SCIENCE
A CLOSER LOOK

BUILDING SKILLS

Activity Lab Workbook

Macmillan McGraw-Hill

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Science Safety Contract

Dear Parent or Guardian,

Today our science class talked about how to work safely when doing laboratory experiments. It is important that you be informed regarding the school's effort to promote a safe environment for students participating in laboratory activities. Please review the safety rules and this entire Safety Contract with your child. This contract must be signed by both you and your child in order for your child to participate in laboratory activities.

Safety Rules:

1. Listen carefully and follow directions.
2. Perform only those experiments approved by your teacher. If you are not sure about something, ask your teacher.
3. Take great care when handling and moving chemicals and hot materials.
4. Conduct yourself in a responsible manner at all times.
5. Always clean up after you have finished an experiment.
6. Always wash your hands before and after an experiment.
7. Do not eat, drink, or chew gum in the laboratory.

Date: ____________

I have read and reviewed the science safety rules with my child. I consent to my child's participation in science laboratory activities in a classroom environment where these rules are enforced.

Parent/Guardian Signature: ________________________________

I know that it is important to work safely in science class. I understand the rules and will follow them.

Student Signature: ____

Science Safety Contract

Estimados padres o tutor:

Hoy hemos hablado en nuestra clase de Ciencias sobre cómo mantener la seguridad al realizar experimentos científicos. Es importante que ustedes estén informados del propósito de la escuela de promover un entorno seguro para los estudiantes que participan en las prácticas de laboratorio. Por favor, examinen cuidadosamente con su niño o niña las reglas siguientes y el Acuerdo de Seguridad. El acuerdo debe ser firmado tanto por uno de ustedes como por su niño o niña para que él o ella pueda participar en las actividades de laboratorio.

Reglas de Seguridad:

1. Escucha con atención y sigue las indicaciones.
2. Haz sólo los experimentos aprobados por tu maestro o maestra. Pregúntale a él o a ella si no estás seguro de algo.
3. Ejercita sumo cuidado al manipular y transportar productos químicos y materiales calientes.
4. Compórtate en todo momento de manera responsable.
5. No te olvides de limpiar cuando termines de realizar un experimento.
6. Lávate siempre las manos antes y después de hacer un experimento.
7. No comas, bebas ni mastiques chicle en el laboratorio.

Fecha: ____________

He leído y examinado las reglas de seguridad de ciencias con mi niño o niña. Doy mi consentimiento para su participación en las actividades del laboratorio de ciencias en un entorno donde se hagan cumplir estas reglas.

Firma de uno de los padres o tutor: ____________________________

Sé la importancia que tiene trabajar con seguridad en la clase de Ciencias. Comprendo las reglas y me comprometo a seguirlas.

Firma del estudiante: ____

Name ______________________ Date ____________

Explore

What do you know about stars?

Materials

- encyclopedia, Internet, and other reference materials

Purpose

Stars are born, shine brightly for millions or billions of years, then collapse and even explode. Stars change over time. How do you think these changes happen? Write your answer in the form "Changes to stars occur over time when . . ."

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Procedure

- Choose one or more of the processes or events you believe account for the changes to stars, and do research on what is known about your chosen topic.
- **Record Data** In the chart below, take notes on the details of observations and theories related to your research topic.

My Topic: ______________________________

Observations	Theories

 Name ____________ Date ________

Communicate Prepare a report for the class on what is known about your research topic. Include your ideas on which theories you think are best supported and any ideas for further observations.

Explore More

Orsola De Marco and Mordecai-Mark Mac Low are astrophysicists. They both work at the American Museum of Natural History in New York City. Astrophysicists are scientists who are curious about how the universe works.

Orsola studies stars by looking through a telescope.

Astrophysicists use different methods to gather data. For example, Orsola studies light to investigate the history of the universe and the behavior of objects in space. Through a telescope, Orsola observes the light given off by distant stars. However, the length of time she can observe does not permit her to see events that may take many, many years to finish. Mordecai uses computer models to investigate how the universe works. Mordecai enters data into a computer. The data he enters is processed by the computer to make a model of an event in space. The model can show what happens in distant space over time.

Mordecai studies stars by making computer models.

By working together, their different skills increase our understanding of stars. What do scientists like Mordecai and

Name ______________________ Date ____________ **Explore**

Orsola learn about stars from their different methods of work? How do scientists study stars?

Open Inquiry

Think of your own question about stars and how scientists study them.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

What do you know about studying the stars?

Materials

- encyclopedia, Internet, and other reference materials
- color pencils

- How does Orsola De Marco study stars?

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- Suppose you were going with Orsola to observe stars through a telescope. What question would you want to investigate?

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- How does Mordecai-Mark Mac Low investigate the universe?

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- “Stars are born, shine for millions or billions of years, then collapse and even explode.” Draw a series of pictures showing a star’s life cycle.

Name ______________________ Date ____________

Explore

How can living things be classified?

Purpose

What characteristics can you use to classify different living things? Observe living things in a drop of water, and group those with similar characteristics.

Procedure

Observe Place 1 drop of aquarium water on a clean microscope slide. Gently lower a coverslip onto the slide so it touches the drop as shown. Lower and release the coverslip so it flattens the drop. Place the slide on the stage of the microscope, and observe it under low power.

Record Data Work with a partner to look for living things in the drop. What characteristics do they have? Record your observations.

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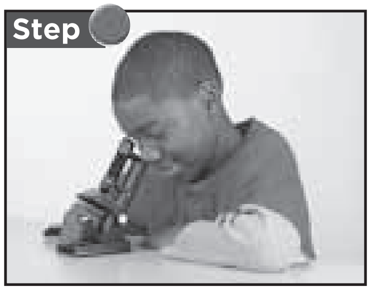
Classify Find different ways to group organisms with similar characteristics.

Materials

- dropper
- aquarium, pond, or ocean water
- slide
- coverslip
- microscope



Explore Name ______________________ Date ____________

- **Communicate** Make a data table of the different kinds of characteristics you observed (motion, shape, color, size, cells, and so on).

Draw Conclusions

- **Interpret Data** What characteristics did you use to place the living things in separate groups? What do the members of each group have in common? What differences do they have?

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- **Compare** Did you find more than one way to classify an organism? If so, why did you decide on one particular way rather than another?

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Name ______________________ Date ____________ **Explore**

Explore More

Add other living things to your classification system. Study living specimens around you. You might observe animals at a local zoo. How does the addition of new living things change your classification system?

Open Inquiry

Think of your own question about classifying similar organisms.

▶ My question is:

▶ How I can test it:

▶ My results are:

Name ______________________ Date ____________

How can you tell if a cell is from a plant or an animal?

Materials

- encyclopedia or biology textbook

- **Observe** Look at pictures of plant cells and animal cells.

- **Compare** What are the similarities between animal cells and plant cells? What are the differences?

- Use the box below to draw the features of a plant cell and the features of an animal cell. Be sure to emphasize any differences between the two types of cells.

Name ______________________ Date ____________

Quick Lab

Measuring Protists

Materials

- microscope
- thin, transparent metric ruler
- dropper
- water sample
- slide
- coverslip

Measure Slide a thin, transparent metric ruler onto the stage of your microscope. Focus on it under low power. Measure and record the field of view in millimeters.

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Obtain a water sample from your teacher. Put a drop of the water in the center of a microscope slide. Gently place a coverslip over it.

Observe Using low power, focus the microscope until you find a protist. Draw what you see.

Use Numbers Estimate the fraction of the field of view that the protist takes up. Multiply that fraction by the size of your field of view to estimate the length of the organism in millimeters. For example, if the field of view is 10 mm in diameter and the microbe takes up one fourth of the field of view, then 10 mm $\times$ 0.25 = 2.5 mm.

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Name ______________________________ Date ____________

Classify

palmate leaf

When scientists **classify**, they place things that share characteristics in groups. In order to do that, scientists need to compare and contrast things to find out what characteristics they share. Remember, to compare you look for how things are alike. To contrast you look for how they are different.

▶ Learn It

Classifying is a useful tool for organizing and analyzing things. When you **classify**, you can learn characteristics of millions of things without actually having to learn about each one. For example, you may not know all the different kinds of bicycles there are in the world, but you know that all bicycles have two wheels.

smooth leaf

It is a good idea to keep notes of the criteria, or rules, you use to classify things. An example of a criterion is the number of wheels something has. If you decide to classify things by the number of wheels they have, then cars, pickup trucks, and carts would be in the group of things that have four wheels. Motorcycles and bicycles would be together in the group of things that have two wheels. Your notes can help you figure out how to classify other things if you want to add to your classification.

You can classify leaves is by their edges. Here are some examples of the different types of leaf edges.

toothed leaf

pinnate leaf

lobed leaf

Name ______________________ Date ____________

Try It

- Find ten leaves of different kinds, shapes, and sizes.
- Examine each of your ten leaves one at a time.
- Draw your leaves on a chart similar to the one below.
- Write a description of each leaf next to its picture.
- **Classify** your leaves according to the type of edge each has. As a guideline, use the leaves shown. Record the type of edge on your chart.

Materials

- variety of leaves
- resealable plastic bags
- hand lens
- white paper
- pencil

Leaf Classification

Leaf	What It Looks Like	Description	Classification
1.		veins smooth edges	smooth
2.			

Focus on Skills

Name ______________________ Date ____________

Leaf Classification			
Leaf	**What It Looks Like**	**Description**	**Classification**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Name ______________________ Date ____________

▶ Apply It

- Now that you know how to classify objects, look around you for more things to classify.
- Think of things you see every day, such as plants, rocks, or animals. What similarities and differences do you see among them?

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- Keep a list of each of those things that you see, and **classify** them by size, shape, color, or any other characteristic they have in common. Share your findings with the class.

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Name ______________________ Date ____________

How does light affect plants?

Materials

- aluminum foil
- growing plant (a large-leafed plant will work best)
- paper clips
- water

Form a Hypothesis

Plants need light to grow. What do you think will happen to a plant's leaves if you cover parts of them so that no light reaches those parts? Write your answer in the form of a hypothesis: "If parts of a plant's leaves do not receive any light, then . . ."

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Test Your Hypothesis

- Wrap small pieces of aluminum foil over parts of several leaves of a growing plant. Secure the foil with paper clips. Wash your hands after handling the plant.

- **Use Variables** Cover at least four different leaves of the plant in the same way.

- Place the plant in a window where it will have lots of light. Water the plant as needed.

Experiment After one day carefully lift the foil and check each leaf. Write down your observations. Gently replace the foil in the same position. Continue your observations each day for one week, placing the foil back in the same position each time. How do the areas covered by the foil differ from the other parts of the leaves?

Draw Conclusions

Interpret Data What changes did you observe after 1 day? After 2 days? After 1 week? How do light and darkness seem to affect the growth of leaves?

Explore More

What will happen if the leaves are no longer covered? Remove the foil from the leaves, and continue to water and observe the plant for another week. Share your findings with the rest of your class.

 Name ______________________ Date ____________

Open Inquiry

Think of your own question about additional factors that would affect the health of plant leaves.

▶ My question is:

▶ How I can test it:

▶ My results are:

Name ______________________ Date ____________

Do all plants need the same conditions to grow?

Materials

- encyclopedia, Internet, or other reference materials

- Choose three different plants.
- Research the specific conditions each plant needs to grow best. Record the information you find.

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- **Draw Conclusions** Do all plants need exactly the same conditions to survive and grow?

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- **Record Data** Use the table below to check off which conditions helps each plant grow best.

Conditions	Plant 1	Plant 2	Plant 3

Name ______________________ Date __________

Leaves

Materials
• variety of leaves
• hand lens
• thin white paper
• crayons

- Collect a variety of leaves.
- **Observe** Examine each leaf with a hand lens, and write down each structure that you can identify.

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- Place a thin piece of white paper over the leaf, and rub back and forth with a crayon, making a print or rubbing of the leaf.
- **Classify** On the rubbing identify the leaf as simple or compound, and label each structure. Record your classifications.

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- Using two colors of crayons, trace the flow of water and food through the veins. Describe how you traced the flow of water.

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Name ______________________ Date ______________

What are some characteristics of animals?

Purpose

What characteristics do you think animals have? Observe brine shrimp, and decide whether they have characteristics of animals.

Procedure

Pour the water into your bowl. Add salt and baking soda according to package directions. Then add the brine shrimp package contents. Place the bowl in a warm area, in front of a sunny window. Allow it to sit for 12–24 hours. Then add a drop of baker's yeast, mixed with a small amount of water. What do you think the yeast is for?

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Materials

- 2 L water
- clear container
- sea salt
- baking soda
- package of brine shrimp
- baker's yeast
- hand lens
- metric ruler
- research books (optional)

Explore

Name ______________________ Date ____________

Observe Using a hand lens, watch the brine shrimp carefully. Draw what you see, and write down any behaviors you notice. Do the brine shrimp have characteristics of animals?

Measure Look at the millimeter marks on your ruler, and estimate the length of an average-sized brine shrimp.

Communicate Record your observations, and compare your results to those of your classmates. Make a poster that shows and explains your observations.

Draw Conclusions

Interpret Data What characteristics do animals display? Make changes to your original ideas based on your observations.

Explore More

Continue observations over the next few days. Have there been any changes? How should brine shrimp be classified? What kind of water environment do they require? Where do they fit in a food chain?

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Open Inquiry

Think of your own question about the conditions in which brine shrimp survive.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

What are some characteristics of brine shrimp?

Materials

- encyclopedias, Internet, and other reference materials

- Find information on the characteristics of brine shrimp.

- **Classify** Are brine shrimp classified as animals? Why or why not?

- Discuss the characteristics of brine shrimp.

- What is the natural habitat of brine shrimp?

- Which reference materials helped you most in your research?

Name ______________________________ Date ______________

Quick Lab

Characteristics of Worms

Be Careful. Handle live animals gently and carefully.

Materials

- earthworm
- wet paper towel
- hand lens
- colored pencils
- reference books

1. Obtain an earthworm specimen from your teacher.

2. **Observe** Look at the worm, and record your observations. Use a hand lens for closer observation. Be sure to wash your hands after touching the earthworm.

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3. **Record Data** Draw the earthworm, and label each part you recognize. Use a reference book to identify parts that are not familiar to you.

4. **Infer** How do worms move?

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Name ______________________________ Date ______________

How does the large intestine help with digestion?

Materials

- scissors
  ⚠ **Be Careful.**
- textured paper towels
- plain paper towels
- construction paper
- computer paper
- graduated cylinder
- water
- stopwatch

Make a Prediction

If you use paper to model the way the large intestine absorbs water, which paper will absorb the most water? Write your answer in the form "If the paper that absorbs the most water is most like the large intestine, then the large intestine will be best modeled by . . ."

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Test Your Prediction

- Cut each type of paper into strips of equal size. Fold the papers to fit into the graduated cylinder.
- Fill the graduated cylinder about half full with water. Record the water level on the chart on the next page.
- Dip one paper into the graduated cylinder until half of the paper is covered by water. Keep it in the water for 1 minute.

Step

Step

Name ______________________ Date ____________

Explore

After 1 minute, remove the paper from the water. Record the water level in your chart. Calculate the amount of water the paper absorbed. Starting from step 2, repeat this process for each type of paper.

Paper Type	Initial Water Level	Final Water Level	Amount of Water Absorbed

Draw Conclusions

Infer Which paper absorbed the most water? Why do you think this happened? What characteristics could it share with the large intestine?

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Name ______________________ Date ____________

Explore More

What other aspect of digestion could you test? Design and perform an experiment. Then share your results.

Open Inquiry

Think of your own question about modeling the small intestine.

- My question is:

- How I can test it:

- My results are:

Does the shape of the intestines aid digestion?

Materials

- paper
- pencil
- string
- meterstick

- Draw a circle on a piece of paper. Draw a wavy line around the inside of the circle, close to the edge. Both the circle and the wavy line inside the circle represent the surface area of the intestines.
- Lay the string on the paper, along the entire line that forms the circle. Use a pencil to mark where the string overlaps. The circumference of the circle will represent its surface area.
- **Measure** Straighten out the string, and measure it. Record the circumference in centimeters.

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- Place the string on the paper, along the entire wavy line inside the circle. Mark where the string overlaps. This measurement represents the surface area of the wavy line.
- **Measure** Straighten out the string, and measure it. Record your measurement in centimeters.

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- **Draw Conclusions** Which shape has the most surface area: the circle or the wavy line inside the circle? What can you conclude from your results?

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Quick Lab

Name ______________________ Date ____________

Vein-Valve Model

Materials
• paper-towel tube
• scissors
• ruler
• construction paper
• tape
• dried beans

- Cut a thin, horizontal slit halfway across the center of the tube.
- Opposite the first slit, but 0.6 cm below it, cut a slit 1.5 cm wide.
- Cut paper inserts for each slit as shown in the text. ⚠ **Be Careful.** Trim the insert for the top slit so it blocks the tube but can swing a little. Cut the insert for the bottom slit wide enough that it can only be inserted partway. Tape the tails of the inserts to the tube's side.
- **Observe** Pour beans down the tube. Try both ends. Explain the results.

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- **Infer** How are your body's veins like the tube with the paper flaps?

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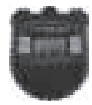
Name ______________________________ Date ______________

Structured Inquiry

How do different-sized blood vessels compare?

Materials

- ruler 
- graduated cylinder 
- dropper 
- food coloring 
- small funnel 
- cup 
- stopwatch 
- plastic tubing

Form a Hypothesis

There are many types of tubes to carry blood from the heart to the body and lungs and back again. The blood vessels that carry blood away from the heart are called arteries. They carry very large quantities of blood. Arterioles are smaller than arteries, but they can still carry large quantities of blood. The blood flows from arterioles into capillaries, which are very small. This is where oxygen and carbon dioxide are exchanged. How does the size of each blood vessel affect the flow of blood? Write your answer in the form of a hypothesis: "If the diameter of a blood vessel is made smaller, then the flow of blood will . . ."

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Test Your Hypothesis


Step


Step

- **Use Numbers** The plastic tubing represents different blood vessels. Measure and record the diameter of each piece of tubing. Record your answers in the data table on the next page.
- Fill a graduated cylinder with 100 mL of water. Add 3 drops of food coloring to represent blood.
- **Experiment** Put the funnel into the opening of the widest tubing. Put the other end of the tubing in a cup. Pour the water into the funnel. Use the stopwatch to record how long it takes for all the water to pass through the tube. Return the water to the graduated cylinder. Repeat this twice, and record the time for each trial in the data table on the next page.

Name ______________________________ Date ____________

- **Use Variables** Repeat step 3 with the medium-diameter tubing. Then repeat step 3 with the narrowest tubing.

- Connect the tubing so that the widest piece is at the top and the narrowest is at the bottom. Repeat step 3. Record your times in the data table below.

Tubing Size (in cm)			
Trial 1 Time (in seconds)			
Trial 2 Time (in seconds)			
Trial 3 Time (in seconds)			

Draw Conclusions

- **Compare** What differences did you observe between the widest tubing and the narrowest? Which required the longest time for the water to pass through the tubing?

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- **Interpret Data** What happened when you connected all three pieces of tubing in step 5?

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- **Infer** What did step 5 demonstrate about the circulatory system in the human body?

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Name ______________________ Date ____________

Be a Scientist

Guided Inquiry

How does the respiratory system work?

Form a Hypothesis

The lungs in vertebrates take in oxygen and expel carbon dioxide. The heart pumps blood, carrying those same gases, around the body. How do the lungs work in the human body? Write your answer in the form of a hypothesis: "If humans have lungs, then the human body must also have the following parts for the lungs to work: . . ."

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Test Your Hypothesis

Design an experiment that uses classroom materials to model the human lungs. Write out the materials you will need and the steps you will follow. Record your results and observations.

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Draw Conclusions

Did your results support your hypothesis? What parts did you find to be necessary for the lungs to work in the human body?

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Name ______________________ Date ____________

Open Inquiry

What else can you learn about the circulatory systems of organisms? For example, what are the differences between a bird heart and a human heart? Design an experiment to answer your question. Organize your experiment to test only one variable. Write your experiment so that another group could repeat your experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

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- My hypothesis is:

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- How can I test it:

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- My conclusions are:

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Name ______________________ Date ____________

Explore

Does a waxy coating help a plant retain moisture?

Form a Hypothesis

Some plants grow where there is very little water. How do these plants survive? Does a waxy coating make a difference? Write your answer in the form of a hypothesis: "If a plant is covered by a waxy coating, then the plant will . . ."

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Test Your Hypothesis

- **Make a Model** Dampen three identical paper towels so that they are evenly moist but not dripping wet. Measure the water in a graduated cylinder, and use the same amount of water to dampen each paper towel.

- **Use Variables** Lay one paper towel in between two identical pieces of waxed paper. Fasten the edges together with tape or paper clips.

- Roll up a second paper towel, and cover it with waxed paper. Fasten the edges together. Leave the third paper towel flat and uncovered.

Materials

- 3 paper towels
- water
- graduated cylinder
- waxed paper
- tape or paper clips
- tray

Name ____________________ Date ____________

Observe Place all three paper towels on a tray in a sunny location. Observe the paper towels after 30 minutes. Which paper towel retained the most moisture? Which retained the least?

Draw Conclusions

Interpret Data Was your hypothesis correct?

Infer How can you explain your observations?

Explore More

Would a different type of coating or covering help reduce moisture loss? Design and carry out an experiment to test your hypothesis, try it, and then share your results.

Open Inquiry

Think of your own question about the loss of water from leaves.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

How do plants control water loss?

Materials

- paper towels
- water
- waxed paper

- Dampen two paper towels with equal amounts of water.
- Place the paper towels next to each other on a flat surface in a sunny location.
- Cover one of the paper towels with a piece of waxed paper.
- **Observe** After 24 hours observe the paper towels. What is the difference between the two?

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- **Draw Conclusions** What would be the function of a waxy coating on the outside of a plant leaf?

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- Use the box below to draw a diagram that illustrates how the waxy coating on the outside of a plant leaf works.

Name ______________________________ Date ____________

Quick Lab

Modeling an Adaptation

Materials

- 64 dried beans
- graph paper
- chopsticks
- cup
- timer
- forceps

- **Make a Model** Lay out 64 dried beans on a sheet of graph paper so they form a square shape.

- Use chopsticks to pick up as many beans as possible. Place the beans in a cup. Give yourself exactly 1 minute, and then stop. Record the number of beans in the cup.

- Repeat steps 1 and 2, using forceps instead of chopsticks.

- **Interpret Data** Suppose that the beans represent a food source. If the chopsticks and forceps represent animals, which is better adapted to feed on the beans?

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- **Predict** Which "animal" will survive longer? Which will produce more young? Explain your predictions.

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Explore

Name ______________________ Date ____________

What do cells look like?

Materials

- piece of cork
- 2 hand lenses
- prepared slide of cork
- microscope

Purpose

Many cells are specialized so that organisms can function and stay alive. How small are these cells that are the building blocks of all living things? Is it possible to see them? Examine pieces of cork, and record your observations in the chart.

Procedure

- **Observe** Examine a piece of cork. Describe and draw what you see, noting details such as shape, pattern, texture, and color. Does cork seem more likely to come from an animal or from a plant?

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- **Observe** What details of the cork can you see with a hand lens? Using a second hand lens, try to magnify the image even more by using both lenses at once. What difficulties did you have?

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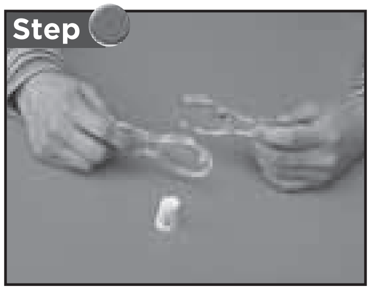
- **Compare** Examine the prepared slide of cork with your hand lens. Compare it to the cork in your hand. What are the differences between the two?



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Name ______________________ Date ______________ **Explore**

Observe View the slide through the microscope under low power. Describe and draw what you see. Repeat this process using high power.

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Tool	Description of What You See	Drawing of What You See
your eyes		
hand lens		
two hand lenses		
microscope under low power		
microscope under high power		

Draw Conclusions

Interpret Data As your sample was magnified more and more, what information did you sacrifice in order to view greater detail?

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Name ____________________ Date ____________

Explore More

Could you use a microscope to recognize cells in other samples? Repeat the investigation, using different samples and slides. Compare your observations. Then share your results with the rest of the class.

Open Inquiry

Do the cells of all organisms look the same? Think of your own question about what cells look like.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

Alternative Explore

How big are cells?

Materials

- pictures of various cells

- **Observe** Look at the assorted pictures of cells provided by your teacher.

- **Compare** Describe the features the cells have in common. Are there any noticeable differences between the cells?

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- **Compare** Is there an obvious difference among the magnifications of the pictures? How does a difference in magnification affect your ability to observe the structures of the cells?

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- **Infer** Would you be able to observe the structures of the cells in the pictures with the unaided eye? What tools do scientists use to observe the structures of cells?

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Name ______________________ Date ____________

Comparing Cells in Animal Tissue

Materials

- sheet of $8\frac{1}{2}$-by-11-inch paper
- slides of epithelial, nerve, connective, and muscle tissue
- microscope

- In multicellular organisms, cells that make up different types of tissue perform specific functions. Obtain slides of epithelial, nerve, connective, and muscle tissue from your teacher. Fold a piece of $8\frac{1}{2}$-by-11-inch paper in half lengthwise and then widthwise, making four boxes. Use this paper to record your observations.

- **Observe** Pick up a slide, and write the name of the tissue in the first box on your paper. Use the microscope to examine the slide. On your paper draw what you see, and note anything interesting about the cells. Repeat this process for the other three slides, using one box of your paper for each type of cell.

- **Compare** Review all four of your drawings. What are some of the characteristics of each type of cell? Can you identify any cell structures? Make additional notes on your diagrams. Label any parts you can identify.

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- **Classify** Use your textbook to label each type of tissue you examined. Record the labels below.

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- **Infer** Based on your observations, why do you think doctors often specialize in the diseases of certain organs or types of tissue?

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Name ______________________________ Date _____________

Observe

Every cell is enclosed in a membrane, or thin covering, that allows nutrients to enter the cell and wastes to exit. Scientists know a lot about how cells work, but they always want to learn more. One way to learn is to **observe** cells during osmosis. What happens to cells when water moves from an area of low salt concentration to an area of high salt concentration?

Materials

- 2 plastic cups
- 2 paper towels
- 2 potato slices
- metric ruler
- water
- spoon
- salt
- 2 index cards
- timer or clock

▶ Learn It

When you **observe**, you use one or more of your senses to identify or learn about something. It is important to record your observations and any measurements you take. It is also a good idea to organize this data on a chart or graph. That way, you can see your information at a glance.

▶ Try It

- Label one cup *Fresh Water,* and label the other cup *Salt Water*.
- Place each cup on a paper towel.
- Place a potato slice on each towel, and trace it.
- Find the diameter of each slice to the nearest millimeter, and record it on the chart on the next page.
- Pour fresh water into each cup. Add 3 spoonfuls of salt to the *Salt Water* cup.
- Put a potato slice in the bottom of each cup. Place an index card over each cup as a lid, and leave the cups undisturbed for 20 minutes.

Name ______________________ Date ____________

- Remove the potato slice from each cup, and place it over its original tracing. Measure the diameter of each potato slice. What do you **observe**?

____

____

- On your chart, record your observations about the *Fresh Water* and *Salt Water* slices.

Contents of Cup	Potato Measurements	My Observations
fresh water	beginning	
	after 20 minutes	
	after 24 hours	
salt water	beginning	
	after 20 minutes	
	after 24 hours	

Name ______________________ Date ____________

▶ Apply It

- What did you observe about the *Fresh Water* potato slice?

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____

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- What did you observe about the *Salt Water* potato slice?

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____

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- Now put each potato slice back into its cup. Cover the cups again with the index cards, and leave them untouched for 24 hours. Then take the slices out, measure them again, and add that data to your chart.

- Compare and contrast these results with your original findings. What can you conclude from your observations?

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Name ______________________ Date ____________

What do you think your results might be if you put one potato slice in salt water and the other in a cup of sugar water? Perform this experiment, and **observe** what happens. What new information have you learned from your observations? Record your data in the chart below.

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Contents of Cup	Potato Measurements	My Observations
fresh water	beginning	
	after 20 minutes	
	after 24 hours	
salt water	beginning	
	after 20 minutes	
	after 24 hours	

Name ______________________________ Date _____________

How do plant and animal cells differ?

Purpose

Cells are the basic units of all living organisms. Plant cells and animal cells share many of the same structures. How do plant and animal cells compare? Look at epithelial cells of both plants and animals. Determine the similarities and differences.

Procedure

1. Make a wet-mount slide of a leaf from near the tip of an elodea plant. Place a small drop of water on the slide with a dropper. Use the forceps to pick up a leaf and place it in the drop of water on the slide. Lower the coverslip onto the leaf.

2. **Observe** Examine the elodea leaf under low power, focusing on the top layer of cells. Focus on one cell, and record your observations. Look at the center of the cell under high power, and draw what you see. Return the microscope to low power. Remove the slide, and follow your teacher's instructions for what to do with it.

3. **Observe** Repeat step 2, using a prepared slide of human cheek cells instead of the elodea leaf.

Materials

- microscope slide
- water
- dropper
- forceps
- elodea leaf
- coverslip
- microscope
- prepared slide of human cheek cells

Step 1

Step 2

 Name ______________________ Date ____________

Draw Conclusions

- **Compare** Describe the similarities and differences in your observations of the elodea cells and the human cheek cells.

- **Interpret Data** What accounts for some of the similarities and differences in these cells?

Explore More

Look at prepared slides of other cell samples. Do they look more like elodea cells or human cheek cells? Why?

Explore

Open Inquiry
Think of your own question about how the shape of a cell is related to its function.

▶ My question is:

____

____

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▶ How I can test it:

____

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▶ My results are:

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____

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Name ______________________ Date ____________

What is inside a cell?

Materials

- onion skin
- glass slide
- microscope
- iodine stain

- Prepare a wet mount of a piece of onion skin on a slide.
- **Observe** Observe the onion skin under a microscope. Draw what you see in the box below. Can you see any of the structures of the cells?

____

____

- **Observe** Add the iodine stain to the onion skin on the slide. Look at the slide under the microscope again. Draw what you see in the box.

- **Communicate** Describe what you saw once the iodine stain was added.

____

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- **Draw Conclusions** Why would a scientist use stains when observing cells?

____

____

Name ______________________ Date ____________

Diffusion and Osmosis in Action

Materials

- very warm water
- jar
- tea bag
- teaspoon
- sand
- paper towel
- scissors

- **Experiment** Fill a jar with very warm water. Place a tea bag in the water, and add 1 tsp of sand.

- **Observe** Shake the jar, and then leave it undisturbed for 15 minutes. What color is the water? Is the water's color evenly distributed?

  ____

  ____

- **Record Data** Remove the tea bag from the jar, and place it on a paper towel. Look closely at the water in the jar. Are there any tea leaves floating in the water? Cut the tea bag open with scissors. ⚠ **Be Careful.** Is there any sand in the tea bag?

  ____

  ____

- **Interpret Data** What moved into and out of the tea bag? How do you know that this happened?

  ____

  ____

  ____

- **Infer** What do you think determines which particles move into or out of a tea bag? What would happen to the water if the tea bag remained in the water even longer?

  ____

  ____

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  ____

Be a Scientist

Name ______________________ Date ____________

Structured Inquiry

What is cellular respiration?

Form a Hypothesis

Cellular respiration is the process cells use to break food molecules into energy and carbon dioxide. Cells use this energy to maintain their functions. Unicellular organisms, such as bacteria, use this energy to regulate the flow of materials into and out of the cell, to move from one place to another, and to perform many other functions. Some organisms go through cellular respiration without oxygen. How can you measure the rate of cellular respiration in yeast? Write your answer in the form of a hypothesis: “If yeast cells are breaking down sugar molecules, then the rate of bubble production will . . .”

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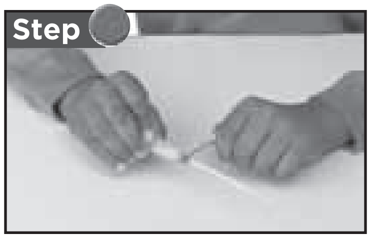
Materials

- water 
- 2 insulated wires (10 cm long) 
- 2 test tubes 
- dropper 
- bromothymol blue 
- scissors 
- stopwatch 
- 2 pipettes
- yeast
- sugar

Test Your Hypothesis

- Fill the bulb of a pipette with a solution of yeast, water, and sugar. Wrap a 10 cm piece of wire around the pipette; this will act as a weight to keep the pipette submerged.
- Fill a test tube half full with water. Add 5 drops of bromothymol blue.
- Use scissors to cut off 2.5 cm of the pipette tip. ⚠ **Be Careful.** This will allow the water to cover the pipette.



Hold the pipette with the tip pointed up, and submerge the pipette in the test tube. Add water to the test tube until it covers the pipette tip.

Communicate Record how many bubbles form in 10 minutes. In addition, record any changes of color in the test tube.

Time (in minutes)	1	2	3	4	5	6	7	8	9	10
Trial 1										
Trial 2										

Repeat steps 1 through 5 for a second trial. Record your results in the chart above.

____

____

Draw Conclusions

Infer Why was it useful to repeat steps 1 through 5?

____

____

____

Infer The yeast solution contained yeast, water, and sugar. What were the yeast cells doing that produced bubbles?

____

____

____

 Name ______________________ Date ____________

- **Infer** If cells break down sugar to produce energy and carbon dioxide, what were the bubbles that formed during the experiment?

___

Guided Inquiry

What affects the rate of cellular respiration?

Form a Hypothesis

Many things can affect the rate of cellular respiration. If you go for a run or ride your bike, you will start to take deeper breaths. How can you increase the rate of cellular respiration in yeast? Write your answer in the form of a hypothesis: "If the yeast's environment is changed by ______, then the rate of cellular respiration will increase."

___

___

Test Your Hypothesis

Design an experiment to increase yeast's rate of cellular respiration. Write out the materials you will need and the steps you will follow. Record your results and observations.

___

___

Draw Conclusions

Did your results support your hypothesis? Why or why not? What affected yeast's rate of cellular respiration?

___

___

Open Inquiry

What else can you learn about cellular respiration? For example, what are some differences between aerobic respiration, which involves oxygen, and anaerobic respiration, which occurs without oxygen? Design an experiment to answer your question. Organize your experiment to test only one variable, or one item being changed. Write your experiment so that another group could complete the experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

  ____

  ____

- My hypothesis is:

  ____

  ____

- How can I test it:

  ____

  ____

  ____

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  ____

- My conclusions are:

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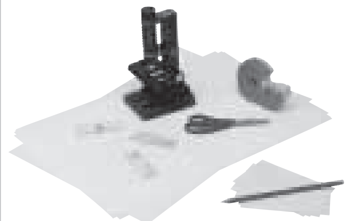
  ____

  ____

  ____

Name ______________________ Date __________

How does one cell become many?



Materials

- prepared slides of cell division
- microscope
- large piece of paper
- scissors
  Be Careful.
- tape
- index cards

Purpose

How does a single cell develop into a fully grown organism? To find out more about this, look at slides of cells that are in various stages of cell division—the process of making more cells.

Procedure

Observe Examine the first slide under low power. Use the large focus knob to get the image nearly focused. Use the smaller knob to make the image clear and crisp. Can you see any details inside the individual cells? If not, repeat this process using high power. What details do you notice inside the different cells? Look at other cells by moving the slide slightly. Draw several examples of what you observe. Repeat this process for each slide.

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Communicate Compare each of your drawings to the others that you made. Which cells seem to be in similar stages of cell division? Which seem to be in different stages? Discuss this with a partner.

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Classify Cut out your diagrams, and group the diagrams of cells that seemed the same. Compare your diagrams to those of your classmates. Your class will decide together how many groups to use. Record the number of groups on the line below.

