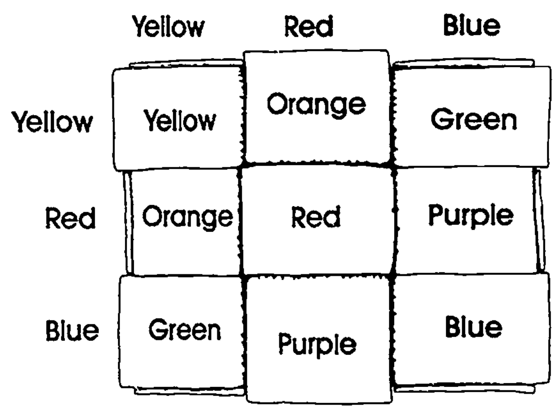
Directions

____ 1. Line up three strips vertically—yellow, red, then blue. See the Rainbow Grid picture below.

Directions, continued

___ 2. Weave the other yellow strip through the vertical strips at the *top*—over the yellow, under the red, over the blue. Staple on the edges.

Rainbow Grid



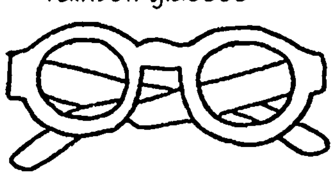
___ 3. Weave the other red strip through the vertical strips in the *middle*—under the yellow, over the red, under the blue. Staple the edges.

___ 4. Weave the other blue strip through the vertical strips at the bottom—over the yellow, under the red, over the blue. Staple the edges.

___ 5. You have just created a color grid. Look for the colors that are created as light goes through the combinations of colors.

___ 6. Look toward the sunlight through the rainbow glasses. Do not look directly at thc sun. Describe what happens. Put the different colored sheets of plastic in front of the rainbow glasses.

rainbow glasses



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Science Background

A color filter is a sheet of transparent plastic that will only allow one wavelength of light to pass through it. It is therefore said to "filter" the other colors.

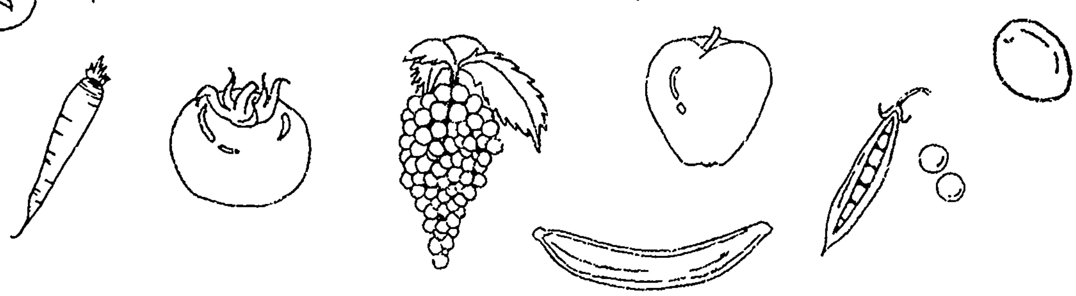
The rainbow glasses are made of a diffraction grating. The plastic has parallel lines that are very close together (about 15,000 lines per inch!). These lines are so close together that they diffract the light so your eye can see the separate colors. Other things that also separate light are thin films of oil, soap films on a surfaces, and bubbles.

Extensions

Create a color wheel. Color the sections appropriately on the color wheel. Mount on tag board. Cut out the wheel. Poke a pencil through the center and spin!

Color a name. Have each student write his/her name or print a message using a different color marker for each letter. Now look at the name through the colored plastic. What do you see? Can you find any patterns?

Color some fruits and vegetables. Have each student find colored pictures of fruits and vegetables. Or you can use the following page, and color the fruits and vegetable appropriately. Look at the pictures through the colored plastic. What do you see? Can you find any patterns?



Connections

Read *Hailstones and Halibut Bones* by Mary O'Neill.

Read *Planting a Rainbow* by Lois Ehlert.

Connections, continued

Write a poem about color and senses. There are a number of brands of scented crayons or markers that would be fun to have the children use here. Ask them to identify the scent and imagine why that scent is used with the particular color.

Decorate the white frames of the rainbow glasses (if you purchased the ones from Rainbow Symphony).

References

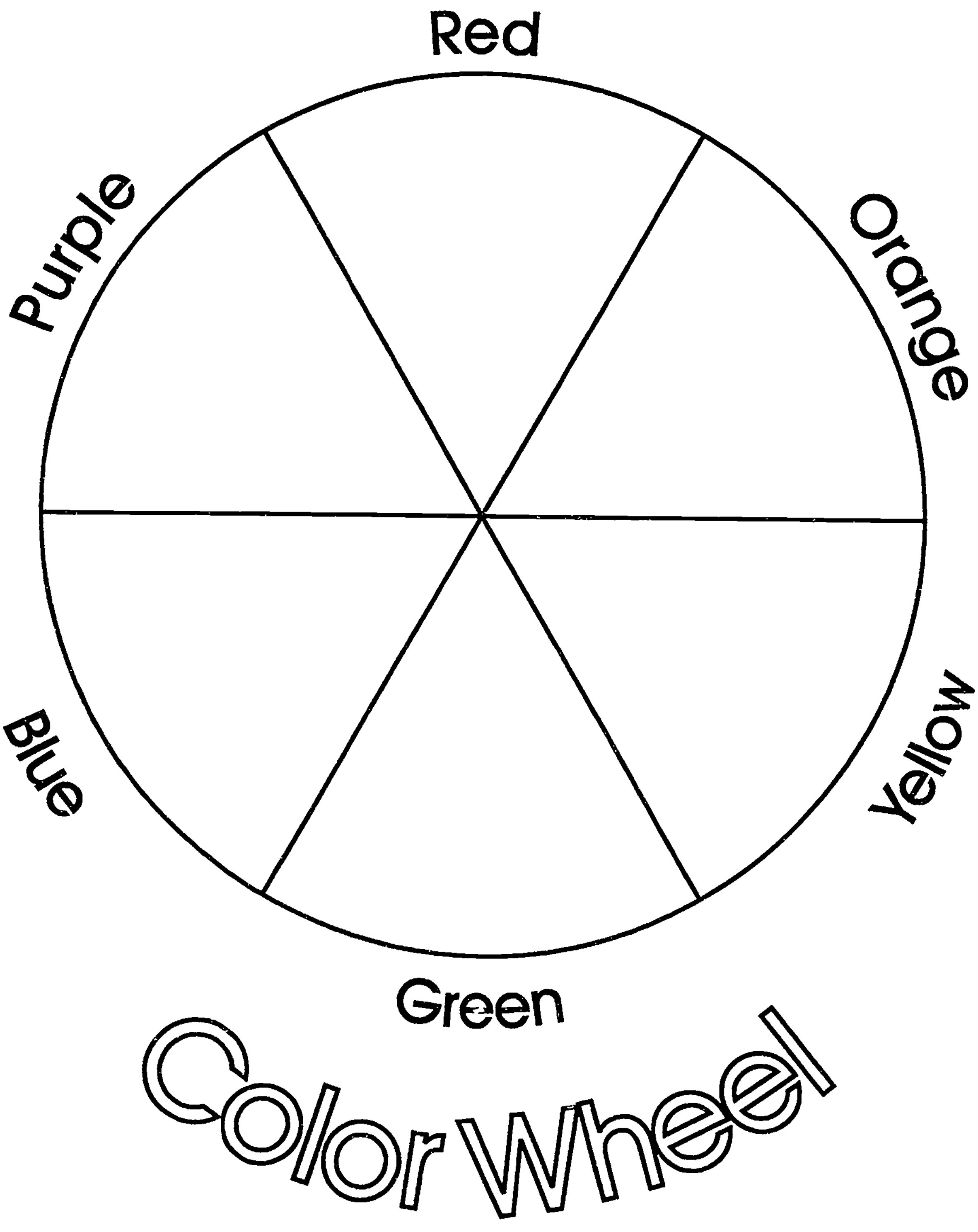
Ehlert, Lois. *Planting a Rainbow*. Harcourt Brace Jovanovich. 1992. ISBN #0-15-262610-7

Murphy, Jenny. The idea for the names, fruits, and vegetables, personal communication, 1994.

O'Neill, Mary. *Hailstones and Halibut Bones*. Doubleday Book for Young Readers. 1990. ISBN #0-385-41078-6.

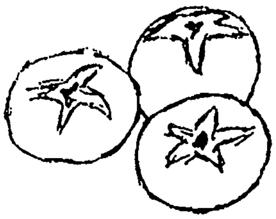
Van Laan, Nancy. *Rainbow Crow, a Lenape Tale*. Knopf Books for Young Readers, 1989. ISBN #0-394-89577-0

Zimmerman, Margie. The idea for the rainbow grid, personal communication, 1994.

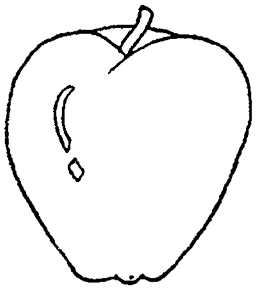


Names of the scientists ______________________

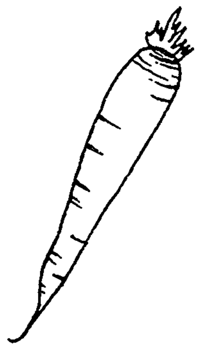
Color these fruits and vegetables.



Blueberries

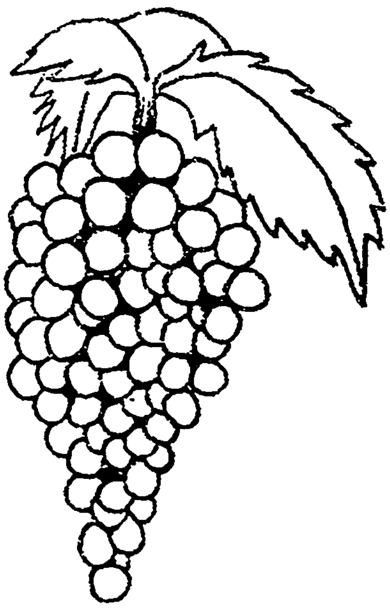


Apple



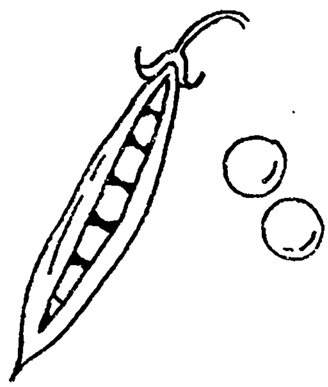
Carrot

Tomato



Grapes

Plum



Peas

Banana

red orange yellow green blue purple red orange yellow green blue

Write a poem about color and senses: (insert a color)

_____________ tastes like:

_____________ smells like:

_____________ feels like:

_____________ sounds like:

_____________ looks like:

Name ______________________________ yellow green

Topic: Color and Light

Rainbow in a Jar

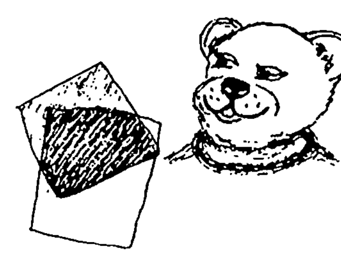
What are the colors of sunlight as shown by polarizing filters and corn syrup?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
jar of corn syrup	______corn syrup	______
A glass with straight sides and a flat bottom. The corn syrup needs to be at least 4 inches (10 cm) deep.	______straight-sided glass	______
two polarizing filters*	______ polarizing filters	______
sunglasses made with polarized lens	______polarized sunglasses	______
flashlight or overhead projector	______flashlight or overhead proj.	______

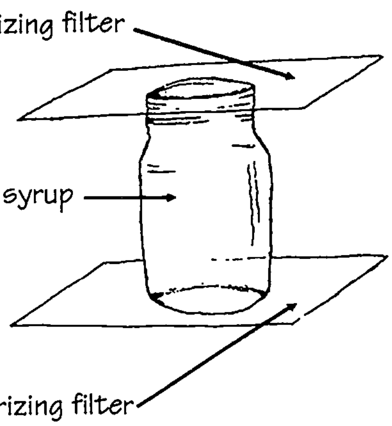
* Available from:
Educational Innovations, Item # PF-3, or Edmund Scientific, Catalog # B41, 168.

Directions

____ 1. Hold the polarizing filter up at the light and look through it. Now put the other filter on top of the first one and look through it again. Turn one of the filters. Observe how the light alternates between dark and light as the top filter is turned.



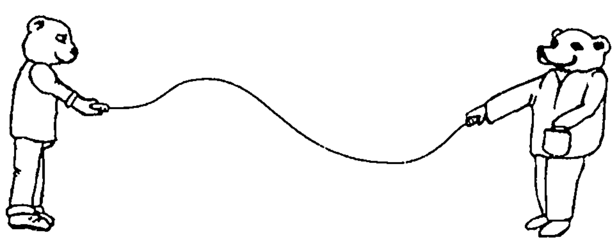
Directions, continued



___ 2. Stand the flashlight upright or use an overhead projector. Put one polarizing filter between the light source and the jar of corn syrup. Put the other filter on top of the jar (cap off!) and rotate it. You will see each of the colors of the rainbow as you rotate the filter. You can also see the colors if you wear the polarizing sunglasses and look through the syrup with a filter between the light and the corn syrup. You can show that all the colors are in white light in this way.

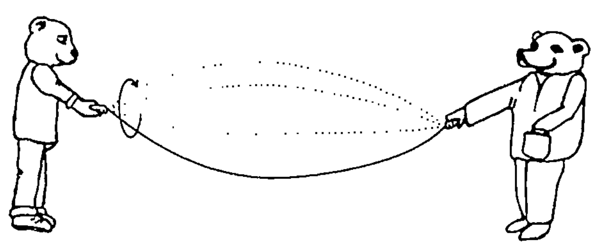
The focus on this activity at this age level should be observation skills and recording skills—not how does it work!

Science Background



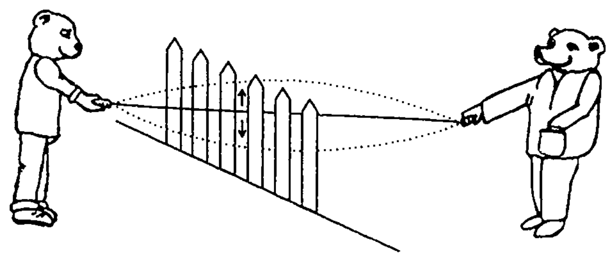
The polarizing filter only lets in light that is polarized in a particular direction. What is polarized light? Light travels like a wave. We can use the analogy of a jump rope to help us picture the wave. If a person at one end of the jump rope snaps the rope, a wave is made that travels to the other person. (You could have your students try this.)

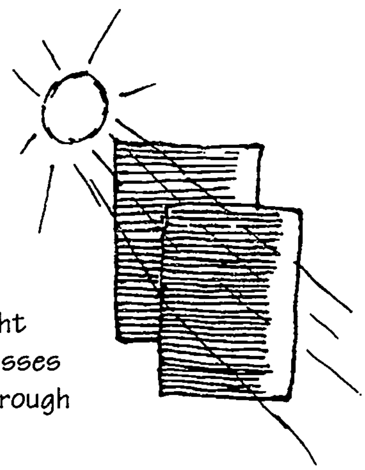
The wave can be made by snapping the rope in any direction (up or down, left or right) because the jump rope can be swung in any direction. If the rope were a wave of light, we would say it was not polarized.



Science Background, continued

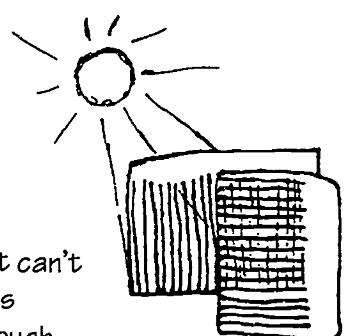
But if you put a picket fence between the two people holding the rope, they could only swing the rope up and down. If the rope were a wave of light, we would say it is polarized. The polarizing filter acts like the picket fence. It only lets the waves of light through that are polarized in a particular direction.





light passes through

The polarizing filter can also be compared to a venetian blind. The blind blocks light coming from most directions, letting in only one "slice". Similarly, the polarizing filter blocks light which is polarized in most directions and lets in only one "slice" of light polarized in one direction. When you see that the light is able to come through both filters then you have both filters lined up in the same direction, e.g. both "venetian blinds" have slats open in the same direction. When you see the dark area, then one of the filters is lined up with its "slats" in a different direction from the other and so no light is able to get through.



light can't pass through

Corn syrup is a very concentrated mixture of sugar and water—lots of sugar that is dissolved in a little water. The sugar molecules rotate the polarization of the light. The amount (or angle) of rotation depends on the color (or wavelength) of the light. When polarized light is going through the syrup, the different colors have their polarization rotated by different amounts. When we look at the light through the second filter, we see the different colors at different filter angles.

Connections

Read *Brown Bear, Brown Bear, What Do You See?* by Bill Martin, Jr.

Read *Hailstones and Halibut Bones* by Mary O'Neill. When reading the poem, leave out the color word and see if the students can identify the color you are reading about.

Read *Mouse Paint* by Ellen Stoll Walsh.

Read *Freight Train* by Donald Crews.

References

Crews, Donald. *Freight Train*. William Morrow & Co., Inc. Greenwillow Books. 1992. ISBN #0-688-11701-5

Kolb, Doris. "Chemical Demonstrations on the Overhead". Institute for Chemical Education. Summer 1993 presentation.

Martin, Jr., Bill. *Brown Bear, Brown Bear, What Do You See?*. Holt, Henry & Co., Inc. 1992. ISBN #0-8050-1744-5

O'Neill, Mary. *Hailstones and Halibut Bones*. Doubleday Books for Young Readers. 1990. ISBN #0-385-41078-6

Walsh, Ellen Stoll. *Mouse Paint*. Harcourt, Brace & Co. 1989. ISBN #0-15-256025-4

Topic: Color and Light

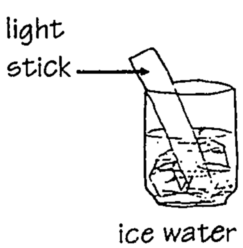
Firefly Light

Can we make light?

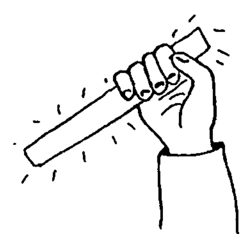
Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
2 light sticks*	_____light sticks	_____
light necklaces**	_____necklaces	_____
clear quart container of very hot water	_____ containers	_____
clear quart container of ice and water	_____ very hot water	_____
	_____ice water	_____

Available from:
* Educational Innovations, Flinn or Edmund Scientific.
** Oriental Trading, Flinn or Edmund Scientific.

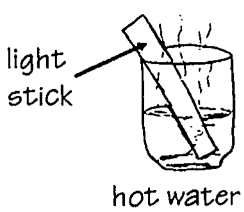
Directions



___ 1. Snap each of the light sticks and shake.



___ 2. Turn out the room lights.



___ 3. Put one light stick in the ice water. Put the other one in the hot water.

Discussion

What happens when the sticks are snapped and shaken? (The chemicals inside mix and the reaction starts. The reaction gives off energy in the form of light.)

What happens to the reaction in hot water? (It is faster—the light is brighter.)

What happens to the reaction in ice water? (It is slower—the light is dimmer.)

Science Background

One of the chemicals for the reaction is inside a glass ampule inside the plastic light stick. When you snap it, you break the glass and the chemicals mix with each other and start to react. Many chemical reactions give off energy. Most times the energy is heat energy—like burning gasoline. Fires are chemical reactions that give off light and heat energy. The chemicals in the light sticks are ones that give off only light energy when they react.

In order to react, the molecules or particles of the chemicals must collide with each other. How fast the particles can move depends on their temperature. Warmer particles will be moving faster. So in the warm water, the particles are moving faster, there are more collisions, and the reaction is faster and we see a brighter light since there is more light energy produced. In the ice water, the particles are slower, there are less collisions, the reaction is slower, and we see a dimmer light.

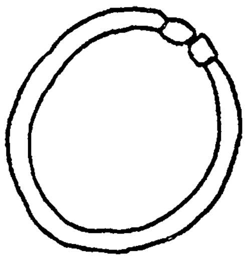
Which light stick will go out first? The one in hot water, because all the chemicals will be used up faster, since they are reacting faster. The opposite of this is that cold slows down chemical reactions. This is why food spoils at room temperature, lasts longer in a refrigerator, and lasts even longer if frozen. Food spoiling is another kind of chemical reaction!

Connections

Read *Sam and the Firefly* by P.D. Eastman.

The **light necklaces** from Oriental Trading are long enough and flexible enough to shape into letters. Make words in a darkened room. Take a picture. Use the

Connections, continued



picture as part of a greeting card. E.g. Make a series of O's. Use the photograph as part of a

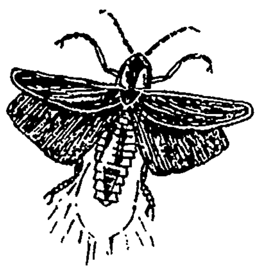
Sooooooooooo SPECIAL

greeting.

Send the light necklaces home with directions to wear them as a **headband** while trick-or-treating as a safety measure. What other uses can the students imagine for light sticks?

A black "glow in the dark" **firefly T-shirt** is available from Great Falls Collections or Hanover House, Item # D573642B.

Find out about the angler fish in the ocean. How do they use light to get food? (A glow in the front of their face attracts tiny fish.) Talk to a bait shop owner or worker. Is light used as a lure for fishing?



Investigate the firefly. How does the firefly make light? What is the purpose of the light? Does the firefly make light only at night? A recommended book is *Fireflies* by Sylvia Johnson or *Fireflies in the Night* by Judy Hawes. Fireflies are beetles. Adults live for about five to thirty days. In South America there is a kind of firefly that produces red light. Different kinds of fireflies have different flashes or signals. They use the light flashes to find a mate. The signal includes the color of the flash, the number of flashes, and the time between each flash. These facts are from a May/June 1992 *Instructor* article by Lynne Kepler. She suggests that you have students design their own **firefly signal** and then show the signals to the class using a flashlight in a darkened room.

References

Cook, Chris. The idea for the headband while trick-or-treating. Personal Communication. Sacred Heart University workshop.

Eastman, P. D. *Sam and the Firefly*. Random House. 1986. ISBN #0-394-80006-0

References, continued

Hawes, Judy. *Fireflies in the Night*. Harper Collins Childrens Books, 1963. ISBN #0-690-01259-4

Johnson, Sylvia. *Fireflies*. Lerner. 1986. ISBN #0-8225-1485-0

Kepler, Lynne. "Shining Science". *Instructor*. May/June 1992. 42-44.

67

Science Concepts

The activities in Insulation include these science content concepts:

- Properties of materials make them appropriate for certain uses.
- Animals have adapted as necessary to survive in their habitat.
- Human beings use the properties of substances to produce the effects they want.

Benchmarks

These benchmarks from *Benchmarks for Science Literacy* apply to this unit:

Objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (olor, size, shape, weight, texture, flexibility, etc.)
Chapter 4: The Physical Setting
Section D: Structure of Matter Grades K–2, page 76

When warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature. A warmer object can warm a cooler one by contact or at a distance.
Chapter 4: The Physical Setting
Section E: Energy Transformations Grades 3–5, page 84

Some materials conduct heat much better than others. Poor conductors can reduce heat loss.
Chapter 4: The Physical Setting
Section E: Energy Transformations Grades 3–5, page 84

Benchmarks, continued

Some animals and plants are alike in the way they look and in the things they do, and others are very different from one another.
Chapter 5: The Living Environment
Section A: Diversity of Life Grades K–2, page 102

Plants and animals have features that help them live in different environments.
Chapter 5: The Living Environment
Section A: Diversity of Life Grades K–2, page 102

For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.
Chapter 5: The Living Environment
Section D: Interdependence of Life Grades 3–5, page 116

Different plants and animals have external features that help them thrive in different kinds of places.
Chapter 5: The Living Environment
Section F: Evolution of Life Grades K–2, page 123

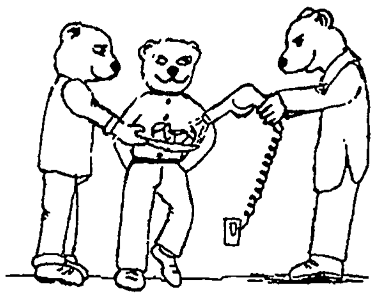
Naturally occurring materials such as wood, clay, cotton, and animal skins may be processed or combined with other materials to change their properties.
Chapter 8: The Designed World
Section B: Materials and Manufacturing Grades 3–5, page 188

Through science and technology, a wide variety of materials that do not appear in nature at all have become available, ranging from steel to nylon to liquid crystals.
Chapter 8: The Designed World
Section B: Materials and Manufacturing Grades 3–5, page 188

People try to conserve energy in order to slow down the depletion of energy resources and/or to save money.
Chapter 8: The Designed World
Section C: Energy Sources and Use Grades 3—5, page 193

Students should be able to make something out of paper, cardboard, wood, plastic, metal, or existing objects that can actually be used to perform a task.
Chapter 12: Habits of Mind
Section C: Manipulation and Observation Grades K–2, page 293

Topic: Insulation



How long can you keep an ice cube from melting?
How fast can you make an ice cube melt?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
one ice cube for each student plus a control cube	_____ice cubes	_____
clock or timer	_____timers	_____
paper plates	_____paper plates	_____
Hair dryer, lamp, or sunn ›lace	_____lamp or hair dryer	_____
Salt to use as 'deicer'	_____salt	_____
Hammer or other tool to crush ice	_____hammer	_____
Rubbing alcohol	_____rubbing alcohol	_____
Other materials commonly available : in the classroom	_____aluminum foil	_____
	_____Styrofoam	_____
	_____thermos	_____
	_____milk carton	_____
	_____foam cups	_____

Directions

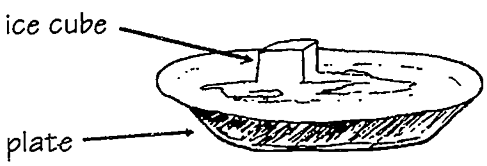
___ 1. Divide into two groups. Allow each group to gather materials and plan their experiment. One group will try to melt an ice cube, the other will try to keep an ice cube from melting. The control will be

Directions, continued

an ice cube in the center of the room on a plate. You may want to divide the class into groups a day before the experiment and allow them to bring materials from home that the group can choose to ɪse. In that case, as a safety precaution, do not allow direct sources of heat like hot plates to be used. Discuss clothing worn during different seasons as an introduction.

___ 2. Predict how many minutes it will take for each ice cube to melt. As each group designs their method to speed up or slow down the melting, have them record what materials were used and how they were used.

___ 3. Place the control ice cube on the plate in the center of the room. Give each of the groups an ice cube. Begin timing.



___ 4. Check periodically throughout the day and record on a bar graph when each of the cubes is completely melted.

Science Background

Heat is a form of energy. The ice cube melts when heat energy is transferred to the ice from its surroundings. When two things are at different temperatures, heat flows from hot to cold until the temperature of each object is the same. It is not possible to prevent the transfer of the heat energy, but it is possible to slow down or speed up the rate of the heat exchange.

Materials that slow down the transfer of heat energy are called insulators. Remember that insulators slow down the transfer in either direction—so they may keep heat inside if the inside is warmer than the outside, or keep the heat outside if the inside is cooler than the outside. Some common examples of these heat barriers or insulators are Styrofoam, the dead air space between windows, wool fabric, and body fat in animals.

Materials that speed up the transfer of heat energy are called heat conductors. For example, the metals used in pots and pans designed for cooking food are good heat conductors.

