Pre-College 4-H STEM

Certificate Program

Level 1 Curriculum

4-H Youth Development
Explore 4-H STEM Training

To make the best better

Milwaukee County UW—Cooperative Extension
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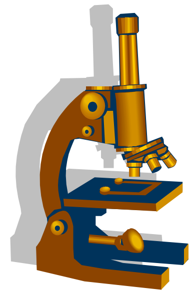
A youth development, educational program from:

MetLife Foundation



Special thanks to those that have helped create and develop the

Pre-College 4-H STEM Level 1 Curriculum:

- Mary Thiry, Pre-College STEM Advisor- Compiled Curriculum, formatted, and acted as editor.
- Crystasany Turner, Pre-College STEM Coordinator/teacher 2010-2011- Compiled curriculum, formatted.
- Eva Terry, Pre-College STEM VISTA Coordinator 2011-2012/2012-2013- Compiled curriculum, formatted, and acted as editor.
- Michelle Gonzalez, Milwaukee County 4-H Program Coordinator- Editor

NOTE: The STEM lessons were created by outside authors, please see the References Page.

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The University of Wisconsin Extension
Milwaukee County 4-H STEM Continuing Education Program

The voluntary **4-H STEM Continuing Education** program provides motivated youth, grades 7 and 8, with the opportunity to achieve mastery in science, technology, engineering, and mathematics by successfully completing a three level learning experience.

The **3 levels of STEM** mastery will:

- Provide youth with opportunities to sample a broad array of STEM experiences, measure personal learning progress, and become self-directed learners.
- Provide a standard of excellence where individuals are recognized for knowledge and skills they have mastered. Completion of all three levels of a certificate indicates mastery of STEM subjects.
- Develop the youths' understanding of preparing for post-secondary education with field experiences at 2 year UW-College campuses.

A participant must complete each STEM level in the following order; however, the time frame for completion will be determined by each youth with the assistance of his/her leader. Typically the first and second level takes at least one school year to complete and the third level is completed the summer following the second level.

- **Level I - Explorer**

Youth explore different facets of STEM, using the Milwaukee County 4-H Exploring STEM unit and complete 3 pre-college activities. Youth will also attend UW-Waukesha for a day of STEM workshops to earn one Continuing Education Unit. Youth will also keep track of their work in a portfolio that will be reviewed.

- **Level II - Researcher**

Youth conduct experiments and demonstrations that are focused on one or two specific STEM areas and complete 3 advanced pre-college activities. Youth will also attend UW-Waukesha for a day of STEM workshops to earn one Continuing Education Unit Youth will also keep track of their work in a portfolio that will be reviewed.

- **Level III -Professional**

Youth demonstrate their leadership potential by utilizing their knowledge of STEM. Youth will be invited to participate in a week long college experience at a 2 year UW Colleges campus, where they will participate in STEM classes. There will be a recognition ceremony at the end in which youth will receive Continuing Education Units and a certificate of completion.

Program requirements are as follows:

- Each participant will be assisted by a 4H project leader who will provide support in setting and achieving personal STEM goals. Leaders will have access to trainings to build their depth of knowledge and a wealth of materials to assist in setting guidelines to enhance and expand project content while identifying experiences specific to the needs and interests of each participant.
- A County 4-H Educator for processing of the STEM Certificate of Achievement and other awards.

- To be qualified to participate, the 4-H youth and leader must have an up-to-date enrollment form on file at the Milwaukee County 4-H office.
- A 4-H Portfolio must also be completed by youth and handed in for review as part of the STEM project.
- Youth must create a science/engineering product that will be entered in the Science Fair.

4-H resources available to help the youth achieve their STEM certificate include:

- The 4-H Publications Catalog which lists a variety of project materials and resources recommended for use in a project. A complete list is provided in the catalog, and on the Milwaukee County (MC) STEM web page. Sample areas of interest include: animal science, plant and soil science, environmental science, mechanical science, aerospace, and computers.
- The Milwaukee County 4-H Educational Resources Lending Library, located at the Milwaukee County UWEX office, includes other projects, books, videos and reference materials that can be checked out by leaders or a 4-H parent.
- Assistance with making connections to local scientists or specialist/groups or organizations in your community who are willing to share their STEM expertise with 4-H STEM participants.

This certificate program was developed by 4-H Milwaukee County WI, using as its model Lake County 4-H Council, California – "Arts & Crafts Proficiency Program"

For more information contact:

Michelle Gonzalez Milwaukee County 4-H Educator	414-256-4626 **michelle.gonzalez@ces.uwex.edu**

The University of Wisconsin Extension
Milwaukee County Pre-College 4-H STEM Program

Level I: Explorer Checklist for Leader

Leader Name: _________________________ Club/School_________________________

Leaders should make sure that all the steps below are completed for the entire club. They are required for the students to graduate to the next level of the program.

_____1. Each school must complete a Memorandum of Understanding with the Milwaukee County UW-Extension.

_____2. Have the students complete the 4-H enrollment process by the beginning of October.

_____3. Schedule a time, before the STEM lessons begin, for the youth to complete the pre-surveys which must be administered by a UW-Extension staff member. These surveys are voluntary and anonymous for all youth participants.

_____4. Complete a minimum of 8 STEM 4-H project activities from the Level I STEM book with the youth.

_____5. Complete the 3 pre-college lessons included in the book with the youth.

_____6. Review with the youth the scientific method and engineering design process for future activities. The scientific method can be found under S in the book and the engineering design process can be found in E.

_____7. Have youth attend the University of Waukesha STEM Day trip during second semester.

_____8. Make sure youth fill out a science fair or demonstration registration form, plan and participate in the Pre-College 4-H STEM Science/Engineering Fair, which takes place before the Recognition Ceremony in May.

_____9. Have each youth complete a 4-H portfolio. This tool will give the youth practice in creating a portfolio for high school and college entrance.

_____10. Keep track of the activities you have completed on the attached sheet and send this to the UW-Extension office. Please add suggestions, what worked and what did not work with the activities.

UW Extension
Milwaukee County

Activities Completed

Please list the activity name and the date that it was completed.

Science-

1. ____ /_________________
2. ____ /_________________
3. ____ /_________________
4. ____ /_________________

Technology-

5. ____ /_________________
6. ____ /_________________
7. ____ /_________________
8. ____ /_________________

Engineering-

9. ____ /_________________
10. ____ /_________________
11. ____ /_________________
12. ____ /_________________

Math-

13. ____ /_________________
14. ____ /_________________
15. ____ /_________________
16. ____ /_________________

Please turn in a copy of the Level I: Explorer checklist and this list of activities to the UW-Extension office.

Student Attendance List

Name	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6	Lesson 7	Lesson 8

Student Attendance List pg. 2

Name	Pre-College 1	Pre-College 2	Pre-College 3	UW-W STEM Day	Science Fair/ Graduation	Portfolio

S

Science

The definition of science is

   a. The observation, identification, description, experimental investigation, and theoretical explanation of phenomena.
   b. Such activities restricted to a class of natural phenomena.
   c. Such activities applied to an object of inquiry or study.
2. Methodological activity, discipline, or study.
3. An activity that appears to require study and method
4. Knowledge, especially which is gained through experience.

Definition provided by yahookids.com

Science is the study of the natural world, it is the study of the earth and other planets, it is the study of animals and plants. Science is the study of every living and nonliving thing around us.

Scientist, to study the world around us, use Scientific Method (also known as science inquiry). There are steps to scientific method, all steps must be followed in order for something to be considered part of the world of science.

The steps to the scientific method are as follows:

1. Ask a question to define the problem or an issue you wish to resolve.
2. Do background research to learn what others have discovered about your topic.
3. Construct a hypothesis to determine how you think your questions should be answered.
4. Test your hypothesis by conducting an experiment.
5. Analyze the data you have collected during the experiment.
6. Formulate a conclusion based on your research and the data you've gathered from your experiment.
7. Communicate your results to others who have an interest in the topic.

One of the most interesting points to remember about the scientific method is that it can't absolutely verify that something is true. The scientific method can only prove that a particular hypothesis is false. In regards to the scientific method, Albert Einstein once said, "No amount of experimentation can ever prove me right; a single experiment can prove me wrong." Information from http://www.scientificmethod.com/

Scientific method information provided by: In 4-H you find science in many of the projects from the arts to Zoology, the following activities have science at its heart. All of life is science so all of science is life, make science a part of your life.

Section One (Science): Leaders please complete two lessons minimum from this section with the youth. The lessons vary in difficulty; please choose lessons that will challenge the youth and spark inquiry. Lessons can be adapted to be made more challenging.

List of experiments-

1b. Bone up on calcium

In this science experiment, you will see why calcium is important to keep your bones strong. To do a science experiment you need to have both a **control** (something you don't change) and a **variable** (something you do change). Then you compare the two. In this experiment, you will soak a chicken bone in vinegar, which is an acid that dissolves calcium. Older people who have not had enough calcium in the foods they eat develop weak bones that break easily.

Project skill:
Discovering the importance of calcium for bone strength

Life skill:
Using scientific methods

Supplies
- 2 quart jars
- 2 chicken leg bones
- white vinegar
- water
- liquid measuring cup

1. Place a chicken leg bone in each jar.
2. Add 2 cups of water to one jar and 2 cups of vinegar to the second jar.
3. Put the lid on each jar and leave for at least three days.
4. Remove the bones and rinse them with water.
5. Compare how flexible the bones are. Try to bend each one.
6. If you want to see more dramatic results, put the bones back in their jars and leave them for four more days.

Science experiments

You can design your own science experiment! Find a topic that interests you and can be tested. Go to the library, look up your topic, then write a hypothesis.

- A hypothesis is an educated guess or statement of your prediction of what will happen after your testing.
- Next, develop a step-by-step procedure to test your hypothesis. In your procedure, there is a control and variable. In the control, nothing is changed. In the variable, one thing is different from the control. This could be an ingredient or the amount of an ingredient.
- After completing the steps in your procedure, look at the results and make a conclusion. The conclusion answers your hypothesis. Was your hypothesis correct?

Kitchen Talk

1. Which bone bent easily? Why? ______________________

____

____

2. Which part of the bone became soft first?

____

____

____

3. Why did you have one bone in the water and one in vinegar?

____

____

____

____

Which one was the control and which one was the variable you changed? ______________________

____

____

____

4. How can you use what you learned to design another science experiment with food? ______________________

____

____

____

Extra bite

Find and prepare a recipe featuring a food that gives you lots of calcium. Serve it to your family or bring it to the next meeting for everyone to taste!

Calcium

Calcium is a mineral that is a nutrient for your body. There is more calcium in your body than any other mineral. Almost all of the calcium is in your bones and teeth. Together with vitamins and other minerals, calcium keeps your bones and teeth growing strong and sturdy. Your body also uses calcium to keep your heart and other muscles working. Most of the calcium you get comes from foods in the Milk Group of the Food Guide Pyramid such as milk, cheese, and yogurt. But you can get calcium from other foods such as broccoli. Also, many foods such as cereals and fruit juice have calcium added to them. The food label will tell you if a food has calcium added to it.

Natural Resources - Water

WHAT'S SO SPECIAL ABOUT WATER: ABSORPTION

Activity Plan – Science Series ACTpa022

Project Skills:
- Youth will test if objects repel or absorb water.
- Youth will create and test possible explanations why some repel, while others absorb.

Life Skills:
- Communication

Science Skills:
- Making hypotheses
- Using "if-then" thinking

Academic Standard:
The activity complements this academic standard:
- Science C. 4.2. Use the science content being learned to ask questions, plan investigations, make observations, make predictions, test predictions, and offer explanations.

Grade Levels: 3-5

Time: 10-15 minutes

Supplies Needed:
- Clay
- Cotton
- Eyedropper
- Paper
- Plastic cups
- Rocks
- Sponge
- Toothpicks
- Water
- Waxed paper

Do Ahead:
- Read through this entire activity plan and perform the experiments.
- Read "Science with Kids, Science by Kids" on how to teach science to kids.

BACKGROUND

Science can be fun, as kids learn science skills along with exploring the natural world of water. They also learn how to share their observations, hypotheses, experiments, and conclusions with each other. This lesson is about the cohesive and adhesive properties of water and why water molecules are attracted to each other.

Key vocabulary words:
- *Cohesion* is the attraction of one water molecule to another. Cohesive property of water is evident in the rounded shape of the water drops on waxed paper.
- *Adhesion* is the attraction of unlike molecules. Adhesive property of water is evident in the attraction of the water molecules to the molecules of the toothpicks. The water drops are attracted to the toothpick and then absorbed by them.
- *Repel* is when water is not absorbed by the object.
- *Absorption* of water is when water becomes a part of the object and does not stand alone.
- The *atom* is the smallest unit of matter that can take part in a chemical reaction. It is the building block of matter.
- A *molecule* consists of two or more atoms chemically bonded together.

WHAT TO DO

Activity: Absorb or Repel

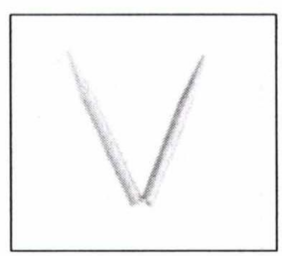
In this activity, first have the youth drop water onto a series of objects, such as clay, cotton, paper, plastic, rocks, sponge and waxed paper.

Have the youth record what happens to the water when it reaches each object. They can sort the objects into two groups: Group 1 for items that *repel* water and Group 2 for items that *absorb* water. Repeat the activity by adding salt or soap to the water. Record the results.

TALK IT OVER

Reflect:
- What helped you decide how to sort the objects into Group 1 or 2?
- Why do you think some objects *absorb* water?
- Why do you think some objects *repel* water?
- How did adding salt or soap to the water affect the results? Why do you think this happened?

Activity: Oh, My Stars



Tape a piece of waxed paper onto the table. Break five toothpicks in the middle but leave them connected (see image at right). Then arrange the broken toothpicks on the waxed paper to look like the spokes of a wheel (see left and center images on next page).

Next, use the eyedropper to place a few drops of water in the center of the wheel. Wait patiently to observe what happens. *Explanation:* The water formed one drop first. The water then collected around the toothpicks. The toothpicks started moving apart and formed a star (see right image on next page). The water eventually disappeared and was absorbed by the wood.

- For more information on water properties, review web sites listed under "Additional Web Links."

Sources:

- Lead author: Sally Bowers, 4-H Youth Educator, UW-Extension, Dane County.
- Contributions by: Dolly Ledin, UW Center for Biology Education and UW Adult Role Models in Science (ARMS); Tom Zinnen, UW-Extension Biotechnology Policy and Outreach Specialist; Linda Eisele, City of Madison, Office of Community Services; and Kathi Vos, Wisconsin 4-H Experiential Learning Specialist.
- "Oh, My Stars" activity adapted from "Oh, My Stars!" by Betty Cordel, http://www.aimsedu.org/magazine/MindBoggler/ohstars.html.

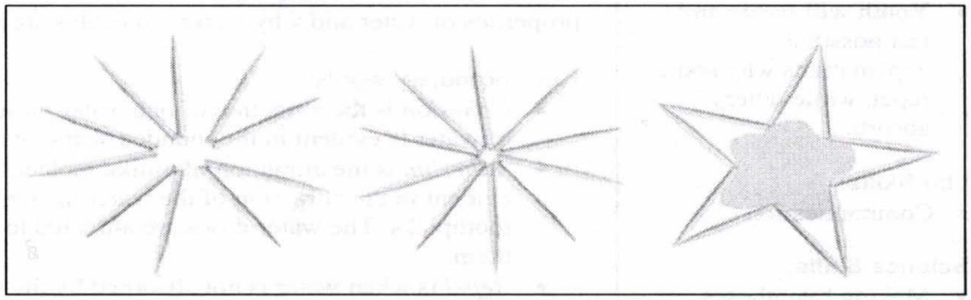
TALK IT OVER

Reflect:

- Explain what you observed during this activity.
- How did you feel when you saw the toothpicks moving apart?
- What happened to the water? Where did it go?

Apply:

- How did the toothpicks form a star? What do you think caused it?
  What are some other ways you could test your ideas about water absorption? (For example, to test the idea that wood absorbs water, put wooden toothpicks side-by-side with toothpicks that have been coated with wax or soaked in vegetable oil, then add water. Or try using plastic toothpicks.)



ENHANCE

Encourage youth to create other experiments to further explore what they are seeing and learning about water absorption.

- For example, "if" the toothpicks form stars because dry wooden toothpicks absorb water, expand in size, and the expansion causes the toothpicks to move, "then" you might expect moist toothpicks to behave differently. Since they're already moist, you might predict they would not absorb as much water, not expand, and therefore not move as much as dry toothpicks.
- Using dry toothpicks, repeat this same experiment several times so more focused observations can be made.
- Try the same experiment with toothpicks using colored water to watch the absorption process.
- Use colored toothpicks to observe if they react differently than non-colored.

Do a side-by-side comparison test. Drop plain water on one group of toothpicks and water that has a couple of drops of dishwashing liquid on the other set of toothpicks. Have the youth share their observations and conclusions regarding the differences.

HELPFUL HINTS

- Coaching youth while doing these science activities is not about *telling* them the answers. It's about *asking* open-ended questions. More importantly, it's about getting them to ask questions that lead to experiments to test possible explanations. Then the search begins for both the teacher and the learner! It's like teaming up to put together a puzzle. For more information about this approach to involve and engage youth in exploring science, read the "Science with Kids, Science by Kids" paper.

ADDITIONAL WEB LINKS

- U.S. Geological Survey, Department of the Interior/USGS, explains the capillary action of water, http://ga.water.usgs.gov/edu/capillaryaction.html.
- The Green lane ™, Environment Canada's World Wide Web Site, gives examples of water molecules binding to one another through capillary action, http://www.ec.gc.ca/water/en/nature/prop/e_motion.htm.

Reviewed by Wisconsin 4-H Curriculum Team: July 2008.

M&M® Mystery Challenge

True or false? "M&M® candies melt in your mouth and not in your hand." Every time you hear an advertising slogan, do you wonder if it is true or false? Test a claim and solve a mystery—is it fact or fiction?

Ag Skill: Understanding that advertising claims for food products can be tested

Life Skill: Solving Problems—Examines information and data

Education Standard: NS.K-4.1 Science as Inquiry

Success Indicator: Examines the advertising claims about a food by performing experiments and examining data

Time Involved: 30–45 minutes

Suggested Group Size: Any size

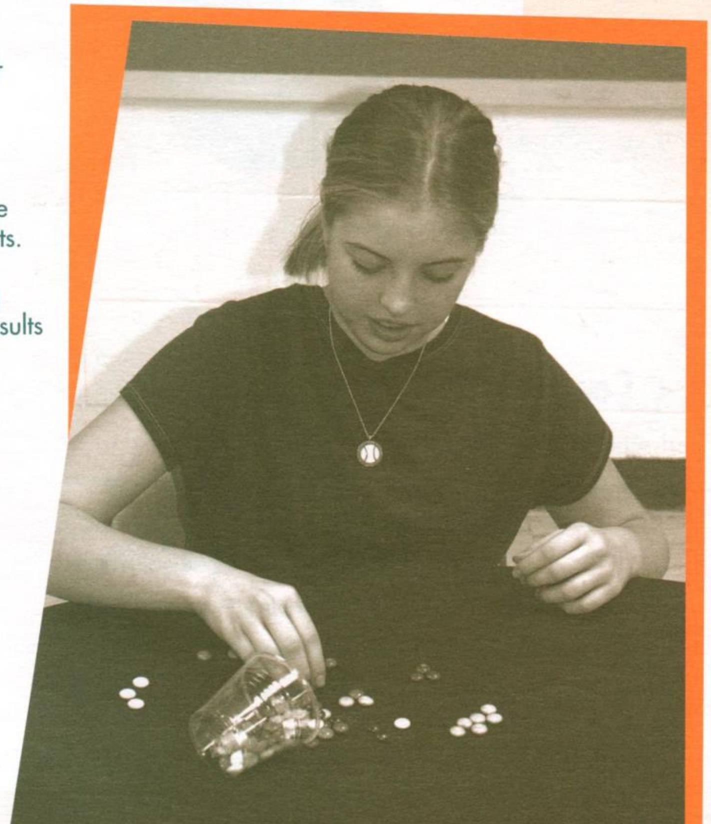
Materials Needed

Per student:

- ☐ "Fun-sized" package of M&M® candies
- ☐ Access to microwave (optional)
- ☐ Timer or clock with second hand
- ☐ Paper and pencil

The Activity

1. Examine the M&M® candies. Discuss the slogan, "Melts in your mouth, not in your hands."
2. Design experiments to test this slogan. Measure the time it takes to melt candy in:
   - **a.** Your hand.
   - **b.** Your mouth.
   - **c.** A sunny window.
   - **d.** A microwave.
3. Decide if a different color affects the melting point.
4. Make recommendations about how to increase the time it takes before it melts.
5. Create a new advertising slogan that reflects the results of the experiments.



Talk it over

Share
- What were the results of the experiments?

Process
- What are some of the variables that may have affected the results of your experiments?

Generalize
- Why do advertisers use slogans about their products?

Apply
- Who should have the responsibility to test the advertising products of different food products? Why?

Notes

AgFacts

History of M&M® Candies

According to the makers of M&M® candies, Forrest Mars Sr. encountered soldiers in Spain who were eating pellets of chocolate encased in a hard sugary coating. This prevented it from melting. Mr. Mars, impressed with this idea, went back to his kitchen and invented the recipe for M&M® Plain Chocolate Candies. They were first sold in 1941, and soon became a favorite of the American soldiers serving in World War II. They were sold to the military in cardboard tubes as a snack that traveled well in any climate. By the late 1940s, they were widely available to the public, who loved them. In 1948, their packaging changed from a tube form to the brown bag in stores today. M&M'S® Plain Chocolate Candies became a household word in the 1950's. In 1954, the famous slogan, "The milk chocolate melts in your mouth—not in your hand"®, was presented in TV advertising. In 1960, M&M'S® Peanut Chocolate Candies added three new colors—red, green and yellow—to the original brown color. In 1976, orange was added to the M&M'S® Peanut Chocolate Candies color mix.

In 1976, due to public controversy surrounding a particular red food coloring, red M&M® Chocolate Candies were removed from the traditional color mix. The red food coloring in question was not actually used in M&M'S® but, to avoid consumer confusion, the red candies were pulled out. However, in 1987 red was returned to the traditional color mix—due to overwhelming request from consumers. Blue was added in 1995.

More Challenges

- Compare M&M® candies with generic brands of coated chocolate candy. Share the results of your experiments.
- Research the history of chocolate. Research caffeine in chocolate. Prepare an informational brochure about chocolate to share with others.
- Study the different colors of M&M® candies. Which color is the most abundant? Least abundant? Prepare a graph showing this information. Do market research on a new color that consumers would like.

Project Online Afterschool Agriculture
www.n4hccs.org/afterschoolag

Acknowledgments: Horton, Warkentien and Gogolski

Food Glue

What makes glue stick to things? Many adhesives we use every day are made in factories. Did you know that many agricultural products are used in the production of adhesives? These activities will instruct you to make glue, test glue, and use glue in some fun ways.

Ag Skill: Exploring the different food products used in making glue

Life Skill: Acquiring and Evaluating Information—Obtains data

Education Standard: NS.K-4.1 Science as Inquiry

Success Indicator: Makes glue, tests glue, and uses glue in papier-mâché

Time Involved: 45 minutes

Suggested Group Size: Any size

Materials Needed

For glue recipes:

- ☐ Bowls
- ☐ Measuring spoons
- ☐ Measuring cups
- ☐ Coffee filters
- ☐ Flour
- ☐ Water
- ☐ Vinegar
- ☐ Baking soda
- ☐ Dry milk
- ☐ Eggs
- ☐ Small whisks or utensils for stirring

For glue tests:

- ☐ Construction paper
- ☐ Ruler
- ☐ Tall 32-ounce cups
- ☐ Small paper/plastic cups
- ☐ Small paper plates
- ☐ String
- ☐ Tape
- ☐ Scissors
- ☐ Peanut butter
- ☐ Pennies

The Activity

1 Provide materials to make several glue recipes:

a. Wheat flour paste

— 1/4 cup water

— 1/2 cup flour

— Mix until smooth. Add food coloring for a fun effect.

b. Egg white glue

Crack an egg and separate the white into a bowl. Discard the yolk. The egg white works as clear glue.

c. Milk glue

— 1/4 cup hot water

— 1 tablespoon vinegar

— 2 tablespoon powdered dry milk

— 1/2 teaspoon baking soda

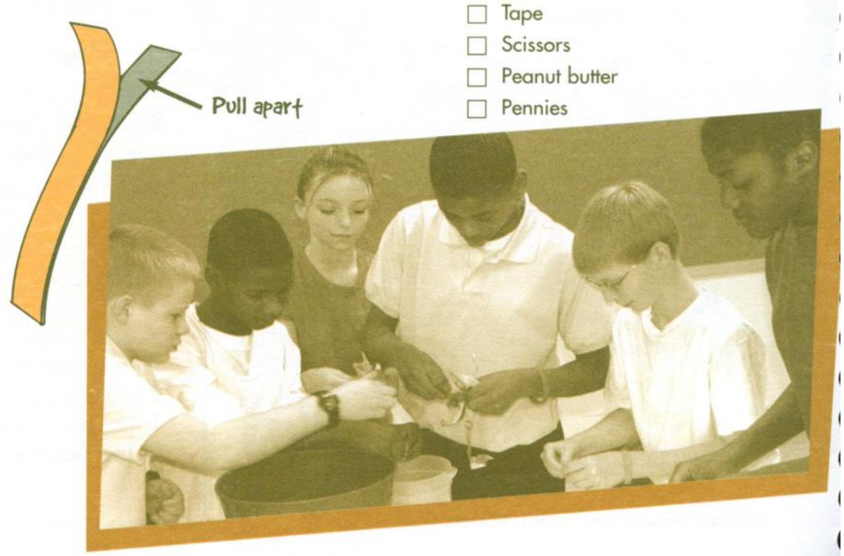
— Water

Mix hot water with powdered milk. Stir until dissolved. Add vinegar and continue stirring until the milk is well separated into solid curds and watery whey. Pour the curds and whey into a coffee filter positioned over a container. Slowly lift the filter, draining the whey. Keep the curd that is in the filter. Squeeze the filter to remove as much liquid as possible. Discard the whey and return the curd to a container. Use a spoon to break the curd into small pieces. Add 1 teaspoon hot water and 1/8 to 1/4 teaspoon baking soda to chopped curd. (Some harmless foaming may occur. This is carbon dioxide gas being produced from a reaction of baking soda with vinegar.) Mix thoroughly until the glue becomes smooth. If the mixture is too thick, add more water. If the glue is too lumpy, add more baking soda. The finished glue can vary in consistency from a thick liquid to a thick paste. WHEN NOT IN USE, COVER YOUR CUP OF GLUE WITH PLASTIC WRAP. Un-refrigerated glue will spoil after 24–48 hours.

2 Provide materials for teams to set up glue tests. Direct students to design tests that will hold two pieces of paper together.

a. Glue together strips of construction paper using the different glues. Allow the glue to dry and then try to pull the papers apart comparing the strength of the glue.

b. Which glues are the strongest? Record and chart your results.



Talk it over

Share

- Which glue ingredients are also food products?

Process

- What adhesives did you find to be the stickiest? The strongest?

Generalize

- What adhesives are used in hospitals? In offices? In schools? In auto repair shops?

Apply

- When might you use this testing process to compare products?

AgFacts

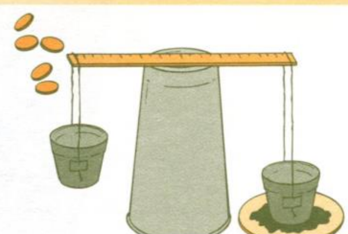
Adhesives

Many agricultural products are used in the production of adhesives. The proteins in milk and the starch in flour are chemicals that have good characteristics for stickiness. A protein in milk called casein is used to make white school glue. The proteins found in the hoofs and bones of beef and swine are used to make glue and also the gelatin we eat for dessert. Flour and water paste is the adhesive used in papier-mâché, which has been used in art for hundreds of years all over the world.

Notes

More Challenges

- Do an additional glue test.
  - **a.** Turn a 32-ounce cup upside down and balance a ruler on the cup.
  - **b.** Tape string to a small paper cup to create a handle. The handle should be just long enough so that the bottom of the cup touches the table when the handle is placed over one end of the balanced ruler.
  - **c.** Make a shorter string handle for another small cup. Tape the two ends of a piece of string to this cup so that it will be about 3 inches off the table when the handle is placed over the other end of the balanced ruler.
  - **d.** Hang the cups from opposite ends of the ruler and tape each cup handle to the ruler to hold the handles in place. Put a small paper plate under the cup with the long handle. Using a spoon, smear a layer of peanut butter on the bottom of the long-handled cup and push the cup down onto the plate. Have one student hold down the paper plate while the other begins to put pennies one at a time into the other cup. When the peanut butter cup pulls away from the plate, count the pennies in the cup. Use a new plate and cup and repeat the experiment using the glue recipes to see which one forms the strongest bond between the cup and the plate. Try again allowing glues to dry overnight.

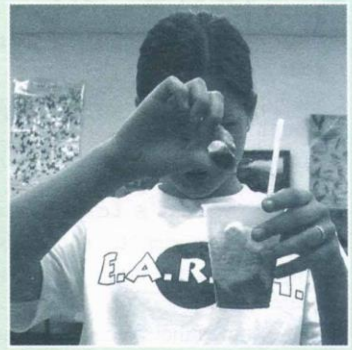


- Use wheat paste to make papier-mâché two different ways. Directions for Sculpted papier-mâché and Papier-mâché piñatas appear in the Appendix.

Acknowledgments: Adapted with permission from Illinois Ag in the Classroom, Oklahoma Ag in the Classroom

Chapter 4 Environmental Education and Earth Science

Environmental Education and Earth Science is one of the eight project areas in the 4-H program. 4-H club members enjoy exploring the vast richness of the environment and learning about this incredible planet. 4-H club members interested in Environmental Education can learn how to take care of the environment, conserve and/or recycle resources and have fun outdoors without harming the natural environment. Members interested in Earth Science have opportunities to literally uncover buried natural treasures while learning about geology, erosion and soils. For more information about this or any of the other project areas contact your local Cooperative Extension or 4-H Office.



Edible Aquifer

Related 4-H Project Area:
Exploring Your Environment

Life Skill:
Wise use of resources

Education Standard:
NSK 4.6, Changes in Environments

Success Indicator:
Demonstrate how water and pollution get into an aquifer.

Time Involved:
20–30 minutes

Suggested Group Size:
2–20 children

Water is an essential resource that is used by every person, community and industry in the world, but there is a limited supply of water on earth. It is very important to know the source of drinking water, so as many water pollutants as possible can be identified and eliminated from the local environment. In this activity you will learn how pollution can seep into your drinking water.

Getting Started

Read through this activity and gather necessary materials. If you need more information about the topic refer to "Background Information." Prepare the pudding and put the toppings into serving dishes ahead of time.

Do the Activity

Each child will use the food items from the material list to construct a model of an underground **aquifer**. Each individual aquifer will be filled with "water" then contaminated with "pollution".

1. Arrange all supplies in a convenient location for children to use. Give each child a plastic cup.
2. Explain to the children that the pudding represents the **confining layer**, or bedrock, that water cannot penetrate.
3. Have each child fill his or her plastic cup ⅓ full of pudding.
4. Explain that the assorted toppings represent the different types of rock and gravel that make up an **aquifer**. Ask the children to predict which layer (topping) will hold the most water and why.
5. Have the children spoon at least three different topping layers over their pudding "bedrock". Tell them to be sure to fill the cup almost to the top.
6. Have the children carefully tap the bottom of the cup on a counter or table to settle the particles (toppings) in the layers.
7. Explain to the children that now they will observe how water moves through the different sized **pores** in an aquifer. Tell them the milk will represent water.
8. Have the children pour ⅓ cup of milk over the layers of their "aquifers".
9. Relate the size of the pores to the size of the particles that make up the layers. Ask the children which layer of the aquifer had the most room for "water"? Were their predictions (step 4) correct?

Materials Needed

- ☐ A least three toppings from the following list: cereal (different sizes and shapes), raisins, peanuts, or chocolate chips
- ☐ Vanilla pudding, prepared
- ☐ Milk
- ☐ Liquid food coloring
- ☐ Clear plastic cups and spoons (for each child)
- ☐ Serving dishes and spoons (for each topping)

10. Discuss **percolation**, **ground water**, **aquifers**, and pollution. Ask the following questions:
    - Why are there rainbows in the water on the road when it rains?
    - What other pollutants might be in rainwater runoff?
    - Where does the rainwater go after a rain?
    - Do you think all the pollutants are filtered out before the water gets to the aquifer?
    - Where do we get our drinking water?
    - How fast do you think pollutants can get into our drinking water?
    - How could polluted water in an aquifer affect your drinking water?
11. Now tell the children that the food coloring represents polluted water from the surface of the soil. Tell them to pour some food coloring onto the top of the aquifer, and to watch the coloring "percolate" through the soil and rock.
12. Discuss with the children that most drinkable water comes from aquifers. Discuss what happens when pollution gets into the water supply. Ask the following questions:
    - Did the layers of "soil" and "rock" filter out the "pollution" before it got to the "water" in the "aquifer"?
    - What happened to the "water"?
13. Eat the aquifer!

Talking it Over

Share What You Did

- What is an aquifer and how do aquifers store water?
- Did your model aquifer store a lot of "water" or a little? Why do you think that was so?

Process What's Important

- What does it mean when we say that water is contaminated?
- How did the "pollution" in your aquifer model get from the "land" to the underground "water"?

Generalize to Your Life

- Make a list of some things in your house, school or community that could contaminate an aquifer.
- How could the things on your list get into an aquifer that is far below the Earth's surface?

Apply What You Learned

- Does polluted water in an aquifer concern you? Why or why not?
- What could you and your family do to help reduce water and soil pollution in your community?

Activity Summary

It is important to protect our supply of clean drinking water by reducing the amount of pollution in the soil and water.

Written by Beth Drescher and Tonya Bronleewe.

Water, Water Everywhere

Background Information

If you dig deep enough in most areas of the world, you will find water. Water that is under the ground is called **ground water**. It seeps into the ground until it reaches a layer of rock that it can't get through. This impermeable rock is called the **confining layer**.