____

____

____

Draw Conclusions

Tape a diagram on the unlined side of an index card to represent one of the groups of cells. Do this for each group. Save your index cards to use as a reference throughout this lesson.

Explore More

Can these same processes be observed in both plant and animal cells? Where in a plant do you think these processes are most likely to occur? Design an investigation to test your prediction. Try it, and share your results with your class.

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Name ______________________ Date __________

Open Inquiry

Think of your own question about cell division in other organisms compared to cell division in plant or animal cells.

- My question is:

____

____

____

____

- How I can test it:

____

____

____

____

- My results are:

____

____

____

____

Name ______________________ Date ____________

Alternative Explore

How does the frequency of cell division vary in different parts of an organism?

Materials

- prepared slide of a plant root
- microscope

- Place the slide of the plant root on the stage of your microscope, and focus on an area near the middle of the root, away from the tip.

- **Observe** How many of the cells appear to be dividing?

____

____

____

- **Observe** Focus on the cells near the tip of the root. How many of these cells appear to be dividing?

____

____

____

____

- **Draw Conclusions** How would you explain any difference in the frequency of cell division near the middle of the root and near the tip of the root?

____

____

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Name ______________________ Date ____________

Mitosis Mania

Materials

- pictures of the stages of mitosis
- index cards from Explore Activity

- Carefully examine pictures of the various stages of mitosis. Use index cards of previous observations if available.
- **Compare** Look carefully at each picture, and consider all the phases of mitosis. If pictures are of the same phase, place them together.
- **Classify** In which grouping does each picture belong? Place each picture in the appropriate category. Be prepared to explain your choice for each picture.

____

____

____

- **Interpret Data** Working in groups, arrange the pictures according to the phases the cells are in. Write the definition of each phase, an explanation, and a sample diagram.

Name ______________________ Date ____________

Explore

What temperatures encourage the growth of yeast?

Form a Hypothesis

What effect does temperature have on the growth of yeast? Write your answer in the form of a hypothesis: "If yeast is grown in either warm or cold water, then it will grow better in . . ."

____

____

____

____

Test Your Hypothesis

- **Observe** Look closely at a sample of active dry yeast with your hand lens. What do you see? What would help you see more detail?

  ____

  ____

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- **Experiment** Fill two beakers with 125 mL of warm water (at about 45°C). Add 4 g of sugar to each beaker, and stir gently until the sugar dissolves completely. Label one beaker *Warm* and the other *Cold*.

Materials

- active dry yeast
- hand lens
- 2 beakers
- graduated cylinder
- warm water
- balance
- sugar
- 2 plastic stirrers
- bowl of ice water
- timer or clock
- 2 droppers
- slides & coverslips
- microscope

Explore

Name ______________________ Date ____________

Use Variables Place the beaker labeled *Cold* upright in a bowl of ice water. What are the independent and dependent variables being tested in this experiment?

Empty one package of active dry yeast into each beaker. Stir the contents of both beakers. After 10 minutes observe the beakers, and describe what you see. In which beaker does there seem to be more activity?

Draw Conclusions

Compare Take a sample from the center of each beaker. Use the microscope under low and then high power to examine the yeast that is growing. Which sample has more yeast cells?

Explore More

Is yeast able to make its own food, or does it absorb nutrients from its environment? Make an inference, and design an experiment to test it.

Open Inquiry

Think of your own question about how yeast works at different temperatures in dough.

- ▶ My question is:
- ▶ How I can test it:
- ▶ My results are:

Name ______________________ Date ____________

How big are some one-celled microorganisms?

Materials

- prepared slides of a yeast cell, a bacterium, and a paramecium
- microscope

- **Observe** Use a microscope to look at the first slide. Record the magnification at which you view the organism.

____

____

- **Measure** Measure the size of the first cell under magnification. Round to the nearest tenth of a millimeter. Record your data in the table below.

- **Record Data** Use the same magnification to observe the other two prepared slides. Measure the size of each cell. Round to the nearest tenth of a millimeter. Record your data in the table.

Organism	Size

- **Draw Conclusions** Of the three slides you examined, which organism had the largest cell? Which organism had the smallest cell?

____

____

Name ______________________ Date ____________ **Quick Lab**

Mold Growth

Materials

- bread slice
- water
- clear, sealable plastic bag
- hand lens

1. Moisten a slice of bread so it is damp but not wet. Place it in a clear, sealable plastic bag, and close the bag. Leave the bag in a dark, warm place for several days.

2. **Observe** Using a hand lens, carefully observe the bread. Examine each structure.
   ⚠ **Be Careful.** Do not open the bag.

3. **Record Data** Record your observations about the bread. Draw and label what you see. Identify the mold's visible parts.

4. **Interpret Data** What do you think caused the changes to the bread?

   ____

   ____

   ____

5. **Infer** Where do you think the mold that is growing on the bread originally came from?

   ____

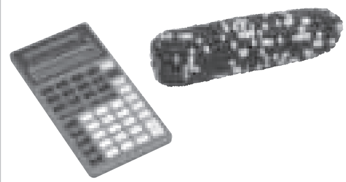
   ____

   ____

 Name ______________________ Date __________

Which inherited traits are dominant?

Materials



- ear of purple-and-yellow corn
- calculator

Make a Prediction

Yellow corn produces yellow corn, and purple corn produces purple corn. Is this always true? What happens when yellow corn and purple corn are crossed? The corn appears to be 100 percent purple! However, it is not really the same as its purple parent plants. What would happen if these new purple ears of corn were crossed? What percent of the corn kernels would be purple? Write your answer in the form of a prediction: "If purple ears of corn, each with a yellow parent and a purple parent, are bred together, then the percent of purple kernels in the offspring will be . . ."

____

____

____

Test Your Prediction

Record Data Look closely at the ear of purple-and-yellow corn. Row by row, count any purple kernels on your ear of corn, and record your answer. Then count any yellow kernels on your ear of corn. Record your answer.

____

____

____

Name ______________________ Date ____________ **Explore**

Use Numbers Write the ratio of purple kernels to yellow kernels. Use a calculator to simplify your ratio to the lowest fraction.

$$\text{ratio} = \frac{\text{purple kernels}}{\text{yellow kernels}}$$

____

____

____

Use Numbers On the board, add the class totals for purple kernels and yellow kernels. Find the average number of each color. Write this as a ratio of purple kernels to yellow kernels.

____

____

____

Draw Conclusions

Interpret Data Which kernel color appears more often? How does the ratio for your ear of corn compare with the ratio for the class total?

____

____

____

Infer Which color seems to be the more likely color for corn? Why do you think so much of the corn that we eat is yellow, not purple?

____

____

____

 Name ______________________ Date ____________

Explore More

Do other corn qualities occur in a similar ratio? Repeat this experiment with another trait, such as white and yellow kernels. Compare your results to those of others in your class.

Open Inquiry

Think of your own question about crossbreeding other vegetables.

- My question is:

- How I can test it:

- My results are:

Name ______________________ Date ____________

Can you predict heads or tails?

Materials

- quarter or other coin

Make a Prediction How many heads and tails will turn up if you toss a coin 10 times?

____

____

Record Data Toss the coin 10 times, and record your results in the table below.

Record Data Toss the coin 50 times and then 100 times. Record your data in the table below.

Number of Tosses	Heads	Tails
10		
50		
100		

Interpret Data Were there any differences in the results among the three trials?

____

____

____

Communicate Were your predictions correct?

____

____

____

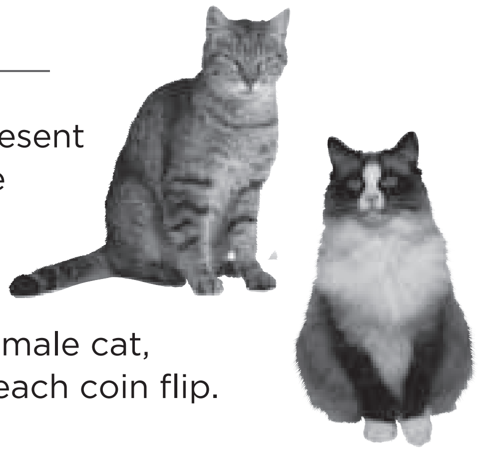
____

Name ______________________ Date ____________

Predicting Cat Traits

Materials

- quarter or other coin



- In cats, short hair (S) is dominant over long hair (s). Which genes will a short-haired hybrid cat have?

  ____

- **Make a Model** Use the sides of a coin to represent heredity for this trait. Let heads represent the dominant trait and tails represent the recessive trait.

- **Record Data** Flip the coins together for the male cat, and write down its genes. Record *S* or *s* for each coin flip. Then flip the coins for the female cat.

  ____

  ____

- **Use Numbers** Make a Punnett square for these two cats. What is the possible ratio of short-haired to long-haired offspring?

- **Predict** If you begin with hybrid cats, how often will you get a purebred short-haired offspring for this trait? Explain.

  ____

  ____

  ____

Use Numbers

Materials

- masking tape
- pennies
- marker

Many traits are determined by just two genes, one from each parent. Each parent passes on one of two genes that may be either dominant or recessive. Knowing this helps scientists predict the probability that a form of a trait will be inherited. How do scientists make these predictions? They **use numbers** by calculating data from Punnett squares.

Learn It

When you **use numbers**, you count, add, subtract, multiply, or divide to explain data. For example, this Punnett square shows the possible hairlines that a child might inherit if his or her parents each had a combination of a dominant, pointed-hairline gene (H) and a recessive, straight-hairline gene (h).

The probability of the child's having HH genes is 25 percent. There is a 50 percent probability of the child's having Hh genes. This means there is a 75 percent probability that the child will have a pointed hairline. At the same time, there is a 25 percent probability that the child will have a straight hairline (hh). It is possible that both parents could pass on the recessive gene to their child. In this activity, you will find the probability that a child will inherit the ability to roll the tongue.

	H	**h**
H	HH	Hh
h	Hh	hh

Focus on Skills

Name ______________________ Date ____________

▶ Try It

- Apply masking tape to both sides of each penny. Write *R* (able to roll) on the head side of each penny and *r* (unable to roll) on the tail side.

- Make a Punnett square with *Rr* at the top and *Rr* down the side. Make a chart like the one shown, with one possible combination from your Punnett square at the top of each column.

- Flip the two coins. Record the results on your chart by making a tally mark under the combination shown on the coins. Flip the coins and record the results a total of ten times. Record the total number of marks in each column, and **use numbers** to figure out the percents for each possible combination.

▶ Apply It

- According to your Punnett square, what is the probability that a child will inherit the ability to roll the tongue?

____

____

____

- How many times out of ten did you actually get a combination that gives a child the ability to roll the tongue?

____

____

- How many times out of ten did you actually get a combination of two recessive genes (rr) for tongue rolling?

____

____

- Now find the probability that a child will inherit one of these other traits that are passed on by parents:
  - long eyelashes (dominant) or short eyelashes (recessive)
  - unattached earlobes (dominant) or attached earlobes (recessive)
  - dimples (dominant) or no dimples (recessive)

- Decide what gene combination you wish each parent to have. Then make a Punnett square using the letter combinations. What is the probability that the child will inherit that trait?

Name ______________________________ Date ____________

Now label your coins with those new combinations, repeat the activity, and record your results. **Use numbers** by calculating your actual statistics.

	RR	Rr	rr
Toss 1			
Toss 2			
Toss 3			
Toss 4			
Toss 5			
Toss 6			
Toss 7			
Toss 8			
Toss 9			
Toss 10			
Probability	____-in-10 or ____%	____-in-10 or ____%	____-in-10 or ____

Name ______________________ Date ____________

Explore

What are some common inherited traits?

Materials

- calculator

Make a Prediction

How can you tell which traits are dominant when gathering data from many different individuals? Write your answer in the form of a prediction: "If I check a group of individuals for the frequency of different traits, then . . ."

____

____

____

Test Your Prediction

1. **Observe** Have a partner check you for each of the traits listed in the table below. Record which traits you have.

2. **Observe** Reverse roles with your partner, and repeat step 1.

Type of Trait	Column A	Column B
Freckles	no freckles	freckles
Tongue Rolling	unable to roll edges	able to roll edges
Shape of Hairline	not pointed	pointed in the middle
Chin Shape	not indented	indented in the middle
Thumb	straight	hitchhiker's
Eyelash Length	short	long
Earlobes	attached	unattached

 Name ______________ Date ______________

Communicate Tally your results in a classroom chart that lists all the traits.

Column A		Column B	
no freckles		freckles	
unable to roll edges		able to roll edges	
not pointed		pointed in the middle	
not indented		indented in the middle	
straight		hitchhiker's	
short		long	
attached		unattached	

Draw Conclusions

Interpret Data Plot the data from the classroom chart on a bar graph. Based on this data, which column lists the dominant traits?

____

____

Classify Of the traits on the chart, how many dominant and recessive traits do you have?

____

____

Infer Why is it important to gather data on many individuals before deciding which traits are dominant? Are dominant traits always more common? Explain your answer.

____

____

____

Name ______________________ Date ____________

Explore More

Find the percent of each trait in the class. The percent is a way of telling the frequency of a trait—how often the trait appears. Research dominant traits in humans. Are dominant traits more frequent in all groups of people?

Open Inquiry

Think of your own question about comparing traits in males and traits in females.

▶ My question is:

▶ How I can test it:

▶ My results are:

Alternative Explore

Name ______________________ Date ____________

How are genetic disorders passed on to offspring?

Many inherited traits, including those that cause genetic disorders, are dominant over other traits.

Materials

- paper
- pencil

Observe The Punnett square below shows the possible offspring from two parents. Offspring could receive from each parent either the dominant gene (C) or the recessive gene (c) for the genetic disorder.

	C	c
C	CC	Cc
c	Cc	cc

Use Numbers What percent of each genotype—CC, Cc, and cc—appears in the offspring?

____

Predict What is the chance that the offspring will have the genetic disorder?

____

____

Predict If the offspring do not have the genetic disorder, is there a chance that their offspring will have with it? Explain.

____

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____

Name ______________________ Date ____________ **Quick Lab**

Pedigrees

Materials

- paper
- pencil

Observe Study this pedigree for eyelash length. Which family members have short eyelashes?

____

____

Infer The trait for short eyelashes can skip a generation. What does this tell you about Sarah's genes for this trait?

____

____

Infer What can you infer about the eyelash genes of Sarah's husband regarding this trait?

____

____

Communicate Choose a trait that is expressed in some members of a family, perhaps your own. Draw a pedigree showing the occurrence of this trait in the members of this family.

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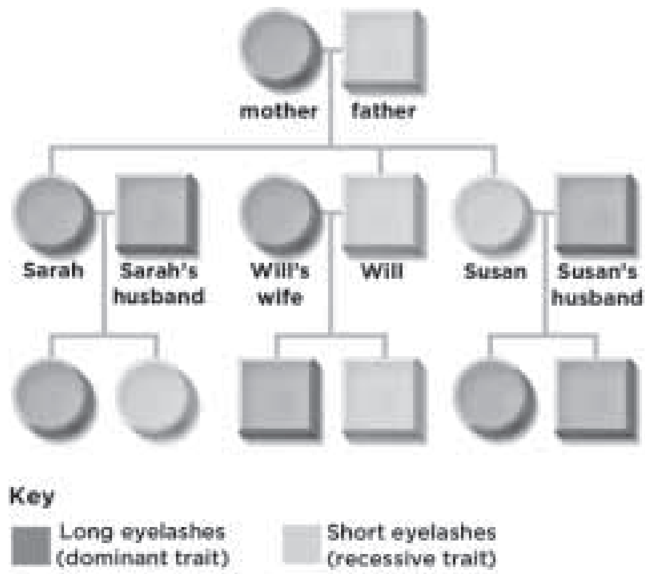


Explore

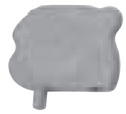
Name ______________________ Date ____________

How does a four-part code work?

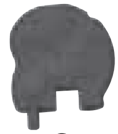
Purpose

Chromosomes are made up of genes. Each gene contains part of the code that controls various traits. How are these codes put together? Use puzzle pieces to make a model of this genetic code. The letters of the puzzle pieces represent the four types of substances that cells use to record and transfer information.

Materials

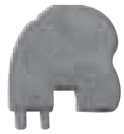


T



G

C



A

- genetic puzzle pieces (or 4 of each shown here)
- colored pencils

Procedure

Make a Model Gather some genetic puzzle pieces together. Arrange your puzzle pieces so that each of them fits together with another piece. Then put all of them together. Use colored pencils to draw a copy of how the pieces in your model fit together.

- **Observe** Can you assemble the pieces in a different way? How many different models can you make? Which parts fit together, and which parts do not? Explain why they do or do not fit.

____

____

____

- **Communicate** How are your models like those of other students? How are they different?

____

____

Draw Conclusions

- **Experiment** Develop a simple way of showing the arrangement of the pieces without actually drawing the assembled pieces. How does your method work?

____

____

- **Interpret Data** What is the main difference among the ways in which you assembled the puzzle?

____

____

- **Infer** How might the different ways of assembling the puzzle be used as a code?

____

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 Name ______________________ Date ____________

Explore More

Make a fifth puzzle piece. Label it *U*. How would you shape the piece so it could link horizontally to piece A and still be part of the puzzle? If you shaped piece U this way, would one of the original four have to be left out? If one would be left out, which one would it be? Try it, and share your findings with the class.

Open Inquiry

Think of your own question about how genes are transferred by the genetic code.

- My question is:
- How I can test it:
- My results are:

Name ______________________________ Date _____________

Alternative Explore

How does a two-part code work?

Materials

- 12 blue pop beads
- 12 yellow pop beads
- 12 green pop beads
- 12 red pop beads

- Create a code for as many letters as possible, using only two beads for each letter. Do not duplicate any codes for any letters. Record your letters and codes below.

____
____
____
____
____
____

- **Communicate** Use your code to create a short sentence. Share the code with a different group, and ask them to read the sentence.

____
____
____

- **Infer** How is communication limited by your code?

____
____
____

- **Draw Conclusions** How many letters could you code if you used three beads per letter?

____
____

Quick Lab

Name ______________________ Date ____________

Researching Genetically Engineered Crops

Materials
• paper • pencil

- Read some information about genetically engineered crops.

- **Record Data** In the center panel of the table below, list all the facts you have collected. On the left panel, list all the positive, or favorable, opinions about genetically engineered crops. On the right panel, list all the negative, or unfavorable, opinions you found.

Positive Opinions	Facts	Negative Opinions

- **Communicate** Compare the facts with the two groups of opinions. How do you feel about genetically engineered crops? Share your researched facts with a partner.

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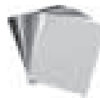
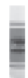
- **Draw Conclusions** Present your opinion to the class. Support your opinion with facts and quotes from your research.

Name ______________________ Date ______________

Structured Inquiry

How do scientists genetically engineer bacteria to produce insulin?

Materials

- construction paper 
- ruler
- scissors  **Be Careful.**
- red and blue yarn 
- glue stick 

Form a Hypothesis

Genetic engineering is intentionally changing DNA so that a gene will produce a specific trait. Geneticists have changed genes in plants to make the plants larger, heartier, or tastier. They have also changed genes in bacteria so that these cells can produce chemicals used in medicines and for other applications. For example, the gene that produces insulin in humans has been added to bacteria so that the bacterial cells produce insulin. The insulin is needed by people who have diabetes. This type of insulin is better for people than the types previously used. How can you model genetic engineering? Write your answer in the form of a hypothesis: "If a gene from a human is added to, or replaces, a piece of bacterial DNA, then the model of this genetic engineering will look like . . ."

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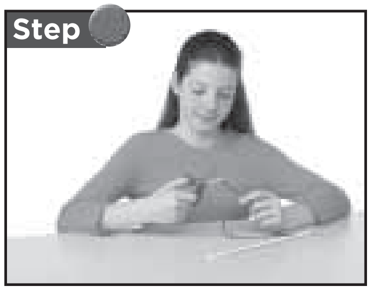
Test Your Hypothesis

1. Draw a large circle on a piece of construction paper. This will represent the bacterial cell.

Name ______________________ Date ____________

- Cut a 12 in. piece of red yarn, and tie the ends together to make a circle. This will represent the bacterial DNA. Glue down half of the DNA to the middle of your bacterial cell.

- Cut a 2 in. piece of blue yarn to represent the human gene for producing insulin. The scissors you cut with represent chemicals used to cut DNA at specific points.



- Cut a 2 in. section from the "bacterial DNA," and replace it with the "human gene," gluing the yarn at both ends.

Draw Conclusions

- **Infer** Genetic engineering must be done in a clean room and under very strict conditions. Why do you think this is necessary?

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- **Infer** Why would scientists be interested in putting the human insulin-producing gene into bacterial DNA?

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Name ________________________ Date ____________

Guided Inquiry

How are genetically engineered seeds different from wild seeds?

Form a Hypothesis

Farmers use many genetically engineered plants that grow faster or better in certain conditions. What differences are there between wild seeds and genetically engineered seeds? Write your answer in the form of a hypothesis: "If a plant is genetically engineered, then there will be measurable differences in the seeds, such as . . ."

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Test Your Hypothesis

Design an experiment to determine the differences between wild and genetically engineered radish seeds. Write out the materials you will need and the steps you will follow. Record your observations.

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Draw Conclusions

Did your results support your hypothesis? Why or why not? What differences did you see between the two different types of seeds?

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____

Name ______________________ Date ____________

Open Inquiry

What else can you learn about genetic engineering? For example, what are some differences in how genetically engineered plants grow? Design an experiment to answer your question. Write your experiment so that another group could complete the experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

____

____

____

- My hypothesis is:

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- How can I test it:

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- My conclusions are:

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Name ______________________ Date ____________

Explore

How do variations help animals survive?

Materials

- paper
- pencil

Form a Hypothesis

How might you explain variations among animals of a single species? What are some factors that may have contributed to the changes within the species? Write your answer in the form of a hypothesis: “If there are variations within a species, then . . .”

____

____

____

Test Your Hypothesis

1. **Observe** The photographs at right show finches found on the Galapagos Islands, a group of islands in the Pacific Ocean. Think like a scientist. Study the differences among the beaks of the birds shown here, and write detailed notes about them. You may want to include sketches as well.

woodpecker finch

large ground finch

tree finch

Darwin’s Finch

 Name ______________________ Date ____________

- **Infer** In your notes, make a column with a list of the traits you observed. Next to each trait, write a possible explanation for how it might help a bird survive and reproduce.

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- Research each bird to see where it lives and what it eats. Include this information in your notes.

- **Infer** Use your observations and notes to propose an explanation for how these variations might have occurred.

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Draw Conclusions

- **Communicate** How do you think the variations occurred? Share your ideas with a partner.

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- **Infer** Some of the finches live on different islands. How might geography have influenced the variations among these birds?

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Name ________________________ Date ____________

Explore More

Research variations among organisms of another species. What types of features can you find? How might these features help the organisms survive?

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Open Inquiry

Think of your own question about color variations in animals.

- My question is:

  ____

  ____

  ____

- How I can test it:

  ____

  ____

  ____

- My results are:

  ____

  ____

  ____

  ____

Name ______________________ Date ____________

Do seeds show variation?

Materials

- hand lens
- scarlet-runner-bean seeds
- metric ruler

Observe Use the hand lens to observe the color and overall appearance of the scarlet-runner-bean seeds. What are some of the similarities and differences among the seeds?

Measure Use the metric ruler to measure the length of each seed in millimeters. How do the seeds compare to one another?

Compare Share your results with another group of students. How does their data compare to yours?

Communicate Are most of the beans nearly identical? Why do you think this is so?

Name ______________________________ Date ____________

Quick Lab

Deep-Sea Creatures

Materials

- paper
- pencil
- art materials
- encyclopedia, Internet, or other reference materials

- What types of creatures might you encounter in the deep ocean?

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- **Infer** Working in small groups, make a list of features that would help an organism survive deep in the ocean. Explain the benefit of each trait.

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____

- **Make a Model** Design your own deep-sea creature, and draw a picture of the organism. Label all the traits from your list. Describe how each trait would help the creature survive and reproduce.

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- Read about some of the unusual creatures that live in the ocean.

- **Classify** Compare your creature to actual, known ocean organisms. Where might your creature fit if it were classified as a new discovery?

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Name ______________________ Date ____________

How does sunlight affect life in an ecosystem?

Form a Hypothesis

How does the amount of sunlight affect the number and types of organisms living in a small area? Write your answer in the form of a hypothesis: "If an area receives more sunlight, then . . ."

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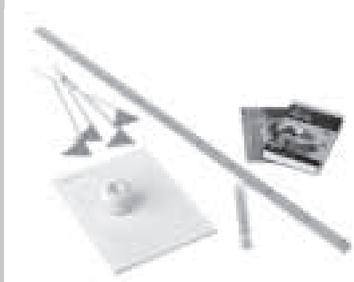
Materials



- meterstick
- small stakes
- string
- thermometer
- graph paper
- field guides

Test Your Hypothesis

Experiment With your teacher select two areas on or near your school grounds to study. Choose one area that receives full sunlight and another that receives very little sunlight. Use a meterstick to mark off a 2 m by 2 m plot in each area with stakes and string.

Step

Use Numbers Measure the air temperature at ground level and at 1 m above ground level in each area. Record your observations.

____

____

Observe Use graph paper to record the locations of the living things in each area. What kinds of organisms do you see? Look closely at the ground.

Step

____

____

____

- **Classify** Use field guides to help you identify the organisms you found.

____

____

____

Draw Conclusions

- **Interpret Data** Compare your observations of the two areas. How do the temperatures differ? Which area contains more living things? Did your observations support your hypothesis? Based on your data, what statement can you make about the effect of sunlight on an ecosystem? Did any other variables affect your results?

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Explore More

How do you think the amount of water in an ecosystem affects living things? Form a hypothesis, and design a procedure to test it. Then share your results with your class.

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 Name ______________________ Date __________

Open Inquiry

Think of your own question about how the type of soil may affect the amount and variety of living organisms in an area.

- My question is:

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- How I can test it:

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- My results are:

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Name ________________________ Date ____________

Do plants need nutrients to grow?

Materials

- ruler
- 3 small potted plants
- water
- water-soluble plant food
- measuring cup

Measure Record the heights of all the plants in the chart below.

Experiment Line up all three potted plants in an area where they will get the same amount of sunlight. Feed the three plants as follows: add water to the first plant, add liquid plant food to the second plant, and add a mixture of liquid plant food and water (at one quarter of the strength listed on the plant-food container) to the third plant.

Observe After one week measure the heights of the plants, and record your data in the chart below. Feed all three plants, following the same pattern as before. Continue to feed the plants once a week for a total of four weeks, observing the growth of the plants and recording your findings in your chart.

Time Elapsed	Plant 1	Plant 2	Plant 3
At Start			
1 Week			
2 Weeks			
3 Weeks			
4 Weeks			

Quick Lab

Name ______________________ Date ____________

Properties of Soil

Materials
• soil samples
• coffee filter
• strainer
• beaker
• water
• clock

- **Experiment** Place a small amount of soil in a filter-lined strainer. Set the strainer on top of a beaker. Repeat this setup for a sample of a different type of soil, but use the same amount.

- **Use Variables** At the same time, pour an equal amount of water into each of the soil samples. Watch both setups carefully for the same amount of time. What are the dependent and independent variables in this experiment?

____

____

____

- **Measure** Which soil sample allowed more water to pass through in the same amount of time?

____

____

____

- **Predict** Which of the two soil types would be better for shallow-rooted plants needing a great deal of water? Design an experiment to test your idea. Then share your results.

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Name ______________________________ Date ____________

Compare

When scientists **compare**, they look for similarities among objects, materials, or data. An ecosystem provides an opportunity for this type of inquiry. As scientists study a particular area over time, they can make comparisons between the way the ecosystem functions in the present and the way that it functioned in the past.

Materials

- soil
- rocks
- small twigs
- dishpan
- watering can
- water

Learn It

An ecosystem may be as small as a puddle or as large as the Sahara. Each of the many types of ecosystems on Earth has its own special characteristics. One small change in an ecosystem can affect everything in it. For example, algae in the Arctic can survive on the relatively small amount of light that passes through 5 to 25 cm (2 to 10 in.) of ice. Exposure to too much light, however, causes the algae to die off. If this occurs, it could destroy the base of the food chain. When scientists study an ecosystem, they examine every variation in order to discover how well parts of an ecosystem will be able to adapt to even the smallest change.

Charts, or data tables, and Venn diagrams are tools used to **compare**. After you have collected and recorded data, you can see at a glance whether the data, objects, or materials are very similar or not that similar at all. Line graphs and bar graphs can also be used to analyze changing conditions over time.

Try It

Sudden events, such as floods or mudslides, can drastically alter the makeup of an ecosystem. The land and other nonliving things may disappear from the area forever. Such conditions force living things to find new ecosystems in which to live. Scientists monitor how sudden events affect the living and nonliving things in an ecosystem. In this activity you will **compare** a miniature landscape before and after a "flood."

Focus on Skills

Name ______________________________ Date ____________

- Build a hill landscape of soil, rocks, and twig "trees" in a dishpan. Draw a picture of your landscape on a chart like the one on this page. Use the watering can to sprinkle water gently on your hills. Record your observations.
- Hold the can higher, and continue to let water fall down on the hills. Record your observations. Then pour the rest of the water quickly over the hills. Record your observations. Draw a picture of the way your landscape looks now.

What I Did	My Observations and Drawings
My landscape at the start of the experiment	
Sprinkled water gently	
Held can higher and sprinkled gently	
Poured remaining water quickly	
My landscape at the end of the experiment	

Name ______________________________ Date ______________

▶ Apply It

- Now use the information from your data table to make a Venn diagram similar to the one on this page. Draw two overlapping circles. In one circle, list the characteristics of your hill ecosystem before the “flood.” In the other circle, list the characteristics of your hill ecosystem after the “flood.” Write the characteristics they share in the area where the two circles overlap.

- How did your hill ecosystem change?

____

____

____

- How did it stay the same?

____

____

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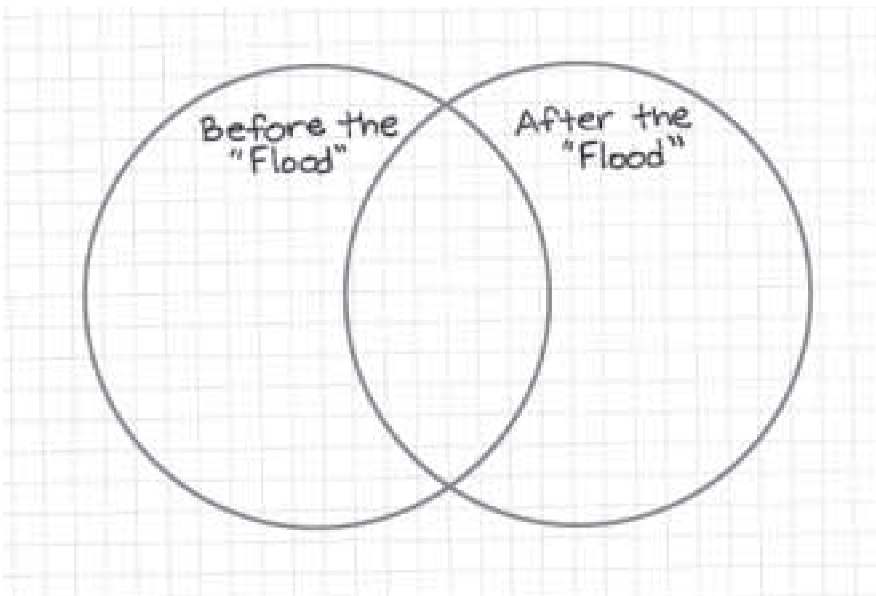
Venn Diagram



Name ______________________________ Date _____________

Choose an ecosystem near your school or home to observe for a month. Note any changes in the ecosystem, and make a chart or Venn diagram to **compare** its characteristics at the beginning and at the end of the month.

Name ______________________ Date ____________

How can you model a food chain?

Materials

- scissors
- construction paper
- hole punch
- yarn
- top half of empty 2 L soda bottle

Make a Prediction

What would a connection of 20 organisms—based on what they eat and what eats them—look like? What shape might the path connecting them seem to take? Write your answer in the form "If a food-chain model includes 20 organisms, then it will look . . ."

____

____

____

Test Your Prediction

1. Cut construction paper into 20 rectangles. ⚠ **Be Careful.** Write the name of one organism on each rectangle. Include 8 plants, 6 animals that eat these plants, 4 animals that eat the plant eaters, and 2 animals that eat the animals that eat the plant eaters. Make a hole in each rectangle, and tie a piece of yarn through each hole.

2. **Make a Model** Cover the top of the soda bottle with a circle of construction paper to represent the Sun. Punch 8 holes around the rim of the "Sun," and attach the 8 "plants" to these holes with yarn. They should hang off the outer edge of the "Sun." Attach each of the 6 "plant-eaters" to only one "food source." Attach each of the "animals that eat plant eaters." Then attach the "animals that eat animals that eat plant eaters."

 Name ______________________ Date ____________

Draw Conclusions

- **Observe** How many levels are in your model? What happens to the number of organisms in each level of your model as the distance from the Sun increases? Using your model, follow the path from the Sun to an animal in the level farthest from the Sun. What do the connections among them look like? Does your model look like you predicted it would?

- **Infer** What could happen to the animal populations represented in your model if a drought destroyed all the plants?

Explore More

What changes might occur in an ecosystem into which new animals move? Make a prediction, and design a way to test it. Then share your ideas with the rest of the class.

Name ________________________ Date ____________ **Explore**

Open Inquiry

Think of your own question about what would happen to an ecosystem if new plants began to grow.

▶ My question is:

___

___

___

▶ How I can test it:

___

___

___

▶ My results are:

___

___

___

___

Name ______________________ Date ____________

What are some food chains in a tropical rain forest?

Materials

- encyclopedia, Internet, or other reference materials
- colored pencils

Tropical rain forests are ecosystems that contain a large variety of living organisms that are adapted to the warm, moist climate of the rain forest.

- Research some of the many food chains that exist in a rain-forest ecosystem.
- Select two of the food chains in your reference materials, and sketch them in the box below with colored pencils.

- **Compare** Are there any similarities between the two food chains that you selected?

____

____

- **Infer** Where does the energy in a tropical-rain-forest food chain originate?

____

____

Name ______________________ Date ____________

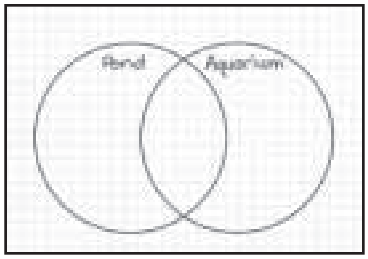
Quick Lab

Water Food Web

- Obtain two different samples of fresh water from a pond or stream and an aquarium. Do not wade into water to collect samples; ask your teacher or another adult to do this.
- **Observe** Place a drop of one water sample on a microscope slide. Carefully place a coverslip over it. Examine the slide under low and high power, with your teacher's help if needed. Draw what you see.
- Repeat step 2 with the other water sample.
- **Communicate** Make a Venn diagram similar to the one shown, in the box below. In the correct spots on your diagram, sketch the organisms that you saw.
- **Infer** Can you tell which observed organisms might be producers? Can you identify any that might be consumers? Label and identify the organisms on your Venn diagram.

Materials

- water samples from a lake or stream and from an aquarium
- 2 microscope slides and coverslips



Name ______________________ Date ____________

Structured Inquiry

What factors affect the carbon cycle?

Materials

- goggles
- straw
- cup
- bromothymol blue
- graduated cylinder
- test tube with cap
- elodea

Form a Hypothesis

The carbon cycle is a series of events that recycles carbon through the environment. Carbon exists in many forms and can be found in the air and in plants and animals. Plants take in carbon dioxide from the air and convert it to a usable form. The amount of carbon found in the air is affected by air pollution, especially pollution from the burning of fossil fuels. What role do plants play in the carbon cycle? Write your answer in the form of a hypothesis: "If carbon dioxide is added to a system containing a plant, then . . ."