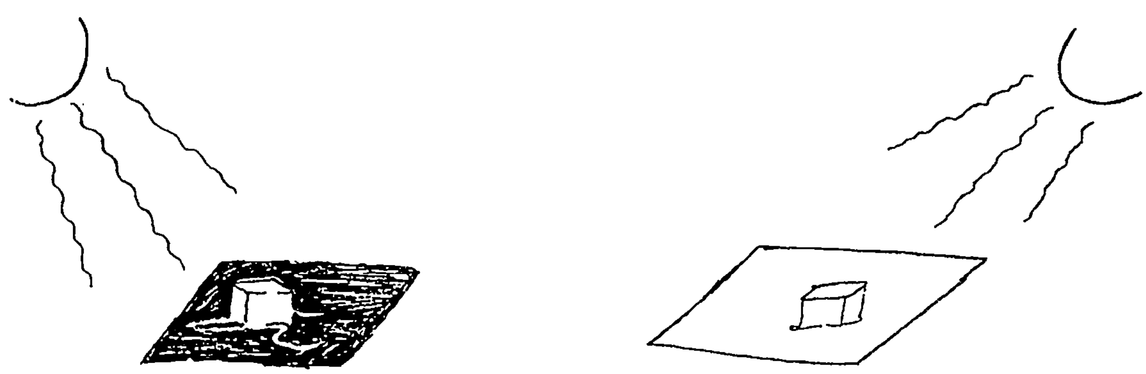
Science Background, continued

There are other ways to change heat transfer besides using insulators or conducting materials. One is to crush the ice so more of the surface is exposed to the warmer air. Another is to sprinkle salt on the ice. This lowers the temperature at which the ice will stay frozen.

Extensions

Have each student **write a story** about what his/her group did to change the melting time. Ask each group to explain what materials were chosen and why. Classify the materials that were used into three categories: helped melting, slowed down melting, and didn't make any difference in melting.

Find out how the background color affects the melting time of an ice cube. You will need two ice cubes of the same size and one sheet each of white and black construction paper. You will also need a sunny day. Put one ice cube on each sheet of paper in a sunny spot outside. Predict when each will melt. Graph the predictions. Observe and record the time it takes for each to melt completely. Graph the actual times and compare. How did the color affect the melting? (The black paper absorbs more of the light energy than the white.)



black paper white paper

Connections

Read *The Snowman* by Raymond Briggs.

Read *The Snowy Day* by Ezra Jack Keats.

Connections, continued

Brainstorm ways in which insulation is important. Why was insulation a good invention? Have a **share day** where students bring an example of an insulator from their home. Involve parents: How is your home insulated? Talk with community resource persons (someone in the building trades) about insulation for the home. Send information home to parents about energy savings that are possible with insulation, if this is available from the business community. Ask your school principal or maintenance person how your school is insulated—both to keep heat inside in the winter and to keep heat outside in the summer. Write to another school in another state. Ask them how their school is insulated. Discuss the geographical location and how climate makes a difference in what is needed.

Two books that would be helpful **science references** for this activity are *The Science Book of Hot/Cold* by Neil Ardley and *Too Hot, Too Cold, Just Right* by Lisa Yount.

References

Ardley, Neil. *The Science Book of Hot and Cold*. Harcourt Bruce Jovanovich. 1991. ISBN #0-15-200612-5

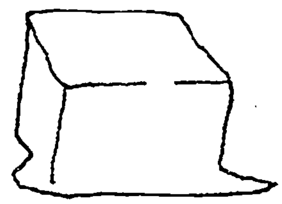
Briggs, Raymond. *The Snowman*. Lady Bird Books. 1990. ISBN #0-679-80906-6.

Keats, Ezra Jack. *The Snowy Day*. Scholastic, Inc. 1993. ISBN #0-590-72632-3.

Kinyon, Karen. Idea for extension with black paper. Personal communication, SSC Workshop, UW–Madison, 1994.

Yount, Lisa. *Too Hot, Too Cold, Just Right*. Walker. 1981. ISBN #0-802-76426. (Out of print).

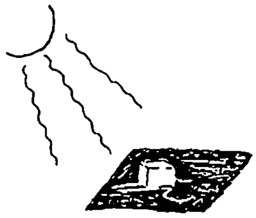
Changing times for melting



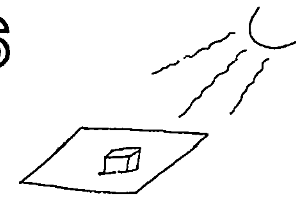
What we used:

What we did:

Names of the scientists



Changing times for melting



These things made the ice cube melt faster:

____

____

____

____

____

These things made the ice cube melt slower:

____

____

____

____

____

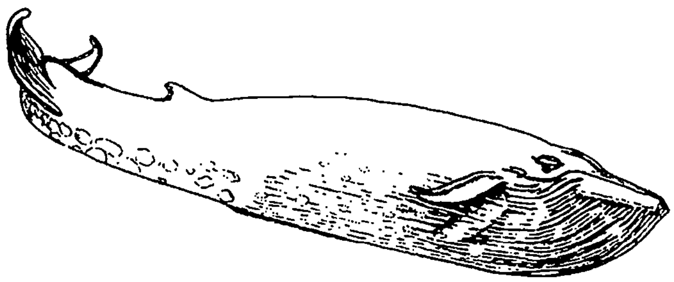
These things didn't change the time it took the ice cube to melt:

____

____

Names of the scientists ______________________

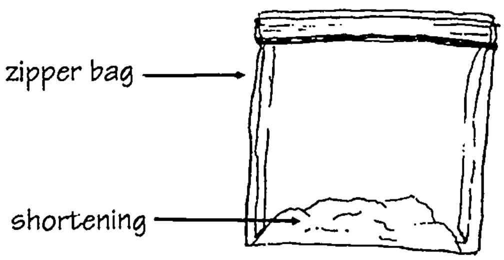
Topic: Insulation



How does fat insulate?

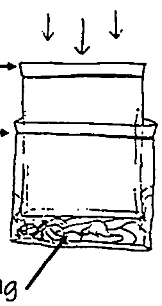
Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
2 qt (1.9 L) freezer zipper bags for each group	_____ freezer zipper bags	_____
2 cups (473 mL) of solid shortening such as Crisco™	_____ cups of solid shortening	_____
bucket of ice water (use a 5 quart (4.7 L) ice cream pail or any bucket big enough for students to put their hands into)	_____ buckets	_____
	_____ ice	_____
duct tape	_____ tape	_____

Directions



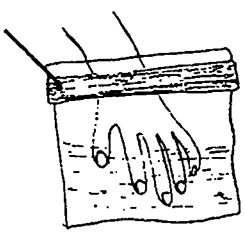
___ 1. Put two cups (473 mL) of the solid shortening into one of the bags.

Directions, continued



___ 2. Turn the other plastic zipper bag inside out. Place it inside the bag containing the shortening. Be careful when you do this so that the zippers are lined up in a way that you can zip the two bags together.

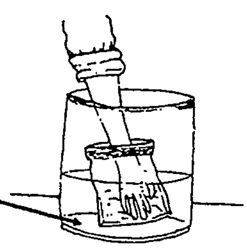
___ 3. Zip the bags together on both sides. If you use the brand of Glad-lock™ where each bag has yellow and blue stripes it is easy to see when it is sealed. If you use duct tape to seal the sides together around the top, these will be reusable for quite a few times. Knead the shortening until it is spread out between the bags in a thin layer on both sides.



___ 4. You have just made a "fat mitten" or "blubber bag".

___ 5. Have each student in the group take a turn. Put the "fat mitten" on one hand. Now put both hands into the ice water! Can you feel the difference?

___ 7. Have a student put the hand he or she uses for writing in the "fat mitten" and then put it into the ice water and then write his/her name. Now have a student put his/her "writing" hand into the ice water WITHOUT any insulation and try to write his/her name again!



Science Background

Fat is stored in the body of animals in the adipose tissue. It has three purposes. It is used as a fuel reserve—energy stored for when it is needed. It is also used as padding or a cushion for preventing injury in a fall or an attack. Finally it is used as a heat barrier or as an insulator against the cold. Fat is in a class of chemicals called lipids. It is a very poor conductor of heat. This is only one of the ways that some animals stay warm.

Extension

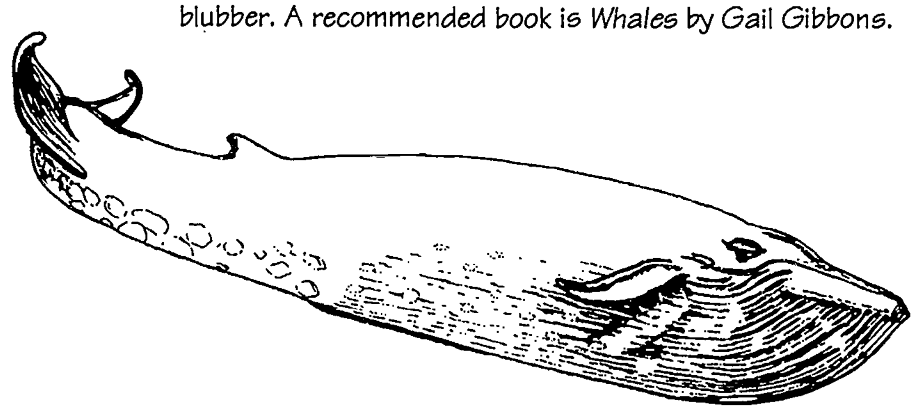
Repeat the activity using a bag of feathers instead of solid shortening. This shows the insulating effect of air and feathers or down. See "Animal Coats" in this unit.

Connections

Find out about how animals are insulated (penguins, whales, birds). The three basic ways that animals can maintain a certain body temperature are its shape, feathers, and fat. Two recommended resources are *Shivers and Goose Bumps, How We Keep Warm* by Franklyn M. Branley and *Too Hot, Too Cold, Just Right* by Lisa Yount.

Birds: Down is "bird underwear". Find out about the use of down in coats, sleeping bags, and comforters. Show the down part of a feather under a magnifying glass.

Whale: Blubber is whale fat. Find out about the historical use of the whale blubber. A recommended book is *Whales* by Gail Gibbons.



Penguin: Read *Tacky the Penguin* by Helen Lester. Find out how its shape helps the penguin stay warm. On the opposite side, what shapes might help an animal in the tropics to cool off? You can demonstrate the effect of shape by freezing one tablespoon of water in an ice cube tray and freezing one tablespoon of water in the bottom of one of the wells in a cupcake pan. After they are frozen, put each on a separate plate in the room and time each to see how long it takes for them to melt.

Find out about fat as a food group.

Connections, continued

Make suet treats for the birds.

Invite the school nurse to discuss the need for **fat in the diet** and the risks to health when people have too much fat in their diet. The American Heart Association will be a good community resource for information on this.

References

Brandley, Franklyn M. *Shivers and Goose Bumps, How We Keep Warm.* Thomas Y. Crowell Junior Books. 1984. ISBN #0-690-04335-X (out of print)

Gibbons, Gail. *Whales.* Holiday House. 1991. ISBN #0-8234-0900-7

Lester, Helen. *Tacky the Penguin,* Houghton Mifflin Co. 1991 ISBN #0-395-56233-3

Super Science Blue. Volume 4, #4. January, 1994. Scholastic, Inc.

WonderScience. "Insulation". Volume 8 (4) American Chemical Society/American Institute for Physics. April 1994.

Yount, Lisa. *Too Hot, Too Cold, Just Right.* Walker. 1981. ISBN #0-802-76426-6 (out of print)

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ICE,

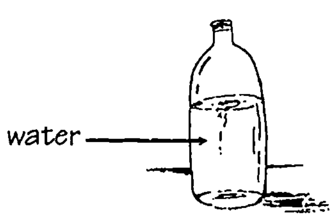
Topic: Insulation

What materials are insulators?

Materials ✔ List (per student or group)	I NEED for my class:		I HAVE:
juice or soda bottles	_____	juice or soda bottles	_____
non breakable spirit-filled thermometers*	_____	thermometers	_____
(We do not recommend using thermometers with mercury because of the toxicity of the mercury if the thermometer is broken)			
coffee cans or large juice cans to use to hold the insulating materials	_____	coffee or large juice cans	_____
Suggestions for insulating materials:	__________		_____
thermos bottle, Styrofoam cooler,	__________		_____
down pillow, insulated underwear,	__________		_____
wool fabric, fats, sand, vermiculite,	__________		_____
cotton balls, play dough, etc.	__________		_____

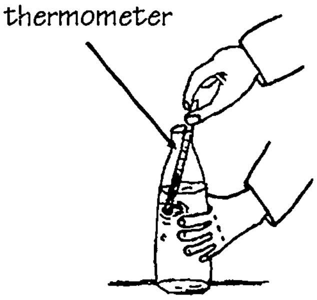
*Available from Delta Education or Flinn Scientific.

Directions



___ 1. Put warm water in a soda or juice bottle—one bottle for each type of material you are using plus one for the control. Take the temperature of the water.

Directions, continued



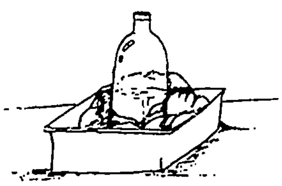
___ 2. Put one bottle on the desk as a control. Surround the other bottles with the material that you are testing.

___ 3. Take the temperature of the water in each location after 30 minutes.

___ 4. While you are waiting, predict what you think will happen.

___ 5. Now repeat the whole experiment starting with ice cold water instead of warm water in the bottle.

Science Background



Various types of materials will slow down heat transfer. They are called insulators. They do this mainly by preventing exchange of heat through the air. The reduction of the heat transfer works in both directions—that is, to keep things that are warmer than the surroundings warmer for a longer time and to keep things that are colder than the surroundings colder for a longer time.

Extensions

Modify the activity to use **different types of clothing** or mittens as the insulators.

Connections

A bulletin board to reinforce the idea of insulation is "Things That Are Good Insulators." Ask for student's help in collecting samples of fat, down, Styrofoam, wool, etc. Post the sample and the name. You can also arrange them in the order of the results of the experiment. Try to answer the question: Do insulators keep cold things cold AND warm things warm? (yes, insulators slow down transfer of heat energy.)

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ICE,

References

Ardley, Neil. *The Science Book of Hot and Cold.* Harcourt, Brace, Jovanovich. 1991. ISBN #0-15-200612-5

Branley, Franklyn M. *Shivers and Goose Bumps, How We Keep Warm.* Thomas Y. Crowell Junior Books. 1984.

Yount, Lisa. *Too Hot, Too Cold, Just Right.* Walker. 1981. ISBN #0-802-76426-6

Names of the scientists ______________________

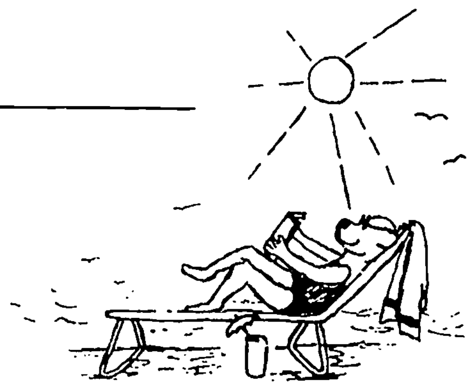
I think that the ______________________
will keep the water the warmest.

The record of the experiment:

We used these materials:	Temperature of the warm water at the beginning:	Temperature of the warm water after half an hour:
None, the control		

I learned that the ______________________

kept the water the warmest.



Names of the scientists ______________

I think that the ______________
will keep the water the coldest.

The record of the experiment:

We used these materials:	Temperature of the cold water at the beginning:	Temperature of the cold water after half an hour:
None, the control		

I learned that the ______________

kept the water the coldest.

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ICE,

Topic: Insulation

How do different animals protect themselves from cold?

Materials ✔ List (per student or group)	I HAVE:
ice cubes in a baggie	____
onion bag mesh	____
baggie full of feathers	____
piece of fur (real or fake)	____
piece of waxed paper	____
piece of sequined fabric	____

Directions

___ 1. Use the five different materials to represent animal skins and furs. The onion mesh represents scales of a reptile, the waxed paper represents amphibian skin, and the sequined fabric represents scales of a fish.

___ 2. Ask for a student to volunteer to represent an animal in each of the animal groups—mammals, birds, reptiles, amphibians, and fish. Examples of animals are a bear with fur, a duck with feathers, a black snake with scales, a frog with an amphibian skin, and a goldfish with scales.

___ 3. Put a bag of ice cubes over a bare arm of each volunteer and ask for reactions to the cold. Typical answers are comments about shivering and goose bumps or suggestions to get a coat or to find a warm place.

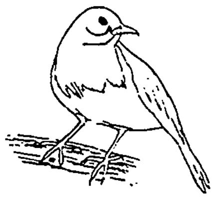
Directions, continued

___ 4. Put the "animal skins" on an arm of each volunteer. Now put the bag of ice cubes on top of the "animal skins" and ask for reactions to the cold.

___ 5. Which type of "animal skin" keeps the animal warm the longest?

___ 6. Repeat step 3 replacing the bag of ice cubes with a jar of warm water. How is that different from the ice cubes?

Discussion

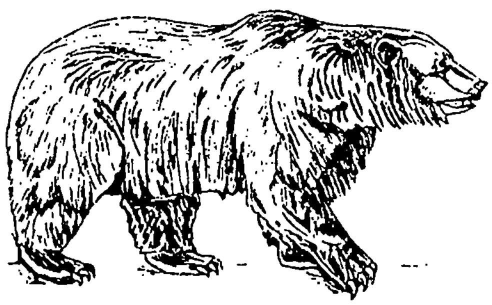


Which animal skins protect from cold by trapping air? (fur and feathers)

What's special about the amphibian skin? (can shed water) Show this by spraying water from a squirt bottle at the wax paper. Most amphibian skins can shed water, but also need to stay moist to prevent dehydration.

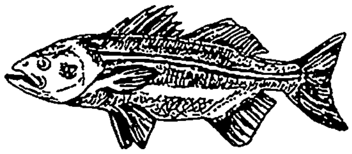
What is the human's protection against cold? (add clothing, also shivers and goosebumps)

Connections



Find out about these five animal groups—mammals, birds, reptiles, amphibians, and fish. These five groups represent the different vertebrate groups of animals—that is, all animals that are vertebrates fit into one of these five groups. Vertebrate animals are ones that have a backbone. How do different animals in each group react to winter? For example, bears find caves to become inactive and live off of the body fat tissues.

Connections, continued



Some birds use down feathers as "bird underwear" for insulation and some birds migrate to warmer habitats. Snakes find warm places and usually coil together for warmth. Stress cold-blooded and what it means to the animals. - Amphibians really can't stand cold very well. Some die in winter if it gets too cold. Most amphibians dig deep into the mud of ponds and hibernate until warm weather returns. Fish remain in the water, which doesn't change temperature as much as air does in the winter. Some fish in the Arctic have a substance like antifreeze in their body to prevent them from freezing in cold water.

Read *Annie and the Old One* by Miska Miles.

Find out about the animal groups. Have children cut out five animals to represent the five groups demonstrated. (*Ranger Rick* magazines published by the National Wildlife Federation are a good source.) If you can't find the pictures, draw a mammal, a bird, a reptile, an amphibian, and a fish on a piece of paper. Then have the children attach a small piece of wax paper to the amphibian, a piece of onion mesh to the reptile, a feather to the bird, a piece of soft, fur-like fabric to the mammal, and a piece of sequined fabric to the fish. Evaluation: have the children tell you why they put the materials on these five animals. Expand to investigate the behavior and/or life cycle of the animals.

Find out about animal tracks. Read *Animal Tracks* by Arthur Dorros. Make prints using vinyl molds of animal tracks (available from Museum Products Company, 84 Route 27, Mystic, CT 06355, 800-395-5400). There are 18 animal hind feet available. They can be used for ink printing or sand casting or plaster casting. The set, catalog # 294, is $45 and includes a field guide and activity booklet. The tracks can be purchased individually for $3 each. To be used, each track needs to be glued to a piece of wood or a stamper.

Create **riddle cards** for the animals. Put a print on an index card and add specific animal facts. For example,

> I have a white stripe.
> Some people say I smell bad.
> I am a _____________.

Read *Is Your Mama a Llama?* by Deborah Gauarino. Investigate how an animal is able to smell. For an activity on the sense of smell, see "Extension: Mama Find Your Baby" in this unit.

References

Dorros, Arthur. *Animal Tracks.* Scholastic, Inc. 1991.

Gauarino, Deborah. *Is Your Mama a Llama?* Scholastic, Inc. 1989. ISBN #0-590-44725-4.

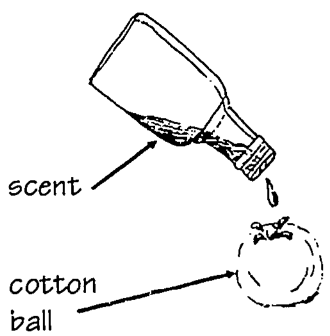
Miles, Miska. *Annie and the Old One.* Little, Brown, and Co., 1985. ISBN #0-316-57120-2.

Insulation

Can you identify something by its smell?
(*An extension of the "Animal Coats" Activity)

Materials ✔ List (per class)	I HAVE:
12 film canisters with lids	____
12 cotton balls	____
drops or small amounts of peppermint extract, vanilla extract, cinnamon, coffee, peanut butter, chocolate	____

Directions

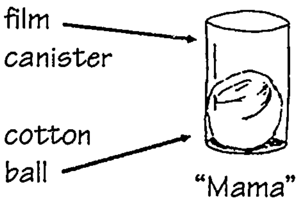


___ 1. Put a cotton ball in each film canister. Scent two of the balls with peppermint extract. Code this pair so that it will be easy for you as the teacher to match pairs later. I suggest a capital letter and a lower case letter.

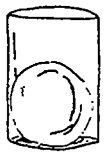
___ 2. Repeat with the other 5 scents.

___ 3. You now have 6 "mamas" and 6 "babies". These will last for several years if you keep them sealed.

Directions, continued



"Mama"


"baby"

___ 4. Divide the class into two groups, the "mamas" and the "babies". Line up on opposite sides of the room. Hand out canisters to the "mamas" and have them smell their canister's scent.

___ 5. Hand out canisters to the "babies" and have them smell their canister's scent.

___ 6. When you say "Mamas Find Your Babies", the children mix together and the mothers try to find their babies by matching the scents of both canisters. When they find each other, they stand together until they are all found.

___ 7. Instead of using the sense of smell, you can vary this game to use sound items in the canisters. Rice, marbles, pennies, hex nuts, etc. can be used.

References

Colegate, Carol. Idea for "Mama Find Your Baby" game. Personal communication, 1994.

Gauarino, Deborah. *Is Your Mama a Llama?* Scholastic, Inc. 1989. ISBN #0-590-44725-4.

Topic: Insulation

What are differences among fabrics?

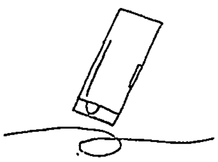
Materials ✔ List (per student or group)	I HAVE:
Fabric samples* of	
wool	____
cotton	____
flax	____
synthetic fabric(s)	____
Microviewer**	____
Microscope (optional)	

* Contact your local county extension office for fabric samples. If unavailable, see the Supplier section of this book.
** Available from American Science Surplus, Delta, Catalog # 53-130-3280, or Edmund Scientific, Catalog # B35, 001.

Directions

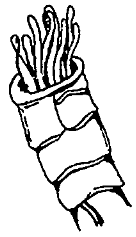
____ 1. Compare the way all the fibers feel. Do not use more than three or four types at one time!

Directions, continued



___ 2. Use the Microviewers to observe the threads of each type. Put the Microviewers directly *on* the object. Make "Classifying Cards" in the Introduction as an easy way to manage these in the classroom. (The Microviewers require 2 size AA batteries. There is an off/on switch for the light and a knob that is used to focus. They magnify 30x.)

___ 3. Look at a strand of human hair with the Microviewer. Compare to the animal hair—wool. Cotton is a hollow fiber. You can see differences with the Microviewer. A more powerful microscope is needed to see the barbs on the wool.

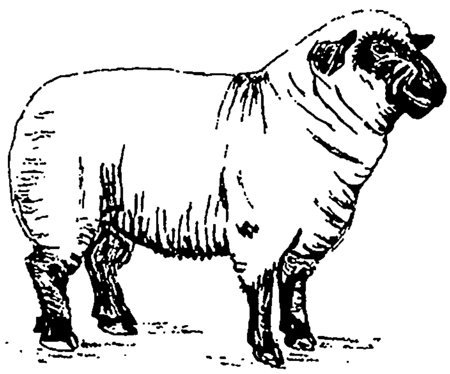


wool fiber

___ 4. Following the pattern of identifying substances from the Classifying Cards activity and using the Microviewers, ask students to predict which one of the fibers is present.

Science Background

Compare natural fibers and manufactured or synthetic fibers. Some natural fibers from plants are cotton, hemp, burlap or jute, and linen. Some natural fibers from animals are wool, silk, and felt. Some manufactured or synthetic fibers are rayon, acetate, nylon, polyester, acrylic, and spandex. The natural fibers will have scaly, twisted, or kinky threads that make good yarns. Manufactured fibers are smooth.



sheep gives wool

cotton

flax

Wool comes from a sheep. Wool is coated with lanolin. This is an oil and it does not absorb water. The lanolin coating the fiber acts like a wax-like outer skin and liquid water is not absorbed by the wool. However, wool fibers can absorb water in the vapor form. This is how wool helps to insulate when you wear it. When the air is cool and damp, the wool absorbs the water vapor and helps to keep a layer of dry air next to the skin. This dry air insulates, and helps keep you warm. If you

Science Background, continued

perspire, the wool absorbs the water vapor and again helps keep a dry layer of air next to the skin. Wool can absorb up to 30% of its weight in moisture and still feel dry! These facts are from *All About Wool*, published by the American Wool Council, a division of the American Sheep Industry Association.

Extensions

Compare clothing. Have students bring in a piece of clothing that helps keep them warm and a piece of clothing that helps keep them cool. Can you find any patterns in the whole class' clothing (kind of fiber, thickness, number of layers, etc.)?

Dye wool with Kool-Aid™. (See "Extension: Dyeing Wool with Kool-Aid™" in this unit.)

Connections

Find out about the history of wool and cotton.

Read *Spring Fleece, A Day of Sheepshearing* by Catherine Paladino.

Read *Working Cotton* by Sherley Anne Williams.

Read *How a Shirt Grew in the Field* by Konstantin Ushinsky, adapted by Margueita Rudolph.

Write a "What if" story. What would happen to sheep if wool didn't have lanolin and therefore did absorb water? Call it The Wacky Wool that Got Wet!

Read *Argyle* by Brooks Wallace.

Read *Marianna May and Nursey* by Tomie de Paola.

References

All About Wool, American Wool Council, a division of the American Sheep Industry Association.

References, continued

de Paola, Tomie. *Marianna May & Nursey*. Holiday House. 1983. ISBN #0-8234-0473-0

Fowler, Marilyn L. "Textile Science: A Thread Connecting Many Disciplines". *Connect: K-8 Hands-On Science and Math Across the Curriculum*. 6(8). May/June 1993. 7-9.