Ground water that settles in an underground reservoir of loose gravel and sand is called an **aquifer**. Many communities obtain their drinking water from aquifers. Water suppliers or utility companies drill wells through soil and rock, then use pumps to bring the water to the surface. The aquifer is **recharged** when rain and melted snow seep through the soil to refill the underground reservoir.

Water moves through the soil by the processes of **infiltration** and **percolation**. Infiltration happens when water fills up the spaces (pores) between soil particles. **Percolation** is the process of water movement from pore to pore through the soil. The speed of water movement through the soil is affected by the size of the spaces (**pores**) between the particles. The size of the spaces is determined by the size of the soil particles—the larger the particle, the larger the spaces and the faster the water can move.

Water that is percolating through soil often dissolves soil minerals, nutrients and/or pollution on its journey to the water table. Even though soil, sand and rocks naturally purify water, some pollutants cannot easily be removed from the water cycle through natural filtration. Water in the aquifer can be contaminated by improper use and disposal of harmful chemicals. Eventually they can make their way into drinking water wells where they pose a serious threat to human health.

There are two ways pollution can be spread to water, soil or air. **Point Source pollution** comes from a specific and easily identified point, such as an industrial plant or municipal waste treatment facility. **Non-Point Source pollution** comes from widely dispersed sources, such as leaks, spills and household waste. Either type of pollution can be brought to the aquifer by rain and snow runoff into rivers, lakes and streams.

More Challenges

1. More discussion questions. What would happen if we used more water from an aquifer than rain and melted snow could recharge? Can you think of any way that people can recharge aquifers? Describe how it might work.
2. Critical thinking exercise. In many places, people argue over who has the right to drill into an aquifer and use its water. Those in the city want to use the aquifer's water for people, but farmers need water from the aquifer to grow crops to make food, clothing and buildings. Many people are concerned that there is not enough water for both uses. Who do you think should get the water and why?

Exploring the Treasures of 4-H

www.n4hccs.org/exploring4h

U.S. Geological Service Learning
EPA's Drinking Water for Kids
U.S. Agricultural Research

4-H NATIONAL YOUTH SCIENCE DAY

4-H National Science Experiment

Expanded Student Version

Helpful HYDROGELS

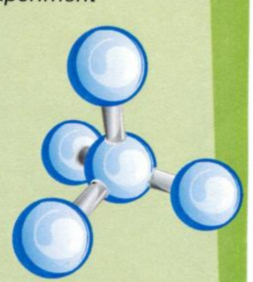
BACKGROUND

Can hydrogels help the environment?

Water is everywhere – in the sky, in the ground, and in our homes. However, caring for this vital resource is often a challenge for each of us. Conservation means using water wisely. Protecting our groundwater is important because it is a source for drinking and irrigation. Consequently, scientists and engineers have developed amazing, superabsorbent polymers, called **hydrogels,** that can help.

In this series of investigations, you will start by looking for a particular polymer at work. Once you discover what this type of polymer can do, you will experiment with other uses for the same polymer. A final step can be taken to consider solutions for water conservation and groundwater contamination.

*A **polymer** is a long chain of molecules. Polymers are all around us, and they make up materials like bicycle helmets, CDs, tires, plastic water bottles, rubber bands, and glue. This experiment focuses on special kinds of polymers that are superabsorbent: hydrogel polymers. Hydrogel polymers are long molecule chains that grab onto water molecules. Some can soak up as much as 500 times their weight in water! This superabsorbent characteristic makes hydrogel polymers useful in water conservation and in solving other environmental issues.*



ENGAGE

Where are the polymers? Why are they there?

PREPARATION

Materials:

- Disposable diaper
- Water
- Newspaper
- Scissors
- Measuring cup and measuring spoons
- Zipper-lock bag; 1 gallon size
- 9 oz. plastic cup

Time Requirement: 20 minutes.

A hydrogel is a class of polymer with some unique characteristics. Find the hydrogel polymer in a diaper and examine its use.

Collect a sample of hydrogel from the cotton and plastic lining of a disposable diaper.

1. Place a new diaper on the piece of newspaper. Carefully cut through the inside lining and remove all the cotton-like material. Put all the stuffing material and plastic lining into a clean, 1 gallon zipper-lock bag.

2. Scoop up any of the powdery material that may have spilled onto the paper and pour it into the bag with the stuffing. Blow a little air into the bag to make it puff up like a pillow, then seal the bag.

3. Shake the bag for a few minutes to remove the powdery hydrogel polymer from the stuffing. Notice how much powder falls to the bottom of the bag.

4. Carefully remove the stuffing and the plastic lining from the bag, and check out the powdery polymer left in the bag. Repeat steps 1-4 with another diaper, if needed, to get 1 teaspoon of the hydrogel powder. *(For larger groups, you can purchase the powder at www.4-H.org)*

5. Now it's time to mix the powder with water to see what happens. Pour 1 teaspoon of hydrogel powder into a 9 oz. plastic cup. Measure ½ cup of water and pour it into the cup along with the powder.

6. After about 30 seconds, observe that the water has changed — it's no longer a liquid... it's a gooey solid!

Take a closer look at the gel by scooping up some of the gel with your fingers. You can poke holes in it and even tear it into smaller pieces. This hydrogel is safe and non-toxic, so you can touch it, but remember: even safe chemicals never go into your mouth, ears, eyes, or nose!*

THINGS TO THINK ABOUT...

- How does this water-slurping powder work? Does it only absorb water?
- How much water will the average diaper absorb?
- What would happen if you let the gel dry out? Is this powder reusable?
- Besides diapers, how else could this powder be used?
- How does the absorbency of the hydrogel compare with other materials that are absorbent: cotton balls, paper towels, sponges?
- How could adding other ingredients (like salt) affect a hydrogel's water-absorbing properties?

**For full safety precautions, visit www.4-H.org and download the experiment safety guide.*

EXPLORE

Can hydrogels help improve the environment?

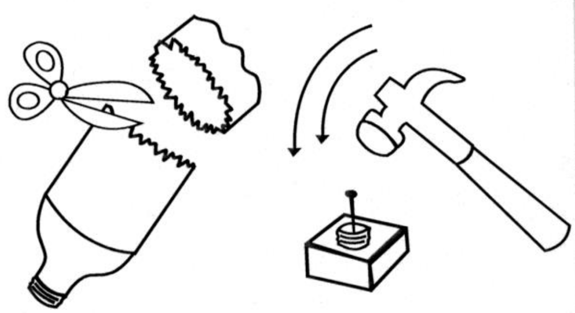
As you discovered, a hydrogel is a **superabsorbent polymer**—which can hold up to 500 times its own weight in water. Could hydrogels be used to address water conservation and groundwater contamination? Create an experiment that tests how hydrogels could work in soil.

Materials for one experiment:

- Hydrogel powder (from disposable diapers or available at www.4-H.org)
- Gallon-size, plastic, zipper-lock bag
- 2, 16.9 oz. clear plastic bottles with screw-on caps
- 2 cups packaged potting soil (it is better NOT to use the "moisture control" type)
- Measuring spoon
- Measuring cup
- 1 packet (0.14 oz./3.9 grams) of unsweetened powdered drink mix (a red color, like cherry or watermelon, works the best)
- 1 cup water

Set up two ***Soil Soakers***, which are the experimental devices you will use for your experiment.

1. Prepare two *Soil Soakers* by cutting off the bottoms of the clear plastic bottles. Put one hole in each screw on cap using a 3/16" diameter nail and hammer or use a 3/16" drill bit (see drawing). *Think safety* — this step might require adult help.



2. Label one bottle as the *Control Soil Soaker* and the other bottle as the *Experimental Soil Soaker.*
3. Put 1 cup of potting soil into the *Control Soil Soaker* and place bottle into tall, narrow drinking glass, lid side down and open side up.
4. Obtain about 1 teaspoon of hydrogel powder (see the Engage activity if you are harvesting hydrogel powder from diapers).
5. Mix 1 cup of potting soil with 1 teaspoon of hydrogel, and place into the *Experimental Soil Soaker.* Place bottle into tall, narrow drinking glass, cap side down and open side up.

Education Standards
NSES Earth and Space Science Standards: K-4 properties of earth materials; *Physical Science:* K-4 properties of objects and materials 5-8 properties and changes of properties in matter; 9-12 structure and properties of matter

4-H SET Abilities:
observe, build/construct, test, problem solve, measure, collect data, compare, communicate with others.

Life Skills:
problem solving, wise use of resources, critical thinking.

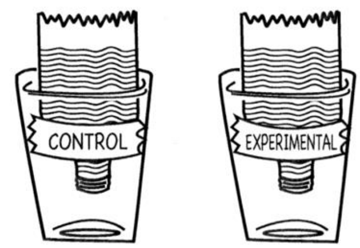
Success Indicators:
perform experiment and record data results on ***www.4-H.org.***

Age Range:
K-12 with the help of a caring adult. Ideal for youth ages 9-13.

Time Requirement:
50 minutes.

EXPLORE Continued

6. Mix 1 packet of unsweetened powdered drink mix into 1 cup of water. This solution represents a water soluble fertilizer application. (Water soluble means "capable of being dissolved in water.")



7. Go to ***www.4-H.org*** and enter your results for each of the following steps:

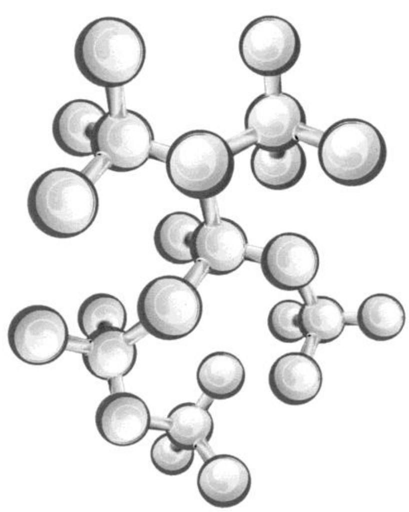
   - **Step 1 -** Pour 1/4 cup red solution into EACH of the *Soil Soakers*. Observe. Does any water drain through the soil into the glasses? For the Control -Yes or no? For the Experimental -Yes or no?

   - **Step 2 -** Add another 1/4 cup red solution into each *Soil Soaker*. Observe the amount of water that seeps through the soil. Which *Soil Soaker* allowed the least amount of water to seep through? Control or Experimental?

   - **Step 3 -** Wait 5 minutes and compare and contrast the solution from each *Soil Soaker*. Answer the following questions.

     – Is there a difference in the amount of water in each glass? Yes or no?
     – Is there a difference in color? Yes or no?
     – Is there a difference in smell? Use a wafting technique (fanning the air over the glass) to check the smell. Yes or no?

   - Once you've entered your data, compare your results with others' experiments from around the country? What might explain the differences recorded from samples you find online?



EXPLAIN

Hydrogels in the environment: Can you explain?
Discuss what you think with others at *www.4-H.org*.

Did the addition of the absorbent hydrogel polymer impact the movement of water through the soil? If yes, how?

If the red solution represented a water-soluble fertilizer or chemical pesticide, what conclusions can be drawn about this contamination entering the groundwater?

If more water is retained in the soil, what conclusions can be drawn about the amount of watering needed to help the plants grow? How might this affect water conservation issues?

FAQs about polymers and other useful information.

What are polymers?

Polymers are one of the classes of materials that we encounter throughout the day. Polymers (commonly known as plastics) are either naturally occurring (rubber, RNA and DNA, proteins, starch, and cellulose) or synthetic (manufactured).

What are hydrogels?

Hydrogel polymers are long molecule chains made up of repeating units that grab onto water molecules. This characteristic makes them a great solution for soaking up water.

How are hydrogels helping the environment?

Many environmental applications for hydrogels have been found for agriculture, as well as the the construction and horticulture industries. Hydrogels help reduce water runoff and soil erosion, thus improving the quality of lakes, streams, and rivers. Hydrogels also help with moisture retention and water conservation by helping soil increase water holding capacity, allowing plants to survive during droughts. Erosion control, soil management, and environmental clean-ups are also ways hydrogels can help the environment. Many scientists continue to study the effect of hydrogels on the environment.

ELABORATE

Go beyond...how much hydrogel works for you?

Use what you know about the environmental impact of adding hydrogel to soil. Follow the engineering design process to create a better soil for your garden.

Ask1: How can I conserve water in my garden? How can I prevent contamination of groundwater from fertilizers? Can hydrogel help me accomplish this? Are there different kinds of hydrogels with different properties? Do different soils absorb water at different rates? What is the type of soil in my garden? Can I design a "better soil" that would conserve water and protect the water table from contamination?

Imagine: Designer soil that reduces the number of waterings and, therefore, conserves water. This soil would retain the fertilizer for the plants instead of entering the groundwater and contaminating it.

Create: To craft a designer soil profile, find out about your soil type*: Is it clay, sandy or loamy? Which soil is the most absorbent? Which is the least absorbent? Which one needs more hydrogel? Which needs less hydrogel?**

Test: Using the Soil Soakers experiment, test your own soil with varying amounts of the agricultural version of hydrogel (Polyacrylamide), available in the gardening section of stores. This form of hydrogel is frequently used as a soil conditioner on farmland and construction sites for erosion control, and to protect the water quality of nearby rivers and streams. What is the optimum amount that holds water without "saturating" the soil, making it too soggy for plants? What amount is necessary to retain water and reduce the number of watering times?

Ask2: What is the optimum amount of hydrogel? Can I use other techniques to improve my soil conditions? What other ways can I conserve water in my garden?

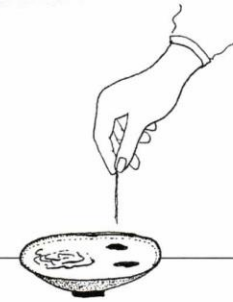
***What are soil types?**
There are three basic different types of soils: clay soils, loamy soils and sandy soils. Loamy soils are the best; the other two soils present irrigation challenges. But how do you find out which type of soil you have? Here is the simplest way to check your own soil:

- Take a marble-sized chunk of moist soil and roll it between your thumb and finger; try to shape it into a small ball.
- With a clay soil, you can do it and you end up with a ball the size of a marble.
- With a sandy soil, you cannot do it—the ball will fall apart.
- With a loamy soil, you will be able to do it but the ball will fall apart when you quit applying pressure.

****What different kinds of hydrogels are there?**
The hydrogel polymers found in most disposable diapers are just one kind. Some scientists have found that hydrogels like these don't work well in soil and agricultural use. New, super-absorbent polymers are rapidly becoming one of the most exciting topics in environmental education. Take a trip to your local garden center, and ask the plant specialist if they carry water polymer crystals or water jelly crystals.

Activity 1A

Swirling Colors



Leader's Guide

What's the point?

Children observe dispersion in colorful milk solutions and experiment to see what household chemicals cause such dispersion to occur. They find that detergents and soaps make the milk colors swirl and also help you to wash oil off your hands. Washing with soap causes oils and fats to break into small droplets that become dispersed in water like the colors do in the milk solutions. *For additional information, read Science: Behind the Scenes (page 19).*

What's the plan?

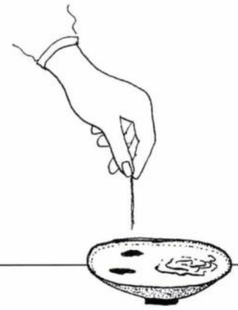
1. Read the activity (page 21).
2. Gather the supplies (page 20).
3. Try the activity.
4. Note special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If children are likely to put their fingers in their mouths, provide reminders and adequate supervision and ask them to wash their hands after the activity.



Activity 1A

Swirling Colors

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

In this activity, you will see that soaps, detergents, and similar cleaning products cause swirling action in milk, whereas other types of liquids do not. In Activity 1B, you will observe that oil and water do not mix well—if you stop shaking a jar containing these two liquids, they quickly settle into distinct layers. But when you add just a few drops of detergent, the oil and water will stay mixed.

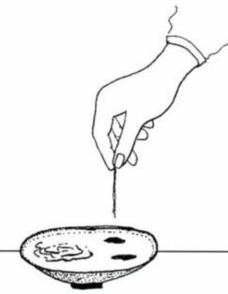
How does detergent make milk swirl or cause layers of oil and water to mix? Soaps and detergents have chemical properties that cause other compounds to disperse, or spread out. When you place a drop of detergent into a spot of color in the milk, it causes the surrounding solution to spread in all directions. When you add a few drops of detergent to the oil and water in a jar, the detergent helps to break the oil into small droplets that spread throughout the water.

These same chemical properties make soaps and detergents very useful for cleaning. These products help to dislodge the oil on your skin or the grease on your dishes or clothing. They cause the oil or grease to break into droplets, which spread out, mix with water, and get washed away.

When cleaning up oil spills in the environment, sometimes we want the oil to remain in one place where it can be collected. Under other circumstances, we want the oil to disperse. These concepts will be explored further in Activity 1B, *Cleaning Up an Oil Spill*.

Activity 1A

Swirling Colors



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

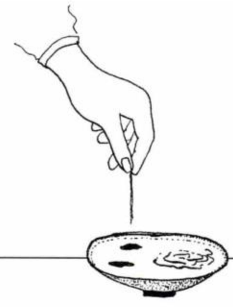
- ❑ small amount of shortening or cooking oil
- ❑ hand soap or a few drops of dish detergent
- ❑ bucket of water or wet washcloth

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ 2 bowls or pie plates
- ❑ 2 cups whole milk[1]
- ❑ liquid food colorings in 2 or more colors
- ❑ several toothpicks
- ❑ 1 tablespoon or more of liquid dish detergent, poured into a bowl (for the group to share)
- ❑ 1 tablespoon or more of a variety of other household liquids, in bowls (for the group to share)[2]

[1]Try to use whole milk instead of 1% or 2% milk. The lowfat milks will swirl, but not as well.
[2]Use some liquids that are soaps or detergents and others that are not (e.g., honey, cooking oil, molasses, shampoo, liquid hand soap, vinegar, fruit juice, or liquid cleaning solutions).



Activity 1A

Swirling Colors

Focus

Rub your hands with cooking oil or shortening and show them to the children. Tell them you would like to remove the oil. Using a bucket of water or a wet washcloth, demonstrate that water alone will not do the job. Ask the children how you could do better. Chances are they will suggest using soap, and you can demonstrate that with soap the oil can be removed much more thoroughly. You could conclude by suggesting that in the following activity we will see this same effect of soap in a different way.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why water won't wash the oil off.

what soap does to the oil.

Activity

1. Cover the tables with newspaper and have the children put on their smocks.

2. Pour enough milk into a bowl to make a layer about $^1/_2$-inch deep.

3. Once the milk has settled, add a drop of two or three different colors of food coloring at different locations on the surface of the milk. Do this gently, being careful not to stir the mixture.

4. Ask the children to predict what will happen if they gently dip a toothpick into one of the colored dots. Then let them try dipping, being careful not to stir, and watch for any changes in the food coloring and milk as they do so.

Conversation

Questions You Might Ask

What does dish detergent do to the color spots?

What do you think makes the colors swirl?

What do you think would happen if you used something besides dish detergent on the toothpicks?

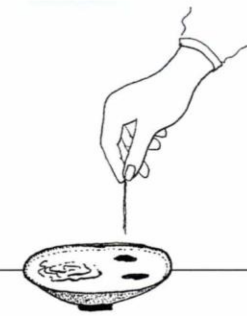
What happens if you put honey on your toothpick? How about a bit of oil?

Can you think of another chemical that might work? How about a different kind of soap or detergent?

Do you think the same kind of swirling would happen if water were used instead of milk?

Activity 1A

Swirling Colors



5. Now pass around the bowl of dish detergent and have the children dip their toothpicks into detergent. Ask what they think will happen when they use these toothpicks to touch the spots of color. Let them try dipping, and give them time to play with their mixtures, watching the colors swirl wherever they dip the coated toothpicks.

6. Starting with a fresh bowl of milk and colored spots, encourage each child to dip toothpicks into substances other than dish detergent, predicting and then testing their effects on the milk spots. You could let them choose from a variety of common substances that will stick to a toothpick, such as honey, cooking oil, shampoo, or liquid hand soap. You could also include liquids that are less sticky but will soak into a toothpick, such as vinegar, fruit juice, or liquid cleaning solutions.

7. Discuss any observations the children have made about what substances caused mixing in the milk.

Transition or Closure

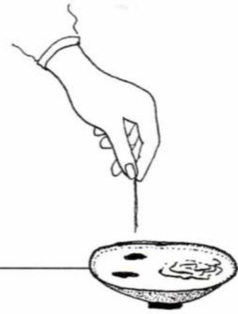
If you are doing only Activity 1A, review the "I wonder..." statements. If you are doing Activities 1A and 1B together, help the children clean up their work areas. Then shift their attention to the oil spill activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why soap makes the color spread out.

why honey doesn't do the same thing.



Activity 1A
Swirling Colors

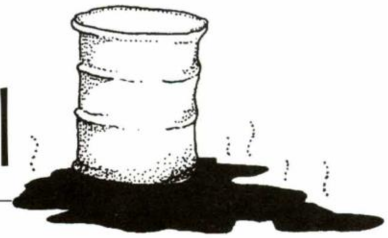
A Step Beyond

I wonder whether this would work in water instead of milk.

Try it! The children might want to try the same activity in a variety of liquids such as water, fruit juice, skim milk, or tea. You are likely to see the same effect in any of these other liquids, but it will be much more dramatic in some than others. In water, most of the food coloring tends to sink, and only the small amount left at the surface will react to the toothpick tests. Liquids that contain tiny suspended particles do a better job of keeping the color in dots at the surface. These include any variety of milk or cream and fruit juices such as orange juice or cider.

Activity 1B

Cleaning Up an Oil Spill



Leader's Guide

What's the point?

Children learn that environmental oil spills are difficult to clean up. For some steps of the cleanup process, it is useful to contain the oil, and for other steps it is desirable to have it spread out or disperse. A detergent is an example of a chemical that helps oil disperse in water, just as it caused the colored spots to spread in milk in Activity 1A.

For additional information, read Science: Behind the Scenes (page 25).

What's the plan?

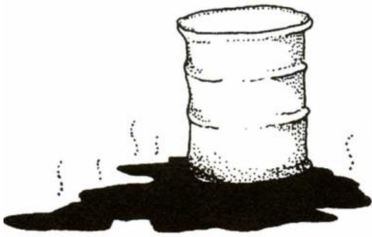
1. Read the activity (page 27).
2. Gather the supplies (page 26).
3. Try the activity.
4. Note special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If a child has problems holding a regular spoon handle, make the handle "fatter" by folding a washcloth in quarters lengthwise and wrapping the folded cloth snugly around the handle, fastening it with rubber bands.



Activity 1B

Cleaning Up an Oil Spill

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

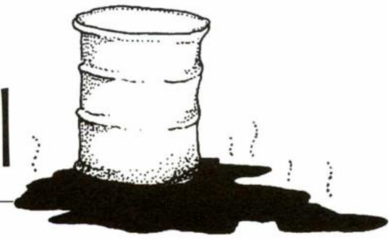
Oil and water do not mix—when you stop shaking them together, they quickly separate into distinct layers. Adding a few drops of dishwashing liquid causes the oil to break up into small drops that tend to remain mixed with the water rather than settling out. This is how dishwashing liquid removes grease from pots and pans, and it can also be useful in cleaning up oil spills in the environment.

When oil is spilled in a lake or ocean, it forms a floating layer called an oil slick that is very difficult to clean up. Exxon spent more than two billion dollars on cleanup operations following the Valdez spill in Alaska! Usually the first strategy in cleanup operations is to try to surround the oil slick so that it will not be able to spread. Then efforts are made to pump or soak it up. In the case of smaller spills, or the residues left after removing as much as possible of larger ones, the next line of attack is to apply dispersants. These are chemicals that act in the same way that dish detergent does in our experiment—they break the oil into small droplets that disperse in the environment.

When an oil tanker crashes, it creates an ecological disaster and big headlines in the news. You may be surprised to learn, though, that much of the oil that ends up in lakes and oceans comes not from these huge accidents but from much smaller leaks and spills. One significant source is used motor oil that people pour into storm drains rather than recycling it or disposing of it safely. Most storm drains lead directly to a river, lake, or ocean. Another significant source is the oil and gas that leaks or gets dumped from motorboats. It's important to remember that it is much easier to keep oil out of water than to try to clean it up once a leak or spill occurs.

Activity 1B

Cleaning Up an Oil Spill



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 jars containing several inches of water, a couple of drops of blue food coloring, and a thin layer of vegetable oil. Make sure that the jars don't leak because the children will be shaking them vigorously.
- ❑ a few drops of dish detergent

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ pie tin or flat bowl
- ❑ water
- ❑ vegetable oil, several tablespoons
- ❑ materials for making small animals or boats[1]
- ❑ oil cleanup supplies such as cotton balls or paper towels[2]
- ❑ optional: 1 cup of gravel or sand
- ❑ liquid dish detergent
- ❑ eyedropper
- ❑ spoon

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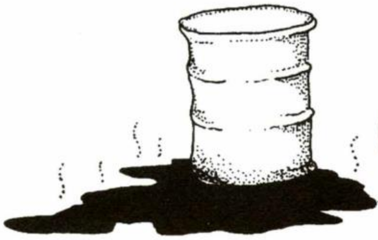
[1] Pipe cleaners, foam trays, feathers, and fuzzy fabrics

[2] Sponges, string, pipe cleaners, cotton balls, paper towels, cotton swabs, pieces of hay or straw, a spoon, etc.



Activity 1B

Cleaning Up an Oil Spill

Focus

Ask whether anyone has seen pictures of an oil spill in an ocean or lake. What does it look like? Does the oil float or sink? As you hold this discussion, pass around a bottle containing water and oil. Ask the children to shake it up and observe what happens when they stop shaking it.

Put a few drops of dish detergent into a second jar containing water and oil. Pass this jar around as well, again asking the children to shake it up and observe what happens.

Activity

1. Cover the table with newspaper and have the children put on their smocks unless already in place from the previous activity.

2. Fill a pie tin or flat bowl with one inch of water. Add several tablespoons of vegetable oil to the water surface in each bowl.

3. Using pipe cleaners, bits of fuzzy fabrics, feathers, or other scrap materials, ask the children to design small animals to float on or swim in the water.

4. Optional: Allow the children to add sand or gravel on one side to make a beach or shoreline area.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why water and oil don't stay mixed.

why oil floats on water.

Conversation

Questions You Might Ask

Suppose that an oil tanker crashed, causing a large oil spill in the ocean. How do you think you might clean it up so that it wouldn't kill too many birds, fish, whales, or other living things?

What materials seem to work best for gathering all the oil into one place?

What materials work best for soaking up the oil?

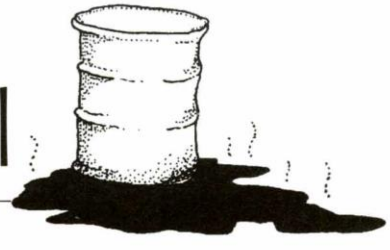
Which materials spread out the oil?

If you mix the oil into the water, can you make the oil slick go away? Does it stay away? If you add a bit of dish detergent, does this help or make it worse?

Is it possible to clean up all the oil?

Activity 1B

Cleaning Up an Oil Spill



5. Provide a variety of supplies such as cotton balls, string, sponges, bits of hay or straw, cotton swabs, and a spoon. Challenge the children to collect as much of the oil as possible and remove it from the water and beach (if they built one in step 4). Encourage them to try various collection techniques.

6. Discuss whether it is possible to remove all the oil and ask whether the children have ideas for additional ways to clean it up. If they don't mention soap, you could remind them to think about when you were trying to get oil off your hands.

7. Now provide dish detergent and eyedroppers and ask the children to figure out whether detergent helps to clean up what's left of their oil spills.

8. Ask what effect the oil has on the toy animals in their bowls and have the children experiment with how this oil might best be removed.

Closure: Connecting Chemistry and Environment

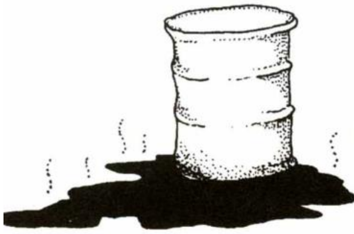
If you are doing only Activity 1B, review the "I wonder…" statements. If you are doing Activities 1A and 1B in one session, talk with the children about how the activities helped them to think about how to disperse an oil spill. Discuss which technique worked better at cleaning up the oil spill. Did adding detergent make the oil easier or more difficult to remove? Did it help when you wanted to mix the oil into the water rather than remove it?

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

how ducks get the oil off their feathers.

how many cotton balls it would take to clean up an oil spill in the ocean.



Activity 1B

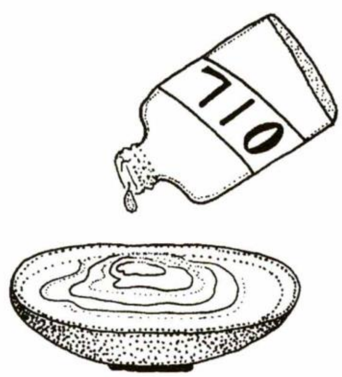
Cleaning Up an Oil Spill

A Step Beyond

I wonder how real oil spills get cleaned up—it would take millions of cotton balls to clean up the ocean! I wonder whether people use detergents to clean up real oil spills.

Looking into questions such as these would make a good library project. *Oil Spill!*, by Melvin Berger, is an excellent book on this topic for young children (see References). Children may also be interested in looking in encyclopedias or books about the ocean, then coming back and sharing ideas they have found about environmental cleanup operations.

Although cotton balls certainly would not be practical on an environmental scale, other absorbent materials are used to soak up oil spills, and chemicals similar to detergents are used to disperse what is left. For more information, see *Science: Behind the Scenes*.



Activity 4A

What Dissolves and What Doesn't?

Leader's Guide

What's the point?

Children learn that some substances dissolve in water and become invisible as they mix into solution. Others dissolve in water but change its color or appearance. And some substances do not dissolve at all.

For additional information, read Science: Behind the Scenes (page 67).

What's the plan?

1. Read the activity (page 69).
2. Gather the supplies (page 68).
3. Try the activity.
4. Note special hint (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Special Hint

If children are likely to put their fingers in their mouths, provide reminders and adequate supervision and ask them to wash their hands after the activity.

Activity 4A

What Dissolves and What Doesn't?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

When a substance dissolves, it becomes part of a liquid solution. Pure water (such as distilled water) contains only water molecules and no dissolved substances. The water we use in everyday life is far from pure—it may contain an assortment of dissolved minerals such as calcium, magnesium, and iron, as well as other chemicals such as dissolved organic compounds, salts, and chlorine, the latter of which is added as a disinfectant during water treatment.

In this activity, some chemicals such as salt and sugar dissolve in water without changing the water's appearance. Others, such as powdered drink mix, change the color of the water when they dissolve. A third category of the substances tested does not fully dissolve—if you stir cornstarch or flour into water, you will notice that many particles quickly settle back out of solution. It may look as if all of the cornstarch and flour settle out, but some actually does dissolve. You can test this by adding a couple of drops of iodine as you did to indicate the "mystery pollutant" in Activity 2B. If the water turns purple, you will know that some of the starch from the flour or cornstarch has dissolved.

So, what does it mean to dissolve, and how can a white powder such as salt or sugar simply disappear into a clear solution? Salt and sugar are examples of chemical compounds that are white crystals when in solid form. When these substances dissolve, the crystals are broken into small, invisible particles, called molecules or ions, that mingle among the water molecules.

Solids are not the only substances that dissolve. See "A Step Beyond" for ideas about simple demonstrations of gases and liquids that dissolve in water.

Activity 4A

What Dissolves and What Doesn't?

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 jars, one containing only water and the other containing water and a bit of sand
- ❑ sugar

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ smocks, old shirts, or aprons
- ❑ measuring cup
- ❑ water
- ❑ clear plastic cup, 9-oz. size
- ❑ a variety of household substances, some of which will dissolve (sugar, salt, Kool-Aid or other colored drink mix, flour, cornstarch, baking soda, dried milk)
- ❑ teaspoon measure
- ❑ spoon

Activity 4A

What Dissolves and What Doesn't?

Focus

Pass around two jars, one containing only water and the other containing water and a bit of sand. Ask the children whether they think anything is in the bottles other than water. The sand doesn't dissolve, so it's easy to see that it is in one of the bottles. But if you added a bit of sugar or salt to the other bottle, the appearance of the water would not change. In fact, unless it has been distilled, all water contains dissolved substances, many of which we cannot see. Try mixing in a pinch of sugar and then ask if the water looks any different. Discuss the idea that some substances dissolve in water and others do not and that some of those that do dissolve become invisibly mixed with the water.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how you can tell if there's anything dissolved in water.

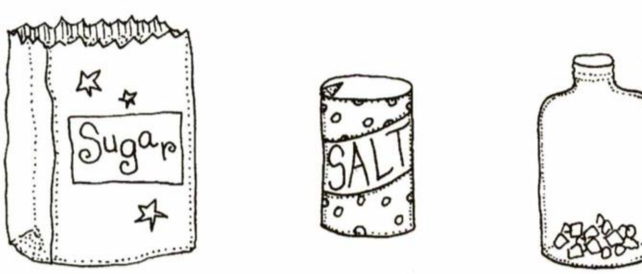
if something dissolves in water, whether it always disappears and becomes invisible.

Activity

1. Cover the table with newspaper and have the children put on their smocks.

2. Measure 1 cup of water into a plastic cup.

3. Put out a selection of common household substances such as sugar, salt, cornstarch, flour, baking soda, powdered drink mix, and dried milk powder.



4. Ask each child to select a substance he or she thinks will dissolve in water, then measure one teaspoonful of that substance and stir it into the cup of water.

Conversation

Questions You Might Ask

Do you think everything will dissolve in water? Can you think of anything that might not?

Does everything that dissolves look the same (for example, a white powder such as sugar or salt)?

Where do you think things go when they dissolve? Why can we no longer see them?

If something dissolves in water, will the solution always remain clear?

Do some substances change the appearance of the water in which they dissolve, while others do not?

Activity 4A

What Dissolves and What Doesn't?

5. Compare what substances the children chose. Ask them whether they can see any particles that have settled out of solution or whether they think their substance has fully dissolved.

