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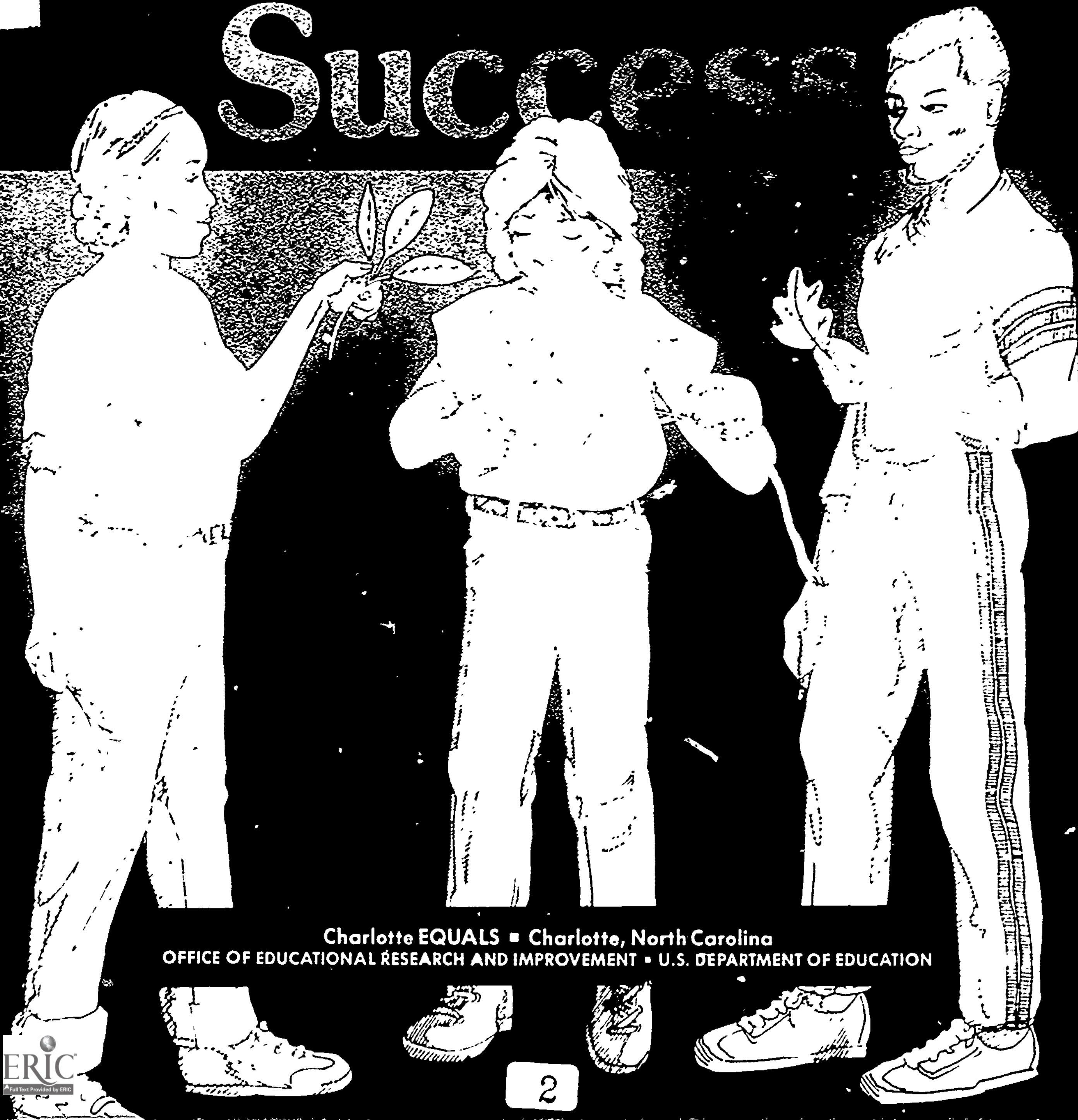
ABSTRACT

The purpose of the EQUALS programs is to increase the interest and awareness that females and minorities have concerning mathematics and science related careers. This book, produced by an EQUALS program in North Carolina, contains 35 hands-on, discovery science activities that center around four EQUALS processes--problem solving, cooperative learning, spatial skills, and career awareness. The activities are designed for use in grades 4-9. All activities were field-tested by teachers from the Charlotte-Mecklenburg (North Carolina) Schools in their classrooms. The activities were then revised according to suggestions made by the teachers and the students. Information given for each of the activities included are a description of the activity, preparation necessary to set up the activity, procedures, teacher notes, suggestions for extensions of the activity, and worksheets, answer keys and drawings where needed. These activities include a variety of life and physical science topics including animal life, prehistoric animals, archaeology, air pressure, surface tension, the human body, architecture, maps, packaging design, physical properties of matter, astronomy, sound, botany, symmetry, radioactivity, geology, classification, scientific careers, simple machines, acids and bases, genetics, spatial visualization, earth science, erosion, observing, elements, and mass. (CW)

Science EQUALS Success



Charlotte EQUALS ■ Charlotte, North Carolina

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Science EQUALS Success

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Cathy Conwell and Kitty Cobb

Introduction

What is EQUALS?

. . . a program developed at the University of California at Berkeley to improve the teaching and learning of math by providing a hands-on, problem-solving approach that helps females and minorities succeed in math. Activities are designed to increase students' interest and motivation in math, improve confidence and competence in doing math, and encourage persistence to stay in math once it becomes optional. As a result of the implementation of EQUALS, more women and minorities will be aware of their options to choose math- and science-related careers.

How did *Science EQUALS Success* begin?

. . . because the EQUALS components merged naturally with a discovery approach to science, science activities gradually became a part of our inservice workshops. As time went on, science activities that met the special need of females and minorities were required. Therefore, staff from the University of North Carolina at Charlotte, the Charlotte-Mecklenburg Schools, and Science Museums of Charlotte, Inc., began working together, developing and field-testing science activities.

What is in this book?

. . . hands-on, discovery science activities that center around four EQUALS processes—problem solving, cooperative learning, spatial skills and career awareness. The activities are designed for use in grades 4–9. All activities were field-tested by Charlotte-Mecklenburg teachers in their classrooms. These activities were then revised according to suggestions made by the teachers and students.

Why focus on problem solving?

. . . because some research has shown that females almost always lag behind males in multistep problem-solving skills. For this reason, they need to experience multistep problem solving as a process.

Why focus on cooperative learning?

. . . because research has shown that females and minorities seem to work better in a setting where they work in pairs or groups to solve a common problem. Cooperative learning occurs when students working together in small groups care about each other's learning. In this situation they depend upon each other and share the responsibility of the learning. This setting allows them to talk through the problem, thereby increasing their understanding. They are able to see different ways of solving problems. They thus become more comfortable in taking risks.

Why focus on spatial skills?

. . . because research has shown that females need experience in perceiving or solving problems associated with relationships between objects or figures. These activities were designed to give students the opportunity to work with the position, direction, size, form or distances associated with an object.

Why focus on career awareness?

. . . because research has shown that females and minorities are underrepresented in science-related careers. These activities help students become aware of a wide variety of careers requiring science preparation and skills. By doing an activity, the students are able to play the role of a scientist in a highlighted career. By having students see science careers in a variety of work settings in business and industry, the students understand that the laboratory is not the only place a scientist works.

How are the activities to be used?

. . . because the activities are designed as a supplement to an existing program, teachers may pick and choose the activities that are appropriate to integrate into their science classes. The activities are organized alphabetically by title in this book. Each activity is designed to stand alone and is not sequential.

What amount of time is required to complete each activity?

. . . it depends on the age and maturity of the students. There is not one right amount of time for these activities. However, listed below is an estimated time for each activity.

Animals Today and Long Ago	30 mins.	It's Your Decision	30 mins.
Bare Bones	45 mins.	More into Less	30 mins.
Bernoulli's Relay	30 mins.	Move a Brick	30 mins.
Berry Basket "Boat" Race	30 mins.	pH Paint	30 mins.
Build a Bionic Humanoid	60 mins.	The Punnett Game	30 mins.
Building Buildings	60 mins.	The Right Box	45 mins.
Can You Get There from Here?	30 mins.	River Study	45 mins.
Coat and Carton	45 mins.	Rock Pairs	30 mins.
Construx	45 mins.	Shadows and the Sun's Path	30 mins.
Crime Stoppers	60 mins.	Shoe Shoo!	30 mins.
Dinosaur Quest	45 mins.	Star Time	30 mins.
Directions from the Sun	30 mins.	Table Manners	45 mins.
Glassy Tunes	30 mins.	That's the Way the Apple Slices	30 mins.
Half-a-Leaf	30 mins.	Touch and Ask	30 mins.
Half-Life Is More than Meets the Eye!	30 mins.	Wash Out	45 mins.
Heavy Rock	30 mins.	Water Balancing Act	30 mins.
I Spy a Critter	30 mins.	What's in a Box?	30 mins.
		What's the Advantage?	30 mins.

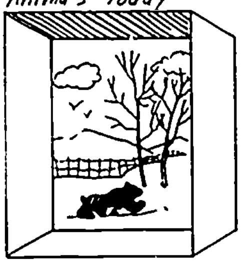
EQUALS Process Chart

Activities	Career Awareness	Cooperative Learning	Problem Solving	Spatial Skills
Animals Today and Long Ago		X	X	X
Bare Bones	X	X	X	X
Bernoulli's Relay		X	X	
Berry Basket "Boat" Race		X	X	
Build a Bionic Humanoid		X	X	X
Building Buildings	X	X	X	X
Can You Get There from Here?		X	X	X
Coat and Carton	X	X	X	X
Construx		X	X	X
Crime Stoppers	X	X	X	
Dinosaur Quest		X	X	X
Directions from the Sun		X	X	X
Glassy Tunes		X	X	X
Half-a-Leaf		X	X	X
Half-Life Is More than Meets the Eye!			X	X
Heavy Rock		X	X	X
I Spy a Critter		X	X	
It's Your Decision	X	X	X	
More into Less		X	X	X
Move a Brick		X	X	X
pH Paint		X	X	
The Punnett Game		X	X	
The Right Box	X		X	X
River Study	X	X	X	X
Rock Pairs			X	X
Shadows and the Sun's Path		X	X	X
Shoe Shoo!	X	X	X	
Star Time		X	X	X
Table Manners		X	X	X
That's the Way the Apple Slices		X		X
Touch and Ask	X		X	X
Wash Out	X	X	X	
Water Balancing Act		X	X	
What's in a Box?	X		X	X
What's the Advantage?			X	X

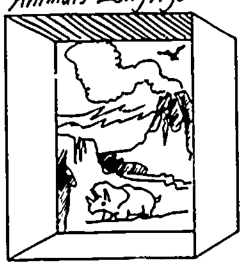
Animals Today and Long Ago

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

Animal's Today



Animals Long Ago



CONTENT
Observe basic likenesses and differences between modern animals and dinosaurs
Scientific Processes: classification and observation

ACTIVITY DESCRIPTION
By feeling a plastic animal in a box, the student will match it to a shadow drawing of the animal and then classify the animal as to whether it lives today or lived long ago.

PREPARATION
Materials needed for teacher preparation:

- Plastic animals that live today
- Plastic animals that lived long ago
- Green and red dots
  Put a green dot on the plastic animals that live today.
  Put a red dot on the plastic animals that lived long ago.
- Two boxes
- Picture of what land looks like today (drawing 1)
- Picture of what land looked like long ago (drawing 2)
  Fix two boxes as illustrated.
  On the Animals Today box put a green dot.
  On the Animals Long Ago box put a red dot.
- Box with hole in top
  Place all animals in box after students make shadow casts.

Materials needed for student preparation:

- Plastic animals from today and long ago
- Paper
- Black marker

Pairs of students will make shadow casts by following the steps below:

- They draw around the animals on paper.
- They fill in each drawing with the marker.
- They put the animal's name on the back of the shadow cast.

THE ACTIVITY
Now comes the payoff!

The pair of students will place the animals in the correct setting using the following steps:

- Child A reaches into the box with all the animals and chooses one.

- Child A describes what she feels to Child B. Child B finds the shadow picture of the animal.
- The children discuss the characteristics of the animal, placing it in the Animals Today box or Animals Long Ago box.
- The children check to see that the dots on the box and the animals match.

Discussion at the end might include the following:

- What characteristics made you decide to put an animal in the Animals Today box? in the Animals Long Ago box?
- Are there any animals that share characteristics of today and long ago?
- Is there a difference in the size ratio of animals today and long ago?

TEACHER'S NOTES

Dinosaurs lived during the Mesozoic era, which began about 200 million years ago and lasted for about 140 million years. This era is called the Age of Reptiles. Reptiles are cold-blooded, covered with scales, and their feet have claws. The most well known of these reptiles were the dinosaurs. Their name means "terrible lizard." Many of the dinosaurs were very large. For example, Tyrannosaurus was about 15 meters (49 ft.) long from head to tail. The only reptiles still living today from the Mesozoic era include crocodiles, turtles, alligators, lizards and snakes.

The next era is called the Age of Mammals. This period, called the Cenozoic era, began about 60 million years ago and has lasted until today. These mammals are warm-blooded, covered with hair, and give milk to their young.

Further research on the names of the animals and their habits might be necessary. For instance, the size of the real animals and its ratio to the plastic animal is important.

Plastic animals can be obtained from variety stores, museums, science stores or drug stores.

EXTENSIONS

The teacher, using the overhead, shows different views of a plastic animal. From the shadows cast, the student identifies the animal.

Have students make fired clay animals to be substituted for plastic animals.

Have students create their own drawings of what land looks like today and what land looked like long ago.

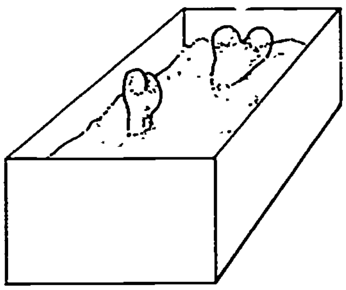
Kathy Shonts

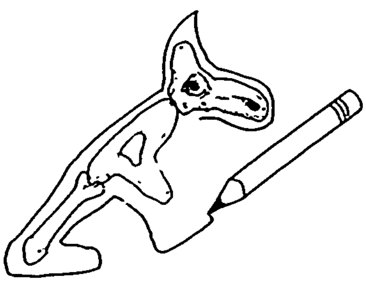
Drawing 1

Drawing 2

Bare Bones

EQUALS Processes
- **Career awareness**
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**





CONTENT
Assume the role of paleontologists by reconstructing animals
Scientific Processes: inference and observation

ACTIVITY DESCRIPTION
The students dig bones, fit them together, and draw what the animals might have looked like.

PREPARATION
Materials needed for each group:

- Bones of a turkey or chicken
  Boil all meat off the carcass.
  Clean and dry bones thoroughly.
- Box of sand
  Bury bones in the box.
- Spoon
- Small paint brush
- Drawing paper
- Crayons

THE ACTIVITY
Groups will reconstruct an animal using the following method:

- They dig out the bones with the spoon, cleaning them with the paint brush.
- They fit them together to make the skeleton.
- They draw a picture of what the skeleton might look like with muscles and skin.

Discussion should include questions that a paleontologist might ask:

- Are there any missing bones?
- Has more than one animal been discovered?
- Is the animal large or small?
- Is it a baby or an adult?
- Are there clues to how it died?

TEACHER'S NOTES
Paleontologists study plant and animal fossils and then interpret prehistoric life. They encounter difficulties when they find incomplete skeletons and must infer or imagine the whole parts.

The Elementary Science Study (ESS) Kit named "Bones" has bones that could be substituted for carcasses.

EXTENSIONS

Write a story about a day in the life of your animal.

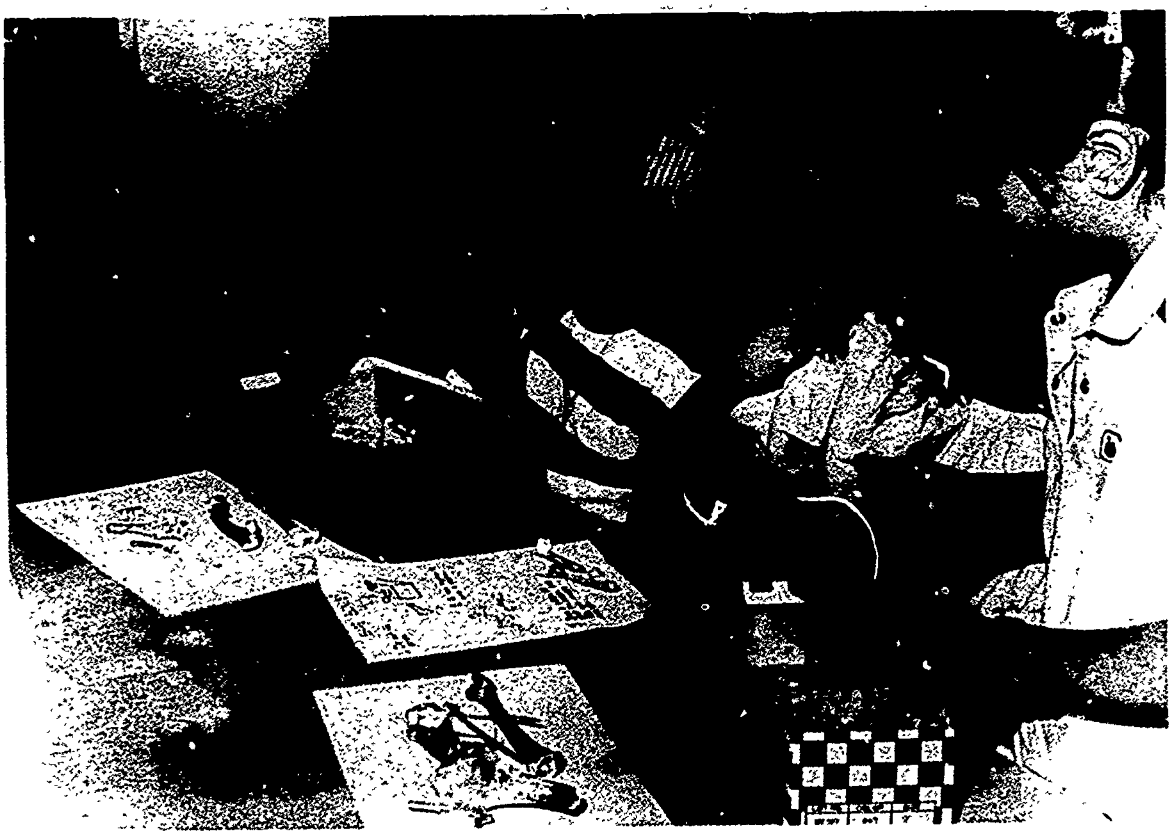
Try this activity as a station.

For more spatial challenge, break some of the larger bones.

Model the reconstructed animal from clay.

Find out how the bones of an animal are held together.

Susan Cline



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Bernoulli's Relay

EQUALS Processes
- **Cooperative learning**
- **Problem solving**

CONTENT
Explore Bernoulli's Principle of Air Pressure
Scientific Processes: experimentation, formulation of hypotheses and observation

ACTIVITY DESCRIPTION
Teams of students will "run" relay races using air pressure to carry ping-pong balls.

PREPARATION
Materials needed per team:

- Students
  Divide them into teams.
  Divide each team into two groups.
- "Start" and "finish" markers
  Set them 15–20 ft. apart
- Hair dryer
- Ping-pong ball
- 10-foot lightweight extension cord
  Plug it in between the two groups.

THE ACTIVITY
Teams plan and practice for the race.

- They discuss as a team how to hold the hair dryer to keep the ping-pong ball in the air.
- They turn on the hair dryers, deciding the air speed that works best.
- They balance the ping-pong ball in the moving stream of air.

Then the fun begins!

- Line one group at "start" marker and the other group at "finish" marker.
- Have the first person on the "start" marker turn on the hair dryer.
- Announce the start of the race.
- Have the first person place their ball in the air current and walk it to their teammate on the "finish" marker.
- Have that team member walk the airborne ball back to the teammate on the "start" marker.
- Alternate the ball between the "start" and "finish" markers until all team members have carried the ball.
- Allow the students to pick up a dropped ball and continue from where the ball is dropped.

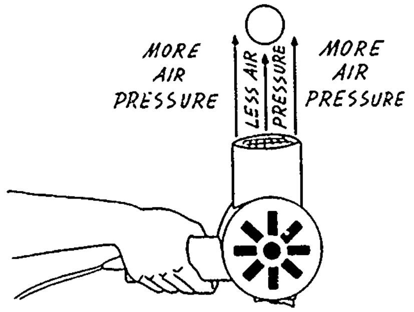
The relay is won by the team that finishes first.

Discussion at the end might include the following:

- How is the ping-pong ball able to stay in the moving air stream?
- What is Bernoulli's Principle and how does it apply?

TEACHER'S NOTES

See illustration for the best way to hold the hair dryer so that the ping-pong ball stays in the air. Students should discover that this happens best when hair dryers are set on high air speed. Due to varied settings, hair dryers used by two competing teams need to be the same.



Bernoulli's Principle states that moving air exerts less air pressure (or push) than still air. The higher air pressure of the still air surrounding the blower pushes the ball into the lower pressure of the moving air stream. The ball is pushed up by the moving air and is pushed down by its weight, so that it bobs rather than being pushed rapidly away.

Bernoulli's Principle is important in giving lift to airplanes and hang gliders. It is one factor responsible for roofs of houses blowing off during a tornado.

EXTENSIONS

Highlight various careers, such as aeronautical engineer, airline pilot, and architect.

Have students form a big circle and pass the dryer and ping-pong ball around. See if they can better their time on different rounds.

Mary Katherine Scarborough

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Berry Basket "Boat" Race

EQUALS Processes
- Cooperative learning
- Problem solving

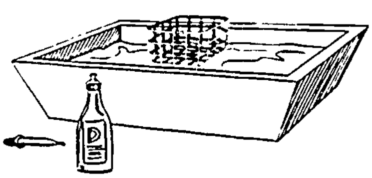
CONTENT
Discover that water molecules clinging together at the surface can be broken by detergent
Scientific Processes: experimentation, formulation of hypotheses and observation

ACTIVITY DESCRIPTION
In this scientific game, students race their berry basket "boats" by dropping detergent on the surface of the water.

PREPARATION
Materials needed for each team:

- Window box planter or long dishpan
- Water
  Fill each planter with about 3" water.
- Plastic berry basket
- Eyedropper
- Small container of dishwashing detergent

THE ACTIVITY
Teams will plan and practice a strategy for moving their "boat" to the finish line.



- They experiment with floating their "boat."
- They choose a plan for racing their boat by deciding the following:
  what they think will happen when they add detergent to the water
  where to drop the detergent
  how many drops of detergent to use
- They try out the plan.
- They select one member to "captain" the boat.

Clean the planter and basket.

The race will then begin.

- Place the boats at one end, designated "starting line."
- Give each captain an eyedropper and detergent
- On the count of "go," the children race the boat to the "finish line" at the other end.

Did any boat make it?

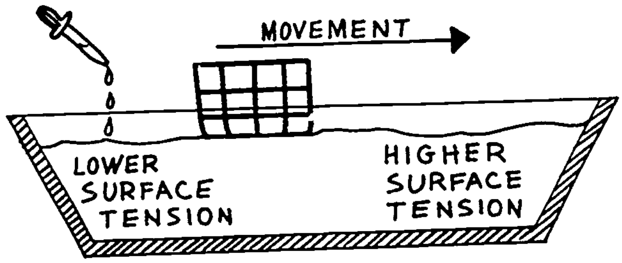
Discussion at the end might include the following:

- What plan(s) succeeded? Why?
- What caused boats to sink?

TEACHER'S NOTES

Water molecules would rather hold on to each other than to stick to anything else. They act like a skin that is tightly stretched over the surface of the water. This is called surface tension. It allows a berry basket, which is full of holes, to float on the water's surface.

Dishwashing detergent weakens the surface tension of the water by moving between the water molecules and reducing their attraction to one another. As the detergent weakens the surface tension behind the boat, the boat moves forward onto the area of higher surface tension. If too much detergent is added, it breaks up the surface tension all around the boat, and causes it to sink.



To repeat the race, the baskets and dishpans must be thoroughly rinsed so the baskets will float. It might be easier to use small dishpans of water to practice strategies before the actual race begins.

EXTENSIONS

Find the best number of detergent drops needed to move the boat over the greatest distance. Work out and record strategies. Try out the plans. For example,

no. of drops	time period	distance moved
2 drops	every 3 seconds	8.5 cm.
1 drop	every 1 second	3.5 cm.

Test different brands of dishwashing detergents to see which brand is the best in moving the boats the greatest distance.

Cathy Preiss

Build a Bionic Humanoid

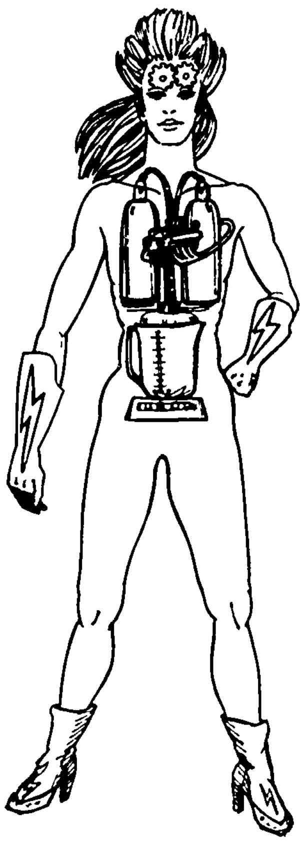
EQUALS Processes
- Cooperative learning
- Problem solving
- Spatial skills

CONTENT
Know the function of body parts
Scientific Processes: communication and use of spatial relationships

ACTIVITY DESCRIPTION
Students create a bionic humanoid using magazine pictures to represent body parts.

PREPARATION
Materials need for each group:

- Magazine pictures
- Large paper
- Scissors
- Glue



THE ACTIVITY
Groups of students create a bionic humanoid using the following method:

- They draw a human form on the paper.
- They use magazine pictures as body parts, creating major organs and body systems.

Groups discuss the function of the body parts.

Then each group presents its bionic humanoid to the class, answering the following questions:

- What advantages do our natural organs and systems have over the created bionic parts?
- Are our bodies engineered as efficiently as they could be?
- Did this activity take cooperation?
- How did you feel about cooperating?

TEACHER'S NOTES
A review of the functions of body parts, organs and body systems might be necessary before beginning the activity.

You might want to give students examples of how to use magazine pictures as body parts. The pictures need to represent the function of the body parts rather than the shape. Encourage students to be as creative as possible and let imagination run to "break set." Some examples might be as follows: hard hat=skull, camera lens=eye, fort with soldiers=immune system, air conditioner=sweat glands, factory=cell, door hinge=knee joint, telephone=ear, plastic wrap=skin, water pump=heart, coffee filter=kidney and computer=brain.

EXTENSIONS

Take the best and most creative parts from each group and collectively make a class bionic humanoid.

Make a three-dimensional bionic humanoid.

What would be the advantages and/or disadvantages of placing any of our organs in a different place? Example:

> Eyes on the tips of our fingers. (Great for looking around corners; not so great when our hands are in our pockets.)

Darryl Hersh and Cathy Preiss

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Building Buildings

EQUALS Processes
- **Career awareness**
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT
Learn skills needed by architects
Scientific Processes: communication, observation, and use of spatial relations

ACTIVITY DESCRIPTION
Students build a three-dimensional building after looking at two-dimensional pictures.