Jobin, Claire. *All About Wool*. Young Discoverer's Library. 1988. ISBN #0-944589-18-9

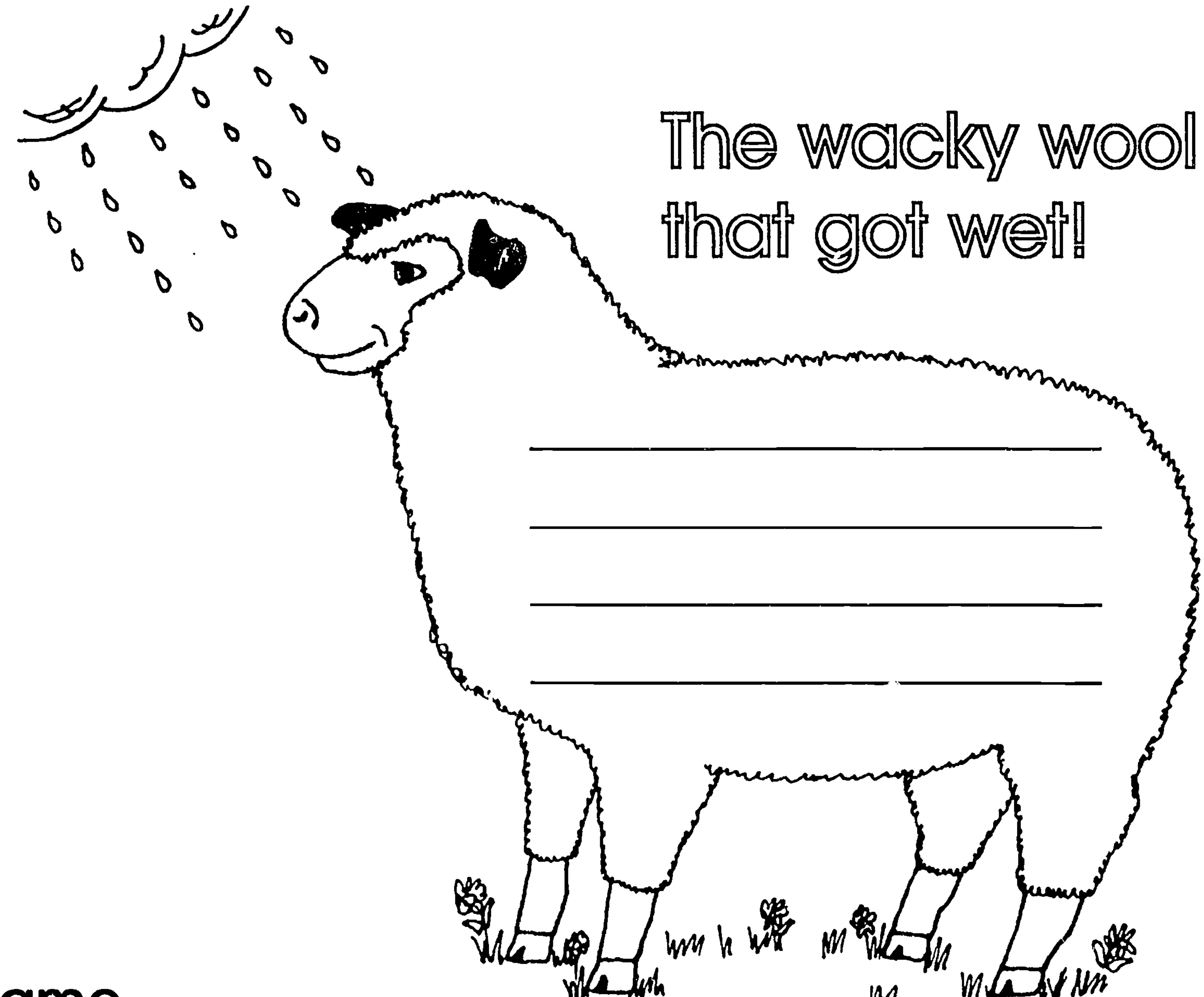
Paladino. Catherine. *Spring Fleece, A Day of Sheepshearing*. Little, Brown, & Co. 1990. ISBN #0- 316-68890-8

Ushinsky, Konstantin, adapted by Rudolph, Margueita. *How a Shirt Grew in the Field*. Clarion. 1992. ISBN #0-395-59761-7

Williams, Sherley Anne. *Working Cotton*. Harcourt, Brace, Jovanovich, Inc. 1992. ISBN #0-15-299624-9

Wallace, Brooks. *Argyle*. Boyds Mills Press, 1992. ISBN #1-56397-043-0

The wacky wool that got wet!



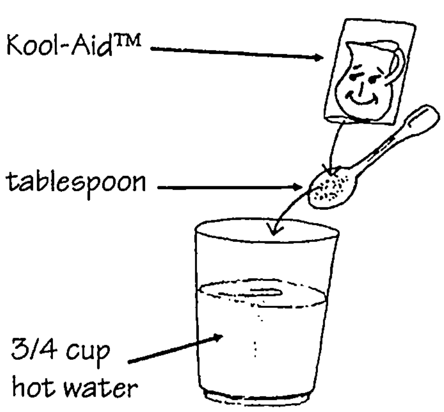
Name ____________________

Can you change the color of wool using a dye?
(*An extension of the "Clothing from Plants and Animals" activity.)

Materials ✔ List (per student or group)	I HAVE:
Kool-Aid™ packets (not presweetened)	_____
clear plastic cups, for the colors	_____
warm water	_____
raw wool *	_____
spoons, for stirring	_____
crockpot, for large quantities (optional)	_____
vinegar (optional)	_____
____________________	

* Contact your local county extension office for raw wool. If unavailable, see Supplies at the end this book.

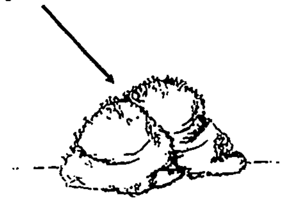
Directions, for Small Quantities



____ 1. Use individual cups for each color for each group of students. Measure 1 tablespoon (15 mL) of each Kool-Aid™ powder into each cup and add 3/4th cup (175 mL) of hot water. Stir.

Directions, for Small Quantities, continued

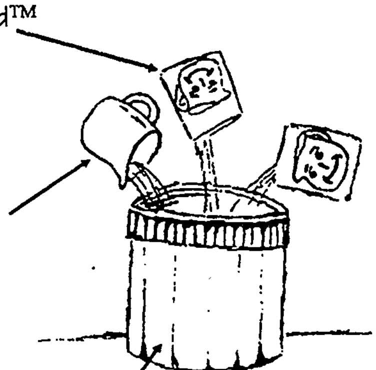
___ 2. Rinse wool in a mild soap solution. Spinners use Woolite™, but almost any soap will do.



___ 3. Add the wet raw wool to the cup. For an even color, stir thoroughly; otherwise don't worry about it. You can also sprinkle the Kool-Aid™ crystals directly on the wet wool for some interesting effects.

___ 4. There are some unexpected results of color, so students will enjoy matching the Kool-Aid™ package colors to the color of the wool. Either label the cups or put the cup on a piece of paper that has the Kool-Aid™ flavor name.

Directions, for Large Quantities



___ 1. Use a porcelain or glass container (eg. a crock pot), and dissolve two packages of Kool-Aid™ in 1/2 gallon (1.9 L) water. Add 1/2 cup (118 mL) of vinegar to set the color deeply.

___ 2. Rinse the wool in a mild soap solution as in step 2 above. Add the wet wool to the dye bath. Make sure it is completely covered. For color blending of the wool, try using two or three colors in different areas of the crock pot. Instead of stirring, use a spoon or stick to poke the wool to test the color. Be very gentle with the wool during the dyeing process to avoid felting the wool. (Felting is shrinking the wool beyond fabric usability. For example, a wool sweater washed in hot water.)

___ 3. Gradually warm the dye bath on low heat.

___ 4. Simmer for at least 30 minutes or until the desired color is achieved.

___ 5. Remove the wool and rinse in room temperature water.

___ 6. Squeeze out the excess water and lay the wool out to dry. If you put the colored wool on paper towels to dry, you get some interesting chromatography results. See "Is Black Really Black?" in Color and Light.

Directions, for Large Quantities, continued

___ 7. When completely dry, or the next day, you can comb the wool with a regular comb and then pull and twist the wool to make wool yarn. A local spinner can use the wool on a spinning wheel as well. The children can spin the wool with their fingers by pulling and twisting the fiber gently. They may notice a "greasy" feel—this is the lanolin that helps waterproof the wool.

Extension

Dye fabrics other than wool with Kool-Aid™.

Connections

Make a bulletin board. Draw a sheep on poster board. Use the caption:

Baa Baa Black Sheep
What color is your wool?

Attach bits of dyed wool to the picture and glue the Kool-Aid™ package next to it.

References

Colegate, Carol. The directions for wool dyeing with Kool-Aid™. Personal communication.

Pressure

Science Concepts

The activities in Pressure include these science content concepts:

- Some chemical reactions produce a gas.
- In a closed system, gases exert pressure.
- Pressure can be used to cause certain actions.
- Air exerts pressure.

Benchmarks

These benchmarks from *Benchmarks for Science Literacy* apply to this unit.

Air is a substance that surrounds us, takes up space, and whose movement we feel as wind.
Chapter 4: The Physical Setting
Section B: The Earth Grades 3–5, page 68

Materials may be composed of parts that are too small to be seen without magnification.
Chapter 4: The Physical Setting
Section D: Structure of Matter Grades 3–5, page 77
and
Chaper 8: The Designed World
Section C: Energy Sources and Use Grades 3–5, page 193

This benchmark from *Benchmarks for Science Literacy* applies to the extension in this unit:

Things that make sound vibrate.
Chapter 4: The Physical Setting
Section F: Motion Grades K–2, page 89

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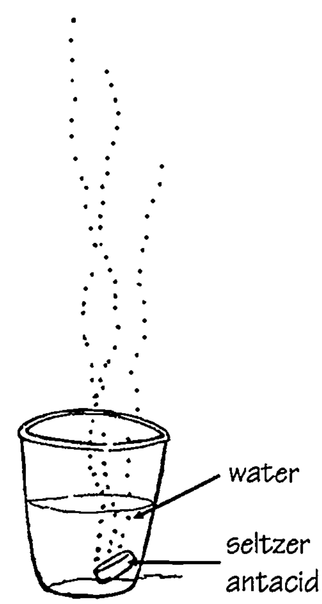
ICE,

Topic: Pressure

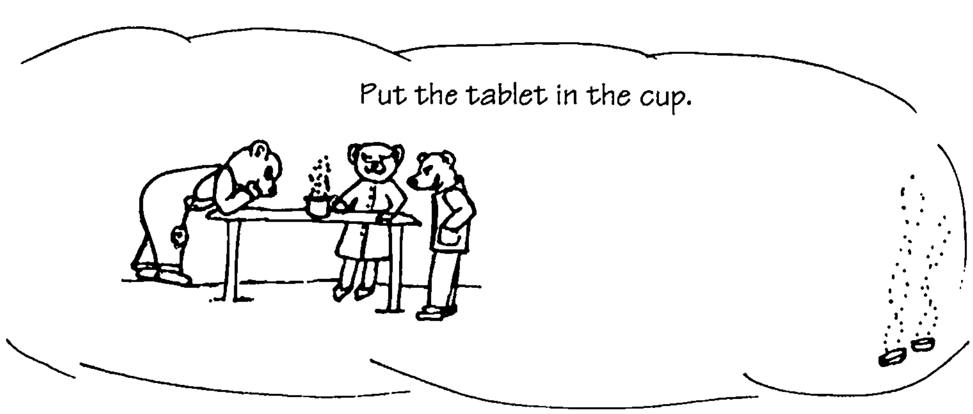
Fizzing I

What happens if a seltzer tablet and water are mixed in a cup?

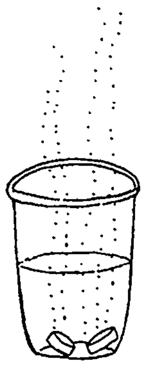
Materials ✔ List	I HAVE:
1 clear container	____
1/4 cup (60 mL) water	____
1 seltzer antacid	____
(A brand name is Alka-Seltzer™, but there are other brands that behave similarly.)	



Directions



Discussion



What do you see? (bubbles of a gas)

What happened to the pieces of the seltzer tablet? (dissolved and reacted)

What is seltzer antacid used for? How could it settle a stomach? (It reacts with the acid in the stomach. Antacid means "against acid".)

What are other things that fizz when mixed?

What are some dangerous things that should NOT be mixed together?

Science Background

The solid seltzer tablet has two ingredients that do not react with each other when they are solids. However both of these ingredients dissolve in water and when they do, there is a chemical reaction between them that produces a gas. One of the ingredients is a bicarbonate and the other is citric acid. From the reaction the gas carbon dioxide is produced. The gas is what causes the fizzing. Another substance that is formed in the reaction is sodium citrate, which reacts with the acid in the stomach.

There is no pressure build up in this experiment because the gas is not trapped, but it is able to go into the air. In this experiment, you are showing that gas is produced by the reaction. To build up pressure you must trap the gas in some way.

You can also use this activity to show the solid, liquid, and gaseous states of matter. The solid seltzer tablet reacts with liquid water to produce the gas carbon dioxide.

Connections

Read *The Seltzer Man* by Ken Rush.

References

Rush, Ken. *The Seltzer Man*. Macmillan Children's Books, 1993. ISBN #0-02-777917-3

This is what we think will happen...

This is what happened...

This is what we learned...

Names of the scientists:

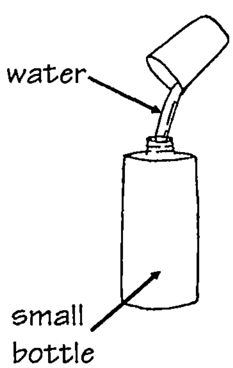
Topic: Pressure

A Seltzer Balloon

What happens if a seltzer tablet and water are mixed in a balloon?

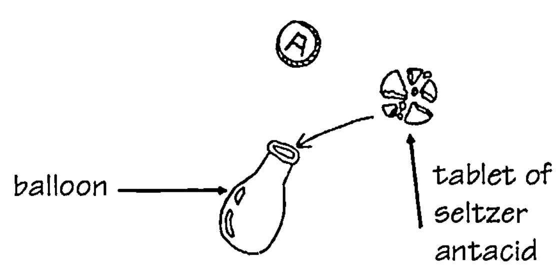
Materials ✔ List	I NEED for my class:	I HAVE:
1 small plastic bottle (e. g. travel size shampoo)	_____ bottles	_____
1 cup (236 mL) of water	_____ cups	_____
	_____ cups of water	_____
balloon to fit the top of the bottle	_____ balloons	_____
3 tablets of a seltzer antacid	_____ tablets of seltzer antacid	_____

Directions



___ 1. Fill the bottle 1/2 to 3/4 full with water.

___ 2. Stretch the balloon several times. Break one tablet into small pieces and place in the balloon. Pieces must be small enough so they will go through the mouth on the bottle in step 4.



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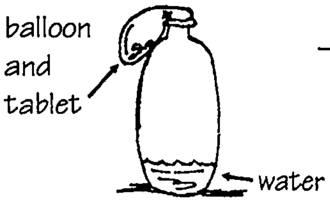
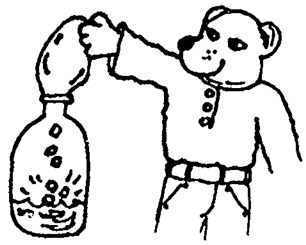
Directions, continued

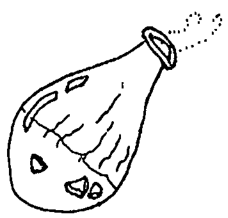


___ 3. Put the balloon over the mouth of the bottle with the pieces of the tablet remaining in the balloon.

___ 4. Lift the balloon so that the tablet goes into the water.



Discussion



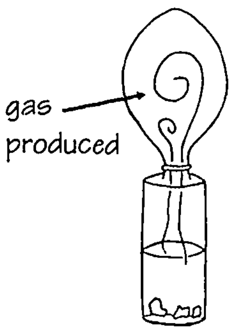
Blow up a balloon with air from your lungs. This will reinforce the concept that it is air (a gas) that makes the balloon get bigger.

What do you think will happen when the water and tablet mix? (balloon will expand)

What do you think will happen when two seltzer tablets are used in step 2? Try it! (the balloon expands more)

➲ SAFETY FIRST: Only an adult, not the children, should blow up the balloons.

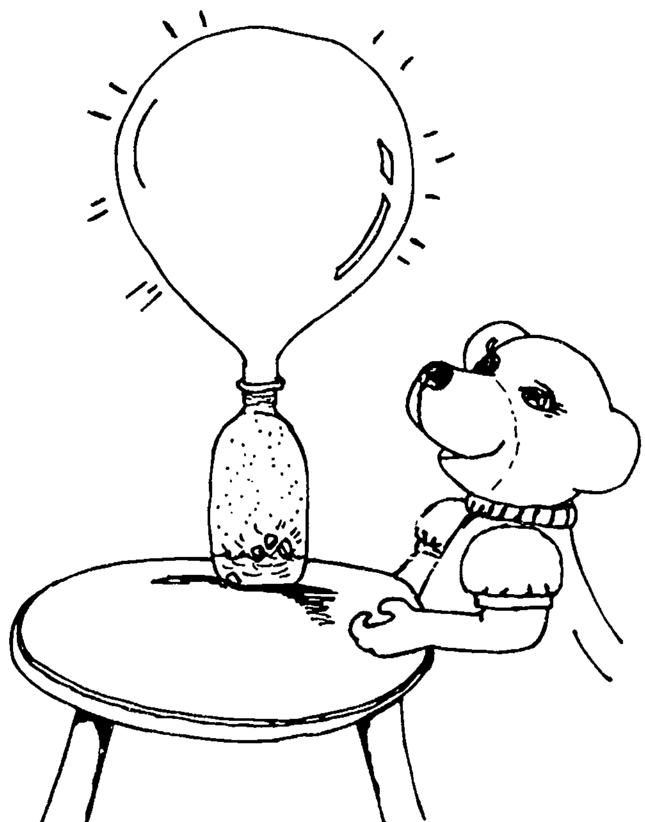
Science Background



The same reaction occurs as described in "Fizzing I". This time, however, the gas that is produced is trapped inside the balloon instead of escaping into the air. This trapped gas builds up pressure. The balloon expands because of the increase in pressure from the gas inside the balloon.

When two tablets are used, twice as much gas is produced. This is because the two inches of water in the bottom of the bottle is more than enough to react with both of the tablets.

What made the balloon blow up?



Names of the scientists

This is what we think will happen...

This is what happened...

This is what we learned...

Names of the scientists:

Topic: Pressure

Seltzer Surprise

What happens if a seltzer tablet and water are mixed in a film canister?

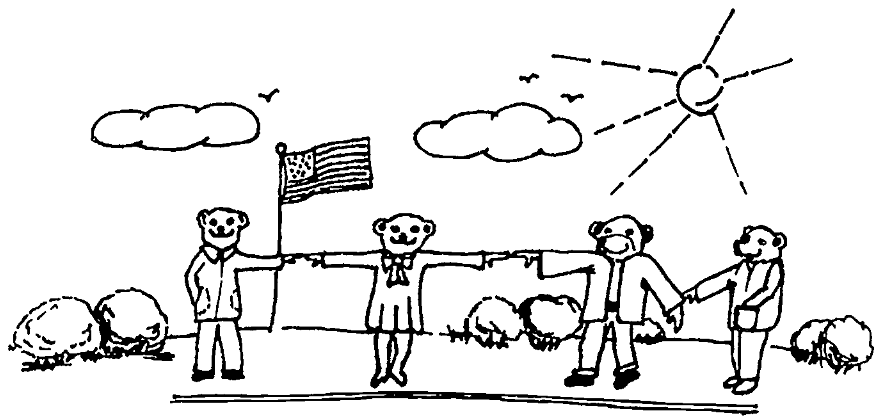
Materials ✔ List (per student group)	I NEED for my class:	I HAVE:
1 empty film canister (plus one per student to send home) plus a few extra since occasionally one doesn't work	_____ film canisters	_____
1 cup (236 mL) water	_____ cups	_____
	_____ cups of water	_____
plastic spoon or medicine dropper	_____ plastic spoons OR medicine droppers	_____
1/2 tablet of a seltzer antacid (plus one per student to send home)	_____ tablets of antacid	_____
safety glasses*	_____ safety glasses	_____

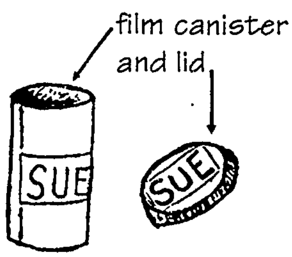
* Available from: Lab Safety Supply, Catalog #WA-10035 or Delta, Catalog #53-190-0030.

Directions

___ 1. Be sure to do this outside. Use a line on the playground and have the class stand behind the line about an arm's width apart.

Directions, continued





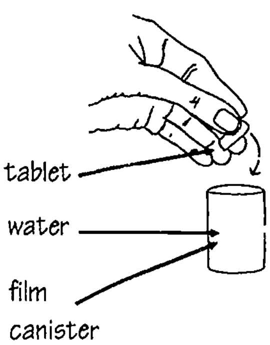
___ 2. Put the student's name on both the canister and the lid, so you can match them again. We have successfully obtained the film canisters from local camera shops. Occasionally, one of the film canisters will not seal well enough to pop, so be sure to have a few extras.

___ 3. Put one spoonful of water in the film canister. If medicine droppers are available, they may be used to add about 10 drops of water, instead of the spoonful.

___ 4. Ask the class to predict what will happen when the tablet is added and the canister is closed.

___ 5. Add the 1/2 tablet of seltzer antacid to the canister and quickly put the cap on.

___ 6. Place the canister on the ground and stand back and wait!



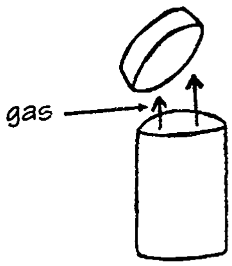
CAP IT QUICKLY!

➲ SAFETY FIRST: The lids do NOT pop with enough force to be a safety hazard. However, the students should not have their faces directly above the film canisters. We also recommend safety glasses as an added precaution.

Discussion

Can you make the lid pop off more than once? (Replace the lid as soon as possible and count the number of times you can make the lid pop off with the same starting materials.)

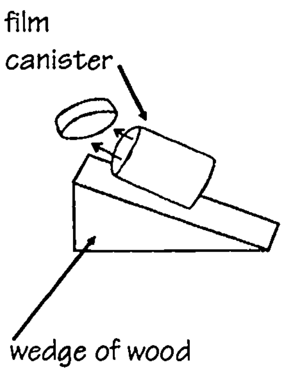
Science Background



The same reaction occurs as described in "Fizzing I" in this unit. This time, however, the gas that is produced is trapped inside the film canister instead of escaping into the air. This trapped gas builds up pressure. When the force on the lid is too great, the lid pops, and the gas rapidly escapes into the air. The pressure comes from the trapped gas. The pressure is released as both sound energy and the energy of motion to move the lid.

Extensions

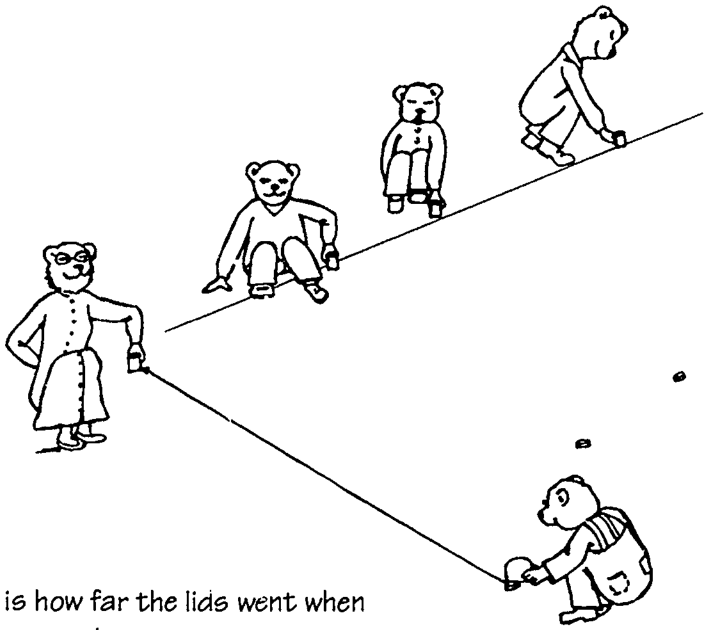
Measure the distance each lid traveled and **make a graph.** Make sure that names are on the lids for each student. You will need meter sticks or tape measures—one per group of four students is recommended. You will also need a wedge of wood, such as a door stop, to prop the film canisters so that they are all angled in the same way. A C or D size battery holder (available from Radio Shack) also works well for positioning the film canisters.



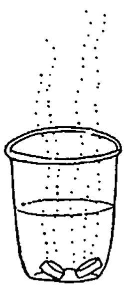
Mark with chalk the starting point for each student. Each student should place the wedge of wood on the line and put the film canister on the wedge. All of the canisters should point in the same direction, away from the students behind the line!

After the lids have landed, mark their location with chalk. Now have each student group of four measure the distance from the starting point to the lid for each student in the group. Collect the class data on a bulletin board. Cut a piece of string the same length as each student's measured value. Staple each string with a tag that states the measurement on the bulletin board. Label the board.

Extensions, continued



This is how far the lids went when they popped.



Vary the amounts of water and tablet that are used in the film canister. Each group should decide what amount of water and tablet they will use for the first test. Only one of the amounts for the water or the tablet should be changed at each trial. Each of the amounts is called a variable and in investigating the effect of changing a variable, it is easier to conclude what might be happening if only one thing is changed at a time. The other factors are called controls—they are the ones that do not change. Each group should predict how far the lid will travel. Each group will mix the water and tablet in the film canister, quickly put the lid on the canister, and stand back and wait. Prop the film canister against a wedge of wood and aim it in the direction you want the lid to pop. When the lid has popped off, each group should measure the distance the lid traveled. Repeat with a different amount of water or tablet. Predict an expected value and explain your prediction. Then try it! Graph your results and compare.

Vary the brand of antacid that is used. How many different brands can you find? Do any of the brands have some of the same ingredients? Choose four or five varieties to test. Choose one of the brands. Write its name. Read the box and list all the ingredients on the label. Put the tablet in the cup. Add 1 teaspoon of water. Observe what happens. Repeat with the other tablets. Can you find a pattern of ingredients in the ones that fizz in water? Only certain ingredients in the antacids will produce a gas when mixed with water. Other tablets work differently as an antacid. The ingredients needed to get the gas bubbles are some type of bicarbonate and an acid.

Connections

Find out about the **use of antacids**. What are some of the precautions? Ask a nurse.

Read:

Noisy Nora by Rosemary Wells
The Thunder King: A Peruvian Tale by Amanda Loverseed
Thunder Cake by Patricia Polacco
Drummer Hoff by Barbara Emberly

Make a list of all the words the class can think of to describe loud sounds. Group the words into categories, if possible. For example, words that describe sounds that animals make, words that describe sounds that motors make, other words for popping, etc.

Write contrast poems. "Loud as a ___________

Quiet as a __________."

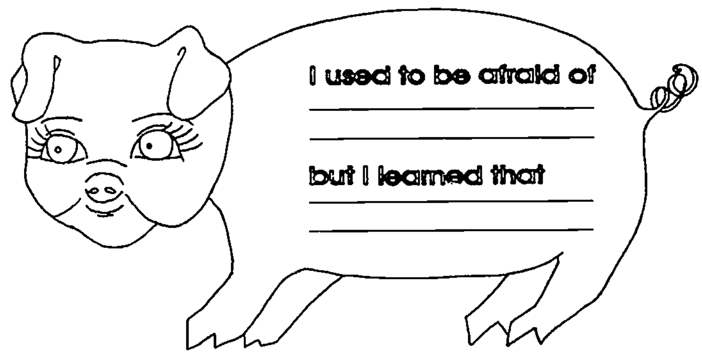
Write an acronym using the word pressure.

Find out about volcanos and geysers. Use this demonstration of pressure to explain the pressure that builds up inside the earth to cause volcanos and geysers to erupt. Volcanic eruptions are caused by trapped gases and melted rock. Geysers are also caused by pressure that builds up from trapped water vapor. When the pressure gets high enough, the geyser erupts, then it is quiet as the pressure slowly builds again. You can make a volcano of clay, put vinegar in a well at the top, and then add baking soda to make it erupt. Use red food coloring to make it look like hot lava. The gas that is produced is carbon dioxide. It is made in the chemical reaction between baking soda and vinegar. See "Fizzing II" in this unit.

Make your own "Thunder Cake". A recipe is included in the book, *Thunder Cake*. This can be used to discuss storms and other things that kids are afraid of.

Write a story: "I used to be afraid of ________________ but I learned that _____________". (Examples: I used to be afraid of thunder, but I learned that it's just a sound. I used to be afraid of ghosts, but I learned that they aren't real. I used to be afraid of a tornado, but i learned that you can hide from them in the basement.)

Make a hall display that uses the title, Who's Afraid of the Big Bad Wolf? Put the writing samples on the body of a pig.



Involve the Parents

Send home a film canister and seltzer tablet with each student.

More Connections

Have a share day called **POP DAY**. Ask students to bring in other things that pop. Some examples are a bicycle tire, a balloon, popcorn. In each case, find out what causes the pop—there will be a gas under pressure and the pop is caused by the sudden release of that gas. In popcorn, it is water inside the kernel that turns to steam when the kernel is heated.