____

____

____

Test Your Hypothesis

- Use a straw to blow slowly into a small cup of bromothymol blue. Record your observations. ⚠ **Be Careful.** Be sure to breathe out through the straw; do not breathe in. Do not drink the liquid in the cup. Wear safety goggles.

____

____

- **Measure** Pour 10 mL of bromothymol blue into a test tube. Record the color of the liquid.

____

____

Name ________________________ Date ____________

Be a Scientist

Experiment Use the straw to blow gently into the test tube until the liquid turns light green. Place one piece of elodea in the test tube, and put the cap on the tube. Record the color of the liquid.

____

____

Place the test tube near a window, and check the color of the bromothymol blue every 30 minutes for 2 hours. Record the color of the liquid at each interval.

____

____

Draw Conclusions

Interpret Data What made the bromothymol blue change color in step 1?

____

____

Infer If you had continued blowing into the test tube instead of capping it, what do you think would have happened during the 2-hour experiment?

____

____

____

Infer What part of the carbon cycle did you represent when you blew into the test tube?

____

____

____

Name ______________________ Date ____________

Guided Inquiry

What factors affect the water cycle?

Form a Hypothesis

Does temperature affect the water cycle? Write your answer in the form of a hypothesis: "If the average air temperature changes over a long period of time, then the water cycle will . . ."

____

____

____

Test Your Hypothesis

Design an experiment to investigate how temperature affects the water cycle. Write out the materials you will need and the steps you will follow. Record your results and observations.

____

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Draw Conclusions

Did your results support your hypothesis? Why or why not? What do you think would happen to the water cycle in a large land area if volcanic ash blocked the Sun's rays for a few months?

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Name ______________________ Date ____________

Open Inquiry

What can you learn about the nitrogen cycle? For example, does pollution affect it? Design an experiment to answer your question, and carry out your experiment. Organize your experiment to test only one variable, or one item being changed. Write down the steps so that another group could complete the experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

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- My hypothesis is:

____

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- How can I test it:

____

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____

____

- My conclusions are:

____

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Name ______________________________ Date ______________

How do different biomes compare?

Purpose

A biome is a region that has a particular climate. Earth's land biomes include taigas, tundras, rain forests, deciduous forests, deserts, and grasslands. Do all biomes have the same kinds of plants and animals? Research the characteristics of one biome, and draw a mural to represent it.

Materials

- masking tape
- long piece of white butcher paper or chart paper
- reference materials
- crayons and colored markers
- index cards

Procedure

- Work in groups of four or five. Each group should select one biome to study.
- Tape the paper to the walls of the classroom.
- Research the biome your group has selected. Find out about the biome's location, climate, soil, plants, and animals. Record your data in the chart below.

Location	
Climate	
Soil	
Plants	
Animals	

Make a Model Draw a mural that represents your biome. Show at least two plants and two animals that live in the biome. Include a world map that shows the locations of the biome. Use the space below to list the plants and animals you chose to show in the mural of the biome.

____

____

____

Communicate List on index cards the information you collected, and attach the cards to your mural. Indicate where you obtained the information. Record your answers below.

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Draw Conclusions

Compare Compare your group's mural to the other groups' biome murals. What similarities and differences do the plants and animals in the biomes seem to have?

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Name ______________________ Date ____________

Explore More

Compare various food chains in the biomes. What are the main producers in each? What are the main consumers?

Open Inquiry

Think of your own question about the characteristics of organisms that live in different biomes.

- My question is:
- How I can test it:
- My results are:

Name ______________________________ Date ______________

How do different biomes compare?

Materials

- encyclopedia, Internet, or other reference materials
- graph paper
- colored pencils

1. **Record Data** Select a month of the year, and use your available resource materials to find the average monthly temperature of each of the six land biomes.

Deciduous Forest	Desert	Grassland	Rain Forest	Taiga	Tundra

2. **Record Data** Using the same month you selected for step 1, find the average monthly precipitation each of the six land biomes receives.

Deciduous Forest	Desert	Grassland	Rain Forest	Taiga	Tundra

3. **Compare** Make a graph that compares the average monthly temperatures and precipitation of the six biomes. Mark the six biomes using a different colored pencil for each one.

Quick Lab

Name ______________________ Date ____________

Wetlands as Water Filters

Materials

- 2 small potted plants
- 2 clear plastic containers
- water
- colored, powdered drink mix

- **Make a Model** Place two small, potted houseplants in two clear containers. Each plant and pot represents a wetland.

- Slowly pour clean water into one of the pots. Observe the liquid that comes out of the bottom of the pot.

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- **Experiment** Add some colored, powdered drink mix to a cup of water, and stir. This represents polluted water. Slowly pour the mixture into the second pot. Observe what happens, and note the color of the water that drains from the pot.

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- **Draw Conclusions** Based on your observations, what can you conclude about the role of wetlands?

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Name ______________________ Date ______________

How do volcanic eruptions affect habitats?

Materials

- photographs of Mount St. Helens before and after the eruption of 1980 (shown)
- map showing extent of damage

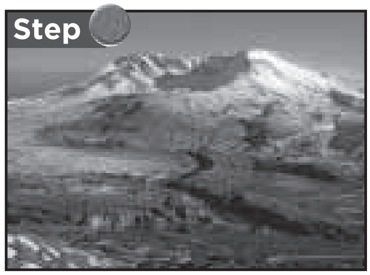
Make a Prediction

If a volcano erupts, what do you think will happen to the habitats around it? Write your answer in the form of a prediction: “If a volcano erupts, then the surrounding area will . . .”

Test Your Prediction

- **Observe** Study the photographs of Mount St. Helens before and after the volcanic eruption of 1980. What changes to the mountain and its vegetation do you see?

- **Compare** How did the upper and lower slopes of Mount St. Helens change?



Name ______________________ Date ____________

Draw Conclusions

- **Infer** A topographic map shows the elevations of landforms in an area. Do you think it would have been necessary to redraw a topographic map of this area after the volcano erupted? Why or why not?

- **Interpret Data** How would you explain what you observed? Did your observations support your prediction? How does an erupting volcano affect the area that surrounds it?

Explore More

Choose another natural disaster to study, such as the tsunami in Asia in 2004 or Hurricane Katrina in 2005. Find photographs taken of the same area before and after the disaster. Describe any changes you see in the landforms and the local vegetation. Analyze your results, and present them to the class.

Name ______________________ Date ____________ **Explore**

Open Inquiry

Think of your own question about what kinds of changes occur in an area after a natural disaster.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

What happened to the animals on Mount St. Helens?

Materials

- encyclopedia, Internet, or other research materials

- **Predict** How do you think the 1980 eruption of the volcano affected the animal population on Mount St. Helens?

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- Use the reference materials available to you to research how animal populations on Mount St. Helens were affected by the 1980 eruption.

- **Use Numbers** Choose one type of animal that you found data on during your research. How did the eruption of Mount St. Helens affect that animal population?

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- **Draw Conclusions** Was your hypothesis correct? Explain.

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Name ______________________ Date ____________

Quick Lab

Testing Soil pH

Materials

- soil samples
- plastic cups
- pH test kit

Experiment Put three different soil samples into separate cups. Test the pH level of each soil sample, using the test kit provided by your teacher. The pH scale measures how acidic or basic a substance is. Soil pH can be a limiting factor.

Interpret Data Record the pH of each sample. A substance with a pH of less than 7 is acidic. A substance with a pH of greater than 7 is basic. A substance with a pH of 7 is neutral, neither acidic nor basic. Look at the colors and numbers as directed in your test kit. Where do your samples fall on the pH scale?

	Sample 1	Sample 2	Sample 3
pH			

Predict What might the results be if you used soil from a field of ripe lemon trees or an orange grove? Design an experiment to test your prediction. If possible, perform your test and share the results.

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Explore

Name ______________________ Date ____________

How can you make a model of Earth's interior?

Purpose

Scientists study earthquake waves that travel through Earth. These waves provide information about the different layers of Earth's interior. Make a model to compare the thicknesses of Earth's layers.

Procedure

- **Make a Model** Draw a small *x* on the ground. This will be your center point for making three circles.
- **Measure** Tie one end of a piece of string to a piece of chalk. Then measure and cut the string to a length of 185 cm. Hold one end of the string at your center point, in the center of the *x*, and have a partner draw a circle around the *x*, keeping the string straight and taut all the way around.
- Repeat the process two times, first cutting your string to 182 cm and then cutting it to 100 cm.

Materials

- chalk
- string
- measuring tape or meterstick
- scissors
  Be Careful.

Draw Conclusions

- **Use Numbers** The scale for your model is 1 cm = 35 km. How many real kilometers are represented by each layer in your model?

- Are the layers in your model the same thickness? According to your model, what is the distance from the surface of Earth to its center?

Explore More

Can a scale model of Earth be designed to fit on a sheet of notebook paper? Measure the paper, and then calculate the scale that would work best for this new size. Try out your model. Is this model as helpful? Explain why or why not.

 Name ______________________________ Date ____________

Open Inquiry

Think of your own question about other ways to build a model of Earth.

- My question is:

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- How I can test it:

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- My results are:

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Name ______________________ Date ____________

What does the inside of Earth look like?

Materials

- encyclopedia, Internet, or other reference materials
- ruler
- compass

- Use research materials to gather information about Earth's interior.
- **Make a Model** Use what you have learned to draw a diagram of Earth's interior in the box below.

- **Observe** Write down the different features of Earth's interior that you were able to identify.

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- **Infer** How can scientists study the different layers of Earth's interior?

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 Name ____________________ Date __________

Map-Challenge Game

Materials

- two identical maps marked with lines of latitude and longitude

- Play the game in pairs. Obtain two identical maps, one for each player, that show latitude and longitude.
- Using his or her map, player A should choose a city and tell player B only its latitude and longitude.
- Player B should look at his or her own map, find the location, and call out the name of the city.
- Switch roles, and continue taking turns until each player has correctly identified five cities.
- **Infer** How might scientists use latitude and longitude to report data?

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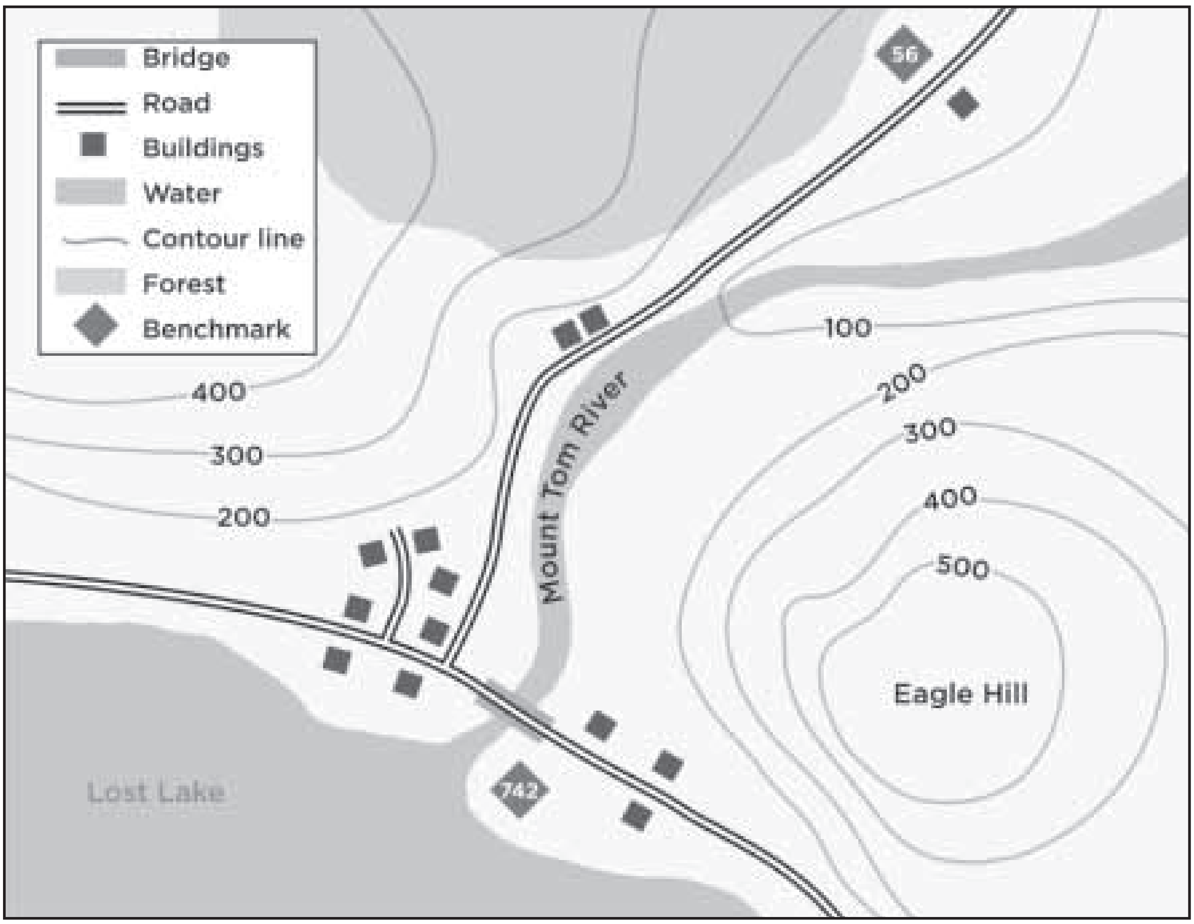
Name ______________________ Date ____________ **Focus on Skills**

Communicate

When you **communicate,** you share information with others. Sometimes, the information may be spoken. At other times, it may be written. Another useful way of communicating information is by making a map. One type of map that is very useful to geologists in particular is a topographic map.

▶ Learn It

A topographic map uses contour lines to **communicate**. Contour lines connect points of equal elevation. By looking at contour lines, you can learn a great deal about how a region looks.



Name ______________________ Date __________

▶ Try It

- With the permanent marker and ruler, mark horizontals line on the side of the plastic container at 1 cm intervals, from bottom to top.
- Make a clay hill that is steep on one side and gently sloping on the other.
- Place your hill in the center of the plastic container.
- Pour water into the container until the water reaches the first mark.
- Use a pencil to scratch a contour line along the entire shoreline of your hill.
- Repeat steps 4 and 5 at successive elevation levels until you have covered your hill with water.
- Carefully pour the water out of your container.

Materials

- permanent marker
- ruler
- plastic container
- modeling clay
- water
- pencil

Surveyors collect the data that are displayed on topographic maps.

Name ______________________________ Date _____________

Apply It

Make a short presentation to **communicate** what you learned about topographic maps from this activity. Use the questions below as a guide.

- Look at your hill from above. Observe the traced lines on the clay. What information do these lines provide?

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  ____

- What is the highest elevation of your hill?

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- What is the contour interval, or the difference in elevation between adjacent contour lines?

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- How does the spacing between contour lines on the gently sloping side of your hill compare to the spacing between contour lines on the steep side of your hill?

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- What can you conclude about the relationship between contour lines and the steepness of a hill?

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Focus on Skills

Name ______________________________ Date ____________

Communicate your results by drawing a topgraphic map of your hill in the space below. Look down on your hill from above as you transcribe the traced lines on your hill into contour lines on the map.

Name ______________________ Date ______________

Explore

Are the continents moving?

Materials

- tracing paper
- map of the world
- pencil
- scissors

Make a Prediction

Were the separate continents we know today one huge landmass in the past? Do the outlines of the continents fit together? Write your answer in the form of a prediction: "If the continents were once connected, then . . ."

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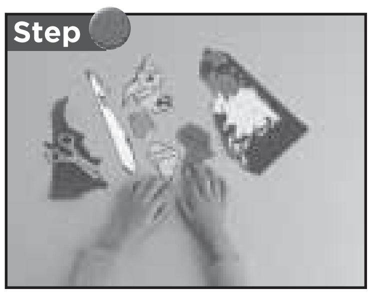
Test Your Prediction

- Place tracing paper over a map of the world. Trace the outlines of North America, South America, Europe and Asia (including India), Africa, Australia, and Antarctica.

- Cut out the continents along their coastlines, and label them. ⚠ **Be Careful.**

- **Experiment** Using your cutouts like pieces of a jigsaw puzzle, find ways the continents might have fit together in the past. On the following page, draw several sketches showing how you could fit them together.



Explore

Name ______________________ Date ____________

Draw Conclusions

- **Interpret Data** Which continents have coastlines that fit together most closely?

- **Infer** Which of your sketches shows the greatest number of continents fitting together? Which continents did you have trouble connecting? How can you explain this?

Explore More

What if the continents in your finished puzzle moved apart to the positions they are in today? If they kept moving, how might they be arranged in the distant future? Make a prediction and map it. Then analyze and present your results.

Open Inquiry

Think of your own question about the effect of moving continents on Earth.

- My question is:

- How I can test it:

- My results are:

Name ______________________ Date ____________

Are the continents moving?

Materials
• Internet resources
• graphics software

- Find a world map on the Internet. Copy it onto your desktop, and open it with your graphics software.
- Use the graphics tools to separate the major landmasses and move them around.
- Do any of the landmasses look as if they might have fit together in the past?

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- **Draw Conclusions** Could two landmasses that do not appear to fit together have been joined at some time in the past? Explain your answer.

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Name ______________________ Date ____________

Quick Lab

Earth's Sliding Plates

Materials

- tape
- construction paper
- 2 textbooks (of similar thicknesses)
- pencil
- building blocks or dominos

1. Tape two pieces of construction paper to the covers of two textbooks of similar thicknesses.
2. Place the books next to each other. Draw a "road" that crosses from one piece of construction paper to the other.
3. Using building blocks or dominoes, construct a small "house." Place it on top of the crack where the two books meet.
4. Slowly slide one book past the other. What happens to the "road" and "house"? Record your observations by drawing a sketch and labeling the details.

5. Rebuild your "house" to match its appearance in step 3.
6. Now tap one of the books sharply along its shorter side. Observe what happens to the "road" and "house." Record all observations.

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Name ______________________ Date ____________

How do mountains form?

Purpose
What happens when rocks in Earth's crust move? Make a model to demonstrate the results of pressure on layers of rock in Earth's crust.

Procedure

- **Make a Model** Make three clay layers, each 15 cm square and 1 cm thick. Pile the layers like a sandwich, and gently push on the top so that the layers stick together. Place the layers in the center of the waxed paper.

- **Observe** Place two books so that the spines touch opposite ends of the clay. Slowly and firmly push the books toward each other. Describe what happened. Flatten the clay.

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- **Observe** Use the knife to cut a "fault" across the clay at a 45-degree angle. Place the books so that the spines touch opposite ends of the clay. Slowly push the books toward each other again. Describe what happened. Flatten the clay.

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Materials

- modeling clay
- metric ruler
- sheet of waxed paper
- 2 hardcover books (of similar thicknesses)
- plastic knife

Name ______________________ Date ____________

Explore

Observe Move the books to the other sides of the clay. Slowly push the books in opposite directions along the "fault." Draw a picture of the layers.

Draw Conclusions

Interpret Data Your model represents forces on layers of Earth's crust. Which step modeled the formation of layers uplifted along a fault? Which step modeled folded mountains? Which step modeled movement without uplift? Explain your answers.

 Name ______________________ Date ____________

Explore More

How could you manipulate your model to demonstrate a fault where the layers on top of the fault move down and the others move up? On which side would the mountain form? Explain.

Open Inquiry

Think of your own question about the formation of an existing mountain or mountain range.

▶ My question is:

▶ How I can test it:

▶ My results are:

Name ______________________ Date ____________

How are mountains formed?

Materials

- Internet, other reference materials
- pencils or markers
- sheet of paper

- Find a diagram that shows how folded mountains and fault-block mountains are formed.
- **Make a Model** Copy the diagram onto the sheet of paper. Note the forces that are present in each process.
- **Observe** Describe the forces that are present in each process.

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- **Compare** Describe the similarities and differences between folded mountains and fault-block mountains.

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 Name ____________________ Date ____________

Making Mountains

Materials

- aluminum foil
- rocks and pebbles

- **Make a Model** Place a sheet of aluminum foil on a flat surface such as a desk or table. Arrange some rocks and pebbles on the foil to represent various landforms.

- **Experiment** Press your hands down flat on the edges of the foil. Slowly slide your hands closer together. Watch the surface of the foil carefully for any changes.

- **Observe** What happens to the foil surface as your hands move? What happens to the rocks and pebbles representing various landforms?

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- **Infer** What would happen if you moved your hands faster or at different angles?

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How does the steepness of a slope affect stream erosion?

Form a Hypothesis

A stream causes erosion by carrying sediment and other materials away. Do you think a stream in a steep streambed causes more erosion than a stream in a level streambed? Write your answer in the form of a hypothesis: "If a streambed is made steeper, then . . ."

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Materials

- aluminum pan
- mixture of sand, gravel, and pebbles
- 2 books or wood blocks
- small watering can

Test Your Hypothesis

1. Make a model of a streambed by filling the aluminum pan with the mixture of sand, gravel, and pebbles. Place a single book or wood block under one end of the model.

2. Use the watering can to pour a thin stream of water down the middle of your model. Be sure to pour the water in a steady flow. Describe what happens.

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Step

Name ______________________ Date ____________

Smooth out the streambed, and use two books or wood blocks to prop up one end of the pan and make the streambed slightly steeper. Repeat step 2, using the same amount of water. Describe what happens.

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Draw Conclusions

Interpret Data Organize your data in a chart. Did your observations support your hypothesis?

Infer What would happen if you made the streambed even steeper? Form a hypothesis, and then test it.

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Explore More

What would happen if you used soil-supporting vegetation, such as grass, in your model? What would happen if you made the river carry a larger volume of water? Form a hypothesis, test it, and then analyze and present your results.

Open Inquiry

Think of your own question about factors involved in the erosion of streambeds by streams.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

How does the steepness of a slope affect stream erosion?

Materials

- bare, sloping land
- watering can or garden hose
- water

- Go outside, and find two sloped areas that have little or no vegetation. The areas should have different slopes.

- **Observe** Pour the same amount of water down each slope. Record your observations.

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- **Draw Conclusions** How does the steepness of a slope affect stream erosion?

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- What happens if you change the volume of water or the speed at which you pour the water? Does the amount of debris or vegetation affect erosion?

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Name ______________________ Date ____________

Layering Sediments

Materials

- jar with lid
- soil, sand, and gravel
- water

- Fill a jar halfway with a mixture of soil, sand, and gravel. Then fill it to the top with water. Allow the water to soak into the mixture. Screw the lid of the jar on tight.
- Predict what will happen if the materials in the jar are shaken and then allowed to settle. Draw a picture showing your prediction.

- Shake the jar for 10 seconds. Place the jar on a table. Observe the results.
- **Interpret Data** Compare your observations to your prediction. Which layer formed first? Which formed last? Explain your observations.

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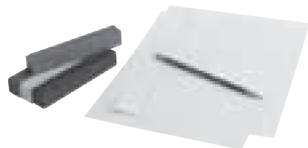
Name ______________________ Date __________

Which rock layer is the oldest?

Materials



- 4 slabs of modeling clay, each a different color (red, yellow, green, and blue)
- notebook paper
- pencil

Purpose

Scientists gather information about Earth's history by looking at the order in which different layers of rock are found and comparing the different layers. Use stacks of clay to make similar observations.

Procedure

- Make an ordered column of clay from the colors you have been given. Each layer represents a different layer of sedimentary rock. Look at your model carefully. Which color represents the oldest layer of rock in your column? Which represents the newest layer? Explain.

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- **Observe** Arrange the class's layered stacks on the table. Label the stacks *A*, *B*, *C*, and *D*. Look for layers with the same colors as yours. Look for patterns. Which layer in stacks A and B is the oldest? The youngest? Explain.

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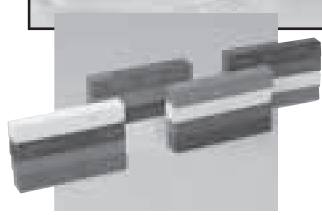

Name ______________________ Date ____________ **Explore**

- **Interpret Data** Using the same procedure, determine the oldest layer in all of the stacks. What is the youngest layer? In what order were the layers formed?

Draw Conclusions

- **Infer** If these were actual layers of rock in a landscape, could you determine exactly how old any one layer was? Why or why not?

- **Interpret Data** How is stack D different from the others? If layers of rock are missing, how can you explain this?

Name ______________________ Date ____________

Explore More

Scientists use the relative ages of geological layers to help tell the geologic history of Earth. Use research books to find more information about how scientists use relative age to explain different events in Earth's history.

Open Inquiry

Think of your own question about formation and patterns in rock layers.

- My question is:

- How I can test it:

- My results are:

Name ______________________ Date ____________

Which layer of rock is the oldest?

Materials

- pen

- Look at the five columns your teacher has drawn on the board. Each color listed represents a layer of rock found below Earth's surface.

- **Record Data** Copy the five columns from the board on a separate sheet of paper.

- **Draw Conclusions** What does the bottom color in each column represent? What does the top color represent?

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  ____

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- Without changing the order in which each item appears, align the colors in all five columns.

- **Sequence** Make a master column that lists all five colors in order from newest to oldest.

Quick Lab

Name ______________________ Date ____________

Modeling a Fossil

Materials
• modeling clay • small disposable pan • small objects such as shells, plastic models, or toys

- **Make a Model** Place a layer of modeling clay in a small disposable pan. Make an imprint of a seashell or another object provided. Press the object down into the clay, and then remove it carefully. Look at the impression that is left. What details do you notice?

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  ____

- Trade clay models with another student in your class. Look at the fossil model carefully. Can you tell what object made the imprint? Describe the clues that helped you figure it out.

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- **Infer** Over long periods of time, what might happen to an imprint fossil such as this one?

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  ____

- **Infer** How would these same skills of observation be used by scientists who find real fossils? How does this help scientists learn more about organisms of the past?

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Name ______________________ Date ____________

Be a Scientist

Structured Inquiry

What makes chemical weathering happen?

Materials

- 2 beakers

- vinegar
- 2 pieces of chalk

- 2 pieces of limestone

Form a Hypothesis

Limestone is a type of sedimentary rock formed from calcium carbonate. Calcium carbonate is the substance found in chalk. How will calcium carbonate react with an acid such as vinegar? Write your answer in the form of a hypothesis: "If I add vinegar to calcium carbonate, then . . ."

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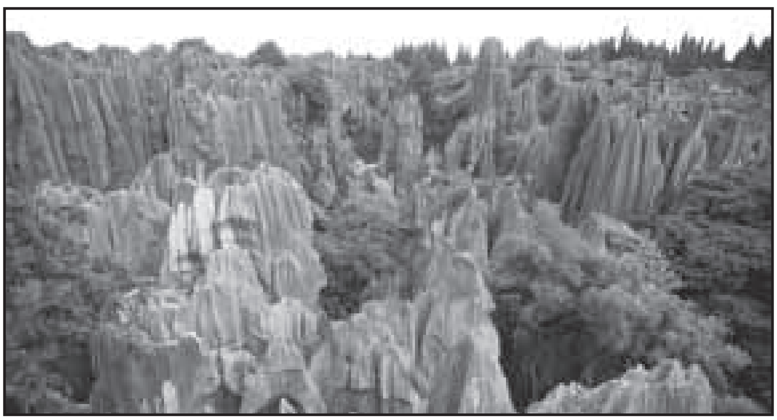
Test Your Hypothesis

- Add 150 mL of water to a beaker. Label the beaker *Water*.
- Add 150 mL of vinegar to a second beaker. Label this beaker *Acid*.
- **Experiment** Place a piece of chalk in each beaker. You may wish to leave the chalk pieces in the beakers overnight.



The Stone Forest in China contains weathered limestone.

Name ______________________ Date ____________

Predict Record your observations. What happened to the chalk? What do you think will happen to limestone in the same conditions?

Use Variables Repeat the experiment, using limestone instead of chalk. You may wish to leave the limestone pieces in the beakers overnight.

Draw Conclusions

Many of Earth's landforms are made of limestone and other similar types of rock. How does the experiment help explain what can happen to Earth's landforms over time?

Infer Based on the experiment, how do you think chemical pollution in the air and water could change natural landforms?

Name ______________________________ Date _____________ Be a Scientist

Guided Inquiry

How do substances affect calcium carbonate?

Form a Hypothesis

You have already tested the effect of one acid, vinegar, on calcium carbonate. How do other substances affect calcium carbonate? For example, would lemon juice have the same effect? Write your answer in the form of a hypothesis: "If I add ________ to calcium carbonate, then . . ."

____

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Test Your Hypothesis

Design an experiment to test your hypothesis. Then write out the materials you will need and the steps you will take. Record your results and observations as you perform your experiment.

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Draw Conclusions

Did your experiment support your hypothesis? Why or why not? Present your results to the rest of your class.

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Name ______________________ Date ____________

Open Inquiry

What other tests can you perform on chemical weathering? Would other types of rock respond to acids in the same way? Come up with a question to investigate. Then carry out an investigation to find out the answer.

Remember to follow the steps of the scientific process.

- ▶ My question is:

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- ▶ My hypothesis is:

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- ▶ How can I test it:

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- ▶ My conclusions are:

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Name ______________________ Date ____________

What is granite made of?

Purpose
Compare the properties of various rocks to determine what substances are found in granite.

Materials

- sample of granite
- hand lens
- samples of other substances, including quartz, mica, and feldspar

Procedure

1. **Observe** Look carefully at the granite sample with your hand lens. Is it made of more than one substance? What does your sample look like? Try to be as descriptive as possible in your observations.

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____

Step 1

2. **Communicate** Examine the other samples. What properties can help you tell one substance from another? Share your ideas and observations with other groups.

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Explore

Name ______________________ Date ____________

Compare Compare the properties of each of the other substances to the properties of the granite. List the properties of each sample on your chart.

Mineral Name			
Color			
Shine			
Flat Surfaces			
Hardness			

Draw Conclusions

Infer Based on your investigation, which of these substances does your granite sample contain?

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Interpret Data Which properties were most useful in comparing the mineral and granite samples?

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Name ______________________ Date ____________ **Explore**

Explore More

Compare different rock samples provided by your teacher to the granite sample. How many different substances does each new sample appear to contain? Are the substances the same as or different from those in granite? Use the chart below to compare these samples' properties.

Mineral Name			
Color			
Shine			
Flat Surfaces			
Hardness			

Open Inquiry

Think of your own question about the properties of rock samples from your local area.

▶ My question is:

____

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▶ How I can test it:

____

____

▶ My results are:

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Alternative Explore

Name ______________________ Date ____________

What are rocks made of?

Materials
• hand lens • samples of granite, feldspar, and quartz

- **Observe** Use the hand lens to carefully examine each of the three rock samples in front of you. Describe the properties of each rock sample in the table below.

- **Observe** Describe what you notice about the three samples.

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- Your teacher will identify each of the three samples for you. Mark the identity of each rock sample on the chart below.

- **Infer** Are you able to identify any substances visible in the granite sample?

____

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Mineral Name			
Color			
Shine			
Flat Surfaces			
Hardness			

Play the Rock Game

Materials
• hand lens • several igneous, sedimentary, and metamorphic rocks

- **Observe** Using a hand lens, examine the mystery rocks assigned to your group.
- **Classify** Sort the rocks into piles of igneous, sedimentary, and metamorphic rocks. In the chart below, record which rocks you placed in each pile.

Igneous	Sedimentary	Metamorphic

- **Interpret Data** Trade places with another group. Use the identification chart provided by your teacher to see whether the other group classified their rock samples correctly. Give the group you are evaluating one point for every correct identification.
- **Communicate** Choose one of the rocks in your group of samples, and write a possible history for it. Why does the rock have its particular properties?

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Focus on Skills

Name ______________________ Date __________

Use Variables

Can you grow small mineral crystals into larger ones? How does the concentration of a mineral affect a crystal's growth rate? To answer questions such as these, scientists **use variables** by doing a series of experiments, using a different procedure each time. Then they put together the results of all their experiments, like pieces of a giant puzzle, to answer questions.

Materials

- 2 labels
- 2 plastic glasses
- marker
- water
- salt
- 100 mL graduated cylinder
- 2 plastic spoons
- 2 pieces of string
- 2 pencils

Learn It

When you **use variables**, you identify factors in an experiment that can be changed. To make sure the results of experiments are valid, scientists try to test all variables, one at a time. First, scientists perform an experiment. Then, they repeat the test while changing only one variable. So that it is a fair test, they make sure all other factors remain exactly the same.

It is important to record your observations when you change variables in an experiment. Then you can compare and contrast the results to find out how each variable affected the outcome of your original experiment.

rock-salt crystal

Name ______________________________ Date _____________

▶ Try It

- Label one glass *Glass 1* and the other *Glass 2*. Fill each glass halfway with warm water. Pour 50 mL of salt into glass 1 and 100 mL of salt into glass 2. Stir the water in each glass until the salt dissolves.
- Tie a string around the middle of each pencil. Balance a pencil across the top of each glass so the string hangs down into the water without touching the sides or bottom.
- Observe the glasses for several days. Record your observations on the chart below.
- Use variables by repeating the experiment, using ice-cold water instead of warm water. Record the results on the chart.

Variable	My Observations
Test 1: Warm Water Glass 1 (50 mL salt) Glass 2 (100 mL salt)	
Test 2: Ice-Cold Water Glass 1 (50 mL salt) Glass 2 (100 mL salt)	
Test 3: _______________ Glass 1 _______________ Glass 2 _______________	

Name ______________________________ Date ____________

- Repeat the experiment again. This time, change a different variable, such as the sizes of the glasses, the amount of water, the length of the strings, or the amount of time before you check the strings. Record the results on the chart.

- In which glass did the lump of crystals form faster? Why? Did changing your variable in step 4 change your results? In step 5? Explain.

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▶ Apply It

- How would the results differ if you were to **use variables** that have changed? What would happen if you
  - used sugar instead of salt?
  - used soda instead of water?
  - used a paper-towel strip instead of string?
  - did not stir the mixture?
  - used an antacid tablet instead of salt?
  - used Epsom salts instead of regular table salt?

- Choose one of these variables or one of your own. List the variable on the chart on the following page, and then repeat the experiment, record the results, and interpret the data. How did changing that particular variable affect your experiment's results?

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Name ______________________ Date ______________

Focus on Skills

- Repeat the experiment with the remaining variables. Use the table below to record your results.

Variable	My Observations
Test 1: ____________ Glass 1 ____________ Glass 2 ____________	
Test 2: ____________ Glass 1 ____________ Glass 2 ____________	
Test 3: ____________ Glass 1 ____________ Glass 2 ____________	
Test 4: ____________ Glass 1 ____________ Glass 2 ____________	
Test 5: ____________ Glass 1 ____________ Glass 2 ____________	
Test 6: ____________ Glass 1 ____________ Glass 2 ____________	

Name ______________________ Date __________

How can you model Earth's water cycle?

Materials

- 2 L plastic bottle with cap
- warm water
- red food coloring
- scissors
  Be Careful.
- sheet of black construction paper
- tape
- sealable plastic bag filled with ice

Purpose

Much of the water on Earth undergoes constant change within the water cycle. Make a model to help understand this process.

Procedure

- **Make a Model** Fill the plastic bottle with about 0.5 L of warm water. Add 2 drops of red food coloring. Place the cap on the bottle. Close it tightly. Cut black construction paper in half lengthwise. Make a ring slightly wider than the base of the bottle. Tape the ends of the paper together. Place the bottle inside this ring base.
- Place the model in a warm, sunny area. After about an hour, carefully place the sealed bag of ice on top of your bottle. Tape the bag in place if necessary. Leave the bag on top of the bottle for 10 to 15 minutes.
- **Observe** Remove the bag of ice from the top of the bottle, and describe what you see.