6. Give them time to experiment with other substances, either mixing them into the same solution or starting with fresh water as they see fit. Ask them to notice any differences in the appearance of the solution with each substance they stir in.

7. Discuss whether anyone has found a substance that did not dissolve. How could they tell?

Transition or Closure

If you are doing only Activity 4A, review the "I wonder..." statements. If you are doing Activities 4A and 4B together, help the children clean up their work areas. Then shift their attention to the water treatment activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why some things disappear when they dissolve.

whether dissolved chemicals can come back out of water.

Activity 4A

What Dissolves and What Doesn't?

A Step Beyond

I wonder what other things will dissolve in water.

As you know, many solids will dissolve in water and many others will not. The children may be surprised to learn that it is also possible for gases to dissolve in water. When you drink a glass of soda, it is the dissolved carbon dioxide that makes the soda taste bubbly.

If you vigorously stir or shake water, you are probably causing more air to dissolve in it, but you cannot see this. What you can observe is gases coming back out of solution. As a glass of cold water or soda warms up, you will see bubbles forming and rising to the surface. These are bubbles of gas that were dissolved but are coming back out of solution as the temperature rises.

Another idea that may be surprising is that some liquids dissolve in water. As you may notice when you shake a jar containing oil and water, those two liquids do not mix and neither dissolves in the other. If you try mixing water and rubbing alcohol, though, you will find that they stay mixed. In this case, the alcohol has dissolved in the water.

The children might wonder how much of a substance will dissolve in water. If you keep stirring more and more sugar into a glass of water, will you reach a point at which it will no longer dissolve? Yes, because at some point the solution will become so concentrated that any added sugar will remain in solid form rather than dissolving. At this point, though, you can warm the solution and find that once again more sugar crystals will disappear.

You can put this idea to practical use by making sugar candy. First you create a highly concentrated sugar solution in hot water, then you let it sit long enough for some of the water to evaporate. Because the sugar does not evaporate, the remaining solution becomes even more concentrated, and crystals will begin to form on the sides of the glass or on a string or stick suspended in the middle.

Activity 5A

Pink? Green? Or in Between?

Leader's Guide

What's the point?

Children learn that chemicals can be classified as acids, bases, or neutral compounds. They use a colored solution to discover which common household chemicals fit into these classifications. Through exploration, children may discover that when acids and bases are mixed together, they tend to cancel each other out and produce a more neutral solution.

For additional information, read Science: Behind the Scenes (page 83).

What's the plan?

1. Read the activity (page 85).
2. Gather the supplies (page 84).
3. Make the solutions and try the activity.
4. Note safety measures (in ***bold italics***).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 107.)
- Help the children relate this activity to their daily experiences.

Plan Ahead

Purchase red cabbage and prepare the red cabbage solution (see "Supplies and Preparation"). Assemble common household chemicals indicated in the supply list or ask children to bring in samples from their own homes.

Activity 5A

Pink? Green? Or in Between?

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

In this activity, children will use red cabbage juice as a simple indicator of whether a solution is an acid or a base. This works because the cabbage juice contains a pigment that changes color depending on the acidity of the solution with which it is mixed.

Acidity of Solution:	acidic	neutral	basic
Color when mixed with cabbage juice indicator:	pink	purple	green

Many chemicals change color in this way. Litmus paper, which scientists use to determine the acidity of a solution, contains an indicator chemical like the one in cabbage juice. Other examples include juices made from purple grapes, blueberries, and cranberries (see *In-Touch Science: Foods and Fabrics*, Activity 4B).

If the children are curious about the chemistry of acids and bases you can explain that a water molecule can separate into two pieces: an H^+ and an OH^- ion. Because pure water contains equal numbers of H^+ and OH^- ions, it is neutral (neither an acid nor a base). In an acid such as vinegar or lemon juice, there are extra H^+ ions in solution. In a base, there are extra OH^- ions. When you mix an acid with a base, the resulting solution will be closer to neutral than either of the original solutions because extra H^+ ions from the acid will combine with OH^- ions from the base to form water.

Activity 5A

Pink? Green? Or in Between?

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 1 cup fruit juice for each child (lemonade, cranberry, or grapefruit juice is best—you want a juice that will pucker up their mouths)

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ goggles or safety glasses
- ❑ smocks, old shirts, or aprons
- ❑ 6 clear plastic cups, 9-oz. size
- ❑ markers
- ❑ measuring spoon (tablespoon size)
- ❑ about $^{1}/_{2}$ cup red cabbage juice[1]
- ❑ eyedropper
- ❑ several drops of white vinegar
- ❑ several drops of washing soda solution[2]
- ❑ small amounts of household substances such as lemon juice, clear soft drinks such as 7-Up or Sprite, tap water, laundry detergent, window cleaner, dishwashing liquid, shampoo, soap, salt, flour, or sugar. Do not use baking soda—it is a buffer and will be used in Activity 5B. ***(Avoid solutions containing chlorine or bleach and check product labels for safe handling instructions.)***
- ❑ Lysol or other disinfectant solution[3]

[1] To make red cabbage solution pour 2 cups of hot water over $^{1}/_{2}$ cup of chopped red cabbage and let stand until cool. Strain and discard the cabbage pieces and refrigerate or freeze the juice until needed. You need about $^{1}/_{2}$ cup of solution per child. Save extra for Activity 5B.

[2] To make washing soda solution mix 1 tablespoon of washing soda into 1 cup of water.

[3] Reminder: Before reusing, disinfect goggles in a solution of 1 $^{1}/_{4}$ oz. Lysol in 1 gallon of water. Rinse well and air-dry.

Activity 5A

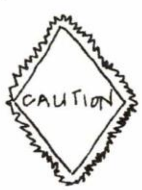
Pink? Green? Or in Between?

Focus

Give each child a glass of lemonade, cranberry juice, or grapefruit juice. As they drink it, discuss how it makes their tongues feel funny because it contains an acid.

Activity

1. Cover the table with newspaper and have the children put on their smocks.



2. ***Make sure that each child is wearing goggles or safety glasses, and instruct them not to taste any of the chemicals they will be using. Although some of these are foods or drinks, others are cleaning products or other inedible compounds. To ensure safety, children shouldn't put any of these substances into their mouths.***

3. Label three clear plastic cups: "acid," "neutral," and "base."

4. Pour 1 tablespoon of red cabbage juice into each cup.

5. To the cup labeled "acid," add a couple of drops of vinegar, then mix.

6. To the cup labeled "base," add a couple of drops of washing soda solution, then mix.

I wonder...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

if all juices are acids, or maybe only the ones that make your mouth pucker up.

whether other drinks, like milk, water, or tea are acids.

Conversation

Questions You Might Ask

What color does cabbage juice turn when you add an acid to it? What color does it turn when you add a base? Does the color change all at once or gradually?

Is the fruit juice an acid or a base?

What other solutions have you tested that are acids? Which ones are bases?

Have you found any that are neutral?

What does it mean if your test solution has a color that doesn't exactly match one of the solutions in the labeled cups?

What color do you think the solution might turn if you mix two acids together?

How about if you mix an acid with a base?

Activity 5A

Pink? Green? Or in Between?

7. Line up the cups, with the "neutral" cup in the middle, and compare their colors. Keep these solutions to refer to in the following steps.

8. Pour 1 tablespoon of red cabbage juice into three more cups.

9. Test the acidity of the juices you used for the focus activity. You can do this by adding a few drops to the cabbage juice solutions, then comparing their colors to those in your labeled cups. In the same way you can test other common household substances such as colorless soft drinks, laundry detergent, window cleaner, dishwashing liquid, and shampoo. You can also test solids such as soap, salt, flour, and sugar. Simply add a small amount to your indicator solution, stir it up, and observe the color.

10. Once you have tested other chemicals, you can experiment with your labeled solutions. Try mixing the acid with the base and compare the color of the mixture with the color of your "neutral" solution.

11. Pour your mixtures down the sink and rinse your cups for reuse.

Transition or Closure

If you are doing only Activity 5A, review the "I wonder..." statements. If you are doing Activities 5A and 5B together, help the children clean up their work areas. Then shift their attention to the buffer activity.

I wonder...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why the colors change.

if any drinks are bases.

Pink? Green? Or in Between?

A Step Beyond

I wonder whether other solutions can be used like red cabbage juice to indicate acids or bases.

Several other household substances work in the same way. You might want to try other indicator solutions, such as juice from blueberries or cranberries, and compare their colors when they are mixed with various household chemicals. (Unlike red cabbage juice, these fruit juices are acidic, so they will not change color when acids are added. They will change color when mixed with a base, though, and then will change back to their original color when mixed with an acid.)

Another household chemical that can be used as an acid and base indicator is the spice called turmeric. If you mix 1/2 teaspoon of turmeric into 1/2 cup water, you will get a yellow mixture. This will turn reddish brown if you mix in a base such as a few drops of the washing soda solution. Then if you add an acid such as vinegar, the mixture will become yellow again.

Activity 9

A Passing Force

Activity:	***Test materials for magnetism and record findings***
Life Skill:	***Acquiring/Evaluating Information—Predicting outcomes, analyzing data and obtaining data***
Electric Skill:	***Determining magnetism***
Science Process Skill:	***Classifying information***
Success Indicator:	***Detects materials that allow magnetic force to pass through***
National Science Standard:	***Magnets attract and repel each other and certain kinds of other materials***

Tools

A magnet that will attract paper clips, several metal paper clips, a piece of string or thread, a piece of tape, one glass beverage container and one made of plastic, a hardback book, a large non metal bowl or dish pan (plastic, glass or ceramic) with 3 inches of water in it

Have you ever tried to pull an object off a magnet? Were you able to feel the force that the magnet had over the object? This force feels almost like the way you can feel the force in a rubber band when you stretch it. Magnetism is a natural force that can be weak or strong, depending on the size of the magnet. In this activity you will test several materials to see if the **magnetic force** is strong enough to pass through them.

Power Up

Try the following experiments to see what materials allow magnetic force to pass through them. Predict what you think will happen before you do each experiment. Record your predictions on the data table. Do the experiment and record your results. Were your predictions correct?

Experiments 1 and 2 – Glass, Plastic & Magnetism

Put the paper clips inside the drinking glass. Then put the magnet on the outside of the glass as near to the paper clips as possible. Slowly move the magnet. Does magnetism travel through glass? Repeat the experiment with the plastic cup.

Experiment 3 - Air & Magnetism

Tie a short string or thread to one of the paper clips and tape the opposite end of the string to the edge of a table or desk top. Let the paper clip hang down off the desk or table. Hold the magnet close to the paper clip (about 1/4" away) but do not let the paper clip and the magnet touch. Carefully move the magnet to the left or right keeping it the same distance from the paper clip. Can you move the paper clip without touching it? Does magnetism travel through the air?

Experiment 4 – Water & Magnetism

Take the pan with water in it and place a few paper clips in the pan. Put the magnet in the water near the paper clips, but not touching them. Can you move the paper clips without touching them? Does magnetism travel through water?

Experiment 5 - Paper & Magnetism

Put the paper clips on the front of the book and place the magnet on the back of the book. Does magnetism travel through a book? Open the book and place paper clips on the inside cover of the book and between each of the first four pages. Put the magnet on the outside of the front cover. Can you use the magnet to move the paper clips? Does magnetism travel through paper?

Glossary Words

- **Gravitational force**
- **Magnetic field**
- **Magnetic force**

TESTING FOR MAGNETISM

Experiment	Material	My Predictions	Will Attract	Will Not Attract	Findings
1	Paper clips in drinking glass				
2	Paper clips in plastic cup				
3	Hanging paper clip				
4	Paper clip in water				
5	Paper clips in book (paper)				

Magnetism

Magnetism is one kind of natural force that can be felt but not seen. The area surrounding a magnet where a force exists is called the **magnetic field**. Weak magnets have weak fields, and stronger magnets have stronger fields that can reach out over greater distances. From your experiments you discovered that magnets exert an attractive force on items that contain metal. This force exists in the space close to the magnet. It can pass through various materials, but the distance it travels is not very great. The stronger the magnet, the greater the distance the magnetic field will travel.

Whenever any force is exerted over an area, all the space into which the force reaches is called its field. This field can extend out in all directions. Another force that we cannot see is the earth's **gravitational force** or gravity. The space over which the earth exerts the force of its gravity is called the earth's gravitational field. It reaches out for millions of miles in all directions!

Every particle of matter exerts an attractive force on every other particle of matter. This force is the gravitational force. The strength of a gravitational force depends on the amount of mass of an object. The bigger the mass of the object, the greater its gravitational force. Since the earth is so massive, it exerts a very large gravitational force on the objects around it.

Brain Boosters

Design a test to see if you can feel magnetism through other materials. Share your design and test results with your helper.

The ancient Chinese and Arabs found they could make their own magnets by rubbing a piece of iron with a lodestone (a naturally occurring magnet). They would use these magnets to make compasses.

Activity 8

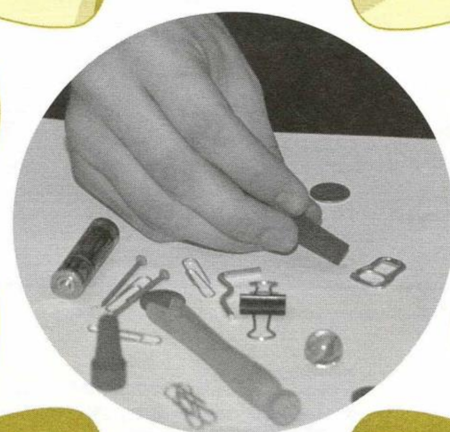
May the Force Be With You

Activity:	*Test and classify materials*
Life Skill:	*Acquiring/Evaluating Information —Predicting outcomes and analyzing data*
Electric Skill:	*Understanding magnetism*
Science Process Skill:	*Organizing and classifying materials*
Success Indicator:	*Determines which materials are attracted to a magnet*
National Science Standard:	*Transfer of energy—Magnets attract and repel each other and certain kinds of other materials*

Tools

Magnet; samples of at least 10 different materials, some made of metal and some that are non-metal (such as wood, plastic, glass, cloth or paper)

Legend has it that a shepherd in a Middle Eastern country called Magnesia discovered **magnetism** more than 3,000 years ago. As the story goes, the shepherd discovered that his iron staff "stuck" to certain dark stones that were lying in the fields. These stones must have been **lodestones**, or naturally occurring **magnets**. Since the Middles Ages scientists have discovered many things about magnetism. You too can make discoveries as you do this activity.



Power Up

List the items you have collected in column one of the data table. Next, predict whether or not the magnet will attract the materials and then write your prediction in column two. Finally, test the material by placing the magnet close to, but not touching, the material. If the material is attracted to the magnet you will feel a force that pulls the material towards the magnet. Is the material attracted to the magnet? Record the results of your tests in the last column. Were your predictions correct?

MAGNETIC ATTRACTION TEST

Material	My Prediction		Outcome of Test	
	Will Attract	Will Not Attract	Will Attract	Will Not Attract
Paper	√			√

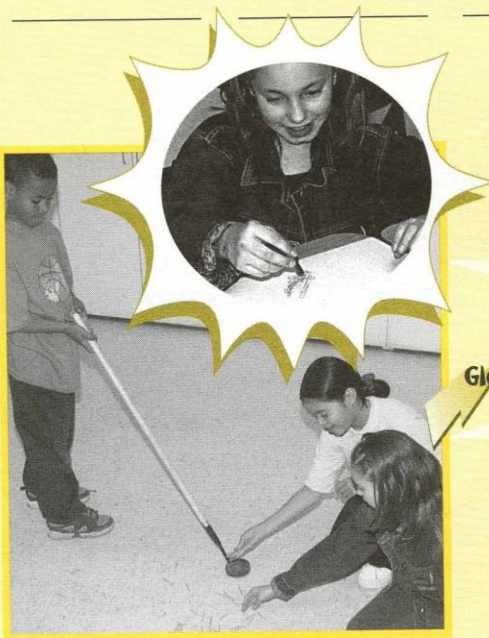
Closing the Circuit

Classification is an important part of understanding the world around us. Place the items found in the WORD LIST into the proper category. Does classifying the items help organize the list and make them easier to understand?

WORD LIST

desk	lemonade
sea water	clock
helium	tea
soda pop	milk
oxygen	hydrogen
air	tree
car	coffee
book	steam
computer	ice cube
window	chair

SOLID	LIQUID	GAS



Classification

People tend to put everything into groups. We group cats into groups that share similar characteristics such as "longhaired cats" and "shorthaired cats." We put plants into groups such as trees, shrubs, vines, flowers and vegetables. If you think about it, people group everything from furniture and music styles, to birds and fish. We call this grouping **classification**.

Placing similar objects into different groups with related characteristics makes it easier for people to understand things, just like you did by determining if something was or was not attracted to a magnet. You found that the magnet attracted anything that contains **iron**, **nickel**, or **cobalt**. This allows you to classify materials into two groups: Materials that magnets attract and those that magnets will not attract.

Note: *the American nickel (5 cent piece) does not contain any nickel metal!*

Glossary Words

- **Classification**
- **Cobalt**
- **Iron**
- **Lodestone**
- **Magnet**
- **Magnetism**
- **Nickel**

Brain Boosters

Test how many and what type of non-magnetic items can be placed between a magnet and an item it attracts to block the attraction. Describe your results to your helper.

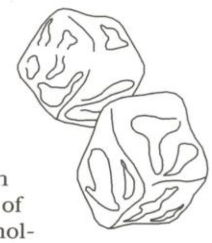
According to legend, a Chinese emperor who lived about 5,000 years ago had a most extraordinary chariot. Mounted on the front of the chariot, turning freely on a pivot, was a small statue of a man carved of black stone (thought to be an ore called magnetite). No matter which direction the chariot moved, the figure always pointed south. This may have been mankind's' first known use of the magnet as a compass to point out direction!

Objective
Youth will learn about a unique characteristic of water.

Audience
Introductory/Intermediate experience level

Time needed
10-15 minutes

Materials needed
- ❒ A container of water
- ❒ Ice cubes



Background information
The three states of matter (solid, liquid, gas) are defined by the amount of motion of the molecules within a substance. Usually gas has the most movement of molecules, which spread out and make it the least dense. Solids consist of molecules which stay close together and, therefore, are the most dense. Youth will learn by doing this activity that water doesn't follow that rule perfectly.

Discuss
Ask youth what temperature at which they believe water most dense?
How can they prove it?

Youth will likely say 32 degrees Fahrenheit (Zero degrees Celsius) because that's the temperature at which water freezes and becomes a solid (ice).

What to do
As a way to test the group's hypothesis, place ice cubes in water.

Discuss
What happens?
Why?
What does this mean?

What to look for
Ice cubes float in water, indicating that frozen water (ice) is lighter (less dense) than water. Water is actually the most dense just before it freezes ... at about 38 degrees Fahrenheit, not 32 degrees. Only water and the element bismuth are less dense as solids than liquids. (The Handy Weather Answer Book, p. 20)

Discuss
Why is this an important characteristic of water in nature?

Underwater life are fortunate for this unique fact. Because ice is lighter than water, fish can live under the ice. If water was like other substances, it would freeze from the bottom up.

4-H

Head, Heart, Hands, and Health

Making the Connection to Science

Complete the following activity – list one idea that relates the 4 "H's" to the STEM Science activities. For example you could list how the polymer activity and understanding polymers can help one's life by providing water retention with your garden or household plants.

So now it is your time to think of one thing for each "H". You can do this by yourself, with your family, or with other 4-H Club members. Remember, have fun! There is no right or wrong answer.

Once this is completed, you can move on to the other sections of Exploring STEM.

- **HEAD** stands for clearer thinking and decision-making. Knowledge that is useful throughout life.

- **HEART** stands for greater loyalty, strong personal values, positive self-concept, and concern for others.

- **HANDS** stand for larger service, workforce preparedness, useful skills, and science and technology literacy.

- **HEALTH** stands for better living, healthy lifestyles.

The 4-Hs' information can be found at- http://4h.uwex.edu/about/

T

Technology

The definition of technology is

tech·nol·o·gy

NOUN:
pl. **tech·nol·o·gies**

1.
    a. The application of science, especially to industrial or commercial objectives.
    b. The scientific method and material used to achieve a commercial or industrial objective.
2. Electronic or digital products and systems considered as a group: *a store specializing in office technology.*
3. *Anthropology* The body of knowledge available to a society that is of use in fashioning implements, practicing manual arts and skills, and extracting or collecting materials.

Section Two (technology): Leaders please complete two lessons minimum from this section with the youth. The lessons vary in difficulty; please choose lessons that will challenge the youth and spark inquiry. Lessons can be adapted to be made more challenging.

List of experiments-

Activity 3

Bright Lights

Imagine that you are out in the woods and your flashlight gets smashed on a rock. It is starting to get dark. You take the flashlight apart and discover that the **incandescent light bulb** and the batteries are okay, but the case has been destroyed. In this activity you will see if you can fix the light to use on your camping trip.

Activity:	*Build a flashlight*
Life Skill:	*Solving Problems—Identifying a problem, generating solutions and evaluating results*
Electric Skill:	*Wiring a simple circuit*
Science Process Skill:	*Solving problems through experimentation*
Success Indicator:	*Understands why an incandescent bulb lights up*
National Science Standard:	*Electricity in circuits can produce light*
Tools	*D-cell battery, light bulb, a piece of aluminum foil*

Power Up

Night is fast approaching, and you really need to light the bulb since it is your only source of light. You look in your backpack and find a piece of aluminum foil. Using only the battery, bulb and the piece of aluminum foil, see if you can make the bulb light. Brain storm with your helper to come up with ideas on how to make the bulb light. Once you have made the bulb light, take a close look at your set-up. Can you imagine the flow of electricity from the battery, through the bulb filament, and back to the battery? Draw a picture of the path that the electricity follows to light the bulb.

"The Pathway to Light"

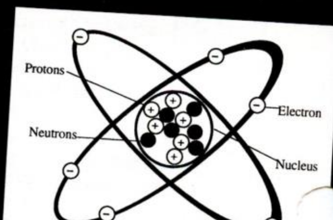
Brain Boosters

1. Using items found around your house, make a flashlight that is easier to use than the one you made in this activity. Demonstrate to your helper how your new flashlight is different from the one you would buy at the store.

2. Think about what other things electrical circuits do other than light up flashlights. Are there circuits in CD players? clocks? doorbells? Explain to your helper how electric circuits run many of the things we use.

What is Electricity

Although we cannot see electricity, we know it exists because we use it every day to run things such as toasters, vacuum cleaners and computers. Scientists have discovered that everything in the world is made of tiny particles called **atoms**. Atoms are made up of even smaller particles called **electrons**, **protons** and **neutrons**. Electrons have a negative charge and protons have a positive charge. Electricity is produced when something upsets the balance between electrons and protons in the atoms, causing the electrons to move from one atom to another. This movement of electrons creates the **energy** that powers your CD player or television!



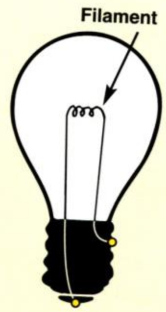
Glossary Words

- **Atom**
- **Battery Terminal**
- **Circuit**
- **Electron**
- **Energy**
- **Filament**
- **Incandescent Light Bulb**
- **Neutron**
- **Proton**
- **D-cell Battery**

Lighting the Bulb

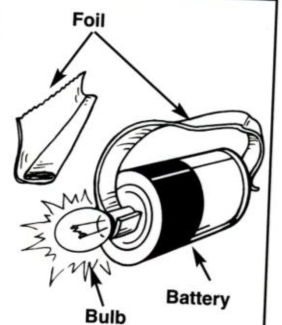
The light bulb in your flashlight needs electricity to light it up. Electricity is the flow of **electrons**. A battery provides a flow of electrons by pushing electrons out of one end and pulling electrons back into the other end. This flow of electrons will only happen when the electrons are given a path that they can travel along. Metal makes a great path for electrons to travel on, which is why aluminum foil is used in this activity. Air, on the other hand, makes a terrible path! That is why the electrons don't just run out of a battery when the **battery terminals** are touching only air.

The only way to make the bulb light is to make sure that the electrons have to go through the bulb to get back to the battery. Look at the picture of a light bulb. When the electrons go through the filament of the bulb the bulb lights up. To make the electrons go through the filament, you must make sure that the filament is part of the path! To do this you must make sure that one part of the path touches the metal side of the light bulb, and another part touches the light bulb at the very bottom of the bulb.



If there is a path that doesn't include the bulb filament, the electrons will choose that path. The filament is a tight squeeze for the electrons and they will take an easier way if it is available.

Making the Bulb Light



1. Cut the aluminum foil into a strip about 2 inches by 6 inches.
2. Fold the foil over and over along the long edge, until you have a piece that is still six inches long, but only a quarter of an inch wide.
3. Touch one end of the battery to the bottom end of the bulb, and then connect the side of the bulb to the strip of aluminum foil.
4. Connect the strip of foil to the other end of the battery.

You have built your first **circuit**! A circuit needs three things:

- Something to push electrons (in this case, a battery)
- A path for the electrons to follow (aluminum foil and light bulb)
- Something for the electrons to do (like light up a light bulb)

To test your understanding of a circuit, see what happens when you connect the foil to both ends of the battery and then put the bulb on top of the foil strip. Does the bulb light up? Why?

Making Connections

Share With Your Helper

- ☐ What equipment was needed to make the bulb light?
- ☐ What was the source of electricity used to make the bulb light?

Process What's Important

- ☐ How is your imitation flashlight different than one you would buy at a store?
- ☐ Why is it important to understand how electricity works?

Generalize To Your Life

- ☐ What is another time that you experimented to solve a problem?
- ☐ Describe another time when brainstorming helped you solve a problem.

Apply What You Learned

- ☐ When faced with a new problem, like fixing a flashlight, describe some ways that you could figure out the answer.
- ☐ Describe how technology can help us organize our thoughts and solve problems.

In 1709, an English scientist, Francis Hawksbee, made the first electric light! First, he removed most of the air from a hollow glass ball. Then he spun the ball on an axle with a crank and let it rub against his hand. As a charge of electricity built up in the hollow globe, it began to glow! Bright Lights!

Activity 4

Control the Flow

Activity:	***Build and test a switch***
Life Skill:	***Solving Problems—Identifying a problem, generating solutions and evaluating results***
Electric Skill:	***Understanding open and closed switches***
Science Process Skill:	***Problem solving***
Success Indicator:	***Builds a working switch***
National Science Standard:	***Electrical circuits require a complete loop through which an electrical current can pass***
Tools	***Two metal paper fasteners, one metal paper clip, two pieces of wire (use wire strippers to remove about 1/2 inch of the plastic covering from each end), one piece of 2" x 2" cardboard, one D-cell battery, one battery holder, one light bulb, one light bulb holder, pencil***

Your favorite singing group has just come out with a new song and you can hardly wait to hear it! Running home, you hurry up to your room and grab your radio. Your favorite radio station will be playing the new song and you know it's going to be great! Now, what's the first thing you do? Do you just wait for the radio to start playing, or do you first flip the **switch** to turn your radio on?

Think about other things you use that are powered by electricity such as a computer, a microwave, the television or an electric can opener. Do you flip a switch or press a button to turn them on or off? Just about everything that uses electricity has a switch that turns the flow of electrons on or off. When the switch is opened, the electrons do not have a complete path to follow and the appliance cannot do its work (an **open circuit**). When the switch is closed (a **closed circuit**), the electrons have a complete path, the circuit is complete and the appliance will work. Today, you will build a simple switch that will turn a light on and off.

Power Up

See if you and a friend can make a simple switch that will turn a light on and off. Use the materials listed under Tools. If you need help, directions appear on the next page. When you have completed your switch, test it to see if it works.

If your design is successful, draw two pictures of your design in the space provided. Draw one with the switch open and one with the switch closed. In which picture will the bulb light up? Describe to your helper the path the electrons follow as they move through the circuit.

Draw your switch design as opened and closed circuits

Closing the Circuit

List 10 things you use every day that have switches to open or close an electrical circuit (remember, anything that uses batteries is an electrical circuit!).

____

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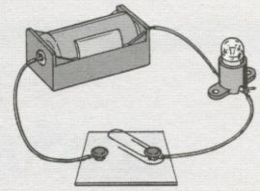
Glossary Words

- **Circuit**
- **Closed Circuit**
- **Current**
- **Open Circuit**
- **Switch**

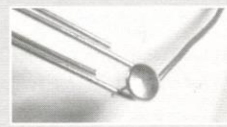
In 1786 Luigi Galvani, an Italian doctor and teacher, discovered an unknown form of electricity. Believe it or not, Dr. Galvani would hang frog's legs from a metal pole as part of a classroom lesson in anatomy. He noticed that the frog's legs would twitch when they were touched by another piece of metal. This led to the discovery of ***current*** *electricity, which is the flow of electrons along a pathway…from metal, through the frog's legs and into another metal!*

Making a Switch

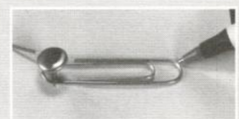


The word **circuit** comes from the word "circle." A circuit is a pathway along which electricity can flow. If the path has a break in it (the switch is open), then the electrons are stopped from flowing around the pathway. This is called an open circuit. When the switch is closed (a closed circuit), the pathway is completed and the electrons can continue flowing around the pathway. Instead of saying a switch is on or off, electrical professionals say a switch is open or closed.

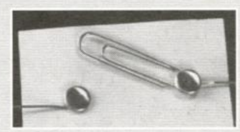
- Wrap the stripped end of one wire around one of the brass paper fasteners.



- Place the brass paper fastener with the wire attached through the paper clip.



- Wrap the second wire around the second paper fastener (just like step 1).
- Make a hole in the piece of cardboard with a pencil and stick the first fastener with the paper clip though the hole.



- Mark the place where the end of the paper clip falls on the cardboard.
- Make another hole with your pencil at the mark on the cardboard and push the second paper fastener through it.

- Turn the cardboard over and open up the fasteners. You can put tape over the open fasteners to hold them securely.

Brain Boosters

1. Write a description of how to make a light bulb light with only a battery, bulb and one piece of wire. Share your description with your helper and see if this person can follow your directions. Did you use any pictures or diagrams to explain how to do it? Why or why not?

2. Can you think of an electrical appliance that does not have a switch? First, think about how we provide electricity to different appliances. Next, explain to your helper how you would turn off an appliance that does not have a switch.

Activity 5

Conducting Things

Activity:	***Identify conductors of electricity***
Life Skill:	***Solving Problems—Analyzing possible causes and generating solutions***
Electric Skill:	***Testing materials for electric conductivity***
Science Process Skill:	***Formulating experimental hypotheses***
Success Indicator:	***Classifies objects as conductors or insulators***
National Science Standard:	***Objects have many observable properties that can be measured and used to separate or sort a group of objects or materials***
Tools	***Your switch from Activity #4, selection of household materials***

Scientists find out how things work by experimenting. Think of an experiment you have done. What were the steps you took to design your experiment? In this activity you will go through the steps of designing an experiment that tests what types of materials are electrical **conductors** (allow electrons to flow) and those that are **insulators** (do not allow electrons to flow). You will:

- Ask a question: What materials make good conductors or insulators?
- Make a **hypothesis** (predict what materials allow or do not allow electricity to flow through them)
- Set up an experiment that allows you to test different materials for electrical **conductivity**
- Test the materials
- Record the results of the experiment
- Think about the results of the experiment
- Make a conclusion about the results of the experiment

Power Up

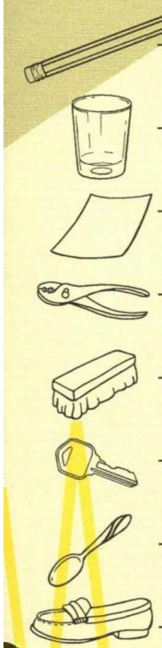
It is your job to determine what materials make good conductors and what materials make good insulators. Collect several items from around your house such as rubber (a rubber band), glass, string, cloth, metal (coat hanger, paper clip, aluminum foil, etc.) and wood. Try to find at least five different materials. List the materials collected in the first column of the table below. In the second column, predict if the material is an insulator or a conductor.

Use your circuit from activity 4 to test each material to see if it will allow electrons to flow. To do this, open the switch and use your material instead of the paper clip to complete the circuit. Make sure that the material you are testing is touching both fasteners. If you need help, check the picture on the next page. Record whether or not the light bulb lights up when different materials are used to complete the circuit. Next, record whether the material is an insulator or a conductor. Were your predictions right?

Material	My Prediction Conductor or Insulator	Test Light On or Off	Test Result Conduct
1. Metal paper clip	Conductor	On	Conductor
2.			
3.			
4.			
5.			
6.			
7.			
8.			

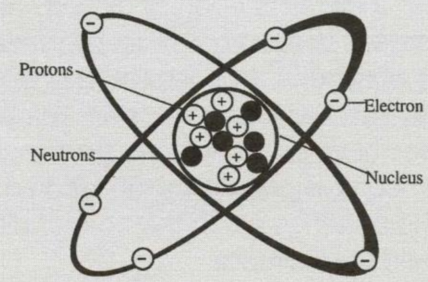
Closing the Circuit

Using what you have learned from this activity, write insulator or conductor next to the following items:

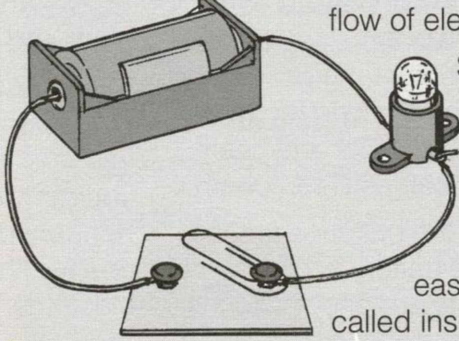


Conductor/ Insulator Test

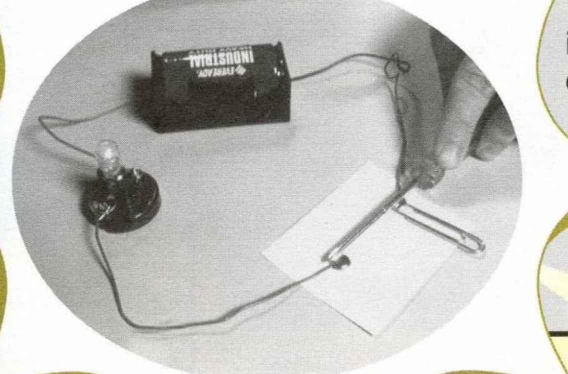
Do you remember that everything in the world is composed of building blocks called atoms? Look at the picture of an atom. Can you see that the atom has protons and neutrons in its center (called a nucleus) and that the electrons move freely around the center?