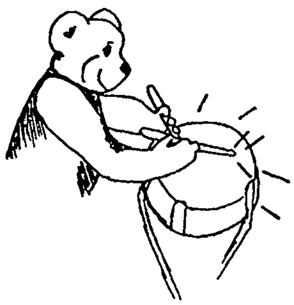
Read *Popcorn* by Frank Asch. Another book to read is *The Popcorn Book* by Tomie de Paola. Students could write their own recipes for making popcorn. They could write their own story or poem about what makes popcorn pop. Or the children can finish a story that begins: "At the factory, I changed the machine so that it put twice as many popcorn kernels in the microwave bag of popcorn and ..." The children can tell or demonstrate to the class the best way to make and eat popcorn: How to make it, the favorite place to munch it, the favorite person to share with, the favorite drink to have with it, etc. Here's a poem for popcorn to share with your class. It is based on the Mother Goose rhyme "Pease porridge hot".

More Connections, continued

Popcorn Hot

Popcorn hot,
Popcorn cold.
Popcorn in the pot
Nine days old.

Some like it hot,
Some like it cold.
Some like it in the pot
Nine days old!



Investigate **sound and musical instruments**. Have students from the upper grades come into class to help with this or to demonstrate their instruments. What is the difference in how the sound is made in a brass instrument, a reed or woodwind instrument, and a percussion instrument? Read *The Bremen-Town Musicians* by Ilse Plume. Another book your class will enjoy is *The Science Book of Sound* by Neil Ardley.

Make a simple musical instrument. The reference section lists some books that will be of help to you in doing this activity or ask the music teacher in your school for suggestions.

References

Ardley, Neil. *The Science Book of Sound*. Harcourt, Bruce, Jovanovich. 1991. ISBN #0-15-200579-X

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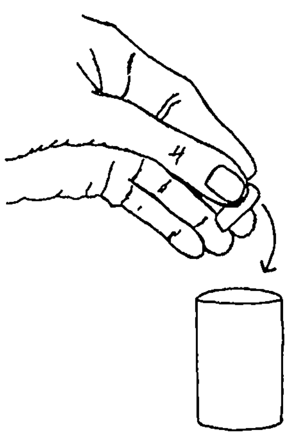
Dear Parents:

Today in our class, we

- used a chemical reaction to make a gas
- trapped the gas to create a higher pressure
- saw and heard the effect of releasing the pressure quickly!

You can do this at home too! Have fun INVESTIGATING with your child!



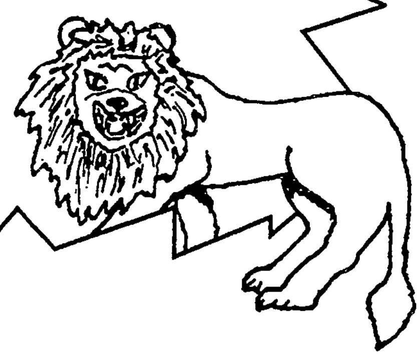
- Put one teaspoon of water in a film canister
- Add one half of the seltzer antacid tablet to the canister
- QUICKLY put the lid on
- Stand back and wait!

Loud as a ...

____

____

____



shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh

Quiet as a ...

____

____

____

____

shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh shh

Names of the scientists ______________________________

P ______________________________

R ______________________________

E ______________________________

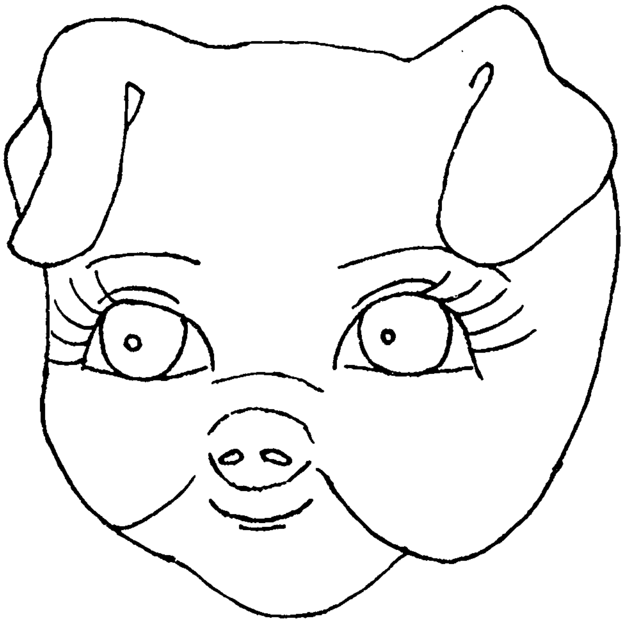
S ______________________________

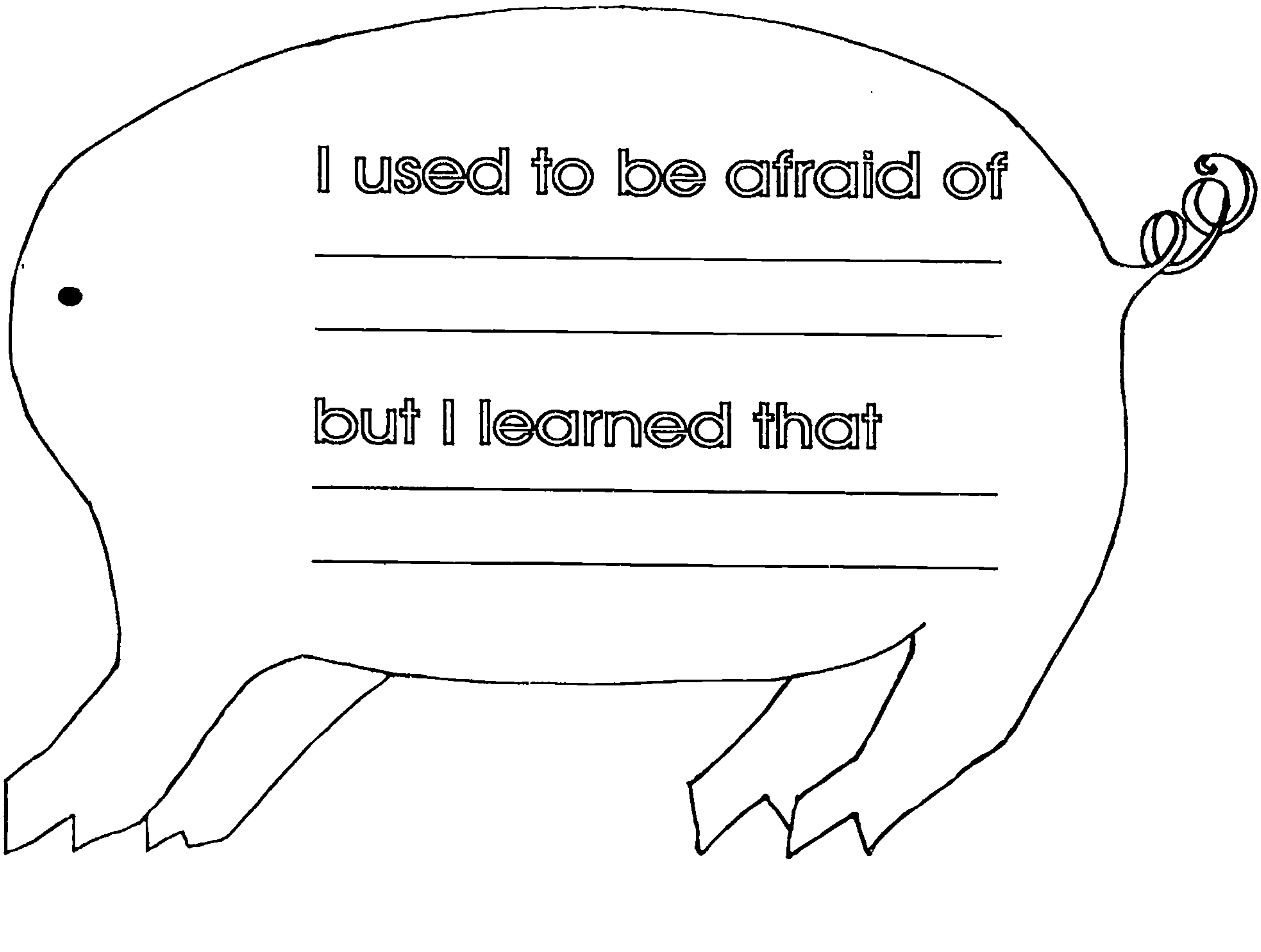
S ______________________________

U ______________________________

R ______________________________

E ______________________________



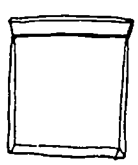

I used to be afraid of
but I learned that

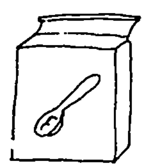
Topic: Pressure

Fizzing II

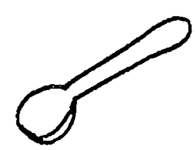
What happens when baking soda and vinegar are mixed?

Materials ✔ List (per student group)	I NEED for my class:	I HAVE:
plastic zipper bag	_____ plastic zipper bags	_____
3 oz. (90 mL) bathroom cup	_____ cups	_____
tablespoon measure	_____ tablespoon measures	_____
1 tablespoon (15 mL) of vinegar	_____ vinegar	_____
2 tablespoons (30 mL) of baking soda	_____ baking soda	_____

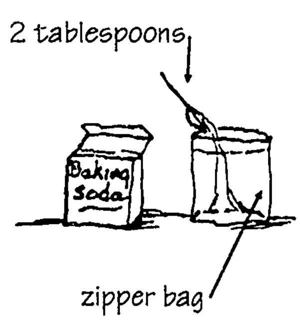

zipper bag


baking soda


cup for vinegar

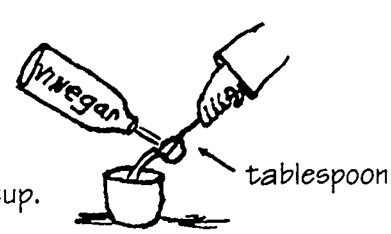

tablespoon

Directions



___ 1. Put 2 tablespoons of baking soda into the plastic zipper bag.

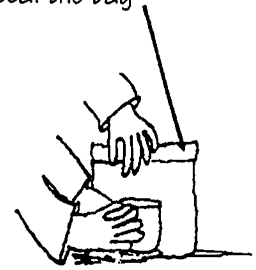
___ 2. Put 1 tablespoon of vinegar into the cup.



Directions, continued

___ 3. Carefully place the cup into the bag without spilling the vinegar.

___ 4. Work with a partner. One person should hold the cup inside the bag and the other person should zip the bag to close it.

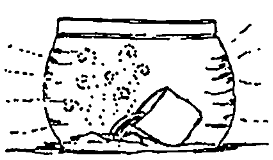


___ 5. Now tip the cup so that the vinegar spills onto the baking soda.

Discussion

What happens? (fizzing, gas is produced, bag expands, bag is colder)

Science Background



Baking soda (also known as sodium bicarbonate) is a base. Vinegar is an acid—acetic acid mixed with water. When the solid baking soda and the liquid vinegar are combined, they react to make the gas carbon dioxide. This is a chemical reaction between an acid and base. The gas that is made takes up more space than the solid or liquid. It is trapped inside the bag as it is made. This increases the pressure on the bag and it expands.

A similar type reaction occurs when a cake is baked and it rises. In this case, baking powder is often used. Baking powder is a mixture of sodium bicarbonate (baking soda) and an acid. When the baking powder is dissolved in the liquid batter, the two components of the powder (the acid and the base) begin to react to form carbon dioxide gas. You might eve. see some bubbles in the batter. When the batter is put in the hot oven, the reaction goes even faster. More bubbles are

Science Background, continued

formed and they expand the batter, making the cake rise. The cake "sets" when it bakes and the little holes formed by the gas remain when the cake cools.

Yeast is used as a leavening agent for breads. Yeast is a living organism that eats the sugars derived from the starches in flour. As the yeast eats, it makes carbon dioxide gas, causing the dough to rise. When you cut some breads you can even see the little holes that were formed by the carbon dioxide bubbles.

Extensions

What happens if you **change the amount of vinegar** that is used?

What happens if you **change the amount of baking soda** that is used?

Mix grape juice and yeast. Put 1/2 cup (100 mL) of unsweetened grape juice and 1/2 package of rapid rise yeast in a quart zippered plastic bag. Squeeze the air out of the bag and seal it. Put the bag in a sink or in a large plastic container. (Grape juice stains if the bag leaks!) Observe what happens to the bag over a 24-hour time period.

Connection

Read *Stega Nona's Magic Lessons* by Tomie de Paola.

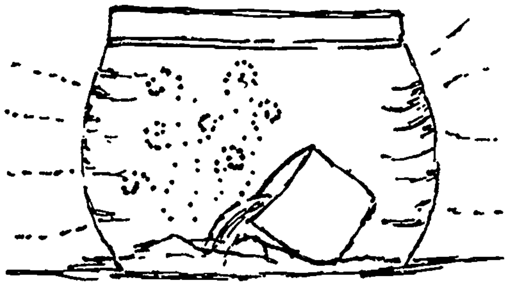
How does making the gas carbon dioxide relate to **baking cakes and breads?**

References

de Paola, Tomie. *Stega Nona's Magic Lessons*. Harcourt Brace Jovanovich. 1982. ISBN #0-15-281786-7.

McKean, Pat. The yeast and grape juice extension. Personal communication. ICE Super Science Connections Workshop. 1994.

What happens when you change....



The amount of vinegar?

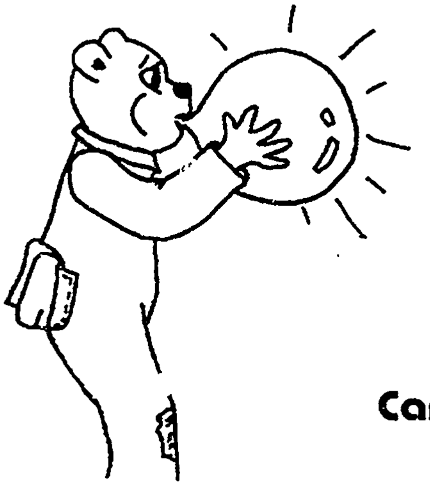
The amount of baking soda?

Names of the scientists

124

ICE,

Topic: Pressure



Bet You Can't

Can you blow up a balloon?

Materials ✔ List	I HAVE:
balloon	____
2 liter soda bottle	____

Directions

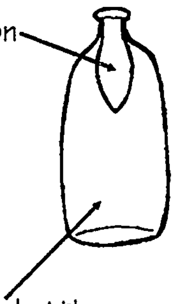
➲ SAFETY FIRST: Only an adult, not the children, should blow up the balloon.

____ 1. Stretch the balloon several times.

____ 2. Blow it up without tying it shut.

____ 3. Release the air. Hold your hand over the opening.

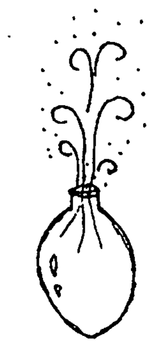
Directions, continued



___ 4. Next, hold onto the open end of the balloon and put the other end *inside* a 2 liter soda bottle. Stretch the balloon over the mouth of the bottle.

___ 5. Try to blow up the balloon now.

Discussion



What happens when the air rushes out of the balloon? (You can feel it.)

Can you blow up the balloon inside the bottle? (No) Why not? (The air trapped between the balloon and the jar exerts pressure.)

Science Background

A balloon expands when it is blown up because of the increase in pressure from the gases put inside the balloon. Outside the balloon, the molecules in the air are free to move away as the balloon expands. But the air inside the bottle is trapped when the balloon is stretched over the mouth. Now, when you try to expand the balloon, the molecules of air inside the bottle cannot move away (get out of the bottle) and you cannot blow up the balloon.

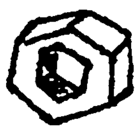
Topic: Pressure

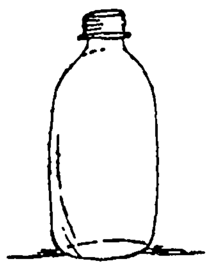
A Tony the Tiger™ Diver

How does pressure change the volume of air?

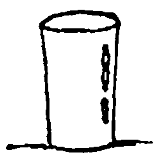
Materials ✔ List (per student)	I NEED for my class:	I HAVE:
1 liter (or 20 oz.) clear plastic soda bottle with cap	_____ soda bottles, w. caps	_____
plastic pipet* or any plastic dropper	_____ pipets or droppers	_____
hex nut—brass, stainless steel, or galvanized—size 12/24 for the pipet model suggested above	_____ hex nuts	_____
plastic cup	_____ plastic cups	_____

* Available from: Micromole Scientific, Flinn, Educational Innovations, or Wren Enterprises.


hex nut


1 liter plastic bottle


pipet

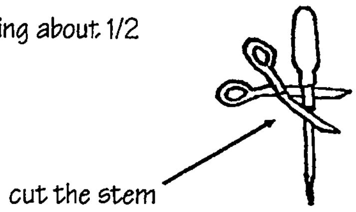

plastic cup

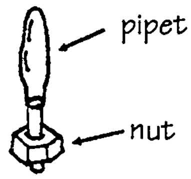
Directions

We suggest this activity as a parent/child project during an evening activity at school. Alternatively, students in the older elementary grades can help the younger children with the construction.

___ 1. Remove the label on the soda bottle so that you can see inside it. Put enough water in the bottle to fill it nearly to the top.

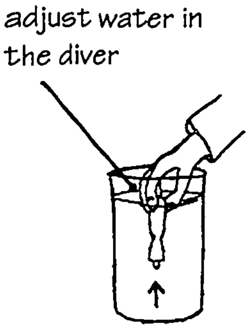
___ 2. Cut off the stem of the pipet, leaving about 1/2 inch (1 cm) below the bulb.





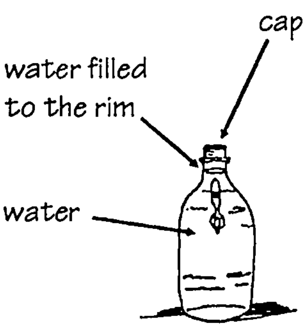
___ 3. Screw the hex nut onto the pipet. If the fit is not quite tight enough, you can use a hot glue gun to glue the nut to the plastic. Be careful not to melt the stem or to close the bottom of the dropper when you do this.

___ 4. This combination of pipet and hex nut is one way to make a Cartesian diver (named after the French mathematician, René Descartes).



___ 5. To use the Cartesian diver, you must fill it with just the right amount of water and air. Put water into the plastic cup—enough so that the diver will float in the water.

___ 6. Now you have to adjust the amount of water in the Cartesian diver so that it just barely floats. Squeeze the diver to force out some of the air and then keep its tip in the water, so that as you release the diver, water is drawn into the diver. Repeat until the bulb of the diver has enough water in it so that the top barely stays above the surface of the water. If the diver is high in the water, it needs more water inside. If the diver sinks, it needs more air inside. To redo if more or less water is needed, squeeze out all the water and begin again!



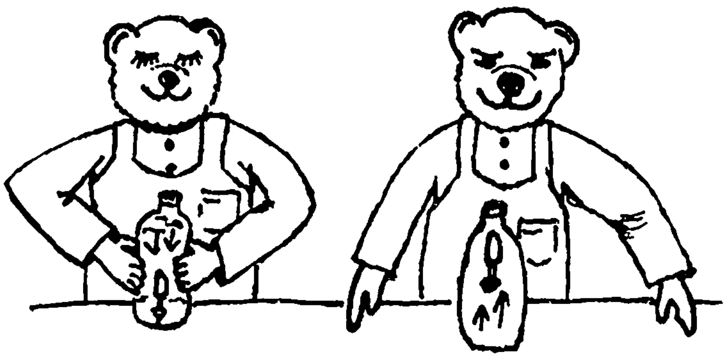
___ 7. Move the diver from the cup to the soda bottle, taking care not to lose any water from the diver. The diver should barely float. If not, readjust the amounts of water and air as in step 5. Add water to the bottle so that it is filled to the rim. Screw on the cap.

Directions, continued

___ 8. Squeeze the bottle. The diver will descend. Relax your hold on the bottle and the diver will rise. Watch what happens to the water level INSIDE THE DIVER as it descends and rises in the bottle.

Science Background

Cartesian divers have a small amount of air trapped at the top of the dropper. The rest of the dropper is filled with water and the dropper is open at the bottom to the water in the soda bottle. The soda bottle is completely filled with water. When the soda bottle is squeezed, the air in the dropper is compressed because of the increased pressure, and it takes up less space. This causes more water to go inside the dropper, which makes it more dense than water alone, and it sinks. When the pressure is released by letting go of the bottle, the air in the dropper expands. This forces some water to go outside the dropper, which makes it less dense than the water alone and it floats. The amount of air and water in the dropper to begin with is critical for this to work. You need just enough water so that it barely floats. This is the reason for the adjustments in a cup of water before putting it into the soda bottle. Sometimes changes in air pressure will make the dropper sink after a few days, and you will have to readjust it so that the diver will work as described.



Extensions

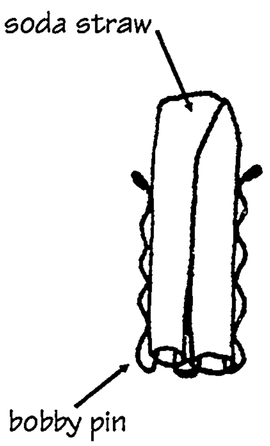
Directions for all kinds of **variations on this basic diver** are published in the *ICE Fun with Chemistry Guidebook* cited in the reference section below. You can make sharks, a Cartesian retriever, and play underwater basketball!

Extensions, continued

A toy called a **Squidy** that is a Cartesian diver covered with plastic so that it looks like a squid is available from Micromole, Wren Enterprises, Flinn or Edmund Scientific. **Tony the Tiger™** toys that are Cartesian divers were given away in Frosted Flakes cereal boxes a number of years ago. They are in demand by toy collectors.

Another Extension

A Cartesian diver made from easy-to-find materials is described in *The Chemical World* by Kotz, et al. All you need is the soda bottle, a plastic soda straw (preferably transparent), and several bobby pins or paper clips.



___ 1. Cut the straw with scissors so that it is about five to six inches long. Fold the soda straw in half and fasten the sides of the two open ends together with a bobby pin or paper clip. Attach two more bobby pins or paper clips to sides of the straw at the open ends to make the diver a little heavier. Be sure to keep the ends of the staw open.

___ 2. Place the straw in the cup of water with the open ends up. Tap or shake the straw until some water flows in.

___ 3. Turn the straw so that the open ends point down and see if it floats. If it floats more than a quarter of an inch above the water, invert it, fill it with more water, and try again. If it sinks, pull it out of the water, let a drop or two of water fall out of the straw and try again. You want just enough water in the straw so that it barely floats.

___ 4. Transfer the straw to the soda bottle filled with water, trying not to lose any water from the straw. If the diver floats too high or sinks, readjust the amount of water in the straw, as in step 3.

___ 5. Squeeze the bottle and watch the diver descend. Let go and it rises.

Connections

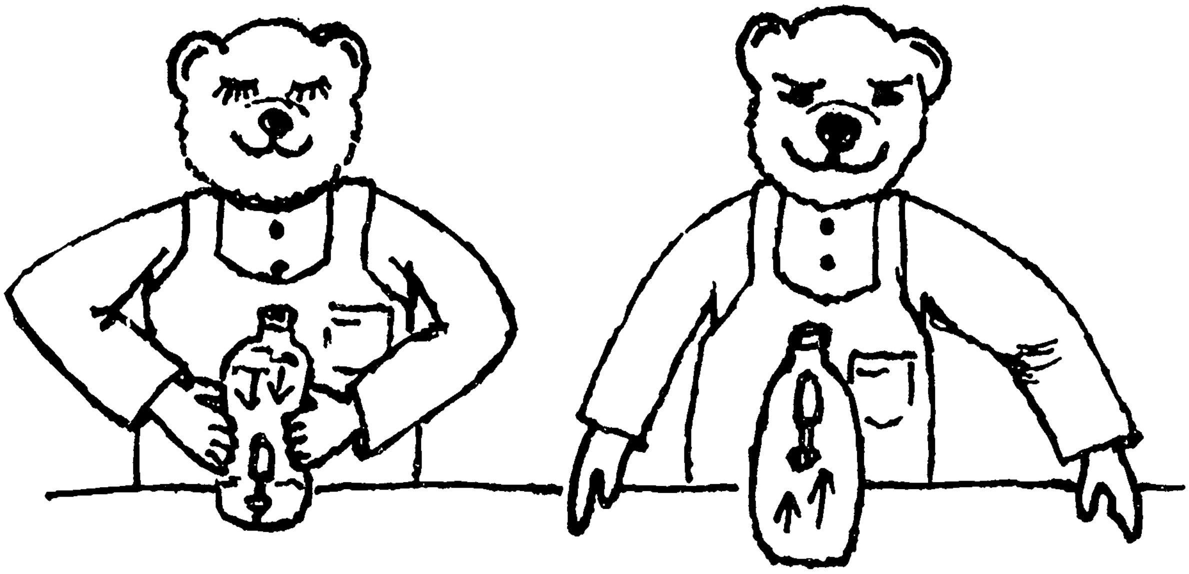
Read *David Bushnell and His Turtle* by June Swanson.

References

Kotz, John C., Joesten, Melvin D., Wood, James L., and Moore, John W., *The Chemical World*, Saunders College Publishing, Harcourt Brace & Co., 1994, p. 509. ISBN #0-03-094659-X.

Sarquis, Mickey and Sarquis, Jerry. *Fun with Chemistry: A Guidebook of K-12 Activities, Vol. 2, Institute for Chemical Education. University of Wisconsin–Madison, 1993. Activities 73 through 78.*

Swanson, June, *David Bushnell and His Turtle*. Macmillan, 1991. ISBN #0-689-31628-3



What happened when you squeezed the bottle?

____

____

What happened when you let go of the bottle?

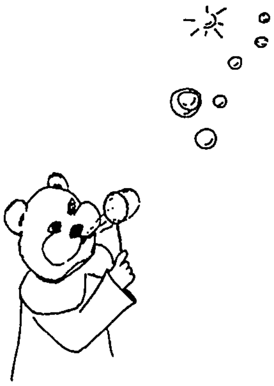
____

____

Names of the scientists ______________________

Surface Tension

Science Concepts



The activities in Surface Tension include these science content concepts:

> ➢ Surface tension is a property of liquids.
>
> ➢ Substances exist that increase or decrease the surface tension of liquids.
>
> ➢ Surface tension influences the shape of bubbles and drops of liquids.

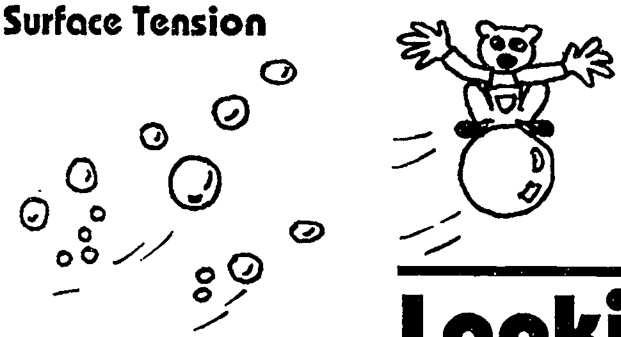
Benchmarks

Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think. Sometimes scientists have different explanations for the same set of observations. That usually leads to their making more observations to resolve the differences.
Chapter 1: The Nature of Science
Section B: Scientific Inquiry Grades 3–5, page 11

Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure, and make things.
Chapter 3: The Nature of Technology
Section A: Technology and Science Grades K–2, page 44

Things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them.
Chapter 4: The Physical Setting
Section D: Structure of Matter Grades K–2, page 76

Topic: Surface Tension

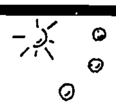


Looking at Lather

How Do Bubbles Behave?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
5 cups (1.2 L) of water	_____cups of water	_____
1/2 cup (120 mL) dish washing liquid (e.g. Dawn™)	_____ cups dish washing liquid	_____
1/4 cup (60 mL) glycerin* (optional)	_____ cups glycerin	_____
baby food jars (for bubble solution)	_____ baby food jars	_____
pail	_____ pail	_____
pipe cleaners	_____ pipe cleaners	_____
straws	_____ straws	_____
sponges (for clean-up)	_____ sponges	_____
powdered tempera paints (for Connection)	_____ tempera paint	_____

* Available from a drugstore or pharmacy



Directions

___ 1. In a pail, mix the water, dish washing detergent, and glycerin in the proportions given above. This mixture can be saved and reused. Stir gently to try to avoid getting froth on the top. Pour into the baby food jars.