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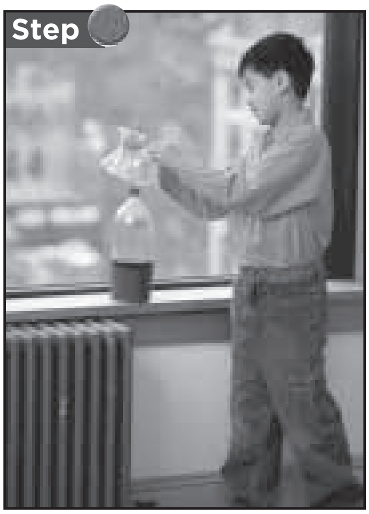

Name ______________________ Date __________

Draw Conclusions

- **Interpret Data** Did all the water in the bottle stay red? If you put the model back in a warm place, do you think the same thing would happen again?

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- **Infer** If the bottle represents Earth, what does the tinted water represent?

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- **Infer** What does the action of this model suggest about the amount of water on Earth?

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Explore More

Can a model of Earth and its water cycle support the life of a green plant? Design an experiment. What materials would you need to test your prediction?

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Name ______________________ Date ____________

Open Inquiry

Think of your own question about the water cycle and the evaporation of rainwater.

- My question is:

- How I can test it:

- My results are:

Name ______________________ Date ____________

Alternative Explore

How does water move and change?

Your teacher will heat water in a container and heat source such as a hot plate or an electric kettle or pot. When the water boils and steam starts rising, your teacher will hold a large sheet of cardboard horizontally over the beaker. Watch carefully.

Materials

- water
- container
- heat source
- large sheet of cardboard

Observe What happens to the cardboard during the demonstration?

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Predict What will happen when your teacher moves the cardboard away from the heat source?

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Draw Conclusions What caused the condensation to form on the underside of the cardboard?

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Infer How does water change states on Earth?

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Name ______________________ Date __________

Earth's Water

Materials

- water
- beaker
- 4 graduated cylinders (1 large, 1 medium, 2 small)
- green and blue food coloring
- dropper

- Pour 1 L (1,000 mL) of water into a beaker. This represents all the water on Earth.
- **Make a Model** Pour 972 mL of this water into a large graduated cylinder. Add green food coloring. This water represents Earth's ocean water.
- Pour the remaining 28 mL into a medium-sized graduated cylinder. Add blue food coloring. This water represents Earth's fresh water.
- Transfer 4 mL of the "fresh water" to a small graduated cylinder. This water represents Earth's groundwater.
- Transfer 3 mL of the "fresh water" to another small graduated cylinder. This water represents water in Earth's lakes and rivers as well as in the soil and air. The remaining fresh water represents Earth's ice caps and glaciers.
- **Use Numbers** Divide each amount of water (in milliliters) by 1,000. Then multiply each answer by 100. Find the percent of Earth's water that each graduated cylinder represents.

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- **Use Numbers** Make a pie chart of these percents to show how Earth's water is distributed.

Name ______________________ Date ____________

Explore

What are objects made from?

Materials

- tape
- long sheet of white butcher paper
- markers or crayons of different colors

Make a Prediction
From which natural resources are most common objects made? Do they come from plants, animals, minerals, rocks, soil, water, metals, or oil? Write your answer in the form of a prediction: "Most objects in the classroom are made from . . ."

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Test Your Prediction

1. Tape the white butcher paper on the wall around the classroom. Divide the paper into four sections, labeled *Plants, Animals, Minerals,* and *Oil*.

2. **Record Data** Your teacher will assign a small group to each section of the paper. One group will identify every object in the classroom made from plant materials, another will identify objects made from animal materials, and so on.

3. **Predict** Draw each object on the mural, and identify the natural resource from which it is made. Indicate for each object whether or not the natural resource is one that will eventually be used up.

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 Name ______________________ Date ____________

Draw Conclusions

- **Interpret Data** Were some objects made from several natural resources? Which objects were made from natural resources that can be replaced? Which were made from resources that cannot be replaced and will eventually be used up?

- **Infer** Consider the objects listed that are made from natural resources that will eventually be used up. Do you think there might be other things you could use instead? List some of your ideas.

Explore More

You have identified resources from which classroom objects are made. Additional resources are needed to manufacture these objects. Choose three different objects listed on the mural, and research the resources used to make each of them. Present your results to the class.

Name ____________________ Date ____________ **Explore**

Open Inquiry

Think of your own question about the use of natural resources.

- ▶ My question is:

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- ▶ How I can test it:

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- ▶ My results are:

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Name ______________________ Date ____________

How do we dispose of materials?

Materials

- 40 index cards per pair of students
- 4 boxes labeled *Reuse*, *Recycle*, *Landfill*, and *Compost*

- **Observe** Take an inventory of all the objects in your classroom. Write the name of each object on an index card. Use one card for each object, and try to use as many of the cards as possible.
- **Classify** Examine each object, and try to determine what materials it is made of. Record the data on the index card.
- **Infer** What is the best way to dispose of each item? There are four boxes labeled *Reuse*, *Recycle*, *Landfill*, and *Compost*. Place each index card in the box that is labeled with the best way to dispose of that item.
- **Record Data** Use the table below to record the number of index cards that were placed in each box.

Reuse	Recycle	Landfill	Compost

- **Draw Conclusions** Which method of disposal was used most often?

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Name ______________________ Date ____________

Quick Lab

Fuel Supply

This table shows how quickly people are using oil and natural gas.

Materials

- graph paper

Fuel Use		
Type of Energy Source	Proven Reserves (as of January 1, 2004)	Amount Used (in 2003)
oil	1,265 billion barrels	about 80 million barrels per day
natural gas	6,079 trillion cubic feet	about 96 trillion cubic feet per year

Source: U.S. Energy Information Administration

- **Interpret Data** Examine the information in the table.
- **Communicate** Based on the data in the table, make a line graph that shows how long the world's supplies of oil and natural gas will last. Assume that the rates of use will remain the same over time. Draw your graph in the box below.
- **Use Numbers** Make a line graph that displays your calculations regarding the use of oil and natural gas. Use different colors for lines and units of oil and gas.

Name ______________________ Date ____________

Do some light bulbs waste less energy than others?

Make a Prediction

Light bulbs give off both light and heat. Do some types of bulbs give off more heat and waste more energy than other types of light bulbs do? Write your answer in the form "If one type of light bulb gives off less heat than another, then . . ."

⚠ **Be Careful.** Let bulbs cool before touching them.

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Materials

- white towel
- gooseneck lamp
- extension cord
- thermometer
- incandescent light bulb
- meterstick
- stopwatch
- compact fluorescent light bulb

Test Your Prediction

- **Measure** Lay the towel on the table. Place a lamp at one end of the towel. Put the thermometer at the other end of the towel where the lamp will shine on it. Put the incandescent light bulb in the lamp. Record the starting temperature. Angle the lamp so that it will shine on the thermometer. Plug in the lamp and turn it on.

- **Experiment** Shine the lamp on the thermometer for 5 minutes. Record the temperature. Turn the lamp off. Unplug the lamp. Allow the lamp and the table to cool back to your starting temperature. Repeat steps 1 and 2 using the fluorescent light bulb. Record your data in the table on the next page.

Name ______________________ Date ____________ **Explore**

Type of Bulb	Starting Temperature	Temperature After 5 Minutes
Incandescent		
Fluorescent		

Draw Conclusions

- **Infer** Which type of bulb appears to waste less energy as heat?

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- **Communicate** Which type of bulb would you recommend to others who want to save energy?

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Explore More

Which would be better to use in an air-conditioned home: incandescent lights or fluorescent lights? Make a prediction, and design a way to test it.

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Name ______________________ Date ____________

Open Inquiry

Think of your own question about the light produced by different kinds of light bulbs.

▶ My question is:

▶ How I can test it:

▶ My results are:

Name ______________________ Date ____________

Alternative Explore

Which bulbs are more efficient?

Materials

- package of incandescent light bulbs
- package of compact fluorescent light bulbs

- **Observe** Read the information on the package of the incandescent bulb. How much light does the bulb produce? How much electricity does it use? For how long is it expected to burn?

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- **Use Numbers** Determine how much light the bulb produces per watt of electricity used. Divide the number of lumens by the number of watts.

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- **Observe** Read the information on the package of the compact fluorescent bulb. How much light does this bulb produce? How much electricity does it use? For how long is it expected to burn?

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- **Use Numbers** Determine how much light the fluorescent bulb produces per watt of electricity used. Divide the number of lumens by the number of watts.

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- **Interpret Data** Which bulb uses electricity more efficiently?

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 Name ______________________ Date ____________

The Power of Water

Materials

- scissors
- plastic cup
- pencil
- running water

- Make a list of factors you think affect how well a waterwheel works. How can you design the blades on a waterwheel so that it turns as fast as possible?

- **Make a Model** Cut eight equally spaced slits from the rim to the base of a plastic cup. ⚠ **Be Careful.**

- Fan out the sections of the cup to form eight "blades." Poke a hole through the bottom of the cup, and insert a pencil as an axle.

- **Observe** Hold the pencil loosely at both ends, and place it in a horizontal position. Hold the fanned-out blades under running water. What happens?

- **Predict** Will your waterwheel turn faster with more blades? With fewer blades? Experiment to find out. Design and test the other factors on your list.

Name ______________________ Date ______________

Be a Scientist

Structured Inquiry

What are some of the characteristics of volcanic rocks?

Materials

- hand lens 
- igneous rock samples 
- cup of water 

Form a Hypothesis

The cooling of lava from volcanoes is one way igneous rocks are formed. The cooling rate determines the crystal structure and the appearance of the rocks. When lava cools immediately, there are no visible crystals, and the rocks look glassy. When lava takes a few days to cool, the crystals appear very small and look like grains of sand. When the lava cools over the span of a few years, the crystals become very large and form large rocks. What are some characteristics of volcanic rocks? Write your answer in the form of a hypothesis: “If a rock is igneous, then . . .”

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Test Your Hypothesis

- **Observe** Use a hand lens to look at each rock sample.
- Sketch the crystals, or grains.

Name ______________________ Date ____________

Record Data Feel each rock. Record the texture of each.

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Classify Record the color and coarseness of the grains in each sample.

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Experiment Place each rock in a cup of water. Record your observations.

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Draw Conclusions

Compare Are any of the characteristics the same in all of your samples? Why do you think this happens?

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Infer What factors influenced the colors of the rocks that you observed?

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Name ______________________________ Date _____________

Guided Inquiry

What happens when the pressure changes inside a volcano?

Form a Hypothesis

Can changes in the amount of pressure inside a volcano change the force of the eruption? Write your answer in the form of a hypothesis: "If the pressure increases inside a volcano, then . . ."

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Test Your Hypothesis

Design an experiment to investigate what happens inside a volcano when there is an increase in magma or gas pressure. Write out the materials you will need and the steps you will follow. Record your results and observations.

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Draw Conclusions

What changes increase the internal pressure of a volcano? Did your experiment support your hypothesis? Why or why not? Present your results to your classmates.

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Name ______________________________ Date ____________

Open Inquiry

What else would you like to learn about volcanoes? Would you like to know about the different types of volcanoes? Design an experiment to answer your question. Organize your experiment to test only one variable, or one item being changed. Record the research materials you used for your experiment.

Remember to follow the steps of the scientific process.

▶ My question is:

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▶ My hypothesis is:

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▶ How can I test it:

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▶ My conclusions are:

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Name ____________________ Date ____________

Explore

How can you observe air pressure?

Form a Hypothesis

When you push inward on an inflated balloon, you see the effect of your pushing. Can air do the same thing as your hand? Write your answer in the form of a hypothesis: "If the air outside a bottle pushes harder than the air inside a bottle, then the bottle will . . ."

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Materials

- 2 L plastic soda bottle with twist-on cap
- large basin or container
- warm water

Test Your Hypothesis

- **Experiment** Open an empty 2 L soda bottle. Place the bottle in a basin or container of very warm tap water. Hold the bottle partly submerged in the water for a few minutes. Put the cap on the bottle, and twist it tightly. Remove the empty bottle from the water, and stand it on a flat surface.

- **Observe** Watch the bottle carefully for about a minute. Record your observations. Move in close, so that your ear is about 10 cm from the top of the bottle. Unscrew the cap, and record anything you observe.

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Name ______________________ Date ____________

Compare Before you put the cap on, how was the air pressure inside the bottle in relation to the pressure outside the bottle? What happened after you tightened the cap?

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Draw Conclusions

Was your hypothesis correct? Describe the evidence that supports your explanation.

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Infer What do you think caused any changes to the sides of the bottle? How would you explain what happened when you removed the cap?

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Name ______________________ Date ____________

Explore More

What would happen if you placed the empty bottle in a freezer instead of in very warm water? Form a hypothesis, and test it. Does your evidence support your hypothesis? Explain.

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Open Inquiry

Think of your own question about how air pressure is affected by changes in weather.

- My question is:

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- How I can test it:

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- My results are:

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Name ______________________ Date ____________

What can air pressure do?

Materials
- index card
- balloon

- Fold the index card so it stands up on your desk.
- Fill the balloon with air, and pinch it closed.
- **Draw Conclusions** What allowed you to inflate the balloon?

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- **Experiment** Aim the pinched end of the balloon toward the index card, and release the pinch. What happens to the index card?

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- **Infer** Why did the air in the balloon act in the manner that it did?

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- **Classify** What would you call the action of the air from the balloon?

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Name ______________________ Date ____________ **Quick Lab**

Analyze Temperature Differences

Materials

- thermometer
- stopwatch
- notebook

1. **Record Data** Stand in an area of paved concrete. Hold a thermometer at about the height of your ankle. After 3 minutes, measure and record the air temperature. Then hold the thermometer even with your waist. Wait 3 more minutes, and record the new air temperature.

2. Repeat step 1 over grass, a patch of soil, and a puddle of water. List your results below.

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____

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3. **Interpret Data** Over which surface was the difference in temperature greatest between the ankle-height and waist-height readings?

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4. **Classify** Over which surface was the ankle-height temperature the highest? The lowest?

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5. **Infer** Which surface seems to absorb the most heat? Which surface absorbs the least heat?

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Focus on Skills

Name ______________________ Date ____________

Interpret Data

Scientists study weather maps and **interpret data** from them. They look at temperature patterns, especially any extreme changes from past years, in order to predict future weather in an area. They also look for fronts, where cold and warm air push against each other. Then they interpret all the data to draw conclusions and explain why things happen.

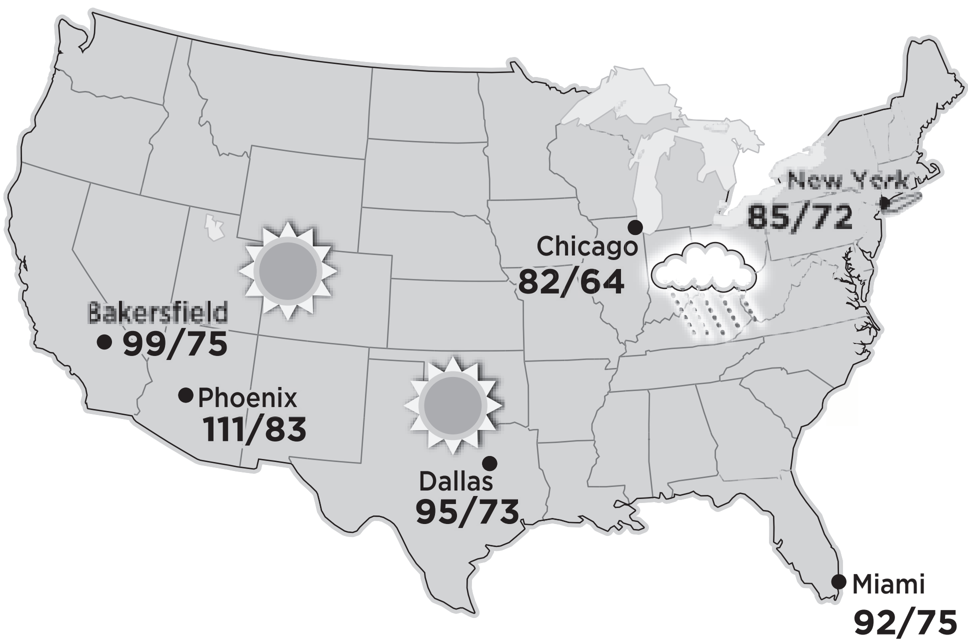
Materials

- map and charts on these pages

Learn It

When you **interpret data**, you use information that has been gathered to answer questions or solve problems. It is usually easier to analyze and interpret data if it has been organized and placed on a chart or a graph. Then you can see at a glance any extreme changes or patterns in the data.

July Temperatures



Try It

- Look at the map on the previous page. It shows high and low temperatures in six cities on one day in July. Then look at the chart below. The chart lists average high and low temperatures and the rainfall for some U.S. cities during July in past years. **Interpret data** from both the map and the chart to answer all the questions.

Average July Temperatures and Precipitation by City						
	Bakersfield	Chicago	Dallas	Miami	New York	Phoenix
High Temperature	98.4°F	84.4°F	95.2°F	88.5°F	80.8°F	109.0°F
Low Temperature	69.4°F	65.7°F	72.0°F	74.1°F	65.7°F	75.9°F
Precipitation	0.0 in.	4.0 in.	2.4 in.	8.1 in.	3.3 in.	0.6 in.

- According to the map and chart, how did the one-day high and low temperatures for Bakersfield differ from its average high and low temperatures?

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- Which city had one-day high and low temperatures closest to its average high and low temperatures?

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- Which city had cooler-than-average high and low temperatures for the day?

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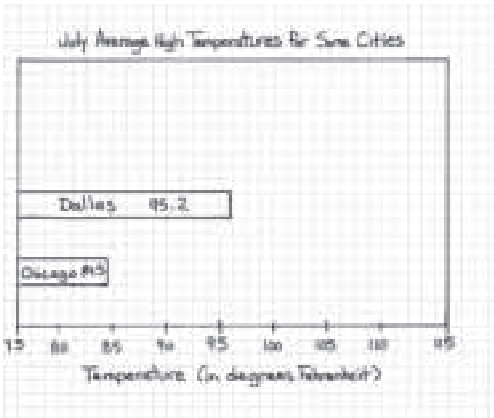
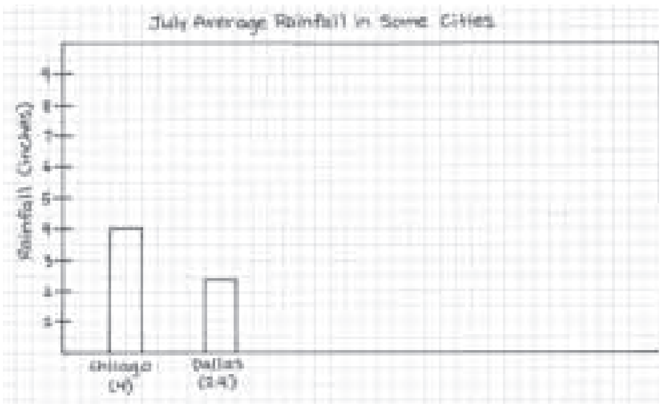
Name ______________________ Date ____________

▶ Apply It

- Now use data from the chart to make bar graphs, like the ones started here, to compare the high temperatures or the amounts of precipitation.





Name ______________________________ Date _____________

Look at a weather map from your local newspaper. Compile data from the map to make a graph. Include temperatures and precipitation for cities in your state or region. **Interpret data** in your graph to predict what the weather in your area may be like tomorrow. Remember to check the following day to see whether your prediction was correct. Make your graph in the box below.

Explore

Name ______________________ Date __________

How can you make a model of fog?

Form a Hypothesis

If pressure increases on a volume of air, the air's temperature increases. When pressure decreases, the air expands and cools. How do you think temperature and humidity affect the formation of fog? Write your answer in the form of a hypothesis: "If moist air in a bottle is cooled, then . . ."

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Materials

- warm water
- plastic water bottle with twist-on cap
- long, wooden safety matches

Test Your Hypothesis

- **Experiment** Pour a small amount of warm water into a plastic water bottle. Twist the cap on, shake the bottle, and remove the cap. Your teacher will then add smoke by lighting a match, blowing it out, and then immediately holding the smoking match inside the bottle.

- After a few seconds, your teacher will take the match out of the bottle. Quickly twist the cap onto the bottle, closing it tightly.

- **Experiment** Squeeze the bottle firmly. Then release this force on the outside of the bottle, and observe what happens inside the bottle.

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Name ______________________ Date ____________ **Explore**

Draw Conclusions

- **Interpret Data** Do you think the force you placed on the bottle affected the air inside the bottle during this experiment? Explain.

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- **Infer** How does the temperature of moist air cause a change from water vapor to water droplets?

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Explore More

What might you see if you did this experiment using very cold water? Form a hypothesis, and test it with your teacher or another adult. Analyze your results, and then present them to the class.

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 Name ______________________ Date ____________

Open Inquiry

Think of your own question about why snow falls.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Where is water in the air?

Materials

- cup of water
- ice

Observe Fill a cup half full of water, and then add plenty of ice. What states of water can you observe in the glass?

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Observe Place the glass in a warm area, preferably under sunlight or a warm lamp. Wait for 10 minutes, and then observe the glass. Describe any changes you observe. How would you explain the changes?

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Compare Compare your experiment to the water cycle and its effects on weather.

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Quick Lab

Name ____________________ Date __________

Comparing Currents

Materials

- plastic containers
- very warm and cold water
- paper spiral

1. **Use Variables** Place two identical plastic containers about 50 cm apart on a table. Pour cold water from the refrigerator into one beaker. Pour very warm water into the other beaker.

2. **Experiment** Hold a paper spiral by a string or thread over the very warm water for about 20 seconds. The bottom of the paper spiral should be level with the beaker but not touching it. Record your observations.

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3. Repeat step 2, using the cold water instead of the very warm water.

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4. **Communicate** How would you explain your observations? (Hint: Think of what happens when water is very warm.)

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5. **Infer** Why do hurricanes form in the tropics but not in the northern Atlantic or Pacific oceans?

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Name ______________________ Date ____________

Be a Scientist

Structured Inquiry

What can change a river?

Materials

- potting soil 
- aluminum pan 
- plastic cup
- water 
- sand 
- gravel 

Form a Hypothesis

All across the United States, people have changed the flow of rivers to accomplish different tasks, such as irrigating fields and powering turbines for electricity.

The flow of water in a river is influenced by various factors. Rain and snowfall can increase the amount of water in a river. Drought and human-made structures can also slow or stop the flow. Even the type of material that a river moves through will affect a river's shape and flow.

What materials affect the shape and flow of a river the most? Write your answer in the form of a hypothesis: "If a mountain is made of soil, sand, gravel, or a combination of all three, then the river's shape and flow will change the most if the mountain is made of ______."

____

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⚠ **Be Careful.** Wash your hands with soap and water after this activity.

Test Your Hypothesis

- Use potting soil to make a mound at one end of the aluminum pan. This will represent a mountain.


Step

- Use a plastic cup to pour a small amount of water onto the top of your soil mountain. Draw and record what happens to the mountain as a result.


Step

Name ______________________ Date ____________

- Repeat steps 1 and 2 with sand and then with gravel.
- Repeat steps 1 and 2 using a mixture of all three materials.

Draw Conclusions

- **Compare** What similarities and differences did you notice among the soil, sand, and gravel mountains?

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- **Interpret Data** Compare your data from the mountains made of soil, of sand, of gravel, and of all three materials. Which of the four mountains do you think was most like a real mountain? Why?

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- **Infer** What type of mountains or land would cause the deepest rivers to form? Why?

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Name ______________________________ Date ____________ **Be a Scientist**

Guided Inquiry

What affects the speed of flowing water?

Form a Hypothesis

What can you do to change the speed at which water flows in a river? Write your answer in the form of a hypothesis: "If a streambed is narrowed, then the speed of the water will . . ."

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Test Your Hypothesis

Design an experiment to investigate how narrowing the streambed affects the speed of the flowing water. Write out the materials you will need and the steps you will follow. Record your results and observations.

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Draw Conclusions

Did your results support your hypothesis? Why or why not? What factors contributed most to the speed of the flowing water?

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Name ______________________ Date ____________

Open Inquiry

What else can you learn about rivers? For example, what effect do dams have on a river's speed and flow? Design and carry out an experiment to answer your question. Organize your experiment to test only one variable, or one item being changed. Write the experiment with enough detail that another group could repeat your experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

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- My hypothesis is:

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- How can I test it:

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- My conclusions are:

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Name ______________________________ Date ______________

Explore

Does temperature affect the movement of air?

Form a Hypothesis

What happens when the temperature of air changes? Does air that is cooler rise or sink? Write your answer in the form of a hypothesis: "If the temperature of air is lowered, then the air will . . ."

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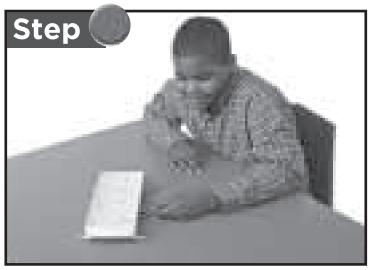
Materials

- ice-cube tray filled with ice
- 4 pencils
- 2 liquid-crystal thermometer strips
- stopwatch

Test Your Hypothesis

- Place a tray of ice cubes on a table. Put pencils underneath each end to raise the tray slightly.
- Slide a liquid-crystal thermometer strip underneath the ice-cube tray.
- Rest two pencils on top of the ice-cube tray. Put a thermometer strip on top of the pencils.
- **Observe** Record the temperature of each strip every minute for 5 minutes.



Time Elapsed	1 minute	2 minutes	3 minutes	4 minutes	5 minutes
Strip Below Ice-Cube Tray					
Strip on Top of Pencils					

Explore

Name ______________________________ Date ______________

Draw Conclusions

- **Use Numbers** Make a line graph showing the temperature changes for each strip. Place time along the *x*-axis and temperature along the *y*-axis.

- **Interpret Data** Which cooled faster: the air above the tray or the air beneath it? Did your observations support your hypothesis?

Name ______________________ Date ____________ **Explore**

Explore More

Design an experiment to test the movement of warm air. Check with your teacher, and then carry out your experiment. Interpret your data, and then present your results to the class.

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Open Inquiry

Think of your own question about what happens when a warm air mass and a cold air mass meet.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

How does the environment affect the temperature?

Materials

- 2 thermometers

Experiment Place a thermometer outside in an area that gets a lot of sunlight. Wait 10 minutes, and then take a reading. What was the temperature in the sunny area?

Experiment Place a thermometer outside in a shady area. Wait 10 minutes, and then take a reading. What was the temperature in the shady area?

Compare What did you observe about the readings of the two temperatures?

Draw Conclusions What types of factors can affect a temperature reading?

Name ______________________ Date ____________

Quick Lab

Weather Prediction

Materials

- national weather map

- Find a weather map that shows the weather across the United States.

- **Communicate** Describe the weather in each region: the Northwest, Southwest, Midwest, Southeast, and Northeast.

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- **Predict** Weather patterns generally move from west to east across the United States. How do you think the weather just east of the fronts will change in the next day or so? Explain.

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Explore

Name ______________________ Date ____________

What can weather patterns tell us?

Materials

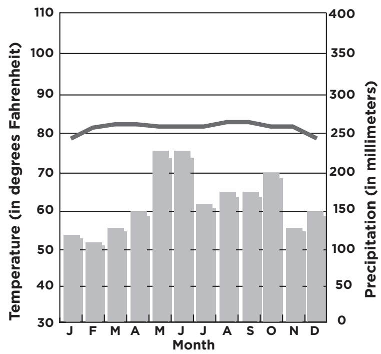
- graphs (shown)

Purpose

What can you learn by studying weather patterns of a region? Could you use this information to compare two regions? Use the data on these graphs to compare the weather patterns of two cities.

Procedure

1. **Use Numbers** Look at the graphs for city 1 and city 2. The bottom of each graph is labeled with the months of the year. The left side of each graph is labeled with average temperature in degrees Fahrenheit. What is the average temperature in city 1 during July? In city 2? (Hint: Temperature is indicated in red.)



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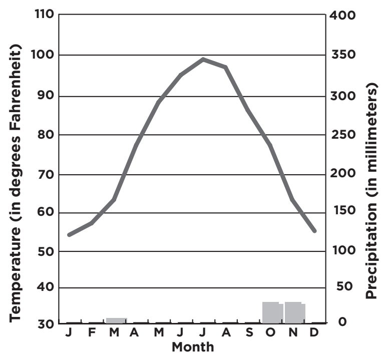
2. **Use Numbers** The right side of each graph is labeled with average precipitation in millimeters. What is the average precipitation in city 1 during July? In city 2? (Hint: Precipitation is indicated in blue.)



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Name ______________________________ Date ____________

Explore

Draw Conclusions

- **Interpret Data** How do the monthly temperatures throughout the year compare for the two cities?

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- **Interpret Data** How do the monthly amounts of precipitation compare for the two cities?

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- **Infer** Describe the average annual weather pattern of each city. Be sure to include information about temperature and precipitation as well as their relationship to the seasons.

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Explore

Name ______________________ Date ____________

Explore More

Research the weather patterns of your town, and make a graph similar to the ones shown. Present your results to the class.

Open Inquiry

Think of your own question about the different climates across the United States.

- My question is:

- How I can test it:

- My results are:

Name ______________________________ Date ______________

What are some different climates?

The climates of different environments can be described in many ways.

Materials

- encyclopedia, Internet, and other research materials

- **Observe** Find photographs of a desert, an arctic environment, and a rain forest. Write descriptions of the climates from what you can observe in the photographs.

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- Use your available resource materials to research each environment, and write descriptions to accompany the photographs of each region.

- **Compare** How do the figures for average temperature and annual precipitation differ among these environments?

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- **Draw Conclusions** Do temperature and precipitation affect the climate of an environment and its organisms?

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Quick Lab

Name ______________________ Date __________

Comparing Climates

Materials

- an atlas or the Internet

- Use an atlas or the Internet to gather data about the climate of your city or town. Record information such as latitude and longitude, average temperature, and annual precipitation.

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- Choose a city about 400 km north or south of your area that is at about the same longitude as yours.

- Repeat step 1 for the city you chose in step 2.

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- **Interpret Data** How do the average temperatures and annual precipitation of the two locations compare?

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- **Draw Conclusions** Describe the climate of each location. How can you account for any differences?

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Name ______________________ Date ____________

Explore

How do we learn about the planets?

Materials

- shoe box
- newspaper
- clear tape
- sheet of thin, tinted, transparent plastic

Form a Hypothesis

Do the tools that scientists use to study stars and planets affect the information they obtain? Write your answer in the form of a hypothesis: "If I change the tools I use to look at an object, then . . ."

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Test Your Hypothesis

- **Make a Model** Cover a shoe box with newspaper, and tape the newspaper in place. The box represents a mystery planet. Place the box on the other side of the room.
- **Observe** View the box through the sheet of tinted, transparent plastic. Draw what you see, and include as many details as you can.
- **Observe** View the box without the sheet of plastic. Draw what you see. Describe the differences from your first observation.

Explore Name ______________________ Date ____________

Observe Walk near the box to view it at close range. Record what you observe.

Infer How did your observation through the tinted, transparent plastic differ from your observations without the plastic? What new information did you obtain from a close-up observation? Explain your observations.

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Draw Conclusions

Infer What is the difference between viewing a planet with a telescope on Earth and viewing it with a telescope in space? What causes the difference? What new information did you get from your "flyby" mission?

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Explore More

What information might be obtained if a space probe landed on the mystery planet? How might you represent a landing with your model? Form a hypothesis, and design an experiment to test it.

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Open Inquiry

Think of your own question about methods of observing objects in space.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________________ Date ____________

How can we observe planets?

Materials

- sheet of thin, tinted, transparent plastic

- Choose an object across the classroom from your seat. This object represents a mystery planet. Identify the object you selected in the box below.

- **Observe** View the object through the sheet of tinted, transparent plastic. Draw what you see in the box below. Include as many details as possible.

- **Observe** View the object without the sheet of plastic. Draw and describe any differences from your first observation.

- **Observe** View the object at close range. Record what you observe.

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- **Infer** How did your observation through the tinted, transparent plastic differ from your observations without the plastic? Did you obtain any new information from the close-up observation? What does the tinted, transparent plastic represent in the experiment?

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Name ______________________ Date ____________

Quick Lab

Rotation and Revolution

Materials
• flashlight

- **Make a Model** Work in groups of three students. Student 1 represents the Sun, student 2 represents Earth, and student 3 represents the Moon.
- Student 1 should stand still, holding a flashlight that remains turned on.
- Student 2 should spin slowly like a top. Then student 2 should walk around student 1 while continuing to spin. ⚠ **Be Careful.** If you become dizzy while spinning, stop right away.
- Student 3 should quickly walk around student 2, in such a way as to be always facing student 2.
- **Observe** Describe how the light from the flashlight falls on students 2 and 3. Draw a diagram and explain in the box below.

Name ______________________ Date ____________

Communicate

Materials

- tape
- sheet of butcher paper
- pencil
- meterstick
- rubber ball

You have read about objects in our solar system that rotate, revolve, and orbit. Gravity is the force that keeps the Moon orbiting Earth. It also keeps Earth and the other planets orbiting the Sun. How much is an object's orbit affected by gravity? What role does the object's speed and direction play? To answer questions such as these, scientists gather data and experiment. Then they **communicate** the results in books, online articles, television and newspaper interviews, and presentations.

▶ Learn It

When you **communicate**, you share information with others. You may do this by speaking, writing, drawing, using sign language, singing, dancing, or pantomiming. Before you can share information, though, you need to gather it. In the following activity, you will test how an object moves through "space," and then you will communicate your findings to your classmates.

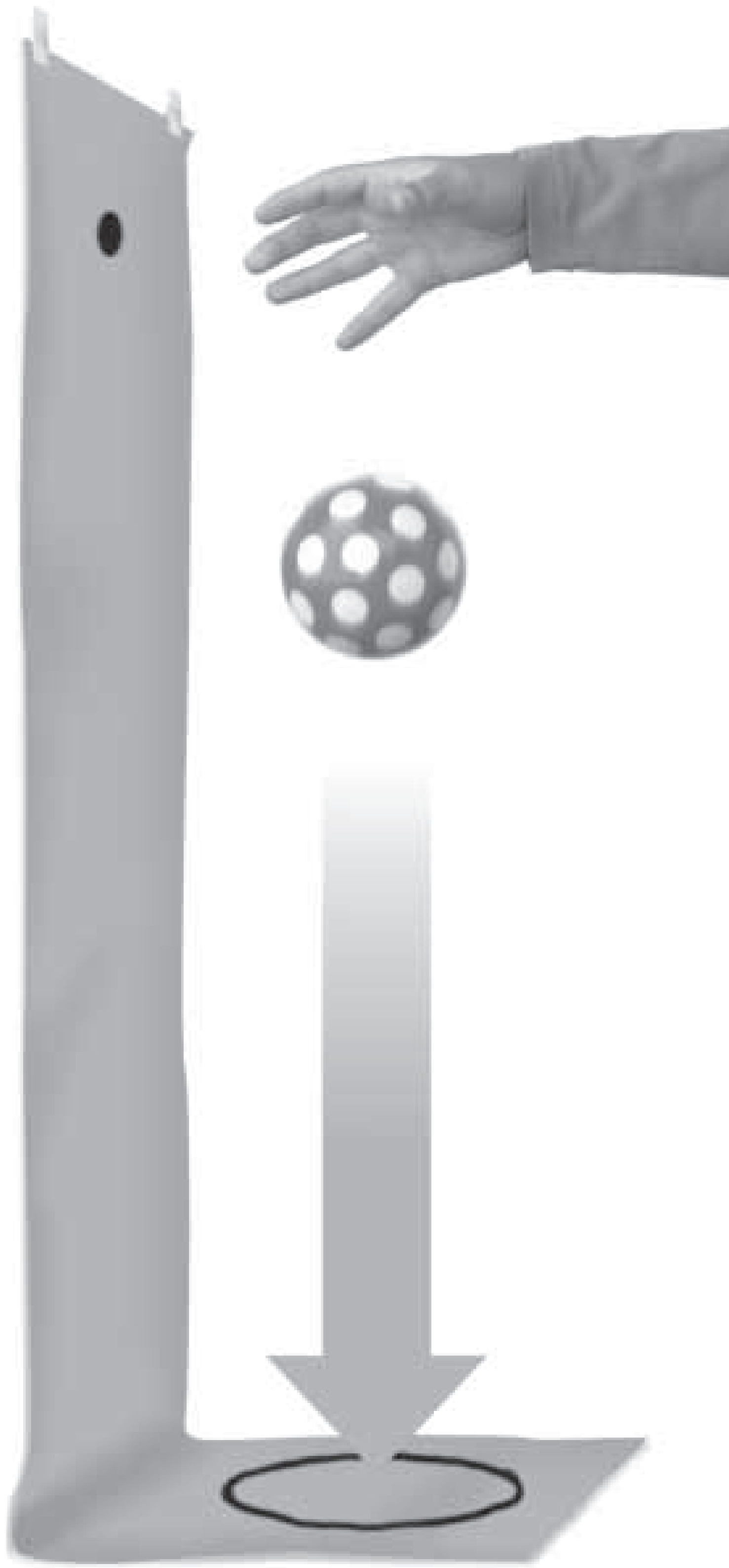
Name ______________________ Date ____________

Try It

- Tape a sheet of butcher paper to the wall. Draw a large circle at the bottom of the paper to represent Earth's surface. Make a small dot on the paper at 1 m above the ground.