When given a "push" the electrons will sometimes move from one atom to another. When a force to push electrons is put on a material that is willing to give up electrons, they will "flow" from one atom to another. We call this flow of electrons "electricity."



Some materials let electrons flow easily—these materials are called conductors. Other materials do not let electrons flow easily—these materials are called insulators. Generally, metals make good conductors. Plastic, rubber and glass are good insulators. By using insulators and conductors, engineers control the flow of electrons and put electricity to work for people.



Brain Boosters

Interview a person who works with electricity. Ask about the kinds of clothing and other protective gear used when working with electricity. Why are these precautions necessary? Report what you discover to your helper.

Glossary Words

- **Conductivity**
- **Conductor**
- **Hypothesis**
- **Insulator**

In 1879, inventor Thomas Edison created the first commercially practical light bulb in Menlo Park, New Jersey. This bulb used carbonized cotton thread (a conductor) for the filament and glowed for 40 hours!

EXPLORATION

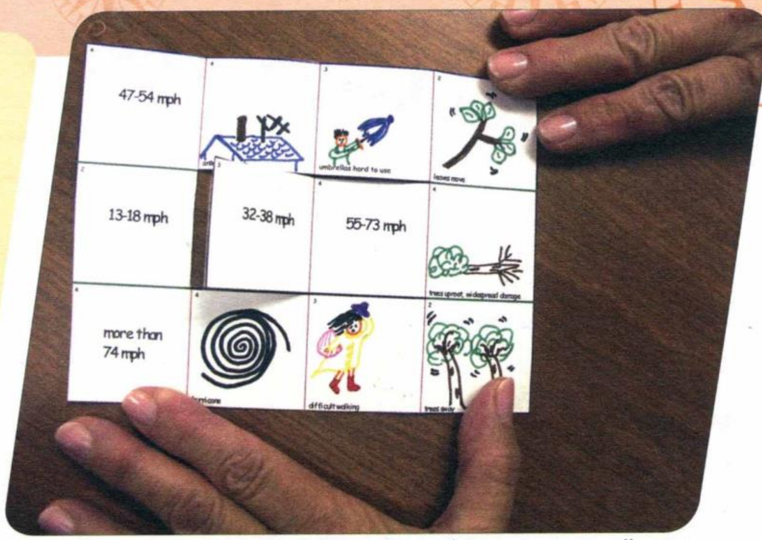
How Do We Observe and Measure the Wind (Part I)?

A method for estimating wind speed based on observations was developed in 1805 by Sir Francis Beaufort.

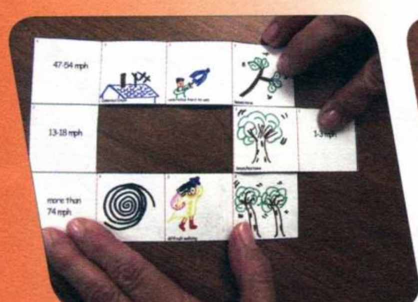
Learn about and use the Beaufort Scale

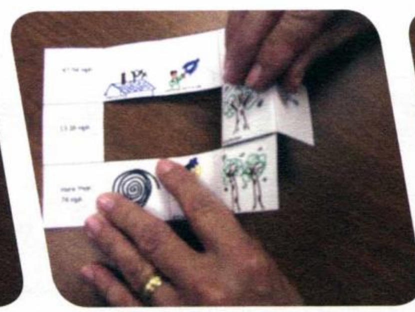
by making this tool. Cut out the tetraflexagon in Appendices D and E. Cut on the heavy black lines and crease on the red vertical lines.

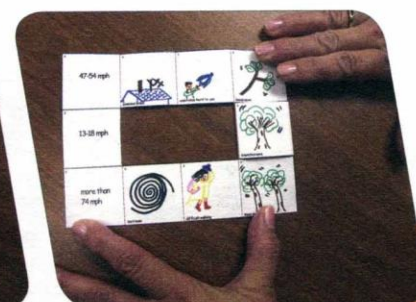
After you cut out the **tetraflexagon**, follow the instructions under the photos.



Draw illustrations in each of the squares that contain small print.

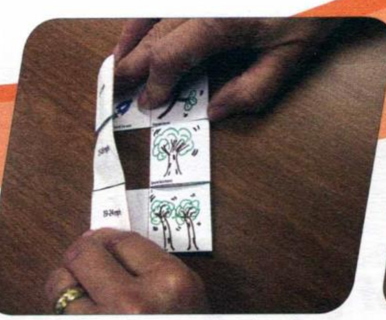




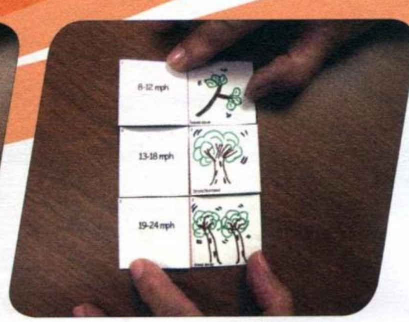


Fold the center flap over and under the right-most vertical column.

Fold the left-most column over the second column.



Fold both over onto the third column.

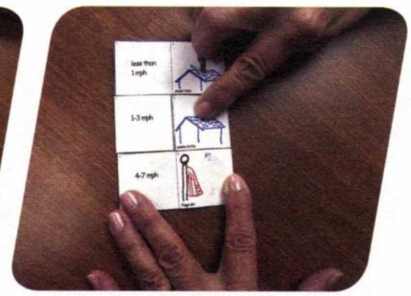


Now the wind speeds from the **Beaufort Scale** are matched up with their illustrations.

WIND FACT

Tornadoes make the highest wind speeds. **Scientists think some tornadoes may produce 400 mph winds**, but they don't know for sure because the tornadoes destroy their wind instruments.

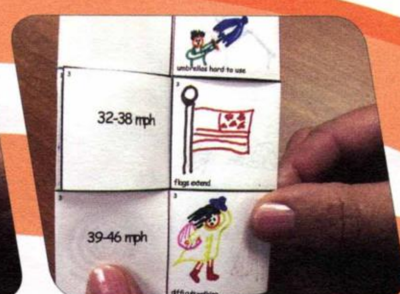
Flip the whole tetraflexagon over and tape.



The Beaufort Scale showing the least wind speeds is face up.

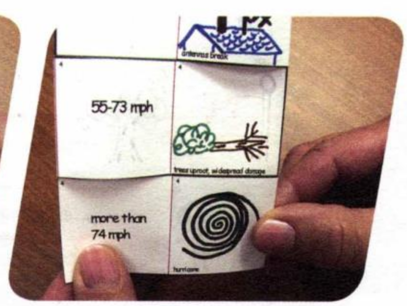
Turn the tetraflexagon over to show the next higher group of wind speeds.

Now the flexagon is ready to flex. Bend it in the middle.



Let the next group of wind speeds fall open.

Bend it in the middle again.



Open to see the highest group of wind speeds.

Flex your tetraflexagon to see all four sides showing the twelve Beaufort Scale categories and their illustrations.

Beaufort Wind Scale – Tetraflexagon (Front Template)

- Cut on the heavy black lines and crease on the red vertical lines.
- Draw illustrations in each of the squares that contain small print.
- Follow the instructions for folding on pages 10–11.

4 47–54 mph Strong gale	4 antennas break	3 umbrellas hard to use	2 leaves move
2 13–19 mph Moderate breeze	3 32–38 mph Moderate gale	4 55–73 mph Whole gale/ Violent storm	4 trees uproot, widespread damage
4 more than 74 mph Hurricane	4 hurricane	3 difficult walking	2 trees sway

Beaufort Wind Scale – Tetraflexagon (Back Template)

4 less than 1 mph Calm	4 smoke rises	3 8–12 mph Gentle breeze	2 25–31 mph Strong breeze
2 13–19 mph Moderate breeze flags extend	3 branches move	4 1–3 mph Light air	4 smoke drifts
4 4–7 mph Light breeze	4 flags stir	3 19–24 mph Fresh breeze	2 39–46 mph Strong breeze

EXPLORATION

How Do We Observe and Measure the Wind (Part 2)?

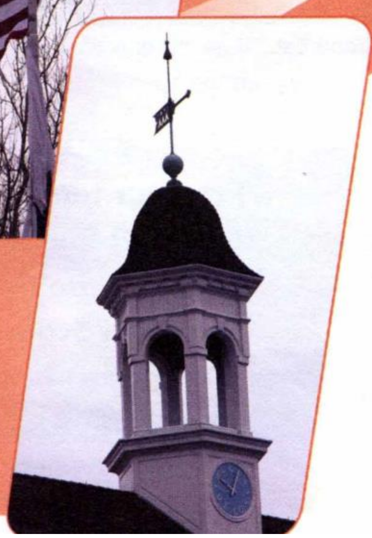
Record

observations in your engineering notebook.

Go outside to observe the wind. Although you can't see the wind, what can you observe that tells you how windy it is?

What do your other senses tell you about the wind?

Observe the wind at regular time intervals for several days. Make a chart and record your wind observations. Include the date and time of day. Use your Beaufort Wind Scale tetraflexagon to estimate the wind speed.



How does a wind vane work like the **rudder** on a wind mill?

Beaufort Wind Scale
Developed in 1805 by Sir Francis Beaufort

Force	Wind Speed (miles per hour)	WMO Classification	Appearance of Wind Effects On Land
0	Less than 1	Calm	Calm, smoke rises straight up
1	1-3	Light Air	Smoke moves in the direction of the wind, wind vanes don't move
2	4-7	Light Breeze	Leaves rustle, wind can be felt on face, wind vanes begin to move, flags stir
3	8-12	Gentle Breeze	Leaves and small twigs are constantly moving, light flags blow out
4	13-18	Moderate Breeze	Dust, leaves, and loose paper lifted off ground, small tree branches move, flags flap
5	19-24	Fresh Breeze	Small trees in leaf begin to sway, flags ripple
6	25-31	Strong Breeze	Larger tree branches move, umbrellas are hard to use, flags beat
7	32-38	Near Gale	Whole trees moving, hard to walk against the wind, flags extended
8	39-46	Gale	Twigs break off trees, walking is very difficult
9	47-54	Strong Gale	Slight structural damage occurs, shingles blow off roofs
10	55-63	Whole Gale	Whole trees are uprooted, severe damage to buildings
11	64-73	Violent Storm	Widespread damage
12	74+	Hurricane	Violent destruction

Talk About It

- What indicators of wind speed do you observe today?
- What is the speed of the wind today?
- How do your observations compare with the official weather information?
- Can you observe different wind conditions in different areas of your neighborhood at the same time? Explain how that is possible.
- Where does the wind blow at the steadiest speeds? The fastest speeds? The slowest speeds?
- Is today a good day to fly a kite? How do you know? Use the Beaufort Scale to determine the wind speed.

Learning from Others

- What members of your community need to know the speed of wind?
- How can you teach others to observe the speed of wind?
- What projects could you do together to observe the wind and gauge its speed?

Use the Beaufort Wind Scale to determine the approximate wind speed in these photos of flags.

Wind Facts

June 5, 1805 a massive **tornado** started in Missouri and then crossed the Mississippi River into Illinois. Fish were scattered all over the countryside of Illinois. Reports were that clothing from one home that was hit was carried 8 miles.

Jet streams form more than 9 km above the Earth. They travel at speeds of 92 km/hr or more.

High Winds

All of these are names of storms that have high winds. What are the characteristics of each? How do they differ from each other?

Hurricane

Tornado

Cyclone

Tropical Storm

Typhoon

Tsunami

Investigate other tools for measuring the wind.

How do they compare to using the Beaufort Scale?

Rippin' Rockets

Rocket science this may be! Still, you will be doing a series of experiments and only you can find the solution. In this activity you will experiment with the design of a balloon rocket until it will fly in the direction of your choice.

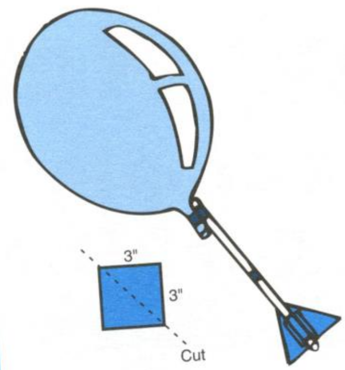
Activity:	Build a drinking straw and balloon rocket
Aerospace Skill:	Building a straw and balloon rocket
Science Skill:	Building models, experimenting

Materials: 2 flexible drinking straws, cellophane tape, 3" square of paper, balloon, scissors

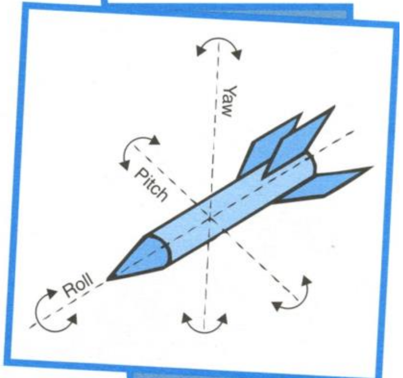
Blast Off

Make your balloon rocket using the directions at right. Then work together with a friend to do the experiments below. Record and compare the results.

1. Inflate your balloon. Let it go.
2. Cut the rim off your balloon. Cut an inch piece of one of the drinking straws (should be just below the bend). Insert open end of balloon and tape securely to the unbendable, 1" cut piece of straw. Inflate your balloon with the straw piece. Let it go. Note changes.
3. Take the remaining piece of plastic drinking straw and insert its end into another whole plastic drinking straw. (Be sure to have the bendable end of the whole drinking straw at one end and not in the middle of each straw!)
4. Tape the 1" piece of straw with balloon to the bendable end of long attached straws. Inflate your balloon with straws now attached. Let it go. Note changes.
5. Take a piece of paper 3 inches square and cut in half diagonally. Tape the pieces of paper to the end of the straw without the balloon to resemble "fins" (see diagram). Inflate your balloon rocket. Let it go. Could you maintain *directional control*? Why?
6. Experiment with your balloon rocket until you can control its direction of flight.



Take a piece of paper 3 inches square and cut it in half diagonally. Tape these pieces of paper to the bottom of the straw as shown.



Test	What happened? Why?	Friend's results? Why?
1		
2		
3		
4		
5		

Debriefing

Ground to Ground (Share)

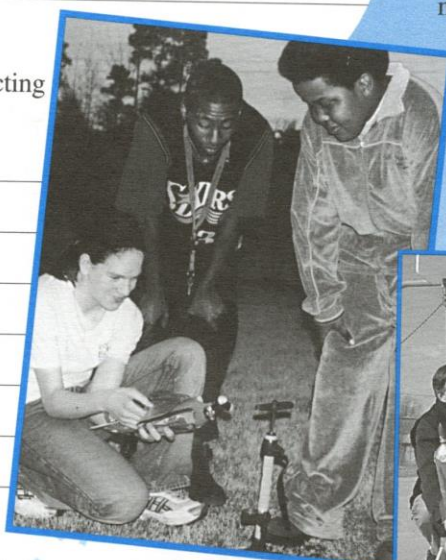
- What experiments did you do?
- How did you and your friend's results compare?

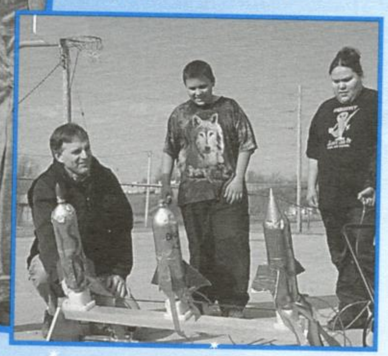
Climb Out (Process)

- What did you learn about directional control?

Level Off (Generalize)

- What did you learn about conducting a series of experiments?





Experiments can be fun to do.

Cross Country (Apply)

- In what other areas of your life do you experiment and make adjustments to solve problems?

Aerospace Facts: Making Rockets Stable

Making a rocket stable requires some form of control system. The simplest of all controls is a stick. Chinese fire-arrows were simple rockets mounted on the ends of sticks.

Rockets are stabilized by the effects of air movement on their fins, which function as controls. Even a long rocket will ***roll***, ***pitch***, and ***yaw*** if the force of air hitting its surface is not controlled. For a rocket to fly properly, pitch and yaw axes are the most important to control because any movement in either of these two directions causes the rocket to go off course. The roll axis does not affect the ***flight path***. A rolling motion helps stabilize the rocket, but it also uses some of the energy needed for forward motion.

Solo Flight

1. Make a Monarch™ or an Alpha™ rocket.

2. Design and build your own rocket using materials other than straws and balloons.

3. Conduct a rocket design and launch contest with your friends. Categories might include designs, distance, height, accuracy, etc.

Float Your Boat

Sometimes a farmer can move a crop across a stream using a boat. Moving cargo across a stream requires ingenuity and a good understanding of physics. Simulate a solution to this problem by creating a way to move some beans across a baby pool.

The Activity

1. Explain the problem using the introduction. Define the task with the following rules:
   - **a.** Use only the available materials to build a boat that can transport 1/4 cup of beans
   - **b.** Boat must have a source of power that cannot include students touching the water, pool, or boat once it is in the water.
   - **c.** Beans must safely reach the other side of the pool. Boundaries should be established ahead of time.
   - **d.** One pilot test is permissible.
2. Teams work within an established time frame to design, create, and test the boat.
3. **Optional**—Add beans, time limits, and/or limit the size of the boat to challenge the teams.

Ag Skill: Investigating the transportation of agricultural products on lakes and rivers

Life Skill: Solving Problems—Judges effectiveness/efficiency of solution

Education Standard: NS.K-4.5 Science and Technology

Success Indicator: Designs and constructs a boat that can stay afloat to deliver the cargo of beans across a baby pool

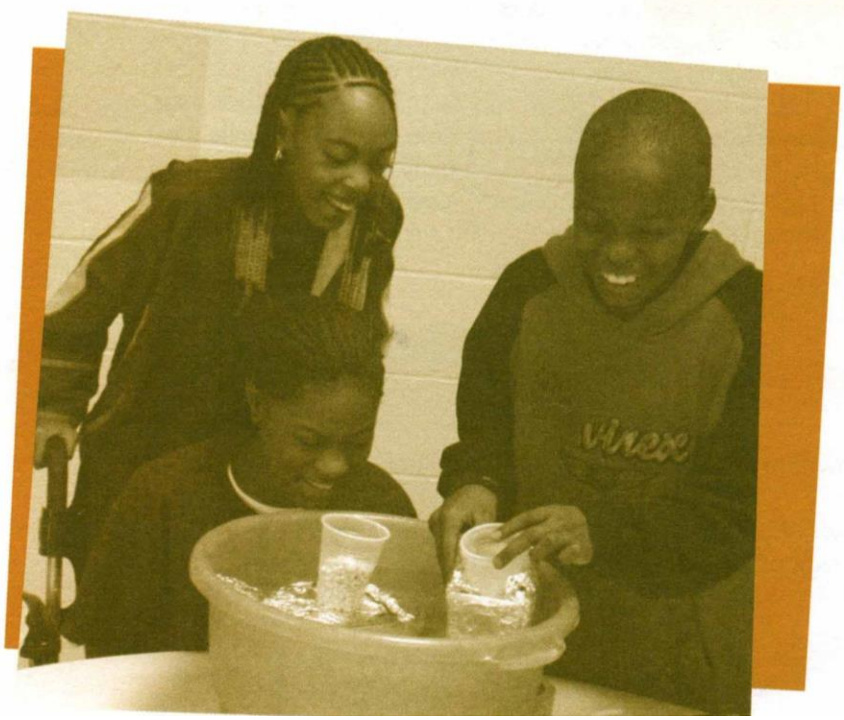
Time Involved: 45 minutes

Suggested Group Size: 10 or more students

Materials Needed

Boat building supplies:

- ☐ 3 kinds of paper
- ☐ Plastic cups
- ☐ Cardboard
- ☐ Scissors
- ☐ Tape and glue
- ☐ Plastic wrap
- ☐ Aluminum foil
- ☐ Straws, rubber bands
- ☐ Clay
- ☐ Navy beans in large bowl
- ☐ 1/4 cup measure
- ☐ Plastic baby pool with water



Talk it over

Share

- What happened to your boat?

Process

- What changes could be made to improve the design of the boat?

Generalize

- What boat or ship design would be necessary to move tons of grain across an ocean?

Apply

- What other transportation vehicles use design technology to improve their performance?

AgFacts

Principle of Flotation

A floating object displaces a weight of fluid equal to its own weight. This is the principle of flotation. Displaced is a term applied to the water that is moved out of the way when a boat is placed in it. A boat with a greater density than the water will sink. A boat with less density than the water will float. This is the "buoyancy" of the boat. Buoyant force is the weight of the volume of fluid displaced. Shape as well as density can affect buoyancy. This can be tested by dropping a 2-inch ball of clay into water; it will sink. Changing the shape of the clay makes it able to float.

Transportation of Farm Products

Transportation of farm products can be a challenge. Agriculture products must meet certain standards in terms of freshness, moisture content, and cleanliness to name a few. Refrigerated storage and transportation can be expensive. Roads and equipment must be maintained. Barge transportation is the most efficient, economical means of transportation and the most environmentally friendly way of moving soybeans to foreign and domestic markets. Over 75 percent of U.S. soybean exports move to world ports via the Upper Mississippi and Illinois river systems. However, many grain commodities are sold in the winter when some of these waterways are frozen, so grain elevators store it for later sale.

More Challenges

- Do additional "float or sink" activities trying a variety of objects. Predict whether an object will float or sink and create/discuss scientific principles that explain observations.
- Create other ways to get the beans across:
  - — Catapult
  - — Gondola under a balloon
  - — Bundle moving on a suspended string

Notes

Siphon Solutions

Here is a farm problem! The tractor is out of fuel. There is plenty of fuel in the combine, but how can you get to it so you can use it in the tractor? Simulate a physics solution to this problem by creating a siphon.

The Activity

1. Present the problem described in the introduction.
2. Give students a set of supplies to simulate the problem.
3. Allow time for experimenting to solve the problem.
4. Share possible solutions. Demonstrate the following steps if necessary.
   - **a.** Place one container on a desk, label it A, and fill it 3/4 full of water.
   - **b.** Place one container at a LOWER level on the floor or on a chair and label it B.
   - **c.** Fill the tube with water and place your fingers tightly over both ends of the tube.
   - **d.** Place one end of the tube deep under the water in bowl A and the other end in bowl B.
   - **e.** Remove both fingers at the same time. If the siphon does not appear to be working, try again from step C.
5. Practice the technique until the siphon works properly.

Ag Skill: Investigating the movement of liquids between differing elevations

Life Skill: Solving Problems—Devises/implements plan of action

Education Standard: NS.K-4.2 Physical Science

Success Indicator: Creates a siphon to simulate a solution to a farm problem

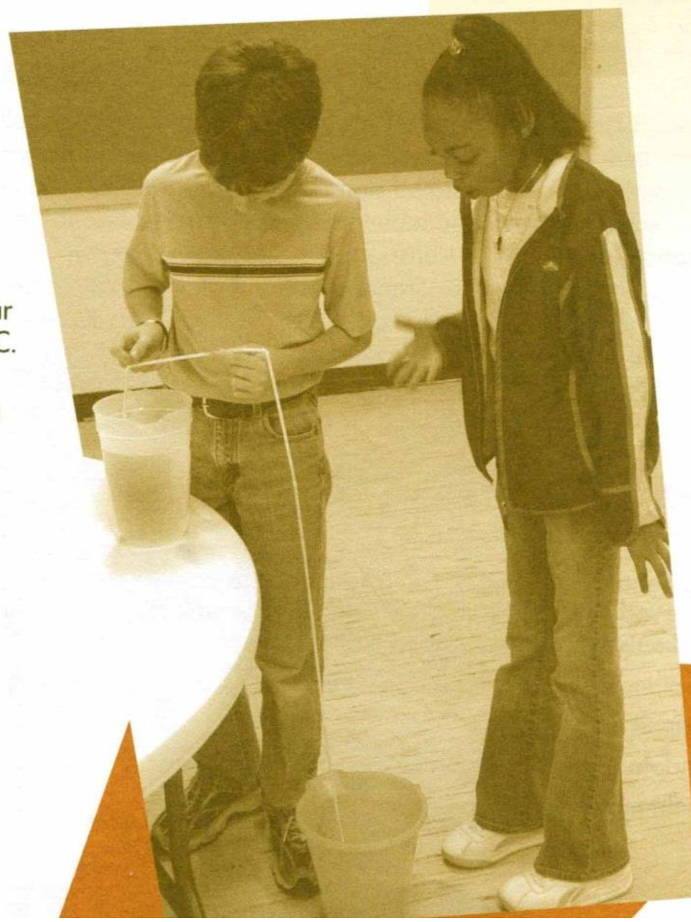
Time Involved: 30 minutes

Suggested Group Size: 6 or more

Materials Needed

Per pair of students:

- ☐ Two large bowls
- ☐ 24-inch transparent tubing 1/2-inch diameter)
- ☐ Tape
- ☐ Marker
- ☐ Tables and/or desks
- ☐ Water



Talk it over

Share

- What different tests did you try?

Process

- What conditions need to be present for the siphon to work?

Generalize

- Why isn't this method used at gasoline stations?

Apply

- How could a siphon be used to solve the need for irrigating a field?

AgFacts

Siphons

A siphon works because of air pressure pushing down on the surface of the liquid. The water falls out of the bottom of the tube and more water fills the empty space and the water continues to flow through the siphon. Air pressure pushing down on the water forces the water into the tube from the full bowl, down through the tube, and into the empty bowl. When both sides of the siphon hold the same amount of liquid, the liquid will stop moving because the water pressure on both sides is equal and counteracts the opposing air pressure.

Sometimes, siphons can be used to move water from a channel to irrigate a field. Small diameter pipes are used to convey water over the channel embankment.

The water cannot be moved to a higher level using this siphon method. An outside force (like a pump creating suction or air pressure) is needed to move the water to a higher level.

More Challenges

- Create a device that uses air pressure to move liquids from one place to another.
- Create a model using real soil and water to show how this method might be used to irrigate a field from a channel.

Notes

Rubber Band Rolling Can

Machinery is an important part of any farm operation. Understanding how machines work will help the farmer to know what kind of repairs need to be made and when. Conduct a simulation that shows how a flywheel inside an engine works to move a truck, tractor, or combine. Demonstrate how rubber bands can create energy and movement.

Ag Skill: Investigating the use of farm machinery to move objects

Life Skill: Reasoning—Applies rules/principles to process/procedure

Education Standard: NS.K-4.2 Physical Science

Success Indicator: Constructs a can that moves by itself using stored energy

Time Involved: 30 minutes

Suggested Group Size: Any size

Materials Needed

Per pair of students:

- [ ] Coffee can with lid
- [ ] Hammer
- [ ] Nail
- [ ] Two rubber bands
- [ ] Four toothpicks
- [ ] Twist tie
- [ ] Weight (fishing sinker or washer)

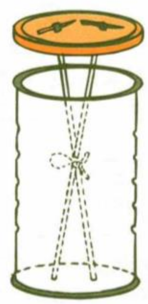
The Activity

1 Provide materials to start the project.

a. Use the hammer and nail to make a hole 1/3 of the way across the bottom of the can and another hole about 2/3 of the way.

b. Make similar holes in the lid.

c. Thread the end of one rubber band through one of the holes in the bottom of the can. Fasten this end with one of the toothpicks.



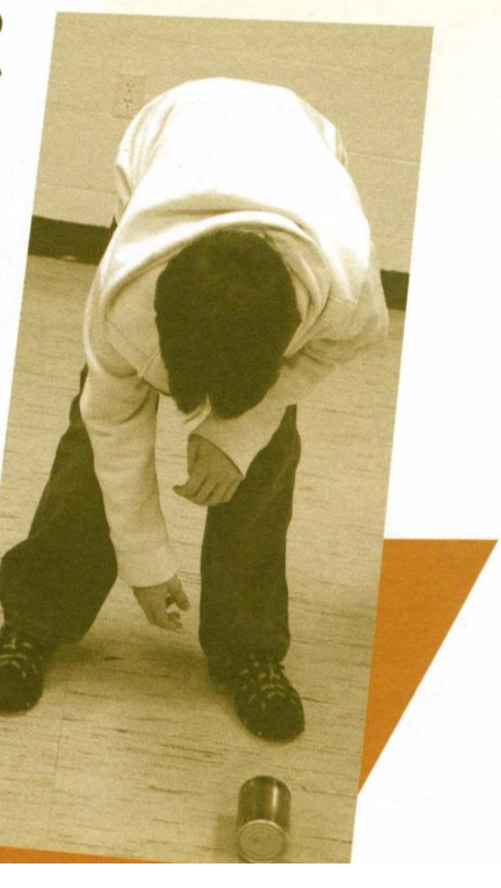
d. Thread one end of the other rubber band through the other hole in the bottom and fasten it with a toothpick. Break the toothpicks in half if they are too long.

e. Thread the other ends of the two rubber bands through the holes in the lid and fasten them with the two remaining toothpicks.

f. Tie the two rubber bands together halfway between the lid and the bottom of the can and attach the weight to this point with the twist tie. The rubber bands will form an X inside the can, with the weight tied to the center.

g. Replace the lid.

2 Roll the can on a smooth surface. Watch it spin back towards you.



Talk it over

Share

- What happens when you roll the can?

Process

- What would happen if you replace the rubber bands with string? If you removed the weight?

Generalize

- What else could go inside the can to make it move?

Apply

- What are some examples where machines make work easier?

AgFacts

Flywheels

As the can rolls, the fishing weight does not spin. Instead, it acts as a stationary anchor. As the can spins, the rubber bands twist up against the fishing weight. When the can stops, energy has been stored in the rubber bands. When they unwind, energy is released and changed into the motion of the can's return. A flywheel is a heavy wheel that, when spinning, can be used to store and then release mechanical energy. A flywheel in an engine is what makes the engine in a machine run smoothly.

Farm Machinery

Machines help farmers do their work. The way farmers work is different today from the way they worked a long time ago. There are more machines to do the work so things get done faster. Tractors plant crops, plow fields, and move heavy loads. Machines milk cows, cut grain and hay, and harvest corn and soybeans. Tractors can cost over $100,000. A combine that harvests crops can cost more than $150,000. In order to maintain expensive equipment, farmers need to have some basic understanding about how this machinery works and how to trouble-shoot problems.

More Challenges

- Use rubber bands to create other toy machines that move such as boats, cars, or planes.
- Research rubber and experiment with rubber bands. Does the elasticity change at different temperatures? Can rubber bands store more energy when cold? Room temperature? Hot?

Notes

Building a Shoebox Cooker

Variation 1

Materials:
- Shoebox
- Aluminum foil
- Tape
- Clear plastic wrap
- Food that is easy to heat (Try melting cheese on chips, chocolate on graham crackers, etc.)
- Pot holders
- Sunglasses

Procedure:
1. Line the shoebox with aluminum foil and tape in place if necessary.
2. Place food on aluminum foil.
3. Cover shoebox with plastic wrap and tape in place.
4. Set box in the sun.

Materials for Variation 2 and 3

- Shoeboxes with lids (one per student or one per group) ***Variation 3***: two boxes per student or team, one being roughly one inch (2.5 cm) larger than the other in all dimensions
- Foam produce trays, well washed (approximately four per shoebox) ***Variation 3***: insulating material such as Styrofoam packing material, crumpled newspaper, cardboard, etc.
- Overhead transparencies (one per shoebox)
- White glue (optional)
- Duct tape (Masking tape is an alternative, but it won't last as long.)
- Heavy-duty aluminum foil (approximately two feet (60 cm) per shoebox)
- Chopsticks or twigs (one stick per shoebox)
- Rulers
- Pencils
- Single-hole punch
- Scissors, knife, or razor cutters
- Oven thermometers (one per group)
- Small food containers made of heat-conducting material such as glass or metal (Make sure food containers will fit inside the cookers! Examples include baby food jars, pot pie pans, petri dishes and Pyrex custard cups, or containers made from aluminum foil.)
- Food that is easy to heat (Try melting cheese on chips, chocolate on graham crackers, etc.)
- Plastic wrap
- Pot holders
- Sunglasses
- Decorating materials and paint (optional)
  NOTE: High-temperature spray paint works best as it won't crack when heated.

NOTE: For a larger solar cooker, use bankers' boxes instead of shoeboxes and acrylic plastic sheets instead of overhead transparencies. Using bankers' boxes will work best with ***Variation 3*** (see **Procedure**).

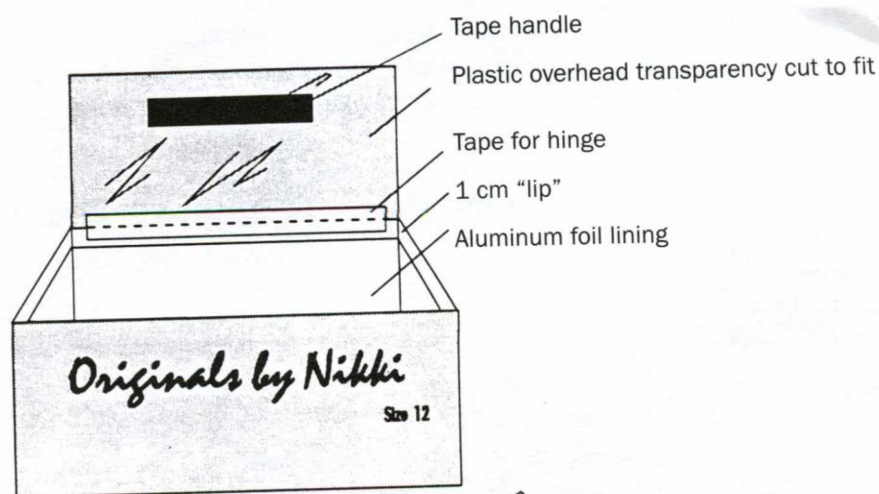
Procedure: Variation 2

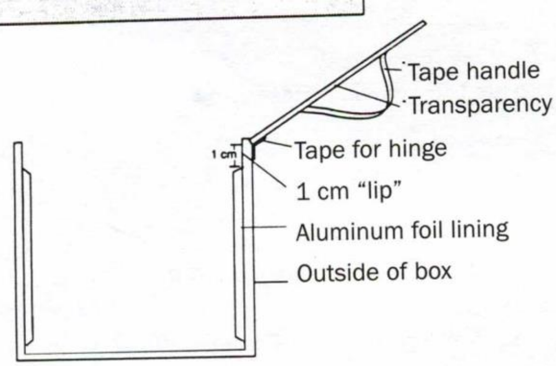
1. Remove and save the lid from the shoebox. Line the inside of the shoebox with foam produce trays. The trays should be placed so that their raised edges are touching the shoebox floor and walls, forming an insulating air space. You may be able to fit trays in the shoebox with minimal cutting. If you have lots of trays, make two layers. If necessary, use white glue to hold the trays in place.