PREPARATION

Materials needed for each group of 4–5 students:

- Two dimensional pictures of buildings (pp. 14–31)
- Legos® or standard-sized building blocks

THE ACTIVITY

Each student in the team practices architects' skills by doing the following:

- Each selects a picture showing a view of a building.
- Using blocks, the student constructs part of the building that matches her picture.

The team fits the parts of the building together.

Check the answer card to see how well the team did.

Compliment the team on working so well together!

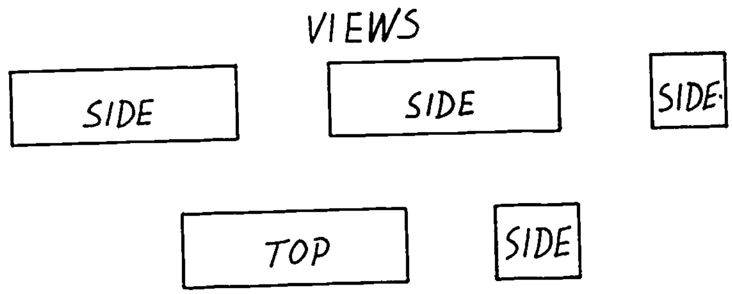
Students discuss the following:

- What skills are necessary to do this activity?
- Would this task be more difficult to do alone? Why or why not?
- How do architects work together to complete tasks?
- What knowledge do architects need in order to build?

TEACHER'S NOTES

This activity allows students to cooperatively solve a problem. This is important because an architect's career demands cooperation due to the wide variety of knowledge and skills necessary in designing and building buildings.

You may want to introduce this activity by drawing the five different views of a block on a board. An example would be:



After looking at the views, have students identify the three-dimensional block represented by the two-dimensional drawings (rectangle).

As students compare their construction to the picture, it is helpful for them to view the construction at eye level. It is also helpful to view the construction from a distance, because this makes a three-dimensional object look more two-dimensional.

"B" cards are a beginner's activity, "I" cards are an intermediate activity and "A" cards are an advanced activity.

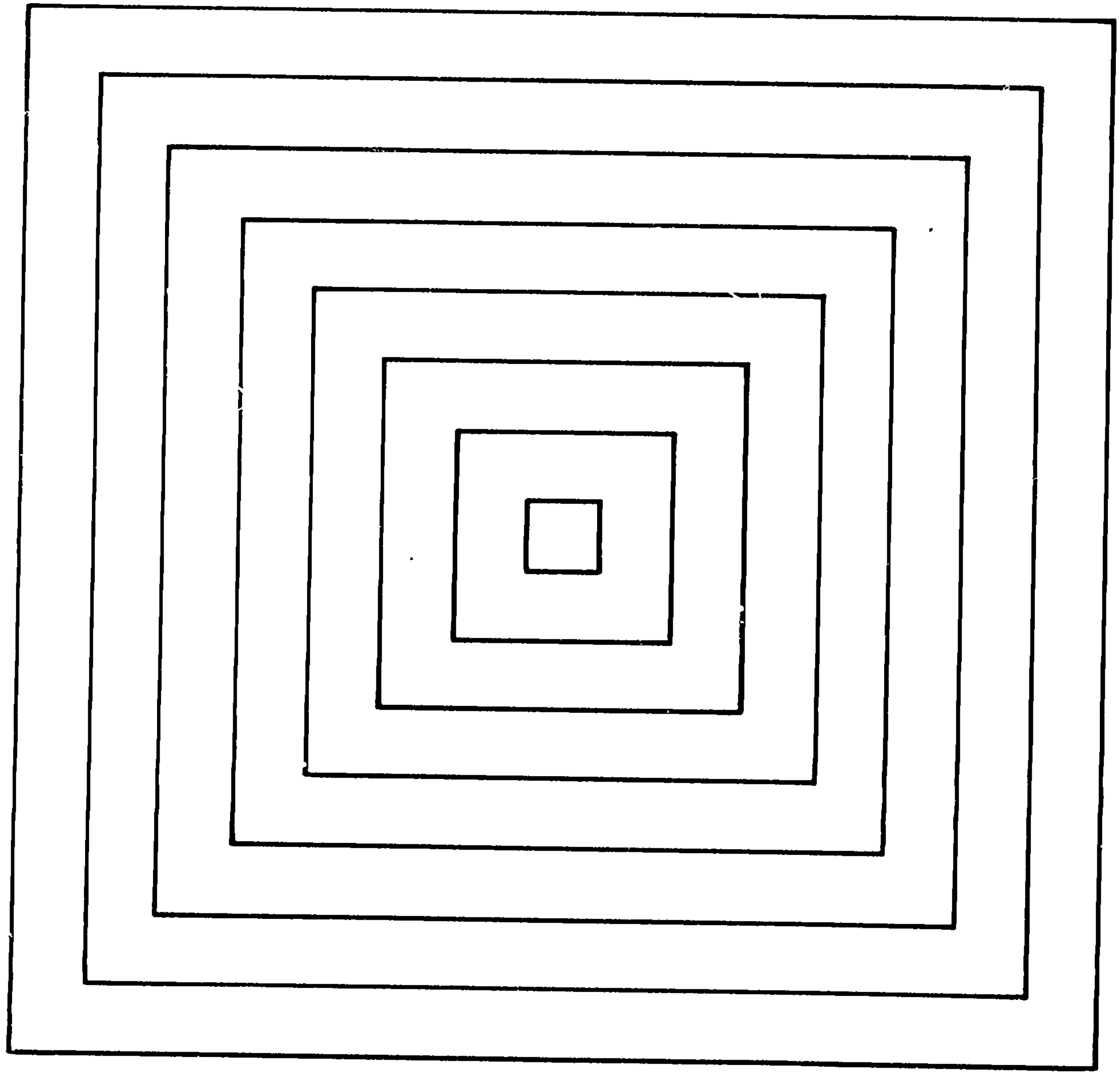
The Elementary Science Study (ESS) Kit "Geoblocks" contains building blocks that work well for this activity.

EXTENSION

Have students or teams of students build their own buildings and then draw pictures of the different views of their building.

Joan Vandenberg Philipp

Top "B"



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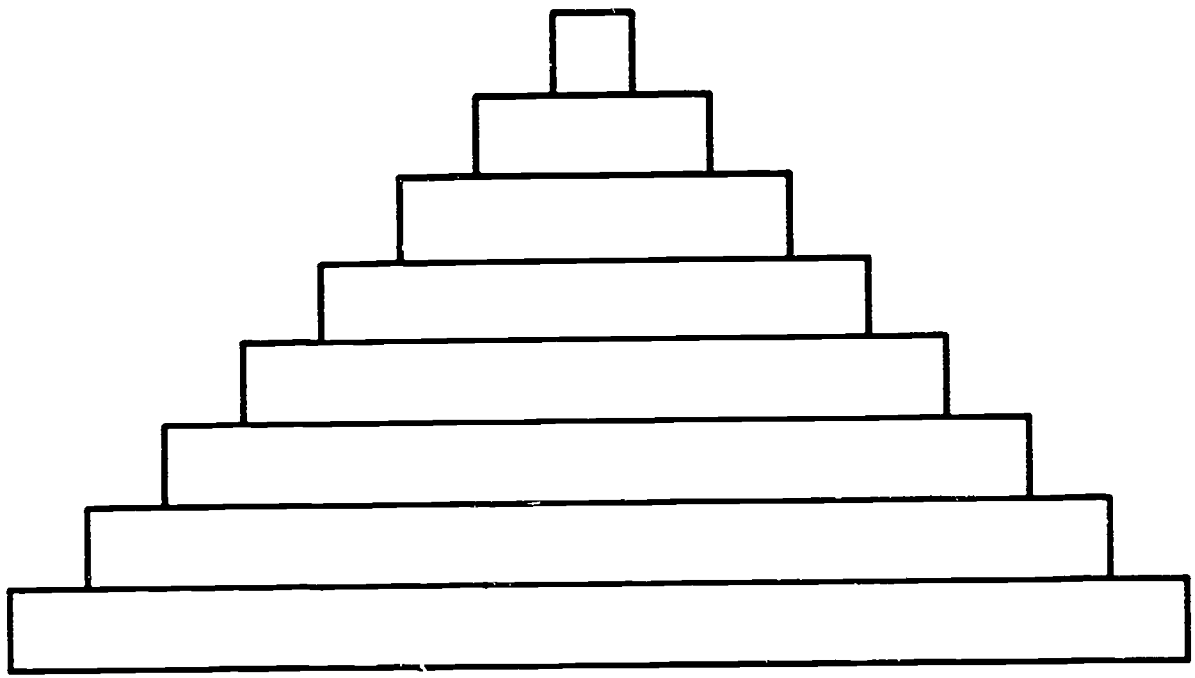

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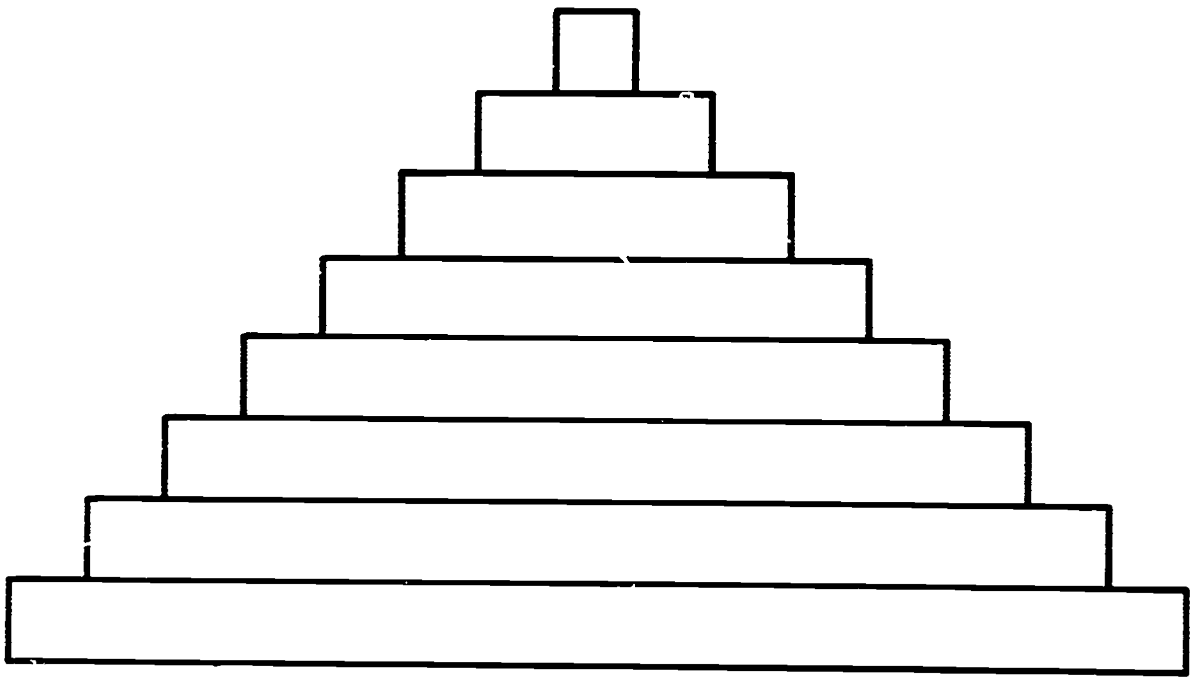

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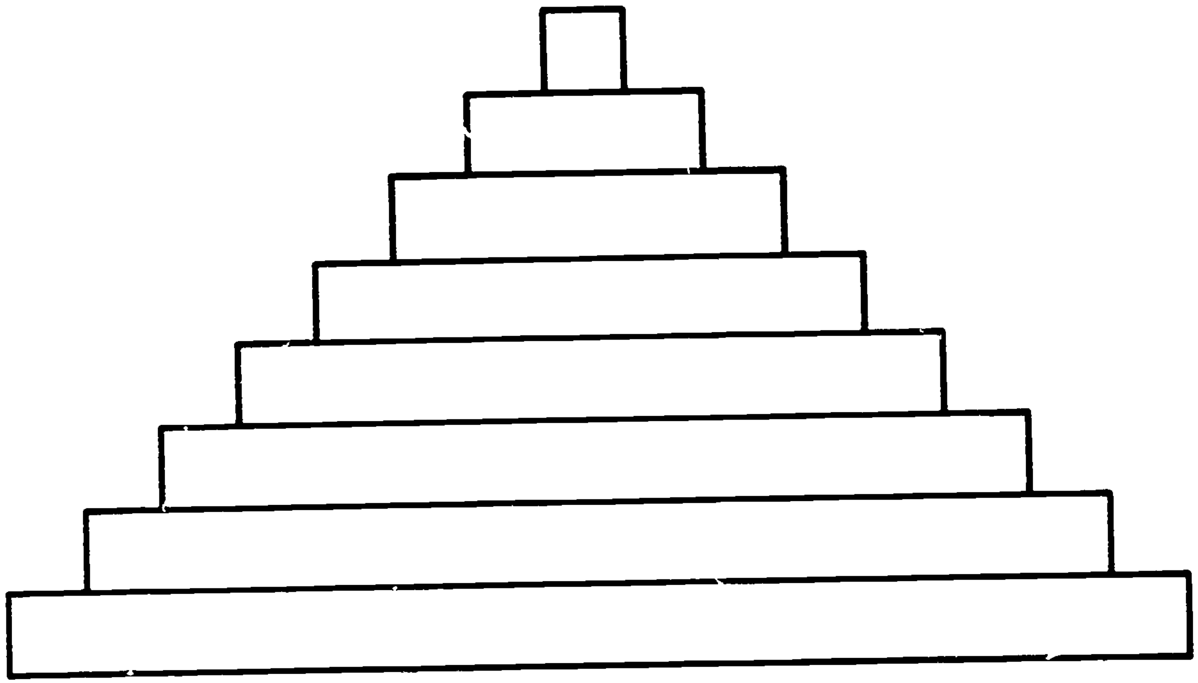

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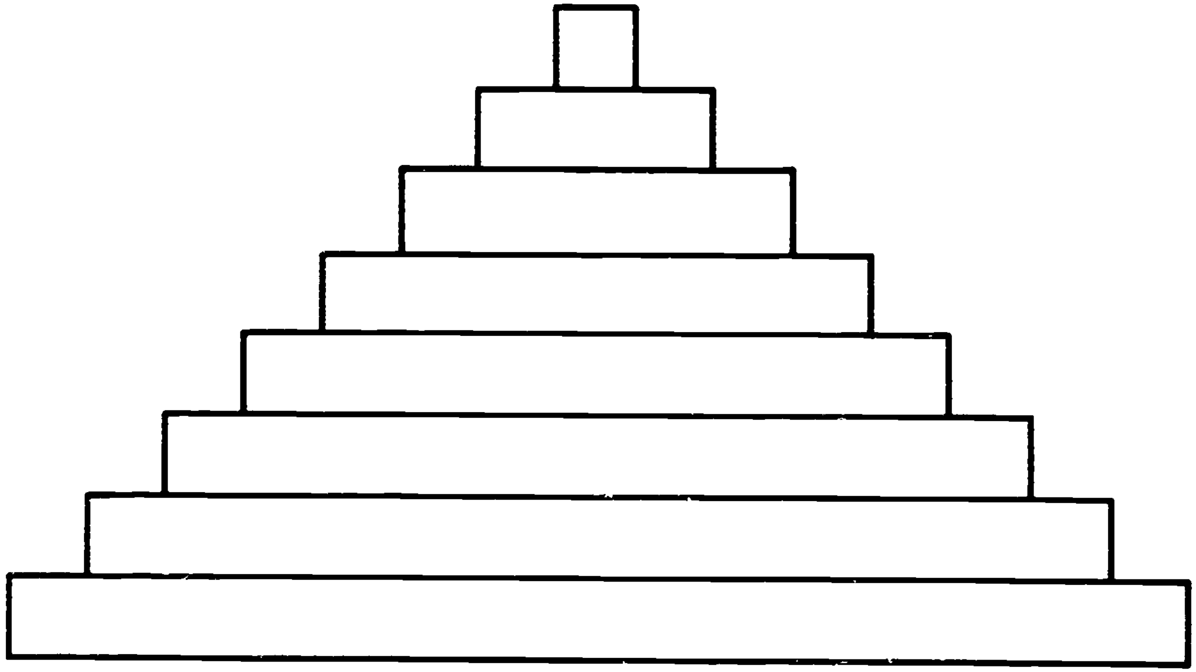

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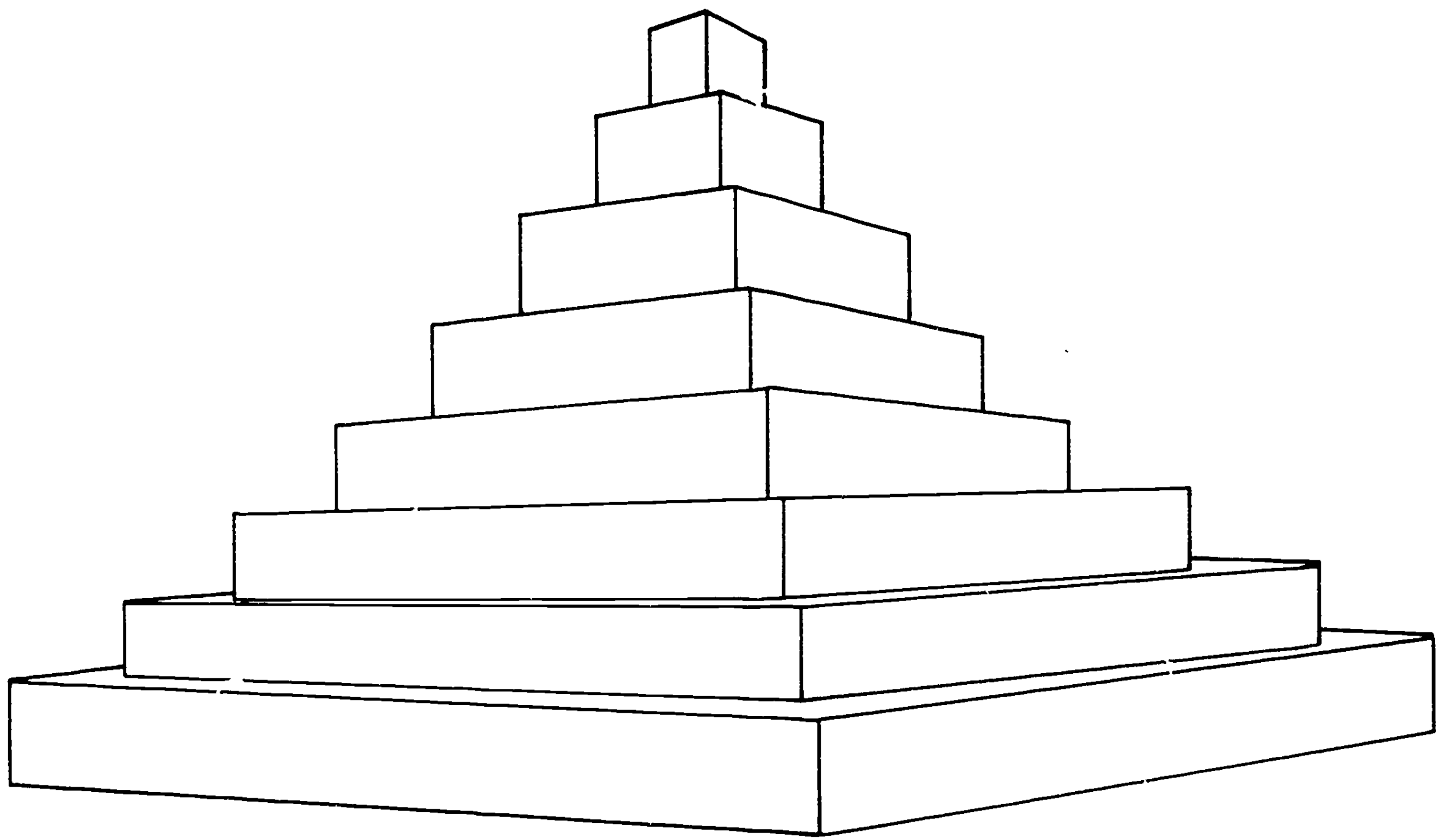

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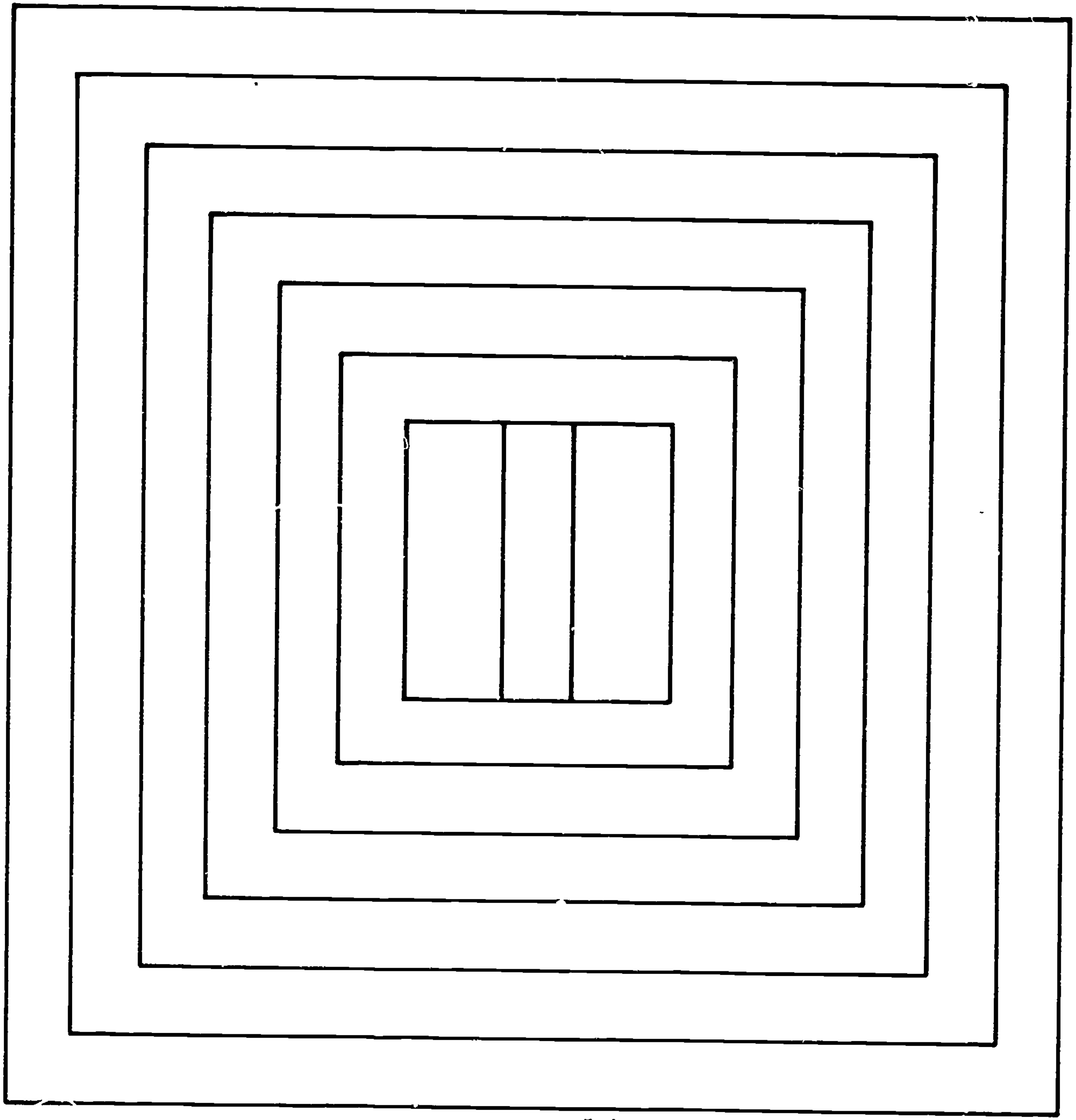

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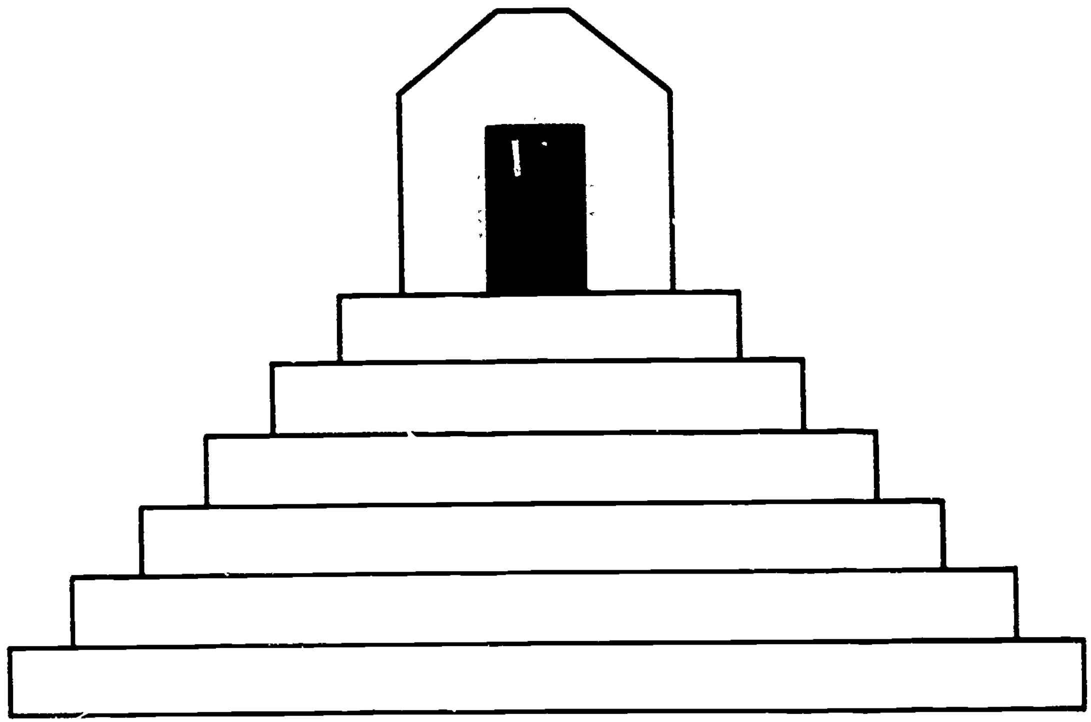