- Hold a rubber ball at the height of the dot, and drop it. Draw its path on the butcher paper.

- Hold the ball at the same height, but this time toss it sideways with just a little force. Observe the ball's path, and draw it on the butcher paper. Repeat this procedure three more times, but throw the ball with a little more force each time. Draw each path on the butcher paper.



Name ________________________ Date ____________

Apply It

- When you threw the ball sideways, was its path straight or curved? Why do you think this was so?

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- How did gravity affect the ball as you threw it with more force?

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- What would happen if a cannon fired the ball into orbit around Earth? Draw the path you think the ball would take.

What do you think would happen if the ball could move fast enough to escape Earth's gravity? Draw that path.

Communicate your actions and results to your classmates. You may write a report, draw a cartoon strip, make a poster, pantomime your actions and the results, or compose and sing a song. Use the lines below to describe how you chose to communicate your results to your classmates.

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Name ______________________ Date __________

What causes the Moon to change appearance?

Purpose

Sometimes the Moon appears perfectly round. At other times, it looks like a small crescent or even seems to disappear. Why does the Moon appear in different shapes, or phases? To find out, model how the position of the Moon changes in relation to the Sun and to Earth.

Materials

- 3 balls of different sizes
- black marker

Procedure

- **Make a Model** The three balls of different sizes represent the Sun, the Moon, and Earth. Place the largest ball, representing the Sun, in one location. Use a marker to darken one half of another ball, representing the Moon. As the "Moon" moves around the third ball, representing Earth, the light side should always face the "Sun." The dark side should always face away from the "Sun."

- **Observe** With a partner, arrange your model of Earth, the Sun, and the Moon in such a way that someone on Earth would see a full Moon.

- **Record Data** On the following page, make a diagram of the locations of the Sun, the Moon, and Earth in your model. Label your diagram. Include a description of how the Moon would appear to an observer on Earth.

- **Experiment** Move your model Moon around your model Earth. Compare how the Moon would look from Earth at different locations. Add this information to your diagram.

Name ______________________ Date ____________ **Explore**

Draw Conclusions

- **Interpret Data** Does the Moon actually change size or shape? If you could view the Moon from the Sun, would it appear to have phases? Explain.

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- **Communicate** What causes the Moon to appear to have phases?

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 Name ______________________ Date ____________

Explore More

Would Earth appear to have phases if you were standing on the Moon? Make a prediction. Then design a similar model to test your prediction. Conduct your experiment, and share your results with your class.

Open Inquiry

Think of your own question about modeling a planet with more than one moon.

- ▶ My question is:

- ▶ How I can test it:

- ▶ My results are:

Name ______________________ Date ____________

What causes the Moon to change appearance?

Materials

- 3 different-sized balls
- black marker

Make a Model Use the three balls to represent the Sun, the Moon, and Earth. Place the largest ball, representing the Sun, in one location. Use a marker to darken one half the smallest ball, which represents the Moon. Move the ball representing the Moon around the third ball, which represents Earth. The light side of the "Moon" should always face the "Sun."

Experiment Arrange your model of Earth, the Sun, and the Moon in such a way that someone on Earth would see a full Moon. Move your model Moon around your model Earth. Compare how the Moon would look from Earth at different locations.

Record Data Make a diagram of the locations of the Sun, the Moon, and Earth in your model. Label your diagram. Include a description of how the Moon would appear to an observer on Earth.

Quick Lab

Name ______________________ Date ____________

Modeling Eclipses

Materials

- 2 foam balls of different sizes
- flashlight

- **Make a Model** Obtain two foam balls of different sizes. One should be at least twice as big as the other

- **Observe** Shine a flashlight directly at the larger ball from a distance of about 3 m. Place the smaller ball between the flashlight and the larger ball. The smaller ball should be about 10 cm away from the larger ball. Record your observations.

- **Observe** Repeat step 2, this time placing the smaller ball behind the larger ball. The larger ball should be between the flashlight and the smaller ball. Record your observations.

- **Infer** What do the flashlight and each ball represent in this model?

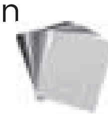
- **Interpret Data** What event did you model in step 2? In step 3?

Name ______________________________ Date _____________

Structured Inquiry

How can you model the solar system?

Materials

- construction paper 
- markers 
- tape 
- 30 m tape measure
- dowels

Purpose

Our solar system consists of the Sun, planets, moons, and other bodies, including asteroids, comets, and meteoroids. Each planet has its own orbit around the Sun. What can making a model of the solar system show you? Construct a model of the solar system on your playground, and use your model to compare the distances between planets.

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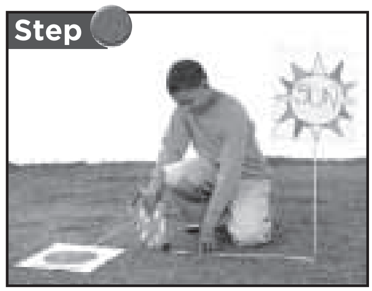
Test Your Hypothesis

- **Make a Model** Make construction-paper labels for each planet and the Sun. Attach each label to a dowel with tape.
- Place the marker labeled *Sun* at one end of the playground.
- **Measure** Use the table on the next page to construct your model. Use a measuring tape to measure the scaled distance from the Sun to Mercury, and place the marker labeled *Mercury* in the ground.



Name ______________________________ Date ____________

Continue marking the distances of the planets from the Sun. Draw your model in the box below, and record your observations about the solar system.

Planet	Distance from Sun (in kilometers)	Distance from Sun, to Scale (1 cm = 1,000,000 km)
Mercury	57,900,000	58 cm
Venus	108,200,000	1 m, 8 cm
Earth	149,600,000	1.5 m
Mars	227,900,000	2 m, 28 cm
Jupiter	778,400,000	7 m, 78 cm
Saturn	1,426,700,000	14 m, 27 cm
Uranus	2,871,000,000	28 m, 71 cm
Neptune	4,498,300,000	44 m, 98 cm

Draw Conclusions

Interpret Data Which planet is closest to the Sun? Which planet is closest to Earth?

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____

Interpret Data What happens to the size of the solar system from the orbit of Jupiter to the orbit of Saturn? What happens to the size of the solar system from the orbit of Saturn to the orbit of Uranus?

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Guided Inquiry

Could you model the solar system, including the planets' sizes and the distances between the planets?

Form a Hypothesis

Why is it so difficult to make a true scale model of the solar system? Write your answer in the form of a hypothesis: "If I try to model the sizes of the Sun and all the planets accurately, then . . ."

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Test Your Hypothesis

Decide what data you need to collect to make your model. Then choose a scale to use for your model, and calculate the sizes and positions of your model Sun and planets.

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Draw Conclusions

How easy would it be to make your model? Explain.

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Name ______________________________ Date ____________

Open Inquiry

Think of a question about the solar system to investigate. For example, are the planets always the same distance from the Sun, or do their distances change? Design a data-collection process or method of research to answer your question. Your data must be organized to test only one variable, or one item being changed.

Remember to follow the steps of the scientific process.

- My question is:

  ____

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  ____

- My hypothesis is:

  ____

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- How can I test it:

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- My conclusions are:

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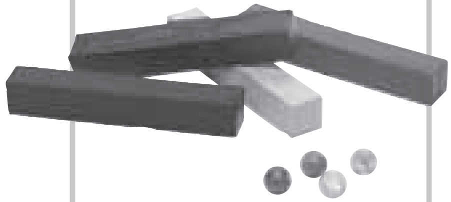
Name ______________________ Date ______________ **Explore**

How can you tell a planet from a star?

Materials



- 4 lumps of clay
- 4 marbles

Make a Prediction

Some lights in the night sky appear to move in relation to others. How can you tell that a particular light comes from a planet, not a star? Write your answer in the form of a prediction: "If an object in the sky is a planet, then it will appear to . . ."

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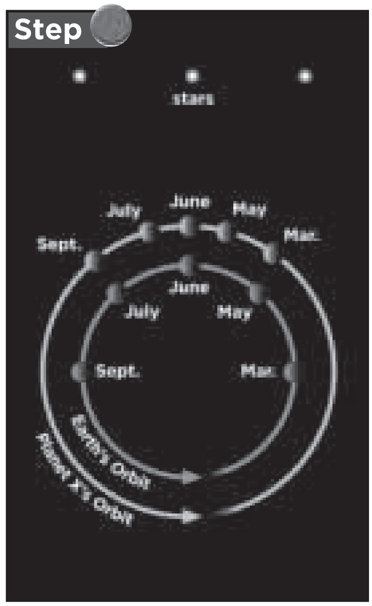
Test Your Prediction



1. **Make a Model** Make a copy of the drawing shown here on a separate piece of paper. Use clay to fix a marble in each of the three star locations.

2. Use clay to fix a marble at the March position of planet X's orbit. Draw a line from Earth's March position to planet X's March position. Extend the line to the stars. Write a *1* to label where planet X appears in relation to the stars.

3. Repeat step 2 for the planets' positions in May, June, July, and September. Label these monthly observations *2*, *3*, *4*, and *5*, respectively.

Name ______________________ Date ____________

Draw Conclusions

- **Interpret Data** Describe the motion of planet X with respect to the stars from March to May. Compare this to the motion from May to June, from June to July, and from July to September.

- **Infer** How can you tell a planet from a star?

Explore More

What would happen if you increased the distance between Earth's orbit and planet X's orbit? Make a prediction and test it.

Name ______________________ Date ____________ **Explore**

Open Inquiry

Think of your own question about the movement of stars.

- My question is:

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- How I can test it:

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- My results are:

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Name ______________________ Date ____________

How do planets appear to move?

Materials

- chair

- **Make a Model** Work in groups of three. Student 1 should sit in a chair in the center of the room. Student 1 represents the Sun.

- **Make a Model** Two other students should model the orbits of two planets. Student 2 should be closer to student 1 than student 3. Students 2 and 3 should move around student 1 in a counterclockwise direction. Student 3 should walk very slowly, and student 2 should walk at a normal pace.

- **Compare** What did you observe about the orbits of the two model planets?

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- **Use Variables** Have students 2 and 3 move in their orbits both at the same speed. What did you observe?

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- **Use Numbers** Count how many times each model planet orbits the model Sun in one minute. Explain your results.

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- **Draw Conclusions** How would you explain the rate at which the model planets orbit the model Sun?

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Name ______________________ Date ____________ **Quick Lab**

Planet Sizes

Materials
• calculator
• pencil
• paper
• compass

- **Use Numbers** Look at the table of planet diameters. Suppose in a scale model Earth's diameter is 2 cm. Calculate the diameters of the other planets to scale in centimeters by multiplying each planet's diameter by 2.

- **Make a Model** On one sheet of paper, draw a circle for each planet using the diameters you calculated in step 1. Draw the smaller circles inside the larger circles. Label each circle with the name of the planet.

- **Compare** Which planet is the largest? Which is the smallest?

- The largest moon in the solar system has a diameter 0.4 times that of Earth. Which inner planet is closest to this moon in size?

Planet Diameters (compared to Earth's)

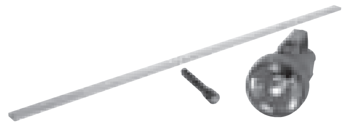
Planet	Diameter (in Earth diameters)
Mercury	0.38 × Earth
Venus	0.95 × Earth
Earth	1.0 × Earth
Mars	0.53 × Earth
Jupiter	11.2 × Earth
Saturn	9.5 × Earth
Uranus	4.0 × Earth
Neptune	3.9 × Earth

Explore

Name ______________________ Date ____________

How does a star's distance from Earth affect its brightness?

Materials



- small "penlight" or pocket flashlight
- large flashlight
- meterstick

Make a Prediction

Can you tell how bright a star actually is by looking at it from Earth? Write your answer in the form of a prediction: "If a bright object is very far away from me, then it will . . ."

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Test Your Prediction

- **Observe** Two partners should each hold one of the two flashlights 2 m away from a third student, who will act as the observer. The observer should record what he or she sees. Is one flashlight now brighter than the other? How can you tell?

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- **Observe** One partner should hold the smaller flashlight less than 0.5 m from the observer, and the other partner should hold the larger flashlight more than 8 m from the observer. The observer should record what he or she sees. Does one flashlight now seem brighter than the other? What has changed?

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Measure The two partners should move forward and backward as directed by the observer until the two flashlights seem to be the same brightness. Measure the distance from the observer to each flashlight.

Draw Conclusions

Interpret Data If you see two lights in the distance, will how bright they appear to be always tell you how bright they actually are?

Explore More

Do other factors affect how bright a star appears to be? Research this question, and then design an experiment to test one of these other factors.

Name ______________________ Date ____________

Open Inquiry

Think of your own question about the color of stars and how the color affects apparent brightness.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ____________________ Date ____________

How does distance affect brightness?

Materials

- small "penlight" or pocket flashlight
- large flashlight

Experiment Gather in a group at one end of the classroom. Your teacher will point the both the large and small flashlights at you.

Observe Describe what you observe about the light coming from the two flashlights.

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Experiment Have one student take the large flashlight to the other side of the room and point it at your group.

Observe Do you observe anything different about the light coming from the two flashlights?

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Measure Measure the distance between your group and the two flashlights. Use the box below to draw a diagram of the positioning of your group and the two flashlights.

Quick Lab

Name ____________________ Date ____________

How Parallax Works

Materials
- pencil

- **Make a Model** Close your right eye. Look at a distant object with your left eye. Hold your thumb about 10 cm in front of your face. Hide the object with your thumb, and look at it again with your left eye. Write or draw your observations.

- **Use Variables** Now close your left eye, and open your right eye. Look at the object with your right eye. Note your observations.

- Repeat steps 1 and 2, holding your thumb at arm's length. Record your observations.

- **Infer** What does your thumb represent in this model?

- **Interpret Data** Compare the parallax you noticed in each case.

Name ________________________ Date ____________

Explore

How are galaxies classified?

Materials

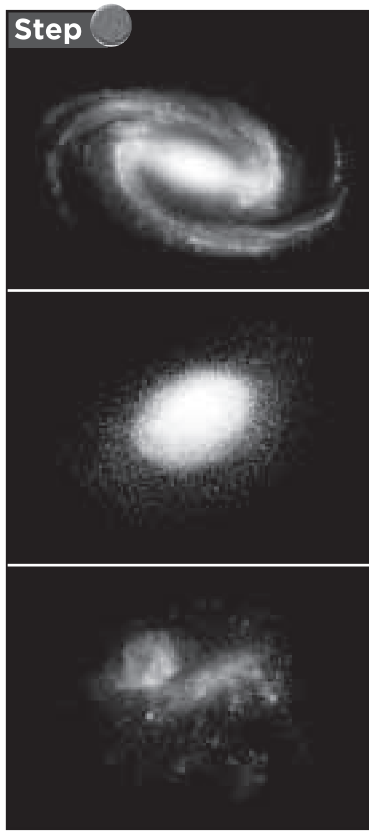
- galaxy diagrams (shown)
- pictures of various galaxies

Make a Prediction

Do some galaxies have visible similarities by which they can be grouped? How could you classify galaxies into three major groups? Write your answer in the form of a prediction: "If I compare diagrams of different galaxies, then I will be able to classify them based on their . . ."

Test Your Prediction

Observe With your team, study the three galaxy diagrams shown here. Write a short description of anything you notice that is different in each picture. Name each grouping according to the description that you gave to its diagram on this page.



Communicate Examine available pictures of different galaxies, or find pictures of galaxies using the Internet or library sources. Discuss with your team which of the three galaxy categories each picture best resembles.

 Name ______________________ Date ____________

- **Classify** Sort the galaxy pictures into three major groups.

- What property did you use to classify the galaxy pictures?

Draw Conclusions

- **Communicate** Look at how other teams classified the galaxies. Explain how their classifications compared to those of your team.

Explore More

Find additional information on different galaxies. What other information might you use to classify and categorize galaxies? Try classifying galaxies in a different way based on your new research. Then share your ideas with others in your class.

Name ______________________ Date ____________

Open Inquiry

Think of your own question about the shapes of galaxies.

- ▶ My question is:

- ▶ How I can test it:

- ▶ My results are:

Name ______________________ Date ____________

How can we classify galaxies?

Materials

- photographs of galaxies

- Look at the three photographs of the galaxies printed out by your teacher.

- **Observe** Describe the shapes of each galaxy.

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- **Compare** Look at the remaining photographs. Which of the original photographs does each one resemble?

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- **Draw Conclusions** Are there any other ways to classify galaxies? Are you able to use the photographs for these approaches?

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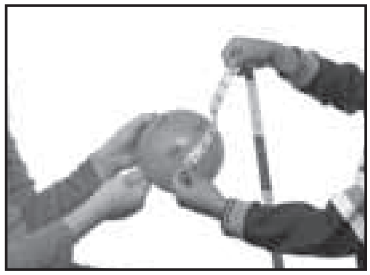
Name ______________________ Date ____________

Quick Lab

A Changing Universe

Materials

- light-colored balloon
- tape measure
- marker



- **Make a Model** Inflate a balloon about one third of the way. Use a tape measure to measure the circumference around the widest part of the balloon. Hold it closed, and have a partner draw three dots on its surface. Label the dots *A*, *B*, and *C*. Measure the distances between each pair of dots.

- **Record Data** Inflate the balloon until the circumference is twice as large as it was in step 1. What has happened to the dots? Measure and record how far dots A and B are from dot C.

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____

- **Observe** What happened to the dots as you inflated the balloon?

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- **Infer** Suppose you were standing at dot A, B, or C. How would the other two locations appear to you as the balloon was inflated?

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Explore Name ____________________ Date __________

What is the density of water?

Form a Hypothesis

Does the density of water depend on the quantity of water? If you change the quantity, does the density change? Write your answer in the form of a hypothesis: "If I change the amount of water, then the density of the water will . . ."

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Test Your Hypothesis

- **Measure** Record the mass of a dry, clear container. Add 25 mL of water to the graduated cylinder. To measure the water properly, view the cylinder at eye level. The bottom of the water's curved surface, the meniscus, should be at the 25 mL mark. Pour the water into the container.

- **Record Data** Record the mass of the container and water together.

- **Use Numbers** Determine the mass of the water by subtracting the mass of the clear container from the total mass. Record your measurement.

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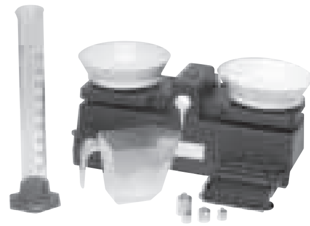
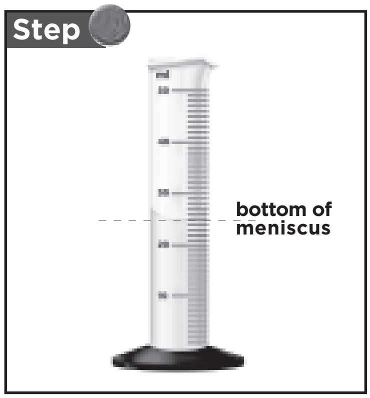
Materials



- balance
- premeasured mass set
- clear container (such as a pitcher)
- water
- graduated cylinder



Name ______________________ Date ______________

Explore

- **Use Numbers** Determine the water's density. The density of a substance is the amount of mass in a given volume. Divide the mass of the water in grams by the volume in milliliters. Round to the nearest tenth.

____

____

- Repeat steps 1–4 three times, using 50 mL, 75 mL, and 100 mL of water.

- **Communicate** Plot the results from the four samples on a graph, with volume on the *x*-axis (horizontal) and mass on the *y*-axis (vertical).

Draw Conclusions

- **Interpret Data** Does the density of water change as the amount of water changes?

____

____

____

____

Name ____________________ Date __________

Explore More

Is this relationship true for other liquids? Repeat the investigation using oil. Would it be true for solids?

Open Inquiry

Think of your own question about factors that affect the density of an object.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

Alternative Explore

Does temperature affect the density of water?

Materials

- encyclopedias, the Internet, or other reference materials

- Use your reference materials to find the density of ice and water at various temperatures.

- **Record Data** Record your data in the table below.

Temperature (°C)	Density of Water	Temperature (°C)	Density of Ice
0		0	
4			
10		⁻10	
20		⁻20	
30		⁻30	
40		⁻40	
50		⁻50	
60		⁻60	
70			
80			
90			

- **Draw Conclusions** What happens to the density of water and the density of ice as temperature increases?

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- **Infer** How could you show the relative densities of water and ice?

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Quick Lab

Name ____________________ Date __________

Density in Action

Materials

- two 100 mL graduated cylinders
- blue food coloring
- at least 20 mL each of water, corn oil, baby oil, and corn syrup

- **Predict** What will water, corn oil, baby oil, and corn syrup do if you pour them into a graduated cylinder and do not mix them?

  ____

  ____

- **Measure** Add blue food coloring to 20 mL of water. Pour the water into a 100 mL graduated cylinder.

- **Observe** Slowly pour 20 mL of corn oil into the graduated cylinder. Then slowly add 20 mL of baby oil, followed by 20 mL of corn syrup. Describe what happens as each substance is poured into the graduated cylinder.

  ____

  ____

  ____

- **Communicate** Make a diagram that shows the graduated cylinder with all of the substances added. Label each of the substances.

- **Infer** What does your illustration show about the density of each substance?

  ____

  ____

- **Predict** Where would a button float if you dropped it into the cylinder? Where would a cork float? A penny?

  ____

  ____

Name ______________________________ Date ______________

Measure

As you know, matter is the "stuff" that makes up all things. There are millions of different things in this world. How do scientists distinguish one thing from another? One way is to **measure** and compare the objects' common physical properties.

▶ Learn It

To **measure** is to find the size, distance, time, volume, area, mass, or temperature of an object. It is important to record measurements. If you use a chart to record information, you will be able to see your data at a glance.

Density is one physical property that can be measured. Density is the ratio of mass to volume. To find the density of an object, divide its mass by its volume. Mass can be measured in grams, and volume can be measured in cubic centimeters, so density can be stated in grams per cubic centimeter.

▶ Try It

Of the objects listed in the chart on the following pages, which do you think matches the "mystery matter" described in this box?

Mystery Matter
color: white
texture: smooth
density: 0.084 g/cm^3

Name ______________________________ Date ____________

Find out if you're right. Here's how.

- Observe the color and texture of each object.
- Record the information on a chart like the one shown on the next page.
- Measure and record each object's mass in grams using the balance and a standard mass set. Record the data.
- Find the volume of regularly shaped rectangular objects using this formula: *volume* = *length* × *width* × *height*. Record the results on your chart.
- Find the volume of the irregularly shaped objects. For each object, partially fill a graduated cylinder with water, and measure the volume. Put the object into the cylinder. If the object floats, use a pencil point to push it under the water. Measure the new volume. Then subtract the volume of the water alone from the volume of the water with the object in it. Record this as the object's volume on your chart.
- Calculate the density of each object by using this formula: *density* = *mass* ÷ *volume*. Record the data on your chart.

Materials

- wooden block
- sugar cube
- golf ball
- table-tennis ball
- sheet of $8\frac{1}{2}$-by-11 inch paper
- piece of chalk
- plastic spoon
- balance
- gram weights
- ruler
- graduated cylinder
- water
- pencil

Physical Properties of Objects					
Object	**Color**	**Texture**	**Mass (g)**	**Volume (cm^3)**	**Density (g/cm^3)**
wooden block					
sugar cube					
golf ball					
table-tennis ball					
sheet of $8\frac{1}{2}$-by-11 inch paper					
piece of chalk					
plastic spoon					

▶ Apply It

Now use the data from your chart to answer these questions. Which object had the lowest density? Which was the "mystery matter"? Will a smaller object always be lighter than a larger one?

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Name ______________________________ Date ____________

Make a bar graph to display your density measurements. Draw a picture of each item, and then color in bars to compare at a glance the actual densities of the objects, from least to greatest density.

Choose some items from your classroom. Predict which of them will have the lowest density. **Measure** the mass and volume of each object, and then calculate its density. Record your data in the chart below. Was your prediction correct?

Object	Color	Texture	Mass (g)	Volume (cm^3)	Density (g/cm^3)

Name ________________ Date ________

Explore

Can you always cut a substance in half?

Materials

- sheet of graph paper
- scissors

Make a Prediction

Throughout history people have wondered what the smallest possible piece of a substance might be that still has all the qualities of that substance. For example, what is the smallest possible piece of gold that still has all the qualities of gold? In this case, you will predict how small or large the smallest possible piece of graph paper might be. Write your answer in the form "The smallest possible piece of graph paper that still has all the qualities of graph paper will be . . ."

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Test Your Prediction

1. **Classify** What qualities distinguish graph paper from regular paper? In other words, what qualities must paper have in order to be considered graph paper?

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____

2. **Measure** What is the measurement (length and width) of a single box on your sheet of graph paper?

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Explore

Name ______________________ Date ____________

Observe Cut your sheet of graph paper in half. ⚠ **Be careful.** Can the paper still be considered graph paper? Explain.

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Experiment Continue cutting the graph paper in half. Keep going until you think you have the smallest piece that can still be identified as graph paper. How big is the piece left after you have finished cutting?

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Draw Conclusions

Infer Why did you stop cutting the paper at that size? State the reasons for the size at which you stopped cutting.

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Explore More

Try this activity using a material other than graph paper. What difficulties will you have in representing the smallest possible piece of that material? What tools will you need in order to be successful?

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Name ______________________ Date ____________

Explore

Open Inquiry

Think of your own question about properties that can be used to show the qualities of a substance.

▶ My question is:

▶ How I can test it:

▶ My results are:

Alternative Explore

Name ______________________ Date ____________

Can you divide it in half?

Materials

- box of paper clips

- **Predict** How many times will you able to divide a pile of 32 paper clips in half until it is no longer divisible?

- Have someone in your group take 32 paper clips out of a box.

- Divide the paper clips into two equal piles. Return one pile to the box.

- **Observe** How many times were you able to divide the piles of paper clips in half? Was your prediction correct?

- **Draw Conclusions** Why is it that you can only divide the piles of paper clips in half a set number of times?

Name ______________________ Date ____________

Quick Lab

Classifying Elements

Materials

- samples of iron, copper, carbon, and aluminum
- hand lens
- sandpaper

Classify How could you classify elements into groups? What characteristics would you compare and contrast?

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Observe Look at samples of iron, copper, carbon, and aluminum. Use a hand lens to look closely at each sample. Note any similarities and differences.

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Experiment Rub each sample with sandpaper. How does this help you tell how the samples differ?

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Classify How could you classify these four elements into groups? Record, compare, and contrast their characteristics.

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Draw Conclusions Which of the four samples is most different from the others? Explain your reasoning.

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Explore

Name ______________________ Date ____________

Does temperature affect the rate at which water evaporates?

Materials

- water
- 2 beakers
- heat lamp
- timer or clock

Form a Hypothesis

Will water evaporate at a different rate if the temperature of the water is changed? Write your answer in the form of a hypothesis: "If the same amount of water is used, then a higher temperature will cause the evaporation of water to . . ."

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Test Your Hypothesis

- **Measure** Using the graduated cylinder, pour 20 mL of water into each of the beakers. Place one beaker under the heat lamp and the other nearby but away from the heat.

- **Predict** Which water sample do you think will evaporate first? Explain.

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Name ______________________ Date ______________

Experiment Check the beakers every 30 minutes. Indicate the total amount of time it took for the water to evaporate from the beakers.

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Use Numbers What is the rate of evaporation for the water in each beaker?

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Draw Conclusions

Interpret Data Compare the data collected for the two beakers. Did your observations support your hypothesis? Does temperature affect the rate of evaporation? Explain.

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Explore More

Do some substances evaporate faster or slower than others? What might happen if you used a substance other than water in this same experiment? Make a prediction and test it. Then present your results to the class.

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Explore Name ______________________ Date ____________

Open Inquiry

Think of your own question about factors that affect the rate of evaporation.

- My question is:

- How I can test it:

- My results are:

Name ______________________ Date ______________

Where does rain come from?

Materials
• encyclopedias, the Internet, or other reference materials

- **Observe** Use encyclopedias, the Internet, or other reference materials to determine where the water that forms clouds comes from.

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- **Infer** Where would more evaporation occur: in areas with higher temperatures or in areas with lower temperatures?

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- **Communicate** Use the reference materials to find out what the movement of water from bodies of water on the surface, to the atmosphere, and back to the surface is called.

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- **Predict** Where would you predict that higher rates of evaporation and precipitation could occur?

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Quick Lab

Name ______________________ Date ____________

Molecular Movement

Materials

- two 250 mL beakers
- warm and cold water
- 2 eye droppers
- food coloring

- **Predict** Does temperature affect the movement of molecules?

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- **Measure** Label one beaker *W* and the other *C*. Fill beaker W with very warm water. Fill beaker C with the same amount of very cold water. Place the beakers near each other.

- **Experiment** At exactly the same time, place one large drop of food coloring into each beaker. Watch carefully, and take notes on what you observe in each beaker.

- **Record Data** Did the food coloring look the same in each beaker? What was different?

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- **Interpret Data** What caused the differences? Would molecular movement explain your observations?

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- **Infer** Expain how temperature and its relation to the movement of molecules applies to cooking.

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Name ______________________ Date ____________

Can black ink be separated?

Materials

- scissors
- filter paper
- ruler
- 3 washable black markers
- paper clip
- plastic cup
- water
- paper towels

Make a Prediction

Picture accidentally getting an ink stain on an article of clothing. What is the first thing you might do to help lighten or remove the stain? If you soak an ink stain with water, what do you think will happen? Write your prediction in the form of a prediction: "If different ink stains are soaked in water, then they will . . ."

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Test Your Prediction

- **Measure** Cut out three strips of filter paper, each 5 cm by 10 cm. ⚠ **Be careful.**

- **Use Variables** Make a small (0.5 cm) dark spot on each strip, using a different black marker each time. Each spot should be about 2 cm from the bottom edge of the piece of filter paper.

- **Experiment** Using a paper clip, secure the first piece of filter paper to the cup as shown. Add enough water to just touch the filter paper. The water level must be below the spot of ink.

Explore

Name ______________________ Date ____________

- **Observe** After 10 minutes, remove the filter paper, and place it on paper towels. Look closely at the filter paper, and observe it as
it dries. Repeat this process with the other strips.

- **Interpret Data** What happened to the ink spots and water? Did the ink from each marker respond in the same way?

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Draw Conclusions

- **Infer** Why do you think some colors traveled farther on the paper than others?

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Explore More

Make changes to your test. Try using rubbing alcohol instead of water. Is the pattern the same each time for each marker? Could you use this as a reliable method for identifying a particular marker?

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Open Inquiry

Think of your own question about separating the ink in ballpoint pens or the graphite in a pencil.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

How can mixtures be separated?

Materials

- coarse sand
- salt
- iron filings
- aluminum pan
- magnet
- water
- strainer or colander

- Mix the coarse sand, salt, and iron filings together in the aluminum pan.

- **Observe** Describe the physical properties of the materials in the mixture.

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- **Predict** How can the iron filings be separated from the mixture?

____

____

- **Predict** How can the salt be separated from the mixture?

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- **Experiment** Add the mixture to water, and stir. Did the salt separate from the mixture?

____

____

- **Experiment** Drain the water, and run a magnet over the mixture. Describe what happens.

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Name ______________________ Date ____________

Quick Lab

Make a Saturated Solution

Materials

- table salt
- balance scale
- graduated cylinder
- water
- 250 mL beaker
- stirring rod

1. **Predict** How much salt do you think will dissolve in 100 mL of water?

____

____

2. **Measure** Weigh out 10 g of table salt using a balance scale.

3. **Experiment** Add the salt to 100 mL of water in a beaker. Stir until the salt has dissolved completely and the solution is clear.

4. Repeat steps 2 and 3 until no more salt will dissolve.

5. **Use Numbers** Approximately how much salt dissolved in the water? Was your prediction correct?

____

____

6. **Infer** Why can you no longer see the salt once it has dissolved?

____

____

7. **Predict** Based on your data, estimate the amount of salt that will dissolve in 1 L of water.

____

____

Name ______________________ Date __________

Structured Inquiry

How can you separate a mixture?

Materials

- spoon 
- mixture items 
- plastic cup
- sieve 
- bowl 
- plastic bag 
- magnet 
- funnel with filter paper 

Form a Hypothesis

How can physical properties be used to separate a mixture? Write your answer in the form of a hypothesis: "If salt, sand, gravel, iron filings, and plastic beads are mixed together, then the following physical properties can be used to separate the parts of the mixture: ________ can separate the salt, ________ can separate the sand, ________ can separate the gravel, ________ can separate the iron filings, and ________ can separate the beads."

____

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Test Your Hypothesis

- Combine a spoonful each of salt, sand, gravel, plastic beads, and iron filings in a plastic cup. This forms the mixture you will use in this experiment. Use the chart on the next page to record your observations after each step.

- **Experiment** Over a bowl, pour your mixture into the sieve. Shake it until no more particles fall into the bowl. Transfer the items left in the sieve to another pan.

Name ______________________________ Date ______________

Be a Scientist

- Turn a plastic bag inside out, and place a magnet inside the bag. Pass the magnet through the mixture. Turn bag right-side out to collect materials attracted by the magnet.

- Add water until the water level is 2 cm of water above the remaining materials. Use the spoon to collect any of the materials that float, and put them aside.

- Stir the mixture. Place filter paper in a funnel, and pour the mixture into the funnel. Use the plastic cup to catch the water.

- **Observe** Leave this cup of water in a warm, dry place for 2 days.

Draw Conclusions

- **Infer** What process was responsible for separating the water from the salt?

  ____

  ____

- **Communicate** Share with the class how each part of the mixture was separated. Compare your results with your original hypothesis, and revise your hypothesis if necessary.

  ____

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  ____

Name ______________________ Date ____________

Guided Inquiry

How can you design your own method for separating mixtures?

Form a Hypothesis

Could you design your own procedure to separate a mixture of different materials? With the help of your teacher, gather a mixture of tea leaves, sugar, marbles, and plastic-foam peanuts. Then write your answer in the form of a hypothesis: "If I have a mixture of tea leaves, sugar, marbles, and plastic-foam peanuts, then . . ."