2. Line the interior of the insulated shoebox with aluminum foil, bringing the edges of the foil up and over the rim of the box. Use only one piece of foil (if possible) to help seal the interior of the cooker. If more than one piece of foil is necessary, overlap the edges to reduce heat loss. It may be easier to use two pieces of foil, one sized to the length of the box and one sized to the width. The two pieces of foil can then be laid in the box across each other (crisscrossed).

3. Using duct tape, tape the loose edges of the foil to the outside of the shoebox. This step completes the body of the cooker.

4. Using a ruler and pencil, draw a rectangle on the inside of the shoebox lid 3/4-inch (1.88 cm) from the edges of the lid. Mark one of the long sides "fold."





Procedure: Variation 2 (Continued)

5. Using the scissors, knife, or razor cutter, cut carefully along the other three sides of the marked rectangle, so that the shoebox lid has a flap in it. Fold the flap up along the last edge of the rectangle. This flap will be your cooker's reflector.

6. Carefully smooth a piece of foil over the underside of the flap. The smoother, the better! Secure the foil with glue or tape; if tape is used, fold the foil onto the top of the flap and tape it on that side, so as not to cover the shiny bottom of the flap with any tape.

7. Cut a piece of overhead transparency to fit inside the shoebox lid. If at all possible, use a single piece to reduce heat loss. If you have to fit two pieces together, overlap them by at least one inch (2.5 cm).

8. Tape the overhead transparency to the inside of the shoebox lid, completely covering the cut opening. Make sure that the tape is securely fastened to the 3/4-inch (1.88 cm) border around the opening. The overhead transparency lets sunlight into the cooker.

9. Securely place the lid onto the shoebox. Raise the reflector flap. Near one of the top corners, punch a hole in the lid with the single-hole punch. Insert the narrow end of a chopstick in this hole, so that the thick end is resting on the shoebox lid, but not on the overhead transparency. You may need to make a "nest" for the thick end of the chopstick with a bit of tape. The chopstick is your reflector support.

10. Your shoebox cooker is complete!

NOTE: You may decorate or paint your solar ovens. Take care not to paint the overhead transparency or the reflector flap. Painting the exterior of the box is a matter of aesthetics; it doesn't affect the box's ability to absorb heat. Experts vary in their opinions of whether the interior of solar ovens should be reflective (to direct more sunlight onto the cooking food) or black (to absorb more heat to help cook the food). If you want the interior to be black, try using black construction paper or electrical tape as painting the interior can expose foods to volatile gases. Set the oven outside in the open with the lid open for a day to allow the gases to escape. An alternative is to line the interior with foil. You may want to conduct an experiment where half the class has a black interior and the other half has foil to discover which method is more effective.

Procedure: Variation 3

1. Remove the lid from the smaller of the two shoeboxes. Line the smaller shoebox neatly with aluminum foil.

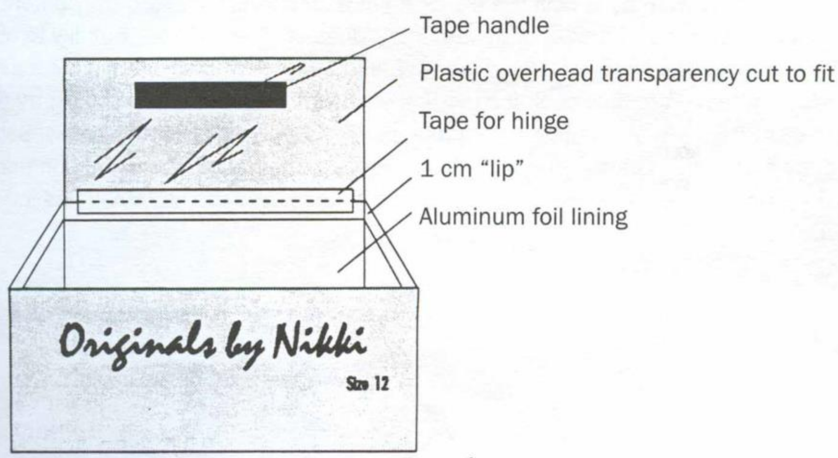
2. Remove and save the lid from the large shoebox. Insulate the bottom of the large shoebox by putting in a layer of insulating material. Pieces of foam trays, crumpled paper, corrugated cardboard, sand, or soil can be used. (You may want to set up an experiment: Which type of insulation works best?) Make the layer no deeper than the difference in height between the two boxes, so that when the small box is set on the insulation inside the big box, the boxes' rims are even.

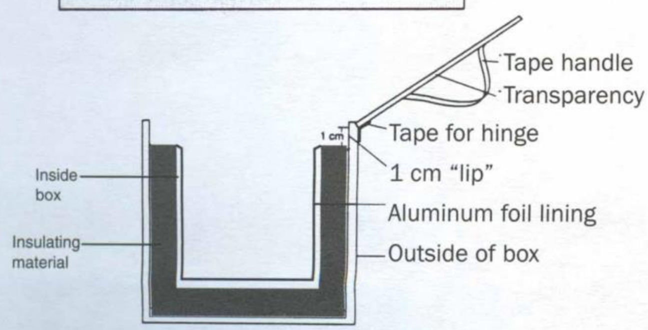
3. With the small box inside the large box, carefully fill in the air spaces between their four walls with more insulation. The insulation should come up to the rims of the boxes.

4. Cover the top of the insulation with a strip of aluminum foil, securing it on the outside of the large box and inside of the small box with tape. The aluminum foil will keep the insulating material isolated from the cooking chamber within the small box. Try to minimize the amount of tape used on the inside of the small box, to avoid covering large areas of the reflective foil.

5. Using a ruler and pencil, draw a rectangle on the inside of the shoebox lid 3/4 inch (1.88 cm) from the edges of the lid. Mark one of the long sides "fold."

6. Using the scissors, knife, or razor cutter, cut carefully along the other three sides of the marked rectangle, so that the shoebox lid has a flap in it. Fold the flap up along the last edge of the rectangle. This flap will be your cooker's reflector.





Procedure: Variation 3 (Continued)

7. Carefully smooth a piece of foil over the underside of the flap. The smoother, the better! Secure the foil with glue or tape. If tape is used, fold the foil onto the top of the flap and tape it on that side, so as not to cover the shiny bottom of the flap with any tape.

8. Cut a piece of overhead transparency to fit inside the shoebox lid. If at all possible, use a single piece to reduce heat loss. If you have to fit two pieces together, overlap them by at least one inch (2.5 cm).

9. Tape the transparency to the inside of the shoebox lid, completely covering the cut opening. Make sure that the tape is securely fastened to the 3/4-inch border around the opening. The overhead transparency lets sunlight into the cooker.

10. Securely place the lid onto the shoebox. Raise the reflector flap. Near one of the top corners, punch a hole in the lid with the single-hole punch. Insert the narrow end of a chopstick in this hole, so that the thick end is resting on the shoebox lid, but not on the overhead transparency. You may need to make a "nest" for the thick end of the chopstick with a bit of tape. The chopstick is your reflector support.

11. Your shoebox cooker is complete!

NOTE: Use larger boxes, such as bankers' boxes, to make a bigger solar cooker. Follow **Steps 1-4** of the procedure. Use the lid of the larger box as the reflector (see Step 7 and 10). You may want to tape one long end of the lid to the box. It may also help to cut the corners so the lid lifts up and down like a door. Use an acrylic plastic sheet instead of overhead transparencies, cutting it so that it rests on the insulation layer. Make handles to put in and remove the glass by using rolls of tape or by drilling holes into the acrylic sheet and inserting knobs. You will need sticks that are at least two feet long to support the reflective lid.

NOTE: NOTE: You may decorate or paint your solar ovens. Take care not to paint the overhead transparency or the reflector flap. Painting the exterior of the box is a matter of aesthetics; it doesn't affect the box's ability to absorb heat. Experts vary in their opinions of whether the interior of solar ovens should be reflective (to direct more sunlight onto the cooking food) or black (to absorb more heat to help cook the food). If you want the interior to be black, try using black construction paper or electrical tape as painting the interior can expose foods to volatile gases. Set the oven outside in the open with the lid open for a day to allow the gases to escape. An alternative is to line the interior with foil. You may want to conduct an experiment where half the class has a black interior and the other half has foil to discover which method is more effective.

Using a Shoebox Cooker

CAUTION: The solar oven can get very hot, so use pot holders. Do not stare at the sun or the sun's reflection in the aluminum; it can damage your eyes. Sunglasses are recommended.

1. Make sure that your food container will fit inside the cooker. Prepare the food you want to cook. For example, sprinkle cheese on nacho chips, make a simple cookie recipe, place pieces of chocolate and marshmallows on graham crackers, etc.

2. Locate a sunny area for the cookers. Watch out for trees, buildings, and other structures that may cast shadows on your cookers. Your cookers will be outside at least an hour, and they must not be shaded. Remember that as the Earth rotates, shadows move and change lengths throughout the day.

3. Put a thermometer in each cooker (or in selected cookers if you don't have enough thermometers). Make sure that the lids are set securely on each cooker and that the reflective flaps are raised. Aim the cookers toward the sun. You can tell when the cookers are aimed correctly by adjusting their orientation until the cookers' shadows are as small as possible.

4. Adjust the reflective flap by moving it up and down and observing the reflected light within the cooking chamber. At the point when the interior is brightest, insert the chopstick support into the hole on the flap, to secure the flap at that angle. NOTE: Because Earth rotates, the cookers' orientation and reflective flap angle may need to be adjusted during the cooking period.

5. Preheat your cooker by letting it sit in the sun. On a sunny day, shoebox cookers can easily reach 200 degrees F (93 °C) in 30 or 40 minutes. Check the thermometers periodically.

6. When the cookers are hot enough (at least 150 degrees F [66 °C]), place your foods in the cooking containers, cover the containers with plastic wrap (optional) and as quickly as possible put the containers in the cookers. The less time the lids are off, the less heat you'll lose. It may help to have one student lift a lid while the other quickly puts the food in.

7. Let it cook! You may wish to keep recording temperatures and weather observations at set intervals.

Solar Cooking Record

Name(s) ____

Date ____

What is the weather like today?

Temperature __________ Cloud cover ____________________ Wind speed ______________

Other ____

Draw or describe where you are placing your solar cooker and why you think this is a good location.

What are you cooking?

Shake down the thermometer to its lowest reading and note this below (the lowest reading of many oven thermometers is 100 degrees F). Put the thermometer in the box, marking the time next to the first temperature reading. Record the temperature every 5 minutes (continue recording on the back if you need more space). Put a box around the time when the food was placed in your cooker. Describe any changes you see in the food.

Time	Temperature	Changes in food after placed in solar cooker

What does our food look like after cooking for at least one hour? Describe if you think it cooked thoroughly or not.

What does it taste like? Does it taste like it's cooked thoroughly?

Shoebox Solar Cooker

Summary: Students build and use a simple solar cooker and experiment using the sun to heat food.

Objectives

Students will be able to
- construct an effective solar oven;
- explain how a solar oven works; and
- discuss the benefits and challenges of using a solar oven.

Rationale

Operating a solar oven helps students learn about solar energy and heat-related principles and appreciate the importance of energy-related technologies.

Materials

- Each group of students will need a copies from the *Student Book*:
  - ***Building a Shoebox Cooker***, *page 125* and materials listed on this student page
  - ***Using a Shoebox Cooker***, *page 130*
  - ***Solar Cooking Record***, page 131 (optional)
- Photographs of commercial solar ovens (optional)

Background

Did you ever hear the expression, "It's hot enough to fry an egg on the sidewalk?" Sidewalks don't really get quite hot enough to cook on, but you could build a solar box cooker, place it on a sidewalk, and allow it to collect the sun's heat energy and cook many different kinds of food. Commercial solar cookers are also available (see **Resources**). To work properly, a solar box cooker (also called a solar oven) must hold heat energy long enough for the food to absorb the heat and cook.

Making a solar oven can be both simple and difficult. Collecting energy from the sun is easy. When sunlight strikes a surface and is absorbed, it gets converted to heat energy (or infrared radiation). A glass or Plexiglas cover works like a greenhouse window to let sunlight in but not let the infrared radiation out. Solar cookers usually include some kind of reflector that increases the amount of energy the cooker receives by reflecting light inside the box onto the cooking container. Keeping the heat energy in the oven is more difficult. Solar box cookers must be carefully insulated and tightly sealed so the captured heat cannot escape.

The key to a successful solar oven is making sure it faces the sun. To keep the solar cooker hot all day, it must be continually turned to follow the path of the sun. For a gradual heating process, place food in an oven and direct it toward the sun's midday position. The food cooks slowly, reaching its peak heat by mid-afternoon. The food is ready to eat by early evening.

Solar box cookers reach between 140 degrees F (60 °C) and 266 degrees F (130 °C) depending on their construction and intensity of the sunlight. Clear, sunny days provide the best results. However, as long as the cooker faces the sun and is well-insulated, the temperature outside the cooker should have little effect on the cooking rate. So solar cookers can be used in December as well as in July.

The choice of ovenware can affect the cooking time in a solar cooker. Ovenware can be made from glass, ceramic, earthenware, or metal. Each material conducts and retains heat differently. Often dark-colored ovenware is best for solar cookers because it absorbs light energy better than light-colored materials.

What can be cooked in a solar oven depends on the quality of the cooker. Any conventional recipe suitable for a slow cooker works well, because the solar cooker will get hotter than a slow cooker. Baking should be done on clear, sunny days as it requires higher temperatures. Cutting the ingredients into small pieces will help the food cook faster. The foods, especially liquids and moist meals such as stews, need to be sealed in the solar box cooker so water does not condense on the glass cover.

Simple solar cookers, such as those made from a shoebox, should be able to do the following:

Grade level: 5-8 (K-4)

Subject Areas: Family Living and Consumer Education, Science, Social Studies, Technology Education

Setting: Outdoors on a sunny day and classroom

Time:
Preparation: one week
Activity: three 50-minute periods

Vocabulary: Greenhouse effect, Insulation, Solar cooker, Solar oven

Major Concept Areas:
- Natural laws that govern energy
- Development of energy resources
- Management of energy resource use

Getting Ready:
Use an unshaded outdoor setting where the solar ovens can remain undisturbed for at least an hour. You may want to provide students with the materials list the week before the activity is scheduled and have them bring the items from home. An alternative is to build one solar oven and have groups use a single oven to conduct experiments. If possible, invite aides or parents to help with the construction. Have students decide what food they'd like to cook and create a shopping list. You may request that students bring in these ingredients as well. See Steps 2 and 3 for variations for younger students.

Resources:

For Teachers

Burns Milwaukee, Inc.
4010 West Douglas Avenue
Milwaukee, WI 53209. Phone: (414) 438-1234. Vendor for solar ovens.

Solar Cookers International
1724 11th Street
Sacramento, CA 95814.

Sun Light Works
P.O. Box 3386
Sedona, AZ 86340.

Complementary Activities

Florida Middle School Energy Education Project. Energy Bridges to Science, Technology and Society. Tallahassee, Fla.: Florida Solar Energy Center for the State of Florida, 1991.

Hawaii Energy Extension SVC
Hawaii Business Cntr
99 Aupuni St., Rm 101B
Hilo, HI 96720
-or-
Hawaii State Dept. of Business, Economic Development & Tourism - Energy, Resources & Technology Div. PO Box 2359, Honolulu, HI 96804-2359

For Students

Arizona Energy Office. A Day in the Sun. Phoenix, Ariz.: Arizona Energy Office, 1991. Videocassette.

Gurley, Virginia Heather. Solar Cooking Naturally. Sedona, Ariz.: Sun Light Works, n.d.

Halacy, Beth, and Dan Halacy. Cooking with the Sun. Lafayette, Calif.: Morning Sun Press, 1992.

- Heat water for hot chocolate, tea, or instant soup
- Warm canned soups, vegetables, and stews
- Prepare hot dogs
- Melt cheese, chocolate, or marshmallows
- Make simple pizzas (cheese and tomato sauce sprinkled on prepared crust)
- Bake chocolate chip cookies

Better built solar cookers can cook regular meals. With a well-constructed or commercial oven you can prepare foods, such as vegetables and grains, that need to be cooked more thoroughly. For example, summer squash, fresh peas, green beans, spaghetti, noodles, instant potatoes and rice cook relatively quickly. White rice, rolled oats, pearl barley, and squash should cook in two hours. Lentils, black-eyed peas, black beans, and potatoes will need about three hours.

Frying eggs may not be the best use for a solar oven, but you can cook eggs in breads, casseroles, and cakes. Whether you decide to make a warm drink on a cold day in December or a complete meal, solar box cooking is fun and delicious.

Procedure

Orientation

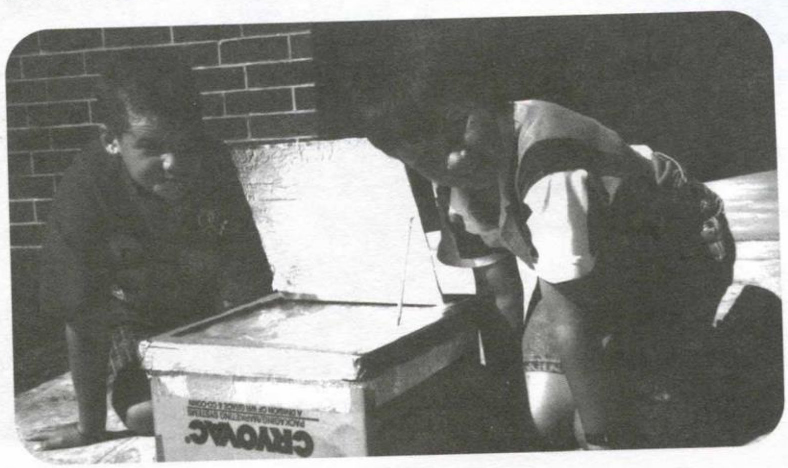
Ask if any students have ever been in a car that has been parked in the sun. Have a student describe what it feels like inside the car. Students may have also heard warnings about not leaving pets and children in parked cars because of the risk of heat exhaustion or stroke.

Discuss how sunlight passes through the glass windshield and windows in a car. When the light strikes the interior surfaces of the car, it is absorbed and converted to heat energy. The heat can not escape through the glass and causes the interior temperature of the car to increase.

Steps

1. Ask students if they think heat from the sun can be used to melt things such as chocolate or cheese. Tell students that by applying what they know about heat collecting in a parked car, they can design an oven that uses the sun's energy to cook food.

2. Divide the class into working groups. Hand out and discuss ***Building a Shoebox Cooker***, Materials and Procedure for Variation #1, #2, or #3. NOTE: Variation #2 involves cutting and placing foam trays in the box for insulation. Younger students may have a difficult time handling the pieces of foam and will get frustrated when they try to line the shifting trays with foil. Shifting can be minimized by cutting the trays to fit tightly against each other. Small hands may



find Variation #3, the two-shoebox method, easier. Variation #1 is the easiest but may not be as effective.

3. Provide students with copies of ***Using a Shoebox Cooker*** and have them prepare the food they want to cook. Have students test and use their cookers. The ***Solar Cooking Record*** can be used to document observations, and this data can also be used to make graphs. NOTE: For younger students, it may be enough to observe that the sun heats food and to note temperature changes.

Closure

Have students share the results of their cooking experiments. Do they think they would regularly use solar ovens? Remind students that the ovens they constructed are simple, and that there are more technical and efficient models available. Inform students that there are companies that sell commercial solar cookers that are very effective at heating food. If available, show pictures or overhead transparencies of some of these cookers. Students can compare qualities of these cookers to their own.

Discuss ways students can test or improve the cookers. Questions to explore include:

- How well does the cooker work on cloudy days?
- What effect does outside temperature have on the cooking rate?
- Is there any difference when the cooker is used in December than when it is used in June?
- Would a bigger box, more reflectors, or different types of insulation improve the effectiveness of the cooker?

Commercial Solar Ovens

Pease, Tom. "Getting Our Energy from the Sun" on *Daddy Starts to Dance*. Madison, Wisc.: Tomorrow River Music, 1996. Audiocassette.

Rickard, Graham. *Alternative Energy: Solar Energy*. Milwaukee, Wisc.: Gareth Stevens Children's Books, 1991.

Related KEEP Activities:

Use this activity as part of a unit on solar energy or heat. See K-5 Energy Sparks for Theme II: "Sunvestigations" or K-5 Energy Sparks for Theme I: "Exploring Heat." A solar cooker can also be used to enrich investigations in "Taking Temperatures." Older students can apply concepts from solar cooking to activities such as "So You Want to Heat Your Home?" Other uses of solar energy such as those found in "The Miracle of Solar Cells" could be done with younger students.

Credits:

Activity adapted from "Now You're Cooking—With the Sun" in *Florida Middle School Energy Education Project: Energy Bridges to Science, Technology and Society*. Tallahassee, Fla.: State of Florida for the Florida Energy Office, 1994. Used with permission.

Activity adapted from Hawai'i Extension Service. *Making Shoe Box Cookers* Contact: Energy, Resources, and Technology Division. Department of Business, Economic Development, and Tourism, 99 Aupuni Street, #101B, Hilo, Hawai'i 96720.

Assessment

Formative

- How well did students construct the ovens?
- Can students explain how a solar oven works?
- How effectively do the solar ovens heat food?

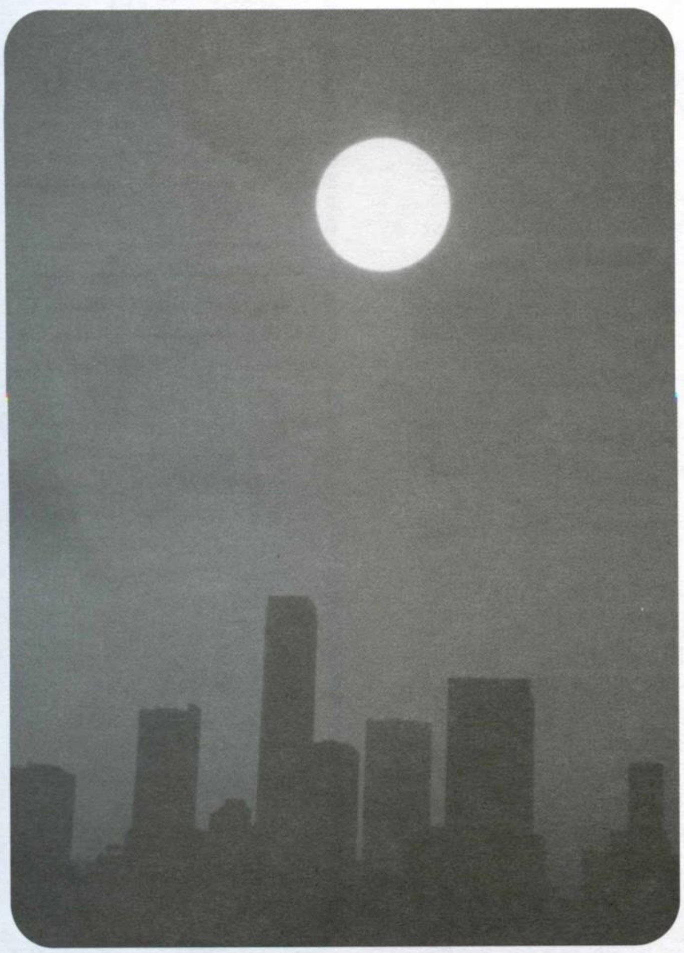
Summative

- Have students plan a party for another class or their parents in which food is cooked in the solar ovens. The event can begin with students explaining how they made the solar ovens and how they work. During the presentation, students can discuss the potential and practicality of solar oven use in their own future.
- Students can research the many different designs for solar cookers and experiment with different properties and adaptations. For example, try placing a thicker piece of metal, such as a piece of a cookie sheet or baking pan, in the bottom of the solar oven to increase heat transfer and storage.

Extensions

Students may be interested in exploring how solar cookers are currently being used worldwide, especially in places where electricity is unavailable and traditional fuel sources, such as wood, are being depleted (see **Resources**).

Purchase a commercial solar oven or invite a guest speaker (such as a vendor) who regularly uses a solar oven to show and discuss more sophisticated models and methods of solar cooking (see **Resources**). Students can also see solar ovens in use at the Midwest Renewable Energy Fair (see Appendix).



4-H

Head, Heart, Hands, and Health

Making the Connection to Technology

Complete the following activity – list one idea that relates the 4 "H's" to the STEM Technology activities. For example, under HANDS you could decide that you want to use your computer programming skills to program a robot for your school science fair.

So, now it is your time to think of one thing for each "H". You can do this by yourself, with your family or with other 4-H Club members. Remember, have fun there is no right or wrong answer.

Once this is completed, you can move on to the other sections of Exploring 4-H STEM

- **HEAD** stands for clearer thinking and decision-making. Knowledge that is useful throughout life.

- **HEART** stands for greater loyalty, strong personal values, positive self-concept, and concern for others.

- **HANDS** stand for larger service, workforce preparedness, useful skills, and science and technology literacy.

- **HEALTH** stands for better living, healthy lifestyles.

The 4-Hs' information can be found at- http://4h.uwex.edu/about/

E

Engineering

The definition of engineering is

en·gi·neer·ing

NOUN:

1.
    a. The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.
    b. The profession of or the work performed by an engineer.
2. Skillful maneuvering or direction: *geopolitical engineering; social engineering.*

Section Three (engineering): Leaders please complete two lessons minimum from this section with the youth. The lessons vary in difficulty; please choose lessons that will challenge the youth and spark inquiry. Lessons can be adapted to be made more challenging.

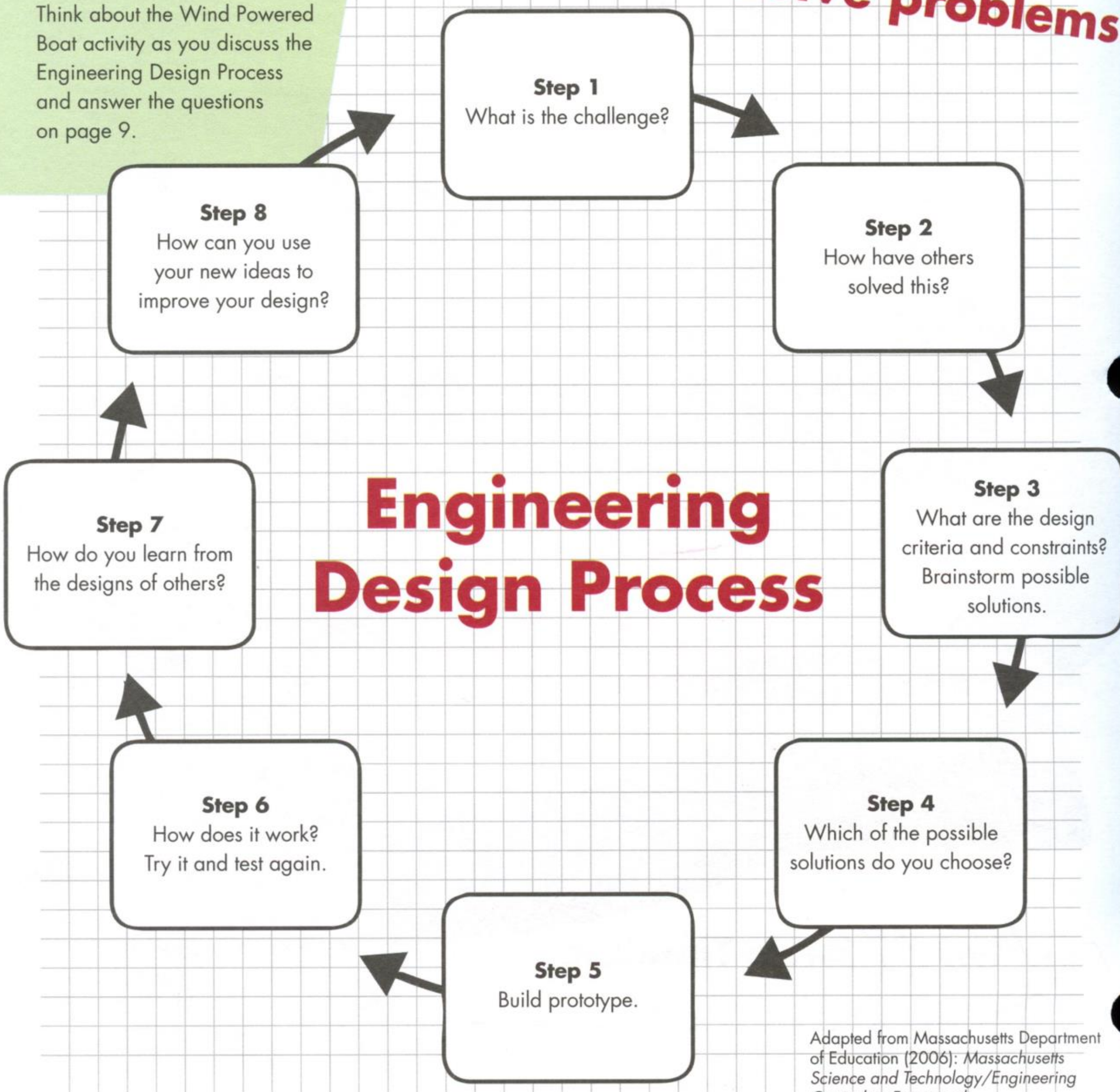
List of experiments-

Learn More About Engineering Design

How do engineers use design to solve problems?

Think About It

Think about the Wind Powered Boat activity as you discuss the Engineering Design Process and answer the questions on page 9.



Adapted from Massachusetts Department of Education (2006): *Massachusetts Science and Technology/Engineering Curriculum Framework.*

Talk About It

- What was the challenge?
- How did you get your first ideas?
- What were your constraints?
- Describe your first **prototype**.
- How did your prototype differ from your final result?

Learning from Others

- How did you use the ideas of others?
- Why do you think the **engineering design process** on page 8 is circular?

Restrictions like "not too heavy" or "not too expensive" are called constraints on the design.

Anything an engineer designs will be the result of choices and trade-offs – balancing the options and the constraints.

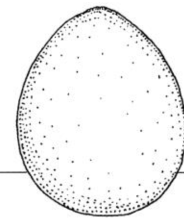
Engineering design always contains some "do-overs" (they're called **iterations**) where you learn something valuable from something that went wrong and you go back and fix it.

Part of design is testing what you've made to see how it works and being willing to adjust as necessary—even to the point of "going back to the drawing board."

It's all part of getting something that works just like you want it to.

Activity 1B

Don't Break That Egg!



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

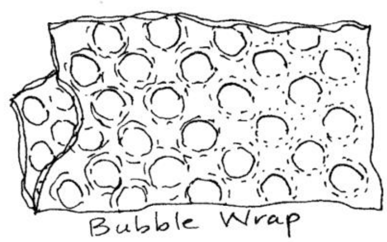
- ❑ 1 dozen eggs in an egg carton

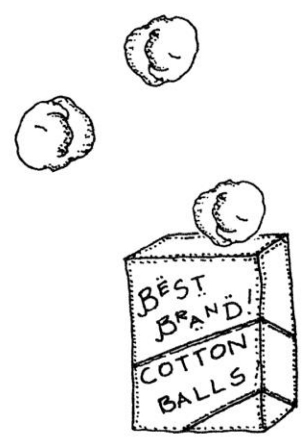
Activity Supplies

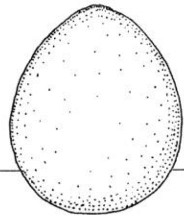
Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ magic marker for writing child's name on package
- ❑ raw egg
- ❑ a variety of wrapping and packing materials[1]
- ❑ anything else you can think of that might be useful for wrapping such as tape, string, and other fasteners
- ❑ scissors

[1] bubble wrap, dried grasses, feathers/fur, packing "peanuts," popped corn, pieces of cloth, paper such as paper towels, wrapping paper or paper bags, cotton balls/lamb's wool, dried beans/seeds, and other "everyday" packing materials that you have. Don't forget "hard" packing materials such as margarine and yogurt containers and small boxes.







Activity 1B

Don't Break That Egg!

Focus

Examine the eggs in the carton. Say something like, "How are the eggs packed? How do cartons protect the eggs from breaking?"

Activity

1. Put out a large assortment of wrapping and packing materials. Include a variety of hard and soft, crushable and absorbent, large and small materials.

2. Cut materials into small, individual-sized pieces if this was not done earlier. Some possible materials are listed, but use whatever you have available.

3. Give each child a raw egg (you can substitute hard-boiled eggs if messiness is an issue).

4. Invite each child to wrap the egg in a protective package that will survive being dropped. As a group, choose a location from which you will drop the eggs. Some suggestions are down a stairwell, out a second-floor window, or from a ladder, porch, desk, or table. ***(Of course, use caution in areas with significant height!)***

5. Set a size limitation to the finished package if you wish to.

6. Give the children a time limit and remind them periodically how much time they have left.

7. Make sure that the children write their names on their creations.

8. You (the adult) stand on a desk, on a ladder, or from wherever you have decided to drop the egg, or choose one child to do this. (Because children's height varies, the eggs would drop from a different distance if each child dropped his or her own egg.)

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how people in other parts of the world keep eggs from breaking.

if eggs would be stronger if they were a different shape.

Conversation

Questions You Might Ask

How do you think milk is protected from spoiling in the summer heat?

How can your parents protect ice cream from melting on the way home from the grocery store?

How can you keep your books dry when you're walking to school in the rain?

Why do people put glass over paintings and photographs?

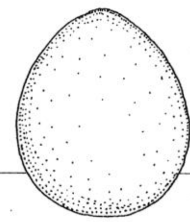
How do people protect themselves from getting hurt? Do different parts of our bodies need different kinds of protection?