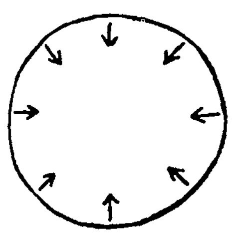
Directions, continued

___ 2. Make a bubble wand from a pipe cleaner by bending one end of the pipe cleaner into a small loop, about 1/2 inch (1.2 cm) in diameter.

___ 3. Clear the table or desk top. Lightly coat the top of the table with the bubble solution. Use the bubble wand to blow some bubbles onto the table top.

___ 4. Make a small puddle of bubble solution on the table top. Insert a straw into the puddle at an angle and blow into it. When the bubbles pop, they leave a ring that can be measured. Measure the diameter of the bubbles made on the table top. Who made the biggest bubble? Who made the smallest? How can you control the size of the bubble?

Science Background

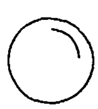


surface tension

The molecules in water are attracted to each other. This creates a surface tension. Surface tension is like stretched skin or stretched elastic. Adding soap to the water lessens the force that attracts the water molecules to each other, i.e. it lowers the surface tension. This makes the water "more stretchable".

A bubble is a soap film with air inside it. When it breaks, a hole in the soap film develops into a tear, and the air escapes. Glycerin helps to keep the bubbles from drying out as fast so that they last longer. Bubbles made from water only don't last. The bubble wall is too thin and it evaporates too quickly.

Colors appear on the surface of the bubbles because different thicknesses of the film reflect the light differently. (See the "Rainbow Grid and Goggles" activity in the Color and Light unit.) You can usually see that the color changes to black just before the bubble pops.

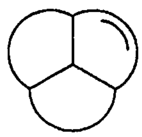


bubble in air

bubble on table (side view)

Why are soap bubbles round? A soap film will shrink to the shape that gives it the smallest possible surface area. A sphere is the geometrical shape that has the smallest surface area for a particular volume. Just as a drop of water gets a rounded surface, so the film of a bubble will form a rounded surface in air. It doesn't matter what the shape of the wand is—after the bubble forms it will be rounded. On a flat surface, the bubble takes on a shape of a half of a sphere (a hemisphere). The bubble is flat where it touches the desk surface because the soapy water is attracted to the desk. This attraction overcomes the attraction of the water molecules to each other and, consequently, overcomes the tendency of the bubble to be rounded. If the

Science Background, continued

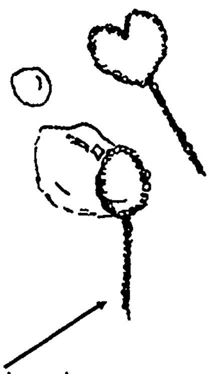


a bubble cluster
on table (top view)

water molecules were not attracted to the desk at all, the bubble would sit like a ball on the desk! Likewise, you may find that individual bubbles in large clusters have various geometric shapes. The bubbles form straight edges where they touch each other and are rounded elsewhere. This result is a balance between each bubble finding its minimum surface area and the bubble's attraction to other bubbles.

Extensions

Some **books about bubble science** that your class might enjoy using are *The Magic Bubble Trip* by Ingrid and Dieter Schubert, *Soap Bubble Magic* by Seymure Simon, *The Unbelievable Bubble Book* by John Cassidy, *Bubbles* by Kimberly Robinson, *Bubble Bubble* by Mercer Mayer and *Bubble Festival*, a Lawrence Hall of Science GEMS Guide. The ideas for Bubble Technology began with the GEMS Guide—some are from the Guide, others were added as we experimented.

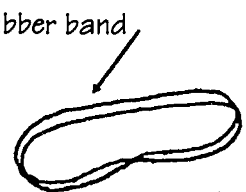


pipe cleaner

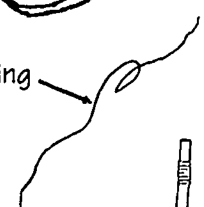
Bubble Technology I: Have students make their own bubble wands from pipe cleaners. Some questions for the students to investigate are:

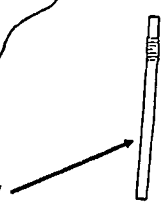
How do two bubbles join?
Can you join three bubbles?
Can you form a cluster of bubbles?
Can you form a tower of bubbles?
Can you make a bubble inside a bubble?
Which takes longer to break—a large or a small bubble?
Do you get different shapes of bubbles if you use a different shaped wand?
What colors do you see on the bubble's surface?
Can you find out what color you will see just before the bubble pops?
Does blowing into or waving the wand make a bubble that lasts longer?

rubber band



string

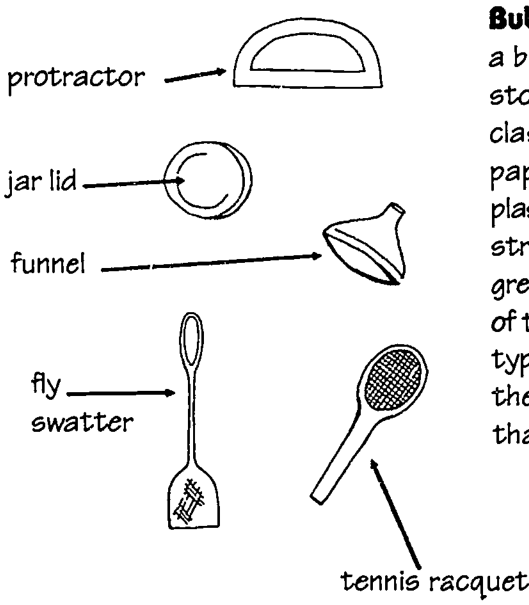




straw

Bubble Technology II: Can you make a better bubble wand than the pipe cleaner? Challenge groups of children in your classroom to work like an inventor to design a bigger, better bubble wand. Some of the things that you might make available are: straws, strings, paper clips, rubber bands, and pipe cleaners. Include some materials that will not work—a spoon or dish, for example. Some of these inventions will have to be tested outdoors! Each group should test their invention and decide if it makes a big bubble, a small bubble, or no bubble at all. See if the class can discover what is the same about all the tools that make bubbles.

Extensions, continued



Bubble Technology III: Can you turn a non-bubble blower into a bubble blower? Look around the grocery store, the drug store, and your home. Challenge groups of children in your classroom to explore protractors, mason jar lids, tea balls, paper towel rolls, a potato masher, a fly swatter, a funnel, plastic rings from a six pack of soda, a wire whisk, or a plastic strawberry basket. A plastic outdoor tennis racket also makes great bubbles. Some of these have to be used outdoors, instead of the classroom, of course! Ask the group to predict what type or size of bubbles they think their wands will make. Have them draw the prediction and then draw the kind of bubble that was actually made.

Connections

Mix some powdered tempera paint with the bubble solution. Form a bubble cluster on a thick sheet of paper using the straw and a small puddle of bubble solution on the paper. From the pattern and shape of the bubbles that develop, draw and name a "bubble beast". **Write a story** about the bubble beast. Create a class-room book by collecting the drawings and stories of the **Bubble Beasts**.

Discuss the language of bubble clusters—foam, lather, froth. Use as many words to describe the bubbles as you can. **Write** a Foam Poem. **Write a story** about the Froth on Top of the Broth. **Write** about what happens if there is Lather on the Ladder!

Write a bubble biography. How is the bubble born? Where does it travel? How does it die? How did the color of the bubble change during its life? **Publish** these biographies in a book. (GEMS Guide, page 136).

Take a trip to a retirement or nursing home and enjoy sharing the bubbles with the residents.

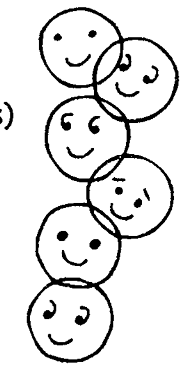
Find out about **animals that make bubbles** and why they make the bubbles. Some examples are spiders, spittle bugs, and frogs.

Connections, continued

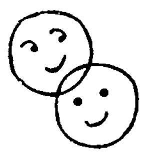
In connection with the bubble technology extensions, share examples of inventions like the story of the Frisbee™, from *Mistakes That Worked* by Charlotte Foltz Jones, page 35. Talk to the children about how an invention is thinking about things in a new way. Perhaps you could organize an **Invention Convention.**

Read *Show and Tell* by Elvira Woodruff.

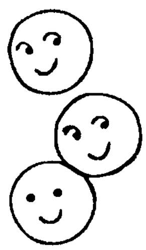
Sing these bubble songs with the class. These songs are from page 4 of Project L•A•B•S: Learning About Basic Science by Frederick Owens.

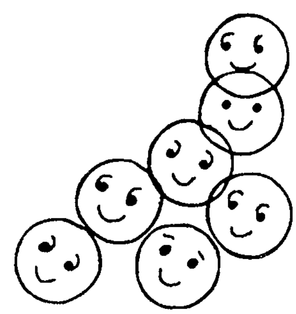


Little Bubbles
(tune of One Little, Two Little, Three Little Indians)



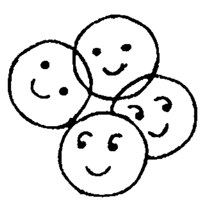
One little, two little, three little bubbles
four little, five little, six little bubbles,
seven little, eight little, nine little bubbles,
ten bubbles gliding in the air!

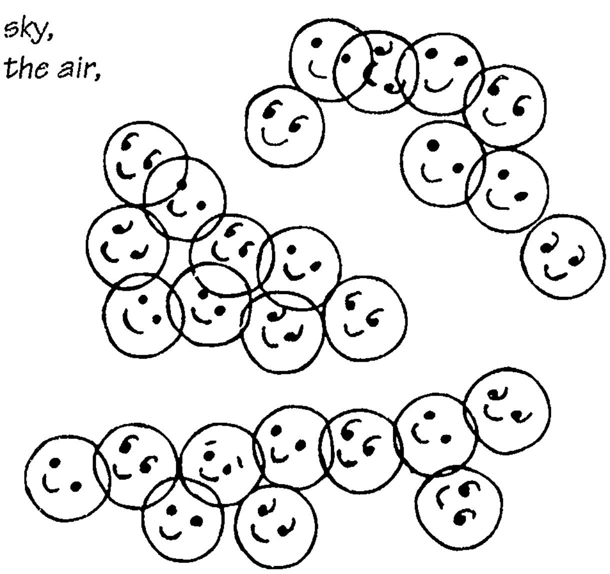


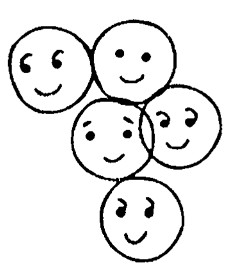


Floating Bubbles
(tune of Frere Jacques)

Floating bubbles,
floating bubbles,
see them go,
see them go,
reaching for the sky,
drifting through the air,
free at last,
free at last.







References

Barker, Jacqueline and Willard, Carolyn. *Bubble Festival.* LHS GEMS Guide. Lawrence Hall of Science. University of California. 1992. ISBN #0-912511-80-X

Cassidy, John. *The Unbelievable Bubble Book.* Klutz Press. 1987 (with David Stein, inventor of the Bubble Thing). ISBN #0-832592-15-5

Jones, Charlotte Foltz. *Mistakes That Worked.* Doubleday, 1991. ISBN #0-385-32043-4

Mayer, Mercer. *Bubble Bubble.* Parents' Magazine Press, 1973. ISBN #0-819306304/0-819306312

Owens, Frederick H. *Project LABS: Learning About Basic Science.* Rohm and Haas Company, 1990.

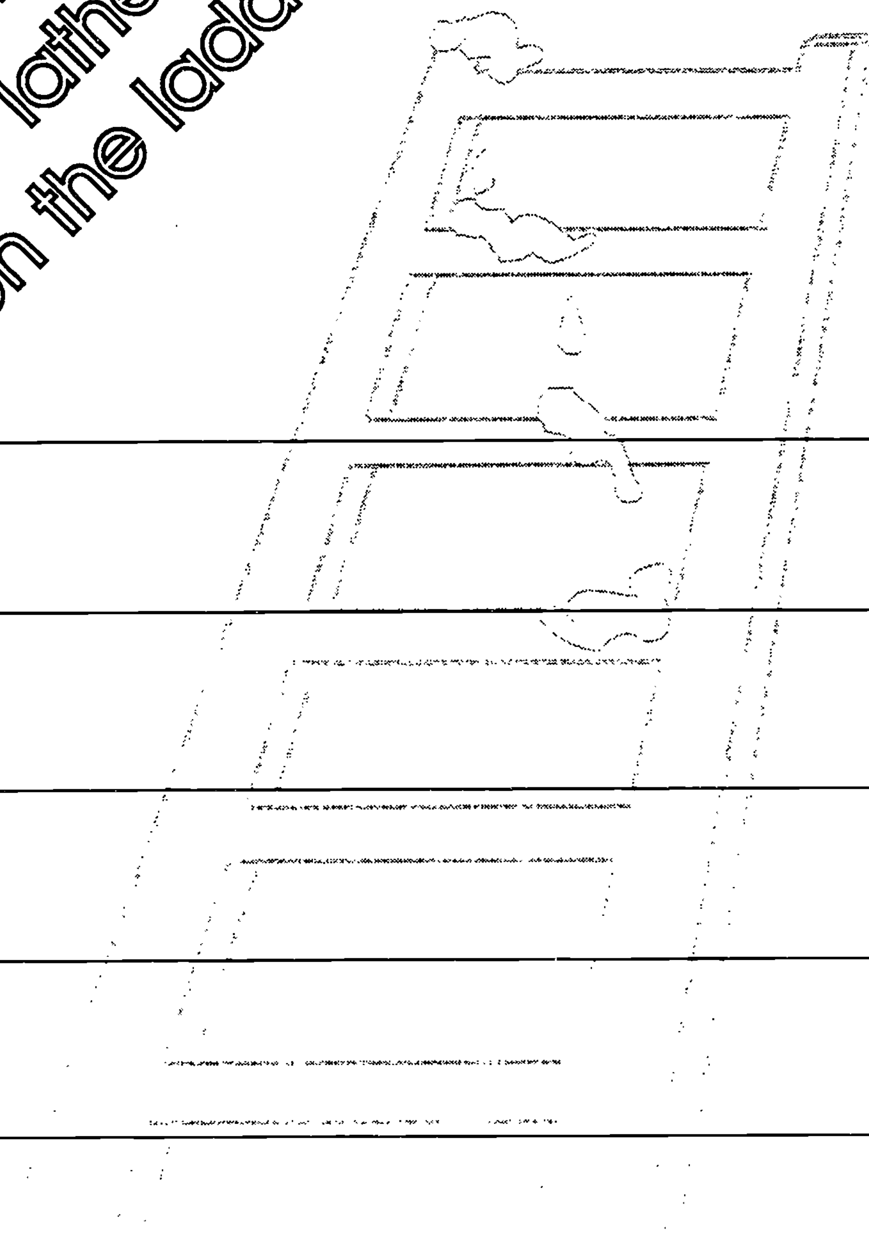
Robinson, Kimberly. *Bubbles.* Teacher Created Materials, Inc., 1991.

Schubert, Ingrid and Schubert, Dieter. *The Magic Bubble Trip.* Kane Miller Books, 1985. ISBN #-0-916291-03-0

Simon, Seymour. *Soap Bubble Magic.* Lothrop, Lee & Shepard Books, 1985. ISBN #0-688-02685-0

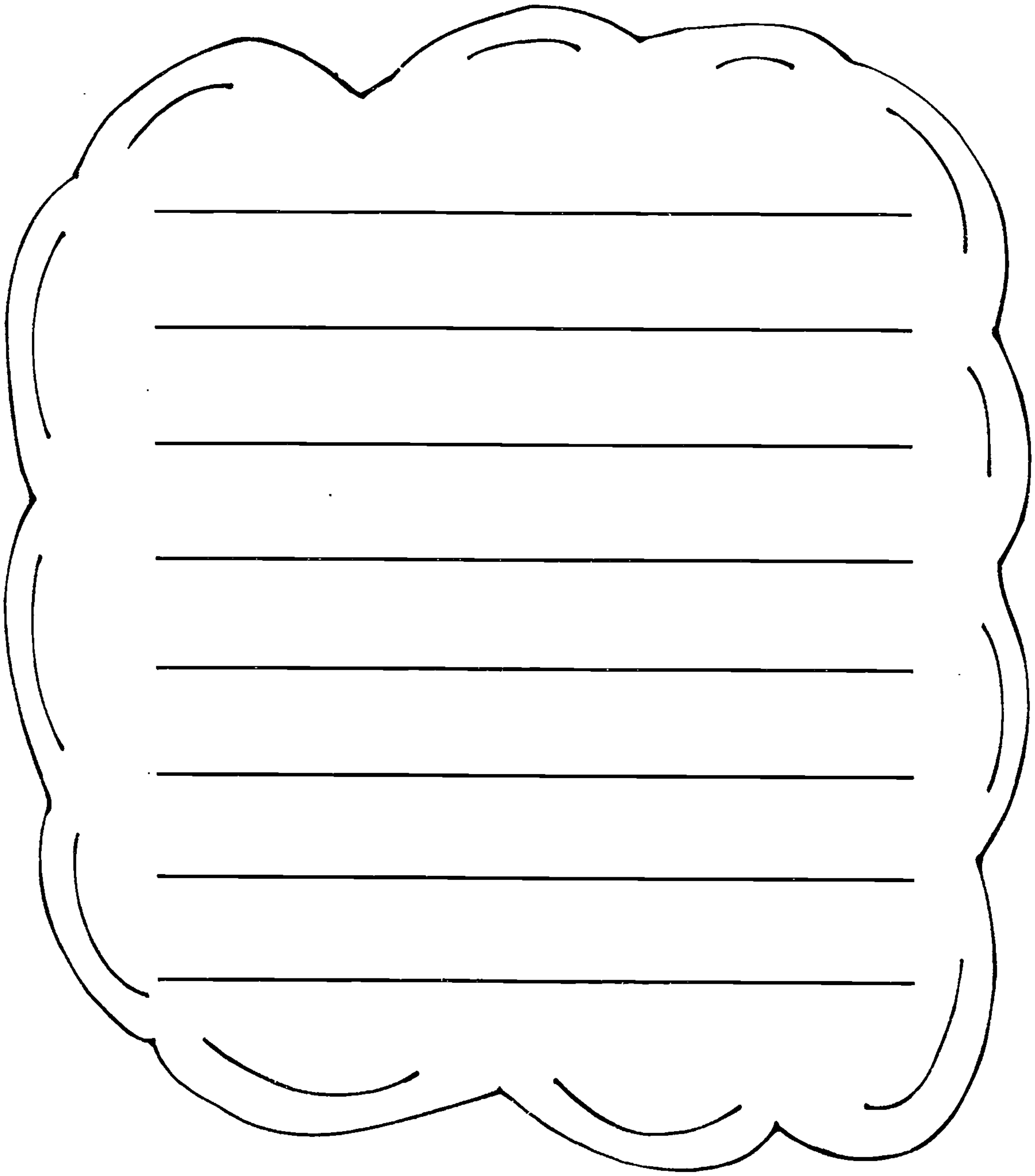
Woodruff, Elvira. *Show and Tell.* Holiday. 1991. ISBN #0-8234-0883-3.

What happens if there is... lather on the ladder?



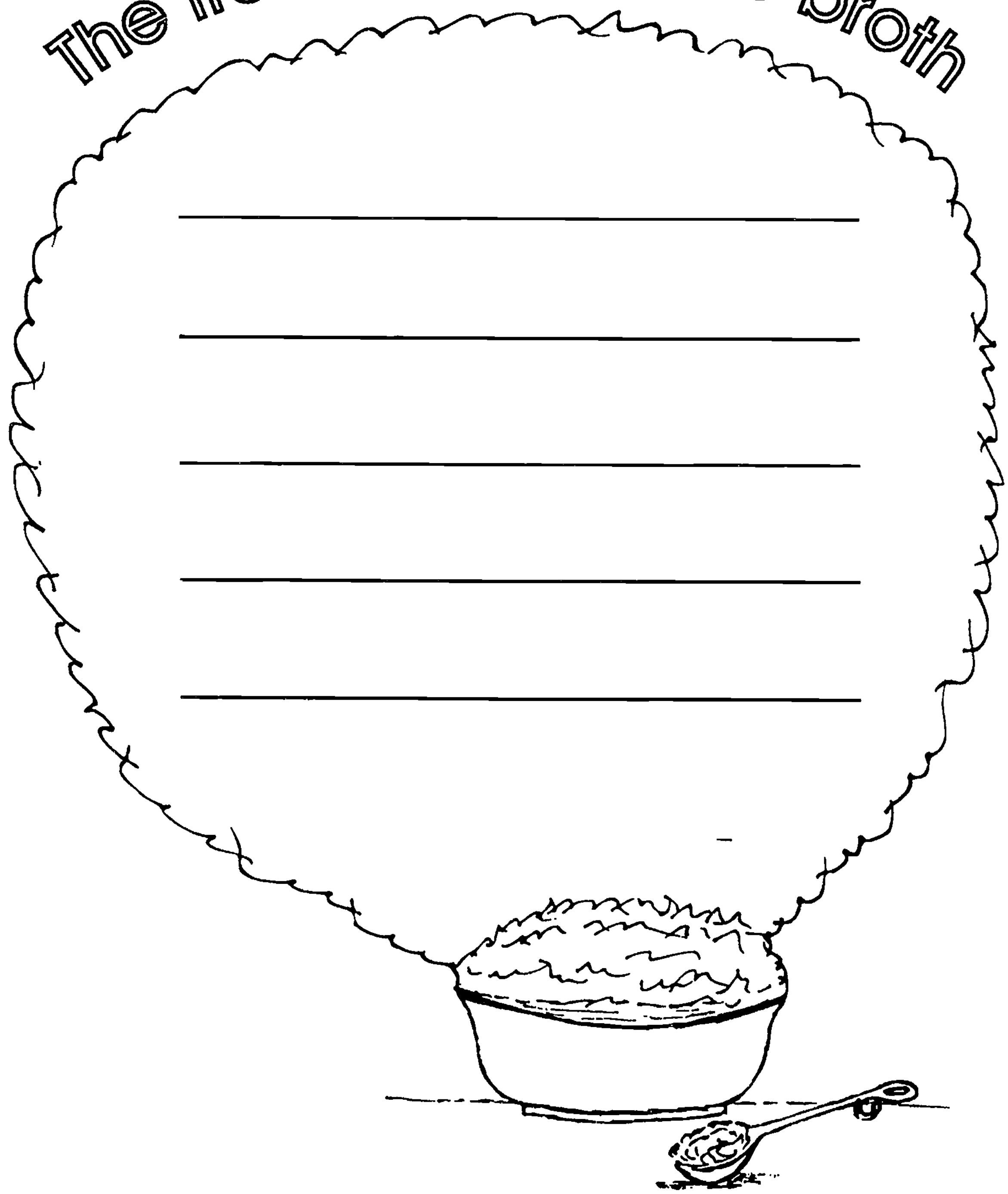
Name ______________________

Write a Foam Poem!



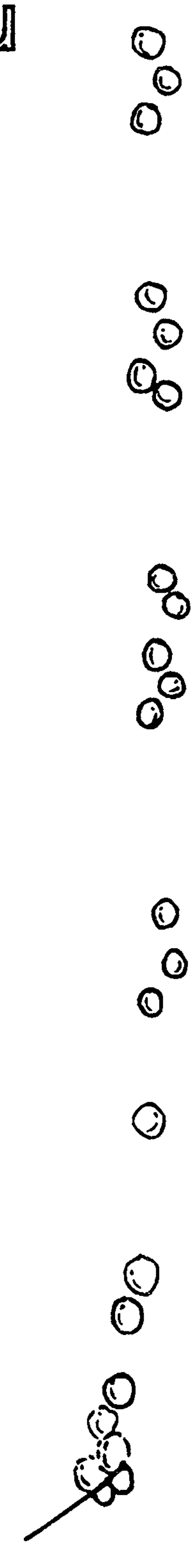
Name ______________________

The froth on top of the broth



Name ______________________

Draw the bubble shape you think your blower will make.



Draw the bubble shape your blower really made.

Names of the scientists ____________________

Topic: Surface Tension

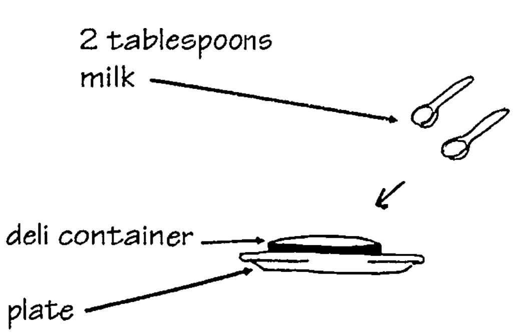
The Milk Explosion

How do we find out about things?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
paper plate	_____ paper plates	_____
clear deli container or plastic petri dish	_____ containers/petri dishes	_____
2 tablespoons whole milk at room temperature	_____ tablespoons whole milk	_____
toothpick	_____ toothpicks	_____
set of food coloring	_____ sets of food coloring	_____
1 teaspoon dish detergent	_____ teaspoons dish detergent	_____
in a small cup	_____ small cups	_____

(You may want to tell the class that the dish detergent is a "mystery" liquid.)

Directions



____ 1. Place the deli container or petri dish on a paper plate for easier cleaning of any spills. Pour the milk into the deli container or petri dish.

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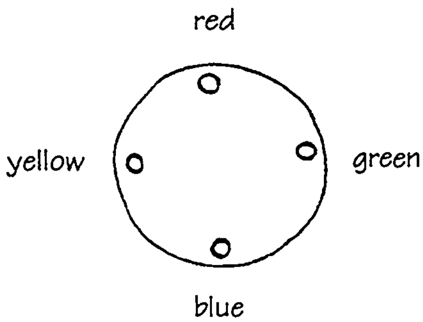
Directions, continued

top view of the milk



food coloring drops

___ 2. Place the food coloring drops into the milk. Pretend that the dish is a clock face. Put a drop of red food coloring at 12 o'clock, a drop of green at 3 o'clock, a drop of blue at 6 o'clock and a drop of yellow at 9 o'clock.

___ 3. Allow the milk and food coloring to sit undisturbed for one minute.

___ 4. Touch the toothpick to the center of the milk to see what happens.

___ 5. Now dip the toothpick into the dish detergent in the small cup.

___ 6. Touch the toothpick to the center of the milk again.

___ 7. Watch what happens. Enjoy!

___ 8. Watch for changes over a period of time. Put the toothpick in the milk again.

Science Background

surface tension before

Part of the explanation for the "milk explosion" is that the detergent affects the surface tension of the milk. The surface of any liquid behaves like a slightly stretched piece of elastic because of an unbalanced pull on the molecules on the surface. They are being pulled toward the center of the liquid by the other molecules. This unbalanced pull is called the surface tension. The higher the attraction of the molecules for each other, the higher the surface tension is in the liquid. The surface tension is the reason that water "beads up" into drops on a surface that doesn't absorb the water.

surface tension after

Detergent weakens the surface tension of the milk at the spot where it is added. This change in surface tension causes the molecules in the milk to move and the detergent to spread out across the surface. As the detergent spreads, a larger surface area of milk is affected. Different

Science Background, continued

students will get different patterns. Scientists think this is because in each dish there are different currents of motion within the milk. The food coloring is there to make the motion of the milk visible.

Fat is necessary for the experiment to work. While scientists know that the surface tension is involved, and that fat is necessary, they are not sure how this experiment works. There are several theories. Emphasize to the class that science is a way of finding out about things. Scientists do not have all the answers! Scientists observe something happening and then try to explain how it works. This explanation is called a theory or hypothesis. Then scientists do another experiment to see if the theory might be part of the answer.

Extensions

You can do additional experiments to help the students discover some of how this "milk explosion" works. Instead of explaining, note that scientists do not know how it works, and encourage them to imagine how they think it works. Three liquids are used—the food coloring, the detergent, and the milk. To find out the role of each of the three, you can change one at a time and see what happens. Another word for change is vary (variable). Each of the three liquids is a variable in the experiment.