Test Your Hypothesis

Design an experiment to test your hypothesis. Write out the materials you will need and the steps you will follow. Record your results and observations as you carry out your experiment.

Draw Conclusions

Did you follow the steps you used to separate the first mixture, or did you change the steps? Why or why not?

Open Inquiry

What else can you learn about mixtures? For example, how do stirring and shaking affect different mixtures? Design an experiment to answer your question. Write your experiment so that another group could repeat the experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

____

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____

____

- My hypothesis is:

____

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____

____

- How can I test it:

____

____

____

____

- My conclusions are:

____

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Name ______________________ Date ____________

What happens when metal rusts?

Make a Prediction
What do you think happens when metal rusts? If you find the mass before a metal rusts, what do you think will happen to that mass after it rusts? Write your answer in the form of a prediction: "When steel wool rusts in air, the total mass will . . ."

____

____

____

Materials

- steel-wool pad
- hand lens
- beaker
- vinegar
- water
- sealable plastic bag
- balance
- gram masses
- protective gloves
- safety goggles

Test Your Prediction

Observe Look closely at the steel wool with your hand lens. Describe its properties.

____

____

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Soak the steel wool in a beaker of vinegar for 2 minutes. Remove the steel wool, and squeeze out the vinegar. ⚠ **Be Careful.** Dip the steel wool into water, and squeeze out the water. Place the damp steel wool in a sealable plastic bag. Trap air in the bag before sealing it.

Measure Use the balance to find the mass of the filled bag. List all the contents of the bag.

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Name ______________________ Date ____________

- **Experiment** Put aside the sealed bag for the length of time your teacher has determined.

- **Record Data** Leave the bag closed until otherwise instructed. Then find the mass of the filled bag.

____

____

Draw Conclusions

- **Interpret Data** Did the mass of the bag and its contents change? Why was it important to leave the bag sealed until after your measurements?

____

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____

____

- **Infer** Now open the bag, and use your hand lens to look carefully inside. ⚠ **Be Careful.** Do the contents seem to have the same properties that you listed earlier?

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____

- **Interpret Data** Draw conclusions based on your experiment. Consider the amount of mass in the bag and the properties of the substances in the bag before and after the experiment. What can you conclude about the substances in the bag?

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____

____

 Name ____________________ Date __________

Explore More

Would mass change during other experiments in which new compounds were formed? Experiment using another metal to test your prediction. Share your results with the class.

____

____

____

Open Inquiry

Think of your own question about what happens when something burns.

- My question is:

  ____

  ____

  ____

- How I can test it:

  ____

  ____

  ____

- My results are:

  ____

  ____

  ____

  ____

  ____

  ____

Name ______________________________ Date ______________

How are chemical reactions in metals prevented?

Materials

- encyclopedia, Internet, or other reference materials

Bridges, trucks, and chain-link fencing are among the many everyday objects made from metal.

- Use your available resources to research how metal objects are protected from rust.
- What causes metal to rust?

____

____

____

____

- How are metals treated to prevent them from rusting?

____

____

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____

- **Draw Conclusions** What is the importance of preventing iron and other metal objects from rusting?

____

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 Name ______________________ Date ____________

Rate of Reaction

Materials
• 2 effervescent antacid tablets
• 2 beakers
• graduated cylinder
• water

- Will a whole or crushed antacid tablet react faster with water? Test this using two effervescent antacid tablets and two similar containers labeled *Whole* and *Crushed*.

- **Use Variables** Pour equal amounts of water of the same temperature into the two containers. Crush one tablet on paper. Do not lose any of the pieces.

- **Experiment** At the same time, add the whole antacid tablet to the *Whole* container and the crushed tablet to the *Crushed* container.

- **Observe** In which container did the reaction start first? Finish first? In which container was the reaction stronger?

____

____

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____

- **Infer** What variable did you test? How did this variable affect the rate of the chemical reaction?

____

____

____

____

Name ______________________ Date ____________

Form a Hypothesis

You learned that chemical reactions have reactants, or the starting substances, and products, or what the reactants change into. You also learned that one possible sign of a chemical reaction is a color change.

Scientists use information they read and observe to help them **form a hypothesis**, or make an educated guess, to answer a question. Then they experiment and interpret the result to see whether it supports or disproves their hypothesis.

Materials

- 2 saucers
- paper towels
- vinegar
- 2 steel paper clips
- copper wire (insulation removed)
- 2 pennies (1 old and 1 new)
- timer or clock

▶ Learn It

When you **form a hypothesis**, you make a testable statement about what you think is logically true. You might form this hypothesis: "If steel wool soaked in vinegar and exposed to the air produces rust, then any other item made of iron or steel will also produce rust."
Anyone can test this hypothesis with an experiment.

While testing a hypothesis, remember to record all your observations. The data provide evidence of whether the results of your experiment support or disprove your hypothesis.

▶ Try It

● Place the two saucers on a table. Fold the paper towels into two squares. Place one square on each saucer.

● Pour enough vinegar on each saucer to cover the folded paper towel. ⚠ **Be Careful.**

Focus on Skills

Name ______________________________ Date ____________

- **Form a hypothesis** about how paper clips, copper wire, and pennies will react to the vinegar. Record your hypothesis on the chart below.
- Place the pennies and copper wire on top of the paper towel in one saucer and the paper clips on top of the paper towel in the other saucer.
- Wait 2 minutes, and record your observations on the chart. Continue to record your observations at 10-minute intervals.
- Leave the saucers overnight. The next day check both sides of the pennies, wire, and paper clips. Record your observations on the chart.

My Hypothesis		
Time	**Paper Clips**	**Pennies and Wire**
2 Minutes		
12 Minutes		
22 Minutes		
32 Minutes		
24 Hours		

Name ______________________ Date ____________

Apply It

- What happened to the paper clips in your experiment? Why?

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- What happened to the pennies and the copper wire? Why?

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- Was there a difference between the changes on the bottoms of the objects and those on the tops? Why or why not?

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- Did your findings in this experiment support your hypothesis?

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- What do you think would happen if you now put the pennies and wire in the bottom of a small cup of vinegar? Would the old penny and the new penny react in the same way? Do you think adding a teaspoon of salt to the vinegar might speed up the chemical process?

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Name ______________________________ Date ____________

Form a hypothesis about what you think would happen when performing one of the experiments above. Test your idea, record your results, and indicate whether or not the results support your hypothesis.

Use the chart below to record what happens when you submerge the pennies and the wire in a small cup of vinegar. Conduct the same experiment with the paper clips, and record your data below.

My Hypothesis		
Time	**Paper Clips**	**Pennies and Wire**
2 Minutes		
12 Minutes		
22 Minutes		
32 Minutes		
24 Hours		

Add a teaspoon of salt to each cup, and record your data in the table below.

My Hypothesis		
Time	**Paper Clips**	**Pennies and Wire**
2 Minutes		
12 Minutes		
22 Minutes		
32 Minutes		
24 Hours		

What are acids and bases?

Make a Prediction

Red-cabbage juice turns pink in acids and blue-green in bases. The stronger the acid or base, the more the color changes. Neutral substances will not cause a color change in the cabbage juice. Which substances do you think are acidic? Basic? Neutral? Write your predictions in the chart on the next page.

Test Your Prediction

- **Predict** Label a plastic cup for each sample. Pour in a small amount of the sample. Fill in the prediction column on your chart.
- **Observe** Add drops of red-cabbage juice to your first sample. Record any color changes. Add more juice if needed. Repeat for each substance. ⚠ **Be Careful.**
- **Classify** Which samples are acidic? Which are basic? Which are neutral? Record your results in the chart on the next page.
- **Interpret Data** Compare your data to the predictions you made. How do they compare?

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Materials

- small, clear plastic cups
- water
- seltzer
- lemon juice
- baking soda dissolved in water
- white vinegar
- clear, liquid soap
- skim milk
- dropper
- red-cabbage juice
- goggles
- apron

Explore

Name ______________________ Date ____________

Sample	Predict: Acidic, Basic, or Neutral?	Color with Red-Cabbage Juice	Result: Acidic, Basic, or Neutral?
water			
seltzer			
lemon juice			
baking soda dissolved in water			
white vinegar			
clear, liquid soap			
skim milk			

Explore More

Are common foods or beverages acidic, basic, or neutral? Test your predictions, and share your results with the class.

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Open Inquiry

Think of your own question about testing the quality of soil.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

How can I make sour milk quickly?

Milk is often needed for cooking recipes. Sometimes a recipe calls for sour milk.

Materials

- encyclopedia, Internet, or other reference materials

- Use your available resources to find ways that milk can quickly be turned sour.
- Describe two ways that you can quickly sour milk.

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- **Infer** Why does the milk turn sour?

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- **Draw Conclusions** How is sour milk used in recipes?

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- Which reference materials helped you most in your research?

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Name ______________________ Date ____________

Neutralization

Materials

- clear plastic cup
- baking soda (bicarbonate of soda)
- 100 mL graduated cylinder
- distilled water
- stirring rod
- red-cabbage juice indicator
- dropper
- clear vinegar
- pH paper

- In a clear plastic cup, dissolve a small amount of baking soda into 50 mL of distilled water.

- **Classify** Add red-cabbage juice to the baking-soda solution drop by drop. Red-cabbage juice turns pink in acids and blue-green in bases. What color is the solution? Is this solution an acid or a base?

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- **Observe** Add clear vinegar to the solution, drop by drop. Vinegar is an acid solution. How many drops does it take to turn the solution a purple color?

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- **Infer** What do you think has happened to this solution? What do you think its pH might now be? Use pH paper to check your prediction.

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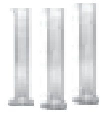
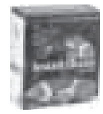
Name ______________________ Date ____________

Structured Inquiry

Can differences in salt levels affect water's physical properties?

Materials

- 3 graduated cylinders 
- ocean mix 
- pencil
- 3 waterproof markers 

Make a Prediction

Organisms living in oceans or in freshwater lakes or streams are well suited to the physical conditions of their environments. Estuaries exist where freshwater streams flow into saltwater oceans. Might the water in estuaries have physical properties different from salt or fresh water? Will a pencil placed in all three environments behave in the same way? Write your answer in the form "If fresh, ocean, and estuary water have different physical properties, then a pencil placed in each will . . ."

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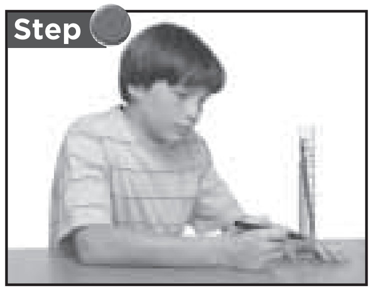
Test Your Prediction

- Label three graduated cylinders *Fresh*, *Ocean*, and *Estuary*.
- **Measure** Pour 200 mL of tap water into the *Fresh* cylinder. Pour 200 mL of water into the plastic cup and make salt water according to the ocean mix directions. Pour 200 mL of salt water into the *Ocean* cylinder.
- **Experiment** Place the pencil in the *Ocean* cylinder. Use a permanent marker to mark just above where the water level reaches on the pencil.

Use Variables Repeat step 3 with the *Fresh* cylinder using a different marker.



Measure Pour 100 mL of water from the *Fresh* cylinder and 100 mL from the *Ocean* cylinder into the *Estuary* cylinder. What happens as they mix?

Use Variables Repeat step 3 with the *Estuary* cylinder, using a different marker.

Draw Conclusions

Compare What happened when you placed the pencil in the *Fresh* cylinder? In the *Ocean* cylinder? In the *Estuary* cylinder?

Interpret Data Based on your experiment, what can you determine about the physical properties of water found in estuaries?

Name ______________________ Date ____________

Guided Inquiry

How do ocean salt levels affect living things?

Form a Hypothesis

What do you think might happen to sea life if the ocean's salt levels changed? Write your answer in the form of a hypothesis: "If the ocean's salt levels change, then the organisms in it will . . ."

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Test Your Hypothesis

Design an experiment to investigate what effect salt levels have on living organisms, such as yeast or brine shrimp. List the materials you will need and the steps you will follow. As you carry out the experiment, keep careful records of all your data.

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Draw Conclusions

Do your results support your hypothesis? Could the rate at which salt levels changed have affected the organisms similarly?

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Open Inquiry

What else can you learn about saltwater, freshwater, and estuary ecosystems? For example, what organisms thrive in water with a very high salt content? What types of salt are part of Earth's oceans? Where are estuaries located? Think of a question to investigate, and design an experiment or write a research strategy. Carry out your experiment or research, and then present your results to the rest of your class.

Remember to follow the steps of the scientific process.

▶ My question is:

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▶ My hypothesis is:

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▶ How can I test it:

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▶ My conclusions are:

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Explore

Name ______________________ Date ______________

Can you recognize differences in carbon-compound concentration?

Materials

- 4 test tubes
- red-cabbage juice
- antacid tablet
- water
- plastic water bottle
- 3 balloons
- straw
- bicycle pump

Make a Prediction

Carbon dioxide (CO_2) is colorless and odorless, so how can it be detected? It dissolves slightly in water and forms carbonic acid. The more carbon dioxide there is, the more carbonic acid forms. Will more carbonic acid form in gas from an antacid, from the air, or from your breath? Write your answer in the form "The highest concentration of carbonic acid will form in gas from . . ."

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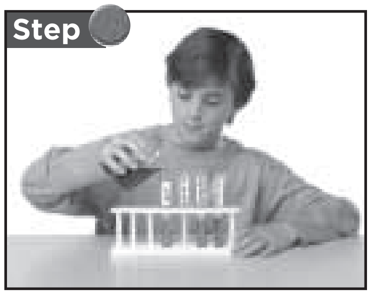
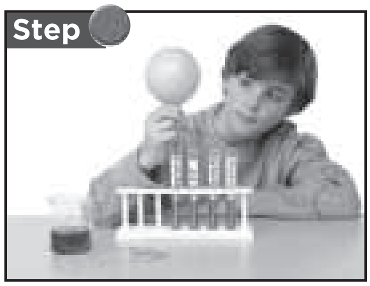
Test Your Prediction

- Label four test tubes *Antacid*, *Air*, *Breath*, and *Control*. Fill each halfway with red-cabbage juice.



- **Experiment** Put an antacid tablet and water in the plastic water bottle. Quickly place a balloon over the bottle's mouth, and collect the gas produced. Remove the balloon, and pinch the opening closed.

- Place a straw in the corresponding test tube. Put the balloon over the end of the straw, and allow the gas to slowly bubble through the juice.



- **Use Variables** Pump a balloon up to the same size, pinch it closed, and repeat step 3. Then inflate a third balloon yourself, and repeat step 3.

Draw Conclusions

- **Interpret Data** Compare the colors of the red-cabbage juice in each tube. Estimate the pH of each sample using the table below.

pH	2	4	6	7	8	10	12
Color	red	reddish-purple	violet	original color	blue	bluish-green	greenish-yellow

Explore More

In nature, the water cycle naturally exposes water to carbon dioxide in the air. Does this affect rain's pH? Design and perform an experiment testing rain's acidity, and then share the results with your class.

Name ______________________ Date ____________

Open Inquiry

Think of your own question about the acidity of rainwater.

- My question is:

- How I can test it:

- My results are:

Name ______________________ Date ____________

What are different forms of carbon?

Diamond and graphite are two forms of pure carbon.

Materials

- encyclopedia, Internet, or other reference materials

- Use your available resources to find the structures of diamond and graphite.

- **Make a Model** Draw the structures of diamond and graphite in the box below.

- **Compare** What are the differences between the structures of diamond and graphite?

Name ______________________ Date ____________

Looking for Lipids

Materials

- brown paper bag
- ruler
- pencil
- sample substances

- On a large piece of a brown paper bag, lightly pencil in a grid of boxes, each 10 cm by 10 cm.
- **Predict** Look at the substances that you will be testing, and guess which have a high lipid content. Some you may already know.

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- **Experiment** Rub a substance you are testing in the center of one box on the grid. At the bottom of the box, write the name of the substance being tested. Repeat this for each substance you are testing. Lipids will leave a spot on the paper that seems oily and allows some light to pass through. Allow the paper to dry overnight. Then check the grid again. What substances did you test?

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- **Classify** Which substances seem to contain lipids, and which do not? Were your predictions correct? Compare your own results with those of other students in your class.

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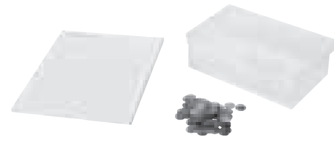
Name ______________________ Date ______________ **Explore**

How can you model radioactive decay?

Materials



- 100 pennies
- plastic box with cover
- graph paper

Make a Prediction

The amount of time it takes for half of a radioactive sample to decay is called its half-life. You will model the radioactive decay of a made-up element called pennium. How many half-lives will it take for your entire sample to decay? Write your answer in the form of a prediction: "It will take _____ half-lives for my entire sample of pennium to decay."

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Test Your Prediction

Make a Model Place 100 pennies in a box, making sure that all the tail sides are facing up.

Experiment Put the cover on the box, and shake it. Open the box, and remove any pennies that now have the head sides facing up. When a penny is head side up, this means the "atom" has "decayed" into a stable form. Write your data on a chart like the one shown.

Record Data Repeat step 2 until no pennies are left tail side up in the box. Record data for each trial until all pennium atoms have decayed.

Trial Number	Number of Pennium Atoms at Start	Number of Pennium Atoms That Decayed	Number of Pennium Atoms That Remain	Percent That Decayed
1	100			
2				
3				

Explore

Name ______________________ Date ____________

Use Numbers Graph the data you recorded.

Draw Conclusions

Interpret Data How many trials were needed for the decay of 50 atoms? For the decay of all 100 atoms? Was your prediction correct?

Name ______________________ Date ____________

Explore

Explore More

The half-life of an element can range from a few seconds to millions of years. How long would it take for your entire sample of pennium to decay if the half-life were five years? Fifteen years? Fifty?

Open Inquiry

Think of your own question about the amount of carbon 14 in living organisms.

- ▶ My question is:
- ▶ How I can test it:
- ▶ My results are:

Alternative Explore

Name ______________________ Date ____________

How is radiation detected?

Materials

- encyclopedia, Internet, or other reference materials

- Describe how Geiger counters are used to detect radiation.

- How could a Geiger counter be used?

- Draw a simple diagram of a Geiger counter in the box below.

Name ________________________ Date ______________

Quick Lab

Domino Chain Reactions

Materials

- dominoes

- **Make a Model** Arrange 15 dominoes standing up on their ends so that no reaction occurs after the first domino is toppled over.
- Arrange the dominoes standing up on their ends so that toppling the first domino causes a single chain reaction that topples them all.
- Now arrange the dominoes so that toppling the first one causes more than one chain reaction to occur simultaneously.
- **Interpret Data** Compare the three arrangements. How do the three reaction models differ?

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- **Infer** Which of these reactions best represents a nuclear reaction? Explain your choice.

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Name ____________________ Date ____________

How can you tell how fast things move?

Materials

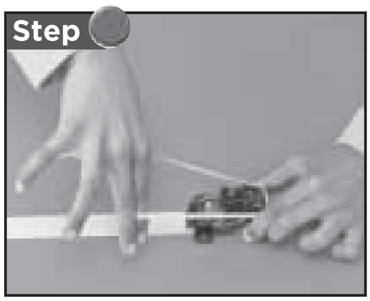
- 2 different toy cars
- masking tape
- large rubber band
- stopwatch (or watch with a second hand)
- meterstick
- calculator

Purpose

How can you determine how fast an object is traveling? See whether you can determine which of two different toy cars is faster.

Procedure

- Label the cars *Car 1* and *Car 2*. Place a long piece of masking tape on a smooth surface.
- **Experiment** Hold car 1 over one end of the tape. Stretch a rubber band with two fingers. Place the toy car against the rubber band, and pull the car and rubber band back about 6 cm with the other hand. Release the car, and have a partner measure the time that it is in motion.



- **Measure** Mark the masking tape where the car came to a stop. Record the distance from the start to the finish in centimeters.

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- Repeat steps 2 and 3 with car 1. Repeat steps 2 and 3 twice with car 2.

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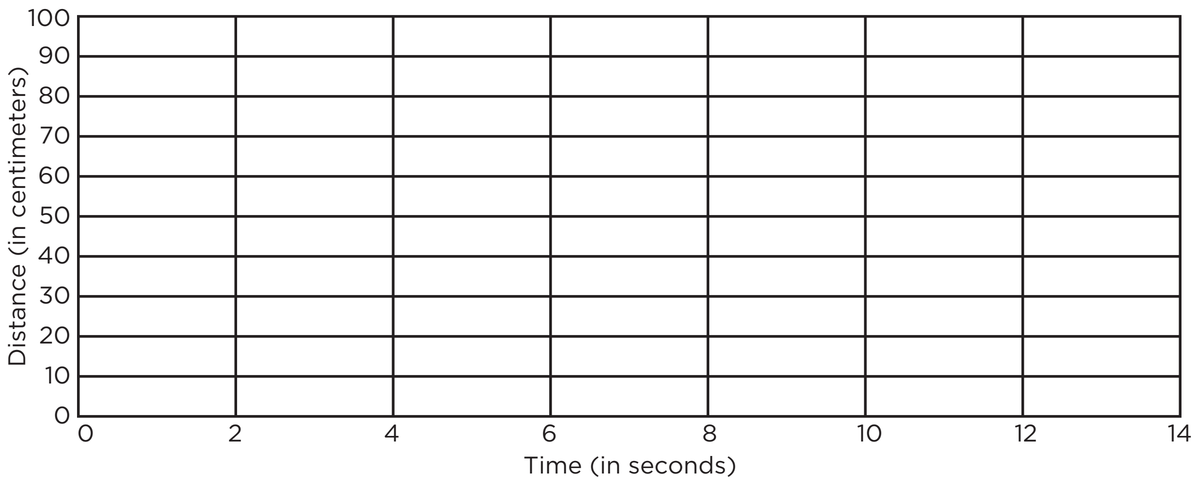
Interpret Data Average the results of each car's trials. Organize your data in a line graph on the grid below. Graph distance in centimeters on the *y*-axis and time in seconds on the *x*-axis. Label the lines on your graph *Car 1* and *Car 2*.



Draw Conclusions

Interpret Data Which car moved the greater distance? Which car was in motion longer?

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Draw Conclusions Which car do you think moved faster? Explain your reasoning.

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Name ____________________ Date ____________

Explore More

If you tape coins to the top of the faster car, will your results for this car differ? Design an experiment to test your prediction.

Open Inquiry

Think of your own question about what happens to a car's speed as it travels.

- My question is:
- How I can test it:
- My results are:

Name ______________________________ Date ______________

How fast can you move?

Materials

- 2 timers or stopwatches
- meterstick
- masking tape

1. **Measure** Make a 12 m track in the hallway. Use pieces of tape to mark the distances of 0 m, 6 m, and 12 m.

2. **Record Data** Starting at the mark for 0 m, walk at a regular pace to the mark for 12 m. Have one classmate record the time it takes you to walk 6 m. Have another classmate record the time it takes you to walk 12 m. Record your data.

3. **Use Variables** Repeat step 2, this time hopping instead of walking. ⚠ **Be Careful.** Then repeat step 2 again, walking backward instead of hopping.

4. **Use Numbers** Calculate the speed in each trial by dividing the distance by the time. Your answers should be in units of meters per second.

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5. **Compare** Which way of moving was the slowest? Which way of moving was the fastest?

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6. **Draw Conclusions** Based on your speed for walking 12 m at a regular pace, how far could you walk in 60 s? How did you get your answer?

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Quick Lab

Name ______________________ Date __________

Investigating Inertia

Materials

- thread
- playing card
- tape
- coin

- **Experiment** Attach a thread to a playing card, and place a coin on the card.
- **Observe** Pull slowly on the thread. How does the coin move?

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- **Observe** Now pull on the thread very rapidly. What does the coin do?

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- **Infer** At the start the coin and the card were at rest. Why would they naturally tend to stay at rest?

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- What did the thread do when you pulled on it?

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- **Comunicate** Explain why the coin moved differently in step 2 and step 3.

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Name ______________________________ Date ____________

Predict

When scientists **predict**, they make a reasonable statement about what might happen under certain conditions. They base their predictions on background knowledge and experience. Then they test their predictions.

Materials

- string
- plastic drinking straw
- tape
- 2 chairs
- 22.5 cm balloon
- binder clip
- measuring tape
- stopwatch

▶ Learn It

To test a prediction, scientists make observations. They may find that their observations confirm the prediction. In other words, they may find out that they were correct. Usually, however, this is not the case—at least not the first time. Most of the time, scientists need to revise the first prediction and make new observations. The accuracy of a prediction improves as more data are collected and analyzed.

Suppose you were to inflate a balloon and let it go. Could you **predict** how fast the balloon would fly through the air? First, you would need to have some background information about how fast things travel. This would give you a basis for comparison.

Have you ever seen a moth fly toward a light? It darts from place to place much like a balloon in flight. Some moths can fly at speeds of more than 13 m/s. Can you guess how fast a balloon flies compared to a moth? Will the balloon move faster or slower? How much faster or slower will it move?

Name ______________________________ Date ____________

▶ Try It

- Run a 10 m length of string through a drinking straw. Tape each end of the string to one of the chairs. Inflate a balloon, and pinch it shut with a binder clip to keep the air in. Use a measuring tape to find the circumference of the balloon. Tape the balloon to the straw.

- **Predict** how fast the balloon will fly when the binder clip is removed. Record your prediction in the data table below.

- Move the balloon to one end of the string. Have a partner ready with a stopwatch. Your partner should begin timing as soon as you release the balloon and should stop the timer as soon as the balloon reaches the other end of the string. Record the time.

- Repeat step 3 twice. Calculate the average speed in meters per second.

Prediction	Results
	time 1:
	time 2:
	time 3:
	average:

Name ______________________ Date ____________

Apply It

- **Interpret Data** Did your observations confirm your prediction? Explain.

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- The way you design an experiment affects the results. For this reason scientists often improve upon their experiments to obtain more-accurate results. How could you improve upon this experiment? (Hint: How could you reduce friction between the string and the straw, in order to simulate how the balloon would fly through the air?) Check your idea with your teacher. Then **predict** the result, and test your prediction. Record your results in the table on the next page.

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- Did your results change after you changed the setup of the experiment? Explain.

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- Which prediction was more accurate? Why?

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Name _______________ Date _______________

- Is there an even better way to test your prediction? Suppose you could have any tools or technology at your disposal. Explain how you could make the most-accurate observations and get the most-accurate results.

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- Use the data table below to record your prediction and results from step 2.

Prediction	Results
	time 1:
	time 2:
	time 3:
	average:

Name ______________________ Date ____________

Explore

What affects acceleration?

Form a Hypothesis

Will increasing the force on an object affect its acceleration? Will increasing the object's mass affect its acceleration? Write your answer in the form of a hypothesis: "If the force on an object is increased, then its acceleration will. . . and if the object's mass is increased, then its acceleration will. . ."

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Materials

- lightweight cardboard
- scissors
  ⚠ **Be Careful.**
- masking tape
- meterstick
- balloons
- 2 balloon-powered toy cars
- 2 coins

Test Your Hypothesis

- **Measure** Make two balloon-inflation gauges with inside diameters of 12 cm and 6 cm by cutting the cardboard into U shapes that can measure your balloons. Mark a start line with tape, and mark a finish line 50 cm from the start.

- **Experiment** How will force affect the acceleration of cars of equal mass? Inflate one balloon to 12 cm. Inflate another balloon to 6 cm. Attach the balloons to the toy cars, and position the cars at the starting line. Let go of the balloons at the same time. Which car crosses the finish line first?

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Name ______________________ Date ____________

Experiment How will mass affect the acceleration of cars with the same force applied to them? Attach one balloon inflated to 12 cm to each toy car, and tape two coins to one of the cars. Position both cars at the starting line. Let go of the balloons at the same time. Which car crosses the finish line first?

Draw Conclusions

Interpret Data What happened to the acceleration of the car with the greater force applied to it? What happened to the acceleration of the car that had more mass? Explain.

Explore More

Design an experiment answering a question about the relationships among force, acceleration, and mass. What variable will you change in your experiment?

Name ______________________ Date ____________ **Explore**

Open Inquiry

▶ Think of your own question about acceleration.

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

What is action-reaction?

Materials
• drinking straw
• string
• balloon
• tape
• 2 chairs

- **Make a Model** Pull a string through a straw. Tie each end of the string to a chair, and pull the chairs apart until the string is tight. The straw should be about halfway between the two chairs.

- Inflate a balloon, and pinch the opening so no air escapes. Have a partner tape the balloon to the straw.

- **Experiment** Let go of the opening of the balloon. Describe what happens.

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- What was the action force in your experiment? What was the reaction force?

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- **Predict** What will happen if you hold an object close to the opening of the balloon in the path of the escaping air?

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Name ______________________________ Date ____________

Quick Lab

Free Fall

Materials

- 2 table-tennis balls
- 20 g mass (washers or coins)
- string or tape
- 2 sheets of paper

1. **Record Data** Does gravity affect all objects in the same way? One partner should drop two table-tennis balls from the same height at the same time. The other partner should record when they hit. Repeat this three times. Did the balls hit the ground at the same time? If not, which hit first?

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2. **Use Variables** Use string or tape to attach 20 g of mass to one of the table-tennis balls. Repeat step 1.

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3. **Observe** Crumple a piece of paper into a ball, and leave another flat. Repeat step 1.

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4. **Experiment** Using paper, string, and tape, make one of the table-tennis balls hit the ground later than it normally would.

5. **Communicate** Was the time required for gravity to pull the object to Earth affected by any of your modifications? Share your ideas with others.

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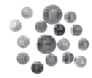
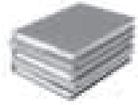
Name ______________________ Date ____________

Structured Inquiry

How does inertia apply to passengers in a moving vehicle?

Materials

- building-block car
- marbles of different sizes 
- books 
- pencil

Form a Hypothesis

Newton's laws of motion explain how objects respond to forces. How do these laws affect you when you travel in a moving vehicle? When a car accelerates positively, what happens to the passengers? What happens when the car accelerates negatively? Write your answer in the form of a hypothesis: "When a car accelerates positively, then the passengers will . . . and when a car accelerates negatively, then the passengers will . . ."

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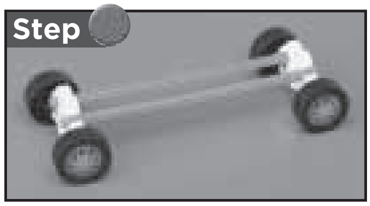
Test Your Hypothesis

- Assemble a building-block car with two connector rods, two axles, four wheels, and two pieces to block the ends of the rods. The rods should be close enough together to hold a marble.



- Place a medium-sized marble in the front of the car. Place the car about 30 cm from books that will stop the forward progress of the car.

- **Observe** Push the car in the direction of the books. How does the marble move in response to your push? Use a pencil to mark the position of the marble.

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Observe Repeat step 3. This time, observe the marble upon impact—when the car hits the books. How does the marble move? Explain.

Draw Conclusions

Did your results confirm your hypothesis, or do you need to make changes to it? Explain.

Form a Hypothesis What will happen if the distance between the car and the books is increased?

Experiment Try changing the distance between the car and the books. Was your hypothesis correct? Explain.

Name ______________________ Date ____________

Guided Inquiry

How is inertia affected by the mass of an object?

Form a Hypothesis

You have modeled a passenger in a vehicle, using a building-block car and a marble. Will it make a difference if the marble has a greater or lesser mass? Write your answer in the form of a hypothesis: “If the marble has a greater mass, then . . . If the marble has a lesser mass, then . . .”

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Test Your Hypothesis

Design an experiment to determine whether the mass of a marble on a building-block car affects its response to the force of a push and the car’s impact with the books. Write out the materials you will need and the steps you will follow. Record your results and observations.

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Draw Conclusions

Did your results support your hypothesis? Why or why not? Present your results to your classmates.

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Open Inquiry

What else can you learn about Newton's laws of motion? For example, what happens when passengers are provided with restraints such as seat belts? Which materials make the best seat belts? How might you test how well a seat-belt design works? Come up with a question to investigate. Then design and carry out an experiment to answer your question. Write your experiment so that another group could repeat the experiment by following your instructions.

Remember to follow the steps of the scientific process.

- My question is:

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- My hypothesis is:

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- How can I test it:

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- My conclusions are:

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Explore Name ______________________ Date ____________

What is work?

Make a Prediction

Scientists define *work* in terms of both a force and a distance through which the force moves an object. Which requires more force: moving an object across a smooth surface or moving it across a rough surface? Write your answer in the form "If the same object is moved the same distance along different surfaces, then . . ."

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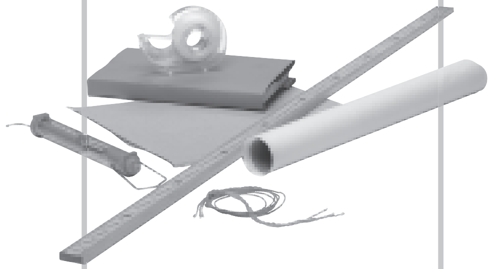
Materials



- string
- book or other weight
- spring scale
- tape
- waxed paper (1 m)
- meterstick
- medium-grain sandpaper (1 m)

Test Your Prediction

- **Measure** Use string to connect a weight to the spring scale. Tape a 1 m sheet of waxed paper to a flat surface. Place the meterstick over the waxed paper.

- **Record Data** Place the weight at the start of the meterstick. Pull on the spring scale's handle at a constant rate, moving the weight to the end of the meterstick. What was the average measurement on the spring scale as the weight moved along? Record the amount of force needed to pull the weight the length of the meterstick.

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- Repeat steps 1 and 2 using 1 m of sandpaper in place of the waxed paper.

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Draw Conclusions

- **Interpret Data** On which surface was more force required to pull the weight the same distance? Why do you think this surface required more force?

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- **Infer** Compare the two trials. Which trial seemed to be more work? If you increased the distance used in the experiment, would that change the amount of work that you would have to do? What if you used a heavier weight? Explain your answers.

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Name ________________ Date ________

Explore More

Do you think the same amount of force is needed to slide the same weight 1 m across surfaces such as carpeted or wooden floors? Test your prediction, and then share your results.

Open Inquiry

Think of your own question about how different slopes affect the amounts of work done.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

How can energy be transformed?

Materials

- construction paper
- ruler
- compass
- scissors
- straight pin
- pencil with eraser

- Make a pinwheel by cutting a piece of construction paper into a 14 cm by 14 cm square. Draw two diagonal lines from corner to corner and mark the center. Use a compass to make a circle with a 1 cm radius at the center of the paper. Cut lines from each corner to the outer edge of the circle. ⚠ **Be Careful.** Bend the corners toward the center in clockwise order. Have your teacher use a straight pin to poke a hole through the center and each corner of the paper and then into the side of a pencil eraser.

- **Observe** What happens when you blow air at the pinwheel? What caused the reaction?

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- **Use Variables** Have a partner hold a small piece of construction paper so that it touches the pinwheel blades as they move around. What happened when the pinwheel hit the small piece of paper? How would you explain what happened?

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Name ______________________ Date ____________

Potential Energy and Distance Traveled

Materials

- spool of thread
- marble
- books
- 2 rulers (1 with groove)

Predict How far will a spool of thread travel when hit by a rolling marble? What will happen if the marble rolls from a greater height?

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Observe Place a marble at the top of a ramp made from three stacked books and a ruler with a groove in it. Place a spool at the bottom of the ramp. Allow the marble to roll down the ruler so that it hits the spool, causing the spool to roll forward.

Measure Find the distance that the spool moved after being hit by the rolling marble.

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Use Variables Vary the height of the ramp by adding books. Repeat steps 2 and 3 using the same ruler, marble, and spool as before. Record your observations.

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Interpret Data What is the relationship between the height of the stack of books and the distance the spool moves?

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Name ______________________________ Date ______________

Explore

How is a ramp a simple machine?