When someone washes the kitchen floor, why do they put "wax" on it?

Why do people paint their houses?

Activity 1B

Don't Break That Egg!



9. One by one, drop the children's wrapped eggs.

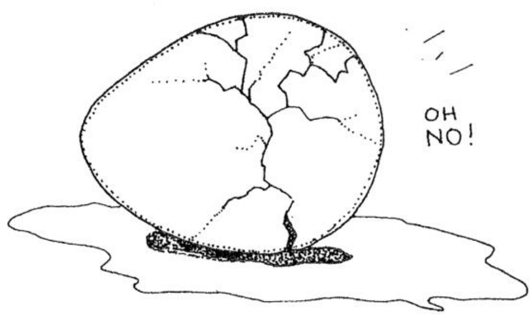
10. Have the children unwrap their eggs over a sink or washable surface and talk about the results.

A Step Beyond

I wonder if my protective package would protect my head.

Different kinds of materials can offer different kinds of protection. In the egg drop, you chose some hard things and some soft things. Why did you choose different materials?

Pass around a motorcycle helmet, football helmet, or bicycle helmet and consider what it is made of. Why is it made of those materials? What does it feel like on the outside? What does it feel like on the inside? Helmets are hard on the outside. Why are they hard? Does it keep the rain out? These items are hard so they can protect your head from sharp edges that might poke or scrape you.



I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

if there would be any way to protect a wrapped egg from breaking if it were dropped from 100 feet in the air.

why and how some birds' eggs are stronger or weaker than others.

how I would design an egg if I could be a "better-egg-designer."

Flying Feathers

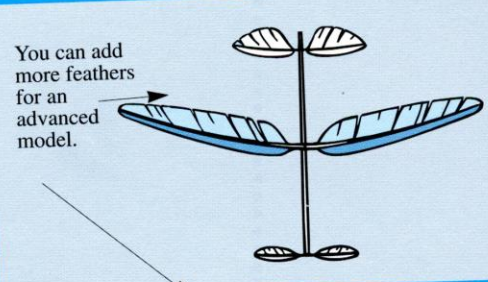
Have you wondered what it would be like to fly like a bird? What would you need? Wings, right? Wings are very special. They have a unique shape called an airfoil. In this activity you will make a glider from feathers, experiment with different airfoil shapes and record your results.

Activity:	Make a flying wing (glider)
Work and Life Skills:	Demonstrates creative thinking while problem solving
Aerospace Skill:	Making a feather wing glider
Science Skill:	Building models, experimenting

Materials: 2 bird feathers from opposite wings (pigeon feathers if available), cement glue, scissors, small drill or pick, sturdy toothpick or quill from another feather

Blast Off

1. Gather the feathers and cut the quill ends to equal lengths. Make the feathers the same shape and size by cutting them if necessary.
2. Make small holes about 1" deep up into the end of each quill.
3. Push both quills onto the toothpick or quill connecting piece. Make sure the aerodynamically well rounded side shows downward.
4. Hold the center between your thumb and forefinger and toss. On the first test flight the wing will probably veer left or right or even crash.
5. Using the chart, experiment with Bernoulli's Principle by performing the maneuvers described and record your results. Glue your wing when you have discovered the best aerodynamic position. Test flights are best performed in a large draft-free room.



Testing 1, 2, 3...

Test 1
Put well rounded aerodynamic side upward; toss.
Result: ______

Test 2
Put well rounded aerodynamic side downward; toss.
Result: ______

Test 3
Bend feather backwards at middle; toss.
Result: ______

Test 4
Twist feather at middle; toss.
Result: ______

Test 5
Bend feathers forward at connecting piece; toss.
Result: ______

Extra Extra!

Discover more about lift through Newton's Apple Television/KTCA/PBS.

Debriefing

Ground to Ground (Share)

Q. How did you make your feather glider?

Q. Describe the results of your tests.

Climb Out (Process)

Q. What did you learn about feathers?

Q. How is your feather glider similar to an airplane's wing? Different?

Level Off (Generalize)

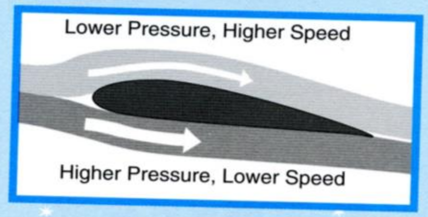
Q. Describe how an airfoil works.

Cross Country (Apply)

Q. Where do we see airfoils in the everyday world?

Aerospace Facts

- Daniel Bernoulli was a Swiss physicist in 1733. He discovered pressure systems better known as Bernoulli's Principle. When applied to flight, Bernoulli's Principle states that air moves quicker over the curve on the top of the airfoil (for example your feather glider or airplane's wing) and creates a low pressure system. Air moves slower under the flatter bottom part of an airfoil, creating a high pressure system. The differences in the air pressure creates lift.



Solo Flight

1. Use four feathers to make a horizontal stabilizer and vertical stabilizer for your feather flyer. Strip all but one thin tip of one feather. This will be your fuselage and horizontal stabilizer. Trim two quills shorter than the quill already made. Make small pin holes with a scissors at the end of the fuselage with the remaining feathers. Stick both feathers into the holes. Glue after several test flights.

Date ________ Initial ________

Resources:
Flying Machine, available from the National Air & Space Museum, Washington D.C., 20506. Feathers are available through pigeon fanciers, zoos, poultry farms and aviaries.

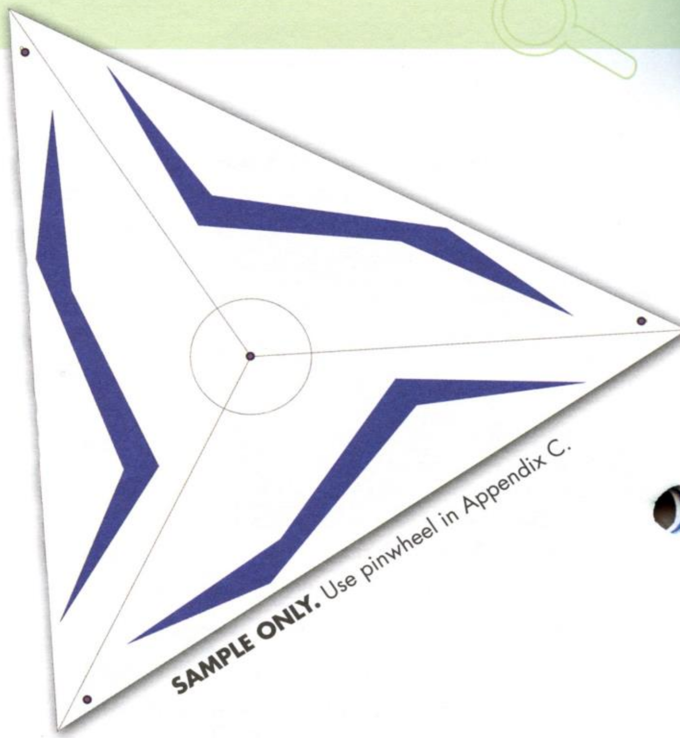
Acknowledgments: Adapted by Don Beccnetti and Judy Rice from A New Experiment Hermann Holzhouser s Flying Feather Aeroplanes by Klaus Strienz (unpublished). *Aerospace Facts* by Leanne Bloom and Dan Shuck.

INVESTIGATION

How Can We Design a Better Pinwheel?

Try It

- Cut out the triangular pinwheel in Appendix C.
- Make a design on the pinwheel that has rotational symmetry.
- Cut on the lines from the corners to the center circle.
- Curl the dots at the corners to line up with the dot in the center circle.
- Push the pin through all three dots and into the eraser of a pencil.
- Design and build another pinwheel with more blades. Start with a hexagon, octagon or other polygon.



You Will Need:

- Scissors
- Straight pins
- Pencils with erasers
- Paper (various weights—construction paper, index cards, cardboard)
- Pinwheel patterns from Appendix C

Other Possible Materials:

- Paper plates
- Aluminum pie plates
- Paper clips
- Coffee stirrer
- Popsicle sticks
- Miscellaneous hardware and office supplies

In Your Engineering Notebook

write or sketch answers to questions you find important or interesting.

Make several pinwheel variations.
What other aspects of the design change the way the pinwheel works?

How well do other pinwheel shapes work?

Vary the number, shape, and size of the blades.
What materials work best? Is stiffer paper too heavy?

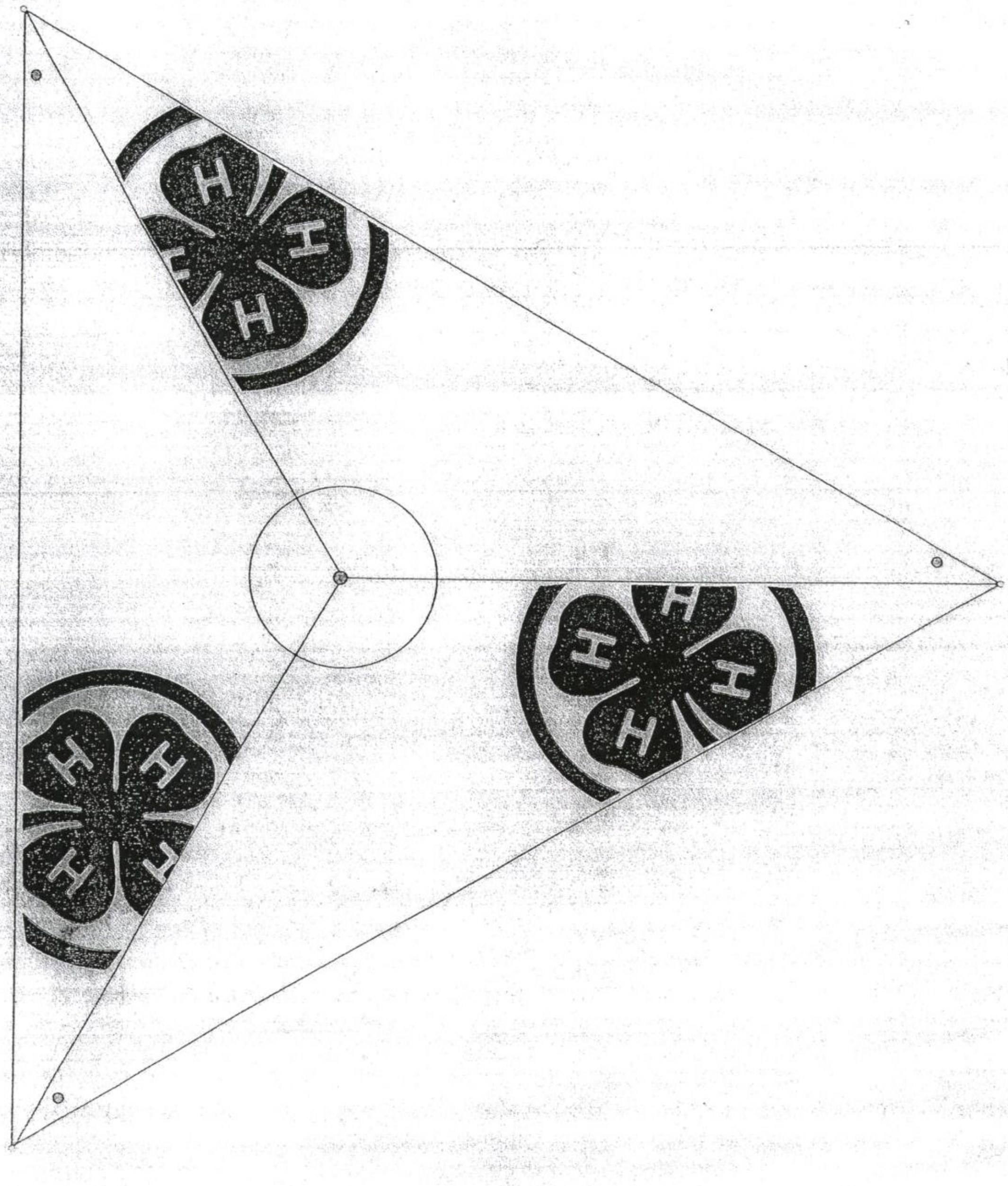
Record your observations about the various designs in your engineering notebook.

Make sketches or include photos.

Appendix C

Triangular Pinwheel Template

Draw a design on this pinwheel using rotational symmetry.



CHALLENGE

How Can We Use Wind To Lift a Load?

Design and Build

a wind turbine that uses wind power to lift a minimum of four pennies in a small paper cup.

Try It

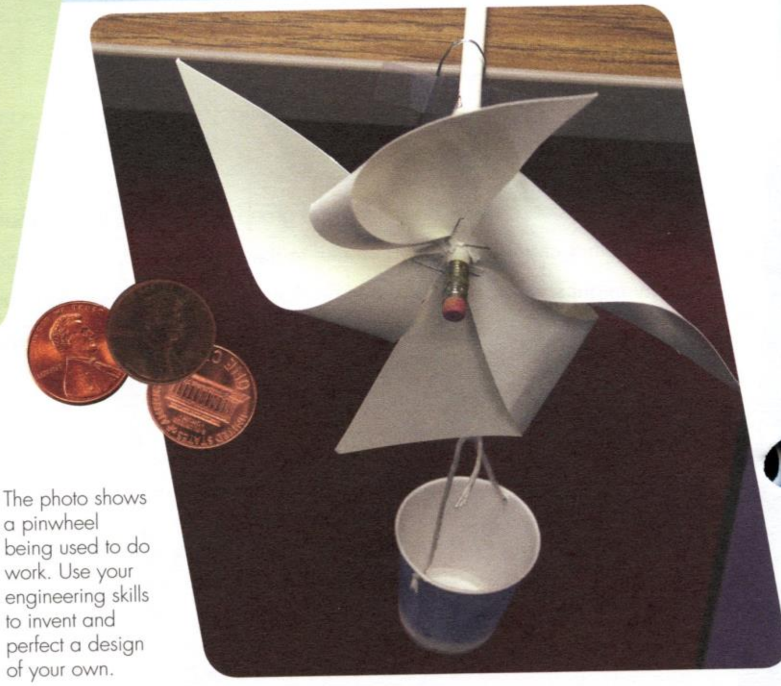
- Simulate the wind with a box fan.
- Position the "wind" near your turbine.
- Lift the load from the floor to a table top.

You Will Need:

- Pennies
- Cardboard or index cards
- Round pencils
- Straws (sturdy straws)
- Cardstock
- String (cotton or poly works best)
- Paper or plastic cups
- Paper clips
- Tape
- Box fan
- Stop watch or watch with a second hand

Other Possible Materials:

- Rubber bands
- Poster board
- Plastic beads for spacers
- Miscellaneous hardware and office supplies



The photo shows a pinwheel being used to do work. Use your engineering skills to invent and perfect a design of your own.

In Your Engineering Notebook

write or sketch answers to questions you find important or interesting.

Describe all of your attempts.

What is the maximum number of pennies your machine is able to lift?

How long does it take your machine to lift four pennies?

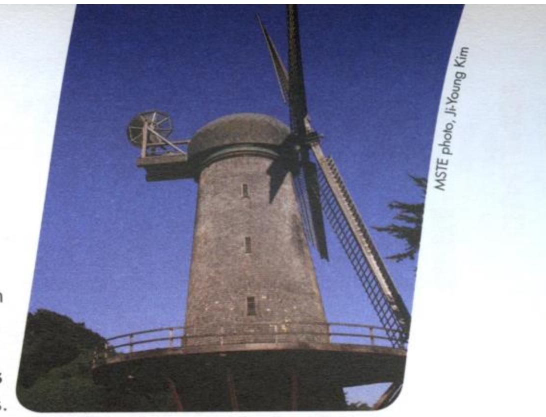
How long does it take to lift eight pennies? Is it twice as long?

The Working *Wind*

We know that windmills were used to do work in Persia at least 3,000 years ago (Persia is now Iran). These windmills looked somewhat like modern day revolving doors. The wind pushed against the door-like paddles and turned a center **shaft**. The shaft was connected to a pump or to a millstone used to grind grain. These were vertical **axis** windmills which work no matter which direction the wind blows.

Early European windmills first appeared about 800 years ago. These horizontal axis windmills had large blades that faced into the wind like a pinwheel. The blades were often wood frames covered by cloth sails. When the direction of the wind changed the windmiller had to turn the blades to face the wind. Later, inventors developed ways for the wind to do this turning. Notice the small set of blades on the windmill in the photo.

In the later 1800's smaller windmills were invented to help farmers in the American West pump water. These windmills were mounted on **towers** and had many thin blades. There was also a fantail or rudder to turn the blades into the wind. These windmills were used by American farmers to do many chores. Over time, improvements were made in the shape of the blades. Some were made of steel. During the years 1880 to 1935, several million windmills operated in the American West.



This Dutch style windmill in Golden Gate Park in San Francisco was built in the early 1900's to pump water from an underground aquifer to irrigate the park.

Talk About It

Describe your first design. What works well? What do you want to improve?

Try Something Else and Test Again

- What improvements did you make in your initial windmill?
- Which adjustments to your design made the windmill work faster and which made it stronger? Discuss your design with your partner or group. Explain the adjustments you want to make and explain why you want to make them.

Learning from Others

- Observe the turbines built by others in your group. How are they similar? How do they differ? What are some features of the turbines that lift the most pennies?
- We need energy to do work. Moving or lifting something is work. Lifting 4 pennies 20 inches is twice as much work as lifting 4 pennies 10 inches. Describe how your turbine uses wind energy to do work.

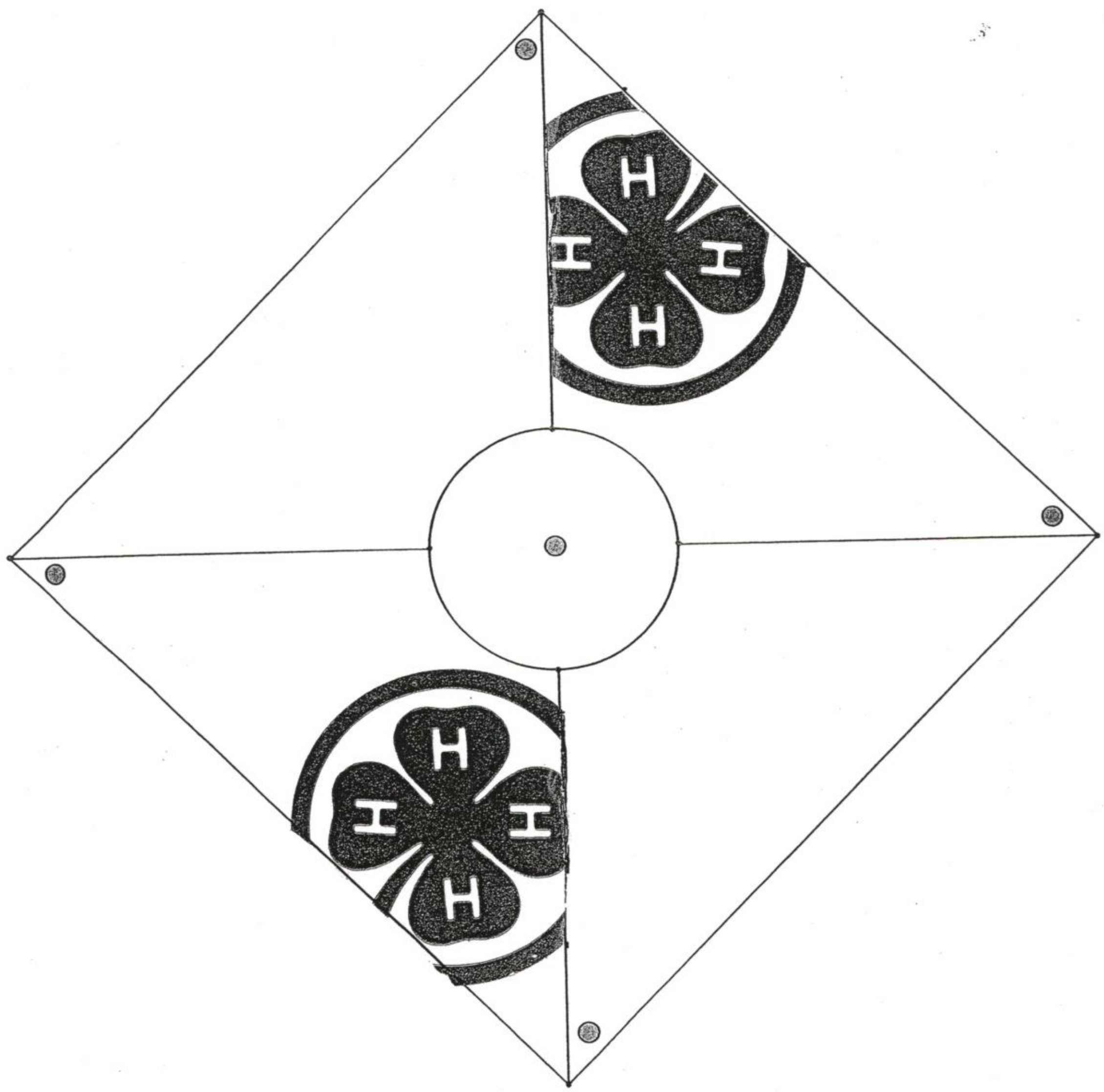
Engineering Design with Sue Larson

Have you ever heard the phrase "go back to the drawing board?" It means that something has gone wrong with a design and it's time to start over. Engineering design always contains some "do-overs" (they're called iterations), where you learn something valuable from something that went wrong and you go back and fix it. Some of these iterations happen early in the design process and some happen much later—even after something is made and the designer sees how people use it. Part of design is testing what you've made to see how it works and being willing to adjust as necessary—even to the point of "going back to the drawing board." It's all part of getting something that works just like you want it to.

In what other situations might you need to "go back to the drawing board?"

Appendix B

Blank Pinwheel Template



Angle of Attack

Have you ever flown a kite and felt it tug on your arms so hard your feet began to move and it felt like you were going to be lifted off the ground? You probably had a very large *"angle of attack."* Kite flying enthusiasts call this a "Puller." In this activity you will build and fly a Diamond kite and experiment with "Pullers" and "Floaters."

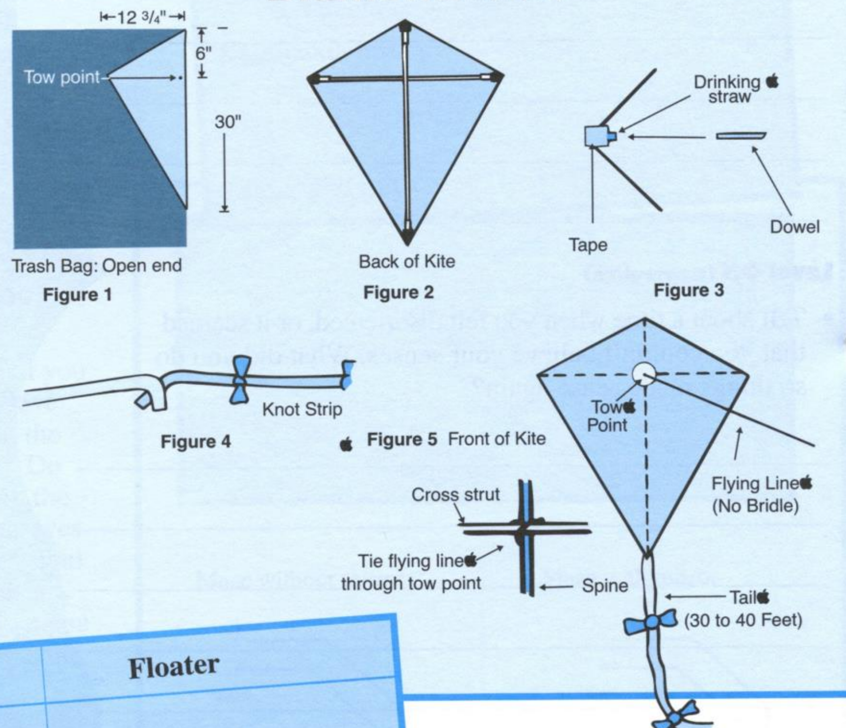
Aerospace Skills:	Understanding "angle of attack"
Science Skill:	Experimenting
What To Do:	Build and fly a Diamond kite

Materials Needed: 1 trash bag (sail), one $25\frac{1}{2}$" x $\frac{3}{16}$" dowel (cross strut), one 30" x $\frac{3}{16}$" dowel (spine), two $\frac{3}{4}$" pieces of drinking straw, strips of trash bag (tail), $\frac{3}{4}$" reinforced nylon packaging tape

Blast Off

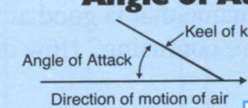
1. Follow the directions to build your own Diamond kite.
2. With a helper fly your kite with a small "angle of attack" and then with a large "angle of attack." Using the chart below record what you saw, felt and heard while flying your kite.
3. On a separate paper draw a picture of what your kite looked like when it flew the best.

Diamond Kite

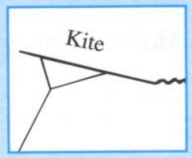


What I…	Puller	Floater
Saw		
Felt		
Heard		

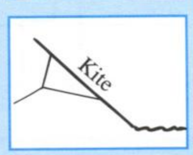
Angle of Attack



A floater kite
Small angle of attack.
Rides high in the sky.
Steep angle on the string.
Light pull on the string.



A puller kite
Large angle of attack.
Rides low in the sky.
Low angle on the string.
Strong pull on the string.)



Debriefing

Ground to Ground (Share)

Share with your helper what you felt, saw and heard while flying your kite as a "Puller" and a "Floater."

- What was the most fun part of this activity?
- Discuss with your helper what you discovered about "angle of attack" from your chart.

Climb Out (Process)

- What would kite flying be like if you couldn't feel the kite? See the kite? Hear the kite?
- How did the "angle of attack" affect how your kite flew? How did you change your "angle of attack"? Why did you change it?

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Level Off (Generalize)

- Describe a recent experiment you have done. How can experimenting help you discover new things?

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Cross Country (Apply)

- What are some ways you sharpen your senses? When might it be helpful to have sharper senses?

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Aerospace Facts

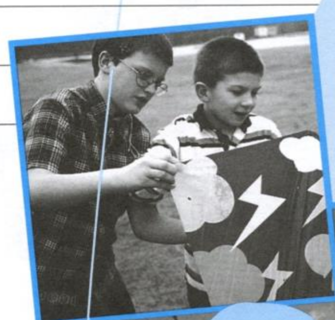
Angle of Attack

A kite must be flown with an "angle of attack" against the wind to overcome gravity and drag. As a kite rises in an arc, the "angle of attack" changes. The final flying angle will depend on the tow point and the efficiency of the kite's lifting surface. If the **tow point** is too high, the kite will not lift but just flutter. If the tow point is too low, the kite no longer provides lift and is said to be **stalled**.

Solo Flight

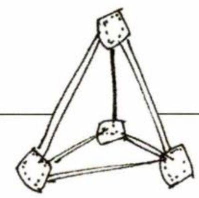
1. Add weight in the form of a tail (drag) to your kite, then fly your kite. Share with your helper how the extra weight affected the "angle of attack" and your kite's performance.

2. Team with a helper to fly an acrobatic kite.



Activity 4B

Flat or Round



Leader's Guide

What's the point?

Children make a connection between the shape and strength of a material. They also learn about repeating an activity several times to arrive at an average "result."

This activity uses the inherent shapes of structures to understand an important part of scientific research—repeated measurements. We use science to make predictions about things, but doing an experiment one time can't tell us that it will always turn out the same way. For example, if we wanted to know whether lima bean plants are taller than green bean plants, we wouldn't plant one of each kind because the single lima bean seed we planted might not be an "average" seed. So we would plant several of each kind and keep track of their height and then compare the averages of each of the groups of plants.

For additional information, read Science: Behind the Scenes (page 77).

What's the plan?

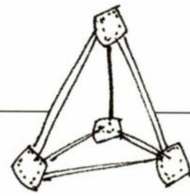
1. Read the activity (page 79).
2. Gather the supplies (page 78).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder…" statements the children make during the activity. (See "I wonder…" statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Activity 4B

Flat or Round



Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

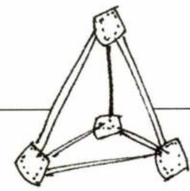
Human beings build structures. Since we moved out of caves, we've been building dwellings, bridges, and towers. How do we decide what materials to use? We try different materials that are available. So if we live in China we build with bamboo, and if we live in the far North we build with packed snow and bones from whales. But the impulse is the same—we select the best materials available to build the structures we need.

How do we select the best materials? Trial and error, experimentation, and research are all ways in which we decide how to build and what materials to use. Expense is often a consideration, as is the weight of the structure. Should we build it out of stone? Out of wood? Out of plastic? Or steel? It is often a complicated decision that has many considerations.

In this activity, the children look at the simple difference of shape to learn about strength. But materials are important as well. Sometimes we have to use materials because of strength, weight, cost, or other factors, but by considering shape as well as materials we can build better structures with the materials available.

Activity 4B

Flat or Round



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 1 piece of linguine and 1 piece of spaghetti for each child

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed

- ❑ 8 marshmallows[1]
- ❑ 18 pieces of raw spaghetti (circular in cross section)[2]
- ❑ 4 pieces of raw linguine (flattened in cross section). The spaghetti and linguine should be about the same size in diameter.
- ❑ paper clip
- ❑ envelope corner cut to make a hanging "basket"
- ❑ approximately 40 pennies
- ❑ white paper
- ❑ calculator

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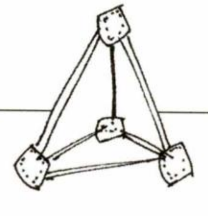
[1] Plan to have extra marshmallows on hand because children will invariably eat them.

[2] ***Make sure the children do not eat the raw pasta. Shards may cut their mouths.***

Activity 4B

Flat or Round



Focus

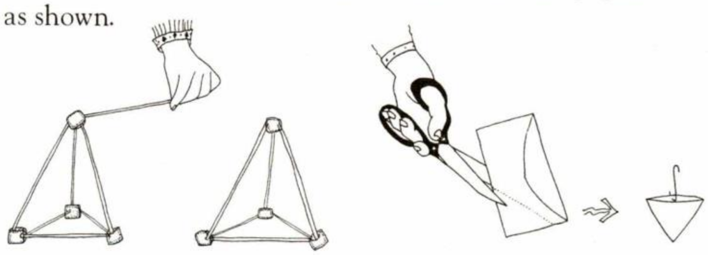
Give each child a piece of spaghetti and a piece of linguine. Have one child at a time slowly bend the two pieces of pasta. Which piece breaks first? Ask, "How are the two pieces different? Why do you think one kind of pasta seems to be the one to break first?"

Activity

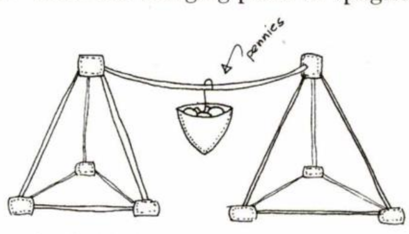
1. Give each child 8 marshmallows and the 18 pieces of spaghetti. Don't give the linguine to the children at this time because they may confuse the two shapes of pasta.

2. Have each child make two pyramids out of the spaghetti and marshmallows as shown in the diagram. Each structure should be solidly constructed. If a piece of spaghetti breaks during construction, replace it with a whole piece so that each structure is of the same size and shape.

3. Connect the two pyramids with a single piece of spaghetti as shown.



4. Using the paper clip as a hanger, hang the envelope "basket" from the bridging piece of spaghetti.



5. Have each child place pennies in the "basket." Make sure the children put the pennies in one at a time.

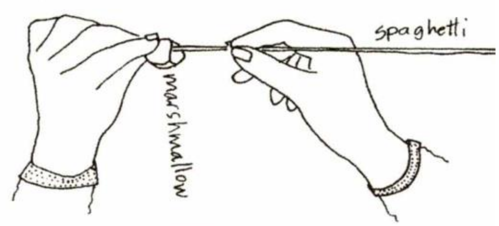
I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how bridges are built or how they are designed.

why each piece of spaghetti doesn't break at exactly the same time.

why it is important to know how strong a material is when I'm building something.



Conversation

Questions You Might Ask

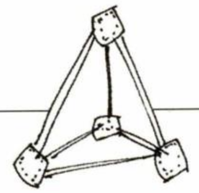
Can you think of times when it's better for a material to be more flexible?

When is it better for a material to be stiffer?

Why is it important to take repeated measurements?

Suppose you want to see how much the average ten-year-old child weighs. What will happen if you select just one child to weigh? What is a better way to do it? How many children do you think you should weigh?

Flat or Round



6. When the bridging piece of pasta breaks, write down the number of pennies that the spaghetti held up without breaking. Each number is an "observation."

7. Have one or two children write down all the numbers of pennies on a worksheet.

8. Have each child repeat the spaghetti experiment three times.

9. Calculate the average number of pennies that the bridging spaghetti can hold by adding all the children's numbers and dividing by the number of observations.

10. Collect any unused spaghetti and give each child four pieces of linguine. Repeat the experiment three times using linguine as the bridging pasta.

11. Again, have one or two children write down all the numbers of pennies on a worksheet and calculate the average number of pennies that the bridging linguine can hold by adding all the children's numbers and dividing by the number of observations.

12. Build any additional structures for fun and eat the leftover marshmallows.

Closure: Connecting Plants and Engineering

If you did only Activity 4B, review the "I wonder..." statements. If you did Activities 4A and 4B, talk with the children about how the two experiences helped them think about structure in both the natural environment and the manufactured environment. Review the "I wonder..." statements for both activities. Say, "Often when scientists do experiments, they come up with lots of new ideas or questions. Which one is the most interesting to you? How could you find out more about it?"

I wonder ...

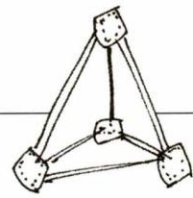
Keep listening for "I wonder..." statements after the activity. Children might wonder

how geodesic domes are built.

what practical things I can think of making where flexibility is really important.