First, **change the milk.** Instead of whole milk, use half and half, 2% milk, 1% milk, powdered skim milk, and heavy cream. The variety of milk used here will illustrate that fat is necessary for the interaction of the milk and the detergent. It is critical that traces of detergent do not remain on the dish from trial to trial. Be sure to rinse thoroughly. The variable in each of these experiments is the type of milk that is used. All the other factors remain the same. This way the scientist can investigate the relationship between the one variable and the observed change.

Next, **vary the "mystery" liquid**. The purpose is to imagine and then test what the "mystery" liquid might be. Students usually predict immediately that the "mystery" liquid is a detergent. In the experiment the students can contribute a household liquid that they think the mystery liquid might be. Tell them that the "mystery" liquid is something they would find in their home in the kitchen or bath or with the cleaning supplies. Tell them also that it is something that is safe for them to handle and emphasize that they should not bring anything from home that is not safe. Tell the students that the containers for each liquid MUST be labeled. A wide variety of soaps,

Extensions, continued

shampoos, and detergents will behave similarly on the surface of the milk. This is because the detergent affects the surface tension.

It is likely that the students will not be able to identify exactly the brand of detergent that you used in the experiment unless it has a distinctive color or odor, but they can usually come close by identifying the type—dish detergent, shampoo, soap, etc. If they are able to identify a group of liquids that behave the same way on the surface of the milk, then they are thinking in the same way as a scientist or chemist who identifies an unknown substance. First, to what group does it belong?

The third variable is the food coloring. Use only one drop of one of the food colors. Repeat with the other colors. Repeat without any food coloring at all. The same reaction occurs with only one of the colors as when you had all four colors in the milk. The colors are there to make it possible to "see" the motion of the molecules as the surface tension changes. The same interaction occurs when the detergent is added to the milk without any of the colors. It is not possible to "see" it, however, by just looking at it without any colors.

Connections

Draw the color pattern that develops on the surface of the milk. It will change over time. You can also make a picture of the pattern by carefully placing a paper towel on top of the milk for a brief time and then removing it and allowing it to dry.

Pretend you have received a letter from a scientist. **Write** a letter to explain how you think the experiment works. **Give a name** to this experiment.

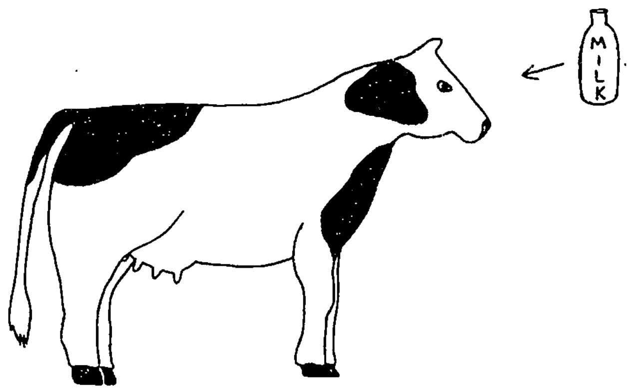
Read stories from *Mistakes that Worked* by Charlotte Foltz Jones to illustrate that invention is thinking about things in a new way.

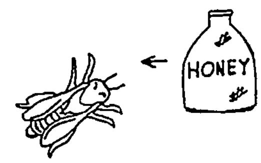
Find out about the word "variable".

Find out about milk as food. Milk and honey are the only two substances made by animals whose only purpose is to serve as food for the same animals. What animals provide milk for their babies? Why does the cafeteria serve milk instead of soda at lunch? Make butter in the classroom and eat it on crackers. *The Amazing Milk Book* by Catherine Ross and Susan Wallace will be a good resource for facts about milk. If possible, arrange a trip to a dairy farm or a manufacturing plant for ice cream. Another book that your class

Connections, continued

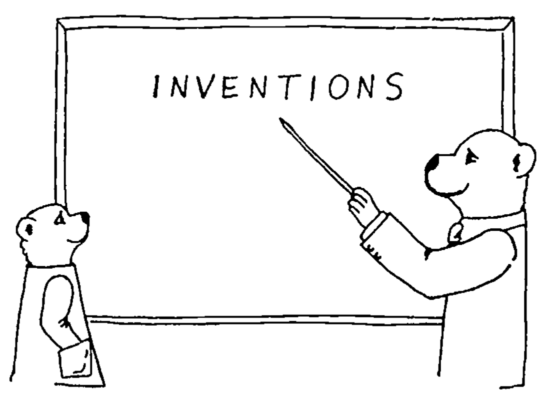
might enjoy about milking and cows is *The Smallest Cow in the World* by Katherine Paterson.





More Connections

As a culminating activity, have the class organize and present a **science convention**. At a science convention, scientists report their discoveries and discuss their work with each other. Sometimes the scientist gives a speech, sometimes he/she writes a paper, sometimes the scientist makes a poster, and sometimes the scientist gives a demonstration. Your class might choose all or one of these ways to report their work. There are always people in the audience who ask questions of the scientist. Sometimes reporters are there to write a story for their newspaper.



More Connections, continued

Instead of a convention, the children could record all their work and compile it later into a classroom **science newspaper** with a title like "Kid Scientists Explore Variables". These connections can be integrated with the use of the computer for drawing and writing, etc., if a computer is available for your students.

References

Jones, Charlotte Foltz. *Mistakes That Worked.* Doubleday. 1991. ISBN #0-385-32043-4

Paterson, Katherine. *The Smallest Cow in the World.* Harper Collins Children's Books. 1991. ISBN #0-06-444164-4

Ross, Catherine and Wallace, Susan. *The Amazing Milk Book.* Addison-Wesley Publishing, 1991. ISBN #0-201-57087-4

1·9

ICE,

Date ____________________

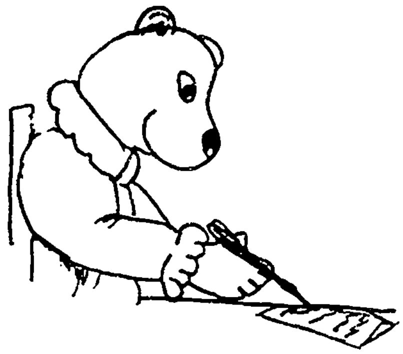
Dear Experimenters:

I know that you did an experiment today with food coloring, milk, and a "mystery" liquid. I have also done this experiment, and I really don't know how it works. I would appreciate if you could tell me what experiments you did, and how you think it works. Are there any other experiments you think I should try?

I look forward to hearing from you. Thank you for sharing your theories with me.

Sincerely yours,

I. N. Vestigate
Chairperson
Science Department
Research University



Write a letter

How the experiment works...

____

____

____

____

____

____

A name for this experiment is...

____

Name ______________________

"Milk explosion!"

What happened when you changed milk?

half and half ______________________________

2% milk ______________________________

1% milk ______________________________

powdered skim milk ______________________________

heavy cream ______________________________

What do you think the "mystery" liquid is?

____

____

Names of the scientists ______________________

The record of our experiment

Type of milk	We predict that	This is what happened
Whole milk		
Half and half		
2%		
1%		
Nonfat dry milk		
Cream		

The pattern we see is:

____

____

Names of the scientists ______________________

The record of our experiment

Type of "mystery" liquid used	We predict that	This is what happened

What we have learned is:

____

____

Names of the scientists ____________________

Dear Parents:

We are investigating a "mystery" liquid in your child's class tomorrow. I have asked each child to bring one example to class. Please allow your child to bring one tablespoon of a liquid that he/she chooses to school in a plastic container that you do not need to have returned.

I have told the class that the "mystery" liquid is something from the kitchen or bathroom of a home. The "mystery" liquid is also something safe for children of this age to handle. If you would not allow your child to handle this material in your home, do not send it to school.

Please be sure that you write the name of the liquid that you choose on the container. When the class discovers the "mystery" liquid, I am sure your young scientist will want to show you this experiment at home. Ask him/her about it tomorrow after school!

Thanks for cooperating in your child's education!

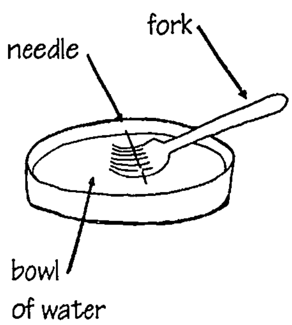
Topic: Surface Tension

A Needle Floats

Can a needle float on water?

Materials ✔ List (per student or group)	I HAVE:
bowl of water	____
needle	____
fork	____

Directions



___ 1. Lay the needle across the tines of the fork.

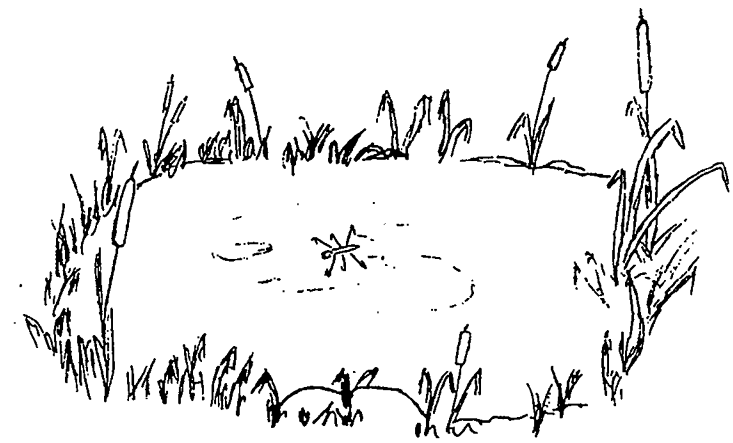
___ 2. Carefully place the fork into the water. Take the fork away and the needle will float off of the fork and remain on the surface of the water.

Science Background

The surface tension of the water or its "skin" can support the needle and keep it floating. If you put the needle into the water by breaking the surface tension (e.g. point first), then the needle will sink. The needle is more dense than the water, and would be expected to sink. However, the surface of the water can support it because of the force of surface tension.

Connection

Find out about the insect called a pond skater. How does this insect use surface tension?



Reference

Walpole, Brenda. *175 Science Experiments to Amuse and Amaze Your Friends.* Random House. 1988. page 27. ISBN #0-394-89991-1

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ICE,

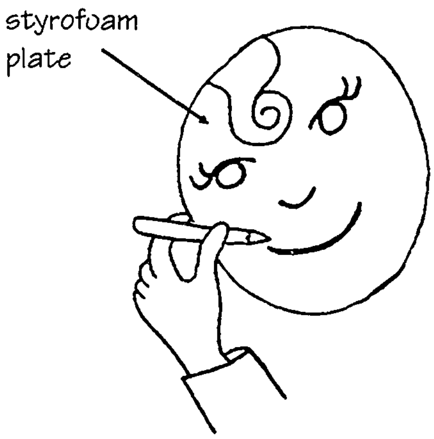
Topic: Surface Tension

Freckle Face

Can you make freckles disappear?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
styrofoam plate	_____ styrofoam plates	_____
crayons	_____ crayons	_____
pepper shaker	_____ pepper shakers	_____
toothpick	_____ toothpicks	_____
bathroom cup with bit of dish detergent	_____ bathroom cups with bit of dish detergent	_____
1/4 cup (60 mL) water	_____ water	_____

Directions



___ 1. Draw a face on the top of the Styrofoam plate with crayons (NOT markers).

___ 2. Cover the plate with water about 1/4 inch (0.6 cm) deep.

___ 3. Sprinkle pepper onto the water (the freckles).

___ 4. Dip a toothpick into the dish detergent.

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Directions, continued

___ 5. Touch the toothpick to the surface of the water. Observe.

___ 6. Send the plate home so the students can show their parents.

Discussion

What happened to the freckles?

Science Background

The pepper floats on the water because of the surface tension of the water. The detergent breaks this surface tension as it spreads out onto the water from the toothpick.

Connections

Read *Freckle Juice* by Judy Blume.

References

Blume, Judy. *Freckle Juice.* Dell Publishing Co., Inc. 1978. ISBN #0-440-42813-0

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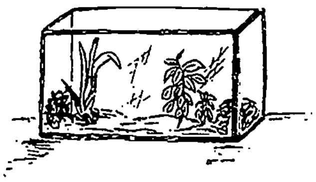
ICE,

Water

Science Concepts

The activities in Water include these science content concepts:



- Water is necessary for the survival of all living things.
- Water is a substance that can easily change from one state of matter to another. Physical properties of water can change when the temperature changes.
- Our water supply is recycled through the earth's water cycle.
- Different substances interact differently with water.

Benchmarks

These benchmarks from *Benchmarks for Science Literacy* apply to this unit:

Some events in nature have a repeating pattern. The weather changes from day to day, but things such as temperature and rain (or snow) tend to be high, low, or medium in the same months every year.
Chapter 4: The Physical Setting
Section B: The Earth Grades K–2, page 67

Water can be a liquid or a solid and can go back and forth from one form to the other. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing.
Chapter 4: The Physical Setting
Section B: The Earth Grades K–2, page 67

Benchmarks, continued

Water left in an open container disappears, but water in a closed container does not disappear.
Chapter 4: The Physical Setting
Section B: The Earth Grades K–2, page 67

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.
Chapter 4: The Physical Setting
Section B: The Earth Grades 3–5, page 68

The sun warms the land, air, and water.
Chapter 4: The Physical Setting
Section E: Energy Transformations Grades K–2, page 83

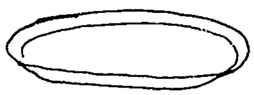
Through science and technology, a wide variety of materials that do not appear in nature at all have become available, ranging from steel to nylon to liquid crystals.
Chapter 8: The Designed World
Section B: Materials and Manufacturing Grades 3–5, page 188

Topic: Water and Changing Its State

No Hands!

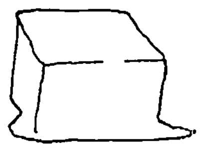
Can you lift an ice cube with string and some salt?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
one ice cube on a paper plate	_____ice cubes	_____
	_____paper plates	_____
two pieces of string or thread, each 6" (15 cm) long	_____6" pieces of string	_____
1 tsp. (5 mL) salt in a bathroom cup or salt shaker	_____teaspoon measure	_____
	_____salt	_____
	_____bathroom cups or shakers	_____
water in a small cup	_____water in a small cup	_____



plate


string

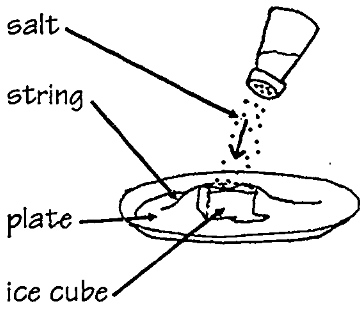

ice cube

Directions

___ 1. Give each group an ice cube, ONE of the pieces of string, the salt, and a small cup of water.

___ 2. Challenge each group to find a way to lift the ice cube with the string and/or the salt. They may not use their hands to hold the ice cube while it is lifted.

Directions, continued



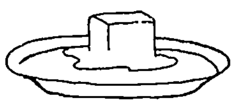
___ 3. Show the class how to do this after they have tried for a few minutes. Do not allow so much time that the children become frustrated.

___ 4. Wet the center of the piece of string or thread with some water. Lay the string over the ice cube, with the wet part on the ice. Sprinkle salt on the top, especially where the string is. Wait about a minute and then gently lift the ice cube by holding onto the ends of the string. If you cannot lift the cube, add some more salt and try again in another minute.

___ 5. It is likely that the students will want to try this themselves after they know how to do it. They will need a new piece of string. If the string has salty water on it, then it doesn't freeze to the ice cube.

Science Background

ice only



melting point 0 °C

The temperature at which a substance will melt is called its melting point or its freezing point. Both are the same temperature. Melting point is used if a solid is changing to a liquid, like ice to water. Freezing point is used if a liquid is changing to a solid, like water to ice. For water/ice this temperature where melting or freezing occurs is 32° Fahrenheit or 0° Celsius.

ice + salt

melting point less than 0 °C

The salt lowers the freezing point of the ice and the ice starts to melt. Because this melting process *requires* heat, the resulting salt water solution becomes colder than the freezing point of pure water. This results in freezing together the wet string and the layer of relatively pure water directly under the string. The activity will not work well if salt gets under the string.

This will last only briefly. As salt dissolves in the water under the string and heat transfers from the room, the newly formed ice, which is sticking the string to the ice cube, melts.

Extensions

You may want to extend this activity to the science table, where groups of students can experiment with different amounts of salt and/or time how long the string stays frozen to the ice cube.

Connections

Brainstorm about ways to make use of the fact that salt in water lowers its freezing point. Two common ways are in making ice cream and in melting ice on roads and sidewalks during winter storms.

Topic: Water and Changing Its State

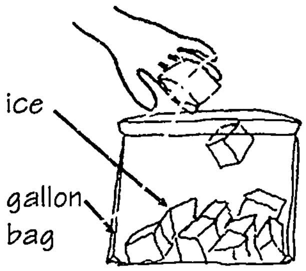
I scream, You scream, We all scream For ICE CREAM!

Is salt needed to make ice cream?

This recipe is adapted from *Let's Make Ice Cream!* by Marilyn McMasters and *The Amazing Milk Book* by Catherine Ross. Another good reference is *The Scoop on Ice Cream* by Vicki Cobb.

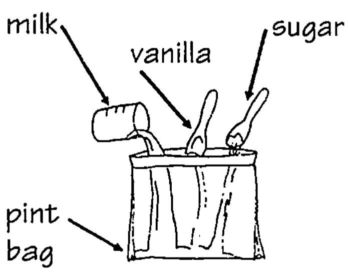
Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
1 gallon plastic zipper freezer bag	_____ gal. zipper freezer bags	_____
1 pint plastic zipper freezer bag	_____ pint zipper freezer bags	_____
tablespoon measure	_____ tablespoons	_____
1/2 teaspoon measure	_____ 1/2 teaspoons	_____
1/2 cup measure	_____ 1/2 cup measuring cups	_____
2 cups (472 mL) ice	_____ cups of ice	_____
(About 16 pounds of ice will be needed for a class of 20)		
6 tablespoons (90 mL) of salt	_____ tablespoons of salt	_____
1/2 teaspoon (2.5 mL) vanilla	_____ teaspoons of vanilla	_____
1/2 cup (120 mL) milk	_____ cups of milk	_____
(2% or whole tastes best and quart containers are easier than gallons for students to pour from)		
1 tablespoon (15 mL) of sugar	_____ tablespoons of sugar	_____
mittens or gloves (optional)	_____ mittens or gloves	_____

Directions

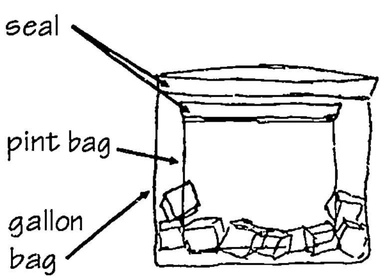


___ 1. Put the ice in the gallon plastic zipper bag.

___ 2. Add 6 tablespoons of salt to the ice. Seal the bag and shake.



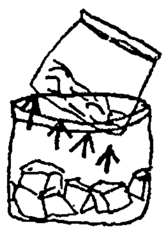
___ 3. Mix 1 tablespoon of sugar, 1/2 teaspoon of vanilla, and 1/2 cup milk in the pint bag. Seal.



___ 4. Open the gallon size bag of ice, and put the pint bag inside. The pint bag must be sealed. Now seal the gallon size again.

Directions, continued

___ 5. Shake the bags for about 5 minutes or until the mixture is frozen. This gets very cold. You might want to ask the students to wear mittens or gloves to do this part.



___ 6. Open the outside bag and remove the pint bag. Wipe the outside with paper towels before opening it to remove all the salt water.

___ 7. Open the pint bag and enjoy eating the ice cream!

Science Background

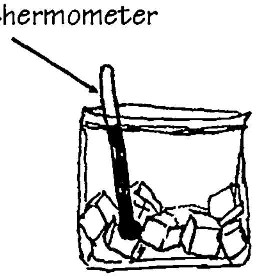
A mixture of salt and water freezes at a lower temperature than pure water. The milk–sugar–vanilla mixture will not freeze at 0° Celsius, but at a temperature below this. When enough salt is added, the temperature in the outside gallon bag gets low enough to lower the temperature of the milk–sugar–vanilla mixture until it freezes and becomes ice cream.

Extensions

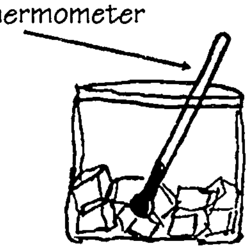
Forget the salt! We suggest that the teacher do this activity with the class and deliberately "forget" to add the salt to the ice. Make a point of noting that yours doesn't seem to be "working" as the class observes that their milk-sugar-vanilla mixture is freezing.

After the class has enjoyed eating the ice cream, ask the class to suggest what you might have done differently since yours didn't "work". Someone is likely to ask "Did you add the salt?" At this point, get another gallon bag, add the ice and salt, and then add the pint bag and its mixture and shake. Now it will freeze, of course.

Reinforce the concept that the salt and ice is needed for the freezing, and that ice alone will not freeze the mixture in the pint bag. Label one gallon bag "ice" and add some ice. Label another gallon bag "ice and salt" and add ice and 6 tablespoons of salt. Seal and shake to mix. Ask the students to touch each of the bags. Does one feel colder than the other?



ice only



ice and salt

Measure the temperatures of each. Put 1 cup of ice in each of two containers. Add 1 cup of water to each. Put 1/2 cup of salt into one of the containers. Stir. Label it "salt + ice". Put a thermometer into each container. We do not recommend the use of mercury thermometers because of the toxicity of the mercury if the thermometer is broken. Look for a "spirit filled" thermometer. (Available from Delta Scientific.) Read the thermometers every 5 minutes.

A mixture of salt and water freezes at a lower temperature than pure water or ice. How much the temperature is lowered depends on how many particles of the salt are in the water—the more particles of salt that dissolve, the lower the freezing point. The salt must dissolve in the water for the temperature to be changed. When you reach the limit of how much salt can dissolve in the water, you can not lower the temperature more. The limit of the dissolving of the salt in water is called the saturation point.

If you are using a Celsius thermometer, you will get a reading of less than zero for the ice and salt mixture. The Celsius thermometer has a zero point at the normal freezing point of water, but temperatures get colder than this, so we have negative temperatures in the Celsius scale. This is read as – (minus) degrees or the number of degrees below zero. The lowest temperature possible is -273° C. This is the temperature where the matter would not have any heat energy at all.

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Connections

Read *Garth Pig & the Ice Cream Lady* by Mary Rayner. Before you begin this activity, ask the students to **write their own recipes** for ice cream. When you finish the activity, send this recipe for ice cream home with your students. Attach it to the individual student recipes that were written before the activity.

Make a class cookbook. Include each child's own ice cream recipe. Include the one that was used in class. Collect favorite recipes to make ice cream or recipes that use ice cream from the families of the students. Compile the recipes. This is a good project to do if you have a computer in your classroom for the students to use for compiling the cookbook. Investigate the resources at your local high school for binding and covering the pages into a book for you. Often the Industrial Arts Department will be able to do this. Distribute to the parents or ask the Parent Teacher Organization to help with the distribution at one of the local events.

Read "18 Flavors" by Shel Silverstein. Ask each student to name his/her favorite flavor of ice cream. Make a list.

Survey another class. Be sure to include a category of "other" for flavors named only once, and a category of "none" for anyone who says they have no favorite flavor! Make a **bar graph** for the bulletin board of the favorite flavors and the number of students who choose each flavor for each class. Look for **comparisons** that are true statements from the graphs. For example, in which class do more students like chocolate? How many more students like strawberry in Ms. Brown's class than in ours?

Write a poem. Use the pattern in Dona Herweck Rice's poem, *How Did That Go Again?* from *Bear Essentials*, May/June 1994 issue and add other verses.

More Connections

Many other ideas for things to do with **ice cream** are published in *Bear Essentials, A Magazine of Creative Ideas for K-3 Teachers*, May/June 1994 issue.

In the Northern United States, **find out about deicers** other than salt. Visit a local hardware store and make a list of the deicers sold. Make a list of the names, the ingredients, the cost, and the size. After finding out about other deicers used in your area you can investigate how much they change the temperature of the water-ice-deicer mixture. Put 1/2 cup of the deicer in a

More Connections, continued

mixture of 1 cup of ice and 1 cup of water. Stir. Measure the temperature. Which one lowers the temperature the most? (−4 is a colder temperature than −2 since it is farther "below zero"). Does all of the deicer dissolve? Have someone from the road crew talk to the class about snow and ice removal from the highway.

Investigate the hazards of ice on the wings of an airplane. Find out what the airlines use to prevent the ice buildup.

Find out about the environmental hazards of deicers. What are some substitutes that can be used on the roads? (For example, cinders and small stones can be used to provide traction on the ice, instead of melting it. The cinders and stones would not lower the melting point of the ice because they do not dissolve in water.) What are other means of reducing salt use?

References

Cobb, Vicki. *The Scoop on Ice Cream.* (How the World Works Science Series). Brown, Little & Co. 1984. ISBN #0-316-14897-0 (out of print)

McMasters, Marilyn. "Let's Make Ice Cream!". AIMS Newsletter. AIMS Education Foundation. January, 1992.

Rayner, Mary. *Garth Pig & the Ice Cream Lady.* MacMillan Children's Group. 1978. ISBN #0-689-30598-2

Rice, Dona Herweck, Ed. *The Bear Essentials: A Magazine of Creative Ideas for K-3 Teachers.* Box 1040, Huntington, CA 92647. 2(3). May/June 1994 issue. (out of print)

Ross, Catherine. *The Amazing Milk Book.* Addison Wesley Publishing. 1991. ISBN #0-201-57087-4

Silverstein, Shel. "18 Flavors", page 116 in *Where the Sidewalk Ends, Poems and Drawings.* Harper Collins Children's Books. 1974. ISBN #0-06-025667-2

How Did That Go Again?

by Dona Herweck Rice, in Bear Essentials, May/June 1994, page 24.

I shout,
You shout,
We all shout
For... pickled snout?

I shriek,
You shriek,
We all shriek
For... buzzard's beak?

I wish,
You wish,
We all wish
For... jellyfish?

I cry,
You cry,
We all cry
For... tuna pie?

I squeal,
You squeal,
We all squeal
For... banana peels?

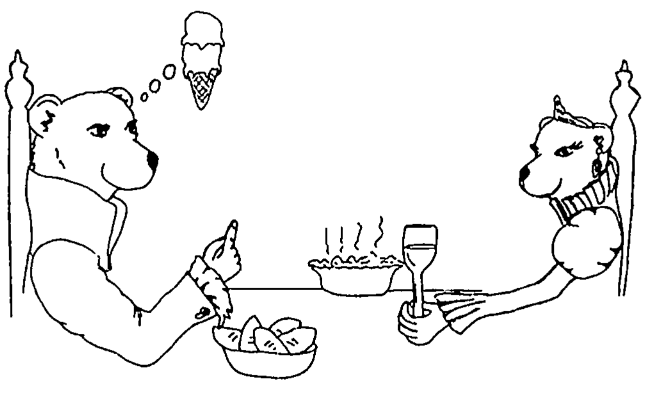
I whoop,
You whoop,
We all whoop
For... spinach soup?

NOW WAIT A MINUTE!
This isn't right!
This just ruins
My appetite!

There's got to be
Another rhyme!
So let's try it
Just one more time.

Oh, yes, of course,
I remember.
Now here we go
All together...

I scream,
You scream,
We all scream
For... ice cream!



My name is ______________________

and here is my recipe for ice cream. First you need these ingredients:

Then you mix and ______________________

And finally you have ice cream!

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Attached to this page is your child's invention of a recipe for ice cream!

After writing this recipe, we made ice cream in class. Here is the recipe we used.

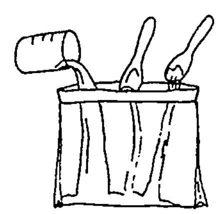
Your child will enjoy showing you how to do this.

Ingredients

One tray of ice cubes
6 tablespoons of salt
1 gallon plastic zipper freezer bag
1 pint plastic zipper freezer bag
1/2 cup milk
1/2 tsp. vanilla
1 tablespoon of sugar

How to mix

First, put the ice and salt in the gallon plastic zipper bag. Then put the vanilla, milk, and sugar into the pint bag. Seal the pint bag. Be sure that it is sealed. Put the pint bag into the gallon bag and seal the gallon bag. Shake the bags for about 5 minutes until the mixture in the pint bag freezes. Then ENJOY your ice cream!