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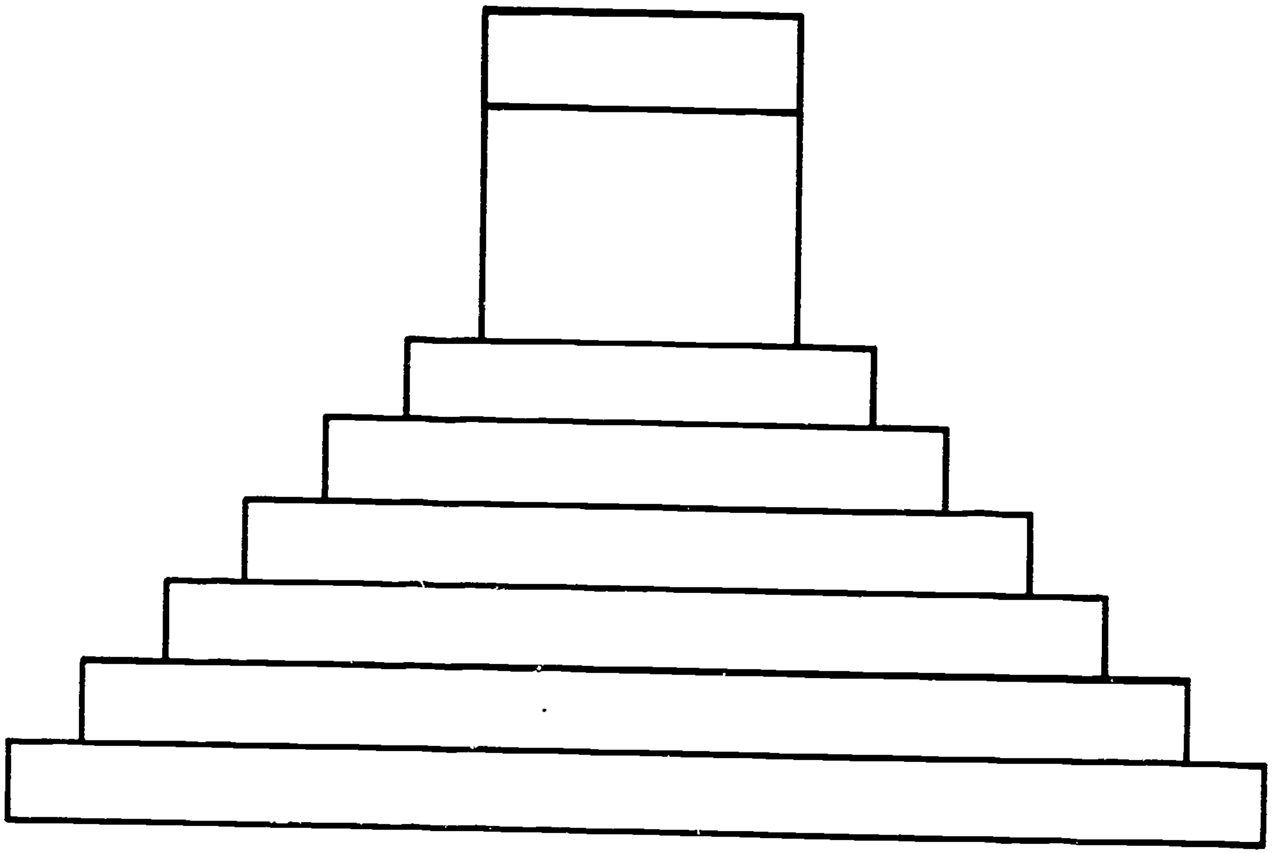

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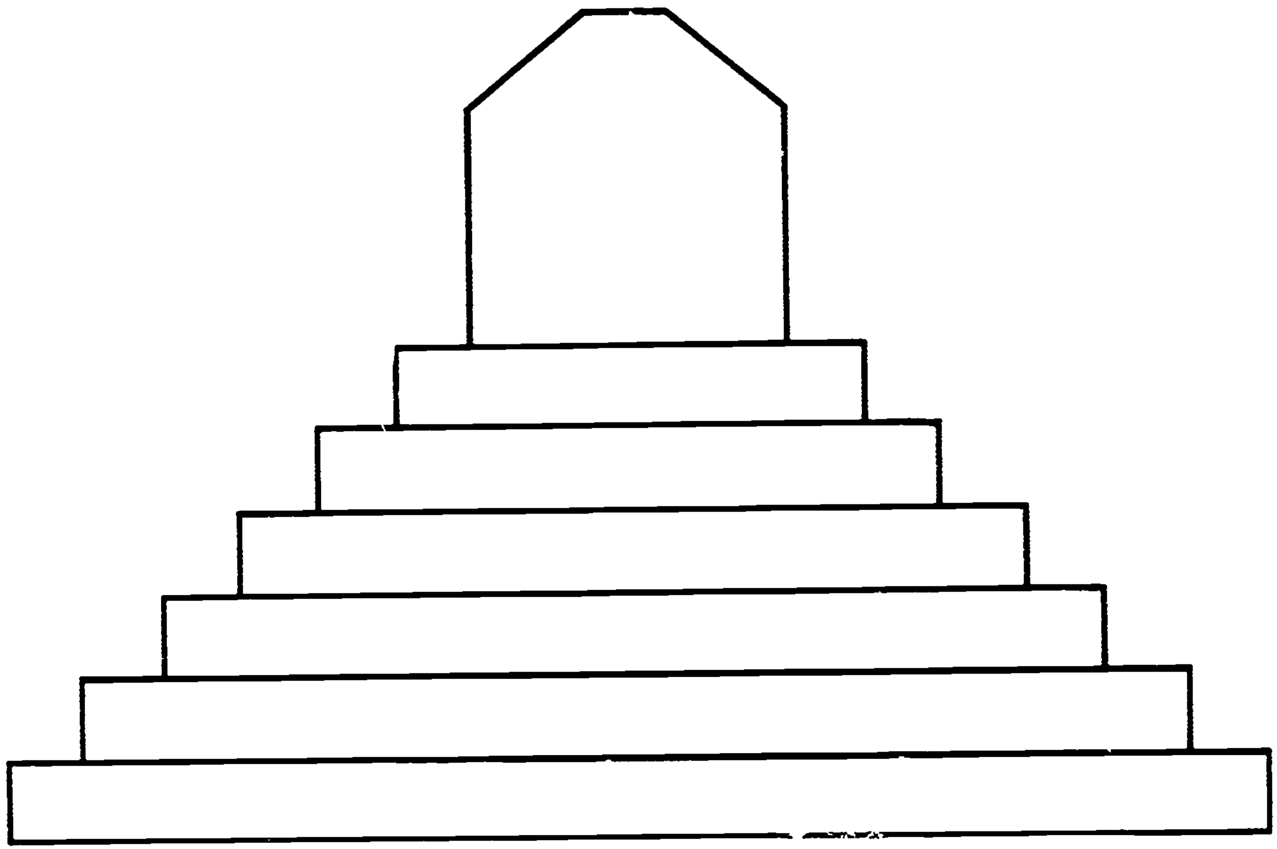

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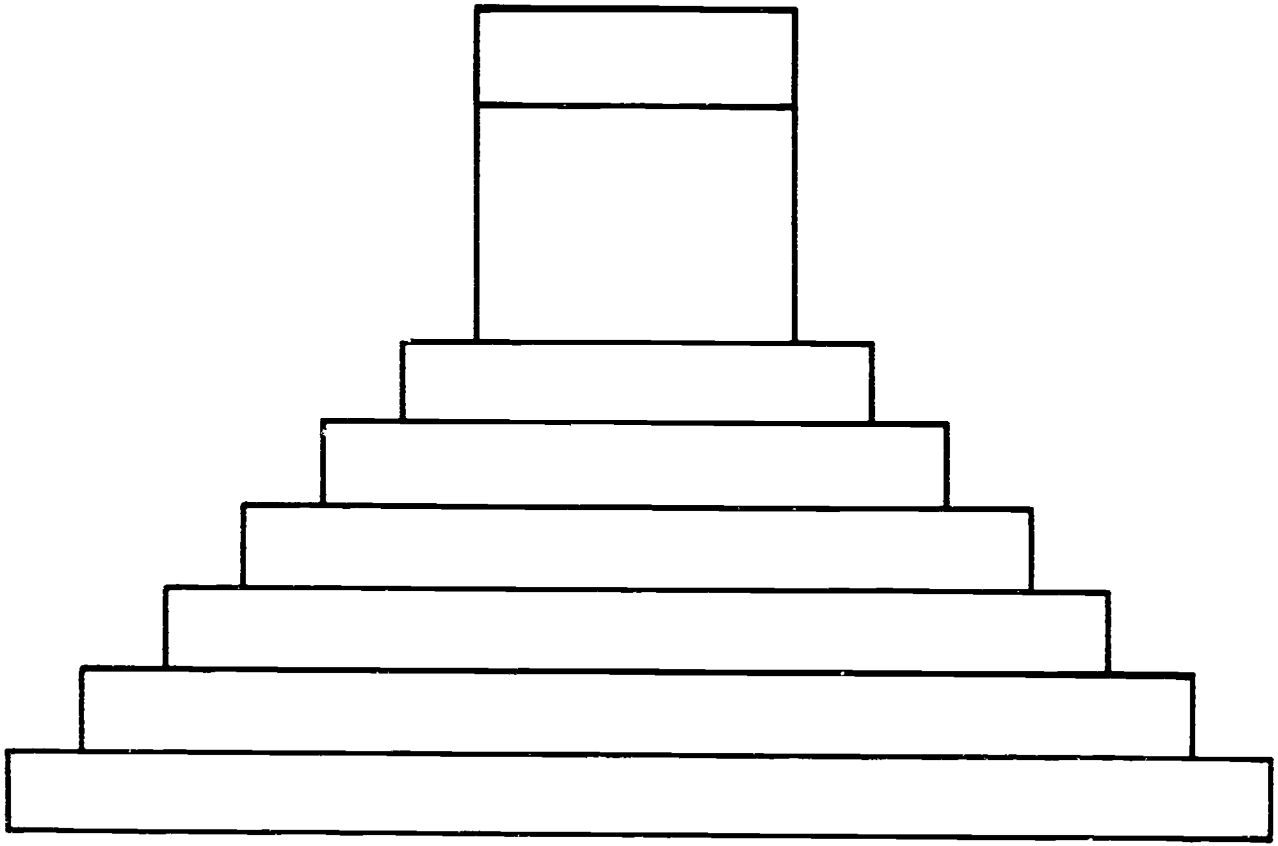

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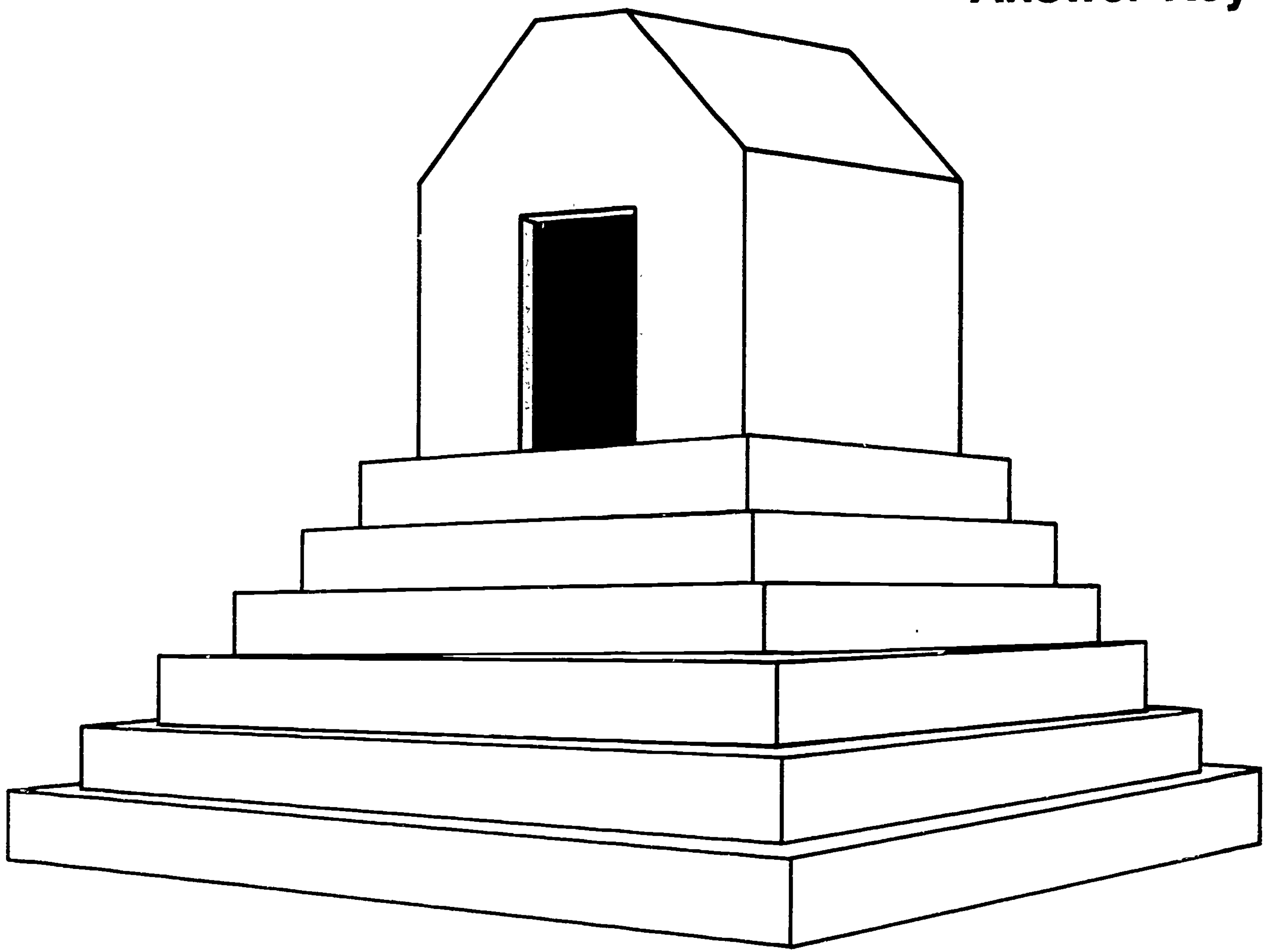

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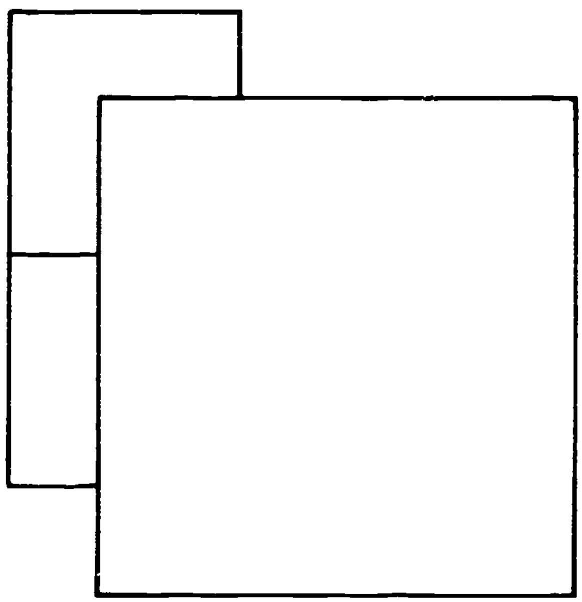

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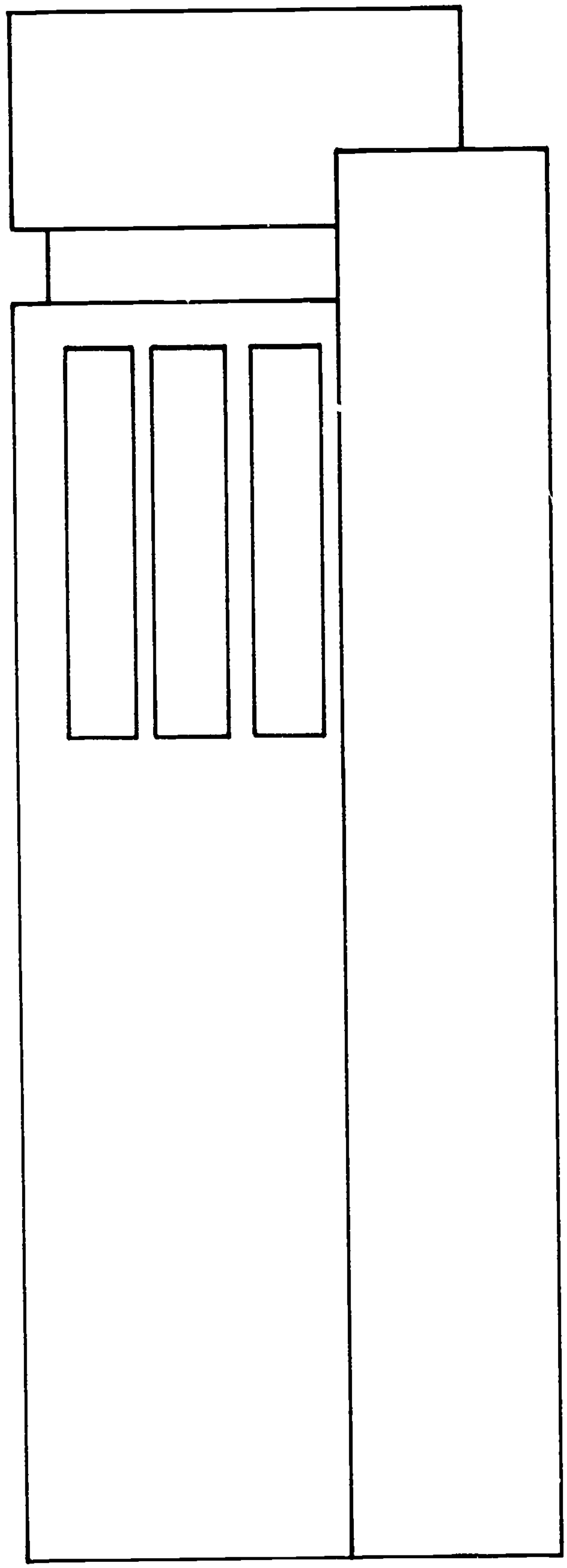

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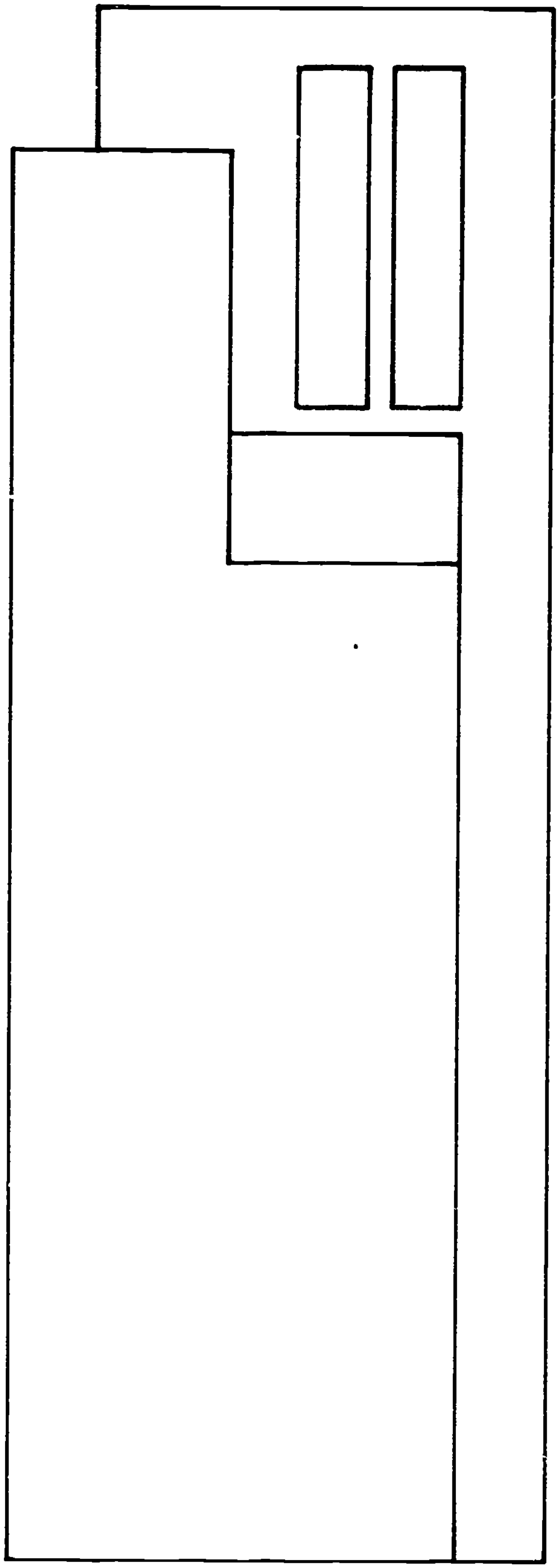

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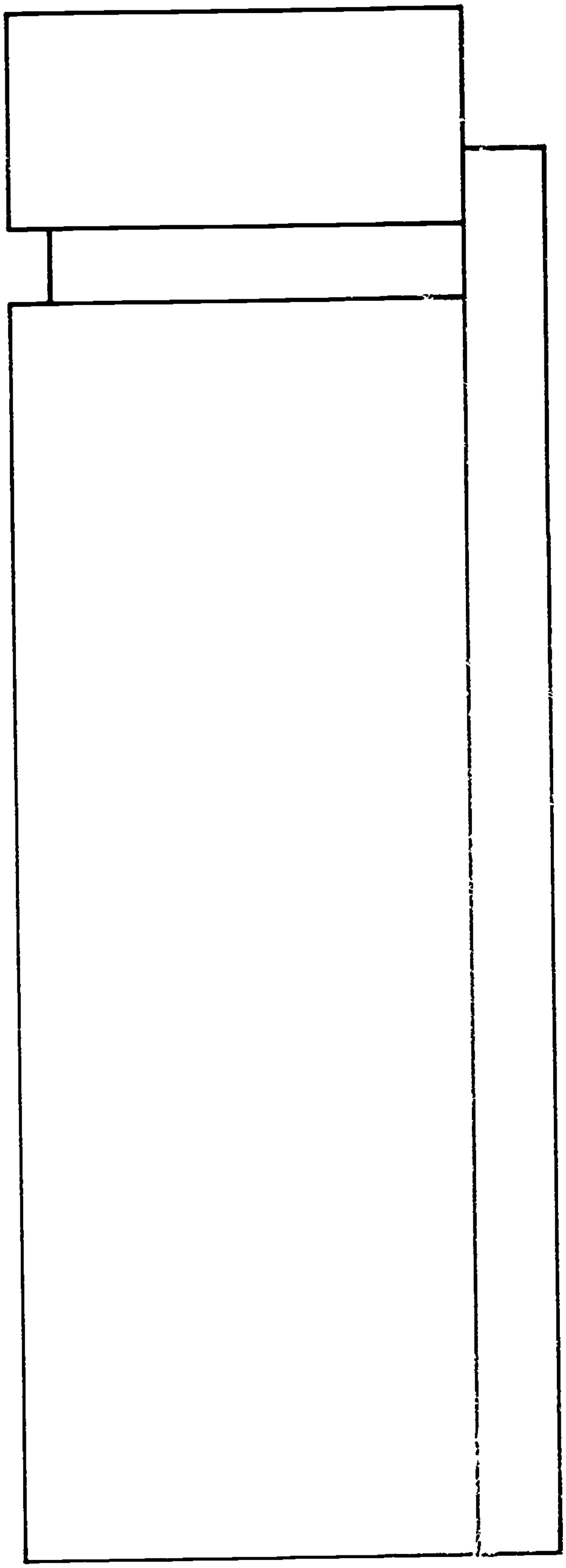

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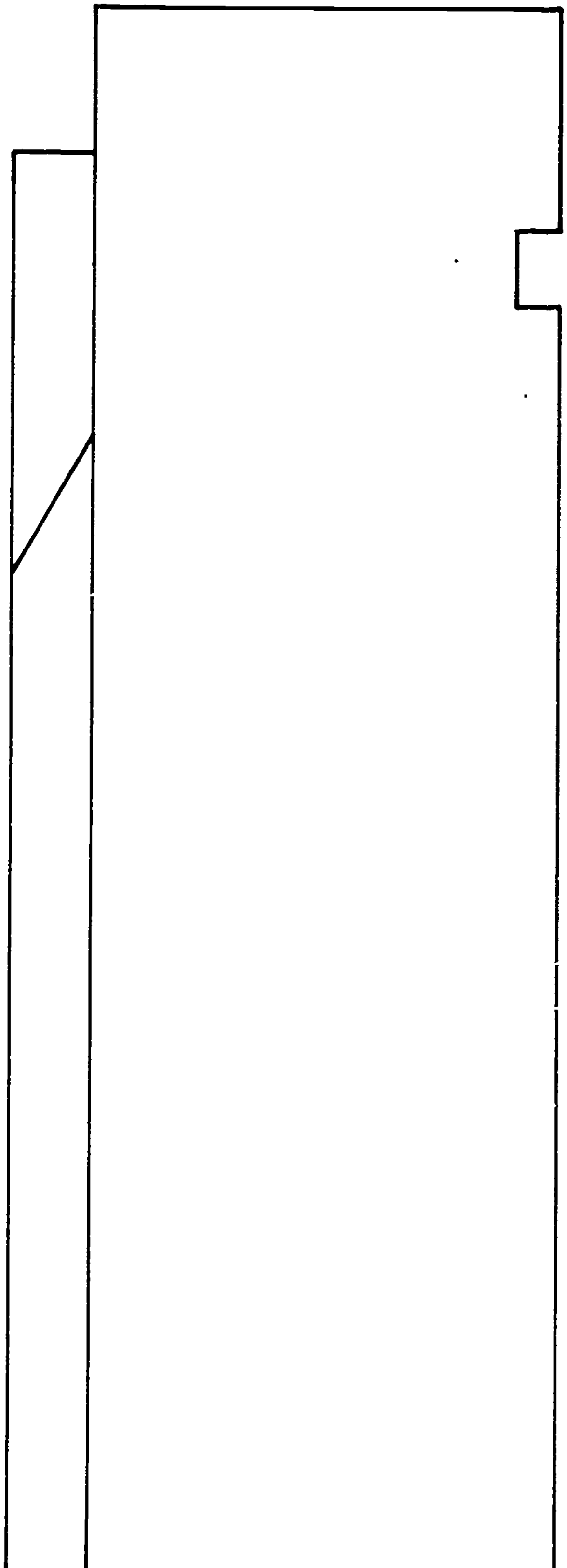

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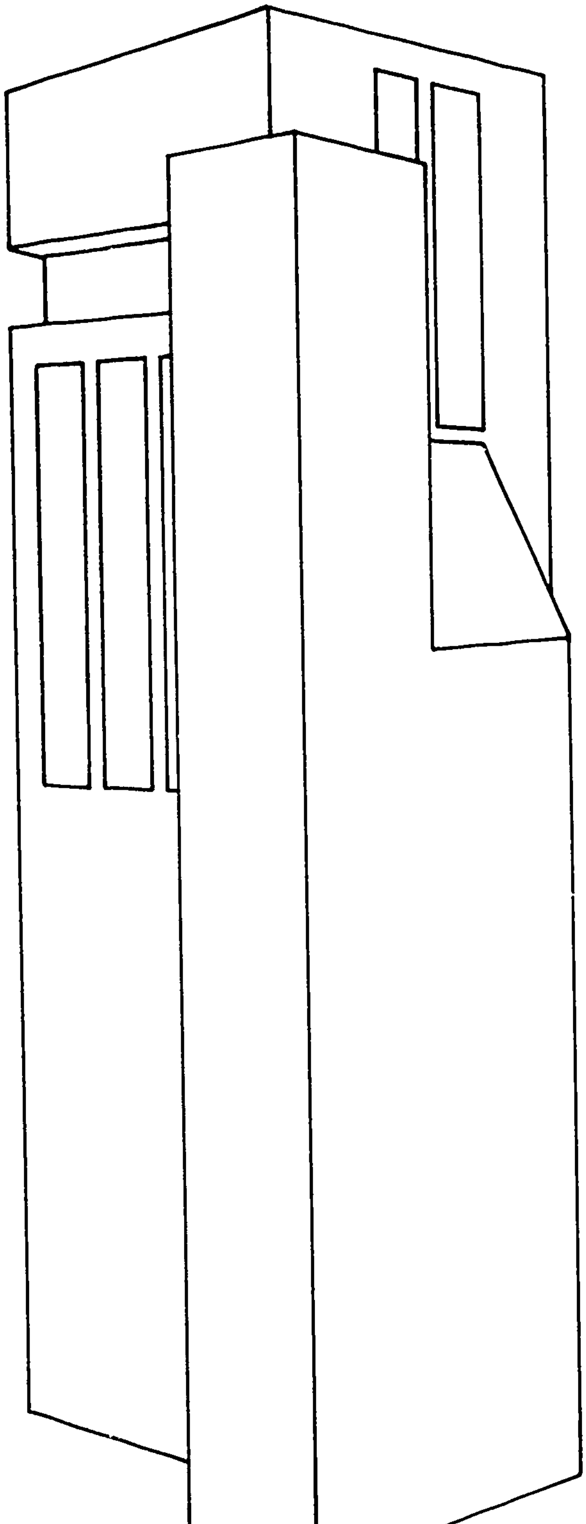


Can You Get There from Here?

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial ability**

CONTENT
Giving and following directions
Scientific Processes: communication, observation, use of numbers and use of space relations

ACTIVITY DESCRIPTION
Navigators plan and give directions to drivers who follow the directions on a map.

PREPARATION

The teacher prepares the students for the activity.

- Divide the class into pairs, one student becoming a navigator and one, a driver.
- Give each pair the following materials:
  two identical maps
  partition (an open book works well)

The navigator prepares for the activity.

- She marks a dot on both maps where the trip will begin.
- She secretly marks an end point on her map only.
- She writes her directions, one direction per line. For example,
  Go southeast on White Birch Lane.
  Turn right on Leamoor Drive.
  Go two blocks.

THE ACTIVITY

Now the challenge!

The navigator will tell the driver how to find the ending point.

- The pair will sit with the partition separating the maps from each other's view.
- The navigator reads her written directions to the driver.
- Both pairs trace the route on their maps as the navigator reads.
- The driver names the location after arriving at the destination.
- The pair check the ending point and the route by comparing maps.

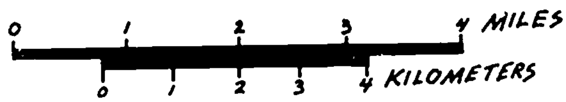
Discussion at the end might include the following:

- Did you both end up at the same ending point?
- If not, what happened?
- If repeating the activity, what might you do differently?

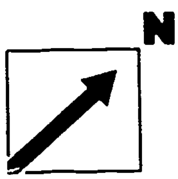
TEACHER'S NOTES

Students need to know that on most maps north is at the top of the map. Therefore, south is directly opposite north at the bottom. East is on the right and west is on the left.

Some maps have legends giving a scale of miles, such as 1 inch = 50 miles. This means that one inch measured on the map is equal to fifty actual miles on the terrain.



EXTENSIONS



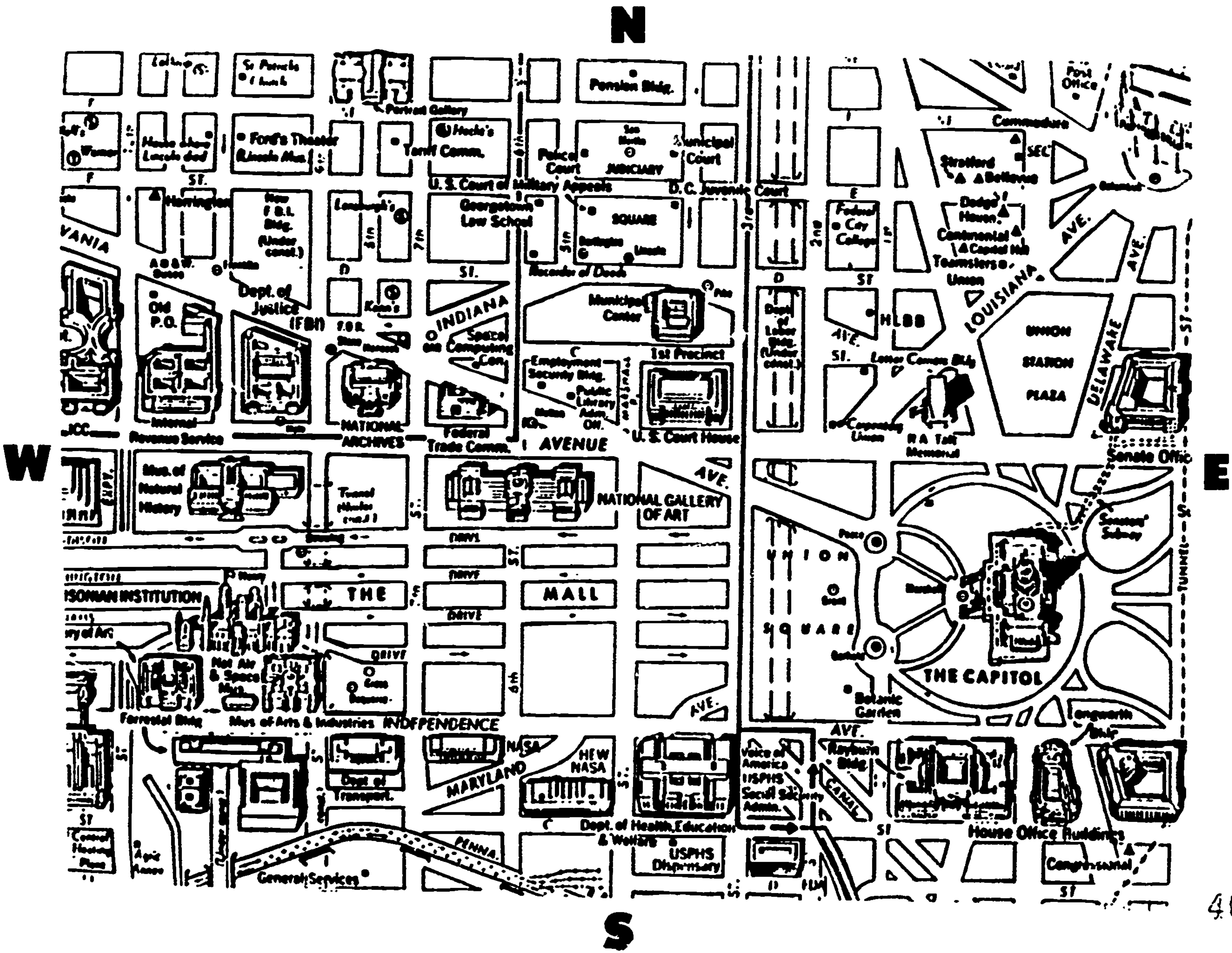
Use a map of your school, playground, community or a community being studied.

Use maps with latitude and longitude grids.

Use maps in which north is not at the top.

Susan Cline

42


N
W
E
S
Pension Bldg.
Ford's Theater
Lincoln Mus.
Tariff Comm.
Police Court
JUDICIARY
Municipal Court
U.S. Court of Military Appeals
D.C. Juvenile Court
SQUARE
Georgetown Law School
New F.B.I. Bldg. (Under const.)
Dept. of Justice (FBI)
Old P.O.
Municipal Center
1st Precinct
Employment Security Bldg.
INDIANA
Internal Revenue Service
NATIONAL ARCHIVES
Federal Trade Comm.
AVENUE
U.S. Court House
Dept. of Labor Bldg. (Under const.)
Federal City College
HLBB
Letter Carriers Bldg.
R A Taft Memorial
LOUISIANA
UNION STATION PLAZA
DELAWARE
Senate Offic
Teamsters Union
Continental
Stratford
Commodore
Dodge House
Post Office
Mus. of Natural History
NATIONAL GALLERY OF ART
AVE.
THE
MALL
DRIVE
SONIAN INSTITUTION
Nat Air & Space Mus.
Forrestal Bldg
Mus. of Arts & Industries
INDEPENDENCE
U N I O N
S Q U A R E
THE CAPITOL
Botanic Garden
AVE.
Rayburn Bldg
Longworth Bldg
NASA
HEW NASA
MARYLAND
Dept. of Transport.
Voice of America
USPHS
Social Security Admin.
CANAL
Dept. of Health, Education & Welfare
USPHS Dispensary
House Office Buildings
Congressional
PENNA.
General Services
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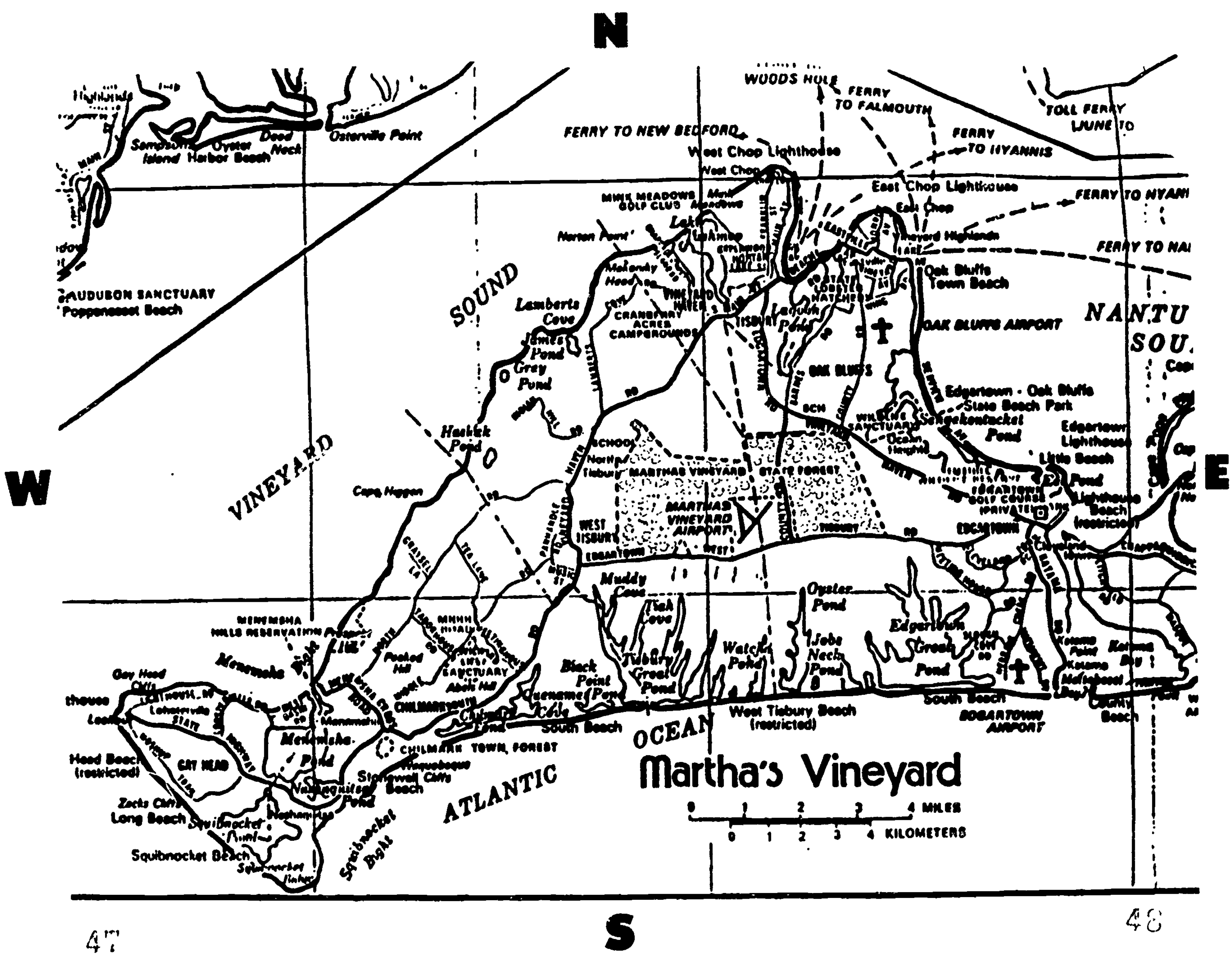
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Martha's Vineyard
0 1 2 3 4 MILES
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WOODS HOLE
FERRY TO FALMOUTH
FERRY TO NEW BEDFORD
FERRY TO HYANNIS
TOLL FERRY
West Chop Lighthouse
East Chop Lighthouse
Oak Bluffs Town Beach
OAK BLUFFS AIRPORT
Edgartown - Oak Bluffs State Beach Park
Sengekontacket Pond
Edgartown Lighthouse
Little Beach
Lighthouse Beach (restricted)
EDGARTOWN
Edgartown Great Pond
South Beach
EDGARTOWN AIRPORT
Katama Point
Katama Bay
Oyster Pond
Jobs Neck Pond
Watcha Pond
West Tisbury Beach (restricted)
Tisbury Great Pond
Black Point Pond
South Beach
CHILMARK TOWN FOREST
Stonewall Beach
Squibnocket Bight
Squibnocket Beach
Long Beach
Zacks Cliffs
Head Beach (restricted)
GAY HEAD
Gay Head Cliffs
Menemsha Pond
Menemsha
MENEMSHA HILLS RESERVATION
Peaked Hill
Cape Higgon
Lamberts Cove
James Pond
Gray Pond
Harthaway Pond
CRANBERRY ACRES CAMPGROUNDS
MINK MEADOWS GOLF CLUB
Lake Tashmoo
MARTHAS VINEYARD STATE FOREST
MARTHAS VINEYARD AIRPORT
WEST TISBURY
Muddy Cove
Tiah Cove
VINEYARD SOUND
ATLANTIC OCEAN
NANTUCKET SOUND
Osterville Point
Sampsons Island
Oyster Harbor Beach
Dead Neck
AUDUBON SANCTUARY
Poppenesset Beach

Coat and Carton

EQUALS Processes

- **Career awareness**
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT

Learn skills used by package designers

Scientific Processes: experimentation, measurement, observation and use of spatial relationships

ACTIVITY DESCRIPTION

Students estimate the flat surface of a milk carton and then test the accuracy of their estimation.

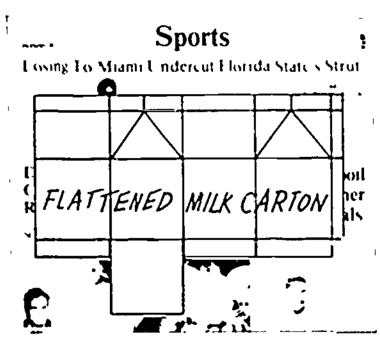
PREPARATION

Materials needed per team:

- Milk carton
- Newspaper
- Ruler
- Scissors
- Tape

THE ACTIVITY

Teams experience skills used by package designers by following the steps below:



- Teams estimate how many centimeters of newspaper is needed to cover the carton with a "coat."
- They cut the estimated "coat" in one flat piece.
- Teams cut the carton so that it can be laid out in one flat piece.
- They place the flattened carton on top of the "coat," checking the estimation.
- They find the surface area of the flattened carton.

Students discuss questions such as:

- What were some strategies you used to get your estimation?
- How did you find the surface area?
- Does this activity take planning? When?
- Does cooperation take planning?

Students discuss the following skills used by package designers:

- examining the carton design
- guessing the purpose of the design
- thinking of ways to improve the design

TEACHER'S NOTES
Estimating surface area is a skill needed by package designers. Packaging products for safe shipment or to save production costs can mean great savings to producers or retailers. For example, the change from the round glass milk bottle to the more rectangular plastic milk jug and finally to the very rectangular milk carton has made shipment of milk easier, thus making it more cost efficient.

Encourage students to find surface area in different ways. Working in cooperative groups encourages students to listen to different points of view and thus see there is more than one way to solve the problem.

EXTENSIONS

Take a close look at the packaging of products in your kitchen, garage or medicine cabinet. Examine the materials as well as their shape.

- Can you guess the purpose of the design? For example, the purpose may be to
  save production costs
  make the shipment, storage and/or safety of the product efficient

Regina Clay

Construx

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT

Discover how geometric designs add strength to structures
Scientific Processes: communication, control of variables, experimentation, measurement and use of spatial relationships

ACTIVITY DESCRIPTION

Students design, construct and test a bridge for maximum strength.

PREPARATION

Materials needed for each team:

- 20 straws
- 100 Lego® blocks
- 24 inches of transparent tape
- Scissors
- Ruler
- Weights (blocks, ceramic tiles or marbles)
- Weighing pan (sardine-size can)

THE ACTIVITY

Teams plan the design of the bridge.

- Students discuss the following rules:
  Bridges should be designed for maximum strength.
  Each bridge will be tested for strength by placing weights on the center of the span.
  The only restriction to the bridge design is that the span must be at least 10" long and self-supporting.
  Students have 35 minutes to complete the activity.
- Teams draw a picture of the design.
- They write reasons for creating this design.

Teams construct their bridge.

Teams test the strength of the bridge by doing the following:

- They place the weighing pan in the center of the span.
- They add weights one at a time until the maximum load is reached.

Give a clap for team effort!

Discussion might include the following:

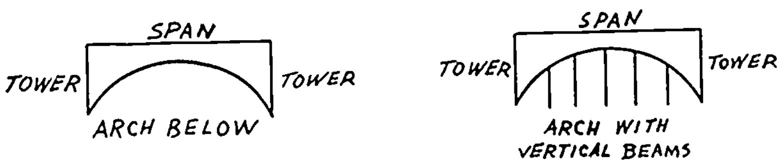
- What factors helped increase the strength of your bridge?
- What factors did you discover to be irrelevant for increasing the strength?
- Did this activity take cooperative planning?
- Were your ideas heard?
- Are you pleased with your structure?

TEACHER'S NOTES

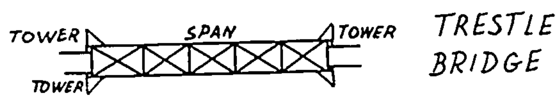
Since students are building their bridges for maximum strength, they need to know that loads are outside forces acting on the bridge. One force is the weight of the span due to the pull of gravity. A long span doesn't make a very good bridge. It can sag from its own weight. Another force adding weights to the span increases the load, causing further sagging.

The teacher and/or students need to decide how much sagging will be permitted (maximum load) when they do this activity. This can be defined in a variety of ways. For example, maximum load is achieved when the span first bends. Another example could be when the span touches the table.

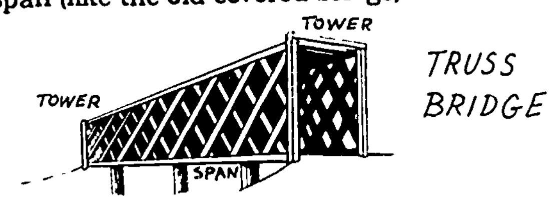
Several factors help increase the strength of the bridge span. Some of these are design, length and materials used in the span and the towers. Various geometric designs are used to add strength when constructing bridge structures. One geometric design used is the arch. Arches are used above or below the span, by themselves or in combination with vertical beams.



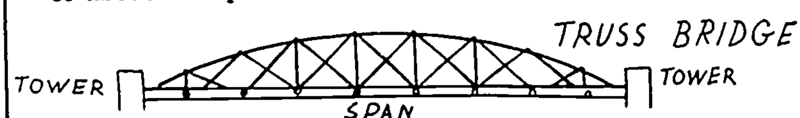
Another geometric design is the triangle arch above. Triangles are used to strengthen trestle bridges and truss bridges. Trestle bridges are made with concrete beams that form crisscrosses.



Truss bridges are made from metal cables that crisscross above the span (like the old covered bridge)



or above the span with an arch.



EXTENSIONS

Look for geometric designs used as supports in buildings.

Construct other bridge designs from photographs or pictures.

Construct a small bridge as a community or school project.

Jim Henley

Crime Stoppers

EQUALS Processes
- **Career awareness**
- **Cooperative learning**
- **Problem solving**

CONTENT

Experiment with physical properties of substances such as solubility, conductivity and particle size
Scientific processes: classification, control of variables, formulation of hypotheses, measurement, operational definitions and prediction

ACTIVITY DESCRIPTION

Students become forensic scientists who solve a crime by examining physical properties in order to separate the substances of a mixture.

PREPARATION

Materials needed for each group:

- 4 substances mixed together in equal amounts:
  - powdered sugar
  - powdered calcium carbonate (obtained by scraping chalk with a knife)
  - coarse ground pepper
  - rock salt
- Water
- Filter paper or paper towel
- Funnel
- Stirrer
- Wool
- Balloon
- Fine mesh screen or flour sifter
- Tweezers
- Pencil
- Paper
- Scissors
- Large paper plate

THE ACTIVITY

Record Sheet

Procedure	Equipment Used
Step 1	
Step 2	
Step 3	
Step 4	
Step 5	
Step 6	
Step 7	
Step 8	
Step 9	
Step 10	

Before doing the experiment, student groups will plan ways to solve a crime.

- They discuss the procedure they might use considering these points:

  The physical state of the substances can be changed. What can each substance do that might be useful in separating the mixture?

  The equipment supplied is sufficient for the procedure. The sample will be divided into several portions to allow many experiments.
- They list the steps and equipment to be used.

Students then proceed as forensic scientists by following their plan.

Discussion at the end might include the following:

- Did your plan work?
- What are the four substances?
- What physical changes occurred?

TEACHER'S NOTES

A forensic scientist uses analytical chemistry and the scientific method in solving crimes. When gathering evidence, this scientist may use the skill separating substances in a mixture. Once the mixture is separated, she will do more experiments to identify the unknown substances.

The substances may be separated through knowledge of physical properties of the substances. Physical properties are characteristics that can be seen with the five senses and do not cause a substance to become a different substance.

Physical properties include the following:

Static charge—an electrical charge that can be brought about by rubbing a balloon with a wool cloth.
Solubility—refers to the ease with which a solid dissolves (disappears) in a liquid. If a solid can dissolve in a liquid, it is said to be soluble in the liquid. Salt and sugar are soluble in water. If a solid cannot dissolve in a liquid, it is said to be insoluble. Pepper and calcium carbonate powder are insoluble in water.
States of matter—exist in three forms: solids, liquids and gasses. A physical change takes place when the state of matter changes, for example, when a solid is changed into a liquid or when a liquid is changed into a gas.

Here is one way to solve the crime:

Sift entire mixture. This should separate the salt and pepper from the calcium carbonate and sugar due to particle sizes.
Remove pepper from the salt with a balloon charged with static charge. The broken facets of pepper will hold a static charge while the stable crystalline structure of the salt will not.
Pour sugar and calcium carbonate into water. The sugar will readily dissolve while the calcium carbonate will not. Pour the whole mixture through the funnel and filter paper. The calcium carbonate will remain in the filter while the sugar will pass through with the water.

ADAPTATIONS

Ways to simplify the activity:

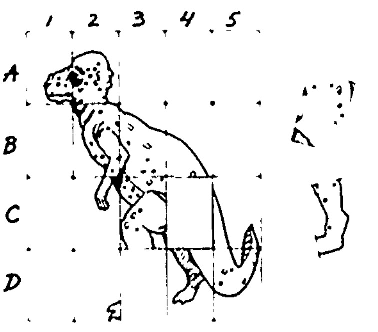
- Put each substance in separate containers and test their physical properties separately before mixing them.
- Use mixtures of two substances instead of four.

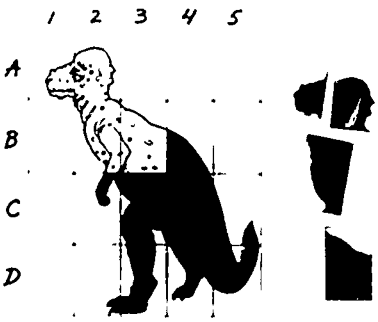
Alice Bick and Chuck Vizzini

56

Dinosaur Quest

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**





CONTENT

Examine unique features of dinosaurs
Scientific Processes: classification, communication, observation and use of numbers

ACTIVITY DESCRIPTION

Students will fit dinosaur picture squares on a grid and then match corresponding shadow squares.

PREPARATION

For each dinosaur you will need the following:

- Dinosaur picture
- Scissors
  - Cut the picture into squares.
  - Mark grid placement on the back of the squares.
- Shadow picture
  - Repeat the procedure used with dinosaur picture.
- Blank grid

THE ACTIVITY

Students working in pairs fit dinosaur pieces together.

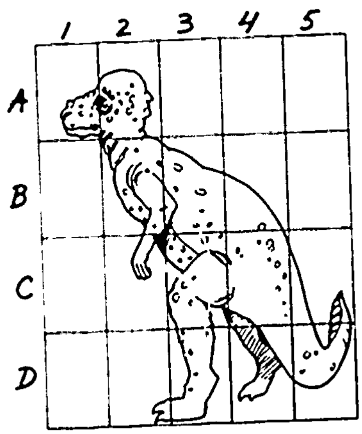
- They place picture squares on the grid.
  - Child A picks the picture square.
  - She uses the grid code on the back to place the square in the proper place on the grid.
  - Child B picks another square and places it on the grid.
  - Students take turns until the puzzle is complete.
- They match shadow squares to picture squares.
  - Students take turns until the picture is complete.

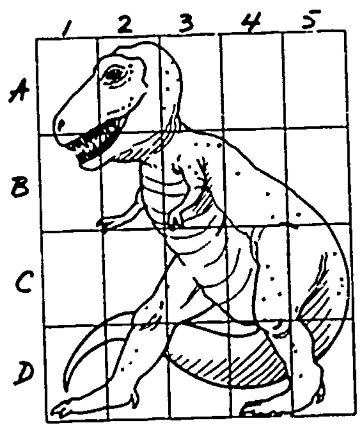
When the picture is complete, the students do the following:

- They discuss special dinosaur features observed.
- They make inferences as to whether the dinosaurs ate plants or meat.

TEACHER'S NOTES

Pachycephalosaurus was called the giant bone head. Its skull was 20" long and the bone was 9" to 10" thick. It had bumps and spikes of bone decorating its head and face. Its forelegs had no claws and its teeth were blunt, indicating it was probably a plant eater.





Tyrannosaurus Rex had a very big head, a large body and very tiny forelegs. The forelegs were used to help Tyrannosaurus get up after resting on its belly. It had sharp, pointed teeth, about 6" long, and claws on its forelegs that were used for eating meat.

EXTENSIONS

Substitute dinosaur skeleton squares for dinosaur shadow squares.

Make a shadow of a student's face, hand or other body part and make it into a picture grid.

Kathy Shonts

Directions from the Sun

EQUALS Processes
- Cooperative learning
- Problem solving
- Spatial skills

CONTENT

Investigate how the relative position of the earth to the sun affects the length and direction of shadows

Scientific Processes: experimentation, measurement and observation

ACTIVITY DESCRIPTION

Students record lengths of shadows before, during and after noontime to discover that the shortest shadow of the day points north.

PREPARATION

Materials needed per team of three:

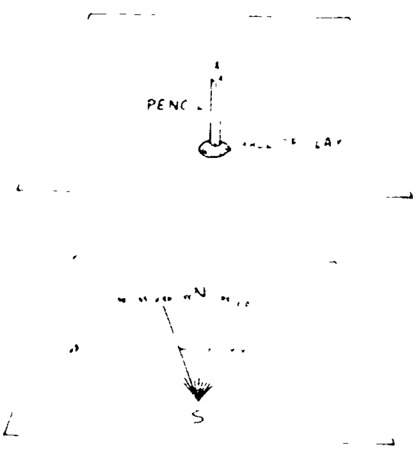
- A sunny day around noon!
- Pencil
- Small ball of clay
- White poster board
- Watch

THE ACTIVITY

Each team member takes one of the following roles:

- Timekeeper—to tell when to draw shadows
- Monitor—to set up and keep the equipment stationary
- Recorder—to draw the shadow and record the time

Team members gather data by doing the following:



- They line up the poster board with the sunny side of a building.
- They stand a pencil in the center of the clay ball.
- They attach the clay ball to the center of the poster board.
- They draw the pencil's shadow.
- They record the time at the end of the shadow.
- They repeat this procedure every five minutes, from approximately 20 minutes to noon to 20 minutes after noon.

Teams discover north and other directions with the following steps:

- They find the shortest shadow and label the tip of the line N for north.
- They remove the clay ball.
- They label the opposite end of the line S for south.
- They draw a perpendicular line across the north-south line at the midpoint.
- They label the left side W for west and the right side E for east.

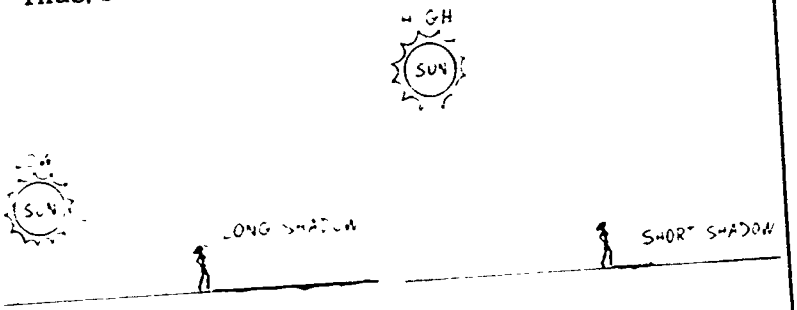
Using the information gathered, students discuss the following:

- Is north the same no matter where the poster board is placed?
- Why is the shortest shadow always pointing north?
- Can you decide which way the school, the gym or the cafeteria faces?
- Did everyone help complete the task?

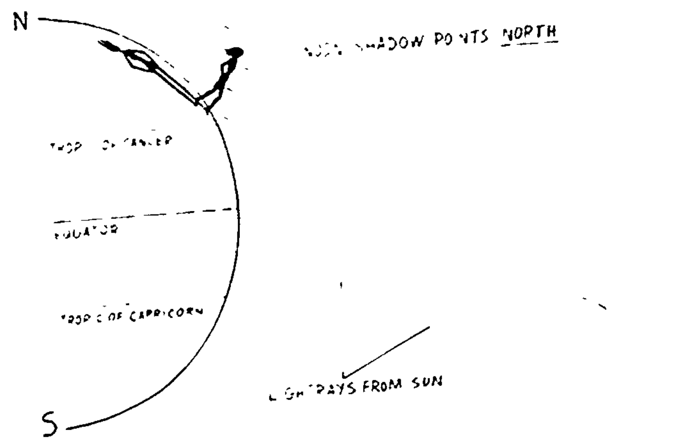
TEACHER'S NOTES

Why does the shortest shadow of the day point north? At noon, the sun is halfway across the sky or halfway between east and west. Shadows cast by the sun will point either north or south.

On any day, the sun is highest in the sky around noon. Thus, shadows will be shortest approximately at noon.



Whether the shadow points north or south depends on where you are on earth. The sun is always south of all parts of the United States (except Hawaii); thus, noontime shadows will point **north**.



Each team receives one set of materials and sets up in a sunny location on a sidewalk or hard playground surface. Line the poster board up with the side of a building. This will help students in comparing results between teams and in answering questions such as "In which direction does the school, gym or cafeteria face?" If materials have to be taken up during the experiment, put them in the exact same location so as not to negate the results.

EXTENSIONS

Have students repeat the experiment at home to find out which way their house faces.

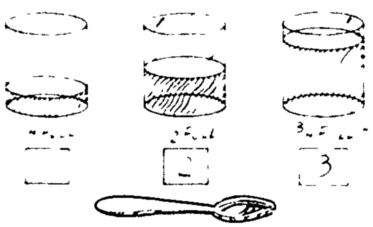
Find locations on earth where a noon shadow does not point north.

If you were lost in the desert, could you find your way to Phoenix if you knew that it was north of the desert? How?

Sue Griswold and Rich Reif

Glassy Tunes

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**



CONTENT
Discover that the pitch of a sound is determined by the mass of the vibrating object
Scientific Processes: communication, experimentation, measurement and observation

ACTIVITY DESCRIPTION
A student attempts to repeat a sequence of sounds that another student has just tapped on water glasses.

PREPARATION
Materials needed:

- 3 identical glasses
- Water
  Fill one glass 1/4 full, one 1/2 full and one 3/4 full.
  Label the glasses 1, 2 and 3.

THE ACTIVITY
The fun begins:

- Choose a bandleader and a musician.
- Let both students practice tapping on the water glasses with the spoon.
- Have the musician close her eyes while the bandleader taps out a sequence of three notes.
- Then have the musician correctly repeat the sequence.
- The musician becomes the new bandleader if the sequence is correct.

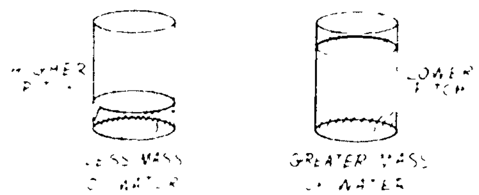
Continue with new musicians until all have had a turn.

Discussion might include the following:

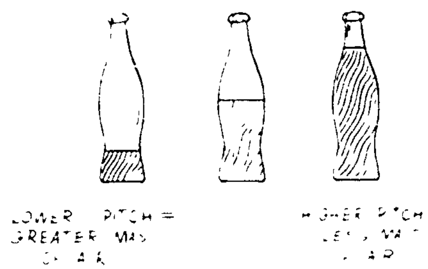
- What made the highest sound? Why?
- What made the lowest sound? Why?
- As a musician, what strategies did you use to hear and remember the sounds?
- Is cooperation necessary in this activity? Why?

TEACHER'S NOTES

Sound is produced by a vibrating object (in this case, a vibrating glass of water and air). Sound travels in the form of sound waves to our eardrums, which vibrate and send a signal to our brains via our nerves. The highness or lowness of sound is called pitch. Pitch depends on the frequency, or number of vibrations. The faster the vibrations are, the higher the frequency and the higher the pitch. The slower the vibrations are the lower the frequency and the lower the pitch. Objects with **less mass** vibrate fast and have a **high pitch.** Objects with **more mass** vibrate slowly and have a **low pitch.** When you tap the glass with the most water in it, you get the lowest pitch because the vibrations are slow. When you tap the glass with the least amount of water in it, you get the highest pitch because the vibrations are fast.



EXTENSION



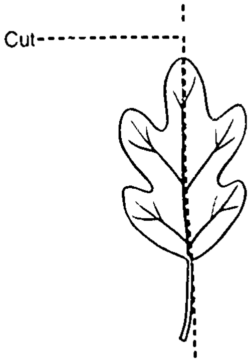
Vary the vibrating object, using air instead of water. Set up a different musical situation by doing the following:

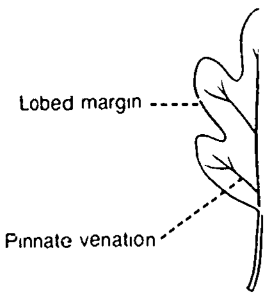
- Use sodapop bottles with varying amounts of water in them.
- Have students predict which bottle will produce the highest pitch when blown across.
- Ask why the emptiest bottle produces the lowest pitch.
- Does the rule of mass still apply?

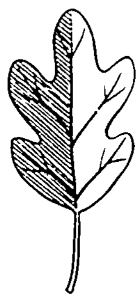
Cathy Preiss

Half-a-Leaf

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**







CONTENT

Compare and contrast leaf characteristics of shape, margin, venation and symmetry
Scientific Processes: observation, classification, measurement, communication and prediction

ACTIVITY DESCRIPTION

Students become amateur botanists by studying and drawing leaf halves, then finding a matching half.

PREPARATION

Materials for each student:

- Sheet of plain white paper
- Pencil
- Ruler
- Magnifier if available
- Small plastic bag

Also needed:

- Large sack

Select and prepare leaves (for each group of ten students):

- Choose five different trees and collect two leaves from each that are about the same size and shape. Look for some with bilateral symmetry and some without.
- Separate the ten leaves into two-leaf sets. Put one leaf from each of the five different trees in each set.
- Put aside one leaf set
- Cut the other leaf set through the center from top to bottom.
- Put each half into a plastic bag.
- Put all of the bagged halves into the large sack.

THE ACTIVITY

While the students are working, the teacher can tape the uncut leaf set on the chalkboard.

Each student draws a bagged leaf from the large sack and makes its acquaintance.

- She looks at and identifies the shape, the margin and the venation.
- The student records its measurements.
- She traces the leaf half onto paper and draws in the details.
- She draws what she thinks the other half will look like to make a complete leaf.

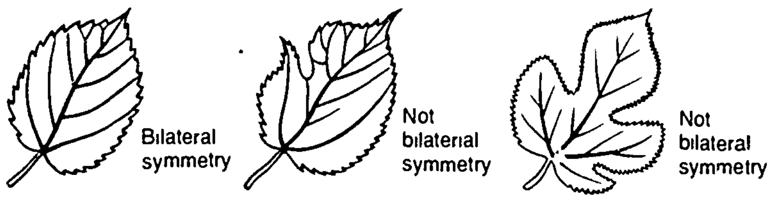
And then comes the fun—finding the person with the other half of your leaf and putting the two halves beside the whole on the chalkboard!

The discussion at the end might include the following:

- What were some of the new words we learned? (venation, toothed, smooth, lobed, palmate, pinnate . . .)
- Were the right and left side of your leaf similar?
- Let's talk about bilateral symmetry, similarity and correspondence.

TEACHER'S NOTES

Scientists observe living things and classify them according to their likenesses and differences. The body plan or symmetry is one way animals and plants are classified. Organisms that can be divided into right and left sides that are similar have a design called bilateral symmetry. Similar sides do not mean that the halves are a perfect match. Humans exhibit bilateral symmetry.



EXTENSIONS

Make rubbings of leaves.

Pick many more leaves and classify them.

Develop a field guide for local trees.

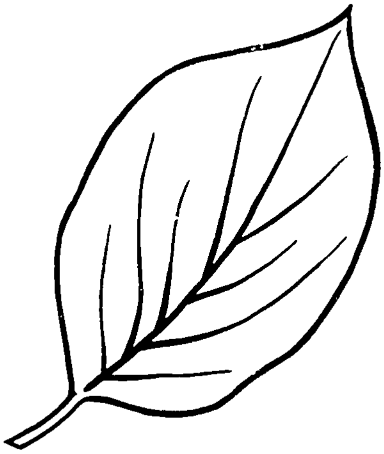
Collect flowers and classify according to symmetry.

Beth Hawfield

Examples of Leaves

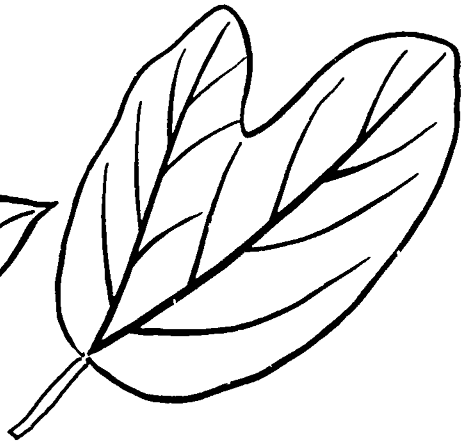
Symmetry of Leaves

Sassafras Leaves



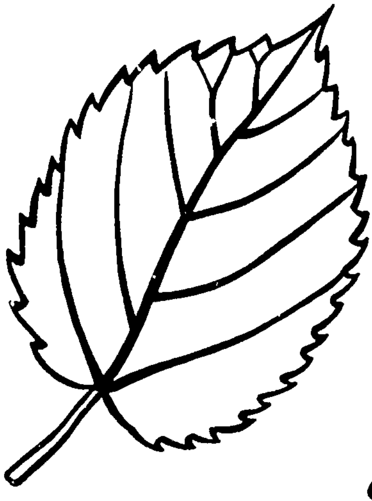
Bilateral symmetry

Bilateral symmetry

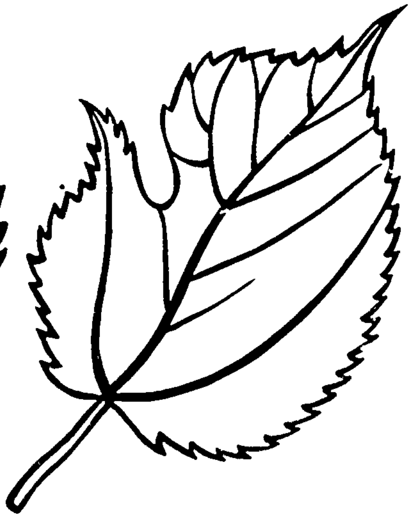


Not bilateral symmetry

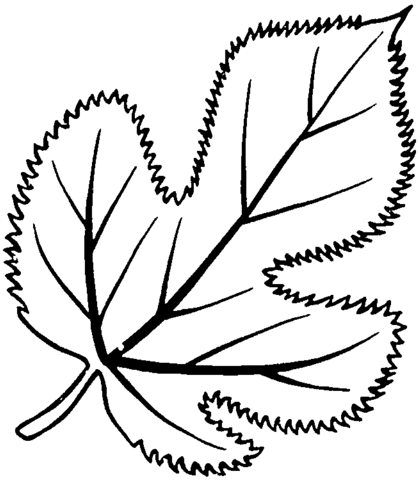
Mulberry Leaves



Bilateral symmetry

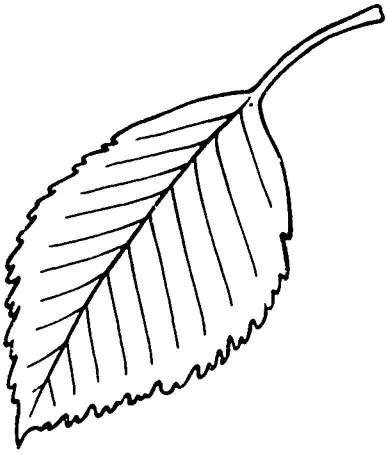


Not bilateral symmetry

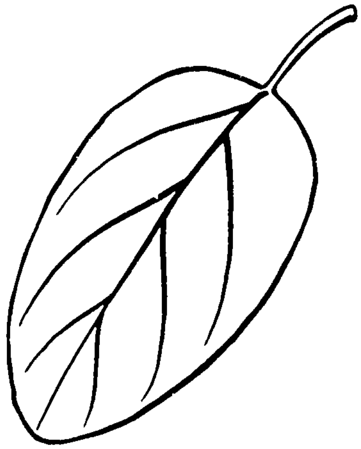


Not bilateral symmetry

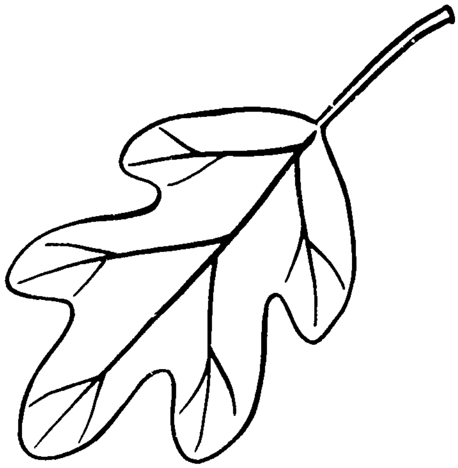
Leaf Margins



Toothed

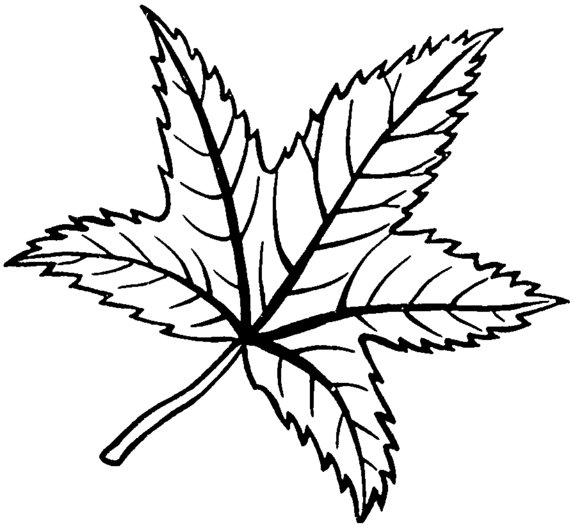


Smooth



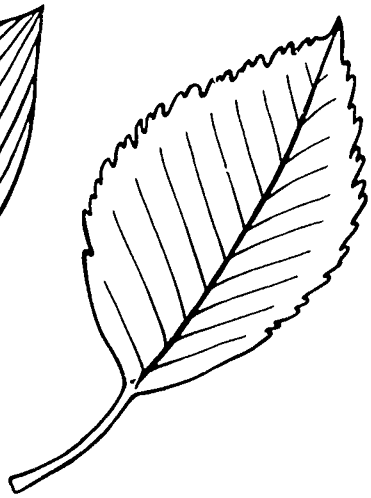
Lobed

Leaf Venation



Palmate

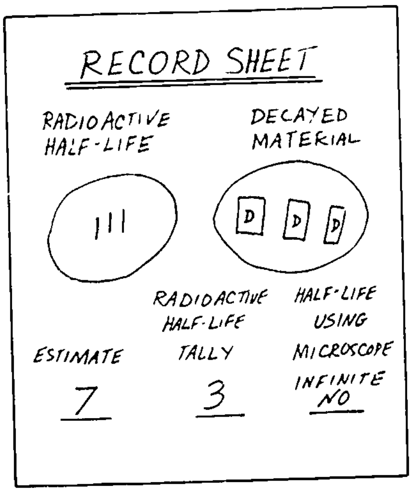
Parallel



Pinnate

Half-Life Is More than Meets the Eye!

EQUALS Processes
- **Problem solving**
- **Spatial skills**



CONTENT

Discover that a radioactive substance never completely disappears from the environment

Scientific Processes: measurement, observation and use of scientific model

ACTIVITY DESCRIPTION

Students simulate radioactive half-life by repeatedly dividing a piece of construction paper in half.

PREPARATION

Materials needed:

- Sheet of construction paper
- Scissors
- Record sheet
- Magnifying glass

THE ACTIVITY

Students pretend that a sheet of construction paper is a radioactive substance.

They estimate how many times this radioactive substance can be divided in half, recording this estimate at the bottom of the record sheet.

Students discover the half-life of this radioactive substance by taking the following steps:

- Cut the construction paper in half, placing one piece in the radioactive half-life pile and the other in the decayed material pile.
- Make a tally mark in the radioactive half-life pile on the record sheet.
- Pick up the paper (radioactive piece) and continue to cut in half, place and tally until it is too small to be cut anymore.
- Count the number of radioactive half-life tallies in the radioactive pile.

Record this number at the bottom of the record sheet.

Students then use a magnifying glass or microscope and discover if the remaining radioactive piece can be divided to the last atom of paper.

Discussion should include:

- How did your estimate compare with the tally of radioactive half-lives?
- How would this tally change when you use the magnifying glass or microscope?
- After doing this activity, what can you infer about the time it takes radioactive substances to disappear?
- What kind of problem(s) does radioactive half-life create for living things?
- Is half-life really more than meets the eye?

TEACHER'S NOTES

Radiation is a type of energy that is given off by unstable atoms. They seek to become stable by dividing in half (decaying). This half-life is the time it takes for a radioactive material to lose half of its radiation. Half-lives range from a fraction of a second to several billion years. Chlorine has a half-life of 2.8 seconds and Uranium 235 has a half-life of 700 million years. The radiation that is given off is harmful to living things because it can change the chemistry of living tissue. Therefore, we must protect ourselves from radiation. Uranium 235 presents a serious containment problem when it remains radioactive (harmful) for so long.

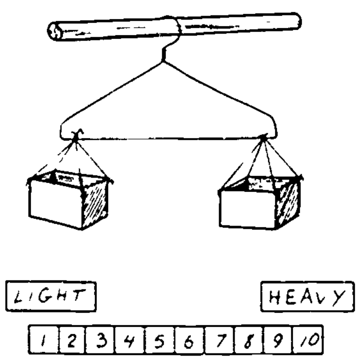
EXTENSION

With sand, use a pan balance, removing half each time until you have less than 1 gram left in the radioactive substance container. Decide how many more half-lives would need to pass before you get down to the last grain of sand. How about the last atom in that grain of sand?

Edie DeMay

Heavy Rock

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**



CONTENT
Compare and contrast the weight and size of rocks
Scientific Processes: classification, communication, measurement, observation, prediction and use of numbers

ACTIVITY DESCRIPTION
Students will order rocks from heaviest to lightest, check their guesses by weighing and then comparing size and weight.

PREPARATION
Materials needed for partners:

- Milk carton

Additional materials needed:

- Rocks of assorted sizes and weights
- Pan balance, made from dowel, coat hanger, milk cartons and string (as shown)
- Markers
- Chart paper
  Label as shown.
  Place on floor.

THE ACTIVITY
Partners will gather rocks.

- They look for the heaviest rock to fit into their container.
- They initial the rock.

The whole class will order rocks.

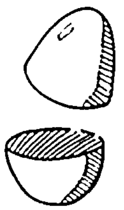
- Partners decide where their rock belongs on the chart.
- They move other students' rocks if necessary.

Check the correct order by comparing the weight of rocks using the pan balance.

Discussions might include the following:

- Can you always determine a rock's weight by looking at its size?
- Does a large rock always weigh more than a small rock?
- What might make a smaller rock heavier?
- Do rocks that are the same size always weigh the same?
- What are rocks made of?

TEACHER'S NOTES
Matter has basic properties such as weight and size. Many students will assume that ordering rocks from heaviest to lightest will coincide with ordering rocks from largest to smallest. They will be surprised to discover that a larger rock does not always weigh more than a smaller rock.

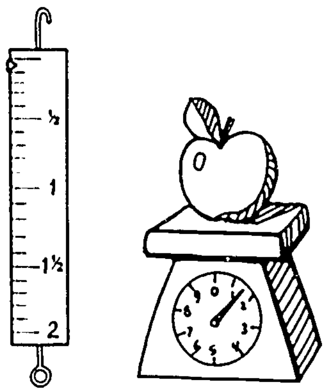


EXTENSIONS

Enclose objects in plastic containers (like the type some hosiery come in). Compare the containers in the same way you do the rocks.

Use other objects for ordering, such as shells, fruits, vegetables or different types of wood.

Use a variety of scales.

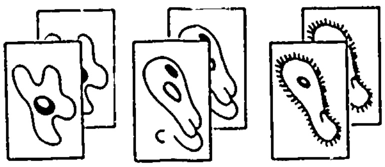


Kathy Shonts

I Spy a Critter

EQUALS Processes
- **Cooperative learning**
- **Problem solving**

kingdom protista



amoeba euglena paramecium

CONTENT
Recognize the classification of organisms
Scientific Processes: classification, communication, inference and observation

ACTIVITY DESCRIPTION
Students use deductive reasoning to guess the identity of an organism.

PREPARATION
Materials needed for each group of four students:

- Set of "Critter Cards," 2 copies of each

THE ACTIVITY
Groups receive their critters.

- They select and mix up three pairs of cards from one set.
- They deal one card, face down, to each player.
- They place remaining two cards face down on the table.
- Each student puts her card on top of her head without looking at it, but keeps it in full view for others.

Then the students deduce their critter.

- They look at other cards, remembering that the cards are in pairs.
- They review clues from other students' guesses.
- The students continue to guess until all critters have been deduced.

Discussion at the end might include:

- How did you decide the identity of your critter?
- Did you need more than one guess? Why or why not?

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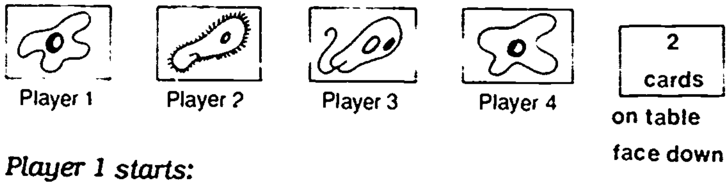
TEACHER'S NOTES

An example of a game might be the following:

Protista cards (2 amoebas, 2 euglena and 2 paramecia)



Player 1 starts:
She sees one of each type. She must merely guess. Let's say she chooses **paramecium.**
Player 2:
She sees two amoebas and one euglena. She would probably think her best choice would be **paramecium,** but player 1 said paramecium. Player 1 must not have seen a paramecium, so player 2 chooses **euglena.**
Player 3:
Player 3 sees two amoebas and one paramecium. Player 1 said paramecium and player 2 said euglena. Player 3 decides to choose **euglena.**
Player 4:
Player 4 sees one of each, but none of the other players said amoeba, so she decides to choose **amoeba.**
Player 1:
Continue until all feel they have the correct identity.

Cards may be used with or without names. You may want to make your cards from one subdivision of a kingdom. An example might be to use three pairs of reptiles.

All living things are grouped into divisions called kingdoms. There are five kingdoms: plant, animal, protista, monera and fungi. Then the kingdoms are subdivided into small groups called phyla. Phyla are divided into classes and so on.

kingdoms
↓
phyla
↓
classes
↓
orders
↓
families
↓
genera
↓
species

The more the group is subdivided, the more similarities there are among the members of that group and the more closely related the members are.

ADAPTATIONS

Mix critters from different subdivisions. An example might be one pair of amphibians, one pair of aves and one pair of mammals. Substitute other objects such as clouds, weather instruments, elements and so on.

Annette Caudle

It's Your Decision

EQUALS Processes
- **Career awareness**
- **Cooperative learning**
- **Problem solving**

CONTENT

Explore careers in science and technology to become aware that current issues in science affect society
Scientific Process: formulation of hypotheses

ACTIVITY DESCRIPTION

Students will cooperatively look at current issues in science from many points of view and then choose one position to present to the whole class.

PREPARATION

Materials needed for each group of four or five students:

- Set of 6 Problem Cards
- Scissors
- 5 x 8 index cards
- Glue

Cut out each Problem Card.
Glue to index card.

THE ACTIVITY

Each group will prepare to problem solve using the following method:

- Look at Problem Card 1.
- Pick a spokesperson.
- Assign roles to other group members.

The group will discuss Problem 1.

- Have the spokesperson read Problem Card 1 to the group.
- The group ponders the problem silently.
- Each player voices concerns, expresses views and defends a position for the role assigned.

The group will prepare for whole class discussion by choosing one of the roles and its position to present.

Now comes the chance to "climb on a soap box."

- The spokesperson from each group presents the position that the group decided on.
- Other students ask questions or add other opinions.

Problem Card 2 will then be discussed.

- The group looks at the card.
- They select a new spokesperson and assign new roles.
- They repeat the same procedure as above.

TEACHER'S NOTES

You may need to do a preliminary activity to define occupations, for example, geologist or physicist.

The teacher's role in facilitating the whole class discussion is critical. You need to act as a consultant rather than answer-giver by asking questions that stimulate higher levels of thinking. You should avoid trying to change or sanction a student's belief. Encourage students to listen to all points of view. Bring in current events where appropriate.

Encourage the class to discuss the issue and help them problem solve. Help them understand the different positions presented by the various roles. You might consider modeling a discussion of a problem with a small group. The teacher might use all or part of the following problem-solving model.

1. **Define the problem.** Paraphrase the problem. If necessary, make models or draw pictures.
2. **Simplify the problem.** Organize information in the form of a graph, list or chart. Break it down into simple steps.
3. **Generate options.** Brainstorm alternatives without judgment or evaluation. Document your options.
4. **Evaluate.** Look at the advantages and disadvantages, and long- and short-term consequences.
5. **Decide what to do.** Eliminate worst choices first. Consider combinations. Review to see if it could be solved differently.

EXTENSIONS

Have students back up the position taken by the various roles by bringing in available data for support.

Have the groups make up their own Problem Cards. Have students bring in newspaper or magazine articles with pertinent current events that can be discussed.

Bring in pictures of scientists showing their on-the-job environment and/or invite members of the community to visit your classroom and discuss their occupations.

Cathy Preiss

Problem Cards

Problem Card 1

A city learns that a major textile company is discharging hazardous waste into a nearby river. The river is the main source of water for the city. The president of the company says that it will cost thousands of dollars to process this waste in order to prevent pollution of the river. She also states that the company cannot afford this expense, and if they are forced to process this waste, they may have to cut back production at the factory. The factory workers are upset because they fear their jobs will be lost if the factory cuts back production. Assume one of the following roles and decide what should be done from that person's point of view:

President of the Textile Company
Engineer
Environmental Protection Agency Official
Newspaper Reporter
Factory Worker

Problem Card 2

A welder in a nuclear power plant that is under construction becomes aware that the inspector is not taking the time or money to x-ray all the welds. If he "blows the whistle" on the inspector, he may lose his job. It is required by law that all welds must be x-rayed. Assume one of the following roles and decide what should be done from that person's point of view:

Welder
Inspector
Nuclear Regulatory Commission Official
Concerned Citizen(s)

Problem Card 3

A hundred different families lease land on a lake from the county. The Browns have a cabin on their leased land, but their fifty-year lease is about to end, and the county commissioners do not want to renew the lease. The commission's reason is that the county's population has grown considerably during the last fifty years, and all the taxpayers should be able to use the Brown's land for access to the lake. They are also considering not renewing any of the leased land as each parcel comes up for renewal. Assume one of the following roles and decide what should happen from that person's point of view:

Ms. Brown
County Commissioner
Lawyer
Angry Taxpayer
Ms. Brown's Neighbor

Problem Card 4

A nurse in a hospital becomes aware that a prominent physician has not followed correct procedures in signing out a controlled substance medication. Assume one of the following roles in making your decision about what should be done:

Nurse
Nurse's Supervisor
Physician
Hospital Review Board Member(s)

Problem Card 5

Your city needs a new landfill site. The city officials have studied the situation and have decided that the Smith farmland is best suited for this purpose. The Smith's land has been in their family for four generations, and they are opposed to this decision. Assume one of the following roles in making your decision on what should be done, using that person's point of view.

Ms. Smith
City Official
Environmentalist
Chemist
Lawyer

Problem Card 6

Everyone in your group has been chosen to be an astronaut on the next trip to Mars. Your mission has the responsibility of conducting geologic experiments in order to find metals that might be useful on Earth. Because your spacecraft is very small, you may only take ten pieces of equipment that are essential to the overall goals of the mission. All standard equipment is accounted for, including food and water. You must decide what you need to conduct your scientific studies, and then defend your reasons for taking it on board. Try to see if all equipment can be used by at least two of the scientists. Assume one of the following roles and decide what equipment should be taken.

Chemist
Physicist
Geologist
Biologist
Medical Doctor

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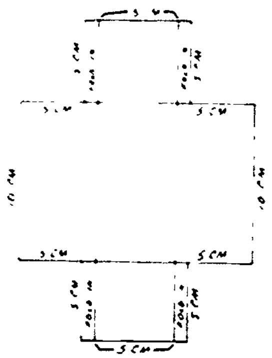
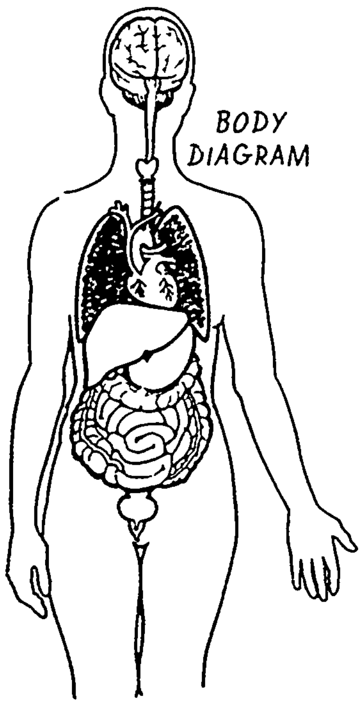
More into Less

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**


BOX PATTERN



CONTENT

Discover how an organ with a large surface area can function efficiently in a small space

Scientific Processes: inference, observation, prediction and use of spatial relationships

ACTIVITY DESCRIPTION

Students fit a large piece of carpet foam into a box and relate this scientific model to organs of the human body.

PREPARATION

Materials for box:

- Poster board
  Trace the pattern and cut.
  Tape edges.

Materials needed for each group:

- Box
- Five-centimeter-thick foam
  Cut 68 square cm.
- Body diagram

THE ACTIVITY

Groups discover how to fit a large surface area into a small space.

- They design at least three different ways to fit the carpet foam into the box.
- They discover which way leaves the greatest amount of ex . sed surface area.

Groups will apply this "more into less" concept to the human body by looking at a body diagram to find organs that demonstrate this concept.

Discussion might include the following:

- What are different ways you discovered for fitting "more into less"?
- Which method exposed the most surface area?
- What are the possible advantages for the organs of the body to use the "more into less" design?
- What possible problems might result from this design?

TEACHER'S NOTES
Have students research the advantages and disadvantages for organs that have the "more into less" design.

There are three organs that demonstrate this design—the intestines, the lungs and the brain. Each of these organs has parts with large surface areas that fit into relatively small spaces and at the same time expose the greatest amount of surface area. For example, the small intestine is 7 meters (23 ft.) long and 2 1/2 centimeters (1 in.) thick. It coils back and forth many times to expose a large amount of surface area and also to fit into the small abdominal cavity. The large amount of exposed surface area allows digested food to pass through the small intestines to the blood stream.

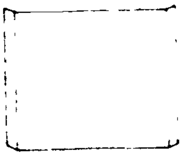
The lungs are composed of one large mass of air sacs. The air sacs have a large surface area that fits into the relatively small lungs. The sacs resemble clusters of grapes. The large amount of exposed area of the air sacs allows more oxygen to pass through the blood.

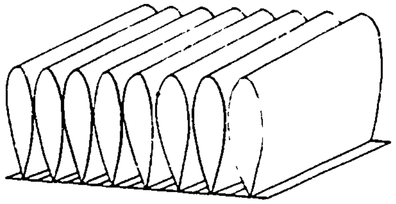
If the cerebral cortex of the brain were to be laid out flat, it would be 5 cm thick and would cover a surface area of about 68 square cm. The cerebral cortex fits into a space of 1,200–1,500 cc in the skull by folding many times, giving the brain a wrinkled surface. This wrinkled surface provides a great deal of exposed surface area, which better supports the complex nerve circuitry of the brain. As a flat area, the cerebral cortex would be difficult to protect. The rounded structure of the skull provides much better protection. Hence the need for the "more into less" design.

EXTENSIONS

To demonstrate a "more into less" design:

- Take an 8 1/2" x 11" piece of paper and calculate the surface area.
- Take other sheets of 8 1/2" x 11" paper, making a fold about a half-inch wide on the 8 1/2" sides.
- Attach the creased paper to the flat sheet while folding each sheet.
- Continue attaching creased paper until the surface of the flat sheet is covered.
- How many sheets were you able to attach?
- This is how many times the surface area has been increased.





THE SURFACE AREA HAS BEEN INCREASED 8 TIMES

Regina Clay

Move a Brick

EQUALS Processes
- Cooperative learning
- Problem solving
- Spatial skills

CONTENT
Discover how simple machines make it easier to perform a task due to mechanical advantage
Scientific Processes: observation and use of spatial relationships

ACTIVITY DESCRIPTION
Students use common objects as simple machines to slide a brick across a surface.

PREPARATION

Materials needed for each group:

- Brick with holes
- Nylon cord
- 2 plastic curtain rings

THE ACTIVITY

Without touching with hands, teams devise ways to move a brick six feet across a surface using each set of materials. They should use the following methods:

- using the cord only
- using the cord and one curtain ring as a pulley
- using the cord and two curtain rings as pulleys

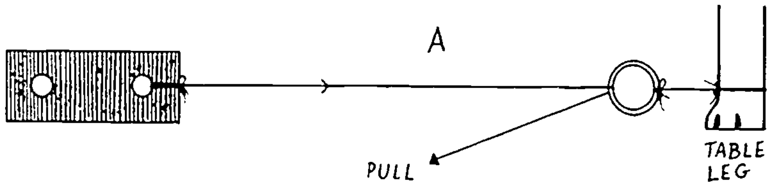
Discussion at the end might include:

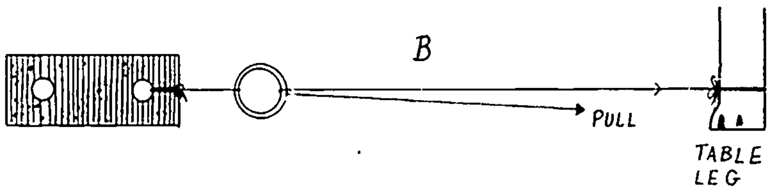
- What ways did your team devise to move the brick?
- Which way required less force or pull?
- How did working together help your team come up with more ideas?

TEACHER'S NOTES

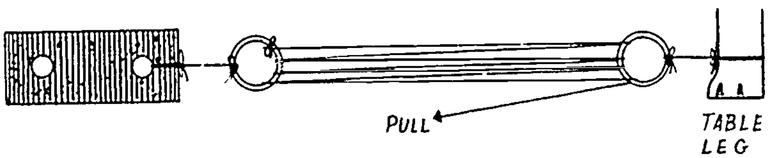
Simple machines are used every day. Examples are wheels on tables and carts, hinges on doors, and arms and elbows used as levers. Machines can provide a mechanical advantage, meaning that the amount of force put into the machine is less than the force needed to do the job without the machine. Because of their mechanical advantage, simple machines make it easier to perform tasks. A pulley is a simple machine.

Using a pulley(s), the students discover several ways to make it easier to move a brick. In this activity, the curtain ring is the pulley. They will find that the **more** strings pulling on the brick in the **same** direction, the easier it is to move (and the more mechanical advantage is present). The mechanical advantage in B is greater than A because the brick in B has two strings pulling on it in the **same** direction. (A has two strings, but they are pulling in opposite directions.)





When two pulleys are used, there are many possible ways to string the cord through the pulleys. The mechanical advantage will be greater the more times the cord is run back and forth between the rings.



The fixed end of the cord, or the fixed pulley, must be fastened to something that will not move. In these cases, the fixed end is fastened to the table leg.

EXTENSIONS

Use two curtain rings and a cord to lift the brick to a higher level.

Have students describe other ways in which pulleys are used every day. Examples are flagpoles, clotheslines and curtain rods.

Bring in a bicycle to see ways in which simple tools are used as machines.

Alice Bick and Rich Reif

8

pH Paint

EQUALS Processes
- **Cooperative learning**
- **Problem solving**

CONTENT
Decide if household chemicals are acidic, basic or neutral
Scientific Processes: experimentation, formulation of hypotheses and observation

ACTIVITY DESCRIPTION
Students test the pH of household chemicals by painting flowers stained with red cabbage juice.

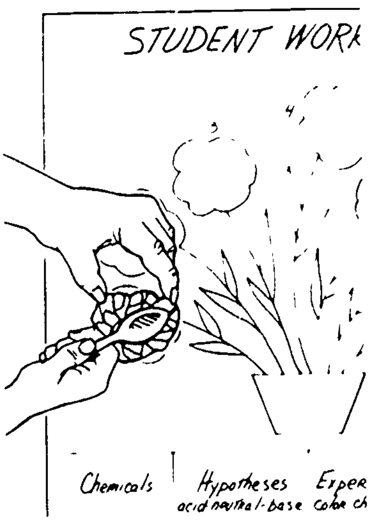
PREPARATION
Materials needed for each group:

- Student Worksheet, printed on white construction paper
- Red cabbage leaves
- Teaspoon
- Household chemicals

  Approximately 1/4 cup each of the following:
  - vinegar
  - lemon juice
  - ammonia

  Approximately 1 T. of each of the following dissolved in 1/4 cup water:
  - washing soda
  - boric acid
  - baking soda
  - wood ashes
    - Strain ashes from water.
- "Paint brushes" (cotton swabs placed in each chemical)

THE ACTIVITY
Students stain the flowers on the worksheet by placing a cabbage leaf on each flower and pressing hard with the teaspoon.



Students make hypotheses deciding if the chemicals are acidic, basic or neutral, recording this on their worksheets.

Now it's time to paint!

Paint each flower with the chemicals.

Write what happens on the worksheet.

Discussion at the end might include the following:

- What were the color changes? Why?
- Were your hypotheses true?
- How do you think dyes are made?

TEACHER'S NOTES

Red cabbage juice is one of the several natural acid-base indicators. Indicators change color depending on the acidic or basic conditions that they are mixed with. In the presence of an acid, red cabbage juice turns red and in the presence of a base, it turns green. When a substance is neutral (neither acidic nor basic), red cabbage juice will show no color change.

The letters pH are used by chemists to indicate the acidic strength of a substance. This is listed on the pH Scale. The lower the pH, the more strongly acidic the solution. Conversely, the higher the pH, the more strongly basic the solution.

pH SCALE

Strongly	0	gastric fluid
Acid	1	
	2	
	3	lemon juice, vinegar, peaches, coke, tomatoes,
	4	pineapple, ginger ale, acid soil, grapes,
	5	beer, Coffee, cheese, cabbage, shrimp, bread,
	6	corn, intestinal contents, milk, water, saliva
Neutral	7	
	8	blood, bile, sea water, baking soda, borax
	9	
	10	soap solution, milk of magnesia
	11	household ammonia
	12	lime
Strongly	13	oven cleaner
Basic	14	lye

Acids are chemical compounds that have a sour taste and usually contain hydrogen. Strong acids can burn your skin or corrode some metals. Some common acids are vinegar, citric acids, hydrochloric acid and sulfuric acid.

Bases are chemical compounds that have a bitter taste and will combine with acid to form a salt. Bases feel slippery and dissolve fats and oils. Some common bases are ammonia, lye, antacids and shampoo.

You may want to try this experiment ahead of time because different types of paper will react differently. White construction paper or white drawing paper works best.

All of the household chemicals for this activity can be bought at the grocery store. When using chemicals, be sure to read the warning labels first.

EXTENSIONS

Make your own egg dye!

- Boil red cabbage leaves in water to make juice.
- Mix this separately with baking soda and vinegar.

Try "painting" with other household chemicals.

Cathy Preiss

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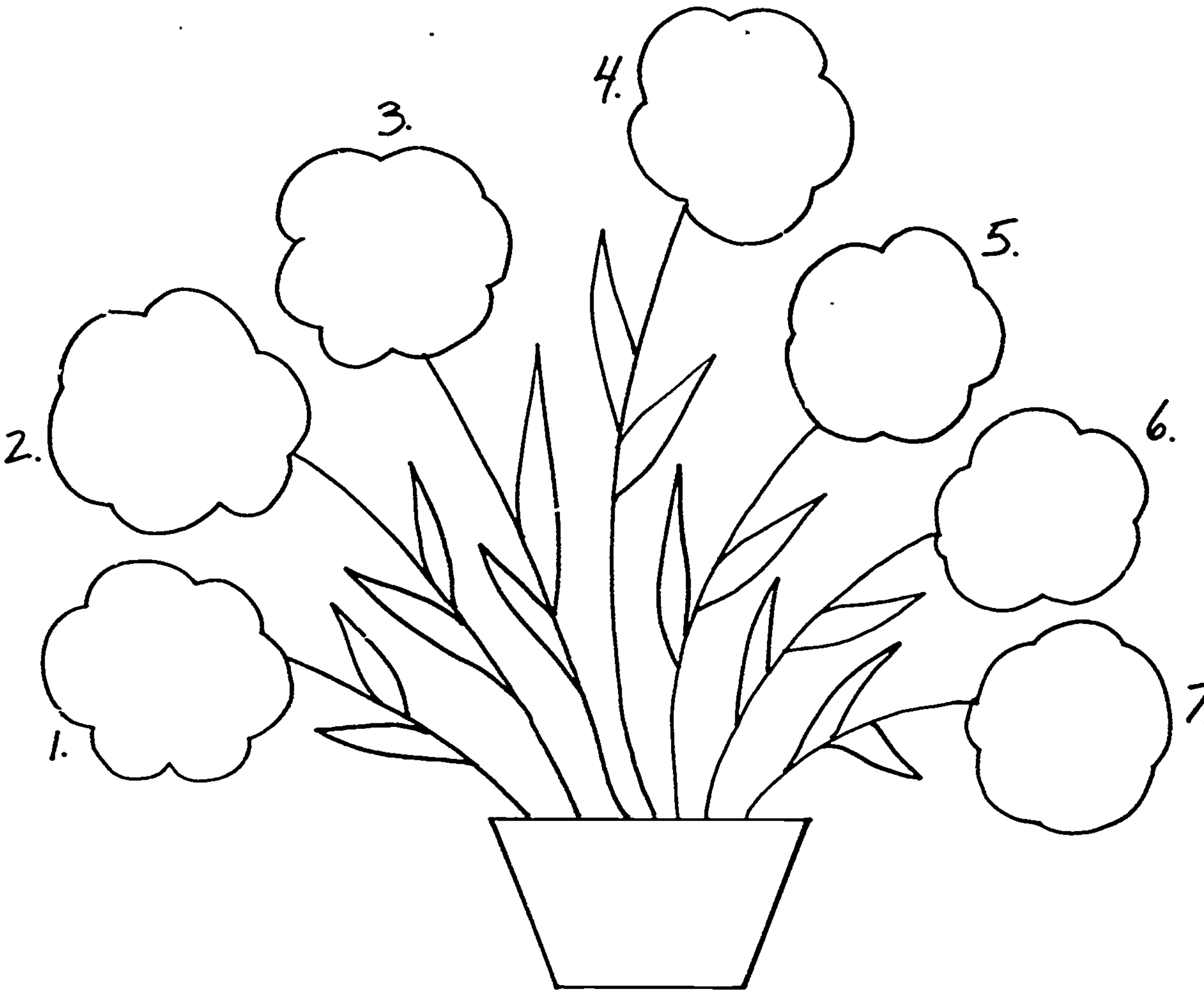
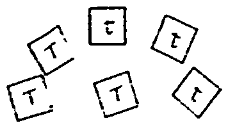
STUDENT WORKSHEET



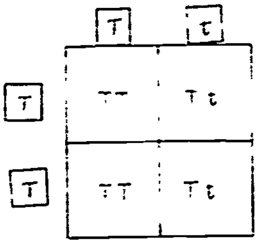
Chemicals	Hypotheses (acid-neutral-base)	Experiments (color change)	Conclusions (acid-neutral-base)
1. vinegar	acid	red	acid
2.			
3.			
4.			
5.			
6.			
7.			

The Punnett Game

EQUALS Processes
- **Cooperative learning**
- **Problem solving**



PARENT TRAIT SQUARES



PUNNETT SQUARE

CONTENT
Simulate manipulation of parents' traits to determine traits of offspring
Scientific Processes: classification, formulation of hypotheses and observation

ACTIVITY DESCRIPTION
Students find genetic combinations using Punnett Squares.

PREPARATION

Materials needed for each pair of students:
- Small envelope
- Six 1" x 1" paper squares
  Label parent trait squares.
  Place in envelopes.
- Blank Punnett Square

THE ACTIVITY

Pairs of students determine offsprings' traits by doing the following:

- Each student randomly pulls two parent trait squares from the envelopes.
- The two students place the parent trait squares outside the Punnett Square.
- They combine traits of parents by writing traits of the offspring inside the Punnett Square.
- Students select new parent traits and continue as above until all combinations of parent traits are found.

Discussion might include the following:

- What traits do each of the offspring have?
- What determined these traits?
- What trait is dominant? recessive?
- How many different parent trait combinations can be found?
- What was the hardest part of this activity?
- Did you learn something by working with someone else?

TEACHER'S NOTES

A Punnett Square is a simple means of figuring the expected results of combining two contrasting pairs of traits. The traits of each parent are placed outside the square.

PARENT'S TRAITS

PARENT'S TRAITS	T	t
T		
T		

The traits of the four offspring are written within the square.

	T	t
T	TT	Tt
T	TT	Tt

In this problem there is one dominant trait. A dominant trait is a trait that conceals another trait (the recessive trait). A capital letter is a dominant trait (T). A lowercase letter is the recessive trait (t).

In this example, T (tongue rolling) is a dominant trait and t (nontongue rolling) is a recessive trait.

TT = tongue rollers
Tt = tongue rollers
tt = nontongue rollers

There are different combinations of parent traits and offspring traits.

	t	T
t	tt	Tt
t	tt	Tt

Offspring
2 nontongue rollers (tt and tt)
2 tongue rollers (Tt and Tt)

	T	t
T	TT	Tt
t	Tt	tt

Offspring
3 tongue rollers (TT, Tt and Tt)
1 nontongue roller (tt)

EXTENSIONS

Have students devise possible Punnett Squares for their own personal traits, those of their parents and those of their grandparents.

Try other traits, like eye color or curly hair.

Annette Caudle

The Right Box

EQUALS Processes
- **Career awareness**
- **Problem solving**
- **Spatial skills**

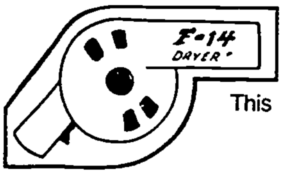
CONTENT
Design a two-dimensional drawing from which a three-dimensional box can be constructed
Scientific Processes: experimentation, formulation of models, interpretation of data, measurement and use of numbers

ACTIVITY DESCRIPTION
Students become package engineers by designing and constructing a box to fit snugly around an object.

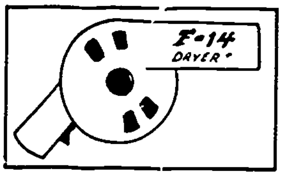
PREPARATION
Materials needed for each group:

- Object, like a blow dryer
- Graph paper
- Metric ruler
- Seamstress tape measure
- Scissors
- Tape

THE ACTIVITY
Groups of students become package engineers designing a box.



This



Not This

- They design a two-dimensional drawing on graph paper, using the following guidelines:
  Decide the best strategy for designing, which may be measuring or tracing the object.
  Use the least amount of paper.
  Make the object fit snugly.

Now comes the challenge—turning the drawing into a real package.

- Cut out the drawing.
- Fold.
- Tape.

Discussion at the end might include the following:

- What strategies did you use in designing your box?
- Did you have edges and corners on all your designs?
- What problems did you encounter?
- What might you do to improve your design?

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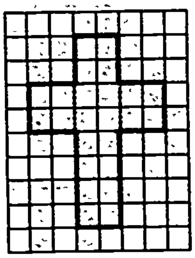
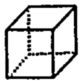
TEACHER'S NOTES
You might want to discuss the following:

- using dotted lines to indicate fold lines
- using solid lines to indicate cut lines





This activity may be adjusted up or down for different age levels, ranging from designing a box for a cube-shaped object to a round-shaped object.

Information about careers in package engineering would be helpful.

ADAPTATIONS

Match boxes with two-dimensional drawings.

Construct boxes from two-dimensional drawings.

Alice Bick

River Study

EQUALS Processes
- **Career awareness**
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT

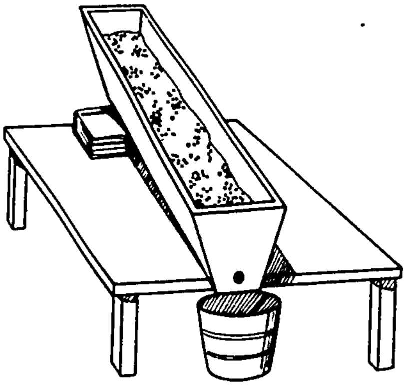
Observe erosion caused by water and experiment with ways to prevent it

Scientific Processes: communication, control of variables, experimentation, formulation of hypotheses, observation and prediction

ACTIVITY DESCRIPTION

Materials needed for each group of students:

- Long trough
- Sand
- Books
- Bucket



Prepare the trough:

- Cut drain hole in one end of trough.
- Fill trough 1/2 full of sand.
- Use books to elevate the trough at the end opposite the drain.
- Place bucket under end with the drain.

Additional materials needed:

- Soil, maybe some with grass or weeds
- Rocks
- Clay
- Plastic model houses
- Water

THE ACTIVITY

Each team will plan an environment resistant to erosion by following the steps below:

- Build a river and surrounding hills and valleys making them withstand soil erosion.
  The students use their hands to sculpt the riverbed in sand.
  They use the soil, rocks and clay for hills and valleys.
- They place their homesite in an area that is most resistant to erosion.

Now the real test!

Each team will observe the erosion that takes place.

- They slowly pour water down the riverbed to simulate a flowing river.
- Then they quickly pour a lot of water down the riverbed to simulate the effects of floods.

Discussion might include the following:

- Would you choose the same homesite again? Why or why not?
- Which contours eroded first? Why?
- Which contours eroded more? Why?
- Did water speed make a difference?
- What features would you look for in riverbeds, hills or valleys to predict the least erosion?

TEACHER'S NOTES
A long cardboard box (available from a floral supply house), a planter or a long dishpan can be used as a trough.

You may want to use this opportunity to highlight the career of a landscape designer and engineer by asking students to assume these roles in their groups.

Running water is the cause of most soil erosion. Erosion starts with rainfall. As the water runs off the land, it forms small streams, which eventually form rivers. At each of these stages, the water causes erosion. The rain loosens the particles of soil and rock and often carries the particles with it along the streams and rivers.

There are several factors that affect the amount of erosion that takes place. These are the amount or speed of running water, the gradient, the type of soil and bedrock on the bottom and sides of the river.

Land is constantly eroding, especially where the slopes are steep. There are ways to slow down water erosion on steep slopes:

- tree and grass plantings, where roots hold soil that might be carried away
- contour plowing, where rows of crops follow the curve of the land; that is, the rows run sideways rather than up and down
- terracing, where ridges follow the contour of the land, also running sideways

EXTENSIONS

Make contour maps and replicate these in river designs.

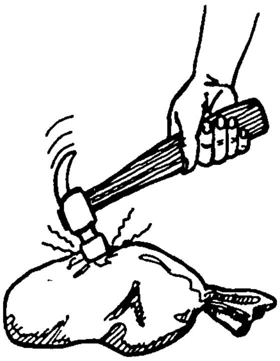
Use different soils (rocky, sandy, clay, loamy) and measure the runoff water to determine which soil has the most erosion.

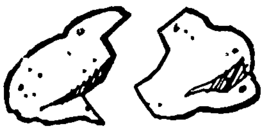
Design a town around the river. Consider the best location for sewage plants, recreational parks, bridges, industrial areas, residential areas, and so on.

Cathy Preiss

Rock Pairs

EQUALS Processes
- Problem solving
- Spatial skills





CONTENT
Compare and contrast properties of rocks
Scientific Processes: classification and observation

ACTIVITY DESCRIPTION
At a station, students will fit the parts of a rock back together after observing the properties.

PREPARATION
Materials needed for each station:

- 6 rocks with different properties, such as color, sheen, hardness, size or shape
- Hammer
- Cloth bag

Break each rock by putting it in the bag and hitting it with the hammer.

THE ACTIVITY
Students will classify rocks by following the Activity Sheet.

EXTENSIONS
Develop a field guide for rocks.

Use broken shells as a substitute for rocks.

Play a game by having students do the following:

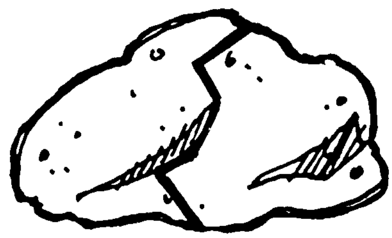
- Sit in a circle, holding a different type of rock.
- Examine their rock.
- Close their eyes and feel their rock.
- Pass the rocks around the circle with their eyes closed.
- Continue to pass rocks until each child finds her own rock.
- Check accuracy by opening their eyes.

Kathy Shonts

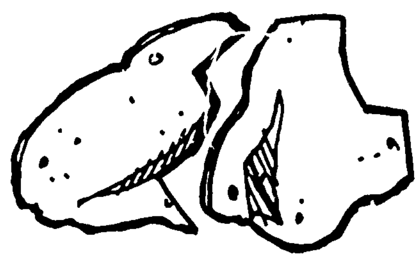
Rock Pairs Activity Sheet

1. Study the broken rocks. Do any of the rocks feel alike? Do any of the rocks look alike?

2. Match the parts that are alike by putting them next to each other.



3. Fit the parts back together.



4. Describe the properties that the rock pairs have.

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Shadows and the Sun's Path

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT
Discover the relationship between the position of the sun and the length of a shadow
Scientific Processes: experimentation, measurement, observation and use of time/space relations

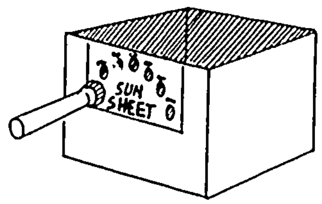
ACTIVITY DESCRIPTION
Students use flashlights to cast shadows simulating the sun's changing position in the sky.

PREPARATION
Materials needed for each group:

- Cardboard box (a box for duplicating paper is a good size)
- Tape
- White paper
- Clay
- Short pencil (approximately 5 cm)
- Sun Sheet
- Penlight flashlight

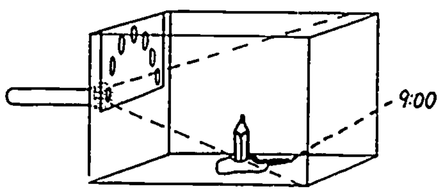
THE ACTIVITY
Students will prepare the box by following the steps below:

- Cover the inside bottom of the cardboard box with white paper, taping it in place.
- Put a small clay ball in the center of the white paper.
- Stand the pencil in the clay, sharpened end up.
- Tape the Sun Sheet to a top, outside edge of the box.
- Use scissors to make holes large enough to fit the tip of the penlight flashlight through.



Now comes the real fun!

Students discover the relationship between the position of the light source and the length of the shadow cast by performing the following steps:



- Place the flashlight in the hole marked 9:00.
- Shine the light on the pencil tip, marking the shadow cast and labeling this 9:00.
- Repeat this procedure for 10:00, 11:00, 12:00, 1:00, 2:00 and 3:00.

Discussion at the end might include the following:

- Do the shadows make a pattern?
- How does the position of the light source affect the length of the shadow?
- Are the lengths of the shadows the same at all times of the year?

TEACHER'S NOTES

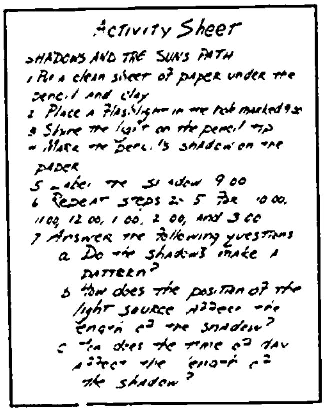
In this simulation, students will learn the relationship between the position of the light source and the length of the shadows. For example, if the light source is low on the horizon, the shadow will be longer than if the light source is high above. Therefore, shadows are longer in the morning and in the evening due to the sun's low position in the sky.

Preparing the box is an important problem-solving activity. Students should thoroughly understand the preparation before beginning to do it.

In order to get the best result from this activity, the inside of the box needs to be dark. Students could discover the best way to do this.

ADAPTATIONS

Try this activity as a station using the Activity Sheet and a prepared box.


Activity Sheet

Shadows and the Sun's Path

1 Put a clean sheet of paper under the pencil and clay

2 Place a flashlight in the hole marked 9:00

3 Shine the light on the pencil tip

4 Mark the pencil's shadow on the paper

5 Label the shadow 9:00

6 Repeat steps 2-5 for 10:00, 11:00, 12:00, 1:00, 2:00, and 3:00

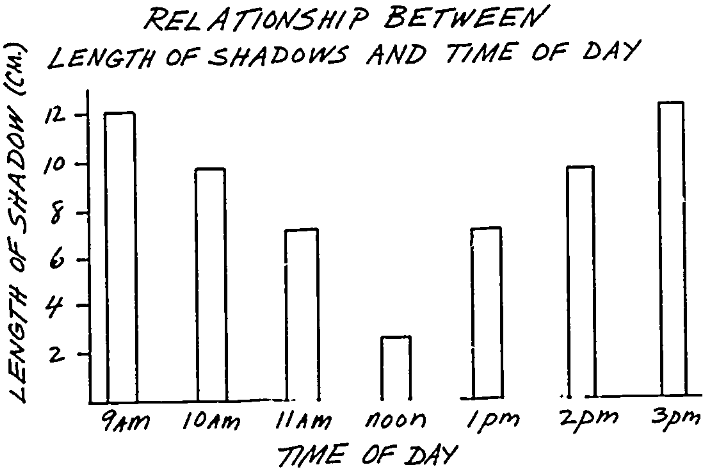
7 Answer the following questions

a Do the shadows make a pattern?

b How does the position of the light source affect the length of the shadow?

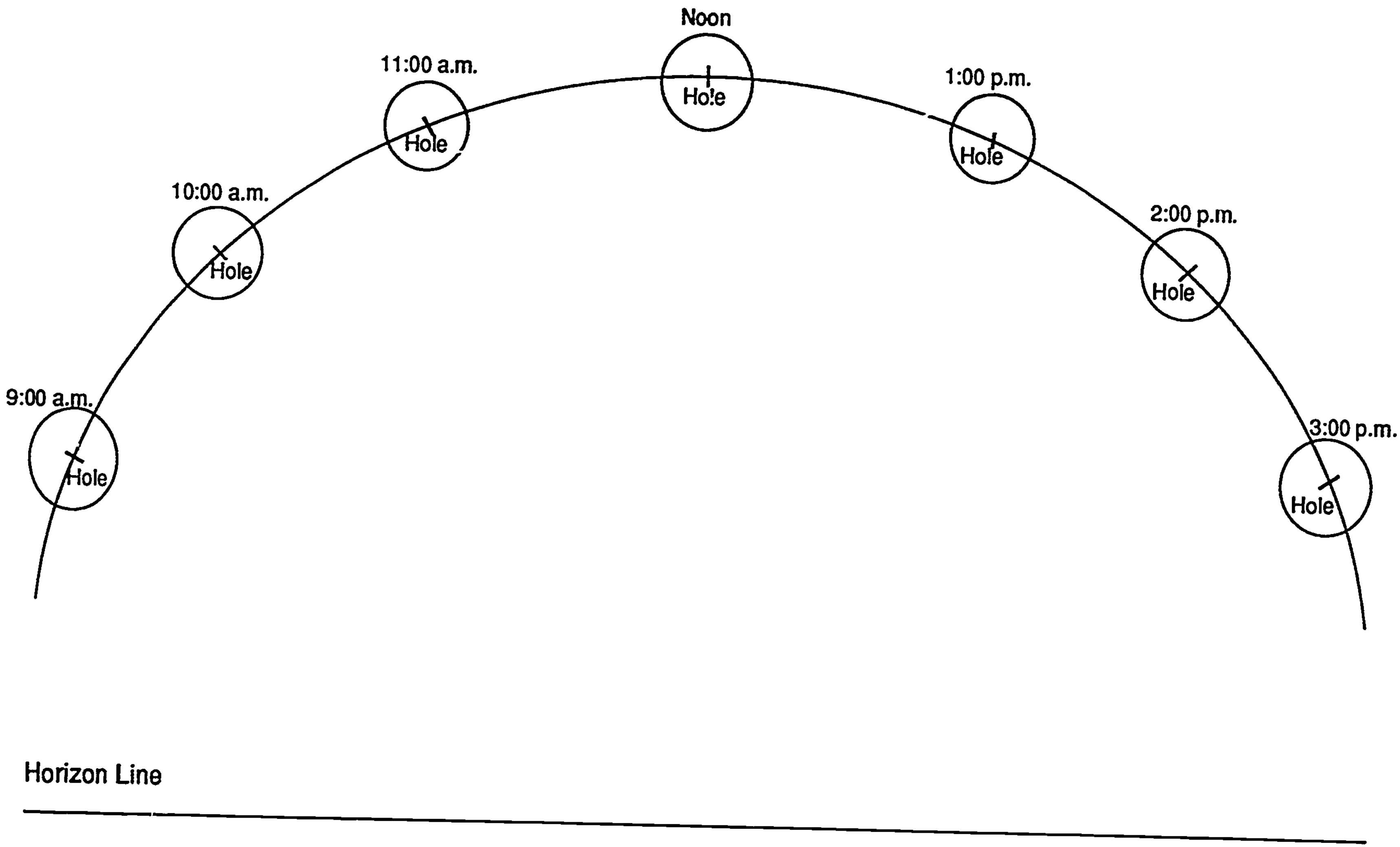
c How does the time of day affect the length of the shadow?

Make a bar graph to illustrate the relationship between the time of day and the length of the shadow cast.



Sue Griswold

Sun Sheet


Noon
11:00 a.m.
1:00 p.m.
10:00 a.m.
2:00 p.m.
9:00 a.m.
3:00 p.m.
Hole
Hole
Hole
Hole
Hole
Hole
Hole
Horizon Line

Shoe Shoo!

EQUALS Processes
- Career awareness
- Cooperative learning
- Problem solving

CONTENT
Create a dichotomous classification key
Scientific Processes: classification, communication and observation

ACTIVITY DESCRIPTION
Students place objects into sets and subsets on the basis of characteristics that the objects have or do not have.

PREPARATION
Materials needed:

- Shoes
- Butcher paper

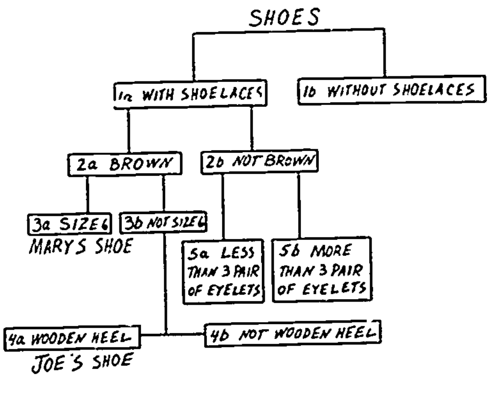
THE ACTIVITY
Students become familiar with the following guidelines:

- Every object in the original set must be placed in a set by itself for the scheme to be complete.
- The characteristics should be distinct. For example, heavy and light are distinct characteristics because an object cannot be both light and heavy. Heavy and small are not distinct because an object can be both heavy and small.

Students classify the shoes:

- They place right shoes in a pile on the butcher paper.
- They divide and subdivide shoes by distinct characteristics until each shoe is in a set by itself.
- They label all sets and subsets by characteristics used.

An example students might use follows:



- Choose a characteristic that will divide the shoes into two sets (example: those with shoelaces and those without shoelaces).
- Label the set.
  with shoelaces—1a
  without shoelaces—1b
- Choose another characteristic for subdividing 1a into two subsets, continuing to divide and label according to the following example:
  2a. Brown color
  2b. Not brown color
- Subdivide the shoes, working with those that are brown and have shoelaces; find another characteristic.
  3a. Size 6—Mary's shoe
  3b. Not size 6
  Continue with next characteristic.

4a. Wooden heel—Joe's shoe
4b. Not wooden heel—empty set

- When all shoes of the first group are in a set by themselves, return to the last undivided set (2b) and insert the number that comes next (5a). Continue with new characteristics.

  5a. Has three pairs of eyelets or less
  5b. Has more than three pairs of eyelets

- Continue until each shoe is in a set by itself.

Discussion at the end might include schemes for classifying objects:

- Consider your bedroom and how things are grouped for your convenience.
- Consider different professions that use classifications. Think about how a pharmacist or a grocer classifies objects.

TEACHER'S NOTES

A dichotomous key is a scheme of classifying objects into sets of likenesses and differences. In a dichotomous key, the original set of objects is subdivided into two sets. They are subdivided into sets that have a particular characteristic or do not have a characteristic. Then the sets are subdivided again and again so that a hierarchy of sets and subsets is established.

EXTENSIONS

Have students pretend to create a store that they must stock and operate. Have them set up a classification system for stocking and maintaining the products they wish to market.

Investigate established dichotomous classification keys.

Jim Henley

Star Time

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT
Observe that the earth's rotation causes the apparent movement of constellations across the sky
Scientific Processes: communication, inference and observation

ACTIVITY DESCRIPTION
The students tell time by observing the position of the Big Dipper relative to the North Star.

PREPARATION
Materials needed for each team:

- Poster
- Question Cards
- Answer Cards

THE ACTIVITY
Teams tell time by doing the following:

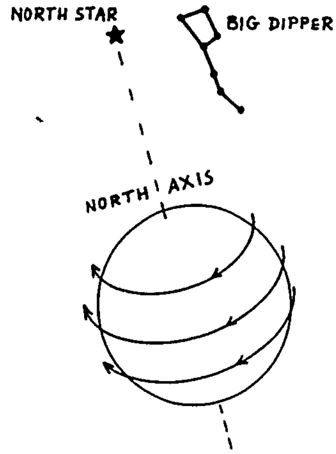
- Select a Question Card.
- Observe the position of the Big Dipper on the Question Card.
- Find a similar position on the Poster.
- Observe the time of this position and line it up with the horizon line.
- Write the time on the Question Card.
- Continue to select Question Cards until all have been selected.

Discussion might include the following:

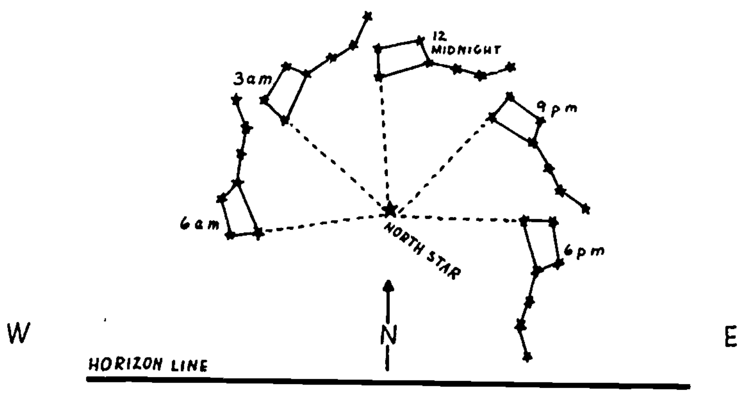
- How did the position of the Big Dipper change?
- Which star "appears stationary"?
- What is the explanation for the apparent stationary star in terms of the earth's axis of rotation?
- What causes the apparent movement of the constellations across the sky?
- How did your group cooperate?
- What was the hardest part about cooperating?

TEACHER'S NOTES

The earth rotates on its axis once every 24 hours with the North Axis aimed toward the North Star. This rotation of the earth causes an apparent movement of the constellations across the sky. The constellations near the North Star appear to circle around it (they are called circumpolar stars). By careful observation of the Big Dipper, a simple and natural "clock" can be devised.



Since constellation positions are different for each month, a particular date was chosen for the poster. This example has dotted lines to show students the relative position of the Big Dipper to the North Star.



This chart represents the position of the Big Dipper at different hours on the night of March 15.

EXTENSIONS

Observe the Big Dipper pattern at different times in the evening and draw its position relative to the North Star. Predict what its position will be at other times that evening.

Make a flip book of the "apparent" movement of the Big Dipper around the North Star.

Make a star chart. Turn the star wheel and see the effect of the earth's rotation on the positions of the constellations.

You are stranded at sea. You have radioed for help and know that your rescue will arrive at 6:00 A.M. By looking at the position on the star card, can you find out how long you have to wait until your rescue arrives? (1:00 A.M.)

STAR CARD

The time is____________________

Sue Griswold

QUESTION CARD

horizon line

The time is________________

QUESTION CARD

horizon line

The time is________________

QUESTION CARD

horizon line

The time is________________

QUESTION CARD

horizon line

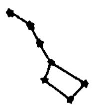
The time is________________

QUESTION CARD

horizon line

The time is________________

QUESTION CARD



horizon line

The time is________________

QUESTION CARD

horizon line

The time is________________

QUESTION CARD

horizon line

The time is________________

ANSWER CARD

horizon line

The time is *6 a. m.*

ANSWER CARD

horizon line

The time is *3 a. m.*

ANSWER CARD

horizon line

The time is *12 midnight*

ANSWER CARD

horizon line

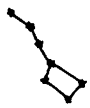
The time is *9 p. m.*

ANSWER CARD

horizon line

The time is *6 p.m.*

ANSWER CARD



horizon line

The time is *9 a. m.*

ANSWER CARD

horizon line

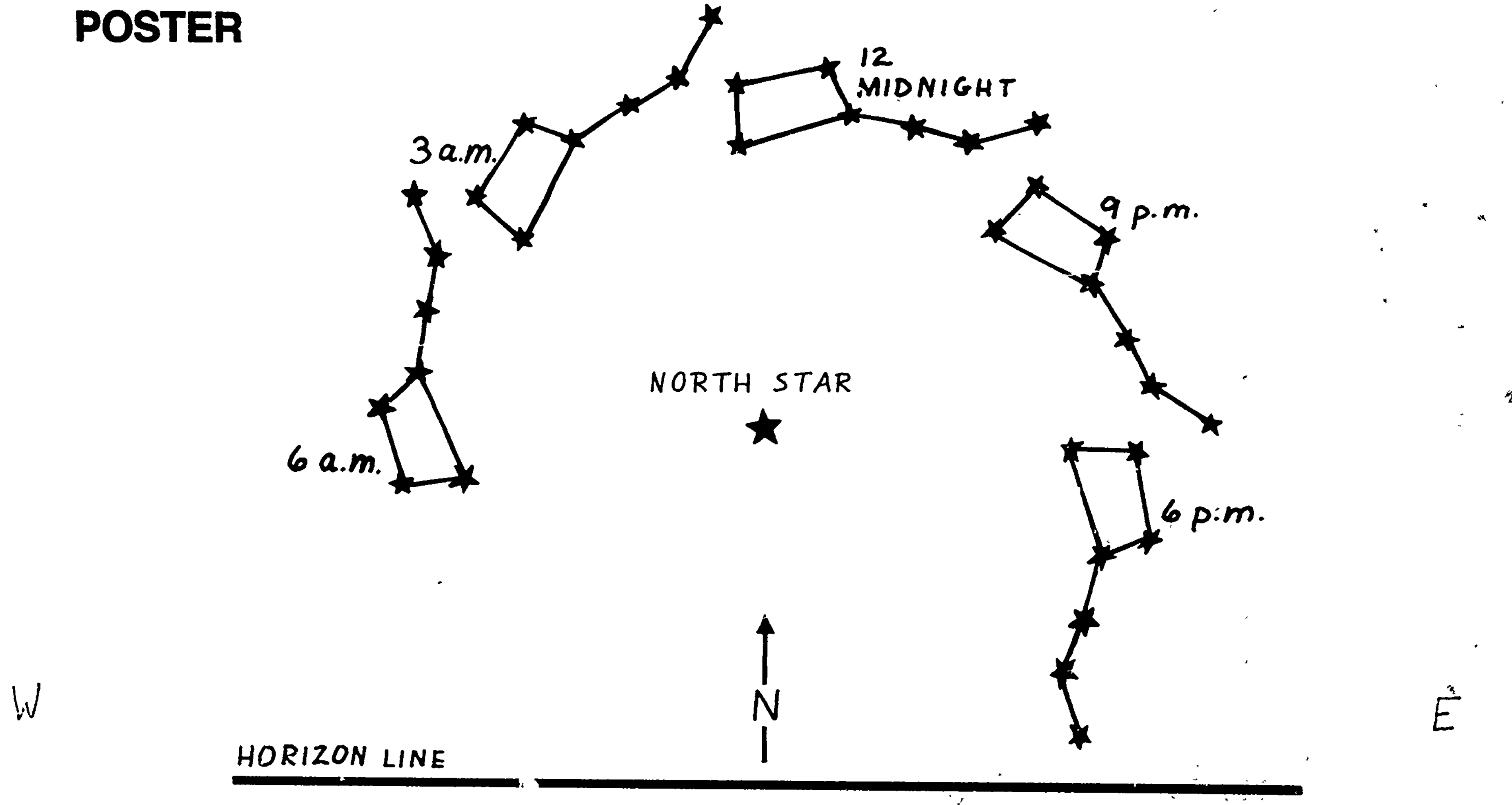
The time is *1 a.m.*

ANSWER CARD

horizon line

The time is *7:30 p.m.*

POSTER



This chart represents the position of the Big Dipper at different hours on the night of March 15.

Table Manners

EQUALS Processes
- **Cooperative learning**
- **Problem solving**
- **Spatial skills**

CONTENT
Learn how elements are organized on the periodic table
Scientific Processes: classification, communication, observation and prediction

ACTIVITY DESCRIPTION
Students discover rules of the periodic table by arranging chemical elements in the proper order.

PREPARATION
Materials needed for each team of six students:

- Packet of 7 Clue Cards (with one starred)
- 24 element pieces cut from periodic table (Argon, Astatine, Barium, Beryllium, Bromine, Calcium, Chlorine, Cesium, Fluorine, Francium, Hydrogen, Helium, Iodine, Potassium, Krypton, Lithium, Magnesium, Sodium, Neon, Radon, Rubidium, Radium, Strontium, Xenon)
- Blank Periodic Table

THE ACTIVITY
Teams discover the order of some of the elements on the periodic table by taking the following steps:

- Separate starred clue, placing it face down.
- Place other Clue Cards, all elements and blank periodic table face up on the table.
- Each student takes one Clue Card.
- She reads and shows the clue to the team.
- The team performs the task.
- The team reads the starred clue to check placement when all elements are on the periodic table.

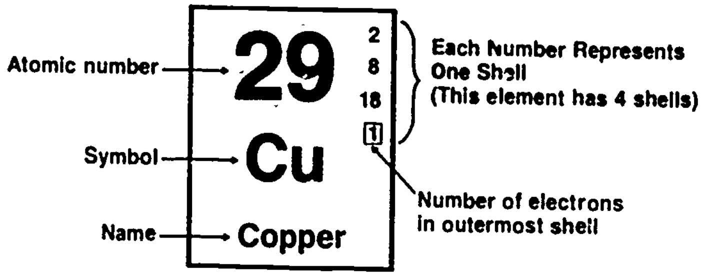
How good it feels to be correct!

Discussion might include the following:

- Did you recognize patterns in the order of the elements? What are they?
- What clues did you find to be irrelevant?
- What inferences can you make about the missing elements?
- Does cooperation take sharing? Is it easy to share all the time?

TEACHER'S NOTES

Students are introduced to the organization of the periodic table in this activity. They learn through observation that elements are arranged according to similar properties. For example, the most active metals are at the lower left of the periodic table and the most active nonmetals are near the upper right. The periodic table is arranged according to the increasing atomic number. Each horizontal row is called a period and the rows are numbered according to the number of shells in each element, 1 at the top and 7 at the bottom. These shells are found in the upper right-hand column of the key. Electrons are found in these shells. The last number signifies the number of electrons in the outermost shell. Elements with the same number of electrons in the outermost shell are in the same vertical column (except for helium).



After doing this activity, students should find these patterns of organization:

1. The number of shells determine which row the element is in.
2. The number of electrons in the outermost shell determines which column the element is in.
3. The atomic number shows the order of elements on the table.

EXTENSIONS

For more challenge, remove the atomic numbers from the element squares.

Using the remaining element squares, place them in their proper place on the periodic table with the facts that you learned in Table Manners.

Vera Rivens

Clue Cards

Table Manners

PROBLEM Place elements in their proper place on the periodic table.

CLUES

1. All of the following elements have 6 shells: Cesium (Cs), Barium (Ba), Astatine (At) and Radon (Rn).
2. The number of electrons listed in the outermost shell are Cesium (Cs)—1, Barium (Ba)—2, Astatine (At)—7 and Radon (Rn)—8.
3. Barium (Bn) is directly to the right of Cesium (Cs).

Table Manners

PROBLEM Place the elements in their proper place on the periodic table.

CLUES

1. Elements with the same number of shells occupy the same horizontal row. They are arranged 1–7, from top to bottom.
2. Hydrogen (H) has 1 shell and Lithium (Li) has 2 shells.
3. Potassium (K) is in row 4, directly to the left of Calcium (Ca), and between Sodium (Na) and Rubidium (Rb).

Table Manners

PROBLEM Place the elements in their proper place on the periodic table.

CLUES

1. The inert gases, Argon (Ar), Helium (He), Krypton (Kr), Neon (Ne), Radon (Rn) and Xenon (Xe), are in the far right column.
2. Helium (He) is the lightest and is above Neon (Ne). Radon (Rn) is the heaviest, and is below Xenon (Xe).

Table Manners

PROBLEM Place the elements in their proper place on the periodic table.

CLUES

1. Elements arranged in vertical columns have the same number of electrons in the outer shell. (Helium is the only exception to this rule.)
2. Barium (Ba), Beryllium (Be), Calcium (Ca), Magnesium (Mg), Radium (Ra) and Strontium (Sr), have 2 electrons in the outer shell. Magnesium (Mg) is above Calcium (Ca) and Strontium (Sr) is below.

Table Manners

PROBLEM Place the following elements in their proper place on the periodic table.

CLUES

1. Francium (Fr) is to the left of Radium (Ra), and below Cesium (Cs).
2. Francium (Fr) is the most metallic element, therefore it is placed on the bottom of the column.
3. Lithium (Li) is the least metallic element and is to the left of Beryllium (Be).

Table Manners

PROBLEM Place the elements in their proper place on the periodic table.

CLUES

1. Bromine (Br) is directly to the left of Krypton (Kr), and between Chlorine (Cl) and Iodine (I).
2. Iodine (I) has 5 shells.
3. Fluorine (F) is an active nonmetal in the same column as Bromine (Br), Chlorine (Cl), Iodine (I) and Astatine (At).

Table Manners*

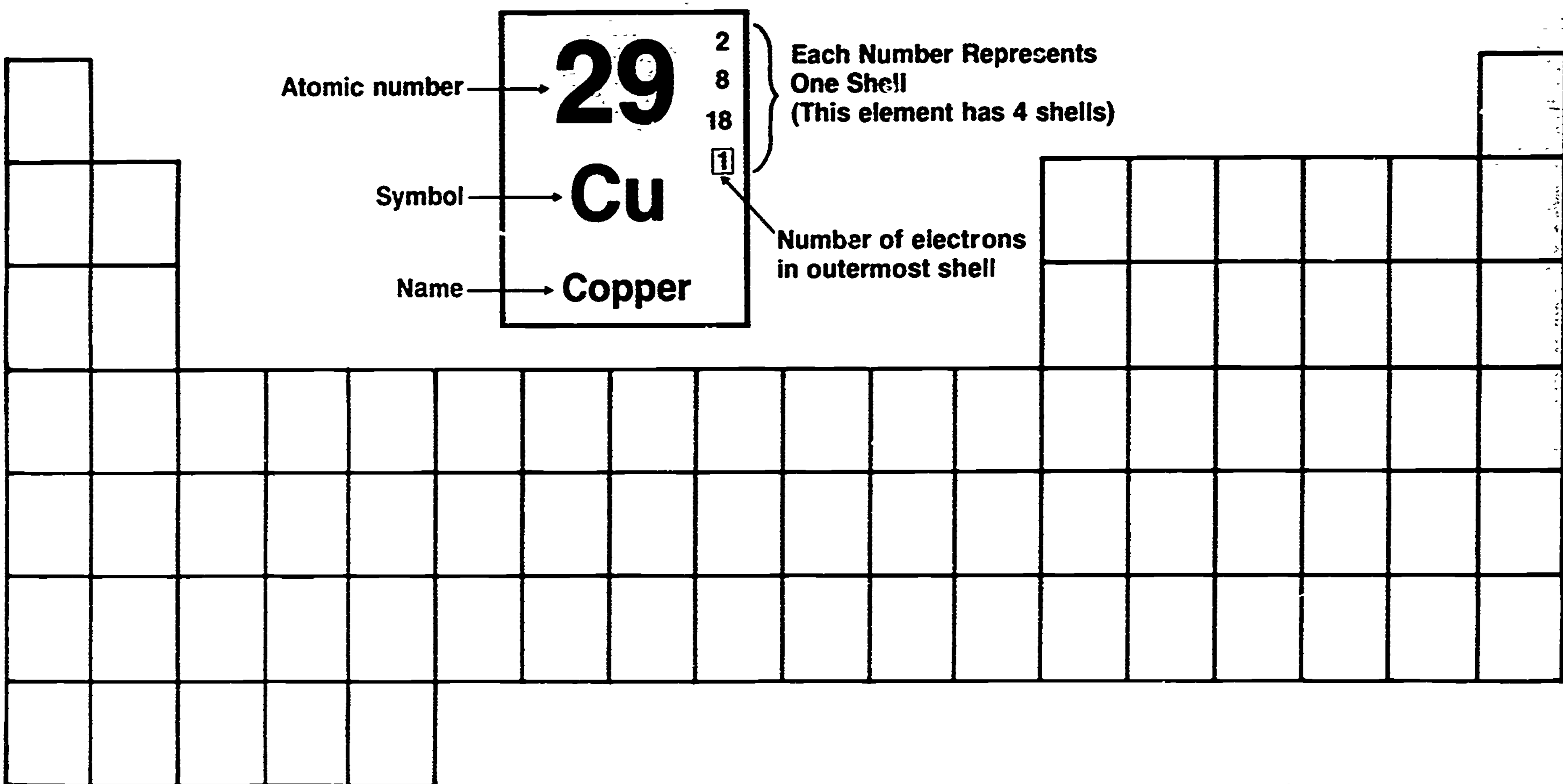
PROBLEM Place the elements in their proper place on the periodic table.

CLUES

1. Elements are arranged on the periodic table according to the atomic numbers left to right and top to bottom.

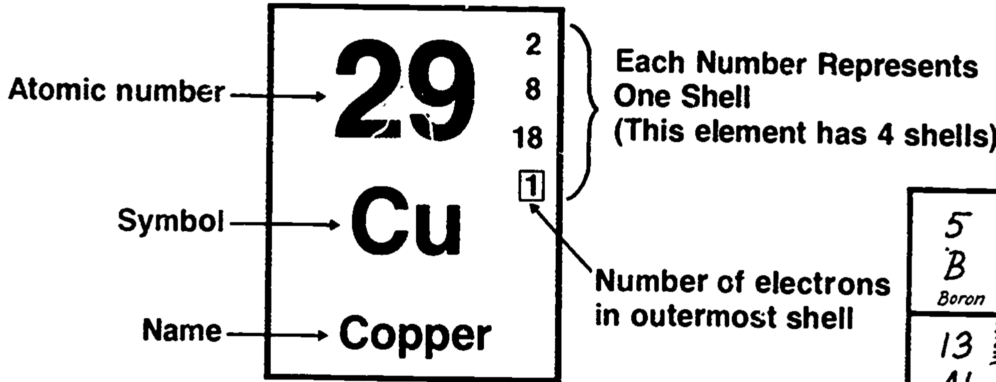
The Periodic Table

Element Square



The Periodic Table

Element Square



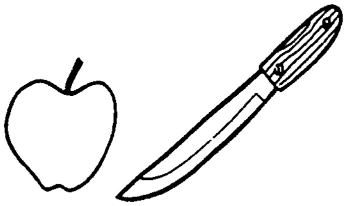
Cut to make element pieces.

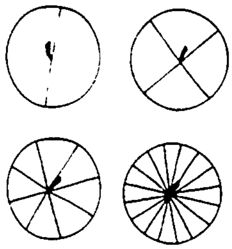
1 H Hydrogen (1)																	2 He Helium (2)
3 Li Lithium (2, 1)	4 Be Beryllium (2, 2)											5 B Boron (2, 3)	6 C Carbon (2, 4)	7 N Nitrogen (2, 5)	8 O Oxygen (2, 6)	9 F Fluorine (2, 7)	10 Ne Neon (2, 8)
11 Na Sodium (2, 8, 1)	12 Mg Magnesium (2, 8, 2)											13 Al Aluminum (2, 8, 3)	14 Si Silicon (2, 8, 4)	15 P Phosphorus (2, 8, 5)	16 S Sulphur (2, 8, 6)	17 Cl Chlorine (2, 8, 7)	18 Ar Argon (2, 8, 8)
19 K Potassium (2, 8, 8, 1)	20 Ca Calcium (2, 8, 8, 2)	21 Sc Scandium (2, 8, 9, 2)	22 Ti Titanium (2, 8, 10, 2)	23 V Vanadium (2, 8, 11, 2)	24 Cr Chromium (2, 8, 13, 1)	25 Mn Manganese (2, 8, 13, 2)	26 Fe Iron (2, 8, 14, 2)	27 Co Cobalt (2, 8, 15, 2)	28 Ni Nickel (2, 8, 16, 2)	29 Cu Copper (2, 8, 18, 1)	30 Zn Zinc (2, 8, 18, 2)	31 Ga Gallium (2, 8, 18, 3)	32 Ge Germanium (2, 8, 18, 4)	33 As Arsenic (2, 8, 18, 5)	34 Se Selenium (2, 8, 18, 6)	35 Br Bromine (2, 8, 18, 7)	36 Kr Krypton (2, 8, 18, 8)
37 Rb Rubidium (2, 8, 18, 8, 1)	38 Sr Strontium (2, 8, 18, 8, 2)	39 Y Yttrium (2, 8, 18, 9, 2)	40 Zr Zirconium (2, 8, 18, 10, 2)	41 Nb Niobium (2, 8, 18, 12, 1)	42 Mo Molybdenum (2, 8, 18, 13, 1)	43 Tc Technetium (2, 8, 18, 13, 2)	44 Ru Ruthenium (2, 8, 18, 15, 1)	45 Rh Rhodium (2, 8, 18, 16, 1)	46 Pd Palladium (2, 8, 18, 18)	47 Ag Silver (2, 8, 18, 18, 1)	48 Cd Cadmium (2, 8, 18, 18, 2)	49 In Indium (2, 8, 18, 18, 3)	50 Sn Tin (2, 8, 18, 18, 4)	51 Sb Antimony (2, 8, 18, 18, 5)	52 Te Tellurium (2, 8, 18, 18, 6)	53 I Iodine (2, 8, 18, 18, 7)	54 Xe Xenon (2, 8, 18, 18, 8)
55 Cs Cesium (2, 8, 18, 18, 8, 1)	56 Ba Barium (2, 8, 18, 18, 8, 2)	57-71 La SERIES	72 Hf Hafnium (2, 8, 18, 32, 10, 2)	73 Ta Tantalum (2, 8, 18, 32, 11, 2)	74 W Tungsten (2, 8, 18, 32, 12, 2)	75 Re Rhenium (2, 8, 18, 32, 13, 2)	76 Os Osmium (2, 8, 18, 32, 14, 2)	77 Ir Iridium (2, 8, 18, 32, 17)	78 Pt Platinum (2, 8, 18, 32, 17, 1)	79 Au Gold (2, 8, 18, 32, 18, 1)	80 Hg Mercury (2, 8, 18, 32, 18, 2)	81 Tl Thallium (2, 8, 18, 32, 18, 3)	82 Pb Lead (2, 8, 18, 32, 18, 4)	83 Bi Bismuth (2, 8, 18, 32, 18, 5)	84 Po Polonium (2, 8, 18, 32, 18, 6)	85 At Astatine (2, 8, 18, 32, 18, 7)	86 Rn Radon (2, 8, 18, 32, 18, 8)
87 Fr Francium (2, 8, 18, 32, 18, 8, 1)	88 Ra Radium (2, 8, 18, 32, 18, 8, 2)	89-103 Ac SERIES	104 Rf Rutherfordium	105 Ha Hahnium													

This table does not show the recently discovered elements 106-109. Elements 104 and 105 are now 104 Unq and 105 Unp.

That's the Way the Apple Slices

EQUALS Processes
- **Cooperative learning**
- **Spatial skills**





CONTENT

Observe shape, color and texture to find matching pieces
Scientific Processes: classification, observation and use of space relations

ACTIVITY DESCRIPTION

Without talking, students will observe the shape, color and texture of their apple slice and then find other matching slices to complete a whole apple.

PREPARATION

Material needed for each group of students:

- Apple
- Knife

    Cut the apple into 2, 4, or up to 16 cuts, making the slices as even as possible.
    Cut each apple used into a different number of pieces.
- Plate

    Randomly place slices from all apples.

THE ACTIVITY

Students will match slices to complete a whole apple by performing the following tasks:

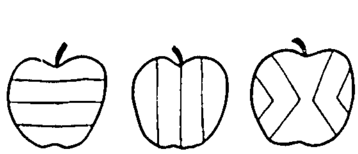
- Students wash their hands in case the apple slice becomes too tempting.
- They select an apple slice.
- They observe the shape, color and texture of their slice.
- Without talking, the students search for the student or students with the matching slice.
- Oops, do students need to try again?

Discussion at the end might include the following:

- How did you find matching slices?
- What problems did you have?

ADAPTATIONS

Use a variety of cuts, like horizontal cuts, vertical cuts, or cuts that don't match.



For less able students, use quarters of different fruits.

Use a combination of vegetables and fruits.

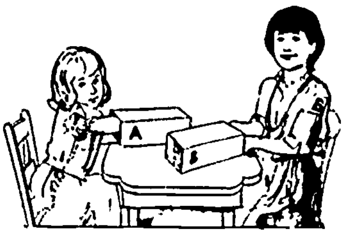
Use a ripple blade knife to cut fruit.

Alternate cuts with a ripple blade and a straight blade knife.

Susan Cline

Touch and Ask

EQUALS Processes
- **Career awareness**
- **Problem solving**
- **Spatial skills**



RECORD SHEET			
NAME	SHAPE	SIZE	TEXTURE
FAYE	1	1	1
TERRI		1	

CONTENT
Compare and contrast such properties of objects as shape, texture and size
Scientific Processes: classification, communication, inference, measurement and observation

ACTIVITY DESCRIPTION
Students develop questioning strategies for identifying scientific tools.

PREPARATION
Materials for partners:

- 2 shoe boxes
  Cut hole in each big enough for a hand to reach in.
  Mark one box A and the other box B.
- 2 identical sets of scientific tools (e.g., tweezers, compass, magnifying glass, test tube, stirring rod and funnel)
  Place one set of materials in each box.

THE ACTIVITY
Challenge the students to identify tools:

- Students choose partners and call each other Player A and Player B.
- Each reaches her hand into her box.
- Player A picks one tool to be "It."
- Player B feels tools in her box, asking questions about different categories of properties such as shape, texture and size. Questions must be answered with either yes or no.
- Students use the record sheet to record the number of questions asked about each category.
- Player B names the object as soon as all categories have been marked.
- The game is repeated with Player A asking the questions.

Discussion at the end might include the following:

- How did your questions help you identify the tools?
- How do scientists use these tools?

TEACHER'S NOTES
Students often ask questions that name an object, rather than questions dealing with properties of the object. Help students develop descriptive questions using categories of properties, such as shape, texture and size.

Some additional scientific tools you might want to use are protractor, compass, battery wire, beaker and safety glasses.

EXTENSIONS

Use other objects, such as geometric blocks, fruits, school tools or shells.

Integrate science and language arts by doing the following:

- Place several objects on a table. Without naming it, a leader selects an object.
- One student asks a question about a property, i.e., "Is it soft?"
- Each team member writes what she thinks the selected object is and writes why.
- Results are shared.
- If no one correctly guesses the object, another question is asked and the process is repeated.

Susan Cline

Wash Out

EQUALS Processes
- Career awareness
- Cooperative learning
- Problem solving

CONTENT
Observe erosion on different types of soil
Scientific Processes: classification, communication, experimentation, inference, interpretation of data, measurement, observation, use of numbers and use of space/time relations

ACTIVITY DESCRIPTION
The students will build hills using different types of soils and monitor the natural erosion caused by weather.

PREPARATION
The teacher prepares the following materials:

- Loam (gravel, sand, clay and humus mixed)
- Clay
- Sand
- Potting soil
- Plastic bags
  Put equal amounts of each soil type in separate plastic bags.
  Label the bags.

Materials needed for each team:

- Bag of soil
- Metric stick
- Tape measure
- Wash Out Activity Sheet
- Wash Out Record Sheet

THE ACTIVITY
Teams of students will observe erosion by following the steps below:

- Obtain a plastic bag of soil.
- Take the soil to a level area outside.
- Follow the directions on the Activity Sheet.

At the end of the project students will decide the following:

- What happened to each hill?
- Did the shapes change?
- Which soil eroded the most?
- Which soil eroded least?
- Where does the eroded soil go?
- What were the causes of erosion?
- How might a farmer use this information?
- Were there other factors, besides rain, that caused erosion?

TEACHER'S NOTES
You may want to use this opportunity to highlight the career of a farmer by discussing how she prevents erosion.

Soil is classified according to the predominant type of material in it. For example, clay soil has mostly clay in it. However, it also has a little sand and humus.

Erosion is the process of the soil wearing away. This may be caused by water, ice or wind.

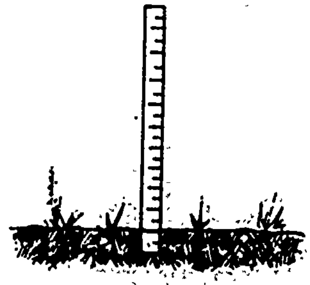
EXTENSION

Make a contour map of each hill before and after the weathering process.

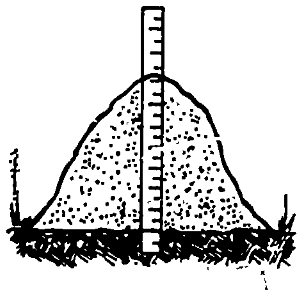
Kathy Shonts

Wash Out Activity Sheet

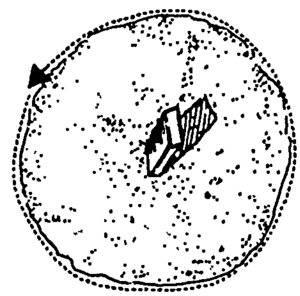
1. Place your metric stick about 5 cm in the ground.



2. Make a hill around your stick using the contents in your plastic bag. Your hill should be the same height as the other teams' hills.



3. Measure the circumference of your hill with the measuring tape.



4. Record the height and circumference on the Wash Out Record Sheet.

RECORD SHEET

DAY	HEIGHT	CIRCUMFERENCE	WEATHER	CHANGES
1				
2				
3				
4				
5				
6				
7				

5. The next day, measure the height and circumference. Record them.

6. Check the hill every day. Record the height and circumference. What causes daily change?

7. At the end of a week, compare your hill with the rest of the hills. Which one changed the most and why?

Wash Out Record Sheet

Day	Height	Circumference	Weather	Changes
1				
2				
3				
4				
5				
6				
7				

Water Balancing Act

EQUALS Processes
- **Cooperative learning**
- **Problem solving**

CONTENT

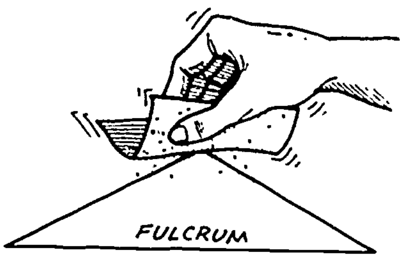
Discover that pennies have different masses
Scientific Processes: communication, control of variables, formulation of hypotheses, measurement, observation and prediction

ACTIVITY DESCRIPTION

Students weigh pennies on a balance using water as the standard for measurement.

PREPARATION

Materials needed for each group:

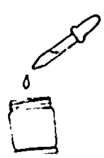


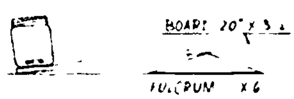
- 20" x 3 1/2" board (scrap 1/4" plywood or paneling)
- Triangle fulcrum
  Cut 1" high, 6" long.
  Round top edge with coarse sandpaper.
- 2 baby food jars
- 10 ml graduated cylinder
- Dropper
- Tap water
- 4 pennies, at least one pre-1980

THE ACTIVITY

Teams determine the mass of one penny by performing the following steps:

- Balance the board on the fulcrum with a jar on each end.
- Put a penny in one of the jars.
- Measure 10 ml water in the graduated cylinder.
- Using the dropper, add enough water to the empty jar to balance the board.
- Determine the amount of water that was needed to balance the penny.
- Convert this amount into mass using the formula 1 milliliter (ml) of water = 1 gram (g).





Teams discuss, agree upon and record what they think three pennies will weigh.

They then determine the actual weight of the pennies by repeating the weighing method above.

Teams discuss their finding, comparing their prediction with actual mass.

Teams hypothesize the following:

- reasons for differences
- possible differences in four pennies

TEACHER'S NOTES

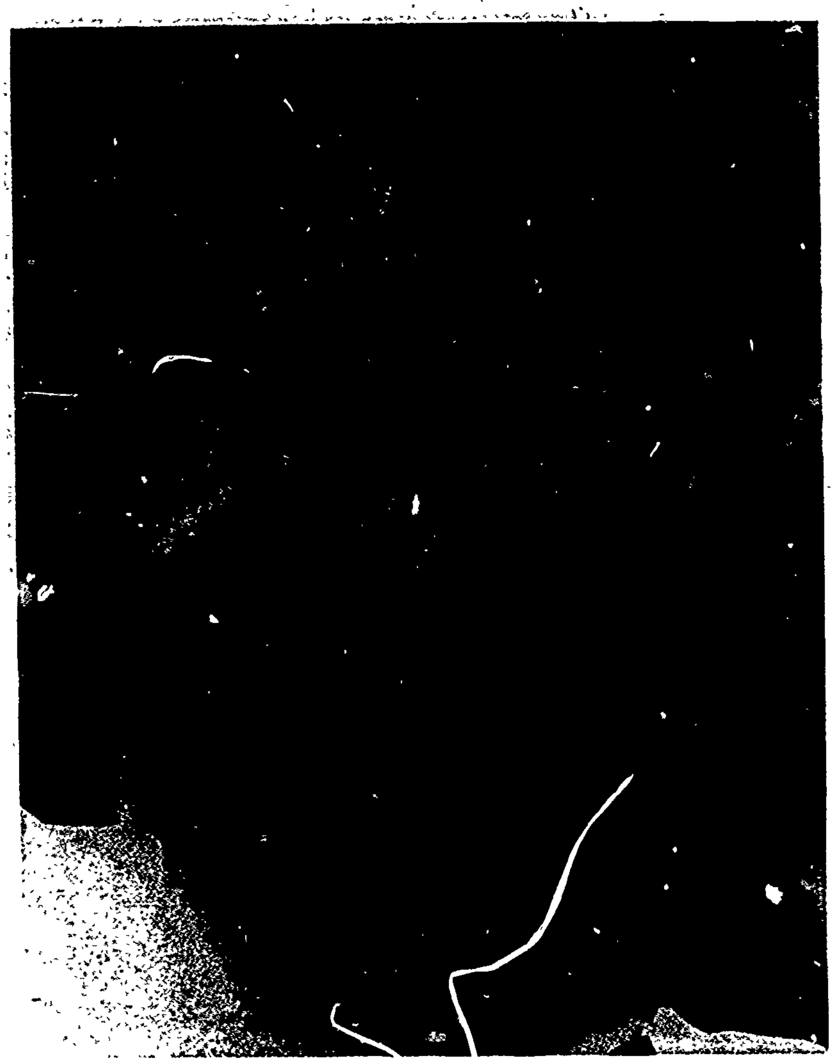
Students will discover that if they used the pre-1980 penny, their prediction does not match the actual mass because pre-1980 pennies are made from different materials.

Liters are used to measure metric volumes. They measure how much liquid something can hold. For measuring relatively small amounts of liquids, milliliters are used. The metric base unit of mass (weight) is the gram. Grams are used to measure relatively light objects. 1 ml of water = 1 gram.

EXTENSION

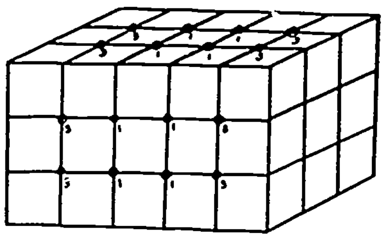
Compare the amount of error between using a triple beam balance and using the water balance. Some sources of error may be impurities in the water and temperature of water.

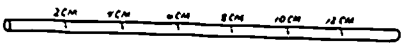
Patsy Richardson



What's in a Box?

EQUALS Processes
- **Career awareness**
- **Problem solving**
- **Spatial skills**





CONTENT
Infer the contents after observing its shape
Scientific Processes: Inferenco, measurement, observation, use of scientific model

ACTIVITY DESCRIPTION
Students become scientists as they explore the contents of a box by inserting dowels into it.

PREPARATION
Materials needed for the box:

- Shoe box
- 2 cm grid paper
- Tape
- Three-dimensional objects (golf ball, can, etc.)
- Pointed instrument

Getting the box ready:

- Wrap box with grid paper.
- Tape in place.
- Glue one object to bottom of box.
- Punch hole at each line intersection on grid with pointed instrument.

Also needed:

- Small dowel, marked at 2 cm increments

THE ACTIVITY
Students determine the shape of the object in the box by doing the following:

- Insert the dowel into each hole.
- Note the distance the dowel goes in.
- Record these distances next to each hole.
- Study all the measurements taken and then interpret the shape of the object.

Students relate the exploration of the box to scientific investigations.

- What did you discover about the shape of the object using the measurement data (dimensions, placement, symmetry, etc.)?
- After having identified the shape, what do you infer the object to be?

- What investigations are scientists experimenting with today?
- How are these investigations like the one you just did?

TEACHER'S NOTES

Exploring the contents of the box is an investigative activity that provides students with a limited amount of sensory information. After gathering as much observational data as possible, students make inferences about the nature of the contents.

This investigation is similar to scientists' investigations in that the subject matter of science is as inaccessible to the scientist as the contents of the box is to the students. Scientists study the universe without being able to travel to its far reaches and they deduce the composition of the earth's interior without being able to see it. Even though the scientists are working with limited information, they continue to gather observational data and make inferences in their study of the unknown.

EXTENSIONS

Infer other properties, such as texture, sound or material when using the dowel.

Use activity as a station by laminating grid paper and marking measurements with a pen that can be wiped away.

Daryl Hersh

What's the Advantage?

EQUALS Processes
- **Problem solving**
- **Spatial skills**

CONTENT

Determine the lever with the greatest amount of mechanical advantage

Scientific Processes: control of variables, experimentation, inference and observation

ACTIVITY DESCRIPTION

Students will discover mechanical advantage by opening paint cans using three different screwdrivers.

PREPARATION

Materials needed:

- 3 screwdrivers of varying lengths
- 3 empty paint cans with lids
- Board to fit over lids
- Hammer

Preparation needed:

- With a marker, make 4–6 equally spaced marks around the edge of the lids.
- Secure lids by placing board on top.
- Hit center of board with hammer, using equal force each time.

THE ACTIVITY

Students will discover which lever requires less force by doing the following:

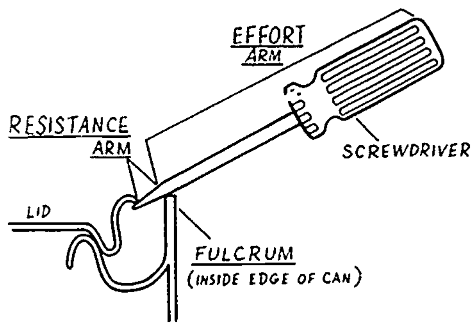
- They will use the smallest screwdriver to pry a lid at marks. (Be sure to exert the same amount of force for each pry.)
- They count the number of prys needed to open the lid.
- Students repeat the procedure using other two screwdrivers and other lids.

Using information gathered, students will discuss the following:

- Which screwdriver requires the least number of prys to open the lid?
- Which screwdriver requires the least amount of force?
- Which screwdriver has the greatest mechanical advantage?
- Why is it important to exert the same amount of force and use the sam iethod when securing the lid?
- What jobs it use this mechanical force?

TEACHER'S NOTES

A lever is one kind of simple machine. A lever consists of a rigid bar, which pivots at one point called the **fulcrum**. A force is applied at one end of the bar, and the bar in turn pushes an object that offers resistance. The force applied to the lever is called the **effort**. The force that the lever overcomes is called the **resistance force**. The distance from the fulcrum to the effort force is the **effort arm**. The distance from the fulcrum to the resistance force is the **resistance arm**.



In this activity, increasing the length of the effort arm (screwdriver handle), results in less effort force necessary to overcome the resistance (tightness of lid).

Mechanical advantage makes it possible, or easier, to perform a task using a simple machine. Increasing the length of the effort arm results in a larger mechanical advantage.

In this activity, the independent variable is the length of the effort arm The dependent variable being observed is the amount of force or effort necessary to open the can. Two other variables affecting the observed effort must be controlled, or kept constant. Those variables are the length of the resistance arm and the load or resistance. The resistance arm is kept constant because the distance between the rim of the can and the lip of the cover is constant. To keep the resistance force constant, you must be sure to reseal the can in the same way and to the same extent for each trial.

EXTENSION

A crowbar is an example of a lever. Have students identify the effort arm, the fulcrum and the resistance arm.

- What factor affects the mechanical advantage of a crow-bar?
- What other common household tools are examples of levers?

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