Activity 4B

Flat or Round



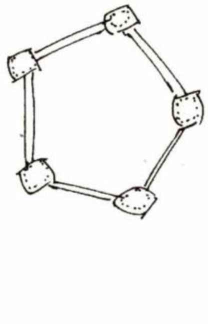
A Step Beyond

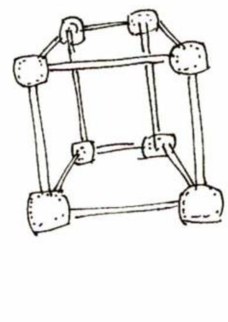
I wonder what shapes are strong and are used for building.

Children can do many other activities with shapes that involve comparing strength and flexibility. Talk about the pyramid that the children built. Why is it sturdy? What is special about a triangle? Try building other shapes using marshmallows and spaghetti. What happens if you build a cube? Is it as sturdy as the pyramid? Many enjoyable activities can be done with marshmallows and spaghetti. If you give them time, the children will enjoy building many complex shapes and constructions with pyramids, cubes, and other fanciful shapes.

If you want to do more experiments with repeated measurements, an enjoyable activity is to give each child a bag (or same-size scoopful) of M & M candies.[1] Have each child count how many of each color M & M they have and the total in their bag. Record each child's numbers and calculate the average number of each color and the average number of total candies. Is each bag the same? Why not?

[1] Remember that some children are allergic to chocolate. You can use a non-chocolate candy like Skittles as a replacement.





Activity M – Chopsticks

Performance Task For Youth

You will learn about joints and linkage by exploring with chopsticks. You will link (use) two chopsticks together to form a gripper and lift small objects.

Success Indicators

Youth will understand the concept of gripping an object using leverage and pressure.

List of Materials Needed

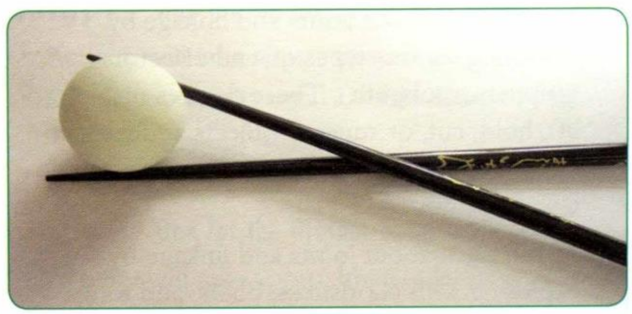
- Robotics Notebook
- Two straws for each participant
- Two chopsticks for each participant
- A selection of small items to pick up: marbles, balls, ping-pong balls, golf balls, plastic eggs, or wood blocks

Activity Timeline and Getting Ready

- Activity will take approximately 15 minutes.
- Divide youth into small groups of two or three.
- Set parts on the table.

Experiencing

1. Ask participants to use the chopsticks and straws to pick up various items such as marbles, plastic eggs, or pencil erasers.
2. Have participants record in their Robotics Notebook their experiences, what they discovered, and what they learned.



Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth use their Robotics Notebook to record ideas, comments, and notes on the activities they have been doing. You may choose one of the questions below as a prompt. If necessary, use more targeted questions as prompts to get to particular points.

- How did you hold the sticks? What was the fulcrum (pivot)?
- What leverage advantage did you get from the sticks? (More or less pressure?)
- What was difficult about holding onto the items you tried to pick up? What was easy?
- How did the straws work differently than the chopsticks?
- What would make it easier to grab an item?

Generalizing and Applying

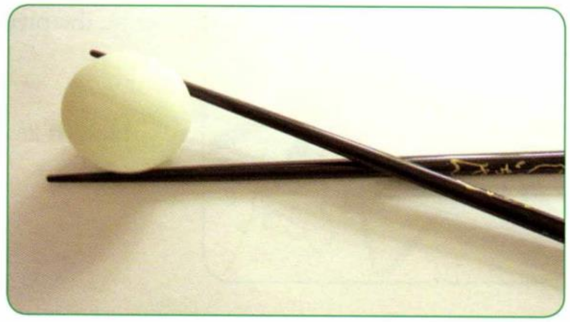
- Identify other items that could be used to lift objects.
- How would you modify chopsticks so that you could use them to eat soup? Other food?
- Youth also can apply what they have learned in Activity N.

Date ____________________

Signature ____________________

To Learn

Activity M – Chopsticks



Where is the pivot joint of your chopsticks?

How were your chopsticks effective?

What was difficult about holding onto the objects? What was easy?

Design a chart to list the items you tried to pick up and list if it was easy or hard to pick them up.

Activity N – Just a Pinch

Performance Task For Youth

You will learn about joints and linkage by exploring various types of end effectors (grippers, tools, etc.). These devices may lift, hold, cut, or squeeze objects. They vary in design depending on the type of object and task to be done.

Success Indicators

Youth will be able to determine and sort the type of grippers and tools based on design, construction, or use of the end effectors.

List of Materials Needed

- Robotics Notebook
- An assortment of pliers, tongs, scissors, and nutcrackers – one for each participant

Activity Timeline and Getting Ready

- Activity will take approximately 20 minutes.
- Arrange youth around a table or circle of chairs. If it is a large group, you may set up multiple tables or circles.
- Collect enough grippers (tongs, pliers, etc.) so that each individual will have one.

Safety Note

Some of the grippers can be sharp; others can pinch. Try to select grippers that will reduce the risk of youth hurting themselves or others. Caution the youth not to poke, pinch, or grab others with these grippers.

Experiencing

1. Place enough items, including a variety of tongs and pliers, in the middle of the group so that everyone will be able to select an item.
2. First, ask each participant to pick one item, examine it, and try to make the item work Have each participant share information about the item with the others, such as the type of lever, mechanical advantage, fixed or adjustable, function of item (to move, grasp, cut, or other use).
3. Have members select a different item. With the second item, have the participants share information about the type of fastener (pivot) used in the item. Is it removable? Is it the same type of material? Does it move?
4. Have members sort the items into groups and describe the groupings (materials from which the items are made, the item's use, the type of lever/fulcrum).
5. Have participants record in their Robotics Notebook their experiences, what they discovered, and what they learned.

Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth use their Robotics Notebook to record ideas, comments, and notes on the activities they have been doing. You may choose one of the questions below as a prompt. If necessary, use more targeted questions as prompts to get to particular points.

- How might a robot hand be like any of these items?
- How are these items different from a robot hand?
- Explain how you would re-sort the items. Why?

Generalizing and Applying

- What do you think a robot hand could look like?
- What types of grippers are used at home or school?
- What other simple machines — besides levers — can you find in the items? Screw? Wedge? Wheel/axle? Pulley? Inclined plane?
- Youth also can apply what they have learned in Activity O.

Date ____________

Signature ____________

To Learn

Activity N – Just a Pinch

Which item(s) did you pick up? Describe the pivot, lever, fulcrum, etc.

How might a robot hand need to be adapted for different items?

Describe several different types of grippers.

Activity O – Hold On

Performance Task For Youth

You will learn about joints and linkage by exploring with chopsticks, pliers, and tongs. You will select a gripper best suited to lift your object.

Success Indicators

Youth will be able to problem-solve and select the best gripper to lift their object.

List of Materials Needed

- Robotics Notebook
- An assortment of pliers, tongs, scissors, nutcrackers, etc. – one for each participant
- A selection of small items to pick up: marbles, balls, ping-pong balls, golf balls, plastic eggs, wood blocks; also, some items that cannot be picked up by the grippers that are available

Activity Timeline and Getting Ready

- Activity will take approximately 20 minutes.
- Divide youth into small groups of two or three.
- Be ready to distribute the items that will be picked up; one item for each group.
- Do not distribute the grippers for the first part of this activity; they are for display only. (During the second part of the activity, they will be selected.)

Experiencing

1. Give each group one item to be gripped and picked up.
2. First, ask each group to discuss the various tongs and pliers and determine which ones they think will work best in gripping and picking up their item without harming or breaking the item. Have them make a list of all the grippers they think would hold/pick up their item and indicate which one would work best. Have the groups share their predictions with the other groups.
3. Have the teams test all of the grippers on their list. Remind them to be careful so they don't harm their "pick up" item. Determine from the testing which grippers worked the best. Were these the same grippers they predicted would work well? Have them share their findings with the other groups.
4. Have participants record in their Robotics Notebook their experiences, what they discovered, and what they learned.

Safety Note

Some of the grippers can be sharp; others can pinch. Try to select grippers that will reduce the risk of youth hurting themselves or others. Caution the youth not to poke, pinch, or grab others with these grippers.

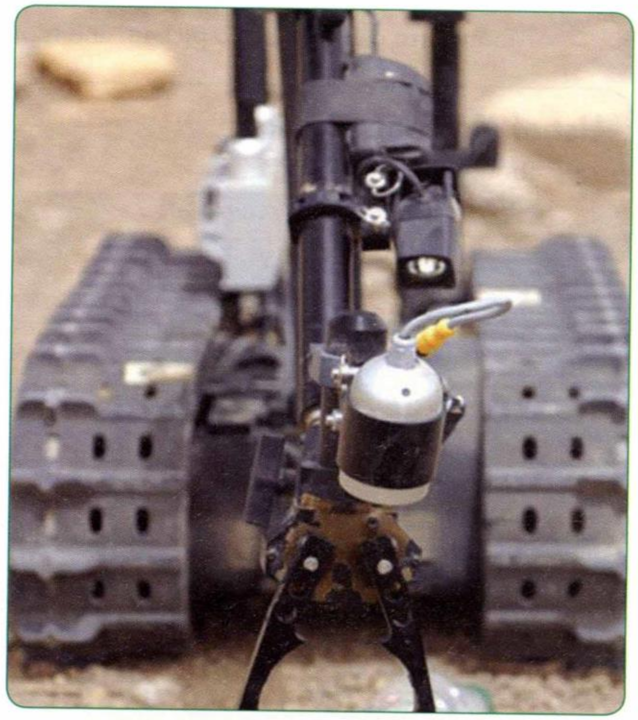
Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Before they share with the group, have youth use their Robotics Notebook to record ideas, comments, and notes on the activities they have been doing. You may choose one of the questions below as a prompt. If necessary, use more targeted questions as prompts to get to particular points.

- How is the structure of your hand related to its function?
- Why was the gripper you used made like it was? Was it designed for the function of the part or was it designed for the look and feel of the part?
- How did you predict which gripper would work for your item? What knowledge did you need?
- How did testing the grippers change your predictions?
- How important was it to know how to describe a certain function or movement?

Generalizing and Applying

- Would a gripper for one item be good for another item?
- If you want to pick up something fragile, such as an egg, how would you design the gripper?
- What types of parts would be useful in building a robot gripper?
- Youth can apply what they have learned in Activity P.



Date ____________________

Signature ____________________

To Learn

Activity 0 – Hold On

What item do you have?

Make a list of grippers that you think would work well to hold this item.

How did testing the grippers change your predictions?

How are the structures of grippers related to their functions?

Draw the gripper that best picked up your object:

4-H

Head, Heart, Hands, and Health

Making the Connection to Engineering

Complete the following activity – list one idea that relates the 4 "H's" to the STEM Engineering activities. For example, under HANDS you could decide that you want to use your engineering design skills to make a planter box for a senior assisted living center.

So now it is your time to think of one thing for each "H". You can do this by yourself, with your family, or with other 4-H Club members. Remember have fun there is no right or wrong answer.

Once this is completed, you can move on to the other sections of Exploring 4-H STEM

- **HEAD** stands for clearer thinking and decision-making. Knowledge that is useful throughout life.

- **HEART** stands for greater loyalty, strong personal values, positive self-concept, and concern for others.

- **HANDS** stand for larger service, workforce preparedness, useful skills, and science and technology literacy.

- **HEALTH** stands for better living, healthy lifestyles.

The 4-Hs' information can be found at- http://4h.uwex.edu/about/

M

Math

The definition of mathematics is

math·e·mat·ics

NOUN:
(used with a sing. verb)

> The study of the measurement, properties, and relationships of quantities and sets, using numbers and symbols.
> Definition provided by yahookids.com

Note, the word math is a shortened form of mathematics

So you're asking, what is **MATH**? Well... Here's our best definition. Mathematics is the study of quantity, structure, and change. Do you think that's a bit general? It was meant to be. Math is a part of everything in the universe.

You might be a farmer that needs to measure your land or count your crops. You might be a cook who needs to know how much food to buy. You might be a nuclear physicist that is studying the movements and activity of atoms. All of those jobs use math at one point or another. Math is just as important when you go to buy a burger, as it is to help plot the movement of planets.

Ideas and concepts in math are also universal because they are based in logic and deductive reasoning. Proofs, definitions, and theorems rule the actions of math whether you are from China, Great Britain, or another planet. The concept of "one" will always be "one" no matter what language you speak. Even computers speak math. They speak with a binary language (ones and zeroes). If this is all new to you, start with **numbers and counting**. You have to start somewhere. From: NUMBERNUT.COM.

In 4-H you will find math in projects from robotics to woodworking: The following activities take a hands on approach, so have fun, mathematics is one of those skills that will last you a lifetime.

Section Four (mathematics): Leaders please complete two lessons minimum from this section with the youth. The lessons vary in difficulty; please choose lessons that will challenge the youth and spark inquiry. Lessons can be adapted to be made more challenging.

2c. Juicy juice

Project skill:
Reading food labels

Life skill:
Making decisions

Supplies
- frozen orange juice concentrate
- orange soda
- orange box drink
- orange beverage crystals
- orange sports beverage
- pencil

Believe it or not, a fruit drink is not always a juice! No foolin'! If you're into reading labels, you know what's going on. The name of a food on the package label can tell you a lot about what's in it. Juices are no different! Check the fine print on a food package. Did you know:

- **Fruit juice** is 100% real juice.
- **Juice drink** is 30% or more real fruit juice.
- **Fruit-flavored drink** is 10% or less real fruit juice.
- **Imitation drink or ade** is 0% real fruit juice.
- **Artificially-flavored fruit soda** is 0% real fruit juice.

Beside what's in a food, labels also tell you:

- What nutrition is in the food.
- The serving size.
- How much is in the package.
- An address where you can send questions about the food.

So let's use what you know about labels to check out some fruit drinks.

1. Check out the labels on the juices. Compare the labels closely. What's different? What's the same? Remember, the ingredient listed first makes up most of the food.

2. Taste the juices, too. Be sure to add water to the frozen orange juice concentrate!

Name of juice	% of fruit juice	Sugar

Extra bite

Make your own fruit drink by mixing together different kinds of real fruit juices. Start out with a big glass and add $1/3$ ice, $1/3$ soda water, and $1/3$ orange, apple, grape, or cranberry juice. If you could sell this juice, how would you write the ingredient label?

Labels

Labels on food products are the best information you have to tell you about the food. The name itself tells you a lot about what is in the package. If you look closely, you'll notice that chicken noodle soup is different from chicken noodle soup with white meat. One soup has meat pieces, the other does not.

The ingredient list can give you this information, too. The main ingredient is always listed first. Next is the ingredient that makes up the second-biggest part of the food, and so on.

By knowing how to read a label, you can:

- Tell what you are actually buying.
- Compare similar products to see which one you really want.

Kitchen Talk

1. Which drink has sugar as the main ingredient?

   ____

2. Which drink has the most real fruit juice in it?

   ____

3. Based on your comparison, which drink do you think would be the healthiest?

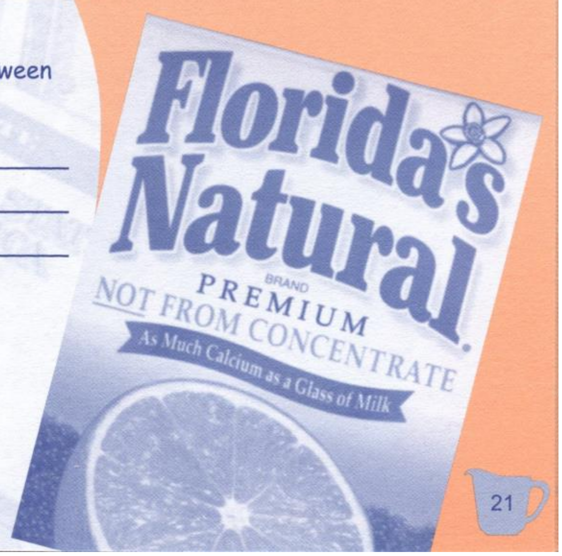
   ____

4. Describe the things you will consider when deciding between two food products.

   ____

   ____

   ____



2a. How much is it?

Project skill:
Determining if quantity purchasing is a better deal

Life skill:
Managing resources

Supplies
- pencil

Many grocery stores display the price of a food right on the shelf. Sometimes, stores list the "unit price" next to the product price. The unit price is how much the food costs per unit of measure, such as ounces, pounds, quarts, or liters.

If the store doesn't list the unit price, you can figure it easily. Just divide the product's price by its unit of measure. For example, if a box of cereal costs $3.25 and there are 25 ounces in the box, then the unit price is $3.25 ÷ 25 = 13¢ per ounce of cereal.

Every family has a budget to work with. Maybe you have to manage allowance money. Sometimes you probably wonder where your money has gone, because you don't realize how much you're spending on stuff!

Take a look at how you buy cola beverages.

If you buy one cola every day from a vending machine, do you know how much you spend in a month? How does $18 sound? And that's if you buy just one a day for 60 cents per can!

How many do you really buy every day? ________
How much is that a month? ________
Multiply that by 12 for how much you spent in a year. ________

Now, just think for a minute about what would happen if you bought a case of 24 cans of cola for $4.99 at the store. How much money would you save each day instead of buying cans in the vending machine? ________ Multiply that by 365 to see how much you'd save in a year. Now let's look at a lot of different ways to buy cola.

Food Fact
The unit price is how much the food costs per unit of measure, such as ounces, pounds, quarts, or liters.

Extra bite

It's not always true that the largest package of a food item costs less (on a unit price basis) than a smaller package. Find an item at the grocery store that costs less per unit in small packages! And remember, if you can't use all the food in a larger package, it may not be a bargain.

1. Go to the grocery store to check out the prices of various sizes of a cola beverage you like to drink. Find as many different sizes as you can.

2. Fill in the chart with the prices you found, then figure the price per ounce.

Size	Price	Number of Fluid Ounces	Unit Price (price / ounces)
2 liter size			
6-pack			
12-pack			
24-pack (case)			
Vending machine			
8-bottle container			

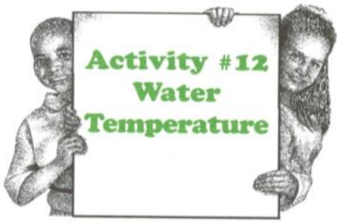
Kitchen Talk

1. Which size is the cheapest according to unit price (price/ounces)?
____

2. Which size is the best buy for you and your family?
____

3. What other foods could you purchase according to their unit prices to save money? ______________________________
____

4. How can you and your family use unit prices to better manage your resources? ______________________________
____



Objective

Youth will learn about differences in air and water temperature and how equilibrium is achieved.

Audience

Introductory/Intermediate experience level

Time needed

About 60 minutes of elapsed time but, once activity is set up, youth only need to be actively involved in recording observations every 10 minutes of that hour. Other activities can be done during the "waiting" time in between.

Materials needed

- ❒ Two pairs of equal-sized containers. (For instance, two one-gallon buckets and two one-pint cans.) Ideally, all containers should be made of similar materials (such as plastic, metal, or glass.)
- ❒ Ice water, warm water
- ❒ Thermometer

What to do

This is best done in a closed environment (indoors) to prevent interference from changing weather outside (hot sun, etc.). Fill one of the small containers and one of the large containers with cold water. Fill the other two containers, one large and one small, with hot water. Ask youth to measure the temperature of each container and the surrounding air every 10 minutes and record them on a chart.

Temperature at each time	Large container with hot water	Small container with hot water	Large container with cold water	Large container with cold water	Surrounding Air
Start					
10 min.					
20 min.					
30 min.					
40 min.					
50 min.					
60 min.					

Discuss

What do you notice? Does the temperature change? Which changes the most?

What to look for

As time passes, both containers with cold water will get warmer and both containers with hot water will get cooler. This is because air molecules seek equilibrium and so temperature is evened out. If it is a "closed" environment (indoors), the temperature of the surrounding air during this experiment should not change because other factors affecting air temperature should be eliminated. The temperature of the larger containers of water are likely to change more slowly than the smaller containers of water. That is because the larger containers have more water molecules and take longer to dissipate heat into the air.

2009 National Science Experiment

BIOFUEL BLAST

4-H NATIONAL YOUTH SCIENCE DAY™

YOUTH WORKSHEETS

OCTOBER 7, 2009

As our nation grapples with important environmental issues such as global warming, sustainability and energy independence, "biofuels" are at the forefront of the discussion of alternative energy sources. For the second annual 4-H National Youth Science Day™, ***"Biofuel Blast"*** will help youth understand and engage in the important environmental issues our global community faces together, and the opportunities available for a greener tomorrow.

introduction

4-H is proud to introduce "Biofuel Blast," the National Science Experiment which will introduce youth all around the nation to biofuels. Millions of young people will actively participate in a live demonstration of how organic materials can be converted to fuel to supply energy. The experiment, designed in conjunction with The University of Wisconsin-Madison Extension and Wisconsin 4-H, offers several activities to showcase how cellulose and sugars in plants can be used to create ethanol.

In addition to testing corn syrup, youth will test and discuss other alternative fuel options, including switchgrass, sawdust, sorghum and even algae. These fuel alternatives – researched by the 106 Land-Grant Universities and Colleges across the nation that oversee 4-H youth development programs in every state – differ by region throughout the U.S., providing an opportunity for youth to learn about their home region as well as others. Along the way, youth can join a national debate through www.4-H.org to discuss the "best" biofuel based on experiment outcomes. Young people will be able to see how their small creations are part of a major current nationwide discussion.

OBJECTIVES AND OUTCOMES:

- Youth across the nation will engage in an experiment that is simple enough for even the youngest to be successful, eye-catching enough to increase interest in science, and deep enough to allow for continued exploration by older participants.
- Participants will understand that yeast can break down sugars through a process called fermentation, releasing carbon dioxide gas and ethanol (which can be used as a "biofuel").
- Participants will learn hands-on that the sugar in corn and other cellulose plants from fields across the nation can be converted into biofuels by yeast.

- Participants will engage in discussion about alternative energies and the need to develop new technologies that decrease our dependence on fossil fuels.
- Participants of all ages will get the chance to build their experimental design skills and understand how scientists test and compare.
- Older participants will get the chance to independently learn more about alternative energies and global climate change —important areas of knowledge for future generations.

getting started

[Youth Worksheet]

Have you ever added yeast to bake bread? Yeast is actually a tiny organism—a fungus. Each individual yeast is a single cell, too small to see with the unaided eye. You can buy yeast packets at the grocery store, which have billions of dried-out, tiny yeast inside. Learn here what happens when yeast break down sugars!

MATERIALS:

- An empty and rinsed out 20 oz. plastic water or soft drink bottle with its cap (you can bring in one from your recycling bin)
- 8 packets or 3 tablespoons of white granulated sugar
- Warm tap water
- A packet of either active dry yeast or dry quick rise yeast (equal to 1 tablespoon if using a jar or bulk package)
- One 9″ latex balloon (the typical party latex variety; if you are allergic to latex—use a substitute)
- Scissors
- String or construction paper (for bottle measurement)
- Small plastic funnel (you may also tape together a paper funnel)

TIME REQUIREMENT:

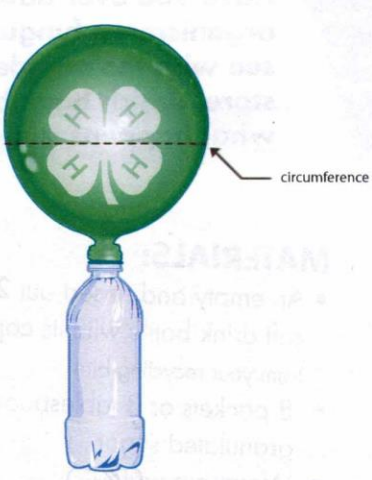
- 10 minutes for preparation
- 10 minutes (or longer if desired) to observe your bottle

PROCEDURE:

1. Add yeast and sugar to your bottle using a paper or plastic funnel, or a paper cup.
2. Fill your bottle half-full with warm tap water that is very warm to the touch, but not so hot that it is painful or scalding. Replace the cap and shake the bottle to mix in the yeast and sugar at the bottom of the bottle.
3. Place a balloon over the open top of the bottle and observe what happens. It will take a few minutes for the yeast to start eating the sugar.
4. Soon you will see the balloon is starting to inflate! Inside the balloon is a gas called carbon dioxide. It is the same gas that you exhale when breathing. As the yeast eat the sugar, they release waste products, one of which is carbon dioxide.

If you are using a plastic baggie instead of a bottle and balloon, add the yeast, sugar, and warm water (as described above) to the sandwich bag. Close the bag tightly, letting out as much air as possible, and mush/mix them together. See what happens to your bag over time! You might want to place the bag on its side and place paper or even a book on it. How high will the object rise? Try measuring how many inches the bag expanded and enter your data on www.4-H.org. Share with us any other variations of the experiment you have tried!

5. You can measure the size of your balloon to compare which balloons have the most carbon dioxide in them. To do this, cut a long piece of string or a strip of construction paper. Wrap it around the largest part of the balloon and mark where the string begins and ends while wrapped around the balloon. This is called measuring the circumference. Compare the size of your balloon with those of others by placing all of the measurements side-by-side or hanging them on the wall!



6. Write down your results below and then go to www.4-H.org/NYSD to share them with other kids in states across the country!

- How large is the circumference of your balloon after 10 minutes (in inches)?

- How large is it after one hour?

- Can you convert that size between inches and centimeters?

- For older students—can you calculate the approximate volume of the carbon dioxide inside the balloon and share it with everyone? [Hint: what is the volume of a sphere?]

THINGS TO THINK ABOUT:

Below are some questions to think about. Try to answer them and keep notes about your own questions that come to mind, then login to www.4-H.org/NYSD to join the discussion.

- Were there any differences in the size of your balloon compared to others? Why do you think this might be?

- Do you think that the yeast would eat other types of foods to make carbon dioxide?

- When you bake bread, you add yeast to make the bread rise. Now that you have seen what happens when yeast eats sugar, how do you think the yeast makes the bread rise?

- What do you think would happen if you added very hot water to the yeast? [Note: Do not attempt this without adult supervision. Hot water may cause injury]

In the **"Getting Started"** activity, you observed the process of *fermentation*. In this process, yeast breaks down sugars to get energy, just like when you eat sugars to give your body energy. In the process, the yeast releases two waste products: carbon dioxide (the same gas that you exhale) and ethanol (a liquid that can be used as a biofuel). Because the ethanol is mixed with water in the experiment, you can not see it directly.

Ethanol is a type of *biofuel*—a source of energy obtained from recently harvested plant materials. On the other hand, fossil fuels like coal or oil are sources of energy from plants and animals that died a very long time ago. The sugars inside of corn kernels can be broken down by yeast to make carbon dioxide and ethanol in the same process. In a chemical plant, the ethanol is removed from the mixture to make a fuel that is mixed with gasoline and sold at some gas stations. You may have noticed this at the gas pump, where the signs may say "E10", which means 10% ethanol, 90% gasoline.

In the United States, most ethanol is made from corn. In this experiment, we are going to observe how yeast can break down processed corn sugars—like those found in corn syrup—through fermentation. We'll also see if other plant products can be used by the yeast to make biofuels!

MATERIALS PER GROUP:

- THREE empty and rinsed out 20 oz. plastic water or soft drink bottles with their caps (you can bring these in from your recycling bin)
- Warm tap water
- THREE packets of either active dry yeast or dry quick rise yeast (equal to 3 tablespoons if measuring from bulk)
- THREE 9" latex balloons (the typical party latex variety; if you are allergic to latex—use a substitute)
- Light-colored Corn Syrup
- Dried, ground-up leaves or wheat bran from the bulk foods section of your grocery store (see details in experiment instructions)
- Scissors
- String or construction paper (for balloon measurement)
- Small plastic funnel or paper cup for pouring
- Masking tape and markers (to label your bottles)

TIME REQUIREMENT:

- 20 minutes for preparation
- 10 minutes (or longer if desired) to observe your bottles

PROCEDURE:

1. Gather the three 20 oz. bottles and add one packet or one tablespoon of yeast to each bottle.

2. In the first bottle, you will not add any carbon source. In science, this is called the negative control—you will use it as a reference to see what happens when no food is added to the bottle.

3. In the second bottle, you will add 3-4 tablespoons of corn syrup—the sugars which are inside of corn. In the factory, the starches inside corn kernels are broken down into sugars to make corn syrup.

4. In the third bottle, you will add dried leaves. Dried leaves are made of cellulose, a material which a lot of sugars connected together. It is also an example of a polymer, which we learned about in last year's National Science Experiment.

   Grind approximately 4 tablespoons of dried leaves and add them to the third bottle. [Note: do not use fresh leaves—only use brown ones. If you don't have a readily available source of dry leaves, a supermarket alternative is purchasing wheat bran from the bulk food bins. Bran is the outer layer of the wheat seed and contains a lot of cellulose.]

5. Scientists across the nation are studying how other parts of plants (and not just the corn syrup from corn kernels) might be used as sources of biofuels. If you would like, for the third bottle, you can use a source of dried plant material that is specific for your state.

   Check out the map of the United States on the next page to see what crop material you might want to use. This map lists the types of crops that farmers could grow in different parts of the country for use in biofuel production.

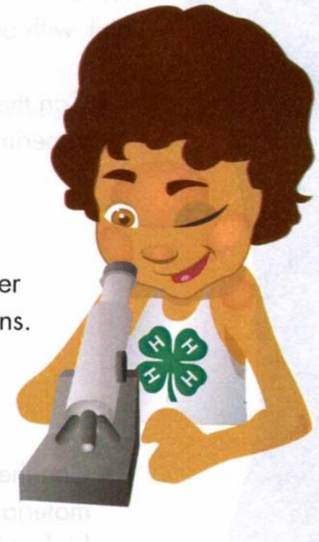
   Here are some suggestions:
   - The West— Wood chips or sawdust, including poplar or eucalyptus
   - The Southwest—Dried corn husks
   - The Great Plains—Dried grasses, like switchgrass
   - The Midwest, Northeast and Southeast— Dried grasses like switchgrass, wood chips or sawdust from trees like hybrid poplar or silver maple.

6. Add the same amount of very warm water to each bottle as you did before, so that each bottle is about half full of water. Replace the cap and shake to mix contents.

Image concept provided by the U.S. Department of Energy Genome Programs: http://genomics.energy.gov

7. Remove the cap and place a balloon over the mouth of each bottle and see what happens! Measure the size of each balloon with string or paper as you did in the first activity.

8. Write down your results below and then go to www.4-H.org/NYSD to share these results with other kids in states across the country!



- What kind of dried plant material did you use in the third bottle?

- Record the size (circumference) of each of your balloons on the 4-H site after 10 minutes and after 60 minutes, if possible. For older students, try to calculate the volume of air that is inside your balloons.

- Do you see any evidence of carbon dioxide inside the bottles (in addition to the fact that the balloons get inflated)?

- What do you think could have caused some of variation in results between different groups?

9. Let the experiment sit overnight, if possible. The next day, note changes in the size of the balloon, if any at all. Remove your balloons from the top of each bottle and compare the smell from each bottle. You might be able to smell a difference between the negative control (bottle #1) and the corn syrup bottle (bottle #2). In the corn syrup bottle, the yeast is breaking down sugars to make ethanol, which has an odor.

10. When you have completed your experiment, empty the contents of your bottles and rinse for your next experiment or place them in your recycling bin!

join the discussion

[Youth Worksheet]

Write down some of your notes or go right to 4-H.org/NYSD to discuss what you think with others:

- Can the yeast use the sugars inside corn syrup as food? How can you tell from your experiment? Do you think you made biofuel from the corn syrup?

- Can the yeast use the sugars inside the cellulose in the dried leaves (or other plant material) for food? How can you tell from your experiment? Do you think you made biofuel from this plant material?

- Although there are a lot of sugars inside of the dried leaves and wood chips, the yeast cannot digest the leaves and wood directly to get energy and release carbon dioxide and biofuels. The cellulose first needs to be broken down into tinier parts before the yeast is able to eat it. However, unlike the process in which the starches inside of corn kernels are made into corn syrup, it is currently much harder and more expensive to break up the cellulose in crops like wood chips or dried grass. Scientists are working on ways to make it easier to break up the cellulose so that all the other crops you saw on the U.S. map can be used to make biofuels for our cars.

CHAPTER 3 Making a Mark

Problem Solving

How are your marking, measuring, cutting and drilling skills? You use many of these skills when you do the woodworking projects in this guide. Not only will you be practicing the skills listed but you will also be practicing your problem solving skills. By identifying problems, gathering information, choosing among alternatives and outlining plans of action, you will become a better problem solver. Answer and discuss with your helper the questions in the Talk It Over section at the end of this chapter as you complete the activities.

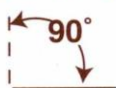
Getting an Angle on Things

Woodworking Skill: Using a T-bevel
Life Skill: Gathering information
Success Indicator: Draws angles using a T-bevel
Supplies Needed: Pencil, protractor, T-bevel, practice piece of lumber

There are many ways to measure wood. You've already learned several different methods of measurement. In this activity you will practice measuring angles.

For Practice

Use the protractor and T-bevel to draw 45, 70 and 15 degree angles on your practice piece of lumber. Show these angles on the diagram and explain to your parent or helper why they are correct. Label your angle like this:



Draw these angles on the lines:

1. 45 degrees ____________

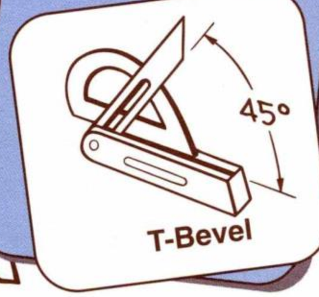
2. 70 degrees ____________

3. 15 degrees ____________

Facts

The T-bevel

The T-bevel is a device with a sharp, sloping edge used to lay out angles. It is most commonly used for transferring (copying) an angle from one board to another. All screws need to be adjusted and tightened before drawing with the T-bevel. Failure to tighten the screws may result in the T-bevel slipping.



T-Bevel

For Fun

Look for things around your house that have angles that are different than 90° and 45°. Use a protractor and T-bevel to measure the angle of three of these items around your home.

Item	Angle

More Challenges

1. Visit your local hardware store to see what other type of tools are available to measure angles. You might even purchase one and try it out.

Plan Magic

Most plans and drawings are scaled down *(reduced)* so that they can be put on paper. When you have a scaled down *(scale drawn)* plan, all the dimensions and measurements are proportional to the finished product. The way to figure out the actual size is to use a scale to enlarge it. For example if the scale on a plan was 1" = 1', 1 inch on the drawing would equal 1 foot of actual size.

Woodworking Skill: Enlarging scale drawn plans

Life Skill: Solving problems

Success Indicator: Transfers patterns to a large grid

Supplies Needed: A pattern (use a copy), paper or graph paper to make a grid, pencil, ruler

Facts

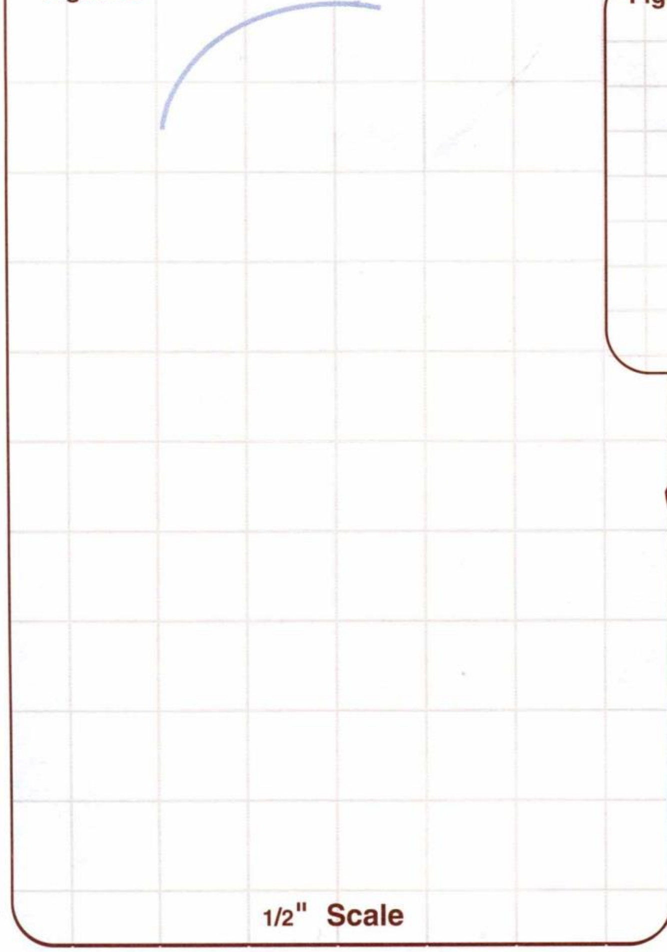
Enlarging a Pattern

A small plan can be enlarged using the grid method. A grid of horizontal and vertical lines is drawn over the original pattern or copy. The lines must all be spaced the same distance apart. Most plans are drawn to scale, meaning that for example 1" on the plan may equal 1' on the actual project. One quarter inch spacing works well for objects that are smaller than a regular piece of paper. A similar grid is then drawn on a heavier and larger piece of paper and the space between the lines is increased. The increase should be in proportion to the desired increase of the size of the pattern. For example, if you wanted to double the size of the original, you would increase the line spacing from 1/4 inch to 1/2 inch. Then draw an outline of the pattern on the new grid using the corresponding lines and squares of the original to guide you.

For Practice

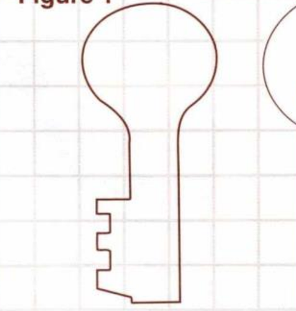
Enlarge a small plan by using the grid method. Use the copy of the pattern and draw a grid over the top (Figure 1). Construct a larger grid (Figure 2). Then transfer the pattern to the larger grid. The pattern for the key (Figure 1) has been started for you in Figure 2. Complete it. Pay close attention to detail. Share with your helper how this procedure helps you solve the problem of a scaled down pattern.

Figure 2

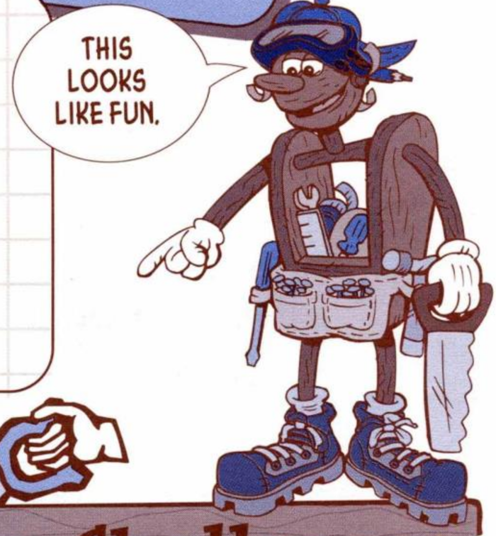


1/2" Scale

Figure 1



1/4" Scale



More Challenges

1. Ever see an item that you would like to make but can't find a set of plans for it? If a pattern is not available, you can simply make one by tracing. You make a tracing by laying a thin piece of tracing paper over a picture and drawing the outline of the object. Then, place the tracing paper over a heavy piece of paper, like tagboard, and cut out the new pattern. Make a plan for an item you want to make in the future.

PROJECT 6

Knowing All the Angles

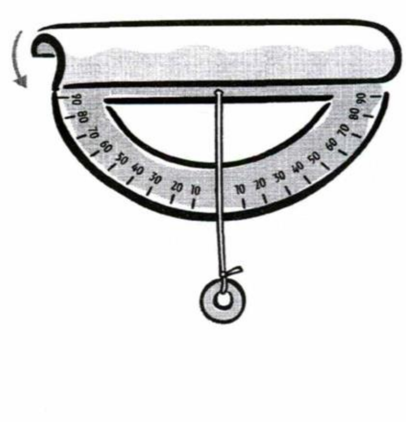
The astrolabe was a very sophisticated tool invented by the Greeks that had many uses, including telling time, calculating the positions of celestial objects, and determining latitude. Probably invented around 150 B.C.E., the astrolabe was used for years by many cultures for astronomy and navigation. To learn more about one way to use an astrolabe, try this activity.

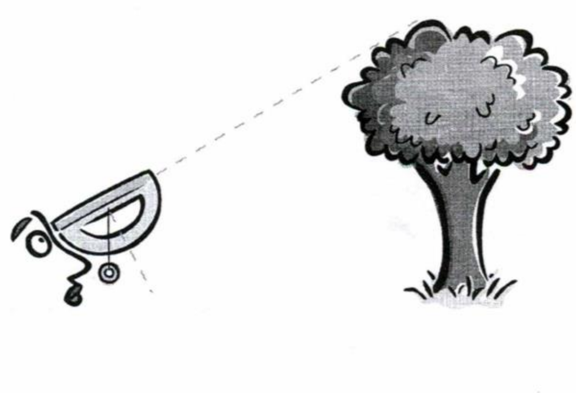
Materials

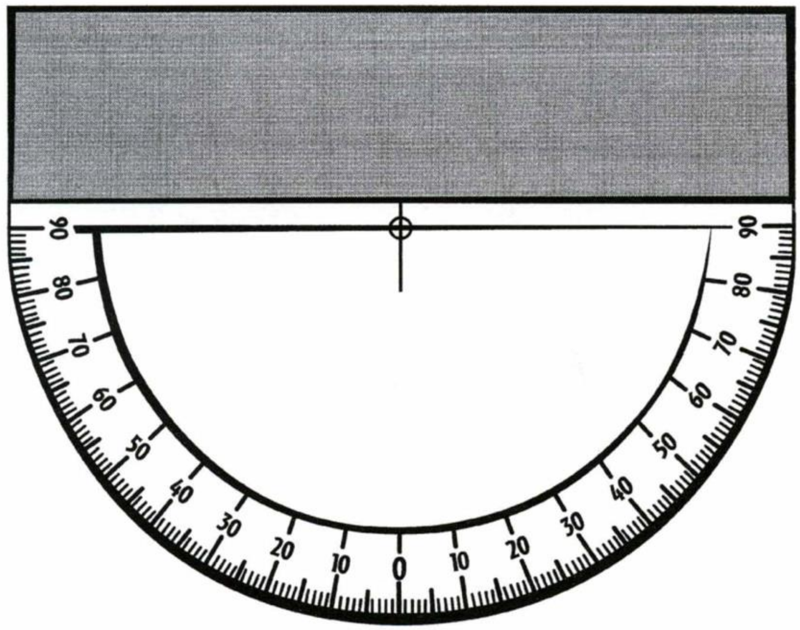
- photocopy of the astrolabe drawing in this book
- scissors
- pencil
- tape
- glue
- string
- metal washer

Procedure

1. Cut out the copy of the astrolabe drawing from the next page. The drawing can be enlarged if necessary.
2. Fold the top section of the drawing over a pencil and roll it down to the heavy double line to make a tube.
3. Tape the rolled paper tube in place and let the pencil slide out. This is your sighting tube.
4. Glue the bottom section of the astrolabe to a 5-by-8 inch (12.5-by-20 cm) card. Trim the excess card from around the astrolabe.
5. Take an 8-inch (20-cm) piece of string and tie one end to the metal washer.
6. Use the scissors to make a small hole in the middle of the top of the astrolabe below the sighting tube.
7. Thread the free end of the string through the hole and tape it in place.
8. With the string hanging free, sight the top of a tree through the sighting tube.
9. Read the number of degrees by looking where the string touches the astrolabe. What does it read?
10. Try moving farther away from the tree and sighting the top of the tree. What happens to the angle you read on the astrolabe compared to when you were closer?







More Fun Stuff to Do

1. Measure 100 feet (31 m) from the base of a tree or other tall object.
2. Face the tree, then look at the top of the tree through the sighting tube of the astrolabe.
3. Without moving the position of the astrolabe, read the degrees where the string touches the astrolabe.
4. Use the chart below to approximate the height of the tree.

Angle (in degrees)	Height of Tree (in ft)	Height of Tree (in meters)	Angle (in degrees)	Height of Tree (in ft)	Height of Tree (in meters)
5	9	2.7	45	102	31.0
10	18	5.4	50	121	36.7
15	27	8.2	55	145	43.9
20	37	11.2	60	176	53.3
25	47	14.4	65	217	65.9
30	59	17.8	70	279	84.5
35	71	21.5	75	379	114.8
40	85	25.8			

Explanation

You used your astrolabe to measure the angle between the tree at eye level and the top of the tree. This angle is measured in degrees. When you move farther away from the tree, as in More Fun Stuff to Do, the angle becomes smaller, so the number of degrees on the astrolabe will become less.

The chart in More Fun Stuff to Do is based on a mathematical principle that the Greeks first noticed called trigonometry. **Trigonometry** is the study of the relationship between the sides and angles of triangles. These relationships are called trigonometric ratios. The ratio you used to find the height of the tree is called the tangent ratio. Trigonometric ratios can find the height of a mountain, the width of a river, or the length of a train without directly measuring them.

The astrolabe made the great Age of Exploration (about 1450–1650) possible by allowing navigators to calculate how far north or south of the equator a ship was.

Ancient Science in Action

One of the earliest astrolabes was designed by a woman, Hypatia of Alexandria, in the 4th century. Astrolabes were borrowed from the Greeks by the Arabs, who improved on their design.

Counting Shapes Among the Splatter

Grade Level
3-4

Classroom Time
Two or three 40-min. periods

Materials/Tools
for 24-30 students

- 24 sheets 9" x 12" 80 lb. or heavier weight paper
- Regular paper towels
- Crayola® Glitter Glue
- Crayola Scissors
- Crayola Watercolor Colored Pencils (12 packages)
- Crayola Watercolor Brushes
- Rulers
- Sandpaper
- Spray bottles
- Water containers

Tips

- Use 80-lb. white drawing paper or an inexpensive watercolor paper of a similar or greater weight for best results.
- Use a clean spray bottle with clear water. For example, empty contents of window cleaner pump sprayer and wash thoroughly. Adjust spray nozzle for finest mist, then hold nozzle 2 to 3 feet away from paper towel surface while spraying for best results.
- Consider sharpening both ends of watercolor pencils and have extra hand-held sharpeners handy for immediate use.
- Use limited palette of pencil color to achieve non-muddy color results.

Resources

Websites with images of Paul Klee's work: *www.nga.gov, www.philamuseum.org* (search "Klee")

Klee by Norbert Lynton

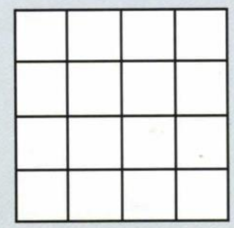
Rocket Minds™: Think-ama-Jink Checkers (age 6+)

Visual Arts Standard 1
Mathematics Standards
Algebra
Reasoning and Proof

Objective

Students analyze shapes and patterns in compositions as they create Paul Klee-like images.

Teacher Preparation



Classroom Teacher: Create a wall poster that depicts 16 squares in 4 columns and 4 rows.

Art Teacher: Create a design that illustrates 16 splattered squares where some of the squares overlap. Find examples of art by Paul Klee to display.

Discussion Starters

Classroom Teacher: Look at the wall poster with squares. How many squares do you see in the poster? Some of you may see 16 squares. Can anyone see more than 16? (Ask students to explain why they do or do not see more than 16 squares.) What is the biggest square you can find? How many squares can you find now? Why do you think most people would only count 16 squares?

Art Teacher: In class you found that if you looked at squares from a different perspective you could change the way you think and reason. If you look at a figure carefully, sometimes you can find geometric shapes and patterns that others may not see. Let's look at some art by Paul Klee and observe the shapes and patterns. Looking carefully often sharpens your thinking and may assist you in solving simple problems.

Process

1. Measure and cut several geometric shapes from paper towels.
2. Brush an even coat of water on heavy weight paper. Place paper towel shapes on wet paper so shapes lay flat.
3. Sand watercolor pencil color over the towel atop wet surface. Sand several colors. Do not remove shapes. Air-dry flat.
4. Reposition dried paper shape over art. Spray a very fine mist of water over the design.
5. Sand a second layer of watercolor pencil over the wet surface. Air-dry again. Display completed art.
6. Consider outlining several shapes with glitter glue to enrich surface design. Air-dry the glue.
7. Count and chart the number of shapes observed.

Assessment

Summarize findings, and have children discuss what they learned. Exchange finished designs with a partner. Partners add up the total number of shapes they see in the finished art. Check to see if their counts match.

Artwork by students from Curlew Creek Elementary School, Palm Harbor, FL.
***Teacher:* Nancy Rhoads**

Quote

Discovering together, what could be more fun? My students learned art and math concepts. I learned how much they already knew as we chatted together about our experience with this lesson. Classroom teachers were amazed to learn that art teachers were not just making pretty stuff. We can be consumers of the Arts in many walks of life. —*Nancy Rhoads, Curlew Creek Elementary School, Palm Harbor, FL*

Background Information

During the 1920's, Swiss artist Paul Klee often spattered watercolor over stencils and netting. The effect of this technique is shown in *Glance of a Landscape.* When Klee taught at the Bauhaus (a famous German art school), he experimented with this technique.

In *Glance of a Landscape*, Klee applied brushstrokes of pale gray opaque watercolor on top of transparent watercolor that was spattered broadly to create trees. Klee usually mounted his drawings on cardboard, which was where he wrote the title and date for this composition.

4-H

Head, Heart, Hands, and Health

Making the Connection to Mathematics

Complete the following activity – list one idea that relates the 4 "H's" to the STEM Math activities. For example, under HANDS you could decide that you want to use your measuring skills to make a planter box for a senior assisted living center.

So now it is your time to think of one thing for each "H". You can do this by yourself, with your family, or with other 4-H Club members. Remember, have fun there is no right or wrong answer.

Once this is completed, you can move on to the other sections of Exploring 4-H STEM

- **HEAD** stands for clearer thinking and decision-making. Knowledge that is useful throughout life.

- **HEART** stands for greater loyalty, strong personal values, positive self-concept, and concern for others.

- **HANDS** stand for larger service, workforce preparedness, useful skills, and science and technology literacy.

- **HEALTH** stands for better living, healthy lifestyles.

The 4-Hs' information can be found at- http://4h.uwex.edu/about/

Pre-College Activities

Pre-College

Color Your Personality

Project Skills:
-Youth will learn how they can use their personality traits to think about a future career.

Life Skills:
-Marketable Skills
-Teamwork

Academic Standards:
-Career Development: **K-8.1** Identify own talents and interests, **K-8.2** Identify own strengths and weaknesses with examples, **K-8.3** Assess how one's strengths and weaknesses relate to a variety of career options.

Grade Levels: 6-8

Time: 50 minutes

BACKGROUND

-Everyone has strengths and weaknesses, likes and dislikes, and positives and negatives. Many people do not stop and think about these relative to themselves and choose careers that do not fit their personalities, and end up resenting their jobs. Youth will learn their personality traits and be exposed to careers that may fit them best.

WHAT TO DO

Lesson: **Color Your Personality**
-Have the students take the Color Questionnaire and when they finish, give them a book mark that matches their personality color. Ask the students to write down what they want to be on the bookmark. Hand out the list of jobs that fit each color and ask if any of the careers they want are under their color. Then, hand out the description of characteristics for each color and have them write down three on their bookmark that fits them. OPTIONAL: have youth complete the activity.

Activity: Hands Off! (OPTIONAL)
- Have the four groups of youth try and get an object across the room without using their hands (ex. feather, cube, paper). Each member of the color group needs to touch the item. Afterwards, have the groups discuss their tactic of getting it across the room and see if it differed per color.

TALK IT OVER

Reflect
-Why do you think knowing your personality traits can help you in school and to find a job?
-How do you think your individual personality traits will help with the career you want?

HELPFUL HINTS
-Ask the students to share their answers throughout the lesson plan.
-Have all the papers separated before the lesson, to save time.

Color Your Personality~Pre-College Lesson

Pre-Plan:

- Print off the lessons to hand out to the students.
- Cut color (blue, green, orange, and gold) paper/foam to bookmark size.
- Need 4 of the same item such as cubes, feathers, paper.

Lesson Plan: This activity is to learn personality traits and learning styles which can help one figure out how they best work within a group and to decide which majors or careers might fit them best.

1. Pass out the Color Quiz.
2. Once they have finished, hand out the color bookmarks that match their personality color.
3. Have the students write down or draw what they want to be on the book mark.
4. Hand out the description of jobs that fit each color.
5. Have them see if what they wrote down on the bookmark is under their color.
    - Are any of their desired careers under their field?
    - Explain: if their desired career is not in their color category, it does not mean that they cannot choose that profession.
6. Hand out the description of characteristics of each color and have them write down three characteristics that they think fits them on their book mark.
7. Have the youth separate into groups according to their color and have them complete the activity.

Activity:

Have the four groups of youth try and get an object across the room without using their hands (ex. feather, cube, paper). Each member of the separate groups needs to touch the item.

Afterwards, have the groups discuss their tactic of getting it across the room.

Reflect

-Why do you think knowing your personality traits can help you in school and to find a job?

-How do you think your individual personality traits will help with the career you want?

Color Questionnaire

Directions: Below are 10 incomplete sentences that describe people. Each sentence has four possible endings. Give **four points** to the phrase that is "**most like you**," three points to the phrase that is "next most like you," two points to the next phrase, and **one point** to the phrase that is "**least like you**."

Use the sentences below to describe your personality.

1. I like to:
_____ **a.** Make quick decisions and impact people around me
_____ **b.** Think about questions people usually don't ask and develop solutions
_____ **c.** Show empathy for the needs of others
_____ **d.** Have others depend on me

2. The best way for someone to show me they love me is:
_____ **a.** To surprise me with something
_____ **b.** To allow me to be myself
_____ **c.** To spend time with me, talking, listening and sharing feelings
_____ **d.** To do the things I've asked them to do

3. In a relationship, I like to provide:
_____ **a.** Excitement and variety
_____ **b.** Objectivity and independence
_____ **c.** Love and compassion
_____ **d.** Stability and security

4. I like to:
_____ **a.** Be impulsive and act freely
_____ **b.** Provide competent/intelligent input
_____ **c.** Help maintain a sense of harmony
_____ **d.** Be responsible and dependable

5. The quality or strength I can be counted on to display is:
_____ **a.** Courage
_____ **b.** Intelligence
_____ **c.** Understanding
_____ **d.** Responsibility

6. When I look at things around me I seek:
_____ **a.** Excitement
_____ **b.** The reasons why/explanations
_____ **c.** Peace and harmony
_____ **d.** Order and structure

7. People who know me best would say I am:
_____ **a.** Passionate and competitive
_____ **b.** Reserved and logical
_____ **c.** Emotional and sensitive to feelings
_____ **d.** Dedicated and traditional

8. I have a great need (desire) to be:
_____ **a.** Free and spontaneous
_____ **b.** Competent and logical
_____ **c.** Accepted and appreciated by others
_____ **d.** In control of my surroundings

9. When I am feeling discouraged, I most often:
_____ **a.** Become defiant and rude
_____ **b.** Withdraw or become sarcastic
_____ **c.** Cry or feel sad
_____ **d.** Feel a lot of self-pity

10. In a social situation with friends or classmates, I usually:
_____ **a.** Have fun and enjoy it
_____ **b.** Talk quietly with one or two people
_____ **c.** Make sure others are happy, accepted and having a good time
_____ **d.** Pitch in and do what is needed to ensure a successful event

Thank you for taking the survey. Now, add up the total number of points for each of the letters.

A _______ B _______ C _______ D _______

Color Characteristics

Category	Blue (C)	Gold (D)	Green (B)	Orange (A)
Esteemed for	Being a good listener	Being dependable	Discovering new insights	Being fun and taking risk
Stressed by	Feeling artificial	Lack of order	Feeling inadequate	Restrictions
Highest virtue is	Loyalty	Responsibility	Objectivity	Courage
Key characteristics	Authenticity	Being prepared	Ingenuity	Talent and skill
On the job	Peacemaker	Organizer	Pragmatist	Energizer
Perception	Concern	Structure	Abstract	Excitement
Primary needs	To be authentic and care for others	To provide stability and order	To be competent and rational	To be free and spontaneous
Seek for	Love and acceptance	Security	Insight and knowledge	Freedom
Strive to foster	Harmony	Traditional values	Thoughtful consideration	Fun and recreation
Take pride in	Empathy	Dependability	Competence	Impact
Specialty is	People	Accomplishments and results	Research and conceptualizations	Entrepreneurship
Validated by	Acceptance of others	Being appreciated	Affirming their wisdom	Achieving visible results
Trust	Intuition/Feelings	Authority/Tradition	Fasts and logic	Impulses

SAMPLE CAREERS

Compassionate Blue	Action Orange	Curious Green	Detailed Gold
Artist	Accountant	Accountant	Accountant
Childcare Worker	Artist	Artist	Administrator
Clergy	Childcare Worker	Computer Programmer	Clergy
Counselor	Coach	Engineer	Cosmetologist
Editor	Dental Assistant	Entertainer	Dentist
Entertainer	Dental Hygienist	Journalist	Editor
Librarian	Emergency Technician	Lawyer	Hairdresser
Media Specialist	Engineer	Librarian	Law Enforcement
Musician	Inspection Agent	Marketing Agent	Lawyer
Nurse	Law Enforcement	Medical Technician	Librarian
Psychiatrist	Marketing Agent	Photographer	Medical Assistant
Psychologist	Musician	Physician	Military
Physician	Nurse	Researcher	Nurse
Rehabilitation Worker	Receptionist	Sales (Technical)	Sales
Service Sector Business	Religious Worker	Social Scientist	Social Service Worker
Social Worker	Sales	Surgeon	Surgeon
Teacher	Storekeeper	Teacher	Teacher
Writer	Teacher	Writer	Technician

Pre-College

The Price of Life

Project Skills:
-Youth will learn about the cost of various types of colleges along with other items they will want and need as they get older.

Life Skills:
-

Academic Standards:
-Economics: **D-8.5** Apply economic concepts to consumer decision making, buying, saving, and investing.

Grade Levels: 7-8

Time: 30-40 minutes

Supplies Needed:
-Rules for the game
-Pictures for each of the 4 games

Attachments:
-Price is Life rules
-True Answers
- Worksheet for youth to write their answers on (optional).

Separate Attachment:
-Pictures

BACKGROUND

- Things cost money. It is important to think ahead when planning for college, a career, or simply for life. This activity teaches youth that things they want and need are not simple to get. They need to plan for the lifestyle they desire.

WHAT TO DO

Activity: The Price is Life

-The youth will be split into smaller groups of 2 to 4 and each team should choose a name. The "game host" will play four different games with the teams. First will be guess the price of three items, the second is judging whether the price of tuition at three different colleges is higher or lower than that given to them. The third game is matching rent prices with three different apartments, and the fourth is rearranging five numbers into the correct price of a new car.

Optional- Give the youth, after the game, a series of graphs that show how much money certain professions make a year depending on the education level. This will emphasize the importance of planning ahead and deciding how far through school one would like to go, to get the lifestyle they really want.

TALK IT OVER

Reflect:
-Why was the tuition at Harvard much more expensive than the others?

Apply:
-What are some ways that you can make going to college affordable?
-Why is it important to think about the price of things now?

HELPFUL HINTS

-Spread the groups out so that they do not influence each other.
-Have individual pictures for each game printed so each team can have one.
-Do not pass out all the pictures for the games at once, do it game by game.
-If doing this activity more than once, have the youth write their answers on the attached work sheet so the pictures can be used more than once.

Rules

1. Split the kids into small groups and have them pick team names or assign team numbers.

2. (Guess the Price) **Material objects**: Give each team a copy of the material items. Ask them to decide amongst themselves how much each item is worth and to write it down on the answer sheet. Ask the teams for their answer for the first item, then reveal the true price, then repeat with each item. The team that guesses a price closest to the correct answer will receive a point (3 points total).

3. (Higher or Lower) **Tuition**: Give each team a copy of the tuition prices. Ask the whole group if they think the true cost of tuition is higher or lower than the price given to them. Have each team give their answer. The teams that guess correctly will get a point (3 points available for each team).

4. (Easy as 1,2,3) **Apartments**: Have three square pieces of paper that each have one of the prices of the three apartments. Have the copy of the apartments in front of each team. Give the teams 15 seconds to match the price with the apartment. For each apartment they match correctly, the team gets a point (3 points available for each team).

5. (Mix and Match) **Vehicle**: Give each team the picture of the SUV and 5 small cards with a number on each, each digit should come from the true price of the car. Have them try and guess the price of the car by putting the numbers in the correct order. The team that guesses correctly will get 1 point.

6. Whichever team receives the most points will get a prize.

Correct Answers-Teacher Copy

These prices may not be exact due to price fluctuations. Make sure to explain that prices may go up or down.

1. Material Objects
    - Tablet with expanded memory- $275 (average)
    - Nike Lebron Basketball Shoe- $178
    - Gucci Valentine Bag- $2250

2. Tuition
    - Harvard- $36,305
    - UW-Waukesha 2 year campus- $4,560
    - UW-Milwaukee- $8,780

3. Apartments
    - East Side Milwaukee- $1,200
    - Martin Drive Milwaukee- $575
    - Manhattan, NY- $2,000

4. Basic Chevy Traverse
    - $29,430

Answers?

1. **Material Objects**

   - Tablet (average)________________________ Correct $______________________
   - Nike Shoes_____________________ Correct $______________________
   - Gucci Valentine Bag__________________ Correct $______________________

2. **1 Year of Tuition**

   - Harvard_____________________ Correct $______________________
   - UW-Waukesha __________________ Correct $______________________
   - UW-Milwaukee__________________ __ Correct $____________________

3. **Apartments**

   - East Side, Milwaukee__________________ Correct $______________________
   - Martin Drive, Milwaukee________________ Correct $______________________
   - Manhattan, NY____________________ Correct $______________________

4. **Chevy Traverse**

   - _______________________ Correct $______________________

Pre-College

In the Works

Project Skills:
-Youth will learn the importance of having interviewing skills.

Life Skills:
-Marketable Skills
-Teamwork

Academic Standards:
-Career Development: **K-8.11** Describe habits needed for career success, **K-8.13** Describe appropriate etiquette for work situations.

Grade Levels: 6-8

Time: 30-40 minutes

BACKGROUND

Workforce Readiness is not something that many middle school students are exposed to. Yet, it is important to be prepared because soon they might apply for their first job. The professional skills needed to obtain this job will also be needed throughout their life and in future careers.

WHAT TO DO

Lesson: **In the Works**
-Explain the interview activity worksheet and have the youth complete the activity. Afterwards, discuss the importance of being professional in an interview. OPTIONAL: Dress up in appropriate business attire and explain that looking professional is also important.

Activity: Hands Off!
-The youth will take turns, in groups of two, asking each other 3 questions and will also rate them on their language, confidence, and mannerisms. The final question is to be answered by the interviewer, whether they would recommend their partner to be hired.

TALK IT OVER

Reflect
-How will you behave at your first interview?
-Why is it important to act a certain way (professional)?

Apply
-How can this activity help you throughout various situations in your life? Please provide 2 or 3 examples and how this skill is used in these situations?

HELPFUL HINTS

-Have the pairs of students spread out.

-Give the youth an example answer for each question.

In the Works Pre-College Lesson 3: Interview Questions

Name of Interviewer: ______________________________

Person Being Interviewed: ______________________________

Position (Job Option Selected): _______________________________

Please ask the following questions of the person you are interviewing:

1. Why are you interested in this position?

2. What qualifications do you have to work here?

3. Why should we hire you?

It is important to maintain a professional attitude and appearance while being interviewed or while interviewing someone. Please rate the person you are interviewing by circling one of the numbers 1-4 for language, confidence, and mannerisms. (1 stands for poor and 4 is excellent)

	Poor	**Not Bad**	**Good**	**Excellent**
Language	1	2	3	4
Confidence	1	2	3	4
Mannerisms	1	2	3	4

Please write down your answer to the following question:

-Would you recommend this person to be hired by the company/boss? Why or why not?

Part time Summer Receptionist

Pay: $7.25 per hour

Qualifications: A person that is content working by themself, friendly, reliable, quick learner, familiar with computers and would be comfortable using Microsoft Word, Excel, PowerPoint, and Publisher. Must be 16 years or older. We are willing to work around your schedule.

Duties: Answering the phone, greeting visitors, sending and receiving mail, opening and closing the office, bulk mailings, paper work, scheduling events, room reservations, cashier duties, and various office projects.

Steins Garden center has two exciting summer positions for those 16 years and older.

Summer Sales clerk

Pay: $6.75 per hour

Become a member of our sales staff and help check out individuals. You will work at both our indoor and outdoor sales area. Person must have strong people skills and be comfortable with technology.

Summer Garden assistant

Pay: $8.00 per hour

Become a member of our garden crew. Move plants around, water plants, help customers take their purchases to their vehicles and answer customers' questions. Training provided. Person must be able to lift 50 pounds and have good people skills.

Part Time Summer Grocery Store Cashier/Stocker

Pay: $7.25 per hour

Join the team! We need people who are friendly and reliable to check out customers and to stock the shelves. Applicants should be content working individually, able to lift 30 lbs., and comfortable using computers. Training will be provided.

Cashiers are responsible for checking out customers and answering questions. Stockers are responsible for keeping the shelves full and clean, lifting products, and answering customers' questions.

How to get ready for the Pre-College 4-H STEM Science/Engineering fair

Selecting an Experiment

Have fun deciding which experiment to conduct, it does not have to be a long one; it can be one we did in class. Determine how much time you have before the project is due. This should help you select a topic and experiment. Make sure it's an experiment you can finish. Read over the instructions very carefully and make sure you have all the necessary items to complete the project. For example: What causes raisins to dance in diet white soda?

Before you begin your experiment, make sure you have paper and pencil ready to write down the steps of your experiment and record your observations. Since some science projects require a formal presentation, think of ways you can enhance your experiment. Should you use photos/drawings? Should you repeat your experiment as part of your presentation? Think of ways you can make your presentation more visually interesting to your audience.

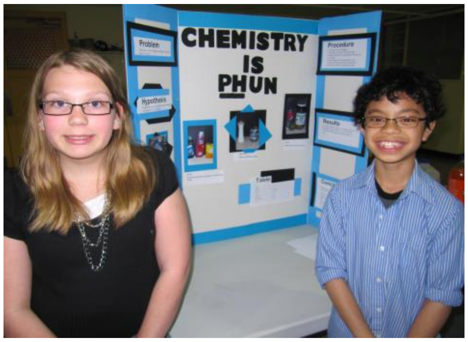
Conduct the experiment, gather data, report and summarize on a conclusion (results of the experiment).

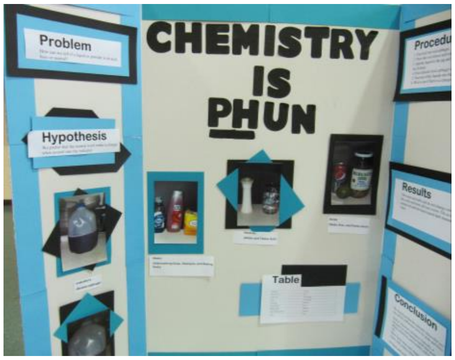
Now, How to Lay Out a Science Fair Poster

Most science fair posters are organized by the scientific method. For the Pre-College 4-H STEM science/engineering fair, you may use the scientific method or you may decide to design and item using Engineering Design (ED steps on next page). These are effective ways to communicate to others how you conducted your experiment.

(over)

Your Science Fair Display Board





Make the board visually interesting, as well as informative. Be sure to include all of the following items on your science fair display board:

Scientific Method

- a title
- a purpose statement
- your hypothesis
- the procedure
- data and results - charts, graphs, analysis
- your conclusions

Or **Engineering Design:**

1. What is the challenge?
2. How have others solved this?
3. What are the design criteria and constraints? Brainstorm possible solutions.
4. Which of the possible solutions do you choose?
5. Build a prototype.
6. How does it work? Try it and test again.
7. How do you learn from the designs of others?
8. How can you use your new ideas to improve your design?

Information adapted from: How to Make a Science Fair Project | eHow.com, By Taryn Chaifetz, eHow Contributor
Layout a Science Fair Poster

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