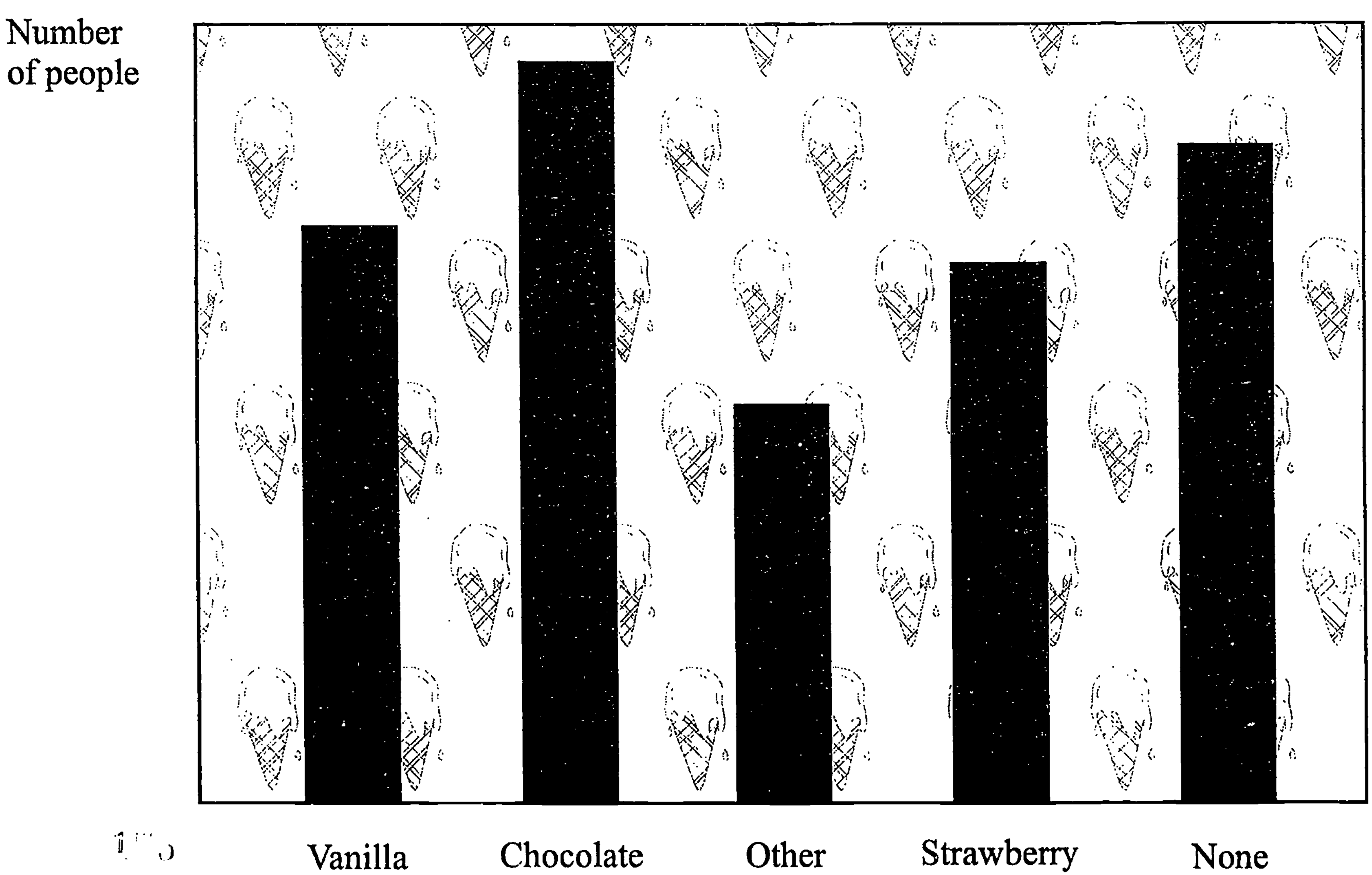
Why is the salt needed with the ice?

The salt and water mixture has a lower freezing point than ice without the salt. The temperature of the ice salt mixture is less than 0°C or 32°F and so the ice cream mixture freezes. Just ice is not cold enough to freeze the milk–vanilla–sugar mixture... Ask your child to explain this to you!

My own ice cream recipe

Name ____________________

Favorite ice cream



Topic: Water and Changing Its State

Waiting on Water

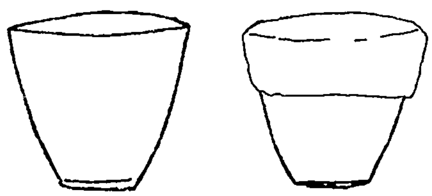
How long will it take for water to evaporate?

Materials ✔ List (per student or group)	I HAVE:
2 cups (472 mL) of water	____
piece of plastic wrap	____

Directions

___ 1. Fill each of two cups with the same amount of water.

___ 2. Cover one with plastic wrap.



Discussion

How long do you think it will be until all the water is evaporated in the open cup?

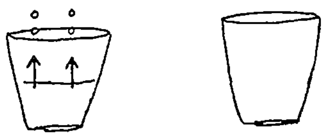
Discussion, continued

How long do you think it will be until all the water is evaporated in the covered cup?

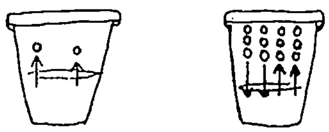
Where is the water when it is evaporated out of the cup?

What's the variable in this experiment? (cup open or closed)

Science Background



beginning after
open cup

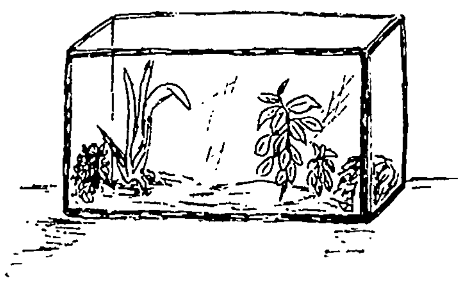


beginning after
covered cup

Water evaporates from the liquid state to the gas state. Eventually, in the open container, all the liquid water will evaporate and the water vapor will be added to the air. In the closed container, however, the air trapped inside the cup will only be able to hold a certain amount of water vapor. At that point, the air is "saturated" with water, and the level of the water inside the cup will remain at the same level.

Extension

Build a terrarium. How is the terrarium like the covered cup? (water is kept inside the container) How is the terrarium different from the covered cup? (plants inside can be using or giving off water)



Connection

Find out about swimming pool covers. Ask someone who has a pool or talk to someone that sells swimming pools. How much water can evaporate from the pool when it is not covered? What does the cover do besides helping to keep the water clean?

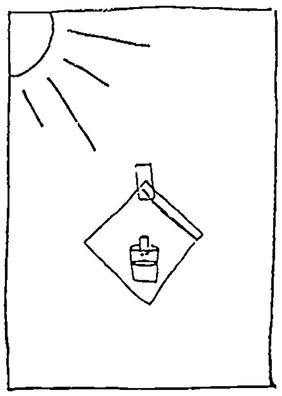
Topic: Water and Changing Its State

Where Does the Water Go?

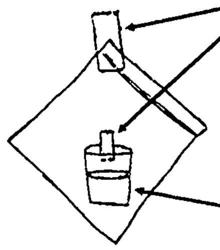
What can we learn about the water cycle?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
pint plastic zipper bag	____ bags	____
3 oz (90 mL) (bathroom) cup	____ cups	____
water (color with blue food coloring)	____ water	____
	____ food coloring	____
tape	____ tape	____
sunny window		

Directions



____ 1. Fill the cup about half full of the blue colored water. Hold the bag by one corner of the top. Tape the cup upright inside the bag at the opposite corner, so that the bottom of the cup is at least one inch from the bottom corner of the bag.



____ 2. Seal the bag, without spilling the water. Tape the bag, on the diagonal, to a sunny window.

____ 3. Observe the bag two times a day for three or four days.

Discussion

How does the water get out of the cup? (evaporation, water becomes water vapor from the heat of the sun)

What happens to the water after it evaporates? (Some remains in the air, some condenses)

How does it rain inside the bag? (drops of water get big enough to run down the side)

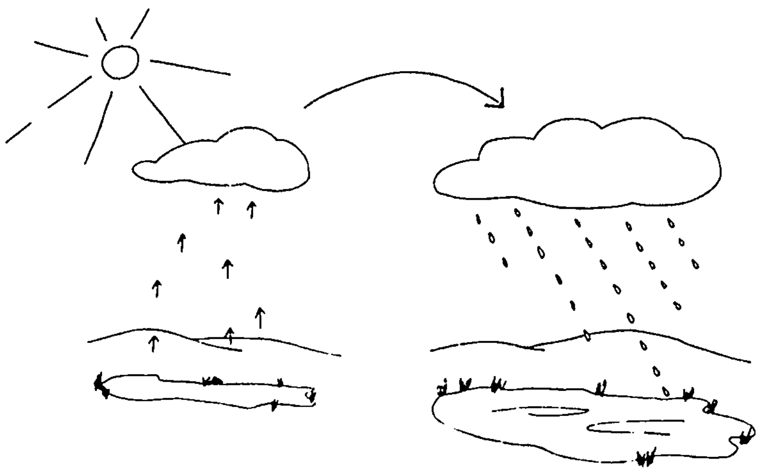
Where does the water go when it rains? (into the puddle on the bottom)

Does the water still evaporate? (Yes)

Did the food coloring evaporate? (No)

Science Background

This activity demonstrates a part of the water cycle. Water evaporates from the liquid state to the gas state. Eventually the air holds all the water vapor that it can. The amount of water vapor that the air can hold depends on the temperature of the air. Warm air can hold more water vapor than cold air. If the air contains as much water vapor as it can hold and the temperature then drops, the vapor begins to condense to form small drops of water. This is how a cloud forms. The drops of water then get big enough to fall as rain. The rain collects in a puddle at the lowest part of the bag, just as it collects in puddles, lakes and streams in nature.



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ICE,

Science Background, continued

Evaporation is a way to purify the water. The food coloring did not evaporate with the water. Many of the usual impurities in water do not evaporate. Distilled water is prepared for sale by boiling tap water (to make it evaporate as fast as possible) and then condensing and collecting the steam that formed. When tap water boils, pure water evaporates. The impurities remain behind in the water that has not yet evaporated and it becomes more and more impure.

Connections

A Poem for Water

Please conserve our water
Don't let it run.
If we waste it,
Soon we'll have none.

Read *It Looks Like Spilt Milk* by Charles Shaw.

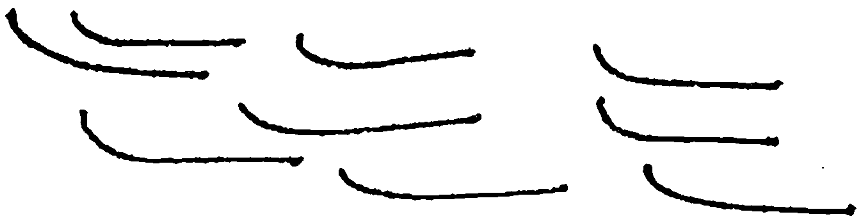
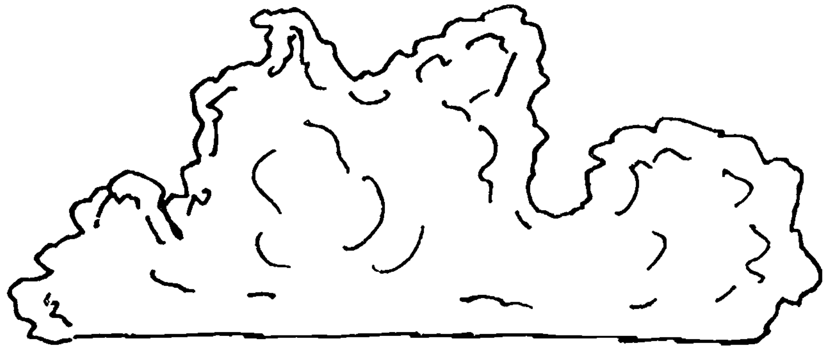
Find out about the types of clouds. Clouds can be layered, fluffy, stormy, or feathery. Layered clouds are closer to the ground than fluffy clouds. Stormy clouds are even higher in the sky and feathery clouds are even higher in the sky. Fog is a cloud at ground level. Use cotton balls and shape them to match the type of cloud and glue the cotton to the picture. This idea for modeling clouds is from page 39 of *Science Process Skills* by Karen L. Ostlund.

References

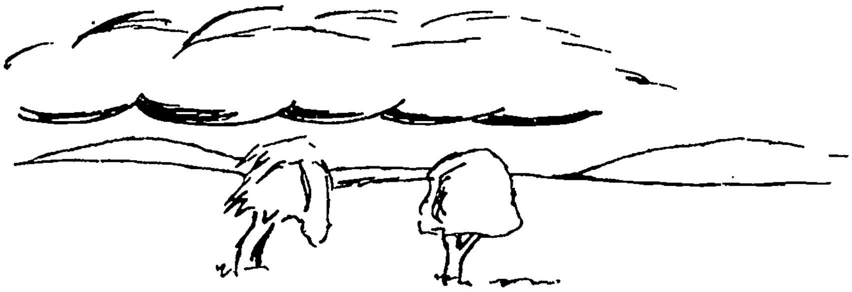
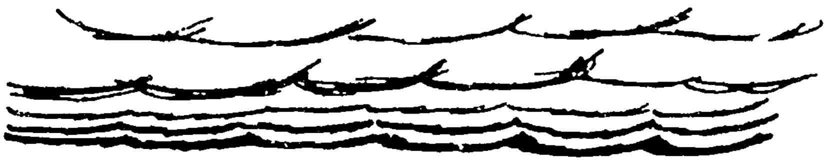
Shaw, Charles. *It Looks Like Spilt Milk.* Harper Collins Children's Books. 1988. ISBN #0-87499-110-2

Ostiund, Karen L. *Science Process Skills.* Addison-Wesley. 1992.

Cloud Types

Name	Picture
feathery	
stormy	
fluffy	

Cloud Types

Name	Picture
Low, heavy rolls	
Layered	
Fog, ground fog	

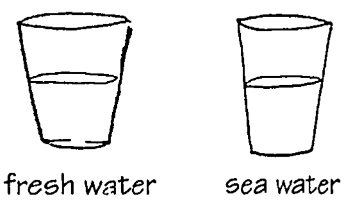
Topic: Water and Changing Its State

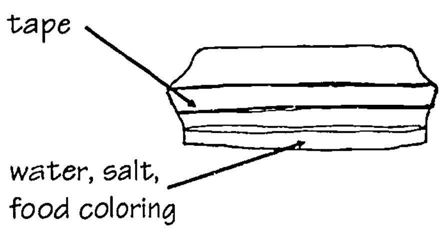
Ocean Water

What happens when salt water evaporates in a covered dish?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
1 clear salad tray with cover, from a fast food restaurant	_____ salad trays	_____
food coloring	_____ food coloring	_____
1/2 cup (118 mL) salt dissolved in 1 cup (236 mL) of water OR sea water	_____ salt water	_____
1 cup (236 mL) tap water OR 1 cup creek water	_____ fresh water	_____

Directions





____ 1. Put 1/2 cup of sea water and 1/2 cup of the fresh water into two paper cups. Allow each to evaporate and compare the results.

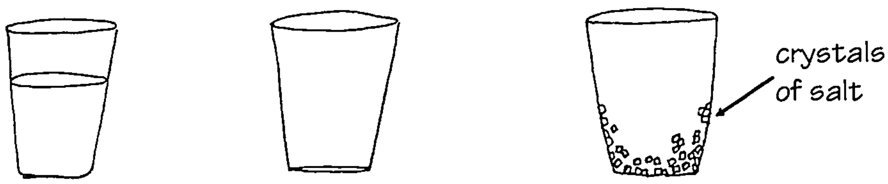
____ 2. To prepare the tray, the teacher should dissolve the salt in the water and put in a few drops of the food coloring. Pour the water into the tray. Tape the tray shut with clear tape. Mark the line for the level of the water on the outside of the tray with a permanent marker. Each day, have the class observe the tray and write in a journal about what they see happening.

Discussion

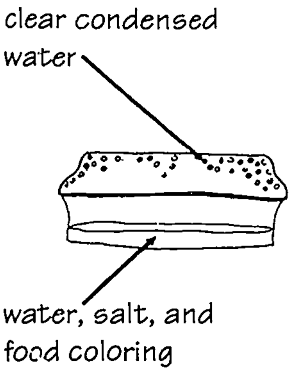
The goal is to have the students observe as many things as possible and explain what they observed. Some questions for them to think about: How did the water get to the top of the container? How did it get clear? Do you think the water on the top would taste salty? Did the water level in the bottom get any lower? Where did the crystals come from? REMEMBER you are not looking for thorough science explanations here! The goal is to have the students observe and think about how it might work.

Science Background

Sea water is the most abundant liquid mixture. (Air is the most abundant gaseous mixture.) The term that scienuists use to describe a mixture where one or more substances are dissolved in another substance is solution. In an open container, eventually all the water will evaporate and salt originally dissolved in the water will be left in the container. You will see the salts crystallize as the water evaporates. The main salt in the ocean water is sodium chloride, which is the chemical name for table salt.



before evaporation — fresh water after evaporation — salt water after evaporation



Inside the closed container, some water evaporates from the bottom and goes into the air. Eventually, you will see water condensation on the top and sides of the tray. The salt does not evaporate. When enough water evaporates, you reach the saturation point of the salt water, and some of the salt crystallizes on the bottom. The food coloring does not evaporate. You can see this because the water on the bottom is colored, but the water that condenses is colorless.

Extensions

Investigate how dish detergent, nails, and pennies are affected by sea water and fresh water. Put 1/2 cup of sea water and 1/2 cup of fresh water into two

Extension, continued

paper cups. Put 5 drops of dish detergent in each and stir. Compare the soap suds that result. Put 1/2 cup of sea water and 1/2 cup of fresh water into two paper cups. Add a nail to each and observe the changes over several days. Repeat with a penny added to each. All the dissolved material makes it more difficult for the salt water to form soap suds and increases the corrosion of the nail and the penny.

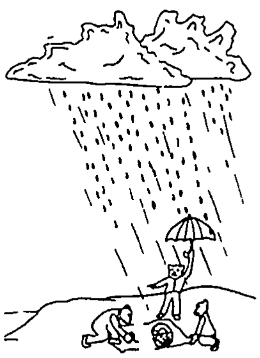
Connections

Find out about the vocabulary words of evaporation and condensation. Find out about ice, water, and water vapor. Find out about gas, liquid, and solid.

Find out about the water cycle. Find out about how water is an important part of the weather. Read *The Magic School Bus at the Waterworks* by Joanna Cole. See the activity "Where Does the Water Go" in this unit.

To show the evaporation of water, **go outside after a rain**. Have each child draw the outline of a puddle with chalk and write their name nearby. After two hours, go outside again and find the puddle and its chalk outline. What happened? Some other recommended books about rain are *Rainy Day Stories and Poems* by Caroline Feelder Baur.

To reinforce the idea of a cycle, **tell this story** from Tracey McFarland. It was published in Science Grasp 1992.



> "A family of teddy bears goes into the woods for a picnic. They find a nice pond to spread their blanket by. The sky is filled with big, puffy, white clouds. The sun begins to dry out (evaporate) the moisture from the grass and the water from the pond. This continues until the clouds get darker and heavier, and the sun is no longer seen. The clouds get so heavy that it rains, so the bears put up their umbrellas. The rain makes the clouds lighter, and the wind blows away the clouds. The sun comes out, and the bears put away their umbrellas. The sun begins to dry up the moisture from the grass, puddles, pond, etc. The moisture goes up into the sky in the form of water vapor. The vapor is cooled until fluffy, white clouds are formed in the sky. The clouds continue to gather moisture (condensation) until they get darker and heavier. It begins to rain, so the teddy bears put out their umbrellas...."

The story continues until someone in the class points out that the story is repeating or going over and over.

Connections, continued

Another recommended book is *The Stream* by Naomi Russell.

Some recommended nonfiction books about water and weather are *Rain and Hail* by Franklyn Branley and *The Science Book of Water* by Neil Ardley, *Follow the Water from Brook to Ocean* by Arthur Dorros, and *The Cloud Book* by Tomie de Paoli.

For a bulletin board, write a **raindrop poem**. Use an outline of a water drop for the poem. Color the paper blue or cover the paper with blue cellophane.

Find out about ice and its effect on geography and the earth. Investigate **icebergs and glaciers**. Find out about **oceans**.

References

Ardley, Neil, *The Science Book of Water*, Harcourt, Bruce, Jovanovich, 1991. ISBN #0-15-200575-7

Baur, Caroline Feelder. *Rainy Day: Stories and Poems*. Lippincott. 1986. ISBN #0-397-32105-8

Branley, Franklyn M. *Rain and Hail*. Harper Collins. 1983.

Carlisle, Madelyn Wood. *Let's Investigate Sparkling, Silent Snow*. Barron's Educational Series, Inc. 1992. ISBN #0-8120-4736-2

Cole, Joanna. *Magic School Bus at the Waterworks*. Scholastic, Inc. 1986. ISBN #-0-590-43738-9

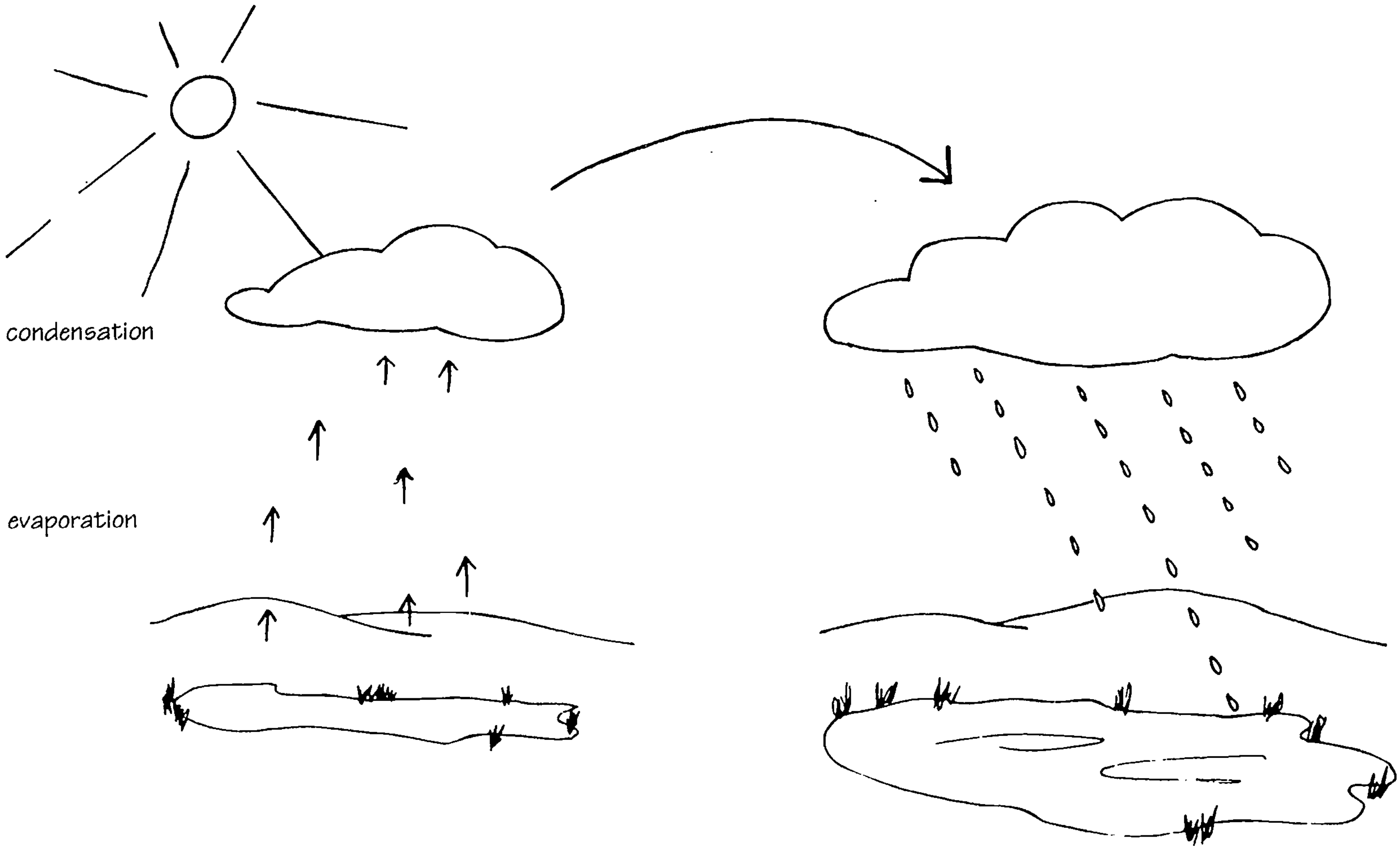
de Paola, Tomie. *The Cloud Book*. Holiday House. 1975.ISBN #0-8234-0259-2

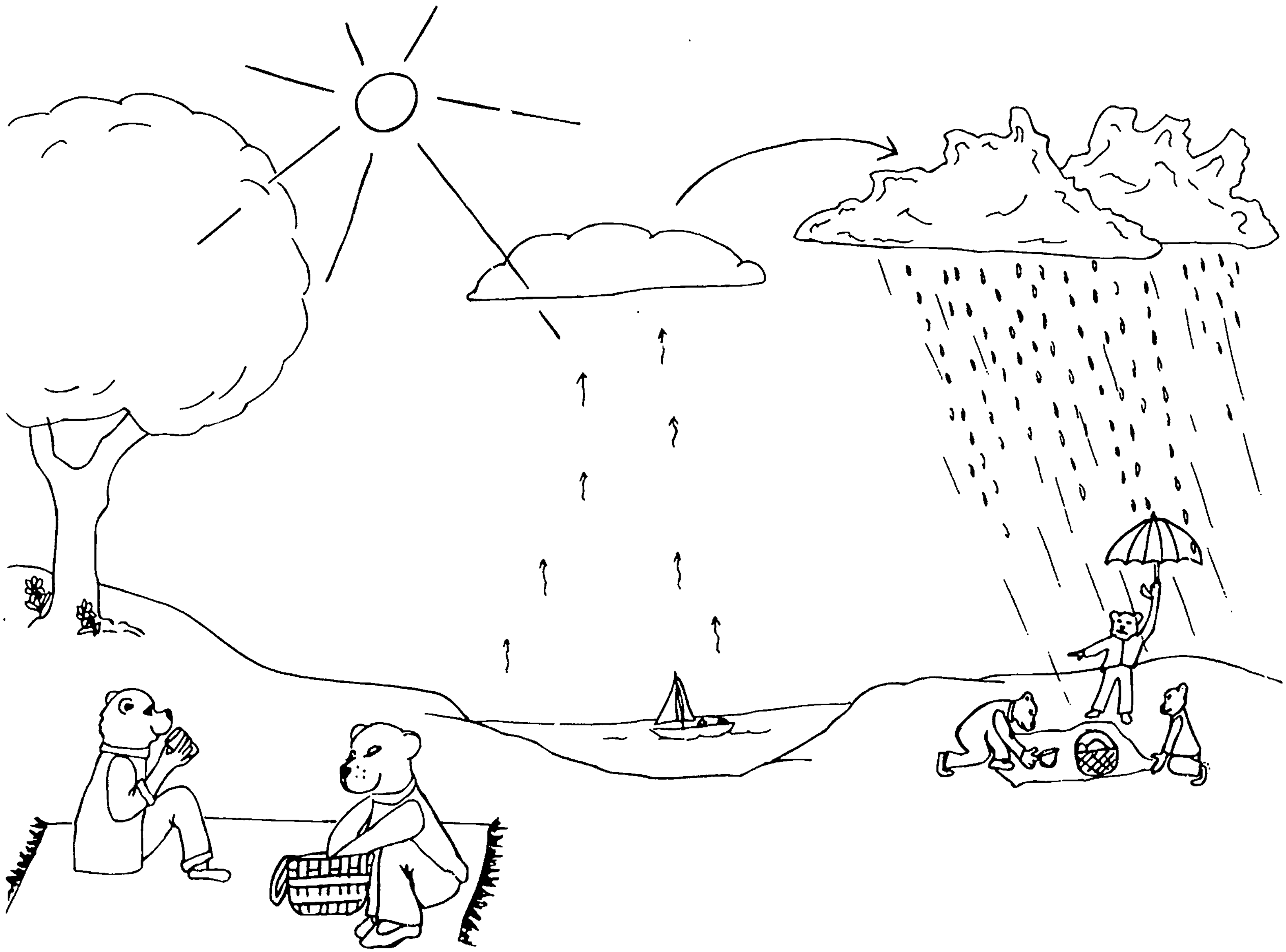
Dorros, Arthur. *Follow the Water from Brook to Ocean*. Harper Collins. 1991. ISBN #0-06-445115-1

McFarland, Tracey. Lesson #1.4 in *Science Grasp 92*. A Hands-on Science Education Workshop sponsored by the Upjohn Company, National Science Teacher's Association, and Apple Computer.

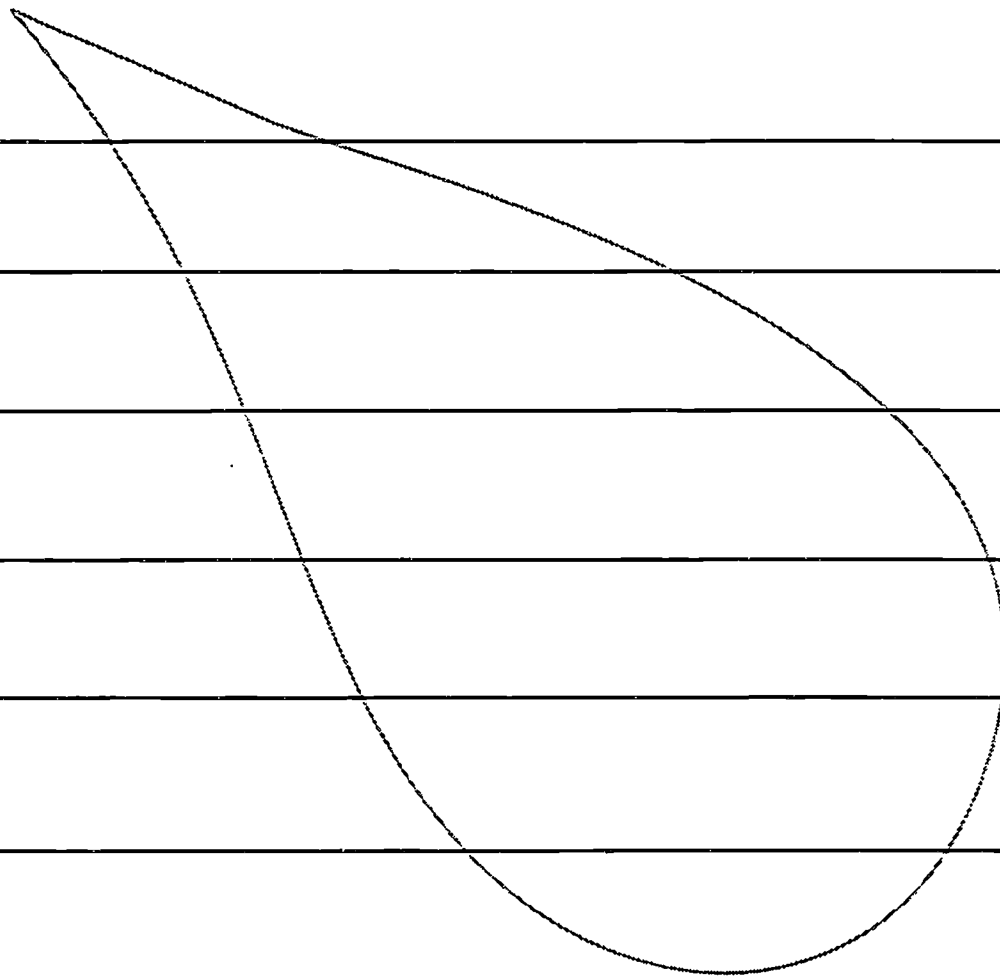
Neitzel, Shirley. *The Jacket I Wear in the Snow*. Morrow, William & Co., 1994. ISBN #0-688-04587-1

Russell, Naomi. *The Stream*. Dutton Child Books. 1991. ISBN #0-525-44729-6


condensation
evaporation



Write a rain poem



Name ______________________

Topic: Water and Changing Its State

Water Motion

Does temperature change the beha‧‧ior of water?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
aquarium	_____aquarium	_____
2 clear containers with caps and narrow necks, e.g. peppermint extract bottles	_____containers	_____
red and blue food coloring	______food coloring	_____

Directions

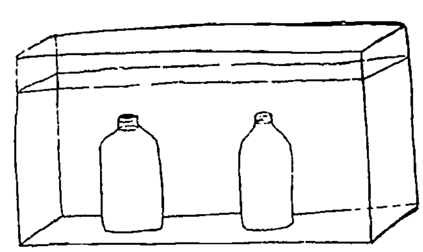
___ 1. Fill the aquarium with cold water.

___ 2. Fill one bottle with hot water colored blue. Fill the other with cold water colored red. Fill the bottles to the very top.

___ 3. Lightly place the caps on the bottles. Do not screw them on.

___ 4. Place both of the containers in the bottom of the aquarium. Carefully knock off the caps.

___ 5. Observe.



warm water cold water

1?4

Discussion

What happens? (the blue water rises out of the container and mixes with the other water, the red water remains inside its container and doesn't mix)

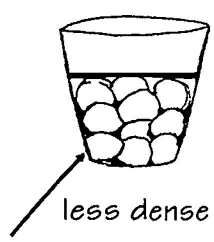
Science Background

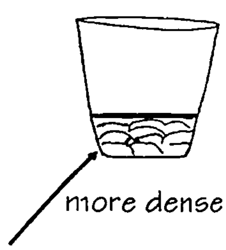
The hot water is less dense than the cold water, so it rises. Density is mass per unit volume. It is the property that determines if a material will float or sink in water. In Italian salad dressing, the oil has a lower density than the water and therefore the it floats on the water.

Temperature affects the density of a substance. At most temperatures, cold water is more dense than warm. An exception occurs near the freezing point of water. Water is most dense at 4 °C (about 39 °F). Below this temperature the density decreases. Hence ice (which is at 0 °C or colder) will float on water.

In this activity, we see that the less dense warm water is rising through the colder water. The food coloring makes the movement of the water easy to see.

Extensions





Color the water in the aquarium yellow before knocking off the bottle caps. As the blue water mixes, there will be a color change to green.

One way to **explain density to your students** is to put the same number of cotton balls in each of two clear cups. Have the class count 20 cotton balls and put them into a clear cup. If a balance is available, weigh the 20 cotton balls. Repeat this in a second cup. Both cups have the same weight of cotton balls. Mark the line on the cup that shows how much of the cup is filled by the cotton balls. This is the volume of the cotton balls. Now squash the cotton balls in one of the cups. This cup now has a lesser volume of cotton balls, so it has a greater density than the other one. Emphasize that the weight stayed the same, but that it takes up less space. You may want to reweigh the cotton balls to show that the mass has not changed.

Connection

Study the ocean currents. Two teachers' resources are *Diving Into Oceans* in the *Ranger Rick's NatureScope* series and *The Sea*, by Leonard Engel and the editors of *LIFE*. Some non-fiction children's books include *Oceans* (A New True Book) by Katharine Carter and Oceans by Martin Bramwell.

Reference

Bramwell, Martin. *Oceans*. Franklin Watts. 1984. ISBN #0-531-04835-7.

Braus, Judy, Ed. *Ranger Rick's Naturescope, Diving into Oceans*. National Wildlife Association. 1989.

Carter, Katharine Jones. *Oceans* (A New True Book). Regensteiner Publishing Enterprises, Inc. 1982. ISBN #0-516-01639-3.

Engel, Leonard and the editors of *LIFE*. *The Sea*. Time, Inc. 1963.

Sarquis, Mickey and Sarquis, Jerry. *Fun with Chemistry: A Guidebook of K-12 Activities*, Vol. I. University of Wisconsin-Madison: Institute for Chemical Education. 1991. Activity #28.

Topic: Water and Changing Its State

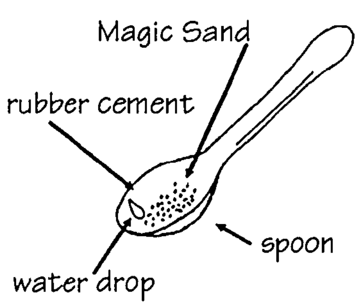
Magic Sand

What is "magic" about this sand?

Materials ✔ List (per student or group)	I NEED for my class:	I HAVE:
Magic Sand* (about 1/2 cup)	_____ containers of sand	_____
plastic spoon	_____ plastic spoons	_____
rubber cement	_____rubber cement	_____
2 clear containers	_____clear containers	_____
water	_____water	_____
pencil	_____pencils	_____
paper towels	_____paper towels	_____

* Available from:
Educational Innovations, Item # SS-2, Flinn Scientific, "Mystic Sand", Item #AP4304, Clifford W. Estes Co., "Astro Sand". Minimum quantity for "Astro Sand" is 5 lbs. (2.3 kg).

Directions



___ 1. Put some rubber cement on the spoon. Dip it into a container of Magic Sand, so that the spoon is coated with the sand.

___ 2. Put a drop of water on the spoon. Observe.

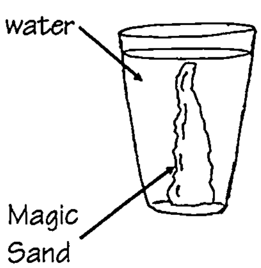
Directions, continued

___ 3. Put a cup of water in a clear container. Slowly pour the Magic Sand into the water. Touch the sand under the water with your fingers. Use a spoon to remove some of the Magic Sand from the water OR pour off the water. The sand will be dry!

___ 4. Carefully pour a layer of Magic Sand onto the surface of the water. The surface tension of the water will make the sand float. Take a pencil and slowly push it through the sand into the water about a quarter of an inch. The Magic Sand will coat the pencil. Now pull the pencil out—it will be dry! If you poke the pencil deeper or more quickly, you can break the surface tension of the water and the sand falls to the bottom of the cup.

___ 5. Magic Sand can be reused. Place the sand on a paper towel to air dry before storing it.

Science Background

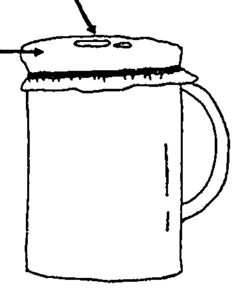


Magic Sand is not wet by water. It has been coated with a special chemical that gives it its "magic" properties. Ordinary sand absorbs water and becomes wet throughout. Magic Sand doesn't absorb water and doesn't mix with it. Scientists call substances that are not attracted to water "hydrophobic", which means "water-fearing". Oil is also hydrophobic—oil and water do not mix. Because Magic Sand and water do not mix, you can do many things with it that you can not do with ordinary sand. When you put a drop of water on the spoon with magic sand, the water beads up and rolls off the sand. When you poured the sand into the water it clumped together, minimizing its contact with the water. And when you poke a pencil into the sand floating on water, it avoids the water by coating the pencil.

Extensions

Repeat the activities using ordinary sand. Observe how the ordinary sand behaves differently.

Extensions, continued



The coating on the sand is like the substance that is used to make Scotchguard™ fabric protection. Spray one tissue with a water repellent spray like Scotchguard™. Allow it to dry. Place the tissue over the top of a clear pitcher and put a rubber band around the top of the pitcher to hold the tissue in place. Do the same thing with a second tissue that has not been treated with Scotchguard™. Pour 1/4th of a cup of water onto each of the tissues. The untreated tissue will break. The treated tissue will hold the water for several minutes, if it has been thoroughly coated.

Connections

Investigate the discovery of Scotchguard™ by reading Jones, Charlotte Foltz. *Mistakes That Worked.* Doubleday. 1991 or writing to 3M for *The Quality Standard*, Winter, 1993. Available from the Marketing Service Coordinator, 3M Speciality Chemicals Division, 3M Center, St. Paul, MN 55144-1000. 612-733-1110.

Investigate the word "hydrophobic".

What other words have the ending of phobic?

Read *Johnny Castleseed* by Edward Ormondroyd.

References

Vitz. E. *Journal of Chemical Education.* 1990. 67(6), 512-515.

Shakhashiri, Bassam Z. *Chemical Demonstrations: A Handbook for Teachers of Chemistry*, Vol. III. University of Wisconsin Press. 1989. Demonstration 9.24, page 305-306.

Ormondroyd, Edward, *Johnny Castleseed.* Houghton Mifflin. 1988. ISBN #0-395-47947-9

Topic: Water and Changing Its State

Sinking Ice

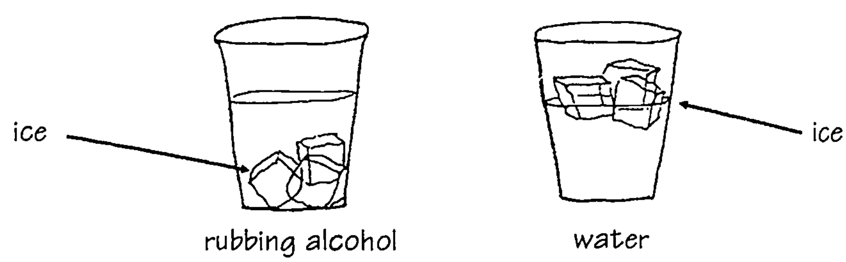
How can you make an ice cube sink?

Materials ✔ List (per student or group)	I HAVE:
2 clear containers	
water	____
ice cubes	____
rubbing alcohol	____

Directions

____ 1. Fill one container half full with water.

____ 2. Fill the other half full with rubbing alcohol.



➲ SAFETY NOTE: Be sure to use the alcohol in a well ventilated area since it evaporates quite easily. Rubbing alcohol is also flammable, so be sure there are no flames in use! Avoid eye contact. If any is splashed in the eye, rinse with water for 15 minutes.

____ 3. Put several ice cubes in each container.

Discussion

Do the two liquids look alike? (yes) Do they have the same smell? (No)

Predict what will happen when the ice cubes are put into the liquids.

How do we know that the liquids are different? (smell, ice sinks in the rubbing alcohol)

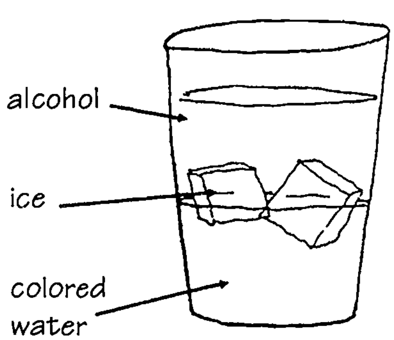
Is it safe to drink something that looks like water if you aren't sure that it is water? (No—alcohol and other liquids can look like water but are not safe to drink!)

Science Background

Water, at a temperature just above its freezing point, has a density of 1.00 gram per milliliter. Ice is less dense than water at this point, so it floats in the water. Ice is an exception—most solids are more dense than the liquid of the same substance. This exception is very important to life on the earth. It means that in winter when ice forms it stays on the top of lakes and rivers. Since it stays on the top, in spring the sun and warmer air can melt the ice. If ice were more dense, it would sink to the bottom of rivers and lakes. It would be much more difficult for the sun to melt it in the spring. Probably after a few winters, the water would be completely frozen.

Rubbing alcohol is less dense than water. Its density is only 0.78 grams per milliliter. It is also less dense than the ice, so the ice sinks. We can determine the order of the densities: Water is greater than ice which is greater than alcohol.

Extensions



Another way to show the density differences: put some water and a few drops of food coloring in a cup. Add several ice cubes. Carefully pour some rubbing alcohol on top of the water. The ice cubes will stay at the level of the water. You have to do this slowly, so that the alcohol and water layers do not mix.

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Making Connections

Contents: By Title, Alphabetically

Contents: By Science Keyword or Concept

Contents: By Science Keyword or Concept, continued

Contents: By Science Keyword or Concept, continued

Contents: By Science Keyword or Concept, continued

Contents: By Science Keyword or Concept, continued

Contents: By Science Keyword or Concept, continued

Contents: By Science Keyword or Concept, continued

Contents: By Science Keyword or Concept, continued

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Contents: By Science Keyword or Concept, continued

Contents: By Connection

Art Connections

Contents: By Connection, continued

Literature Connections—Children's Fiction Books

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Contents: By Connection, continued

Literature Connections—Children's Fiction Books

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Contents: By Connection, continued

Literature Connections—Children's Fiction Books

Literature Connections—Children's Nonfiction Books

Contents: By Connection, continued

Literature Connections—Children's Nonfiction Books

Contents: By Connection, continued

Literature Connections—Children's Nonfiction Books

2 1 7

Contents: By Connection, continued

Math Connections

Music Connections

Other Connections (non-science)

Contents: By Connection, continued

Other Connections (non-science)

Parent/Home Connections

Writing Connections

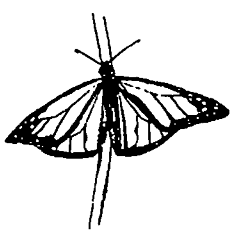
Contents: By Connection, continued

Writing Connections

Benchmarks

All of the activities in Super Science Connections are designed to follow the following general Benchmarks from *Benchmarks for Science Literacy*[1]. Specific content Benchmarks are included with each unit. The ones listed here include both content and process skills.

Chapter 1: The Nature of Science



Section A: The Scientific World View Grades K–2, page 6
When a science investigation is done the way it was done before, we expect to get a very similar result.

Section A: The Scientific World View Grades K–2, page 6
Science investigations generally work the same way in different places.

Section B: Scientific Inquiry Grades K–2, page 10
People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.

Section B: Scientific Inquiry Grades K–2, page 10
Tools such as thermometers, magnifiers, rulers, or balances often give more information about things that can be obtained by just observing things without their help.

1 *Benchmarks for Science Literacy*. Project 2061. American Association for the Advancement of Science, 1993.

Section B: Scientific Inquiry Grades K–2, page 10
Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.

Section B: Scientific Inquiry Grades K–2, page 10
When people give different descriptions of the same thing, it is usually a good idea to make some fresh observations instead of just arguing about who is right.

Section B: Scientific Inquiry Grades 3–5, page 11
Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think. Sometimes scientists have different explanations for the same set of observations. That usually leads to their making more observations to resolve the differences.

Section C: The Scientific Enterprise Grades K–2, page 15
Everybody can do science and invent things and ideas.

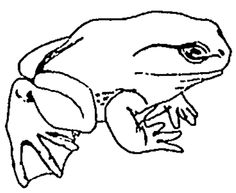
Section C: The Scientific Enterprise Grades K–2, page 15
In doing science, it is often helpful to work with a team and to share findings with others. All team members should reach their own individual conclusions, however, about what the findings mean.

Section C: The Scientific Enterprise Grades K–2, page 15
A lot can be learned about plants and animals by observing them closely, but care must be taken to know the needs of living things and how to provide for them in the classroom.

Section C: The Scientific Enterprise Grades 3–5, page 16
Science is an adventure that people everywhere can take part in, as they have for many centuries.

Section C: The Scientific Enterprise Grades 3–5, page 16
Clear communication 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.

Section C: The Scientific Enterprise Grades 3–5, page 16
Doing science involves many different kinds of work and engages men and women of all ages and backgrounds.



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Chapter 2: The Nature of Mathematics

Section C: Mathematical Inquiry Grades K–2, page 36
Numbers and shapes can be used to tell about things.

Section C: Mathematical Inquiry Grades 3–5, page 36
Numbers and shapes—and operations on them—help to describe and predict things about the world around us.

Chapter 3: The Nature of Technology

Section A: Technology and Science Grades K–2, page 44
Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure, and make things.

Section A: Technology and Science Grades K–2, page 44
When trying to build something or to get something to work better, it usually helps to follow directions if there are any or to ask someone who has done it before for suggestions.

Section B: Design and Systems Grades K–2, page 49
People can use objects and ways of doing things to solve problems.

Section C: Issues in Technology Grades K–2, page 54
People, alone or in groups, are always inventing new ways to solve problems and get work done. The tools and ways of doing things that people have invented affect all aspects of life.

Chapter 4: The Physical Setting

Section B: The Earth Grades K–2, page 67
Some events in nature have a repeating pattern. The weather changes from day to day, but things such as temperature and rain (or snow) tend to be high, low, or medium in the same months every year.

Section B: The Earth Grades K–2, page 67
Water can be a liquid or a solid and can go back and forth from one form to the other. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing.

Section B: The Earth Grades K–2, page 67
Water left in an open container disappears, but water in a closed container does not disappear.

Section B: The Earth Grades 3–5, page 68
Air is a substance that surrounds us, takes up space, and whose movement we feel as wind.

Section B: The Earth Grades 3–5, page 68
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.

Section D: Structure of Matter Grades K–2, page 76
Objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (color, size, shape, weight, texture, flexibility, etc.)

Section D: Structure of Matter Grades K–2, page 76
Things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them.

Section D: Structure of Matter Grades 3–5, page 77
Materials may be composed of parts that are too small to be seen without magnification.

Section E: Energy Transformations Grades K–2, page 83
The sun warms the land, air, and water.

Section E: Energy Transformations Grades 3–5, page 84
When warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature. A warmer object can warm a cooler one by contact or at a distance.

Section E: Energy Transformations Grades 3–5, page 84
Some materials conduct heat much better than others. Poor conductors can reduce heat loss.

Section F: Motion Grades K–2, page 89
Things that make sound vibrate.

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Chapter 5: The Living Environment

Section A: Diversity of Life Grades K–2, page 102
Some animals and plants are alike in the way they look and in the things they do, and others are very different from one another.

Section A: Diversity of Life Grades K–2, page 102
Plants and animals have features that help them live in different environments.

Section D: Interdependence of Life Grades 3–5, page 116
For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

Section F: Evolution of Life Grades K–2, page 123
Different plants and animals have external features that help them thrive in different kinds of places.

Chapter 6: The Human Organism

Section D: Learning Grades K–2, page 140
People use their senses to find out about their surroundings and themselves. Different senses give different information. sometimes a person can get different information about the same thing by moving closer to it or farther away from it.

Section D: Learning Grades K–2, page 140
People can learn from each other by telling and listening, showing and watching, and imitating what others do.

Section D: Learning Grades 3–5, page 141
Learning means using what one already knows to make sense out of new experiences or information, not just storing the new information in one's head.

Chapter 8: The Designed World

Section B: Materials and Manufacturing Grades 3–5, page 188
Naturally occurring materials such as wood, clay, cotton, and animal skins may be processed or combined with other materials to change their properties.

Section B: Materials and Manufacturing Grades 3–5, page 188
Through science and technology, a wide variety of materials that do not appear in nature at all have become available, ranging from steel to nylon to liquid crystals.

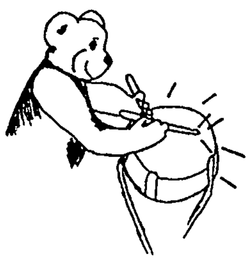
Section C: Energy Sources and Use Grades 3–5, page 193
The sun is the main source of energy for people and they use it in various ways...

Section C: Energy Sources and Use Grades 3—5, page 193
People try to conserve energy in order to slow down the depletion of energy resources and/or to save money.

Chapter 9: The Mathematical World

Section A: Numbers Grades K–2, page 211
Numbers can be used to count things, place them in order, or name them.

Section A: Numbers Grades K–2, page 211
Simple graphs can help to tell about observations.



Section B: Symbolic Relationships Grades K–2, page 217
Similar patterns may show up in many places in nature and in the things people make.

Section B: Symbolic Relationships Grades 3–5, page 218
Tables and graphs can show how values of one quantity are related to values of another.

Section D: Uncertainty Grades K–2, page 227
Some things are more likely to happen than others. Some events can be predicted well and some cannot. Sometimes people aren't sure what will happen because they don't know everything that might be having an effect.

Section D: Uncertainty Grades K–2, page 227
Often a person can find out about a group of things by studying just a few of them.

Section D: Uncertainty Grades 3–5, page 227
Some predictions can be based on what is known about the past, assuming that conditions are pretty much the same now.

Section E: Reasoning Grades K–2, page 232
People are more likely to believe your ideas if you can give good reasons for them.

Section E: Reasoning Grades 3–5, page 232
One way to make sense of something is to think how it is like something more familiar.

Chapter 11: Common Themes

Section A: Systems Grades K–2, page 264
Most things are made of parts.

Section B: Models Grades K–2, page 268
A model of something is different from the real thing but can be used to learn something about the real thing.

Section B: Models Grades K–2, page 268
One way to describe something is to say how it is like something else.

Section C: Constancy and Change Grades K–2, page 272
Things can change in different ways, such as in size, weight, color, and movement. Some small changes can be detected by taking measurements.

Chapter 12: Habits of Mind

Students should be able to...

Section A: Values and Attitudes Grades K–2, page 285
...raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out.

Section A: Values and Attitudes Grades 3–5, page 286
...keep records of their investigations and observations and not change the records later.

Section A: Values and Attitudes Grades 3–5, page 286
...offer reasons for their findings and consider reasons suggested by others.

Section B: Computation and Estimation Grades K–2, page 290
...use whole numbers and simple, everyday fractions in ordering, counting, identifying, measuring, and describing things and experiences.

Students should be able to...

Section C: Manipulation and Observation Grades K–2, page 293
...make something out of paper, cardboard, wood, plastic, metal, or existing objects that can actually be used to perform a task.

Section C: Manipulation and Observation Grades 3–5, page 293
...measure and mix dry and liquid materials (in the kitchen, garage, or laboratory) in prescribed amounts, exercising reasonable safety.

Section C: Manipulation and Observation Grades 3–5, page 293
...keep a notebook that describes observations made, carefully distinguishes actual observations from ideas and speculations about what was observed, and is understandable weeks or months later.

Section D: Communication Skills Grades K–2, page 296
...describe and compare things in terms of number, shape, texture, size, weight, color, and motion.

Section D: Communication Skills Grades K–2, page 296
...draw pictures that correctly portray at least some features of the thing being described.

Section D: Communication Skills Grades 3–5, page 296
...write instructions that others can follow in carrying out a procedure.

Section D: Communication Skills Grades 3–5, page 296
...make sketches to aid in explaining procedures or ideas.

Section D: Communication Skills Grades 3–5, page 296
...use numerical data in describing and comparing objects and events.

Section E: Critical-Response Skills Grades K–2, page 298
...ask "How do you know?" in appropriate situations and attempt reasonable answers when others ask them the same question.

Section E: Critical-Response Skills Grades 3–5, page 299
...recognize when comparisons might not be fair because some conditions are not kept the same.

Section E: Critical-Response Skills Grades 3–5, page 299
...seek better reasons for believing something than "Everybody knows that ..." or "I just know" and discount such reasons when given by others.

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ICE Publications	ICE, the Institute for Chemical Education University of Wisconsin-Madison Department of Chemistry 1101 University Ave. Madison, WI 53706-1396 608-262-3033 Internet: ice@chem.wisc.edu
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Science and Children Membership and Publications List	National Science Teachers Association 1742 Connecticut Ave., NW Washington, DC 2009 703-243-7100
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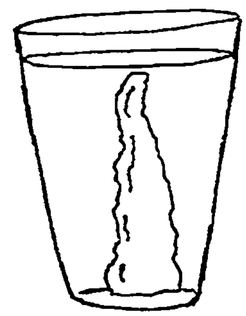

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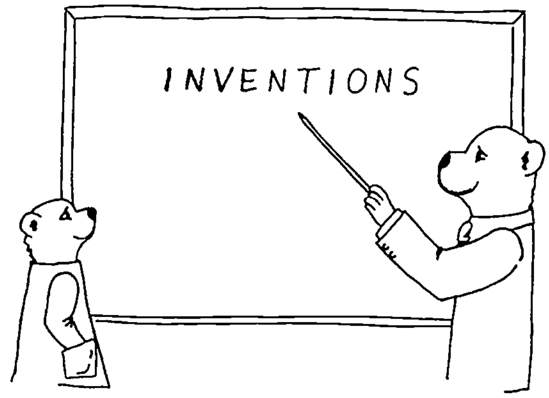

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