You can use a ramp to help lift objects. Will the steepness of the ramp affect how much force is needed to lift an object? Write your answer in the form of a hypothesis: "If I make a ramp steeper to lift an object, then the amount of force needed will . . ."

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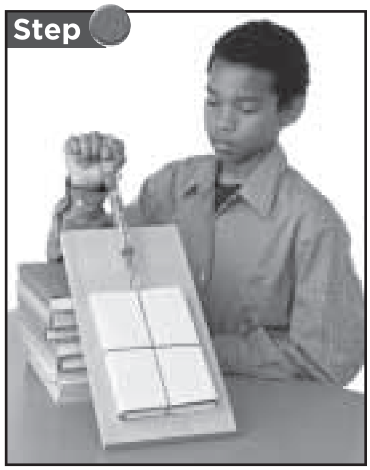
Materials

- spring scale
- book with string tied around it
- meterstick
- several other books
- flat cardboard or board

Test Your Hypothesis

- **Measure** Use the spring scale to measure the amount of force needed to lift the book tied with string straight up to a height of 20 cm. Record your results in the table on the following page.

- **Experiment** Stack books to a height of 20 cm. Position the end of the board on the stack so that the board forms a ramp up to the top book.



- **Predict** How much force do you think will be needed to pull the book up the ramp? Use the spring scale to slowly pull the book to the end of the ramp at a steady pace. Hold the spring scale so that you are pulling in a direction parallel to the ramp. Record your results in the table on the following page.

- **Record Data** Make the ramp steeper by positioning the board so that its midpoint rests against the top of the stack. Predict the force needed to pull the book up the steeper ramp. Then use the spring scale to pull the book up this ramp. Record your results in the table on the following page.

Explore

Name ______________________ Date ____________

	Amount of Force
No Ramp	
Ramp	
Steeper Ramp	

Draw Conclusions

- **Interpret Data** Which required more force: lifting the book straight up or pulling it up the ramp? Explain your answer.

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- **Interpret Data** Did the amount of force needed to pull the book up the ramp change when you made the ramp steeper? Explain your answer.

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- **Infer** What caused these differences?

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Explore More

Perform this experiment again, using objects of different masses. Calculate the amount of force needed. Do you always save the same amount of force?

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Open Inquiry

Think of your own question about the effectiveness of other machines.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

How does a ramp help you do work?

Materials

- 4 thick books
- ruler
- wide, long book with glossy cover
- plastic bag full of unpopped popcorn
- rubber band, cut open

- **Measure** Stack four thick books on top of one another. Measure the height in centimeters.

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- **Experiment** Tie a rubber band around a bag of unpopped popcorn. Pull the rubber band to lift the bag of popcorn until it is even with the top of the stack of books. Measure the length of the rubber band, and record your data in the table below.

- **Experiment** Lean a wide, long glossy book against the stack of books to make a ramp. Use the rubber band to pull the bag of popcorn up the ramp. Measure the length of the rubber band when the bag is halfway up the ramp, and record your data in the table below.

Method of Moving	Length of Rubber Band (in centimeters)
no ramp	
ramp	

- **Draw Conclusions** Which method of moving required more force to move the books? How can you tell? What does this show about how ramps affect work?

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Name ______________________ Date ____________ Quick Lab

Make an Inclined Plane into a Screw

Materials

- construction paper
- ruler
- scissors
  Be Careful.
- colored marker
- pencil
- tape

1. **Make a Model** Does a screw include an inclined plane? Draw a right triangle on a piece of construction paper. Make the base 22 cm and the height 12.5 cm. Cut it out, and label it *Triangle A*. Color the hypotenuse with a marker.

2. **Measure** Place a pencil parallel to the base of the triangle. Roll the triangle tightly around the pencil so that the colored edge makes a model of the threads on a screw. Measure the distance between the colored lines on your model screw.

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3. Repeat steps 1 and 2, using a right triangle with a 22 cm base and an 8 cm height. Label this *Triangle B*.

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4. **Infer** Which model screw had more threads in a given distance? If used as a screw, which triangle would result in a higher mechanical advantage? Explain your answer.

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Name ______________________________ Date ____________

How do waves affect the motion of objects?

Materials

- rectangular baking pan
- water
- ruler
- cork

Make a Prediction

On calm days, ocean waves are usually small, and they roll gently toward the shore. On windy days, the height of ocean waves increases. What happens when waves reach floating objects? Do the objects move with the wave or stay in the same position? Write your answer in the form of a prediction: "If a wave hits a floating object, then the object will . . ."

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Test Your Prediction

- **Experiment** Fill the pan with water to a depth of about 2.5 cm. Place the cork in the middle of the pan, and wait until the cork stops moving.

- **Observe** Gently move the pan back and forth once or twice, so that a series of waves moves across the pan. Observe and record the motion of the cork.

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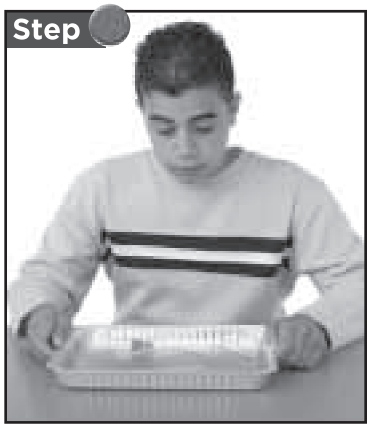

- When the waves stop and the cork stops moving, what is the cork's final position compared to where it started in the middle of the pan?

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- **Experiment** Try moving the pan from side to side. How does this change the waves? How does this affect the cork's motion? Move the pan a little harder. What happens to the cork?

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Draw Conclusions

- **Interpret Data** Would this type of wave move an object through a distance? Explain.

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Name _______________ Date _______________

Explore More

Try using more or less water or using a container with a different shape. How will these changes influence how a wave moves an object? Test your prediction, and share the results with your class.

Open Inquiry

Think of your own question about how waves affect the motion of objects.

- ▶ My question is:

- ▶ How I can test it:

- ▶ My results are:

Name ________________________ Date ____________

How does a wave move an object?

Materials

- tape
- 2 cm by 4 cm strip of paper
- 75 cm length of string

- Tape a paper strip in a loop, and place the loop around a string about midway along its length. Hold one end of the string, and have a partner hold the other end, stretching the string gently to keep it straight.

- **Predict** What will happen to the paper loop if a wave moves along the string?

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- **Experiment** Move your hand gently up and down so that a wave moves along the string. Observe what happens.

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- **Interpret Data** Would this type of wave move an object through a distance? Explain.

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- **Infer** Would you expect a similar result if you put the paper loop in a container filled with water and moved the container to make waves? Explain.

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Quick Lab

Name ______________________ Date ____________

String Telephone

Materials

- 2 paper cups
- 10 m string
- sharp pencil
- wax

Make a Model Obtain two paper cups and about 10 m of string. Make a small hole in the bottom of each cup. Thread one end of the string through each hole. Tie a knot in each end of the string so the ends cannot slip through the holes.

Experiment Try your model with a partner. Each partner should take one of the cups. Move far enough apart that the string is taut between the two of you.

Observe Take turns speaking softly into the cup as your partner listens. How well are you able to communicate?

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Use Variables Coat the string with wax. Does doing this improve your ability to communicate using this device?

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Predict What other variables could you test that might make your string telephone more effective?

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Name ______________________________ Date ____________

Experiment

Materials

- heavy rubber band

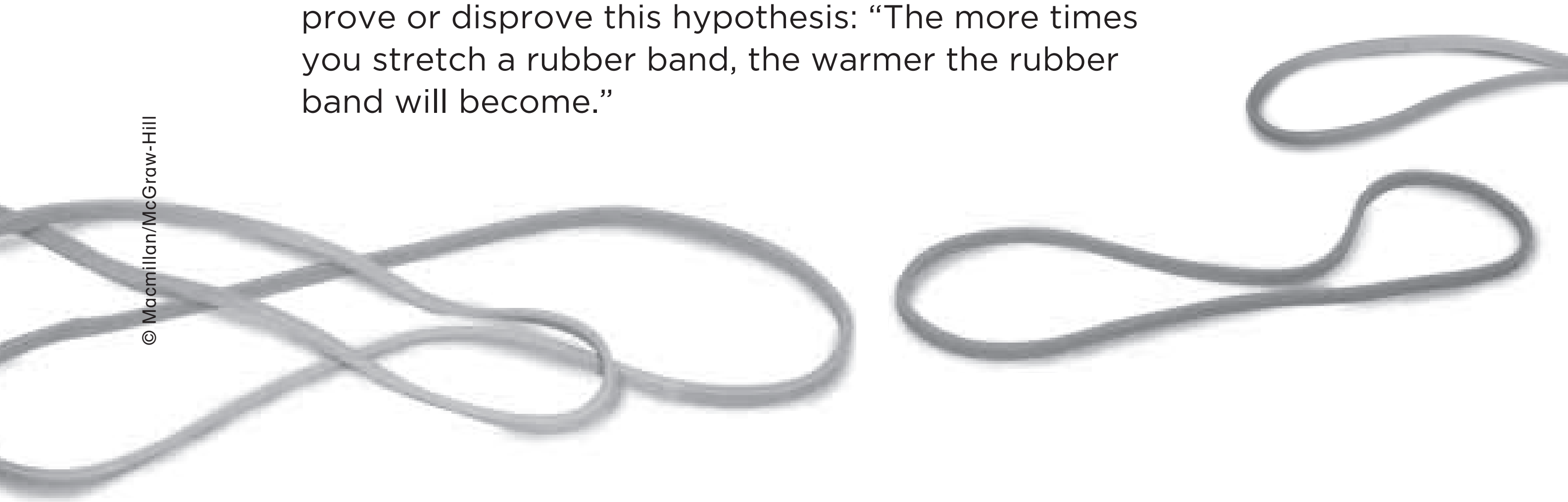
Scientists **experiment** by performing procedures under controlled conditions that help them test a hypothesis, discover an unknown effect, or illustrate a known effect or scientific law.

Sometimes an experiment does not produce the expected result. Does this mean the experiment was a failure? No. It just means that now you have new data to lead you to more experiments to find out why you got the results you did. Who knows—you may come up with results that change everyone's thinking about a hypothesis.

▶ Learn It

When you **experiment** you perform a test to support or disprove a hypothesis. To carry out a successful experiment, you need to plan and perform a procedure, make observations, and record data. It is usually easier to record data on a chart or graph. That way you can see differences at a glance. Once you have enough information, you can draw a conclusion about whether or not the hypothesis has been proved. Of course, the more information you have, the more accurate your conclusion will be.

In the following experiment, you will gather data to prove or disprove this hypothesis: "The more times you stretch a rubber band, the warmer the rubber band will become."



Name ______________________________ Date ____________

Try It

- Link a thumb through each end of a heavy rubber band. Without stretching it, hold it to your forehead. Does the rubber band feel warm, cool, or the same as your skin? Record your results on the chart below. Hold the rubber band away from your face, and quickly stretch it as far as you can. Hold it steady, and touch it to your forehead. Does it feel warmer, cooler, or the same as before? Record the results.

- Continue to **experiment** by holding the rubber band away from your face again. Relax the rubber band, and then hold it to your forehead. Record how the rubber band feels. Repeat stretching the rubber band and touching it to your forehead, then relaxing it and touching it to your forehead, two times. Record the results. Try stretching the rubber band four times before touching it to your forehead to see whether there is a change in the amount of heat energy that builds up. Record the results.

Trial Number	Rubber Band Position	Result
1	Relaxed	
	Stretched	
2	Relaxed	
	Stretched	
3	Relaxed	
	Stretched	
4	Relaxed	
	Stretched 2 times	
5	Relaxed	
	Stretched 4 times	

Apply It

- Now analyze the results of your experiment. Do they prove or disprove the hypothesis? From your results, can you draw a conclusion about why the stretched rubber band felt warmer than, cooler than, or the same temperature as your skin? If the rubber band felt warmer or cooler after stretching, does that mean that the rubber band itself had more or less heat energy after stretching than it did before?

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- Can you predict what would happen if you used a thinner rubber band? A thicker one? **Experiment** to test one of your predictions. Then share the results with the rest of your class.

Name ______________________ Date ____________

Experiment to test your remaining predictions from step 2. Test any additional variables you may wish to try. Record your data in the chart below.

Variable	Rubber Band Position	Result
	Relaxed	
	Stretched	
	Relaxed	
	Stretched	
	Relaxed	
	Stretched	
	Relaxed	
	Stretched	
	Relaxed	
	Stretched	
	Relaxed	
	Stretched	

Name ______________________ Date ______________

Explore

How does light move away from its source?

Make a Prediction

On what kind of path does a light beam travel? How many mirrors are needed to bend a light beam around an obstacle? Write your answer in the form "To bend a light beam around an obstacle, it will take . . ."

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Test Your Prediction

Make a Model Trace the outline of a flashlight's face on a piece of construction paper. Cut out the shape, and make a small hole in the center. Tape the cutout over the face of the flashlight. Fold a second sheet of construction paper in half. Set it in a lump of clay at one end of a meterstick, as a target. Darken the room.

Observe Hold the flashlight at the other end of the meterstick. Aim the beam at the target. Blow powder into the beam to make it more visible. Compare the beam's path to the meterstick. What is the shape of the light beam's path?

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Materials

- pen
- flashlight
- 3 pieces of construction paper
- scissors
  Be Careful.
- tape
- modeling clay
- meterstick
- talcum powder
- 2 mirrors

Step

 Name ______________ Date ______________

Experiment Block the beam of light from reaching the target. Fold a piece of construction paper in half. Set it in a piece of modeling clay, and attach the clay to the middle of the meterstick. Can you bend the light beam to reach the target with mirrors while keeping the flashlight steady? Are one or two mirrors needed to get the beam to the target?

Step

Draw Conclusions

Interpret Data Could you make a light beam follow a curved path? How could you change a light beam's path?

Name ______________________ Date ____________ **Explore**

Explore More

What if you wanted the light beam to hit the back of the target? How many mirrors would you need? Design an experiment to test your prediction.

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Open Inquiry

Think of your own question about other ways a mirror's ability to bend light can be useful.

▶ My question is:

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▶ How I can test it:

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▶ My results are:

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Name ______________________ Date ____________

Can you trace the pattern of a shadow?

Materials

- tape
- black construction paper
- lamp with open bulb
- plastic cup
- yellow marker
- scissors
  Be Careful.

- Tape a piece of black construction paper to a wall. Place a lamp 2 m away from the wall, and turn it on.
- Have a partner stand in front of the paper with his or her shoulder touching the wall. Use a plastic cup to keep his or her head still by placing it between the wall and head.
- **Experiment** Use the yellow marker to trace the shadow made by your classmate's head. Remove the paper from the wall, and use scissors to cut out the silhouette.
- **Draw Conclusions** How would you explain the shadow on the paper?

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- **Infer** Based on this experiment, what can you determine about the properties of light rays?

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- **Use Variables** Repeat the experiment by moving the lamp away from the wall at regular intervals. Explain what happens to the shadow of your partner's head.

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Name ______________________ Date ____________

Quick Lab

Investigating Light

Materials

- pin
- 3 index cards
- tape
- flashlight
- ruler

- Make a small hole in the center of each of three index cards. Tape the cards upright in a row on a flat surface. Be sure that the holes are aligned.

- **Observe** Place a flashlight behind the last card, and turn the flashlight on. Stand in front of the first card so that your eyes are level with its hole. Record your observations.

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- **Observe** Move the middle card 3 cm to the left. Return to your position in front of the first card. Record what you observe.

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- **Interpret Data** Compare your observations. Were they the same? Different? Explain.

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- **Infer** What caused the difference, if any, noted above?

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Explore

Name ______________________ Date ____________

What makes up white light?

Materials

- glass prism
- white paper

Make a Prediction

You can use a specially-shaped piece of glass or plastic called a prism to make a rainbow out of sunlight. What colors will you see? What order will they be in? Write your answer in the form of a prediction: "The colors formed by a prism will be . . ."

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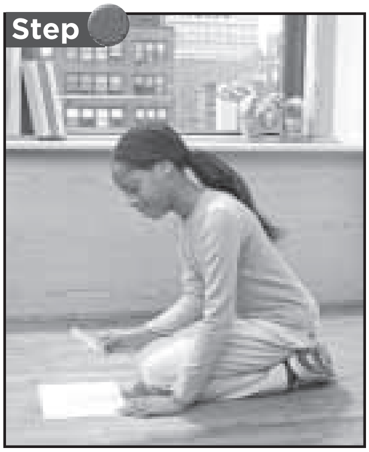
Test Your Prediction



- **Experiment** Place the glass prism on an elevated, flat surface that receives direct sunlight.
- **Record Data** Hold the white paper in front of the prism. Move the prism slowly at different angles and in different locations until you see bands of colored light on the paper. Make a sketch of your observations, labeling the colors that you observe.

Name ________________________ Date ______________ **Explore**

- **Sequence** What is the order of the colors, beginning with red?

Draw Conclusions

- **Interpret Data** What color light entered the prism? What did the prism do to the sunlight?

- **Communicate** Compare your color-sequence data from step 3 with the data of others in your class. What do you notice?

- **Infer** Do you think that you can change the order of the colors by turning the prism? Try it, and then compare your results with others in your class.

 Name ______________________ Date ____________

Explore More

Would using a blue light source change your data? Make a prediction and then design an experiment to test it.

Open Inquiry

Think of your own question about the refraction of light from other sources.

- ▶ My question is:

- ▶ How I can test it:

- ▶ My results are:

Name ______________________ Date __________

What colors make up white?

Materials
• compass
• ruler
• white paper
• scissors ⚠ **Be Careful.**
• crayons
• pencil
• foam cup

- **Make a Model** Use a compass to make a circle with a diameter of about 15 cm on a piece of white paper. Cut the circle from the paper.
- **Make a Model** Divide the circle into six even sections. Make a color wheel by coloring each section with one of the following colors: red, orange, yellow, green, blue, and violet. Start with red, and color clockwise. You should wind up with the violet section right next to the red section.
- Use a pencil to make a hole in the center of the foam cup. Now push the pencil through the center of the color wheel, and put the pencil into the hole in the cup.
- **Experiment** Spin the color wheel quickly. What did you observe?

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- **Draw Conclusions** How would you explain what you observed while the wheel was spinning?

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Quick Lab

Name ______________________ Date ____________

Colors from Light

Materials

- tape
- cellophane of different colors (including red, green, yellow, and blue)
- flashlight
- different-colored objects

1. **Predict** What color will different-colored objects become if lighted with red light? Blue? Green?

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2. **Observe** Tape a piece of red cellophane to a flashlight. Darken the room, and shine the red light on objects of different colors. Observe how the red light changes the appearance of each object.

3. **Use Variables** Repeat step 2 using cellophane of other colors, such as blue, green, and yellow. Shine the different colors of light on the same group of objects. Record your findings in a data table.

4. **Predict** What will happen if you place two or more colors of cellophane on the flashlight at once? Test your prediction.

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5. **Interpret Data** How many different colors of light can you make? How do these colors interact with objects of various colors?

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Name ______________________________ Date ______________

Explore

How can you measure heat flow?

Make a Prediction
Does heat energy move between warm and cool objects? What will happen if a jar of water is placed in a bowl of water at a different temperature? Write your answer in the form of a prediction: "If a jar of warm water is placed in a bowl of room-temperature water, then . . . If a jar of cool water is placed in a bowl of room-temperature water, then . . ."

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Materials

- 2 jars
- water
- 4 thermometers
- 2 large bowls
- watch or stopwatch

Test Your Prediction

1. Fill one jar with water at 30°C. Fill a second jar with water at 10°C.

2. **Measure** Place each jar in a separate bowl of room-temperature water between 22°C and 24°C. Record the starting temperatures of the water in the bowls and jars in the chart below.

Time	Temperatures				Time	Temperatures			
	Bowl 1	Jar 1	Bowl 2	Jar 2		Bowl 1	Jar 1	Bowl 2	Jar 2
Start					12 min				
2 min					14 min				
4 min					16 min				
6 min					18 min				
8 min					20 min				
10 min					50 min				

 Name ______________________ Date ____________

Experiment Record the temperatures of the four containers every 2 minutes for 20 minutes. What differences in the temperatures do you notice? Record your observations. When do you think the temperatures will stop changing? Thirty minutes after your last observation, check the thermometers again, and record the temperatures in the chart on the previous page.

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Draw Conclusions

Interpret Data Make a line graph that shows how the temperature of the water in each jar and each bowl changed over time. What happened to the temperature in the jar with warm water? How did the heat flow? How could you explain what you observed?

Explore More

What would happen if you placed a jar of warm water in a bowl of ice water? What would the graph of temperature and time look like? Make a prediction and test it. Present your results.

Open Inquiry

Think of your own question about variables that affect heat flow.

- My question is:
- How I can test it:
- My results are:

Name ______________________ Date ____________

How can you observe heat flow?

Materials

- 2 empty soda cans
- very warm water
- cold water
- 2 thermometers
- plastic bowl

Record Data Fill one empty soda can with very warm water. Fill the other with cold water. Place a thermometer in each can. After 1 minute record the temperature of the water in each can. Record your data in the table below.

Record Data Remove the thermometers from each can. Carefully pour the water from each can into the plastic bowl. Wait 1 minute. With the thermometer that you used in the can with the cold water, measure the temperature of the mixed water in the plastic bowl. Record your data in the table below.

Sample	Temperature
cold water	
warm water	
mixed water	

Compare How does the temperature of the mixed water compare to the temperatures of the cold and warm water? Explain.

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Name ______________________ Date ______________ **Quick Lab**

Heat From Friction

Materials
• thermometer

Form a Hypothesis Can friction from rubbing your hands together generate enough heat to raise the temperature of your hands? Record your prediction.

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Measure Hold a thermometer in one hand so that your hand completely covers the bulb. Record the temperature after the liquid stops moving.

Experiment Remove the thermometer, and rub your hands together vigorously for about a minute. Repeat step 2.

Initial Temperature	
Temperature After Rubbing Hands	

Interpret Data Did the temperature of your hand change? How might you explain this?

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Infer Relate the change in temperature to the molecules of your hand. Did the average kinetic energy of these molecules change?

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Explore

Name ______________________ Date ____________

What happens to charged objects that are brought together?

Materials

- clear tape

Make a Prediction

What happens when a balloon is rubbed with cloth and then brought near your hair? The balloon seems to have a type of energy that can make other objects move closer or farther away. This is called a charge. Can pieces of clear tape show similar effects when brought together? Write your answer in the form of a prediction: "If clear tape can hold a charge, then the pieces of tape will . . ."

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Test Your Prediction

- **Experiment** Press two pieces of clear tape tightly to your desk, folding over one side of each piece to make a small tab. Pull the strips of tape off the desk, and hold the ends of the tape close together. Observe what happens.

- **Experiment** Tightly press two new strips of tape to your desk, but this time, stick one of the pieces on top of the other. Pull both strips off the desk, and then pull them apart. Hold the ends of the tape close together, and observe what happens.

- **Record Data** What happened in step 1 when you brought the ends of the tape near each other? What happened in step 2 when you brought the ends of the tape near each other?

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Name ______________________ Date ____________ **Explore**

Draw Conclusions

- **Interpret Data** What seems to have caused the difference between step 1 and step 2?

- **Compare** What other substances have you observed interacting in a similar manner?

- **Infer** What do you think pulling the strips of tape off the desk may have done to them?

Explore More

Is there something that you can do or apply to the pieces of tape that will prevent this from happening? Make a prediction, test it, and share your results with others in your class.

Explore

Name ______________________ Date ____________

Open Inquiry

Think of your own question about the charges of different materials.

▶ My question is:

▶ How I can test it:

▶ My results are:

What happens when a balloon has an electric charge?

Materials

- 2 balloons
- woolen cloth
- long string

Experiment Inflate a balloon. Rub it briskly with a woolen cloth, and place it next to your cheek. Describe what happens.

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Inflate another balloon. Tie one end of a string to this balloon. Tie the other end of the string to the first balloon you inflated.

Experiment What happens if you rub each of the balloons briskly with the woolen cloth, then try to make them touch one another? What causes the reaction of the balloons?

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Infer How would you explain how the first balloon interacted with your cheek compared to how it interacted with the second balloon?

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Quick Lab

Name ____________________ Date ____________

Make Your Own Compass

Materials
• needle
• bar magnet
• slice of cork
• cup of water

- Rub a bar magnet many times in one direction over a needle. Place the needle on a thin slice of cork that is floating in water.

- **Experiment** Place the south end of the bar magnet near the needle, and observe what happens.

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- **Infer** Which end of the needle points to Earth's North Magnetic Pole? How can you verify this?

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Name ______________________ Date ____________

Structured Inquiry

How can you make an electromagnet stronger?

Form a Hypothesis

Electromagnets work by using electric current to magnetize a metal object. Wire is wrapped around a metal object and then hooked to a source of electrical energy. The current in the wire causes the metal object to become magnetized. Electromagnets can be found in stereo speakers, doorbells, and many other household objects. How can you make an electromagnet stronger? Will an increase in electrical energy cause an increase in magnetism? Write your answer in the form of a hypothesis: "If the number of batteries in an electromagnet is increased, then the strength of the electromagnet will . . ."

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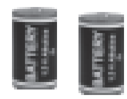
Materials

- wire-cutting and wire-stripping tool
- measuring tape 
- insulated wire 
- large nail
- 2 battery clips 
- 2 D cell batteries 
- paper clips 

Test Your Hypothesis

1. **Measure** Use a wire-cutting and wire-stripping tool to cut a 30 cm piece of insulated wire. Strip about 2 cm of plastic insulation off the ends of the wire. ⚠ **Be Careful.**

2. Tightly and neatly wrap the wire around a large nail. Draw a picture of the setup on a piece of paper.

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Name ______________________ Date ____________

Experiment Connect the ends of the wire to the battery clip. Pick up the nail. Be careful not to disconnect the battery. Hold the nail near some loose paper clips, see how many paper clips the nail will pick up and hold. Record this number on your paper. Disconnect the wires from the battery.

Step

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Use Variables Use a second battery clip to connect two batteries in a series. Then repeat step 3.

Step

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Draw Conclusions

Interpret Data How did adding a second battery affect the strength of your electromagnet? How do you know?

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Form a Hypothesis In what other ways might you make your electromagnet stronger, without changing the number of batteries?

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Name ________________________ Date ____________

Guided Inquiry

What other variables can be changed to make an electromagnet stronger?

Form a Hypothesis

How else can you increase the strength of your electromagnet? Will adding more wire coils improve its strength? Write your answer in the form of a hypothesis: "If more wire coils are added to an electromagnet, then the strength of the magnet will . . ."

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Test Your Hypothesis

Design an experiment to determine how additional wire coils will affect the electromagnet. Write out the materials you will need and the steps you will follow. Record your results and observations.

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Draw Conclusions

Did your results support your hypothesis? Why or why not? How did you achieve your best results? Present your electromagnet design to your classmates.

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Name ______________________ Date ____________

Open Inquiry

What more can you learn about electromagnets? For example, what happens when other materials are used in place of a nail? Design an experiment to answer your question. Write your experiment so that another group could complete the experiment by following your instructions.

Remember to follow the steps of the scientific process.

▶ My question is:

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▶ My hypothesis is:

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▶ How can I test it:

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▶ My conclusions are:

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Name ______________________________ Date ____________

Growing Bacteria

Bacteria are everywhere. They are found in the foods you eat, in the places where you study and play, and inside your body. Many bacteria are good for you, but there are also bacteria that can cause illnesses. Most food poisoning is caused by bacteria. Bacteria can also cause cavities, strep throat, and ear infections. Many of these illnesses can be cured by taking an antibiotic. Antibiotics kill the bacteria that cause many kinds of disease.

Materials

- sterile plastic petri dish
- sliced beets
- permanent marker
- plastic forceps
- antibiotic cream
- cotton swabs
- tape

Purpose

Your task is to grow bacteria on a beet slice, one half of which has antibiotic on it.

Form a Hypothesis

How would you grow bacteria on a beet slice? What will happen to the beet? Write your answer as a hypothesis in the form *"If an antibiotic is placed on half of the beet slice, then . . ."*

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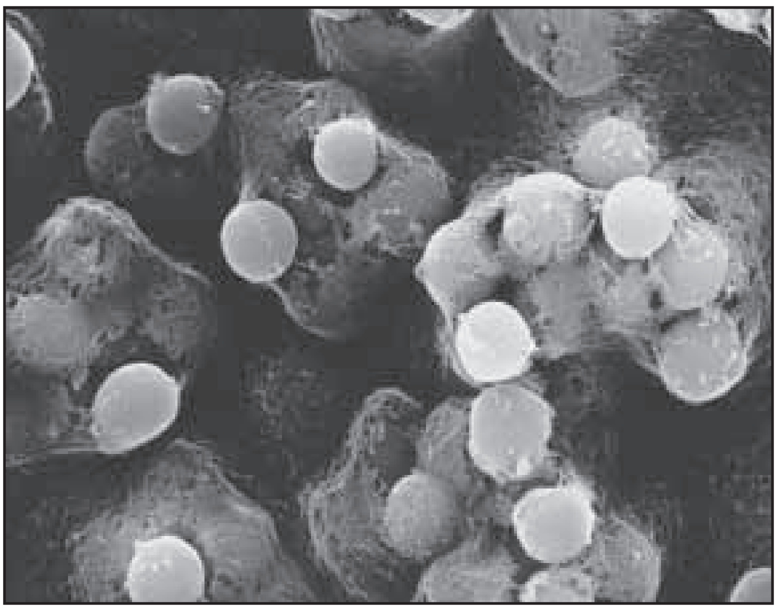

The bacteria Streptococcus pyogenes, magnified 2,000 times in this photo, causes strep throat and scarlet fever.

 Name ______________________ Date __________

Test Your Hypothesis

- Turn the petri dish upside down, and use a marker to divide the dish in half. Label the sides A and B.
- Use the forceps to pick up the beet slice. Slightly lift the lid of the petri dish with your other hand and place the beet slice in the center of the dish. Replace the cover.

- Rub a cotton swab over the fingers of one hand, slightly lift the cover of the petri dish, and gently rub the swab over the surface of the beet slice. Make sure that you touch the entire surface of the beet slice.
- Use another cotton swab to add antibiotic cream to the half of the beet slice on side B of the dish.

- Replace the cover, and tape the lid to the dish.
- Place the petri dish where it will not be disturbed.
- **Observe** Count colonies of bacteria and check for their growth every day for 4 days. What happens to the beet slice? Do you see any pattern in the growth?

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Draw Conclusions

- Based on your results, what is your conclusion?

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Critical Thinking

- Why are refrigerators and freezers used to store food for long periods of time?

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- What is antibiotic cream useful for?

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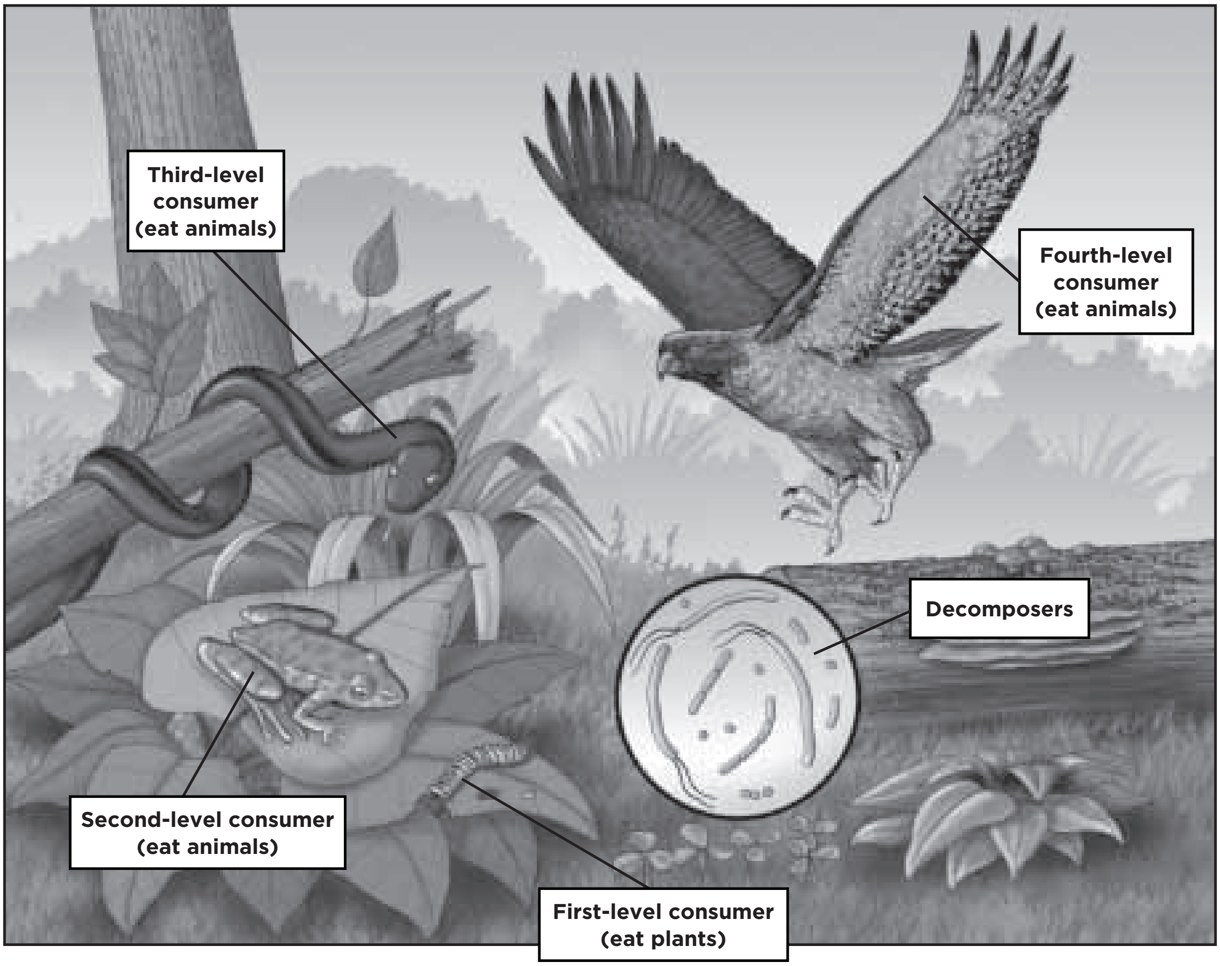
Name ______________________ Date __________

Carnivore Investigation

Food chains and food webs show how energy is passed from one living thing to the next. At the bottom of the food chain are plants, because they make their own energy using the Sun. Herbivores (animals that eat plants) are the next group in the food chain, or first-level consumers. Then come carnivores (meat eaters) and omnivores (meat and plant eaters), or second-, third-, and fourth-level consumers. When an animal at the top of the food chain dies, it is broken down by decomposers. Decomposers are small organisms that break dead plants and animals down into very small pieces that are then returned to the soil and used as nutrients by plants. Every living thing gets recycled in this way.



Name ______________________________ Date ____________

Everyday Science

Materials

- black construction paper
- sterilized owl pellet
- toothpicks
- plastic bowl with bleach solution and plastic cup
- piece of screen
- plastic forceps
- bone-sorting chart
- rodent-skeleton diagram

Purpose

Your task is to conduct an experiment that will determine whether an owl is a carnivore.

Form a Hypothesis

How can you use an owl pellet (undigested material that an owl regurgitates) to determine whether an owl is a carnivore? Write your answer as a hypothesis in the form *"If the pellet contains* _________, *then the owl is a carnivore."*

____

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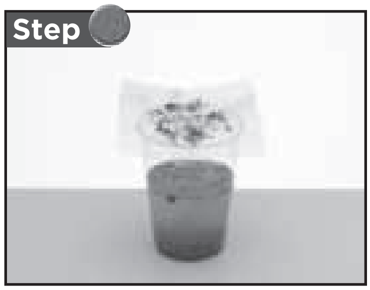
Test Your Hypothesis

- Cover a workspace with newspaper, unwrap the owl pellet, and place it on a piece of black construction paper.
- Using toothpicks, carefully take the owl pellet apart, and look for bones. (The bones are very fragile and need to be removed gently to avoid breaking.)

Name ______________________ Date ____________

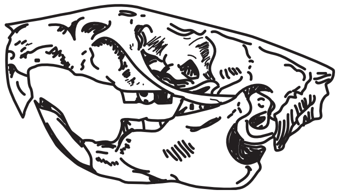
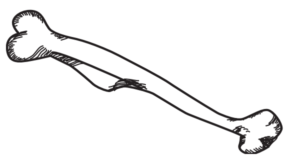
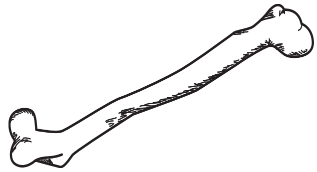
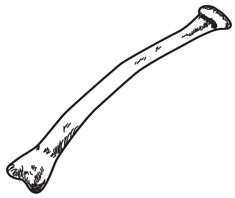
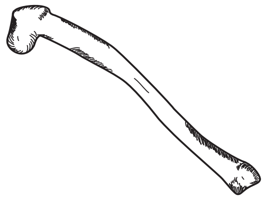
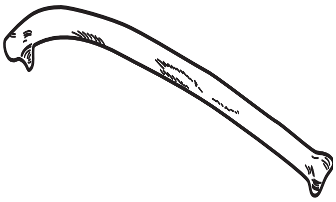
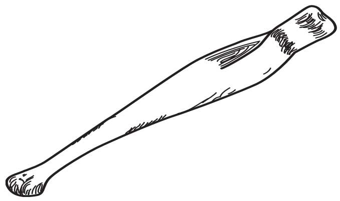
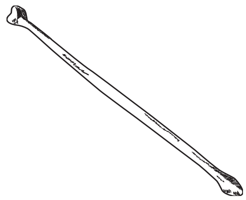
- Once you have removed any bones, put them in the bowl of bleach solution for about 5 minutes or until the bones are thoroughly cleaned and whitened.
- Put the screen over the top of a plastic cup, and gently pour the solution through the screen. You will now have any bones on the screen. Gently remove the bones with the plastic forceps, and put them on a paper towel to dry.



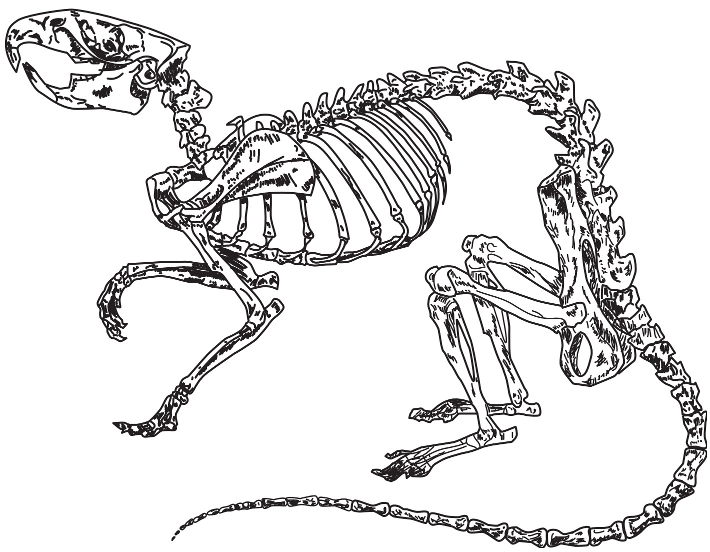
- Sort the bones, using the bone-sorting chart on the next page.
- Glue the appropriate bones on the rodent-skeleton diagram on the next page.

Name ________________________________ Date ____________

Bone-Sorting Chart

 skull	 humerus	 femur
 vertebra	 radius	 tibia
 rib	 ulna	 fibula

Rodent-Skeleton Diagram



 Name ______________________ Date __________

Draw Conclusions

- **Observe** What did you observe?

- Based on your results, what is your conclusion? Is the owl a carnivore? Why? What evidence leads you to your conclusion?

Critical Thinking

- Why is it important to protect owls and their habitats?

- What would happen if all the owls in a large farming area died?

Electricity from the Sun

A solar panel is made up of photovoltaic cells. These cells work together to convert sunlight (*photo-*) into electricity (*-voltaic*). Photovoltaic cells are commonly made of silicon. When silicon is exposed to sunlight, its electrons start flowing. The flowing of electrons is called an electric current. The current from the silicon of the photovoltaic cells is directed toward the metal wires attached to the solar panel. In this way the energy of the Sun is converted into electricity. Electricity will continue to be generated by the solar panel's cells as long as sunlight is available.

Purpose

Your task is to show that a solar panel can produce electricity.

Form a Hypothesis

How can you use a small, homemade motor to prove that a solar panel produces an electric current? Write your answer as a hypothesis in the form *"If a solar panel produces an electric current and I connect it to a motor, then the motor will . . ."*

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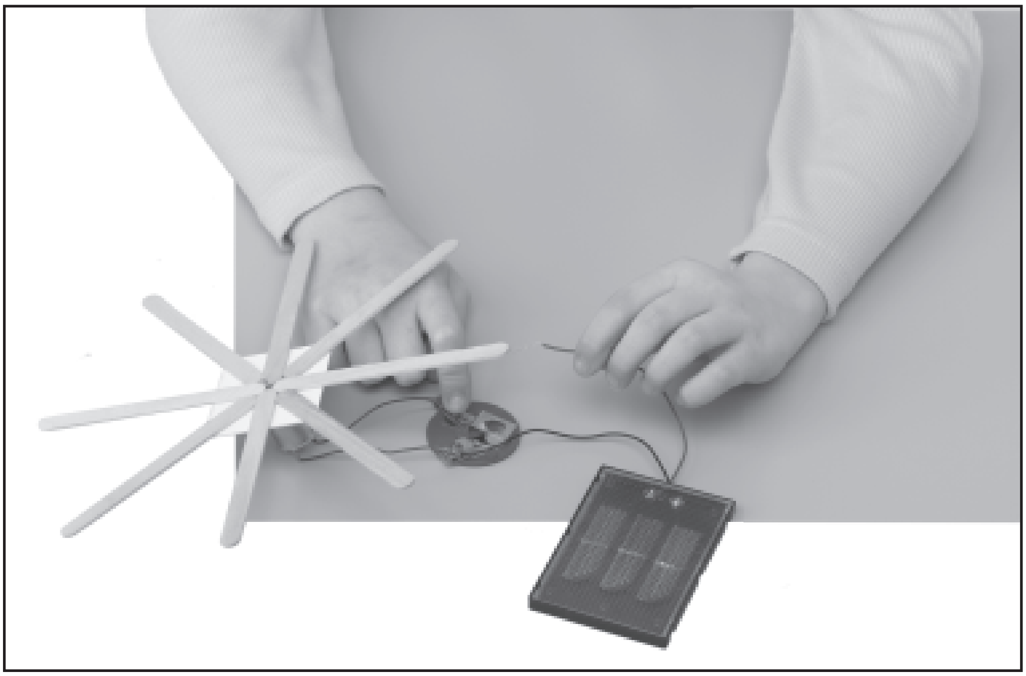
Name ____________________ Date __________

Test Your Hypothesis

- Use craft sticks to make a structure such as a windmill, a Ferris wheel, a helicopter, or a merry-go-round.
- Attach the moving parts of your structure (such as windmill blades or helicopter blades) to the motor with the glue or tape.
- Attach the wires from the solar panel to the leads on the motor.
- Place the solar panel in sunlight or under a very bright light.
- Observe what happens.

Materials

- 50–100 craft sticks
- small solar panel
- small motor
- glue or double-stick tape



Name ______________________ Date ____________

Draw Conclusions

- What did you observe?

- Based on your results, what is your conclusion?

Critical Thinking

- How can you stop the motor from running without moving your structure?

- Do you think that solar panels could work in very cold climates?

Name ______________________ Date ____________

Rocks That Float, Rocks That Sink

When a volcano erupts, hot molten lava can be thrown into the air or can flow from fissures and cracks and flow over Earth's surface. When the lava cools and hardens, it forms igneous rocks. These rocks are called *extrusive* igneous rocks, because they form by cooling and hardening on Earth's surface. *Intrusive* igneous rocks are formed deep within Earth. They are often exposed by an earthquake or other natural event.

Purpose

Your task is to design an experiment that will determine whether pumice, an extrusive igneous rock, will sink or float when put in water.

Form a Hypothesis

Examine the pumice. What do you think will happen if you put a piece of pumice in a bowl of water? Will it sink or float? What would happen if you did this with other rocks? State your hypothesis in the form *"If I place a piece of pumice in water, then the pumice will . . ."*

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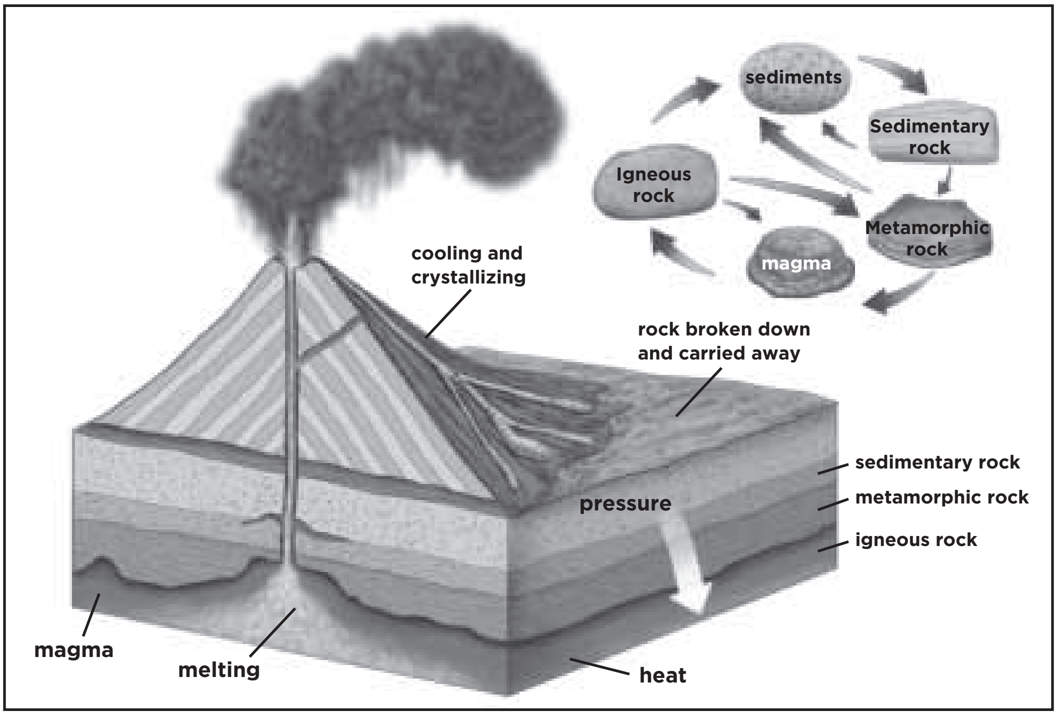

Name ______________________ Date ____________

Test Your Hypothesis

- Fill your bowl with water.
- Place a piece of pumice in the water.

Materials

- piece of pumice
- bowl
- water

Draw Conclusions

- What did you observe?

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- Based on your results, what is your conclusion?

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Name ______________________ Date __________

Critical Thinking

- Why do you think the surface of pumice is full of holes or pores? How does this affect its buoyancy?

- Feel the surface of the pumice. Why do you think pumice is added to some soaps?

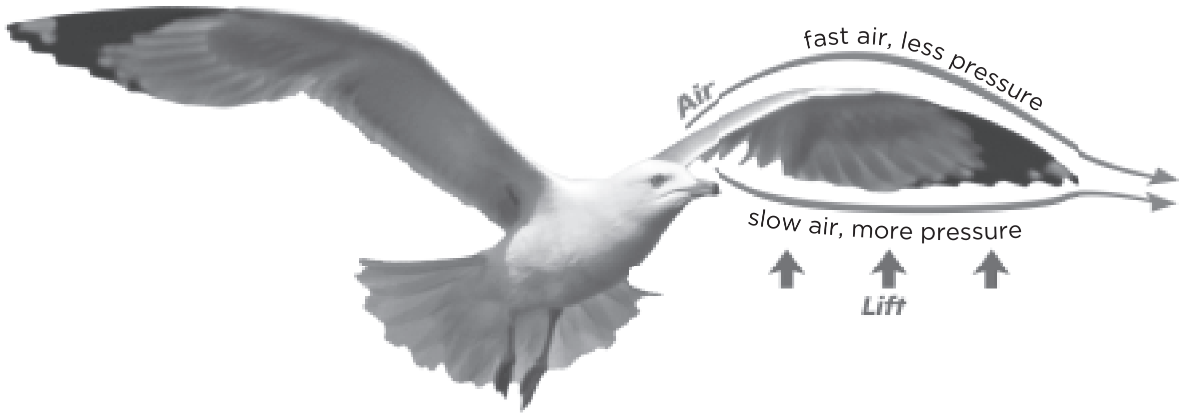
Name ______________________________ Date ____________ Everyday Science

The Pressure Is On

Though we are not aware of it, air pressure is pushing on us from every direction all the time. Usually we are only aware of sudden changes in air pressure—for example, when our ears pop in an airplane or when traveling to high altitudes in a car or bus. Air pressure and changes in air pressure have far-reaching effects on our environment. Changes in air pressure even affect the weather, as when air moving from a high-pressure area to a low-pressure area creates wind.

Purpose

Your task is to design an experiment that will prove or disprove Bernoulli's principle: If the movement of a fluid increases in speed, the pressure, or force, of that fluid pushing against an object will decrease. (Fluids include both liquids and gases.)



Name ______________________ Date ____________

Form a Hypothesis

How can you use a simple strip of paper to prove Bernoulli's principle? Write your answer as a hypothesis in the form *"If I take a strip of paper and blow hard over the top of it, then . . ."*

Materials

- strip of paper 15 cm long and 1 cm wide

Test Your Hypothesis

- Hold one end of the strip of paper just below your lower lip.
- Blow hard over the top of the paper.

Draw Conclusions

- What did you observe?

- Based on your results, what is your conclusion?

Name ______________________ Date ____________

Critical Thinking

- How does Bernoulli's principle apply to an airplane taking off?

- Why does low air pressure mean bad weather?

Name ______________________________ Date ____________

Sponges from Oil

Polymers are formed when many molecules are linked together. Some polymers, such as plastic, are created from petroleum. Petroleum, or crude oil, is a black liquid pumped out of the ground. Superabsorbent polymers can be made from a by-product of petroleum refining. These polymers attract water and are linked in such a way that there are many "pockets" within the linkages that hold water molecules.

Materials

- ultrathin diapers
- plastic cups
- small garbage bag with twist tie
- scissors

Purpose

Your task is to design an experiment that will show how superabsorbent polymers work.

Use with **Activity Flipchart page 83**

Name ______________________ Date ____________

Form a Hypothesis

How can you use water and disposable baby diapers to demonstrate how superabsorbent polymers work? Write your answer as a hypothesis in the form *"If disposable diapers work because they contain superabsorbent polymers, then these polymers will . . ."*

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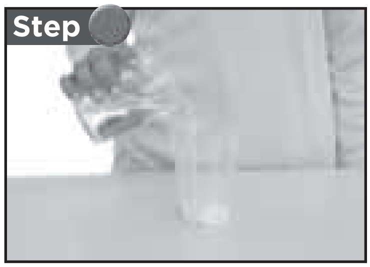
Test Your Hypothesis

- Cut open a diaper, and put the cottonlike filling into the garbage bag.
- Feel inside the bag, and note that the filling feels gritty.
- Close the bag with the twist tie.
- By manipulating the closed bag, tear the filling into small pieces.

Name ________________________ Date ____________

- Rub the filling between your fingers (still holding the bag closed).
- Shake the bag.
- Open the bag, and see whether there is powder at the bottom of the bag. If the filling still feels gritty and there is not enough powder, repeat steps 3–6.
- Once enough powder has been collected, remove the filling from the bag and pour the powder into a plastic cup.
- Fill a second cup with water.
- Pour the water from the second cup into the cup with the powder.
- Pour the mixture from one cup into the other several times.



Name ______________________ Date ______________

Draw Conclusions

- What did you observe?

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____
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- Based on your results, what is your conclusion?

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Critical Thinking

- What is the advantage of putting superabsorbent polymers in diapers?

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____
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- Why do you think farmers use superabsorbent polymers in the soil?

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 Name ______________________ Date __________

Potential to Kinetic Energy

Potential energy is energy stored in an object. Kinetic energy is the energy of motion. Fuel such as wood, oil, and gas contains potential energy. When fuel is burned, heat is released. This heat is used to do work such as moving a car or heating a stove. Chemical reactions also involve the conversion of potential energy to kinetic energy. For example, food contains chemical bonds that contain potential energy. Digestive enzymes break down these bonds and release the potential energy. This energy is eventually converted to kinetic energy—energy used for activities such as running, jumping, and breathing.

Purpose

Your task is to devise an experiment that converts potential energy to kinetic energy, using an effervescent tablet as a test material.

Name ______________________ Date ____________

Form a Hypothesis

How can you use an effervescent tablet and water to demonstrate how potential energy is converted to kinetic energy? Write your answer as a hypothesis in the form *"If an effervescent tablet is added to water in a film canister and the top is put on the film canister, then the canister will . . ."*

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Materials

- safety goggles
- effervescent tablet
- a film canister with a snap-on lid (a lid that snaps inside the canister, not outside)
- water

Test Your Hypothesis

This experiment must be done outdoors.

- Put on your safety goggles.
- Fill the film canister half full with water.
- Put an effervescent tablet in the water. Immediately snap the top on the canister.
- Hold two fingers on the top and your thumb on the bottom of the canister to prevent the cap from coming off.
- Shake the canister briskly, and walk to a clear spot, away from people. **(Hold the canister away from your body and face.)**

Name ______________________ Date ____________

- Put the canister cap-down on a hard surface on the ground. **Move back.**

Draw Conclusions

- What did you observe?

- Based on your results, what is your conclusion?

Name ______________________ Date __________

Everyday Science

Critical Thinking

- How is the launch of a space shuttle similar to your effervescent-tablet "rocket"?

- Why does the space shuttle not fly to the Moon?

Name ______________________ Date __________

The Light We Cannot See

The electromagnetic spectrum is made up of electromagnetic radiation of different wavelengths. These include radio waves, microwaves, infrared rays, visible light, ultraviolet (UV) light, X rays, and gamma rays. Humans cannot see ultraviolet light, but some animals can. Exposing skin to ultraviolet light without using sunscreen can damage the skin.

Purpose

Your task is to design an experiment using UV beads that will determine how to protect yourself from damaging ultraviolet light. UV beads are special beads that contain a pigment that changes color when exposed to ultraviolet light from the Sun.

skin cancer lesion

Use with **Activity Flipchart page 85**

Name ______________________ Date ____________ **Everyday Science**

Form a Hypothesis

How can you determine whether UV-protective lenses block ultraviolet light from the Sun? Write your answer as a hypothesis in the form *"If UV-protective lenses block ultraviolet light from the Sun, then UV beads under such sunglasses in sunlight will . . ."*

Materials

- UV beads
- pair of sunglasses with UV-protective lenses

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Test Your Hypothesis

● Put the UV beads in sunlight, and see if they change color.

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● Take the UV beads out of the sunlight, and see if they change color.

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● Cover the UV beads with the lenses of the sunglasses, and place them in sunlight.

● What color are the UV beads?

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Name ______________________ Date ____________

Draw Conclusions

- What did you observe?

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- Based on your results, what is your conclusion?

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Critical Thinking

- What would happen if you covered the UV beads with sunscreen lotion and then put them in sunlight?

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- The ozone layer around Earth acts like a large layer of sunscreen, protecting the planet from most ultraviolet light coming from the Sun. What do you think would happen to Earth if the ozone layer were damaged or weakened?

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Name ______________________________ Date ____________

How can you build a living ecosystem in a container?

Structured Inquiry

Create a Producer Habitat

Materials

- shoebox-size transparent plastic or glass container
- cover for the container (with holes for air circulation)
- natural loam soil
- water mister
- leaves, twigs, and small stones
- several small plants and seeds

Ask Questions

Can you build a plant habitat in a small container? What will you need to put in it? Where do plants get the food and energy they need to grow? How will your plant habitat grow?

Make a Prediction

Write your answer as a prediction in the form *"If I build a plant habitat in a small container, the habitat will . . ."*

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Name ______________________________ Date ____________

Test Your Prediction

- Place the soil in the container to a depth of 5 centimeters, and use the mister to add water. The soil should be damp but not soaking wet. Place the leaves, twigs, and stones on top of the soil. Plant the plants and seeds in the soil, and cover the container.

- Place your plant habitat where it will get plenty of light but will not get too hot. Make a detailed drawing of the habitat in the space on the next page. Predict what you think it will look like in 2 to 3 weeks. Write your prediction below your drawing.

My Habitat on the First Day

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- **Observe** The next day check your plant habitat, and add water as needed to keep the soil moist. Compare your habitat to the drawing you made on the first day.

- **Record Data** What changes are occurring on top of the soil? What changes are occurring beneath the soil?

Habitat Data Sheet						
	Week 1		Week 2		Week 3	
	Watered Soil	Observations	Watered Soil	Observations	Watered Soil	Observations
M						
T						
W						
TH						
F						
S						
SUN						

Conclusions/observable changes after 3 weeks:

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____

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- Repeat steps 3 and 4 for 2 to 3 weeks. Do the changes support your prediction?

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Name ______________________ Date __________

Communicate Your Results

Have a class discussion, and share your drawings and data. What did you learn? What caused the changes over time in the plant habitat? Use your data to answer these questions:

- How were the needs of the plants in your habitat met? How did the plants get light, water, air, and food?

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- How did the habitat grow and change? What abiotic factors might limit the growth of the plants?

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- What could you do to turn your producer habitat into an ecosystem?

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____

Name ______________________ Date ____________

Learning Lab

Guided Inquiry

Building an Ecosystem

Materials

- plant habitat
- worms, insects and small animals
- cardboard
- tape

Ask Questions

How will the plant habitat change if you introduce worms and other small animals? How will the worms interact with the soil? Will interaction between the producers and the consumers benefit all of the organisms? What constitutes an ecosystem?

Make a Prediction

Write your answer as a prediction in the form *"If I introduce worms, insects and other small animals into the plant habitat, then . . ."*

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Test Your Prediction

- Tape the cardboard in place around three sides of the habitat.
- Gently and carefully add the worms and other small animals to the container. Replace the cover.

Name ______________________ Date __________

- **Observe** Note where each animal goes once it is inside the container.

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- **Observe** The next day check the container, and add water as needed to keep the soil moist.

- **Record Data** Write down the location and activities of each animal. Describe any plant and animal interactions you observe. What changes are occurring on top of the soil? Beneath the soil? Record your data in the chart below.

Habitat Data Sheet						
	Week 1		Week 2		Week 3	
	Watered Soil	Observations	Watered Soil	Observations	Watered Soil	Observations
M						
T						
W						
TH						
F						
S						
SUN						

- Repeat steps 4 and 5 for 2 to 3 weeks. Did the changes you recorded support your prediction?

____

____

Communicate Your Results

Have a class discussion, and share your results with the other students. What did you find out? Use your data to answer these questions.

▶ What changes did the animals cause in the plant habitat over time?

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▶ Were the worms, the soil, the plants, and other animals beneficial to each other? Explain.

____

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____

▶ Did you build an ecosystem? Why or why not?

____

____

____

▶ If you built an ecosystem, identify the producers, consumers, and decomposers. What abiotic factors are important in your ecosystem?

____

____

____

Name ________________________ Date ____________

Open Inquiry

Design Your Own Ecosystem
Invent and test other ways to build an ecosystem. Make a prediction, and design an experiment to test your prediction. Record your data, and communicate your findings.

Make a poster that illustrates what you found out. Here are some ideas to get you started.

- ▶ Use a different kind of soil. How well does a plant habitat work with soil that is sandy or high in clay content? What types of plants will grow in these soils?
- ▶ Use different plants and animals. How do these organisms interact? Do these plants need more water? Less light?
- ▶ Use fish and plants to make a water ecosystem in an aquarium. What types of fish can share this ecosystem? What types of plants provide food for the fish? Can you add decomposers to your ecosystem?
- ▶ My question is:

  ____

  ____

- ▶ My prediction is:

  ____

  ____

- ▶ My experiment is:

  ____

  ____

- ▶ My results are:

  ____

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Name ______________________ Date ____________

How can you model the energy of moving fluids?

Structured Inquiry

Tracking the Movement of Wind

Materials

- 50 centimeters of string
- helium balloon
- 5 to 10 3-inch by 5-inch index cards
- hole punch

Ask Questions

Can a helium balloon be used as a tool for tracking moving air?

Make a Prediction

Write your answer as a prediction in the form *"If the air in a classroom is moving, then a helium balloon will . . ."*

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____

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Test Your Prediction

1. Tie one end of the string to the helium balloon. Punch a hole near the corner of each 3-inch by 5-inch index card, and tie the cards to the other end of the string, one at a time, until the balloon just begins to sink. Tear small pieces off the index cards until the balloon neither rises nor sinks.

Name ______________________ Date __________

- Bring the balloon into a large room where it can float sideways or up and down. Choose a location, and let the balloon hang freely in the air.
- **Observe** Keep your eye on the balloon. As the air in the room moves, the balloon will move with the air.
- **Record Data** In the space below, draw a picture of the room, and show the path the balloon has taken around the room.

Room and Balloon Paths

- The air may be moving in different directions at different speeds in various locations in the room. Choose three more locations in the room, let the balloon hang freely in the air, and repeat steps 3 and 4, showing the path of each balloon in a different color or a different style of line.

Name ______________________ Date ____________ **Learning Lab**

Communicate Your Results

Have a class discussion, and share your drawings. With other students create a map that shows air movement in your classroom. Use your data to answer these questions:

- Is the air in the room moving? How did you reach your conclusion?

  ____

  ____

- If the air in the room is moving, what causes the air to move?

  ____

  ____

- Does a balloon move at different speeds and in different directions at different locations in the room? How can you explain your observations?

  ____

  ____

  ____

  ____

- Did your observations confirm your prediction?

  ____

  ____

  ____

Name ____________________ Date __________

Guided Inquiry

Warm and Cold Water

Ask Questions

How can you use warm and cold water in a container to explain how mixing hot and cold fluids can make the fluids move?

Make a Prediction

Write your answer as a prediction in the form *"If I mix warm and cold water, then the warm water will ________ and the cold water will ________."*

____

____

____

Materials

- 2 empty, 35-millimeter film containers with smooth lids
- hole punch
- clear, 2-liter soda bottle with top 10 centimeters cut off
- room-temperature water
- thermometer
- warm tap water and cold (refrigerated) tap water
- red and blue food coloring
- 2 large beakers or cups

Test Your Prediction

- Use the hole punch to make two holes side by side in each film canister lid.
- Fill the clear soda bottle with room-temperature water to within 5 centimeters of the top. Use the thermometer to determine the temperature of the water, and write it down on the chart on the next page.
- Fill one beaker with warm tap water, and add a few drops of red food coloring. Use the thermometer to determine the temperature of the water, and write it down on the chart.
- Pour the red-colored water into the film container, and secure the lid.

Name ______________________ Date __________ **Learning Lab**

- Gently push the sealed film canister into the room-temperature water in the clear soda bottle to about halfway between the surface and the bottom, then turn the canister sideways.
- **Observe** What happened to the colored water? Where did it go? Record your observations on the chart.
- Repeat steps 2 through 6, substituting refrigerated water for the warm tap water and blue food coloring for red food coloring.

Starting Temperature of Room-Temperature Water: ________	
Red-Colored Water Starting temperature: ________ Observations:	**Blue-Colored Water** Starting temperature: ________ Observations:

Communicate Your Results

Work in groups of four to eight, and discuss your findings.

▶ How did the warm, red-colored water move once it was in the room-temperature, clear water? Draw a picture that shows the path of the red-colored water within the soda bottle in the space at the right.

____

____

Path of red-colored water:

Name ______________________ Date __________

▶ How did the blue-colored water move once it was in the room-temperature, clear water? Draw a picture that shows the path of the blue-colored water within the soda bottle in the space at the right.

Path of blue-colored water:

▶ Develop a hypothesis that explains how hot and cold water or air causes ocean currents or wind to form.

▶ How can this model help explain the way energy from the Sun gets distributed on Earth?

Open Inquiry

Keep It Moving

Invent and test other ways to explore the movement of fluids. Design and perform an experiment. Ask a question, make a prediction, do an experiment to test your prediction, record your data, and communicate your findings. Make a poster to show what you did and what you found out. Here are some ideas to get you started:

- If you filled a balloon with warm water, would it float or sink in cold water? Would a balloon filled with cold water float or sink in warm water?
- Would a helium balloon that neither floats nor sinks move differently in a moving stream of warm air and one of cold air? Could you find out using a handheld hair dryer?
- What other experiments can you do with balloons to explore air currents?

My question is:

____

____

My prediction is:

____

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My experiment is:

____

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My results are:

____

____

Name ______________________ Date __________

How can you find out what happens to thermal energy?

Structured Inquiry

Mixing Warm and Cold Water

Be Careful. Wear safety goggles.

Materials

- measuring cup or beaker calibrated in milliliters (capacity of 100 milliliters or more)
- 2 clear 20-ounce plastic cups or 2 500-milliliter beakers
- plastic spoon
- 2 thermometers
- warm tap water and cold (refrigerated) tap water
- safety goggles

Ask Questions

How does the temperature of cold and warm water change when they are mixed together? Can you predict the result?

Make a Prediction

What will happen to the temperature of water that was mixed from warm and cold water? Write your answer as a prediction in the form *"If warm and cold water are mixed together, then the temperature of the mixed water will . . ."*

____

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____

____

Test Your Prediction

1. Measure and pour water into the plastic cups or beakers as indicated in the investigation guide, and measure and record the temperatures on the chart on the next page.

Use with **Activity Flipchart pp. 90–91**

Name ______________________________ Date ____________

- Pour the water from one cup or beaker into the other, and stir for a few seconds with the spoon.

- Measure and record the temperature of the mixed water on the investigation guide. (It may take a minute for the thermometer to show the correct temperature.)

Mixing Warm and Cold Water Investigation Guide

Test A		
Beaker #1: +	**Beaker #2:** =	**Beaker #3:**
100 mL COLD water Temperature: ______	100 mL WARM water Temperature: ______	200 mL MIXED water Temperature: ______
Test B		
100 mL COLD water Temperature: ______	200 mL WARM water Temperature: ______	300 mL MIXED water Temperature: ______
Test C		
100 mL COLD water Temperature: ______	300 mL WARM water Temperature: ______	400 mL MIXED water Temperature: ______
Test D (invent your own test)		
_____ mL COLD water Temperature: ______	_____ mL WARM water Temperature: ______	_____ mL MIXED water Temperature: ______

- **Record Data** Repeat steps 2 and 3 for Tests B, C, and D, writing down your data in the chart. Do you see any patterns?

____

____

Name ____________________ Date __________

Communicate Your Results

Have a class discussion, and share your results. What did you find out? Use your data to answer these questions:

- What do your results tell you about temperature changes when warm and cold water are mixed together?

  ____
  ____
  ____

- Based on the test results, can you state a general rule about what happens when liquids of different temperatures are mixed? Share your rule with the class.

  ____
  ____
  ____

Guided Inquiry

Warming Up or Cooling Down

Ask Questions

How does wrapping a cup of warm or cold water in different materials affect how quickly the water in the cup cools down or warms up?

Make a Prediction

Write your answer as a prediction in the form *"If a glass is wrapped in aluminum foil (or another material of your choice), then the temperature of the water it contains will heat (or cool) _________ than water at the same temperature in an unwrapped glass."*

____
____
____

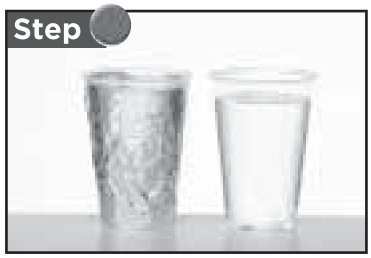
Name ______________________________ Date ____________

Test Your Prediction

- Refer to *Cooling or Warming Water,* Test #1, on the next page.
- Decide whether you want to use warm or cold water. Circle *Cooling* on the table if you decide to start with warm water; circle *Warming* if you decide to start with cold water.
- Fill two cups with the same amount of water. Measure and record the starting temperatures on the chart on the next page, making sure the temperatures are the same.
- Choose a material, and wrap one cup in it. (The unwrapped cup is the control.)
- **Record** Write down your choice of covering material on the chart.
- Place the cups side by side in a safe place. Measure and record their temperatures on the chart every 3 minutes for 30 minutes.
- **Use Numbers** Use your data to create a line graph on a separate piece of paper. Put the temperature on the vertical axis and the time on the horizontal axis. Plot the changes in both cups of water on the same graph, using 2 colors or 2 types of line (for example, solid and dotted) to distinguish between the covered cup and the (uncovered) control.
- Repeat steps 2 through 7 for Test #2. You might start with cold water instead of warm water or vice versa, or you might use a different material to wrap one cup.

Materials

- 2 clear 20-ounce plastic cups or 2 500-milliliter beakers
- 2 thermometers
- warm tap water and cold (refrigerated) tap water
- enough aluminum foil, bubble wrap, or other material to wrap a 20-ounce cup



Learning Lab

Name ______________________ Date __________

Cooling or Warming Water

Test #1:	What I Wrapped My Cup In:	
Time After Start	**Control-Cup Temperature**	**Variable-Cup Temperature**
0 minutes		
3 minutes		
6 minutes		
6 minutes		
9 minutes		
12 minutes		
15 minutes		
18 minutes		
21 minutes		
24 minutes		
27 minutes		
30 minutes		

Cooling or Warming Water

Test #2:	What I Wrapped My Cup In:	
Time After Start	**Control-Cup Temperature**	**Variable-Cup Temperature**
0 minutes		
3 minutes		
6 minutes		
6 minutes		
9 minutes		
12 minutes		
15 minutes		
18 minutes		
21 minutes		
24 minutes		
27 minutes		
30 minutes		

Communicate Your Results

Work in groups of four to eight, and discuss what you found out about the cooling or warming of the water.

- What did you observe? How did the temperatures change? Did different students have different results?

  ____

  ____

- Compare your data to your predictions. How do you explain what happened? Was there a difference between keeping the water cold and keeping the water warm? What is the difference?

  ____

  ____

  ____

Open Inquiry

More Cool (and Hot) Experiments

Invent other ways to explore cooling off and heating up. Ask a question, make a prediction, design and perform an experiment to test your prediction, record your data, and communicate your findings. Make a poster to show what you did and what you found out. What did you observe? Here are some ideas to get you started.

- Where do ice cubes melt the fastest? Find out by having each student in your class place some ice cubes in a different container or on a different surface. For example, place ice in a cup of room-temperature tap water, in a cup of salt water, on a paper plate, on a metal pie plate, or in a glass with no water.
- Do different materials feel warmer, colder, or the same if subjected to the same temperature? Place a cotton towel and a metal spoon in a refrigerator for 2 hours. Take them out of the refrigerator. Which one of them feels coldest? Is the one that feels coldest really colder? Explain.

Learning Lab

Name ______________________________ Date ____________

Would a cup of warm water cool faster if you put two metal spoons in the water? What if you put two plastic spoons in the water? Does it make a difference, and if so, why?

My question is:

My prediction is:

My experiment is:

My results are: