Activity Lab Book
**LIFE SCIENCE**

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**PHYSICAL SCIENCE**

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What are plants and animals made of?

Make a Prediction
Animals and plants are living things. Think about the differences between plants and animals. Do you think these differences mean that the parts that they are made of are similar or different?

Test Your Prediction

1. **Observe**  Look at the prepared slide of a leaf under the microscope. For help using the microscope, ask your teacher and look at page 461.

2. **Record Data**  Draw what you see.

3. **Observe**  Look at the prepared slide of blood under the microscope.

4. **Record Data**  Draw what you see.

Materials
- microscope
- prepared slides of leaf cells
- prepared slides of blood cells
Draw Conclusions

5 Compare  How were the plant leaf slide and animal blood slide alike? How were they different?

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6 Communicate  Write a report explaining whether or not your observations supported your prediction.

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Explore More
Examine the drawings you made and think about the living things they came from. Do you think that a leaf from another plant would look the same? Make a prediction and plan an experiment to test it.

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How are plant and animal cells different?

Cell Identification

1. Plant and animal cells have similarities and differences. Look at the images labeled plant cells and animal cells.

2. With your partner, discuss similarities and differences in the cells. Record what you notice.

Materials

- one labeled image of a plant cell
- one labeled image of an animal cell
Plant and Animal Cells

1 **Make a Model**  Put one plastic bag in the storage container. This is your plant cell. The other plastic bag is your animal cell.

2 Using a spoon, carefully put gelatin in both bags until the bags are almost full.

3 Pick the vegetables that look the most like the plant and animal organelles.

4 Place the vegetables that you have picked into the appropriate container and seal the bags.

5 **Compare**  Try to stack your models. How well do the plant cells stack compared to the animal cells?

6 **Communicate**  Discuss with your classmates which vegetables you selected for your organelles and explain why.

---

**Materials**

- two sandwich bags
- one sandwich container with lid
- masking tape (optional)
- pencil (optional)
- gelatin
- spoon
- vegetables
Experiment

All living things are made up of cells. Every cell has a cell membrane, or a layer around the outside of the cell. A cell membrane acts like the door to the cell. It lets things in and out of the cell. One way to learn more about how cell membranes work is by doing an experiment.

## Learn It

An **experiment** is a test that supports or disproves a hypothesis. To carry out a successful **experiment** you need to perform a test that examines the effects of one variable on another using controlled conditions. You can then use your data to draw a conclusion about whether or not the hypothesis has been supported.

In the following **experiment**, you will test the effects of variables on a cell membrane. Using vinegar, you will dissolve the shells of two eggs to expose the egg membranes. Then you will gather and analyze data to support or disprove the following hypothesis: *If the liquid outside a membrane is thicker than the liquid inside the membrane, then the liquid inside the membrane will move out to balance the concentration.*
Try It

- Pour 200 mL of vinegar into two jars with lids and carefully lower two eggs into the jars of vinegar. Tighten the lids and leave the eggs inside for one day.
- Use a spoon to carefully remove the eggs and rinse them under water.
- Measure each egg using either the measuring tape, metric measuring cup, or balance. Record the measurements in the chart below.
- Pour 200 mL of water into a beaker and 200 mL of corn syrup into another beaker. Carefully lower an egg into each beaker. Leave the eggs inside for one day.
- Use a spoon to carefully remove the eggs and rinse them under water.
- Measure the eggs again using the same measuring tool you used earlier. Record the measurements in the chart below.

### Materials
- an uncooked egg
- 2 jars with lids
- 200 mL of white vinegar
- 200 mL of water
- 200 mL of corn syrup
- measuring tape
- balance
- metric measuring cup
- spoon

<table>
<thead>
<tr>
<th>Measurement Tool Used</th>
<th>Initial Measurement</th>
<th>Final Measurement</th>
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<tbody>
<tr>
<td>Egg in water</td>
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<tr>
<td>Egg in corn syrup</td>
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</table>
3 Apply It
Now it is time to analyze your data and observations. Use your chart to compare your initial and final measurements of the eggs.

► Did both eggs change in size? Did one change more than the other?

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► Why do you think this happened? Does this support or disprove the hypothesis?

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Use this page for any notes you have about the experiment.

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What are the levels of organization of living things?

Purpose
To research the levels of organization of an onion plant.

Procedure
1. Peel the skin of an onion.
2. Make a wet-mount slide by placing a small piece of onion skin in the center of the slide, then put a drop of water on the onion skin. Carefully put a cover slip on top.
3. Observe View the onion skin under low power. What do the cells look like? Draw what you see.
4. Observe Use the hand lens to observe another piece of onion skin. Draw what you see.
5. Take the remaining onion and remove all of its parts. Make a diagram of the structure of the onion.
Draw Conclusions

6 Compare Are the various onion cells you observed in the onion layer similar or different?

Infer How do these cells work together?

Explore More
Research the levels of organization of the onion plant. Answer these questions with a labeled diagram. What is an onion? Is it part of the roots or the stem?
Model Cell Structure

1. **Record Data** Draw and label the parts of the vegetable you are examining.

   ![Blank space for drawing]

2. Use a hand lens to search for different cells in a slice of your vegetable.

3. Record what you see as you examine the parts of the vegetable.

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**Muscle Tissues**

1. **Make a Model** Tie a piece of yarn between two chairs. Have two classmates sit on each chair. This yarn represents one cell in your muscle tissue.

2. Using a metal ruler, twist the yarn until it snaps.

3. Now tie two pieces of yarn to the chairs. Try to break the yarn again.

4. Repeat this experiment until you have enough pieces of yarn that the twisting cannot break it.

5. How does this model show how muscle cells work in your body?

---

6. **Infer** Are your muscles stronger when cells work together?

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**Materials**

- two chairs
- metal ruler
- yarn
Inquiry: Structured

How do cells from different tissues in the human body compare?

Form a Hypothesis
A cell can be an organism that carries out its own life processes. Bacteria and protists are unicellular organisms. A cell can also be a part of a multicellular organism. Cells in multicellular organisms might have a single, very specific, function. For example, a cell in the stomach might only be responsible for producing one digestive chemical.

Do you think cells from different tissues in the human body have different forms? Are all cells from the human body alike or different? Write your answer as a hypothesis in the form “If cells belong to different tissues in the human body, then . . .”

Test Your Hypothesis

1 Experiment Place the muscle slide on the microscope stage. Follow your teacher’s instructions to focus the microscope.

△ Be Careful. Tell your teacher immediately if a slide breaks.

2 Observe Use colored pencils and draw the image you see in your journal. Label your drawing.
**Experiment**  Repeat steps 1 and 2 with the skin and nerve slides.

**Draw Conclusions**

1. **Communicate**  Describe the cell size and shape for each cell type.

2. **Compare**  What similarities and differences did you see?

3. Did the experiment support or disprove your hypothesis? Explain your answer.
Inquiry: Guided

How do cells from different plant tissues compare?

Form a Hypothesis
You have already learned about the differences between animal and plant cells. You also know that, like animals, plants are made up of cells that form tissues. Do you think cells from different tissues in a plant have different forms? Write your answer as a hypothesis in the form “If cells belong to different tissues in a plant, then . . .”

Test Your Hypothesis
Design a plan to test your hypothesis. Then write out the materials, resources, and steps you need. Record your results and observations as you follow your plan and conduct your experiment.

▶ My Materials and Resources:

▶ The Steps I Will Follow:

▶ These Are My Results:
Draw Conclusions
Did your experiment support your hypothesis? Why or why not?

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Inquiry: Open
What else can you learn about cells and tissues in plants and animals? For example, how many types of tissues do we have? Determine the steps you will follow to answer your question. Record and document the resources you use throughout your investigation.

1 My Question Is: _________________________________________________________
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________________________________________________________________________
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2 How Can I Test It: ______________________________________________________
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3 My Results Are: _________________________________________________________
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How would you classify a new plant?

Purpose
You are part of an expedition that is studying plants in the jungle. You find a plant you’ve never seen before. How do you classify it? You could use a classification key. A classification key lists traits of organisms. It gives directions that lead you to the organisms’ identities. Use this classification key to classify plants.

Procedure
1. Observe Choose a plant and examine its structures with the hand lens.
2. Use the classification key to identify your plant. Start with the first pair of traits and choose the trait that applies to your plant.
3. Repeat steps 1 and 2 for the other four plants.

<table>
<thead>
<tr>
<th>Plant 1:</th>
<th>Plant 2:</th>
<th>Plant 3:</th>
<th>Plant 4:</th>
<th>Plant 5:</th>
</tr>
</thead>
</table>

Classification Key for Plants

| 1. Stem ...................... Go to 2  
No stem ...................... Moss |
|---------------------------|-----------------|
| 2. Produces flowers ...... Geranium  
No flowers .................. Go to 3 |
|---------------------------|-----------------|
| 3. Waxy leaves ............ Conifer  
Non-waxy leaves ........... Go to 4 |
|---------------------------|-----------------|
| 4. Grows in soil ........... Fern  
Grows in water ............ Elodea |
|---------------------------|-----------------|

Materials
- water plant, such as an elodea
- flowering plant, such as a geranium
- small pine or other conifer
- moss plant
- fern plant
- hand lens
Draw Conclusions

4 Why do you think classifying organisms helps scientists? Explain.


5 Infer Which of the plants you classified are more similar, or more closely related, to each other? Explain.


Explore More
What traits could you use to identify other organisms, such as birds? Research another group of organisms and create a classification key for them. Your key should begin with general traits and end with traits that are more specific.
Classifying Flowers

1 **Observe** Look at the bouquet. What similarities and differences do you notice about the flowers?

2 **Record Data** Make a chart like the one below to record your observations.

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<th>Similarities</th>
<th>Differences</th>
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3 **Communicate** Share your observations with the class.

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Bread Mold Activity

1. Trace the outline of a slice of bread on graph paper.

2. Put a drop of water on one corner edge of the bread and put it in a bag. Place the bag in a warm, dark corner.

3. **Observe** On the first day you see mold, sketch the shape of the moldy area on your graph paper.

4. For the next three days, use a different color to sketch the next growth.

5. **Record Data** Count the number of squares that were covered with mold each day.

6. Create a graph to show the growth of the mold each day.

**Materials**
- bread
- paper
- sealable sandwich bag
- water
- colored pencils
- centimeter ruler
- dropper
What are the parts of vascular plants?

Purpose
You have learned that all vascular plants have vessels in their stems. What else do vascular plants have in common? You will examine several vascular plants to find out.

Procedure
1. Examine each plant. Look at the roots, stems, and leaves.

2. Record Data Make a chart for each plant. Draw what the plant’s root, stem, and leaves look like. Record the color, size, and shape of each plant part.

Materials
- cactus plant
- water plant
- flowering plant
- disposable plates
- gloves

3. Compare Which of the plant parts look similar? Which parts look different?

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Chapter 2 • Plant Structures and Functions
Activity Lab Book

Use with Lesson 1
Vascular Plants
Draw Conclusions

4 How do the stems of the water plant and the cactus compare? Why do they have these differences?

________________________________________________________________________________________

________________________________________________________________________________________

5 Infer Would the flowering plant be able to survive in a hot, dry area? Why or why not?

________________________________________________________________________________________

________________________________________________________________________________________

6 Infer Would the water plant be able to survive out of the water? Why or why not?

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Explore More
Look at the plants where you live. Observe three plants and compare them to these three plants. Based on your observations, decide if each of the plants you observed are also vascular plants.

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Inside a Cactus

1. **Observe** Use a hand lens to make observations of the physical characteristics of the outside of a succulent variety of cactus.

2. **Experiment** Use a knife to cut the cactus in half from top to bottom.

3. **Observe** Look at the inner tissues of the cactus. What do you notice?

4. **Record Data** Make a drawing of your observations of the external and internal structures of the cactus.

**Materials**
- cactus
- knife
- gloves
- hand lens
Quick Lab

Fern Spores

1. **Observe** Carefully examine a fern leaf. Draw what you see and write down any observations.

   ![Image of fern leaf]

2. Place a drop of water on a slide.

3. Use a toothpick to scrape one of the spore cases into the drop of water.

4. **Observe** Examine the spore case under the microscope on low power. What does the spore case contain?

5. Draw what you see and write down any observations.

6. **Infer** How does the size of the fern spores relate to their function?
Classify

When scientists **classify**, they place things that share traits and characteristics into groups. In order to do that, scientists need to compare and contrast. 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 the 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 something about all bicycles: Bicycles have two wheels.

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, cars, pickup trucks, and carts would be in the same group because they all have four wheels. Motorcycles and bicycles would be in the same group because they have two wheels.

One way to **classify** things is by their shape. You can **classify** leaves by the shape of their edges. See page 78 of your textbook for some examples of the different types of leaf edges.
2 Try It

▶ Find ten leaves of different kinds, shapes, and sizes.
▶ Examine each of your leaves one at a time.
▶ Draw your leaves in the chart shown.
▶ Write a description of each leaf next to the picture.
▶ **Classify** Classify your leaves according to the type of edge each has. Use the leaves on page 78 of your textbook as a guideline. Record the type of edge on your chart.

<table>
<thead>
<tr>
<th>Leaf</th>
<th>What It Looks Like</th>
<th>Description</th>
<th>Classification</th>
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</table>
Apply It

- Look around you for more things to **classify**. Choose something you are interested in or enjoy. Think of things you see every day, such as plants, rocks, or animals.

- **Classify** them by size, shape, color, or any other characteristic that they have in common. Share your findings with the class.

<table>
<thead>
<tr>
<th></th>
<th>What It Looks Like</th>
<th>Description</th>
<th>Classification</th>
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</table>
Use this page for any notes you have from the experiment.
How does water move in a plant?

Make a Prediction
What will happen if you leave a celery stalk in colored water? Make a prediction.

Materials
• hand lens
• celery stalk
• colored pencils
• food coloring
• water
• container
• spoon

Observe
1. Use a hand lens to look at the celery stalk.
2. Place the celery stalk in a container with water.
3. Put three drops of food coloring into the container. Stir the water until the food coloring is thoroughly mixed.

Record Data
4. Use colored pencils to draw a picture of the celery stalk. Record the date and time.

Observe
5. On the following day, use the hand lens to look at the celery stalk. Note any changes.

Record Data
6. Use colored pencils to draw a picture of the celery stalk. Record the date and time.
Draw Conclusions

7 What can you conclude about how water moves in a plant?

________________________________________________________________________

8 Communicate Write a report of your investigation. Describe any differences between your results and those of your classmates.

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Explore More

You used a celery stalk in this experiment. What do you think would have happened if you used a plant that had a white flower? Answer this question by making a prediction and a plan to test it. Then follow your plan and write a report of your results.

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What plant part am I?

1 **Classify** Is your vegetable a stem, leaf, or root?

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2 **Infer** What job would your plant part have?

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Root Cross Section

1. **Observe** Examine a cross section of a root with a hand lens. Draw what you see.

2. Place the cross section and a few drops of water on a slide. Cover it with a cover slip. Look at it under a microscope at low power.

3. Draw what you see. Label the parts that you can identify.

4. **Draw Conclusions** Which parts of the root carry water? How can you tell?

5. **Communicate** Other groups in your class have looked at different kinds of roots. Discuss whether their cross sections were similar or different from yours.

**Materials**
- root vegetables (carrots, radishes, turnips)
- hand lens
- microscope
- glass slides
- cover slips
- water
- eye dropper
- scalpel or sharp knife
Inquiry: Structured

How does water move in and out of plants?

Form a Hypothesis

Plants need water to survive. If a plant loses too much water it will wilt and eventually die. How do plants lose water? Plants lose water through transpiration, the evaporation of water from the leaves. As the water evaporates, it pulls water from the roots up through the xylem tissue. The rate of transpiration changes depending on a number of variables. How does the amount of light a plant receives affect its transpiration rate? Write your answer as a hypothesis in the form “If the amount of light a plant receives is increased, then the rate of transpiration . . .”

Test Your Hypothesis

1. Use the spray bottle to water the 4 plants. Be sure to give all of the plants the same amount of water.

2. Place each of the plants’ pots in a plastic bag and use the string to tie the bag around the stem of each plant.

3. Record Data  Weigh all 4 plants using the metric balance. Record their masses.

<table>
<thead>
<tr>
<th>Time</th>
<th>Plant 1</th>
<th>Plant 2</th>
<th>Plant 3</th>
<th>Plant 4</th>
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<tbody>
<tr>
<td>Beginning</td>
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<td>30 minutes</td>
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4 **Use Variables** Place 2 of the plants under the light source. Place the other two plants away from the light source.

5 **Record Data** After 10 minutes weigh all 4 plants again. Record their masses.

6 Return the plants to their original locations.

7 Repeat step 5 every 10 minutes for 30 minutes.

**Draw Conclusions**

1 What is the independent variable in the investigation?

2 **Analyze Data** Did the mass of any of the plants change? Did your data show a correlation between the transpiration rates and the amount of light?

3 Did your results support your hypothesis? Why or why not?
Inquiry: Guided

How is water loss in plants affected by changes in the environment?

Form a Hypothesis
You have seen how light affects the rate of transpiration. What other variables affect the rate of transpiration? How about wind? Write your answer as a hypothesis in the form “If wind increases, then the rate of transpiration . . .”

Test Your Hypothesis
Design a plan to test your hypothesis. Then write out the materials, resources, and steps you need. Record your results and observations as you follow your plan.

1 My Materials and Resources: ____________________________________________
   ____________________________________________
   ____________________________________________

2 The Steps I Will Follow: ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
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3 My Results Are: ____________________________________________
   ____________________________________________
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Draw Conclusions
Did your results support your hypothesis? Why or why not? Present your results to your classmates.

Inquiry: Open
What other conditions in the environment can affect the rate of transpiration? Come up with a question to investigate. For example, how does humidity affect the rate of transpiration? Design an experiment to answer your question. Your experiment must be organized to test only one variable, or item being changed.

1. My Hypothesis Is: __________________________
   __________________________
   __________________________

2. My Materials and Resources: __________________________
   __________________________
   __________________________
   __________________________

3. The Steps I Will Follow: __________________________
   __________________________
   __________________________
   __________________________
   __________________________

4. My Results Are: __________________________
   __________________________
   __________________________
What do plants produce?

Purpose
You will observe elodea, a water plant, to find out what it produces.

Procedure
1. Mix 200 mL of water and 10 g of baking soda in the beaker. Baking soda is a source of carbon dioxide.
2. Pour water from the beaker into the large plastic cup until the cup is half full.
3. Place the elodea into the test tube with the cut end facing up. Fill the test tube with water from the beaker.
4. Place your thumb over the end of the test tube. Turn the tube upside down and lower it to the bottom of the plastic cup.
5. Place the plastic cup near a lamp or sunny window. Draw a diagram of the plant and water level.
6. Observe On the next day, look closely at the elodea and at the water level in the test tube. Draw a diagram of the plant and water level.

Materials
- water
- baking soda
- glass beaker
- spoon
- large plastic cup
- water plant, such as elodea
- large test tube
- light source
Draw Conclusions

Look at your two diagrams. What did you observe? Why do you think this happened?

Explore More

What are the variables in this experiment? Did light have something to do with your results? Would you get the same results without the baking soda? Form a hypothesis and design an experiment to test it.
How important is light?

1 Use the scissors to cut out some small geometric shapes in the aluminum foil, such as circles, squares, or triangles. Each shape should be large enough to cover about half of the leaf of the plant.

2 Experiment Paperclip each shape to a different leaf and place the plant in a sunny place.

3 Observe After five days, remove the shapes and observe the leaves.

4 Record Data What happened?

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</table>
The Food in Leaves

1. Place a leaf in a jar. Fill the jar 3/4 full with rubbing alcohol. Replace the lid on the jar. Alcohol breaks down some of the structures in the leaf.

2. Draw a picture of the jar. Record the date and time.

3. Leave the leaf in the jar for 24 hours.

4. Remove the leaf from the jar and blot it dry with a paper towel.

5. Place the leaf in a Petri dish. Add enough iodine to cover the leaf.

6. Observe Look at the leaf and draw a picture of it. Record the date and time.

7. Draw Conclusions What food do you think is in the leaf? Hint: In the presence of starch, iodine turns black.

8. Communicate Discuss your results with other groups of students. Were your results the same or different? If they were different, suggest a reason for the variation.

Materials
- green leaf
- rubbing alcohol
- tincture of iodine
- 1-pint jar with lid
- Petri dish
- paper towel
What parts of your body are you using?

Make a Prediction
Pick one of the following activities:

► Write your name.
► Pick a pencil up from the floor.
► Whistle or hum a tune.

Predict the body parts that you will use as you do this activity.

Test Your Prediction

1. Trace an outline of your partner’s body on craft paper.

2. Start from a sitting position at your desk. Do the activity you chose.

3. On your body outline, color or circle all of the parts of the body that you used during your activity. How much of your body did you use?
Draw Conclusions

4 Compare What differences do you see between your original list and the body parts you circled on your outline?

5 What part of your body controlled the activity you did?

6 Infer How did your body get the energy it needed to do the activity? What body parts turn food into the energy that you used when you moved?

Explore More
Think about all the activities you do in one day. Keep track of all of the things you do. What part of your body do you use to complete every activity? Write a report that explains your observations.
Heart Rate

1. Find your pulse in your wrist or neck.

2. Measure your resting heart rate, counting the number of beats in 10 seconds. Multiply by 6 to get beats per minute. Record your resting heart rate.

3. After two minutes of jumping jacks, measure your heart rate again.

4. Sit up tall and close your eyes, quietly focusing on deep, slow, even breathing. Measure your heart rate after recovering, and compare the three heart rates in a chart like the one below.

<table>
<thead>
<tr>
<th>Resting Rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic Rate</td>
<td></td>
</tr>
<tr>
<td>Recovered Rate</td>
<td></td>
</tr>
</tbody>
</table>

5. Discuss the relationship between your heart rate and your breathing.
The Skeletal System

1. Take two chenille sticks. Bend a loop in one end of each.

2. **Make a Model** Alternatively string pasta wheels and hard candy circles on one chenille stick.

3. Alternatively string pasta wheels and soft candy circles on the other chenille stick.

4. Fold the ends of the chenille sticks so the pasta and candy do not fall off.

5. **Compare** Slowly bend each model. How far can you bend each model?

6. **Infer** Which model better represents the structure of your backbone? Explain your answer.

**Materials**

- chenille sticks
- pasta wheels
- hard candy circles
- soft candy circles
Form a Hypothesis

The nervous system allows the brain to communicate with every part of the body. It controls your senses and your body movements. Your ability to react to stimuli, such as catching a ball, depends on how fast messages get transmitted, or sent to or from your brain.

The time between when you sense something and when you act, is called reaction time. Scientists study people’s reactions to various situations to learn more about how the nervous system works. Scientists use what they learn to form a hypothesis. When you form a hypothesis, you make a testable statement about what you think is logically true.

1. Learn It

A hypothesis is a statement about the effect of one variable on another. It should be based on observations or collected data. For example, when you play baseball, you might notice that you catch the ball more times when you keep your eyes on the ball. Based on this observation, you might form the hypothesis: “If I keep my eyes on the ball, then I’ll hit the ball more often.”

A hypothesis is tested using an experiment. You might test this hypothesis by trying to hit a ball several times with your eyes on the ball and elsewhere. The results of the experiment will either support or disprove the hypothesis.
Try It

Test your reaction time by trying to catch a falling object. Think about any observations you’ve made in the past about reaction times. What variables might affect your reaction time? Will you react faster to a sound or a sight? Write your answer as a hypothesis in the form “If my eyes are shut, then . . .”

Create a chart like the one shown to record the results.

Hold a ruler at the highest number. Have your partner put one hand at the bottom of the ruler without touching it.

Drop the ruler and observe the spot where your partner caught the ruler. This is the control. The closer to the bottom numbers, the quicker the reaction. Repeat the test 5 times.

Repeat this activity, but this time have your partner cover their eyes and make a noise as you drop the ruler. This is the variable. Repeat the test 5 times and record your results.

Now have your partner drop the ruler for you, and record your results.
### Your Partner’s Results

<table>
<thead>
<tr>
<th>Reaction Times</th>
<th>Control</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes Open</td>
<td></td>
<td>Eyes Shut</td>
</tr>
</tbody>
</table>

| Trial 1        |         |          |
| Trial 2        |         |          |
| Trial 3        |         |          |
| Trial 4        |         |          |
| Trial 5        |         |          |

### Your Results

<table>
<thead>
<tr>
<th>Reaction Times</th>
<th>Control</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes Open</td>
<td></td>
<td>Eyes Shut</td>
</tr>
</tbody>
</table>

| Trial 1        |         |          |
| Trial 2        |         |          |
| Trial 3        |         |          |
| Trial 4        |         |          |
| Trial 5        |         |          |
3 Apply It

- Now it’s time to analyze your data. Compare your reaction times. Do you notice any patterns? Does your data support or disprove your **hypothesis**?

- What will happen to your reaction time if you try the same experiment with your other hand? Write your answer as a hypothesis in the form “If I use my other hand, then . . .”

- Test your **hypothesis** and record the results during five attempts. Analyze the results to find out if they support or disprove your **hypothesis** and share them with the class.

<table>
<thead>
<tr>
<th>Reaction Times</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Eyes Open</td>
</tr>
<tr>
<td>Eyes Shut</td>
</tr>
<tr>
<td>Trial 1</td>
</tr>
<tr>
<td>Trial 2</td>
</tr>
<tr>
<td>Trial 3</td>
</tr>
<tr>
<td>Trial 4</td>
</tr>
<tr>
<td>Trial 5</td>
</tr>
</tbody>
</table>
Why is the small intestine full of folds?

Make a Prediction
Compare the structure of the construction paper, the computer paper, and the paper towels. Make a prediction about the type of paper that will absorb the most water.

Test Your Prediction
1. Pour the same amount of water into each graduated cylinder. Observe and record the water levels on the graduated cylinders.
2. Fold the construction paper twice lengthwise.
3. Dip the construction paper into a graduated cylinder until half is covered in water.
4. After 30 seconds remove the paper. Observe and record the water level in the graduated cylinder.
5. Repeat steps 2–4 for the other paper types.

<table>
<thead>
<tr>
<th>Paper Type</th>
<th>Water Level</th>
<th>Water Left</th>
<th>Water Absorbed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plain Paper Towel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ridged Paper Towel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Materials
- construction paper
- ridged paper towels
- plain paper towels
- computer paper
- water
- 4 graduated cylinders
- stopwatch
Draw Conclusions

Which type of paper absorbed the most water? Do these results support your prediction?

_________________________________________________________________________________

_________________________________________________________________________________

Compare  How does the structure of the paper that absorbed the most water compare to the small intestine?

_________________________________________________________________________________

_________________________________________________________________________________

Infer  What is the function of the small intestine?

_________________________________________________________________________________

_________________________________________________________________________________

Explore More
What do you think would happen if you repeat the experiment using a bath towel? Form a hypothesis and test it. Analyze your results and write a report explaining them.

_________________________________________________________________________________

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_________________________________________________________________________________
Small Intestine

1. Your teacher will form students into a line that is as long as your intestines, about 22 feet.

2. How can something so long fit inside your body?

3. Work with the kids in the line to demonstrate your idea.
Your Teeth

1. Use a mirror to observe your teeth.
2. Count your teeth and record the number in a chart.
3. Draw each of your teeth on your chart.
4. Compare your chart to the pictures of the teeth in the book.
5. Classify each of the teeth you drew as incisors, canines, or molars.

<table>
<thead>
<tr>
<th>Kind of Tooth</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Compare How do the shapes of your teeth compare to each other?

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

Materials
- mirror
- pencil

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Chapter 3 • Human Body Systems
Activity Lab Book

Use with Lesson 2
The Digestive System
How much air do you breathe?

Purpose
The purpose of this activity is to see how much air you can hold in one breath.

Procedure

1. Breathe in as much air as you can.
2. Exhale out into the balloon and quickly tie the balloon shut.
3. Holding one end of a piece of string, wrap the string around the balloon at its widest point.
4. Mark the other end of the string with a pen.
5. Use a ruler to measure the length of string. The string represents the amount of air you breathe out.

6. **Record Data**  Keep track of the number of times you breathe in one minute.
Draw Conclusions

7 Communicate  Compare the length of your string and the number of times you breathed in to those of your classmates. Were they the same or different? Why do you think this is?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

8 Analyze Data  What relationship, if any, can you see between the breathing rate and how much air can be held in one breath?

________________________________________________________________________

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Explore More

How would your breathing rate and the amount of air you breathe out change if you tried the activity after exercising? Form a hypothesis and test it. Then analyze your results and write a report explaining them.

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Breathing Differences

1 Form a hypothesis about how breathing compares among any of the following groups: amphibians, birds, fish, insects, mammals of different sizes, plants, and reptiles.

________________________________________________________________________

2 **Observe** Collect data from pets at home or animals at school. What will you observe?

________________________________________________________________________

3 **Draw Conclusions** Does your data support your hypothesis, or will you have to change it?

________________________________________________________________________

________________________________________________________________________
The Gas You Exhale

Bromothymol blue (BTB) can be used to indicate the presence of carbon dioxide. If CO₂ is present, BTB in water changes from blue to yellow.

1. Pour 1 cup of water into a plastic cup with a lid.

2. Using an eye dropper, add drops of BTB slowly until the water turns blue.

3. **Observe**Place a cut straw in the cup lid and blow into it. Note any changes to the water.

4. Take the straw out and shake the cup. Note any changes to the water.

5. **Draw Conclusions** What gas is present when you exhale? How do you know?

6. What do you think will happen if you run in place and then blow into the BTB solution?

**Materials**
- plastic cup
- water
- bromothymol blue solution (BTB)
- eye dropper
Inquiry: Structured

What are the products of respiration?

Form a Hypothesis
During cellular respiration, living cells use oxygen to break down sugar and release energy. This process also produces carbon dioxide. Yeast cells will be placed in water and in a sugar solution. What will happen to the level of carbon dioxide when sugar is present? Write your answer as a hypothesis in the form “If sugar is present, then . . .”

Materials
- 2 600 mL beakers
- 2 test tubes
- 3 droppers
- bromothymol blue
- sugar, yeast
- goggles, gloves
- warm water

Be Careful. Wear goggles and gloves. Do not inhale bromothymol blue. If bromothymol blue comes in contact with skin, wash that area immediately.

Test Your Hypothesis

1. Make 2 solutions. In Solution A, mix 2 teaspoons of yeast, 3 tablespoons of sugar, and 1.5 cups of warm water. In Solution B, mix 2 teaspoons of yeast and 1.5 cups of warm water.

2. Fill one dropper with Solution A. Fill the other dropper with Solution B.

3. Pour water into 2 test tubes until they are 3/4 full. Put three drops of bromothymol blue in each test tube. Observe and record the color of the water.
4. Place each (solution-filled) dropper into a test tube with the opening of the dropper pointed up. Add water if the opening of the dropper is not covered.

5. Place each test tube in a beaker of warm water.

6. Observe the droppers and water color every 15 minutes for 45 minutes. Record what you see.

________________________________________________________

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Draw Conclusions

1. As you know, bromothymol blue changes from blue to yellow-green in the presence of carbon dioxide. Based on this information, what do your observations of the color of the water in the test tubes indicate?

________________________________________________________

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2. Do your results support your hypothesis? Explain why or why not.

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Inquiry: Guided

How does temperature affect the respiration rate of cells?

Form a Hypothesis
Sometimes a cell’s temperature will increase due to an increase in activity. How do yeast cells react to an increase in temperature? Write your answer as a hypothesis in the form “If the temperature increases, then . . .”

Test Your Hypothesis
Design a plan to test your hypothesis. Then write out the materials, resources, and steps you need. Record your results and observations as you follow your plan.

1 My Materials and Resources: ________________________________
   ____________________________________________________________
   ____________________________________________________________

2 The Steps I Will Follow: ____________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3 My Results Are: __________________________________________
   ____________________________________________________________
   ____________________________________________________________
**Draw Conclusions**
Did your experiment support your hypothesis? Why or why not?

__________________________________________________________________________
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**Inquiry: Open**
What else would you like to learn about respiration or the respiratory system? Come up with a question to investigate. For example, how does your respiration rate change when you exercise? Design and carry out an experiment to answer your question. Your experiment must be organized to test only one variable, or one item being changed.

1 My Question Is: ____________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

2 My Materials and Resources: _______________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

3 The Steps I Will Follow: ____________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

4 My Results Are: ____________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
When does your heart work the hardest?

Form a Hypothesis
When you exercise, your body requires more oxygen. What happens to your heart when you exercise? Write your answer as a hypothesis in the form “If the body requires more oxygen, then . . .”

Test Your Hypothesis

1. Take your pulse when you are resting. Press lightly on the skin on the inside of your wrist until you feel a beat. Then count how many beats you feel in 15 seconds. Record this number in a chart.

2. Walk in place for one minute. When you are done, take your pulse. Record your data.

3. Run in place for one minute. When you are done, take your pulse. Record your data.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Heart Rate/15 Seconds</th>
<th>Breath/15 Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>sitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>running</td>
<td></td>
<td></td>
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</tbody>
</table>

Materials
- stopwatch
- graph paper
4 Record Data Make a bar graph of your heart beats when resting, walking, and running.

Draw Conclusions
5 Did your results support your hypothesis?

Explore More
Repeat the above experiment, but this time measure your pulse for 1 minute after every step. Now multiply your results in the first experiment to make the unit into minutes. How do the two sets of experiment results compare? Which set of results is more accurate?
Blood Pressure

1 **Predict**  How hard does your heart have to work to push your blood against gravity?

2 **Record Data**  Use a measuring tape to measure the distance from your feet to your heart when you are standing. Then, measure the distance from the top of your head to your heart.

3 **Experiment**  How hard does your heart work when you are standing still? How hard does your heart work when you stand on your head?

4 **Draw Conclusions**  Does your heart have to pump against gravity when you lie flat on your back?
Vein Valves

1. **Be Careful!** Cut a slit in the center of a cardboard tube.

2. Insert a small piece of cardboard through the tube, sideways, so that it touches the other side of the tube.

3. Stand the tube up vertically so the piece of cardboard is pointing down.

4. Pour some kidney beans through the top of the tube.

5. **Observe** Look inside the tube. Describe what happened to the beans.

6. Now turn the tube over so the piece of cardboard is pointing up. Repeat Step 4.

7. **Infer** How is this model similar to your veins?

---

**Materials**

- paper towel tube
- scissors
- heavy construction paper or cardboard
- dried kidney beans
- tape

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Chapter 3 • Human Body Systems
Activity Lab Book

Use with Lesson 4
The Circulatory System
How do your kidneys filter out waste?

Purpose
Your kidneys filter waste out of your blood using a special kind of membrane. The membrane has very small openings that allow some molecules to pass through and not others. Waste particles are kept inside the kidneys and useful substances are sent back into the body. Make a model of a kidney’s membrane.

Procedure

1. **Experiment** Mix 1 teaspoon of cornstarch and 200 mL of hot water into a beaker.

2. Mix 150 mL of water and 5 mL of iodine in the other beaker.

3. Pour 50 mL of the cornstarch water into the bag and close it with a twist tie.

4. Gently place the bag in the iodine solution without letting the twisted top get wet.

5. **Observe** Check the beaker every 3 minutes for 15 minutes. Write down your observations.

   1. 
   2. 
   3. 
   4. 
   5. 

Materials
- cornstarch
- measuring spoon
- water
- eye dropper
- 2 beakers
- spoon
- iodine
- cellophane bag
- twist ties
Draw Conclusions

6. What happened to the cornstarch in the bag? Why do you think this happened?

________________________________________________________________________
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7. How is the bag similar to the membrane of the kidneys?

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Explore More
Would you expect salt or pepper to filter through the bag? Make a Prediction. Plan and conduct a test to test your results. Then write a report of your results.

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Clean Up

1. **Make a Model**  Your teacher will give you a model consisting of frosting on a paper towel.

2. **Infer**  What does the paper towel represent?
   _____________________________________________
   _____________________________________________

3. **Infer**  What does the frosting represent?
   _____________________________________________
   _____________________________________________

4. **Experiment**  How can you clean the paper towel without tearing it?
   _____________________________________________
   _____________________________________________

5. **Draw Conclusions**  What is the relationship between water and kidney health?
   _____________________________________________
   _____________________________________________
   _____________________________________________
   _____________________________________________

**Materials**
- frosting
- paper towel
- water
Tiny Filters

1 Mix pepper and water in a cup.

2 Pour the pepper and water mixture through a paper towel into another cup. What went through the paper towel and what did not?

3 Mix sugar and water in a cup.

4 Pour the sugar and water mixture through a paper towel into another cup. What went through the paper towel and what did not?

5 How would you explain what you observed?

6 Infer How is the paper towel similar to the nephrons?

Materials

• black pepper
• sugar
• cups
• paper towels
• water
How much of Earth’s water is salty and how much is fresh?

Purpose
Make a model that shows how much of Earth’s water is salty and how much is fresh.

Procedure
1. Fill the 1-liter bottle with water. The water in this bottle represents all of the water on Earth. Remember, 1 liter (L) holds 1,000 milliliters (mL).

2. Label the cups frozen water, liquid water, and water vapor.

3. **Measure** Using the water in the 1-liter bottle, measure 28 mL of water, in the metric measuring cup. This cup represents all of Earth’s fresh water.

4. **Measure** From the metric measuring cup, pour the following:

   | Frozen water cup | 22 mL |
   | Liquid water cup | 6 mL  |
   | Water vapor cup  | 1 drop |
Draw Conclusions

5 Infer What kind of water is represented by the remaining water in the 1-liter bottle?

6 Use Numbers About how many times more salt water than fresh water does Earth hold?

7 Interpret Data People can only easily use fresh liquid water. What percentage of Earth’s water is available for people to use?

Explore More
Describe how you would make a model to show the proportions of the different types of fresh water on Earth.
What affects ocean levels?

1 Predict How would the melting of ice sheets and glaciers, as a result of global warming, affect ocean levels?

2 Make a Model Make an “island” of soil, sand, and rocks in a tray of water.

3 Record Data Measure the depth of the water, from the bottom of the tray to the water’s surface.

4 Experiment Place several ice cubes on the island to represent glaciers.

5 Record Data After the ice melts, measure the depth of the water again.

6 Draw Conclusions What happened after the ice melted?
How the Ocean Becomes Salty

1. In a container, mix 2 tablespoons of salt and a few drops of food coloring. Then mix in 2 cups of dirt or sand.

2. Put the salt and dirt mixture into a pan so it is on one side.

3. Tip the pan so the side with the mixture in it is slightly off the table. Try not to knock any of the mixture to the other side.

4. As you hold the pan slightly off the table, slowly pour some water onto the mixture.

5. **Observe** Note what color the water is when it reaches the other side. How does the color of the water compare to the color of the dyed salt?

6. **Infer** How does this model resemble what happens as fresh water flows down to the ocean?
Observe and Measure

The amount of salt in the ocean has increased over millions of years. Oceans are salty because the salt is left behind when fresh water evaporates. Does all of the salt stay in the ocean? Scientists often think of questions that have not been answered yet. To find the answers, they measure and observe things around them.

1 Learn It
When you observe, you use one or more of your senses to identify or learn about an object. When you measure, you find the size, distance, time, volume, area, mass, weight, or temperature.

It is important to record measurements and observations you make during your experiment. You can organize this kind of data on a chart or graph so you can compare information at a glance. Once you have enough information, you can make predictions about what might happen if you changed a variable in the experiment.

Materials
- 225 mL of water
- 2 large clear plastic cups
- measuring cup
- salt
- teaspoon
- marker
- lamp (optional)
- refrigerator (optional)
Try It

What happens to the salt in the ocean when water evaporates?

▲ Measure  Add 225 milliliters of water to each of two large clear plastic cups. Mark the level of the water in each cup on the outside.

▲ Dissolve a teaspoon of salt in each cup. Stir each cup to mix the salt and water as much as possible.

▲ Use Variables  Place one cup in a warm location, such as in sunlight or under a lamp. Place the second cup in a cooler location, such as in a refrigerator or a shady spot.

▲ Record Data  Mark the level of the water on each cup once every day until all of the water has evaporated. Using the chart, record the temperature in each spot each time you measure the level of the water. Also record any other observations you made.

<table>
<thead>
<tr>
<th>Day</th>
<th>Shady Cup</th>
<th>Sunny Cup</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
<td></td>
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<td>3</td>
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<td>4</td>
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<tr>
<td>5</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

▲ Measure  Once the water has evaporated, measure the amount of salt left in each cup. Record the measurements.
Apply It
Use the information from your measuring and observing to answer these questions.

▶ Analyze Data  How does temperature affect the rate of evaporation?

............................................................................................................
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............................................................................................................

▶ How much of the original teaspoon of salt was left in each cup after the water evaporated?

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▶ Can you predict what would happen if you used more salt than water? What if you used equal parts of salt and water?

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How do water droplets form?

Form a Hypothesis
One of the variables that can affect water droplet formation is temperature. You will use a glass filled with room temperature water and a glass filled with ice water to see if water droplets form on the sides of the glasses. Before you begin, write a hypothesis in the form “If the glass is . . . then water will . . .”

Test Your Hypothesis

1. Fill one glass completely with ice. In a separate glass, add a few drops of food coloring to some cold water and stir. Then pour the water into the glass that is full of ice.

2. Fill the empty glass with room temperature water. Add a few drops of food coloring to the water and stir.

3. Sprinkle salt onto each saucer. Then put one glass on each saucer. Let the glasses sit for half an hour.

4. Observe What do you see on the sides of either glass?

<table>
<thead>
<tr>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 glasses</td>
</tr>
<tr>
<td>food coloring</td>
</tr>
<tr>
<td>water</td>
</tr>
<tr>
<td>ice</td>
</tr>
<tr>
<td>2 saucers</td>
</tr>
<tr>
<td>salt</td>
</tr>
</tbody>
</table>
Draw Conclusions

5 **Draw Conclusions** Are the water droplets dyed? What does this indicate about where the water droplets came from?

__________________________________________________________________________

__________________________________________________________________________

6 **Use Variables** The independent variable in this experiment was temperature. What was the dependent variable in this experiment?

__________________________________________________________________________

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7 **Infer** Why do you think water droplets formed where they did?

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Explore More

What happened to the salt under the glass with water droplets? Plan and carry out an experiment that shows where the salt is.

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Observing the Water Cycle

1. Fill two jars halfway with water and secure the lid.

2. Place one jar in a warm, sunny location and the other in a cool, dark corner for 30 minutes. Record your observations during this time.

Date

Name

Materials

- 2 jars with tight-fitting lid
- water
- ice cubes
Types of Clouds

1. **Predict** Which type of clouds do you see most frequently?

2. Look for clouds in the sky. How many types of clouds do you see?

3. **Record Data** Make a chart to record what you see.

4. **Classify** Do the clouds that you see look like cirrus, cumulus, or stratus clouds?

**Cloud Observation**

<table>
<thead>
<tr>
<th></th>
<th>Cirrus</th>
<th>Cumulus</th>
<th>Stratus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Day 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Continue your data collection for one week.

6. **Analyze Data** Which type of cloud did you see most frequently?

7. **Communicate** Write a report about the types of clouds that you saw. Do you think you would get different results at a different time of year?
Inquiry: Structured

How can you tell that water vapor is in the air?

Form a Hypothesis
Water is constantly evaporating. You will cover a cup of water and use cobalt chloride paper to find out if this is true. Cobalt chloride paper is blue. It turns pink in air that has water vapor in it. Write a hypothesis in the form “If water is constantly evaporating, then the amount of water vapor in the air . . .”

Test Your Hypothesis

1 △ Be Careful! Cut the tops off of the two clear plastic bottles.
2 Tape one strip of cobalt chloride paper in the bottom of each plastic bottle.
3 Place one bottle upside down over an empty plastic cup. Place the second bottle upside down over a cup half-full of water.
4 Tape a third strip of cobalt chloride paper to a sheet of paper. Leave it in open air.
5 Observe Examine the color of the cobalt chloride paper.

Materials
- 2 clear plastic bottles
- 2 clear plastic cups
- cobalt chloride paper
- scissors
- tape
- sheet of paper
6 **Record Data** Write down your observations of any changes in color of the cobalt chloride paper. Also record any changes in the level of water in the cup.

________________________________________________________________________

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**Draw Conclusions**

1 **Use Variables** Identify the variables in this experiment. What purpose does the cobalt chloride paper that is taped to the piece of paper serve?

________________________________________________________________________

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2 **Draw Conclusions** Does the evidence from your observations support your hypothesis?

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Inquiry: Guided

How does surface area affect how fast water evaporates?

Form a Hypothesis
You have already learned that water evaporates and can be detected as water vapor in the air. Does water evaporate faster from a body of water with a bigger surface area? Write your answer as a hypothesis in the form “If you increase the surface area of water, then the evaporation of the water will . . .”

Test Your Hypothesis
Design a plan to test your hypothesis. Write out the materials, resources, and steps that you need to take. Record your results and observations as you follow your plan.

▶ My Materials and Resources:

▶ The Steps I Will Follow:

▶ These Are My Results:
Draw Conclusions
Did your test support your hypothesis? Why or why not? Present your results to your classmates.

---

Inquiry: Open
How would being near a larger body of water affect the rate of precipitation in an area? What effect does wind have on the evaporation rate of water? Come up with a question to investigate. Design an experiment to answer your question. Your experiment must be organized to test only one variable, or one item being changed. Your experiment must be written so that another group can complete the experiment by following your instructions.

1. My Question Is: ____________________________
   ____________________________
   ____________________________

2. How I Can Test It: ____________________________
   ____________________________
   ____________________________
   ____________________________
   ____________________________

3. My Results Are: ____________________________
   ____________________________
   ____________________________
How much fresh water do you use?

Make a Prediction
How much water do you use in a day for a particular activity such as brushing your teeth or washing your hands?

Test Your Prediction
1. Put the container in the sink.
2. Turn the water on and pretend to brush your teeth or wash your hands. Run the water as long as you would if you were really doing that activity. Once you are done, turn the water off.
3. Measure Using the measuring cup, scoop water out of the container into the sink. Keep track of each cup that you pour so you can estimate the total amount of fresh water you used in that activity.

Draw Conclusions
4. Communicate Discuss how much water you used with your classmates. Exchange data for the amount of water you used for your chosen activity. Whose use of water was closest to their prediction?
5 **Use Numbers**  Figure out how many gallons of fresh water you use for the activity in a week, a month, and a year. Remember to include how many times each day you do that task.


6 **Analyze Data**  Design and complete a table or graph to display your results.


**Explore More**
Think of a way you can reduce the amount of water that you use. Predict how much water you can save. Redo the activity you chose using your new idea. Were you able to save water? Discuss your idea and its result with your classmates.
How do you read a water bill?

1. **Observe and Classify** Examine a water bill and classify the information it contains.
   - 
   - 
   - 
   - 
   - 

2. **Measure** How many gallons of water is 1 cubic foot?
   - 

3. **Use Numbers** If your water bill said you used 100 cubic feet of water in April, about how many gallons of water did you use each day?
   - 

**Materials**
- water bill
- 1 cubic foot rectangular container
- gallon bucket
Cleaning Polluted Water

1. Make a model of polluted water by mixing 3 liters of fresh water with soil, rocks, and leaves of different sizes.

2. Cut the tops off of three clear 2-liter plastic bottles.

3. Fill the first bottle with 3 inches of sand. Fill the second bottle with 3 inches of sand and then a layer of 3 inches of pebbles. Fill the third bottle with 3 inches of sand, 3 inches of pebbles, and a top layer of 3 inches of rocks.

4. Using a sharpened pencil tip, carefully make a small hole into the side of each container near the bottom.

5. **Experiment** Hold a clear plastic cup up to the hole in the first bottle. Then pour about 1/3 of the polluted water into the bottle. Collect the water coming from the hole. Repeat these steps for the second and third bottles using different cups.

6. **Observe** Compare the water in each cup.

7. **Communicate** Explain the differences you observe. Which cup had the clearest water? Why?
How much precipitation falls in your community?

**Purpose**
To measure the amount of precipitation in your area and see if your community gets enough water from precipitation to supply what your families use every day.

**Procedure**

1. **Be Careful.** Use the scissors to cut off the top of the carton.

2. Tape your carton into the baking pan and put the pan on the ground outside in an open area.

3. **Measure** At the same time every day, check the carton to see if there is any water inside. If there is water, measure the height in inches of water in the container.

4. **Record Data** Write down the daily results on a table. Then empty the carton and put it back in the same spot outside.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Amount of Precipitation</th>
</tr>
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<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Materials**
- scissors
- orange juice carton
- masking tape
- baking pan
- ruler
**Draw Conclusions**

5 **Analyze Data** Design and complete a graph to display your results.

6 **Use Numbers** How can you convert your daily measurement of inches of precipitation into gallons? HINT: The conversion rate is 1 cubic inch = 0.004 gallons.

7 **Draw Conclusions** An average family in California uses 224 gallons of water every day. Did you get that much water in precipitation?

**Explore More**

How close were your results to an official rain measurement for your area? Were there any problems that you ran into with the experiment? How could you improve the data collection?
Analyzing Rainfall Data

Find how much precipitation actually fell in your region over a specific period of time.

1 **Research** Collect information on average amounts of rainfall for the region.

2 **Record Data** Make a chart of the data, like the one below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual precipitation</th>
<th>Expected average precipitation</th>
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<tbody>
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</tbody>
</table>

3 **Analyze Data** Plot your data on a bar graph.

4 Did your area suffer from water shortages in any year?
Your Water Sources

1. Look at the map on page 216. Use modeling clay to make a map of California. Make sure to include the mountain ranges.

2. Use a different color of modeling clay to show the routes of the major aqueducts in California.

3. Does your community get its water from an aqueduct? Use a piece of string to trace the route that your community’s water travels to get to you.

Materials

- map of California
- modeling clay, 2 colors
- string
How does air density change if the volume is changed?

**Make a Prediction**
If you have a plastic bag attached to the top of a container and the container is full of air, will it be hard to push the bag into the container?

**Materials**
- plastic container
- plastic sandwich bag
- rubber band
- masking tape

**Test Your Prediction**

1. **Make a Model**  Set up the bag and container as shown. Make sure your set up is sealed.

2. **Observe**  Have a partner place both hands on the container and hold it firmly. Slowly push the bag into the container.

3. Pull the bag back out of the container. Using a pencil, carefully poke a hole in the plastic bag.

4. **Observe**  Push the bag into the container again while holding your hand near the hole in the bag.

**Draw Conclusions**

5. Did the volume or the amount of air change as you pushed down in Step 2?
**Infer** How did it feel when you pushed the bag into the container in Step 2? Why?

________________________________________________________________________

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**Infer** Did the volume or the amount of air change as you pushed down in Step 4? How could you tell if it was changing?

________________________________________________________________________

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________________________________________________________________________

**Infer** How did it feel when you pushed into the container in Step 4? Why?

________________________________________________________________________

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**Explore More**
Predict what you think will happen if you repeat the set up so the bag is tucked into the container and you are pulling it out of the container. Test your prediction.

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________________________________________________________________________
Power of Air Pressure

1. Fill a small paper cup with water and push a square piece of cardboard firmly against the mouth of the cup.

2. Quickly invert the cup over the plastic bowl, being careful to keep the cardboard in place.

3. Remove your hands from the cardboard.

4. Observe What happens?

<table>
<thead>
<tr>
<th>Observation 1</th>
<th>Observation 2</th>
<th>Observation 3</th>
<th>Observation 4</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

Materials
- paper cup
- cardboard
- plastic bowl
- water
Air Pressure and Weight

1. Tie a length of string around the middle of a meterstick so the stick is balanced. Tape the string in place. Hang the meter stick from a shelf or other object so the stick can swing freely.

2. Blow up a balloon and knot it shut. Attach it with a piece of string to one end of the meterstick. Tape the string in place.

3. Add paper clips or binder clips to the other side of the meterstick until the stick is balanced.

4. Carefully use a pin to poke a small hole in the neck of the balloon under the knot so the air will run out slowly. DO NOT PUNCTURE THE BALLOON BELOW THIS POINT.

5. Observe What happens to the meterstick?

6. Infer How do the results show that air has weight?

Materials
- string
- meterstick
- tape
- balloon
- paper clips or binder clips
- pin
Communicate

When scientists complete an experiment, they communicate their results by writing books and articles, doing newspaper and TV interviews, and making presentations. When you communicate, you share information with others. You may do this by speaking, writing, drawing, using sign language, pantomiming, singing, or dancing.

Learn It

In the following activity, you will do an experiment to test whether air can lift a notebook off the table. Keep notes as you do your experiment. Your notes should include a list of your materials, your observations at each step of the experiment, and whether or not you were able to prove your hypothesis.

Scientists often try new experiments based on work that other scientists have done. If you accurately communicate everything that you do, other people will be able to do new experiments based on what you did. If you get an unexpected result or disprove your hypothesis, you should communicate that information as well. Writing down exactly what you did also lets you plan new experiments with different materials and different variables.
2 Try It
You know that air has weight and takes up space. Do you think air will be able to lift a notebook off a table?

► Place the notebook on a table. Tape two balloons to the notebook, leaving enough of the ends of the balloons sticking out for you to blow them up. Flip the notebook over.

► Blow into the balloons to fill them with air. When you need to take a breath, pinch the tips of the balloons to keep air from leaking out. What happens to the notebook?

► Measure Using a ruler, measure the distance between the table and the bottom of the book at the highest point.

► Communicate Exchange data with your classmates about the distance you were able to raise the notebook.

Materials
• balloons
• notebook
• tape
• ruler
Analyze Data  Using data from your classmates, figure out the average height that your class was able to lift the notebooks. Make a bar graph to compare your results. Who was able to raise their notebook the highest? Was anyone unable to lift it?
Apply It

How could you use air to lift the book even higher? Think about what you can change in the equipment you just did. What would happen if you used bigger balloons? If you placed little balloons under each corner of the notebook? Could you use the same materials to lift a heavier book?

Plan a new experiment using different materials. Test your idea and draw conclusions about using the power of air to lift objects. Finally, communicate to the class about the results of your experiment by writing a report, drawing a cartoon strip, or composing and singing a song!
How does the angle of sunlight affect temperature?

Be Careful. Do not look directly at the Sun.

Form a Hypothesis
What happens to the temperature of Earth as the angle of sunlight increases? Write your answer as a hypothesis in the form “If the angle of the sunlight increases, then . . .”

Test Your Hypothesis

1. Cut a hole for your thermometer in the middle of each piece of construction paper.
2. Tape one sheet of construction paper to each of the pieces of cardboard.
3. Place a thermometer into each hole so the bulb is between the cardboard and the paper and the scale can be read.
4. Tape the thermometers in place. Leave the thermometers in the shade until they read the same temperature. Record this temperature.
5. Put the thermometers out in the sunlight.
6. Record Data Every two minutes, record the temperature shown on each thermometer.

Materials
- three sheets black construction paper
- scissors
- three pieces of cardboard
- masking tape
- three thermometers
- protractor
Draw Conclusions

What are the independent and dependent variables in this experiment?

Analyze Data

Graph the change in temperature over time for each thermometer. Which thermometer’s temperature rose faster?

Explore More

How does the angle of sunlight change during different seasons? Plan an experiment to find out.
Intensity of Sunlight

1. Fill two small paper cups with water at the same temperature and place a thermometer in each cup.

2. Shine one light source directly on one paper cup, and the other light source indirectly on the other paper cup.

3. Take temperature readings from each paper cup every 20 minutes for 60 minutes.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Direct Light</th>
<th>Indirect Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. **Analyze Data**  Discuss how the angle at which light hits an object affects the temperature of that object.

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
Land and Water Temperatures

1 **Predict** Write down your prediction about whether water or land holds heat longer.

2 **Make a Model** Fill one container with room-temperature water. Then fill another container to the same height with sand.

3 **Record Data** Measure the initial temperature of each material by placing a thermometer about halfway down into the middle of the container. Record it on a table.

4 **Experiment** Place both containers in a tub of ice water.

5 **Record Data** Record the temperature in each container every 2 minutes.

6 **Analyze Data** Graph the change in temperature over time for both containers. Which one had a faster drop in temperature?

7 **Communicate** Write a report. Include the details of the experiment and tell whether or not the evidence supports your prediction.

**Materials**
- 2 identical containers
- water
- sand
- thermometer
- ice

<table>
<thead>
<tr>
<th></th>
<th>Cup with Water</th>
<th>Cup with Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th Reading</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Inquiry: Structured

How does warmed air affect weather?

Form a Hypothesis
When air is warmed, it becomes less dense and has a higher pressure. How does warm air move? In this experiment, you will hold a spiral of paper over a heat source. What do you think will happen to the paper? Write your hypothesis in the form “If the air warms, then the paper spiral will . . .”

Test Your Hypothesis

1. Cut a circle of paper to form a spiral.
2. Tie a piece of fishing line to one end of the paper.
3. Have your teacher turn on a heat source. Carefully hold or hang the spiral about 6 inches above the heat source.
4. Observe Describe what the spiral does.
5. While holding the spiral above the heat source, turn the heat source off. Describe what happens to the spiral.
**Draw Conclusions**

1. Why did the spiral of paper move when the heat source was on?

2. Why did the spiral stop moving when the heat source was not off?

3. **Infer** What happens to air over ground that is warmed throughout the day?
Inquiry: Guided

Which type of land changes temperature fastest?

Form a Hypothesis
You have already figured out what air does when it is warmed. Air is warmed by heat released from the land or from water. Of soil, sand, or rock, which type of land holds heat longer? Write your answer as a hypothesis in the form “If soil, sand, or rock are heated, then . . .”

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

Test Your Hypothesis
Design an experiment to determine which type of land holds heat longer. Write out the materials you will need and the steps you will follow. Record your results and observations as you follow your plan.

1. My Materials and Resources: ____________________________
   __________________________________________________________________________________
   __________________________________________________________________________________
   __________________________________________________________________________________

2. The Steps I Will Follow: ____________________________
   __________________________________________________________________________________
   __________________________________________________________________________________
   __________________________________________________________________________________
   __________________________________________________________________________________

3. My Results Are: ____________________________
   __________________________________________________________________________________
   __________________________________________________________________________________
Draw Conclusions
Did your experiment support your hypothesis? Why or why not? Present your results to your classmates.

Inquiry: Open
What else can you learn about air and temperature? For example, what do you think about how much heat fresh water can hold compared to ocean water? How does the size of a body of water affect how much heat it can hold? Design an experiment to answer your question. Your experiment must be organized to test only one variable, or one item being changed. Your experiment must be written so that another group can complete the experiment by following your instructions.

1 My Hypothesis Is: ____________________________________________
   ____________________________________________
   ____________________________________________

2 How I Can Test It: ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

3 My Results Are: ____________________________________________
   ____________________________________________
   ____________________________________________
What can cause two places to have different temperatures?

Make a Prediction
How does being close to an ocean affect the temperature of a city? Make a prediction.

Test Your Prediction

1. Find Stockton and San Francisco on a map of California on p. 252. Where are they located compared to the Pacific Ocean?

2. Compare Use the temperature data in the charts on page 253 to compare the monthly high and low temperatures of the two cities.
Draw Conclusions

3 Analyze Data Examine the data to determine whether the temperature changes less throughout the year in one city than the other.

4 Infer How might the ocean affect the temperature changes in these cities?

5 Communicate Write a report explaining how the data for these two cities either support or do not support your prediction. Would examining data for more cities improve the accuracy of your prediction?

Explore More
Write a prediction explaining how being near an ocean will affect another weather variable. Collect and compare weather data for both cities. Write a report explaining how the data support or do not support your prediction.
The Ocean’s Effect on Temperature

1. Place an ice cube on a piece of plastic wrap.

2. Place one thermometer 5 centimeters from the ice cube and the other thermometer 20 centimeters from the ice cube.

3. Shine a lamp over both thermometers and place the fan so it blows from the ice over the thermometers.

4. Record the temperatures on both thermometers over four 2-minute intervals and analyze the data.

<table>
<thead>
<tr>
<th></th>
<th>5 cm</th>
<th>20 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature 1</td>
<td></td>
<td></td>
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<tr>
<td>Temperature 2</td>
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<tr>
<td>Temperature 3</td>
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<td></td>
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<tr>
<td>Temperature 4</td>
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</tbody>
</table>

Materials

- plastic wrap
- ice
- fan
- lamp
- 2 thermometers
Ocean Currents

1. Fill a white or clear wash-basin or pan with about 2 in. of water at room temperature. This represents the ocean.

2. Fill one 8-oz paper cup with ice water and several drops of blue food coloring. Fill another 8-oz paper cup with hot water and several drops of red food coloring.

3. Place the cups in the pan. Then stick a pushpin into each cup about 1 in. from the bottom.

Make a Model  Gently pull out the pins to form currents.

Observe  What happens to the food coloring?

Does the colored water float or sink?

How does this model resemble ocean currents?

Materials
- clear pan
- hot and cold water
- 2 8-oz paper cups
- blue food coloring
- red food coloring
- pushpin
Inquiry: Structured

How does a land mass affect the speed of an ocean current?

Form a Hypothesis
If you measure the time a current takes to travel a certain distance and then measure the time the current takes to travel the same distance when it has to flow around a landmass, will the time the current takes change? Write your answer as a hypothesis in the form, “If a landmass is placed in a current, then the time the current takes will . . .”

Test Your Hypothesis

1. Pour cold water in a large plastic container to a height of 4 cm.

2. Add 6 drops of food coloring to warm water and mix. Then fill a sportwater bottle and put the cap on the bottle.

3. Hold the sportwater bottle down at one end of the container so it touches the bottom. Have your partner get the stopwatch ready. Then squeeze the sportwater bottle gently.

4. Record Data  Record the time the current takes to reach the other side of the container.
Replace the cold water in the large plastic container and refill the sportwater bottle with warm water and food coloring.

Make a landmass from modeling clay. Place the landmass in the middle of the container. Then repeat steps 3 and 4.

**Draw Conclusions**

1. Did the test support your hypothesis? Explain why or why not.

2. What is the independent variable in this experiment? What is the dependent variable?

3. **Communicate** Discuss your results with your classmates. How did your times compare with theirs?
Inquiry: Guided

Will the time change if the current goes between two landmasses that are different distances apart?

Form a Hypothesis
Write your answer as a hypothesis in the form “If the distance between two landmasses increases, then the time the current takes to reach the other side will . . .”

________________________________________________________

________________________________________________________

________________________________________________________

Test Your Hypothesis
Design an experiment to test your hypothesis. Write out the materials you will need and the steps you will follow. Carry out the procedure and record your results and observations.

1 My Materials and Resources: ________________________________________________________

________________________________________________________

________________________________________________________

2 The Steps I Will Follow: ____________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

3 My Results Are: ________________________________________________________________

________________________________________________________

________________________________________________________
Draw Conclusions
Did the data you collected support your hypothesis? Present your results to your classmates.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Inquiry: Open
What else would you like to learn about ocean currents? Come up with a question and design an experiment to answer it. Your experiment must be organized to test only one variable. Write instructions that another group can follow.

1. My Hypothesis Is: _________________________________________________________

__________________________________________________________________________

2. The Steps I Will Follow: __________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

3. My Results Are: __________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
What happens when masses of air meet?

Form a Hypothesis
What happens to air when it meets warmer air? Write your answer as a hypothesis in the form “If a mass of air meets warmer air, then . . .” Like air, water flows and carries heat. Using water as a model for air can help you test your hypothesis.

Test Your Hypothesis

1. Measure  Cut the cardboard so it fits tightly in the clear box. Wrap the cardboard in aluminum foil.

2. Pour 4 cups of cool water into one container, and 4 cups of warm water into the other one. Place a few drops of food coloring into the cool water container.

3. Hold the cardboard tightly against the bottom of the box. Pour the cool water on one side and the warm water on the other.

4. Observe  Watch the box from the side as you remove the cardboard.

5. Repeat the experiment using warm water in both containers and food coloring in one.

Materials
- scissors
- cardboard
- aluminum foil
- cold water
- warm water
- 2 containers
- food coloring
- clear plastic box
Explore

Name ___________________________________ Date ____________

Draw Conclusions

6 What are the variables in this experiment?
________________________________________________________________________
________________________________________________________________________

7 Infer Which experiment looked more like it would create storms? Why?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Explore More
Will a greater difference in temperature between the warm and cold water increase the observable effects? Form a hypothesis and test it.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Storm Tracking

Tornadoes usually form over land and hurricanes usually form over water.

1 Use research materials to find the areas on Earth that are most often hit by hurricanes and tornadoes.

2 Research weather patterns in these areas to determine whether they have similar conditions that might account for the frequency of these storms.

Materials
- encyclopedias
- internet
Tornado in a Bottle

1. Fill a 2-liter plastic bottle one-third full of water.

2. Place an empty 2-liter plastic bottle upside down over the mouth of the first bottle. Tape them together.

3. Holding the bottles by the necks, flip them upside-down so the bottle with the water in it is now on top. Place the bottles on a desk. What do you see?

4. Make a Model  Swirl the water and turn the bottles over again. Then put them down and observe.

5. How is this model similar to a tornado?

Materials

- 2 two-liter plastic bottles
- water
- tape
How can you tell the direction that wind is blowing?

**Purpose**
To make a weather vane and record the direction of the wind.

**Procedure**

1. Carefully use scissors to cut an arrow shape with a tab out of a piece of cardboard or heavy construction paper. Squeeze the end of one straw and insert it in the other to make a longer tube.

2. Put the tab of the arrow in one end of the straw. Put the other end of the straw in the bottle.

3. Put the bottle in a pan and pile rocks around it to keep it steady when the wind blows.

4. Use a compass to find north, and then mark the four sides of the pan North, South, East, and West with a marker.

5. Set your weather vane in a high, open place.

6. **Record Data** For a week, record the direction of the wind every morning.
Draw Conclusions

7 Analyze Data  Find the wind direction from a local weather station. Make a graph to compare your data with the data of the local station.

8 Communicate  Write a report about your weather vane project. Include details about its construction and accuracy.

Explore More
How can you measure wind speed? Research the Beaufort Wind Scale. Suggest and test a scale to use for wind speed measurements in your area.
Measuring Wind Speed

1. Cut a 10-cm by 10-cm piece of cardboard and stick a push pin into the upper left corner.

2. Cut a strip of aluminum foil 3 cm wide by 10 cm long and hang the foil strip from the push pin.

3. Turn the fan on the lowest setting and hold the cardboard in front of the fan. The strip of aluminum foil will move higher as the air hits it.

4. Compare the height of the aluminum foil strip as the fan is moved to faster settings.

Materials
- cardboard
- push pin
- aluminum foil strip
- fan
Highs and Lows

How do winds in high and low pressure systems rotate?

1. **Make a Model** To model a high pressure system, stand one step away from your partner facing in the same direction. You represent the wind. Your partner represents the high pressure center.

2. Walk two steps away from your partner and turn to your right. Walk around your partner. In what direction is the wind moving around the high-pressure center?

3. **Make a Model** To model a low pressure system, stand four steps away from your partner. You represent the wind. Your partner represents the low pressure center.

4. Walk two steps toward your partner and turn to your right. Walk around your partner. In what direction is the wind moving around the low-pressure center?
How do the sizes of Earth and the Sun compare?

**Purpose**
To study the size difference between Earth and the Sun.

**Procedure**

1. **Use Numbers**  What proportion does the size of Earth have to the size of the Sun?

2. **Use Numbers**  What would the diameter of the Sun be if the diameter of the Earth was 0.5 cm?

3. **Make a Model**  Use appropriate tools to design a model of Earth and the Sun to this scale.

4. How many Earths would it take to cover the length of the model Sun’s diameter?
Draw Conclusions

Communicate Explain why this model does, or does not, show an accurate comparison between the diameters of the Sun and Earth.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Explore More
How does the Moon's diameter compare with that of Earth? Do research to answer this question and create a model to represent the difference in their sizes.

__________________________________________________________________________

__________________________________________________________________________

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__________________________________________________________________________
Sizes of Distant Objects

1 **Make a Model**  Work in groups of four. The student with the beach ball represents the Sun. The student with the tennis ball represents the Moon. Another student represents an observer on Earth. The fourth student will take measurements.

2 Have the three students stand in a line in this order: Earth, Moon, Sun.

3 **Observe**  While the Moon student stands still, let the Sun and Earth students move away from each other until the Moon and Sun appear to be the same size to the observer on Earth.

4 **Measure**  The fourth student takes measurements from Earth to the Moon, and Earth to the Sun.

5 **Compare Results**  Compare your data with data found by other groups in your class.

---

**Materials**
- beach ball
- tennis ball
- meterstick

---

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The Parts of the Sun

1. **Make a Model**  Use modeling clay to make a model of the Sun that includes all of the layers.

2. **Be Careful.** Using a plastic knife, cut away a quarter of your Sun so you can see into it.

3. Add sunspots and solar flares to the surface of your Sun.

4. **Communicate**  Write a description of your Sun. Include a color key to identify the layers.

---

**Materials**

- poster board
- colored pencils or crayons
- modeling clay (six different colors)
- meterstick
- plastic knife
Draw Conclusions

Scientists began recording data about sunspots in 1749. After they collected years of data, scientists concluded that the number of sunspots increases and decreases during an 11-year cycle. From the beginning of the cycle, the number of sunspots tends to increase over a period of about five years to a maximum number. Over the next six years, the number of sunspots decreases to a minimum number. A new cycle begins when the number of sunspots increases.

Learn It

When you draw conclusions, you look at all the facts and decide what can be based on those facts. Be careful not to “jump to conclusions,” or to draw conclusions that are not supported by the data.

Look at the chart. It lists the number of sunspots recorded each year beginning in 1750. When scientists looked at the first two years of data, they could have concluded that the number of sunspots always decreased. However, in 1752, the number of sunspots increased. This means that their conclusion was no longer supported by the data. They needed to collect more data and draw a new conclusion.

When you gather data, it is important to record it. Having a record of your data gives you the information that you need to be able to draw conclusions.
Try It
Use the chart to draw conclusions as you answer the following questions.

<table>
<thead>
<tr>
<th>Year</th>
<th>Recorded Sunspots</th>
</tr>
</thead>
<tbody>
<tr>
<td>1750</td>
<td>1,001</td>
</tr>
<tr>
<td>1751</td>
<td>572</td>
</tr>
<tr>
<td>1752</td>
<td>574</td>
</tr>
<tr>
<td>1753</td>
<td>368</td>
</tr>
<tr>
<td>1754</td>
<td>147</td>
</tr>
<tr>
<td>1755</td>
<td>115</td>
</tr>
<tr>
<td>1756</td>
<td>122</td>
</tr>
<tr>
<td>1757</td>
<td>389</td>
</tr>
<tr>
<td>1758</td>
<td>671</td>
</tr>
<tr>
<td>1759</td>
<td>648</td>
</tr>
<tr>
<td>1760</td>
<td>754</td>
</tr>
<tr>
<td>1761</td>
<td>1,030</td>
</tr>
</tbody>
</table>

In which year would you conclude that this cycle began? Why?

If you were a scientist studying sunspots, in which years did you observe changes in the number of sunspots that might make you question the existence of a cycle?
If you only had ten years of data, but you hypothesized that the sunspot cycle was longer than ten years, what would you have to do before you could draw a conclusion?

Apply It
This chart shows data about sunspots and solar flares from 1993 to 2004. Use it to draw conclusions as you answer the following questions.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sunspots</th>
<th>Solar Flares</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>657</td>
<td>2,541</td>
</tr>
<tr>
<td>1994</td>
<td>359</td>
<td>1,066</td>
</tr>
<tr>
<td>1995</td>
<td>210</td>
<td>639</td>
</tr>
<tr>
<td>1996</td>
<td>103</td>
<td>280</td>
</tr>
<tr>
<td>1997</td>
<td>258</td>
<td>790</td>
</tr>
<tr>
<td>1998</td>
<td>769</td>
<td>2,423</td>
</tr>
<tr>
<td>1999</td>
<td>1,118</td>
<td>3,963</td>
</tr>
<tr>
<td>2000</td>
<td>1,433</td>
<td>4,474</td>
</tr>
<tr>
<td>2001</td>
<td>1,331</td>
<td>3,597</td>
</tr>
<tr>
<td>2002</td>
<td>1,245</td>
<td>3,223</td>
</tr>
<tr>
<td>2003</td>
<td>763</td>
<td>1,552</td>
</tr>
<tr>
<td>2004</td>
<td>486</td>
<td>728</td>
</tr>
</tbody>
</table>

In which year do you conclude that an 11-year cycle began? How do you know?
What can you conclude about the frequency of sunspots between 1993 and 2004 compared to between 1750 and 1761?


What can you conclude about expected sunspot activity in 2005 and 2006?


Scientists recently began recording data about the number of solar flares that occur every year. Their hypothesis was that solar flares increase and decrease on the same cycle as sunspots. Would you conclude that the recorded data supports this hypothesis? Why?


What could you do to provide additional support for your conclusion that solar flares increase and decrease on the same cycle as sunspots?
How far apart are the planets?

**Purpose**
To learn about the distances between the planets by making a model.

**Procedure**
1. Let the length of each paper towel equal 1 Astronomical Unit. Using the chart, lay out the number of paper towels you need to show the distance from the Sun to Pluto.

2. **Make a Model** Mark the location of the Sun and each planet on the paper towels.

<table>
<thead>
<tr>
<th>Planets of the Planets from the Sun</th>
<th>Distance in A.U.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>.39</td>
</tr>
<tr>
<td>Venus</td>
<td>.7</td>
</tr>
<tr>
<td>Earth</td>
<td>1</td>
</tr>
<tr>
<td>Mars</td>
<td>1.5</td>
</tr>
<tr>
<td>Jupiter</td>
<td>5.2</td>
</tr>
<tr>
<td>Saturn</td>
<td>9.5</td>
</tr>
<tr>
<td>Uranus</td>
<td>19.2</td>
</tr>
<tr>
<td>Neptune</td>
<td>30</td>
</tr>
<tr>
<td>Pluto</td>
<td>39.4</td>
</tr>
</tbody>
</table>

**Materials**
- paper towels
- markers
- ruler

California Standard 5 ES 5.b.
**Draw Conclusions**

3 **Analyze Data** Compare the distances between Mercury and Mars, Mars and Jupiter, and Jupiter and Pluto. Which are the farthest apart?

4 **Infer** What can you conclude about the distances between the planets in the solar system?

**Explore More**

Your model has all of the planets in a line. Actually, the planets move in circles around the Sun. What kind of model would you make to show the positions of the planets at a specific time? Write instructions that others can follow to make the model.
Make Planet Fact Cards

1. Your teacher will give you nine index cards. Write the name of one planet on one side of each card.

2. On the other side, write the distance between that planet and the Sun.

3. Put the cards in order from the planet nearest the Sun to the planet farthest from the Sun.

4. Add information to your cards as you learn more about the planets.

Materials

- index cards
- colored pencils
- markers or crayons
Moon Craters

1. Cover the floor with newspaper and place a pan on the paper.

2. **Make a Model** Fill the pan with about 1 inch of flour. Gently tap pan until the flour layer is smooth. Then sprinkle whole wheat flour on top to represent topsoil.

3. Measure the diameter of three different-sized marbles.

4. Drop the largest marble from about 3 inches straight above the pan. Remove it carefully, then measure the diameter and depth of the crater.

5. Drop the other marble over different spots from the same height. Measure each crater and record the data.

6. Are the craters bigger or smaller than the diameter of the marble?

7. What do you see at the crater sites? Why did this happen?

8. How is your model similar to what happens when an object hits the surface of the Moon?

**Materials**
- newspaper
- flour
- whole wheat flour
- marbles of different sizes
- string
- meterstick
Inquiry: Structured

Why do comets have tails?

Form a Hypothesis
Comets are made of frozen gases, ice, dust, and rock. The orbit of a comet around the Sun is usually a long oval with the Sun closer to one end of the oval. At some point in the orbit, comets develop tails. What causes the tails to form? Write your answer as a hypothesis in the form “If a comet forms a tail, then . . .”

Test Your Hypothesis

1. Using a spoon, mix 2 cups of melted frozen yogurt with 1 cup of seltzer water. These ingredients represent the frozen water and frozen gases in a comet.

2. Divide the mixture into two sealable containers. Put the lids on the containers and freeze the containers overnight. Mark an oval orbit on the floor for your comet to follow.

3. Make a Model Take one container out of the freezer and put it 3 inches from a desk light. This container represents a comet when it is close to the Sun.

4. Make a Model Take the other container and put it 3 feet from the desk light. This container represents a comet when it is far away from the Sun.

Materials
- spoon
- frozen yogurt
- seltzer water
- 2 sealable containers
- measuring cup
- desk light
- stopwatch
5 **Observe** Watch the containers of comet material as they melt. Look for changes in the surface, such as bubbles or melting.

6 **Record Data** Note the surface changes that you see. Record the time at which you first see bubbles form and when the contents of the container look melted.

**Draw Conclusions**

1 **Analyze Data** Which of the containers showed bubbles first? What else did you observe?

2 **Draw Conclusions** Where on a comet’s path around the Sun would you expect the most melting gas to be present?

3 **Predict** In your experiment, enough heat energy was present to eventually melt the contents of both containers. When a comet is so far away from the Sun that no energy reaches it, would you expect it to have a tail of gases?
Inquiry: Guided

Does the direction of a comet’s tail change as it goes around the Sun?

Form a Hypothesis

Energy from the Sun radiates out into space in all directions. What do you think this means about the direction of a comet’s tail? Write your answer as a hypothesis in the form “If energy radiates out from the Sun in all directions, then . . .”

Test Your Hypothesis

Design a plan to test your hypothesis. Then write out the materials and resources you need and the steps you will do. Record your results and observations as you follow your plan.

1  My Materials and Resources: ________________________________
   ________________________________
   ________________________________
   ________________________________
   ________________________________

2  The Steps I Will Take: ________________________________
   ________________________________
   ________________________________
   ________________________________
   ________________________________

3  My Results and Observations: ________________________________
   ________________________________
   ________________________________
   ________________________________
   ________________________________
Draw Conclusions
Did your test support your hypothesis? Why or why not? Present your results to your classmates.

Inquiry: Open
You have studied comets that orbit in ovals around the Sun. How do you think a different-shaped orbit around the Sun would affect the tail of a comet? Come up with a question to investigate and design an experiment to answer your question. Your experiment must be organized to test only one variable, or one item being changed. Your experiment must be written so that another group can complete the experiment by following your instructions.

1. My Question Is:  

2. How I Can Test It:  

3. My Results Are:  

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What keeps the Moon moving around Earth?

**Form a Hypothesis**
If you let go of a ball being swung in a circle, where will the ball go? Write a hypothesis in the form “If I let go of a ball being swung in a circle, then . . .”

**Test Your Hypothesis**

1. Place the ball on the fabric and bring the four corners together so it covers the ball. Then tie one end of the string around the four corners, forming a pouch.

2. ▲ Be Careful. Lean forward and slowly whirl the ball in a circle near your feet.

3. Observe Let go of the string. Watch the path that the ball takes.

4. Record Data Draw and label a diagram showing the path the ball took when you let it go.

---

**Materials**
- tennis ball
- square of fabric
- 0.5-meter long piece of string
- graph paper

---

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Repeat the experiment, letting the ball go at three different spots on the circle.

**Draw Conclusions**

Did the experiment support your hypothesis? Why or why not?

If this activity models the solar system, what do you, the ball, and the string represent?

**Explore More**

What results would you expect if you repeated the experiment using a lighter ball? Form a hypothesis, do the experiment, analyze your data, and write a report.
Find the Center of Gravity of a Mass

Two conditions contribute to the gravitational attraction between two objects:
• The total mass of the two objects.
• How far apart the centers of the two objects are.

Objects are balanced when their weight is evenly distributed. The balancing point of an object is its center of mass, also called its center of gravity.

1 Experiment Put a meter stick between your two feet. Record the exact center between your feet.

2 Observe Stand on one foot. Are you still centered on the same measurement? What do you have to do to keep from falling down?

3 Infer Why do you have to change body position to stand still on one foot?

4 Draw Conclusions What happens to your center of gravity when you stand on one foot?
Gravity and Inertia

1. Pour beans into a sock. Tie a knot in the top of the sock.

2. Place the pencil on the ground. The pencil will be your target.

3. **Be Careful.** Start 20 ft from the target. Holding the sock in your hand at waist height, run toward the target.

4. Drop the sock at the moment the sock is above the target. After you drop the sock, you can stop running.

5. **Record Data** Record the distance the sock lands from the target.

6. **Analyze Data** Where did the sock land? Why?

7. Repeat this experiment. Does the sock always land in about the same place?

8. How is what happens to the sock similar to a planet’s orbit?

**Materials**
- beans
- sock
- pencil
What makes a large object light?

Make a Prediction
Which is lighter, an inflated balloon or a tennis ball? Which is larger, an inflated balloon or a tennis ball? Why do you think this is? Do you think what they are made of is the reason for this difference? Make a prediction to answer this question.

Test Your Prediction
1. **Measure**  Using an equal pan balance, find out which object is heavier. Record your observations.

2. **Measure**  Using a bowl of water, find out which object is larger. Record your observations.

3. **Analyze Data**  Look at the unfilled balloon and the halved tennis ball. What are the inflated balloon and the tennis ball made of?

Materials
- inflated balloon
- tennis ball
- equal pan balance
- bowl of water
- tape
- empty balloon
- halved tennis ball
Draw Conclusions

4 How can you explain what you observed?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

5 Did your observations support your prediction?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Explore More

Predict which is lighter, a box of popped popcorn or a box of unpopped popcorn? Design an experiment to test your prediction. Write a report of your results.

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________________________________________________________________________
________________________________________________________________________
What’s the Difference?

How can you describe the difference between a golf ball and a table tennis ball by identifying which is “more?”

1 Record Data Trace the outline of the golf ball and the table-tennis ball on a sheet of paper. Draw a diagram showing the sizes.

2 Experiment What happens when you place the golf ball in a beaker of water? Try it. Record your observations.

3 Repeat this procedure for the table-tennis ball. What happened? Why?

4 Draw Conclusions Summarize your observations by indicating which ball was “more” in terms of size, and in terms of some other measurement.

Materials

• golf ball
• table tennis ball
• water
• beaker
Changes of State

1 **Make a Model** Place enough marbles in a small transparent plastic container to fill half the bottom with a single layer. Leave enough room for the marbles to roll around the bottom. Put a cover on the container.

2 Tilt the container slightly to bring all the marbles together. Shake the container slightly so the marbles settle down. What state of matter have you modeled?

3 Tilt the container in other directions so the marbles roll slowly around but stay together. What state of matter does this model?

4 Shake the container gently so the marbles bounce off the walls in all directions. What state of matter does this model?
Record Data and Infer

You just read that particles in hot liquid move faster than those in cold. Since hot water has more energy to get rid of before it freezes, it shouldn’t freeze as fast as cold water.

Well, that’s what many people thought. But scientists wanted to know for sure, so they did a series of experiments and recorded their observations. Then they used that data to make an inference: Sometimes hot water freezes faster than cold water, a phenomenon known as the *Mpemba Effect*. The *Mpemba Effect* is named after a high school student in Tanzania, Africa in 1969.

1. **Learn It**
   - When you **record data** you accurately arrange and store information collected in science investigations. When you **infer**, you form an opinion after analyzing recorded data.
   - It’s easier to analyze data and form opinions if you organize the information on a chart or in a graph. That way you can quickly see differences between data and **infer** results.
Try It

- Make a chart like the one shown to record data and your observations.

- Get one cup and fill it with hot tap water (approximately 70°C) and label it HOT WATER.

- Fill another cup with the same amount of cold tap water (approximately 18°C) and label it COLD WATER.

- Place both containers in a freezer. Record the placement in the freezer, size of freezer, separation between containers, and space from the side of top of freezer.

<table>
<thead>
<tr>
<th>Time to Freeze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Hot Water</td>
</tr>
<tr>
<td>70°C</td>
</tr>
<tr>
<td>Cold Water</td>
</tr>
<tr>
<td>18°C</td>
</tr>
</tbody>
</table>

- Check the freezer every 25 minutes. Record how long it takes the water in each container to begin to freeze. Record how long it takes the water in each container to completely freeze.

Materials

- 2 clear cups
- water
- graduated cylinder
- thermometer
- clock
Which froze first, cold water or hot water? Repeat this experiment to confirm your findings.

<table>
<thead>
<tr>
<th>Time to Freeze</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature</strong></td>
</tr>
<tr>
<td>Hot Water 70°C</td>
</tr>
<tr>
<td>Cold Water 18°C</td>
</tr>
</tbody>
</table>

Scientists inferred that sometimes hot water freezes before cold water. What can you infer from the data you recorded?
Apply It
What do you think would happen if you repeated this experiment using a smaller container or starting with really icy or even hotter water? Try it and record data about the investigation. Finally, use that data to help you infer, or develop an opinion, about the freezability of hot versus cold water.
Do living things contain carbon?

**Purpose**
Carbon is a vital component of all living things. In this activity you will use a blackened spoon to find out if carbon is present in living things.

**Procedure**

1. **Observe** Examine a stick of charcoal with a hand lens. Charcoal is pure carbon. Draw what you see.

2. Rub the charcoal on a sheet of paper. Examine the result more closely with the hand lens. Note any distinctive color and other properties of carbon.

3. **Experiment** Your teacher will give you a blackened metal spoon. It was held above the tip of a paraffin candle flame for a few seconds. Paraffin is extracted from petroleum which is formed from ancient plants and animals. What substance do you think is on the spoon?
Rub the spoon on paper. Examine the result with a hand lens.

Draw Conclusions

Infer  What substance did the paraffin candle seem to contain?

Explore More

A wooden toothpick is made of plant tissue. How would you find out if a wooden toothpick contains carbon? Write the procedure and materials you would need to find out. Carry out the procedure with the help of your teacher. What did you find?
How can objects be classified?

1. Collect a group of different objects from home or around the classroom.

2. Write down words to describe each object. Your teacher will show you a sample classification key. Ideas for questions you might ask to classify objects are: “Is it used in the kitchen?” “Is it used in the classroom?” Include information about how it looks and what it is used for.

   __________________________________________
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   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
Map of Elements

① Make a Model  Use colored pencils to model the most common elements on Earth. You can trace a map of Earth, with continents and oceans, and draw the atmosphere around it. Use a different color to represent each element.

② How many different colors did you use on your model?

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

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__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

③ What does each color represent? Identify the elements in your model.

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________

__________________________________________________________________________________________________________________________________________
Inquiry: Structured

How can unknown elements be identified?

Form a Hypothesis

Elements are pure substances that cannot be broken down into any simpler substances. Each element is made up of one kind of atom and the atoms of an element have a specific set of properties. Even though scientists can’t “see” atoms, they can find out which atom they are looking at by observing the atom’s properties.

You are going to classify six substances according to their properties. These properties include state at room temperature, heat conductivity, and magnetism. The first property you will observe is state at room temperature. What happens to a gas, a liquid, or a solid when you squeeze it? Write the answer as a hypothesis in the form “If the state at room temperature is a ________, then . . .”

Test Your Hypothesis

1. Record Data  Prepare a chart to gather your data. Keep in mind you are going to run at least three tests on six unknown substances. Design your chart so that you may add other tests later.

2. Measure the temperature of the six substances to ensure they are all at room temperature.
3 Squeeze substance A. What happens? What is its state at room temperature?


4 Repeat step three for substances B, C, D, E, and F. Record your results.

<table>
<thead>
<tr>
<th>State at Room Temperature</th>
<th>Heat Conductivity</th>
<th>Magnetism</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Draw Conclusions

5 **Classify** What is the state of the substances at room temperature?
Inquiry: Guided

How can heat conductivity help you identify an element?

Form a Hypothesis
You have already recorded the state of the unknown elements at room temperatures. However, this is only one property. To identify an element, scientists have to test and record more than one property. The second property you will observe is heat conductivity. Will raising the temperature help you determine which substance is a good heat conductor? Write your answer as a hypothesis in the form “If a temperature is raised, then the temperature of good heat conductors . . .”

Test Your Hypothesis
Design a plan to test your hypothesis. Write out the materials and resources you will need and the steps you will take. Record your results and observations as you follow your plan.

My Materials and Resources: __________________________

________________________________________

________________________________________

The Steps I Will Take: __________________________

________________________________________

________________________________________

My Results Are: __________________________
**Draw Conclusions**
Did your experiment support your hypothesis? Were you able to use temperature to find out if substances were good or poor conductors of heat? Record your results on your chart.

________________________________________

________________________________________

**Inquiry: Open**
You already know the state at room temperature and if the unknown substances are good heat conductors. What else can you find out about them? What about if they are magnetic? Think of a question to investigate. Then form a hypothesis and carry out the investigation to learn more about the six unknown elements. Record your results in your chart.

My Hypothesis Is: __________________________________________

________________________________________________________________________

The Steps I Will Take: __________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

My Results Are: __________________________________________

________________________________________________________________________

________________________________________________________________________
What patterns can you find?

Purpose
Classify different shapes into groups to understand how scientists use classification.

Procedure

1. **Make a Model**  Work in pairs. Draw a small, medium, and large-sized square, circle, and equilateral triangle on each sheet. Make the sides or diameters to be about 2, 3, and 4 cm long (1, 1 1/2, and 2 in long). Cut out the 18 pieces. Mix them up. Each can represent a different element.

2. How can you bring order out of this? Can you find any patterns?

3. **Classify**  Organize pieces that share one characteristic into rows. Place pieces under each other when they share two or more characteristics.

4. **Record Data**  Draw a labeled diagram showing your arrangement.
Draw Conclusions
5 Where do you find the most closely related groups in your arrangement? What criteria did you use?

________________________________________

________________________________________

________________________________________

________________________________________

6 Communicate Compare your results with the other groups.

Explore More
Think about how you would organize and classify a collection that you have or would like to have. Write out instructions that someone else can follow to classify the collection.

________________________________________

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________________________________________
What patterns do you follow?

1. Think about your own activities. Make a list of all the activities you do in a week. Include school, meals, sleeping, sports, clubs, and any other activities.

2. Write your activities on the calendar. For example, if you play soccer every Saturday morning, write “soccer” on each Saturday of the calendar.

3. If the same activity is repeated, circle each time it appears in the same color. For example, all soccer games should be circled in red, all chess club meetings should be circled in blue.

4. Can you see that a pattern is formed when an activity occurs over and over again in a predictable way?

5. Which activities occur on a daily pattern?

6. Which activities occur in a weekly pattern?

7. Which activities occur in a monthly pattern?

8. Which activities appear in the same row (week)?

9. Which activities occur in a column (day)?

Materials

- one-month calendar
- crayons, markers, or colored pencils
Magnification

1. **Observe** Examine a newspaper photograph with just your eyes. Then examine the same photograph with a magnifying glass.

2. **Communicate** How are your observations similar to what an electron microscope would show? Write out your ideas.

3. **Predict** Suppose you look at the newspaper photo with an electron microscope. At different levels of magnification, what would the views be like? Do research to find your answers.

**Materials**

- newsprint photographs
- strong magnifying glass

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How can you separate mixed substances?

**Purpose**
The purpose is to mix two substances and then separate them. You can separate mixed substances if they have different properties. Can a magnet help you separate iron fillings and sand after they are mixed?

**Procedure**

1. Your teacher will give you sand and iron filings. Write a procedure for mixing and separating them. Have your teacher approve your procedure before you start. Record your observations and results as you follow the procedure.

2. **Experiment** Carry out your procedure. You should end up with separated iron filings, sand and salt.

3. **Observe** Examine your samples carefully. Was the separation of the iron and sand complete or partial? Record your observations.

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
Draw Conclusions

4 Analyze How did the iron and sand differ in their properties and how they allowed you to separate them?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

5 Infer What kind of changes took place during the separation process?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Explore More
What if salt was added in with the sand and iron filings? Write a procedure for separating the new mix of substances.

______________________________________________________________________

______________________________________________________________________

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______________________________________________________________________
How is a mixture different from a pure substance?

1. **Record Data** Make a list of the different types of items in the bowl. Write a few words describing each type of item.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

2. **Classify** Separate the items into groups based on their descriptions. Each item should be placed in a group with similar items. How many groups did you make?

   __________________________________________

3. **Analyze** Explain how the individual groups are different from the original mixture.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

4. **Draw Conclusions** Based on this activity, define mixture and substance in your own words.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________
Quick Lab

Temperature in Solutions

1 Predict  Do you think you could dissolve more sugar in hot water or cold water? Why? Write down your reasons.

2 Observe  Place 7 level teaspoons (25 g) of sugar in each of 2 clear cups. Working with a partner, add 25 mL (1 oz) of cold water to one batch of sugar and 25 mL (1 oz) of hot water to the other. Stir the sugar and water in both cups.

3 In which cup does the sugar seem to dissolve most rapidly? How can you tell?

4 Draw Conclusions  Was your prediction correct? Write out your findings.

Materials
- table sugar
- hot and cold water
- small Styrofoam cups
- measuring spoons and cups
- stirrers for stirring
What is rust?

Form a Hypothesis
When steel is exposed to air, the iron in it rusts. Does steel become stronger or weaker when it rusts? Think about rust to answer this question. Write your answer as a hypothesis in the form “If steel is exposed to air, then it becomes . . .”

Test Your Hypothesis

1. **Experiment**  Soak a small piece of steel wool in vinegar for three minutes, remove it and let it sit exposed to air. The vinegar exposes the iron in the steel.

2. Take another small piece of steel wool from the same pad and let it sit in the air near the first piece.

3. **Observe**  After 25 minutes, examine both pieces of steel wool. Which piece of steel wool rusted?

4. Look at the properties of rust. Is it the same color as iron? Does it have the same strength?

**Materials**
- small bowl
- vinegar
- steel wool pad
Draw Conclusions

5. Did your results support your hypothesis?

_________________________________________________________________________

6. **Infer** Did a new material form? Explain.

_________________________________________________________________________

7. Which element could have caused the change?

_________________________________________________________________________

8. What would you need to do to find out the specific element that caused the change?

_________________________________________________________________________

Explore More
Which makes steel rust faster, air or water? How could you determine the answer? Plan and conduct an experiment to find out.

_________________________________________________________________________

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_________________________________________________________________________
What type of change has occurred?

△ Be Careful. Wear safety goggles, gloves, and an apron.

1 Make a Model  Fill the plastic bottle halfway with hydrogen peroxide.

2 Slowly lower the bottle into the plastic bag without spilling its contents.

3 Tip the bottle so that the hydrogen peroxide spills onto the steel wool.

4 Observe  After several minutes, feel the bag and decide whether a chemical change has occurred. What do you observe?

Materials

- steel wool
- 3% hydrogen peroxide solution
- plastic self-sealing bag
- small plastic bottle
Identify the Compound

Your teacher will give you two mystery compounds. Use the property of density to identify them.

1. Find the mass of an empty container.

2. Pour 100 mL of one of the compounds on the container.

3. Calculate the mass of the compound.

4. Repeat step 3 with the second compound.

5. What is the density of the mystery compounds?

6. The density of water is 1 g/mL. Is either of the compounds water? Which one?

Materials

- 2 mystery compounds
- container
- balance
Inquiry: Structured

How can you tell if a substance is a compound or a mixture?

Form a Hypothesis

Compounds formed by chemical reactions are much more difficult to separate than mixtures formed by physical combinations. You will classify three substances as mixtures or compounds by using physical separation methods to find out if they can be separated into their parts. The first separation method will be filtration. The filter allows small particles to pass through it while trapping larger particles. Observe the three samples. Will filtration separate any of the substances? Write your answer as a hypothesis in the form “If I pass mixture X through a filter, then . . . .”

Test Your Hypothesis

1. Fold the filter paper in half. Then fold it in half again. Press the edges together gently so it opens up into a cone. One side will have one layer of paper, the other side will have three layers. Moisten the cone with your fingers so it does not come apart and put it in the funnel.

2. Place the funnel over the beaker. Pour substance A through the filter paper. Did the filter trap anything? Record your results.
3 Empty the beaker back into container A. Rinse the beaker and prepare a new piece of filter paper for the funnel.

4 Repeat steps 2 and 3 for unknown substances B and C. Record your results.

__________________________
__________________________

Draw Conclusions

1 Infer What can you infer from the results?

__________________________
__________________________
__________________________
__________________________

2 Did the experiment support your hypothesis? Why or why not?

__________________________
__________________________
__________________________
__________________________
Inquiry: Guided

Can density help determine if it is a mixture or a compound?

Form a Hypothesis
One of the remaining substances is the compound water. Use density to find out which one is water. Remember that density determines what can float in a liquid and how high it can float. Write a hypothesis in the form “If __________, then the substance is water.”

______________________________________________________________________________

______________________________________________________________________________

Test Your Hypothesis
Design a plan to test your hypothesis. Then write down the materials, resources, and steps you need to test your hypothesis. Record results and observations as you follow your plan.

My Materials and Resources: ______________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

The Steps I Will Follow: ______________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

My Results Are: __________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________
Draw Conclusions
Did your test support your hypothesis? Why or why not? Were you able to prove that one of the substances remaining was a compound?

Inquiry: Open
Filtration helped you determine that one of the substances was a mixture. Density helped you determine that one of the substances was a compound. You have one substance left. How can you find out if it is a mixture or a compound? How about evaporation? Come up with a question and a hypothesis to find out whether the last substance is a mixture or a compound. Then plan a procedure to test your hypothesis. Present your results to the class.

1 My Question Is: 

2 This Is How I Will Test It: 

3 My Results Are: 
What happens when substances change?

Form a Hypothesis
Does the total mass of matter change during a chemical change? Think about chemical changes you have observed, such as an egg being cooked, a roasted marshmallow, or wood burning in the fireplace. Write your answer as a hypothesis in the form “If a chemical reaction occurs, then the total mass of matter . . .”

Test Your Hypothesis

1. **Be Careful.** Wear safety glasses! Pour about 40 mL of washing soda solution into a bag. Place about 40 mL of Epsom salt solution in a paper cup. Put the cup inside the bag so that it rests upright. Seal the bag.

2. **Measure** Carefully place the bag on a balance. Don’t mix the solutions! Record the mass.

3. **Observe** Without opening the bag, pour the solution in the cup into the solution in the bag to cause a chemical change.

4. **Measure** Once again, place the bag and its contents on the balance and record the mass.
Draw Conclusions

5 What can you conclude about chemical reactions?

________________________________________________________________________

________________________________________________________________________

6 Does the data support your hypothesis? If not, how would you change it?

________________________________________________________________________

________________________________________________________________________

Explore More
What else could you do to test the hypothesis? Plan an experiment that would provide information to support your conclusion.

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________________________________________________________________________

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________________________________________________________________________
A “Happy Birthday” Reaction

1 **Observe**  Team up with a partner to look at a birthday candle. Record the physical properties of the candle.

2 Place the birthday candle in a small metal cupcake tin filled with sand.

3 **Record**  Your teacher will light the birthday candles. Look at them and record the chemical properties of the lighted candle.

4 ▲ **Be Careful.** Carefully place a piece of foil a few centimeters above the candle to collect soot from the reaction.

5 Why is the candle disappearing? What is the black substance on the foil?

6 What kind of change are you witnessing?
Compare Reactivities

1 △ Be Careful. Use a metal file to scratch a tic-tac-toe pattern on both sides of a new penny. You should be able to see silvery zinc in the scratches. Also make several scratches around the penny’s edge.

2 Observe Put the penny in a cup of vinegar and let it stand for several days. Observe it each day and note what is happening.

3 Observe Based on your observations, which metal in the penny is more reactive, the zinc or the copper? How do you know?

Materials
- shiny penny minted after 1982
- 150 mL of vinegar
- cup
- metal file
Use Variables

If you crush a certain kind of antacid tablet, and then stir it in a large bowl of hot water, the reaction will happen faster than if you put the whole tablet in a cup of cold water. What causes this? Is it the crushing of the tablet? Is it the stirring of the water? Is it the temperature? To answer such questions, scientists experiment by changing one thing at a time. What they change is the controlled (independent) variable.

1. Learn It
The reaction speed is the dependent variable. The reaction speed shows the effect of the controlled (independent) variable. Scientists would first observe the reaction speed of a whole antacid tablet in a cup of cold water. This is called a control test. Next, they would place a crushed tablet in a cup of cold water. Then they would observe separately the effects of stirring, the amount of water, and temperature.
2 Try It

Which independent variable has the most effect on the reaction of the antacid and water: using a crushed tablet, a whole tablet that’s stirred, or a whole tablet in more water? Test the variables to find the answer. Use a stopwatch to measure the total reaction times. Make a chart like the one shown to record your results.

▲ As a control, place 1 whole antacid tablet in 1/2 cup of cold water.
▲ Crush a tablet in a plastic bag and put it in 1/2 cup of cold water.
▲ Place 1 whole tablet in 1/2 cup of cold water and stir with a spoon.
▲ Place 4 cups of cold water in a pitcher. Then place 1 whole tablet in the pitcher.

<table>
<thead>
<tr>
<th>Water</th>
<th>Tablet</th>
<th>Time to Dissolve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1/2 cup</td>
<td>whole</td>
</tr>
<tr>
<td>Test 1</td>
<td>1/2 cup</td>
<td>crushed</td>
</tr>
<tr>
<td>Test 2</td>
<td>1/2 cup</td>
<td>whole stirred</td>
</tr>
<tr>
<td>Test 3</td>
<td>4 cups</td>
<td>whole</td>
</tr>
</tbody>
</table>

▲ Which independent variable increased reaction speed the most?

Materials

- sheet of paper
- 4 antacid tablets
- stopwatch
- 3 clear cups
- cold water
- plastic bag
- pitcher
- spoon
Apply It

How do you think the results might change if you changed another independent variable? What would happen if you used warm water or stirred with a fork? Pick one of these variables or one of your own to test. Use the chart to record your results.

<table>
<thead>
<tr>
<th>Time to Dissolve</th>
<th>Water</th>
<th>Tablet</th>
<th>Water Tablet Time to Dissolve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1/2 cup</td>
<td>whole</td>
<td></td>
</tr>
<tr>
<td>Test 1</td>
<td>1/2 cup</td>
<td>crushed</td>
<td></td>
</tr>
<tr>
<td>Test 2</td>
<td>1/2 cup</td>
<td>whole stirred</td>
<td></td>
</tr>
<tr>
<td>Test 3</td>
<td>4 cups</td>
<td>whole</td>
<td></td>
</tr>
</tbody>
</table>
Use this page for any notes you have from the experiment.
How can you tell if it is metal?

Purpose
In this activity, you will observe, compare, and contrast metal and nonmetal objects.

Procedure
1. Prepare a table to record your observations.

<table>
<thead>
<tr>
<th>Object</th>
<th>Metal Properties</th>
<th>Nonmetal Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>plastic rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>metal rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>glass rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>steel wire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>toothpick</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aluminum foil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>paper</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Experiment Put on your goggles. Use the conductivity tester to see how well each object or material allows electricity to flow through it. The buzzer will sound, or the bulb will light, for materials that let electricity flow through them.
Bend the wire in the paper tie. Bend a toothpick. Which holds its shape without breaking?

Compare the aluminum foil and sheet of paper. Which reflects light better?

Draw Conclusions

Classify Use your observations to place the materials and objects you’ve tested into groups.

Summarize Based on your observations, summarize the properties of metals and nonmetals.

Explore More
Are the properties of all metals the same? Plan and conduct an experiment to find out.
Aluminum in Our World

1. Observe  Look at each object made from aluminum.

2. Record Data  What do you notice about each object’s color, shape, thickness, and general appearance?

   -
   -
   -
   -

3. Experiment  Try to bend each object. Write down what happens.

   -
   -
   -
   -

4. Draw Conclusions  What is the purpose of each aluminum object?

   -
   -
   -
   -

Materials
- soft drink can
- aluminum foil
- aluminum wire
- disposable pie plate
- foil cupcake holder

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Hardness vs. Flexibility

1. △ Be Careful. Wear goggles to protect your eyes. Bend one end of the paperclip 90° and then bend it back to its original position.

2. **Predict** How many times can you repeat this step before the paperclip breaks? Record how many bends were required to break the steel.

3. Repeat the experiment with a steel bobby pin. Note any differences in the bobby pin compared to the paperclip. Make your prediction. Record the actual results.

<table>
<thead>
<tr>
<th>Object</th>
<th>My Prediction</th>
<th>Actual Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper clip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bobby pin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Which steel product was harder? Explain your reasoning.
Inquiry: Structured

How can you compare the electrical conductivity of metals?

Form a Hypothesis
Are some metals better conductors than others? What would happen if you used a poor conductor in electrical circuits? Would the brightness of a light bulb connected to the circuit change? Write your answer as a hypothesis in the form: “If a poor conductor is used in an electrical circuit, then the brightness of the light bulb will . . .”

Test Your Hypothesis

1. Place the battery in the battery holder. Connect one alligator clip wire to one end of the battery holder. Connect another alligator clip wire to the other end of the battery holder.

2. Connect one of the alligator clip wires from the battery to the miniature bulb in the socket. Use a third alligator clip wire to attach the light socket to one end of the copper electrode. You still have an open circuit. Draw your setup.
3 **Experiment** Connect the second wire from the battery to the other end of the electrode to close the circuit. Observe how brightly the light bulb glows and record the results.

4 **Observe** Replace the copper electrode with the aluminum, iron, and tin electrodes. Observe and record your results for each.

5 **Compare** Rank the metals from highest to lowest conductivity.

**Draw Conclusions**

6 **Explain** Did the light bulb act as a conductivity tester?

7 **Infer** Why is copper used to make wire?

8 **Do your results support your hypothesis? Explain why or why not.**
Inquiry: Guided

How does alloying metals affect their electrical conductivity?

Form a Hypothesis

You have already used a light bulb to discover how conductive some metals are. If an alloy is made of two highly conductive pure metals, will the alloy’s conductivity be higher or lower than either or both of the pure metals? Answer your prediction to the question as a hypothesis in the form: “If an alloy is made from two metals with high conductivity, then the alloy’s conductivity will be . . .”

Test Your Hypothesis

Design an experiment to determine if a metal alloy has higher or lower conductivity than the pure metals that were mixed to form it using the materials provided. Then write out the resources and steps you will follow. Record your results and observations as you follow your plan.

1. My Materials and Resources:

2. The Steps I Will Take:
Draw Conclusions
Did your experiment support your hypothesis? Why or why not?

My Question Is:

How I Can Test It:

My Results Are:
What are salts made of?

Make a Prediction
Metals conduct electricity, but nonmetals do not. What do you think salt is made of? Do you think that a solution with salt will conduct electricity?

Test Your Prediction
1. Fill three cups halfway with distilled water. Stir one teaspoon of table salt in one of the cups. Stir one teaspoon of Epsom salts into another cup. Label your cups.

2. Make a chart like the one shown to record your results.

<table>
<thead>
<tr>
<th>Cup</th>
<th>Conductivity Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>distilled water</td>
<td></td>
</tr>
<tr>
<td>Epsom salts</td>
<td></td>
</tr>
<tr>
<td>table salt</td>
<td></td>
</tr>
</tbody>
</table>

3. Observe Put the wires of your conductivity tester into each liquid. Rinse the wires with water between tests! If the light is lit, the conductivity is good. If the light is out, the conductivity is poor. After testing, fill in your data table with “good” or “poor.”
Draw Conclusions

4 Infer What did you observe? Did any of your samples conduct electricity? Based on what you have learned, why do you think that was?

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Explore More

A student has developed this hypothesis: *If the amount of salt dissolved increases, then the conductivity of a salt solution will increase.* How could you use a conductivity tester to test the student’s hypothesis? Explain your ideas.

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________________________________________________________________________
Which salt conducts the best?

Be sure to wear safety goggles.

1. Fill three small plastic cups one-third full with water.

2. Add 1 teaspoon of table salt to the first cup and stir.

3. Repeat this step with Epsom salts and potassium chloride.

4. Use the conductivity tester to determine which of the three salts is the best conductor of electricity. Which solution produces the brightest light?

   __________________________________________
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   __________________________________________
   __________________________________________
Red Cabbage Juice Is an Indicator

1. Fill a cup halfway with vinegar. Repeat with water and clear ammonia solution for a total of three cups.

2. Observe Put one tablespoon of cabbage juice into each cup. Record the color you see in each case.

<table>
<thead>
<tr>
<th>Cup</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinegar (acidic)</td>
<td></td>
</tr>
<tr>
<td>Water (neutral)</td>
<td></td>
</tr>
<tr>
<td>Ammonia (basic)</td>
<td></td>
</tr>
</tbody>
</table>

3. Infer Based on your observations, what cabbage juice color indicates an acid? What cabbage juice color indicates a base?

4. Soak a paper towel or coffee filter in red cabbage juice and allow it to dry overnight. The next day, cut the paper into test strips.

5. Communicate Suppose that you are going to sell your paper strips to scientists as an acid-based indicator. Write a set of instructions for the use of your product.

Materials
- red cabbage juice
- clear plastic cups
- vinegar
- clear ammonia solution
- water
- paper towel or coffee filters
- measuring spoon
- safety goggles

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Salty Cells

The cell is the smallest unit of a living thing and it is made up mostly of water. In fact, 2/3 of the body’s water is found in its cells. There are many different kinds of cells in your body such as muscle, skin, brain, blood, liver, and stomach cells. All cells are surrounded by a cell membrane. The cell membrane controls what comes in and out of the cell. Osmosis is a very important process in regulating the amount of water in the cells. Osmosis is the movement of water through the cell membrane from an area of low concentration of a substance to an area of high concentration of a substance. Water molecules will move in or out of cells depending on where there is a higher concentration, or amount, of a substance such as salt.

Purpose

Your task is to test the concentration of potato cells in salt water.

Form a Hypothesis

What would happen if you put a slice of potato (which contains lots of cells) in a dish with very salty water? State your hypothesis in the form of an “if”, “then” statement. (“If a slice of potato is put in a dish with salty water, then the potato will get . . .”)

Materials

- potato slices
- 2 bowls or petri dishes
- salt
- water
- tablespoon

Chapter 1 • Structure of Living Things
Activity Lab Book

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Test Your Hypothesis

1. Fill two petri dishes with enough water to cover several potato slices.
2. Add two tablespoons of salt to one of the dishes.
3. Put 3 potato slices in the dish with the salt and 3 slices in the dish without the salt.
4. Let the potato slices soak for at least 20 minutes.
5. Drain the remaining water from the potato slices. Observe the potato slices.

Draw Conclusions

6. What did you observe?

________________________________________________________________________
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Based on your results, what is your conclusion?

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Critical Thinking

1. Why do potato chips make you thirsty?

2. Why did you use two dishes with water and potato slices?
Leaf Pigments

Leaves are usually green because they contain a green pigment, or color, called chlorophyll. This chemical is very important. It absorbs sunlight so that the plant can make its own food. In the fall, there is less sunlight so less chlorophyll is made. As result, the other pigments in the leaves become more visible. This is what gives leaves their fall colors.

Scientists use chromatography to separate different kinds of substances, such as pigments. Chromatography is when a fluid travels up special chromatography paper and carries small substances with it. The liquid, such as alcohol, travels at different speeds up the paper depending on the weight of the substances. Bands of color will appear on the chromatography paper to show which substances are present.

Purpose
Your task is to use chromatography to test leaves.

Form a Hypothesis
Which pigments are present in leaves? State your hypothesis in the form of an “if”, “then” statement. (“If ? colored leaves are mixed with alcohol, then ? will be seen on the chromatography paper.”)
Test Your Hypothesis

1. Tear 2 to 4 green leaves into small pieces and add them to the small plastic cup. Tear 2 to 4 yellow or red leaves and add them to the other small plastic cup.

2. Add rubbing alcohol to both cups so that the leaves are covered.

3. Mix the leaves and alcohol solution with the popsicle stick for 2 minutes.

4. Place each cup in a beaker half full with warm tap water. Leave the cups in the beakers until the rubbing alcohol in the cups changes color. If the water cools off replace it with new warm water.

5. Carefully remove the cups from the beakers.

6. Put a strip of chromatography paper in each cup and leave it for 1 hour.

Draw Conclusions

7. What did you observe?

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Based on your results what is your conclusion?

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Critical Thinking

1. Why do many trees lose their leaves in the winter?

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2. When do evergreen trees lose their leaves?

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Stomach Acid

The digestive system is important for taking in, breaking down, and absorbing food. Food travels from your mouth through the esophagus to your stomach. Your stomach has an enzyme called pepsin. Pepsin is important because it starts breaking down proteins into smaller pieces. This is necessary for their absorption by the small intestine. However, pepsin is only active when it is in the presence of an acid called hydrochloric acid (HCl). This acid is secreted by special cells in the stomach wall.

Purpose
You task is to digest a protein (gelatin) using pepsin.

Form a Hypothesis
How does pepsin break down proteins? State your hypothesis in the form of an “if”, “then” statement. (“If the pepsin is added to the gelatin, then the gelatin will . . .”)

Materials
- shallow dish
- gelatin
- drinking straw
- toothpick
- pepsin
- cup
- eye-dropper
- water
Test Your Hypothesis

1. Prepare the gelatin and put it in the shallow dish.
2. Put the dish in the refrigerator until the gelatin sets.
3. Use the straw to poke 10 holes in the gelatin (spread the holes out).
4. Use the toothpick to take the gelatin plugs out of the holes.
5. Break open the pepsin capsule into the cup. Add 1 teaspoon of water to the cup and mix. Draw up the pepsin mixture into the eye-dropper.
6. Fill up 5 of the holes with the pepsin mixture. Keep track of which holes have the pepsin. Let it sit for a couple of hours or overnight.

Draw Conclusions

8. What did you observe? What happened?

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9 Based on your results, what is your conclusion?
Critical Thinking

1. Why didn’t you fill up all 10 holes with the pepsin mixture?

2. What else was in the pepsin capsule besides the pepsin enzyme?
The respiratory system is an organ system that takes in oxygen and removes carbon dioxide. The respiratory system is made up of the airway, lungs, and diaphragm. The diaphragm is a muscle that controls the physical motion of breathing. When you inhale, the diaphragm contracts to let in air. By contracting, it makes room for the lungs to expand and fill with air. When you exhale, the diaphragm expands. By expanding, it pushes the air out of the lungs.

Purpose
Your task is to create a model of a lung and the diaphragm to show how they work.

Form a Hypothesis
What would happen if there was a hole in the diaphragm? State your hypothesis in the form of an “if”, “then” statement. (“If the diaphragm has a hole in it, then . . .”)

Materials
• 2-liter bottle
• balloon
• plastic wrap
• tape
• construction paper
Test Your Hypothesis

1. **Be Careful!** Cut off the top half of the 2-liter bottle and attach the balloon to the neck. Then push the balloon into the bottle top.

2. Stretch plastic wrap over the bottom of the bottle and tape it to the bottle tightly, making an airtight seal.

3. Fold a strip of construction paper in half and securely tape it to the bottom of the plastic wrap so that a handle is created.

4. Observe the model as you pull and push on the handle gently.

5. Use a pencil to poke a small hole in the plastic wrap on the bottom of the bottle. Then pull and push on the handle of the bottle again.

Draw Conclusions

6. What did you observe?

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7 Based on your results what is your conclusion?

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8 Did your results support your hypothesis?

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Critical Thinking

1. Do plants also take in oxygen and give off carbon dioxide?

2. Where does oxygen go once it enters the lungs?
Growing Plants Without Watering Them

Water exists in three phases: liquid, solid, and gas. Water can change from one phase to another. Condensation, evaporation, and precipitation are parts of the water cycle. How can you set up an environment in which the water cycle provides water for plants so you do not need to add any extra water to the environment?

**Purpose**
To make a model of the water cycle which will provide water for plants.

**Procedure**

1. Place the glass jar sideways on a table. Using the spoon, put a layer of charcoal on the bottom of the jar.
2. Pour water onto the dirt until it is soaking wet. Using the spoon, place the wet dirt on top of the charcoal.
3. Place ten seeds on top of the soil.
4. Cover the seeds with a thin layer of soil.
5. Using a spoon, add more water to the soil.
6. Screw the lid onto the jar.

**Materials**
- glass jar
- charcoal
- dirt
- seed mixture
- spoon
- water
Observe  Where do you see water in the jar? What happens to the seeds?
Draw Conclusions

8  **Infer** How does the water cycle in the jar resemble the water cycle on Earth?

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9  **Communicate** Whose plants are the tallest? Did all ten of your plants grow? Write a report about your investigation.

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Critical Thinking

1. Would you expect to see fog or clouds form in your jar?

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2. Do you think the amount of water on Earth has changed?

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The Humidity of the Air

You learned that air contains some amount of water vapor. The amount of water vapor in air is called humidity. How can you measure humidity?

Purpose
To make an instrument to measure humidity.

Procedure

1. Pull a cotton ball over the bulb of one thermometer. Tape that thermometer to one side of the carton, then tape the second thermometer to another side of the carton.

2. Using a hole punch, punch two holes in the top of the carton.

3. Thread a long piece of string through the holes. Tie the ends of the string together to form a large loop.

4. While holding the carton, pour water on the cotton ball.

5. ▲ Be Careful. While holding onto the string, swing the carton gently around for one minute.

6. Record Data  Write down the temperatures on the two thermometers. Which thermometer has a lower temperature?
   thermometer 1 _______________
   thermometer 2 _______________

Materials

- pint-sized carton
- water
- two thermometers
- cotton ball
- string
- masking tape
- hole punch
- container
Draw Conclusions

7 Infer Why does one thermometer have a lower temperature?


8 Use Numbers Use the chart below to calculate the humidity.

Relative Humidity

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Humidity ________________
Communicate  Write a report about your investigation. Include your results. What humidity measurement did you get?
Critical Thinking

1. How does having one wet and one dry thermometer help you figure out the amount of water in the air?

2. If you measured the humidity on a sunny day and a rainy day, on which day would you expect the humidity to be higher? Why?
Gravity and Inertia

An orbit is the path of an object, such as a planet, through space. There are two forces that keep a planet in an orbit. One force is gravity, which pulls the planet towards the Sun. The other force is inertia, a force created by the planet’s speed. When these forces are balanced the planet moves in an orbit. How can you use these forces to keep a marble inside an upside-down soda bottle?

Purpose
To demonstrate that inertia will keep an object in orbit.

Procedure

1. Drop the marble into an empty plastic bottle. Holding the bottle by the top, swirl the bottle so the marble starts rolling in a circle around the bottom.

2. ▲ Be Careful. While swirling the bottle rapidly and holding the bottle by the top, quickly flip the bottle upside-down, and continue to swirl the bottle.

3. Observe  What path is the marble taking?

Materials
- 2-liter bottle
- marble
4 Decrease the speed with which you are swirling the bottle. What happens?

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5 Have another student hold his or her hands under the opening of the bottle. Then stop swirling the bottle completely. What happens?

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Draw Conclusions

6. What do the marble, the swirling, and the opening of the bottle represent in this model?

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7. How does this model resemble what would happen between a planet and a Sun if the speed of the planet slowed?

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8. Write a report about your investigation. Include your results. Where could you see the effects of inertia and gravity in this experiment?

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Critical Thinking

1. What would happen to a planet if there were no inertia?

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2. How fast must a satellite travel to stay in orbit?

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Electroplating

Electroplating is when a thin layer of metal is attracted by electric charges to the surface of another metal and deposited there. For example, pennies are actually copper-plated zinc, zinc with a thin layer of copper covering it. Over time, pennies become dull because the copper is reacting with the air forming copper oxide. Copper oxide is dull and greenish. Pennies can be cleaned by putting them in an acid such as vinegar. It dissolves the copper oxide into the liquid. The copper in the liquid can now react with another metal when put in a salt and vinegar solution.

Purpose
Your task is to see if you can plate another metal with copper.

Form a Hypothesis
What do you think would happen if you put 10 pennies and 2 galvanized nails in a cup of vinegar and salt? State your hypothesis in the form of an “if”, “then” statement. (“If I put 10 pennies and 2 galvanized nails in a vinegar and salt solution, then . . .”)

Materials
• vinegar
• salt
• cup
• galvanized nails
• 10 pennies
Test Your Hypothesis

1. Mix 60 mL of vinegar and 1 teaspoon of salt in a cup.
2. Put 10 dull pennies in the cup.
3. Take 5 of the pennies out when shiny, 10–15 minutes.
4. **Observe** Add two nails to the cup and wait 10–15 minutes.

Draw Conclusions

5. What did you observe?

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6 Based on your results, what is your conclusion?

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7 Write a report about your investigation.

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Critical Thinking

1. Can you think of a better way to copper plate an object?

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2. Can you think of additional examples of electroplating?

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How does temperature affect the rate of water transport through plant stems?

Inquiry: Structured Water Race

Form a Hypothesis
Vascular plants transport materials through specialized tissues. Water is transported from the roots up to the leaves through xylem tissue in the stem. How does temperature affect the rate the water is transported through the xylem of a plant stem? Write your answer as a hypothesis in the form “If the water temperature is decreased, then . . .”

Materials
- 6 celery stalks with leaves
- water
- ice
- blue food coloring
- 2 500 mL beakers
- 2 thermometers
- ruler
- paper towels
- scissors
Test Your Hypothesis

1. Fill one beaker, labeled Beaker A, with room temperature water (about 25 degrees Celsius) and the other beaker, labeled Beaker B, with ice water (about 10 degrees Celsius).

2. Add 10 drops of blue food coloring to each beaker.

3. Place a thermometer in each beaker. Be sure to add ice to Beaker B if the temperature goes above 15 degrees celsius.

4. Place 3 stalks of celery in each beaker.

Experiment

5. Observe After 15 minutes remove one stalk of celery from Beaker A and one from Beaker B and place them on a paper towel. Use the scissors to carefully scrape the celery stalks to expose the xylem tissue. What do you observe?

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6 **Measure** Use the ruler to measure how far the water has traveled up the celery stalk. Record your measurements.

7 Repeat steps 5 and 6 every 15 minutes for 30 more minutes.

   Measurement 1: Celery Stalk A (ice water) ________________
   Celery Stalk B (warm water) ________________
   Measurement 2: Celery Stalk C (ice water) ________________
   Celery Stalk D (warm water) ________________
   Measurement 3: Celery Stalk E (ice water) ________________
   Celery Stalk F (warm water) ________________

8 **Record Data** Use your data to make a bar graph. Put the celery data along the bottom or horizontal side of the graph. Put the water height measurements on the left, or vertical side of the graph. Draw a bar for each celery stalk.
Communicate Your Results
Have a class discussion and share your results and graphs. What did you find out? Use your data to answer the questions.

► What was the controlled variable in this experiment? the dependent variable? the independent variable?

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► Analyze Data Did you observe a correlation between the rate of water transport and the temperature of the water?

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► Did your results support your hypothesis?

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Inquiry: Guided
Salty Celery

Form a Hypothesis
You have already tested the effects of water temperature in plant stems. What other variables will slow or increase the rate that water flows through a plant stem? Will dissolving substances, such as salt or sugar, change the water flow rate? Write your answer as a hypothesis in the form “If salt is dissolved in water, then . . .”

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Materials
• 6 celery stalks with leaves
• 2 500 mL beakers
• salt
• tablespoon
• blue food coloring
• scissors
• ruler
• paper towels
Test Your Hypothesis

1. Fill 2 beakers with water and add 10 drops of blue food coloring to each beaker.
2. Pour 2 tablespoons of salt into one of the beakers.
3. Place 3 celery stalks in each beaker.
4. **Observe** After 15 minutes remove a stalk of celery from each beaker and place them on a paper towel.
5. Use the scissors to carefully scrape the celery stalks to expose xylem tissue.
6. **Measure** Use the ruler to measure how far the water has traveled up the celery stalks. Record your measurements.
7. Repeat steps 4 through 6 for the remaining celery stalks.

   Measurement 1: Celery Stalk A (fresh water) 
   Celery Stalk B (salt water) 

   Measurement 2: Celery Stalk C (fresh water) 
   Celery Stalk D (salt water) 

   Measurement 3: Celery Stalk E (fresh water) 
   Celery Stalk F (salt water)
Communicate Your Results
Work in groups of 4 to 8 and discuss what you found out about water transport in plants.

How did adding salt affect the transportation rate of water in the celery?

How did your results compare with the group?

Did your results support your hypothesis? Why or why not?
Inquiry: Open

Water Transport Systems in Other Plants
Invent and test other ways to explore the xylem tissue in plants. Design and do an experiment. Ask a question, make a prediction, record your data, and communicate your findings. Make a poster to show what you did and what you find out. What did you observe. Here are some ideas to get you started.

▲ What is the structure of xylem tissue in parts of other plants? Does this tissue look like and function the same as xylem in celery stems? You could test the root parts of other vegetables like carrots or potatoes or flowers like carnations or daisies.
What effect does temperature have on the formation of clouds?

Inquiry: Structured
Temperature and Cloud Formation

Ask Questions
Clouds form when water vapor condenses. What effect does temperature have on the formation of clouds?

Form a Hypothesis
If you have two sources of water vapor and you lower the temperature of the air above one of the sources more than you lower the temperature of the air above the other one, over which source would you expect a more visible cloud to form? Write your answer as a hypothesis in the form “If the temperature of the air above one source of warm water vapor is lowered more than the other, then . . .”

Materials
- hot water
- 4 identical clear containers
- 2 sealable storage bags
- ice
- clear tape
Test Your Hypothesis

1. Label 2 of the containers “Bottom.” Label the other two containers “1” and “2.”

2. Put Container 1 in a cool place for about ten minutes.

3. Place three ice cubes in each sealable storage bags and seal the bags.

4. Fill the two containers labeled “Bottom” with equal amounts of hot water.

5. **Make a Model** Place Container 1 upside down on top of one of the Bottom containers. Tape the two containers together.

6. **Make a Model** Place Container 2 upside down on top of the other Bottom container. Tape the two containers together.

7. Put the storage bags full of ice cubes on top of the containers.

8. **Observe** What did you observe? Where did your observations take place?

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Draw Conclusions

1. **Record Data** Draw what you observed in both setups.

2. What is the independent variable in this experiment?

3. How was the independent variable changed to collect information?

4. Do clouds appear more visible when they form in colder air?
Inquiry: Guided
Presence of Dust in the Air and Cloud Formation

Ask Questions
Clouds form because as the air cools, the water vapor contained in it begins to condense. Is temperature the only factor that controls how visible a cloud is when it forms?

Form a Hypothesis
What effect do you think the presence of dust in the air has on cloud formation? Write your answer as a hypothesis in the form “If there is dust in the air, then . . .”

Materials
- 2 large glass jars
- 2 large balloons
- scissors
- chalk dust
- large rubber bands
- markers
Test Your Hypothesis

1. Cut the ends off of the two balloons.
2. Spray a few drops of warm water on the sides of each jar.
3. Stretch one balloon over the top of the first jar. Wrap rubber bands around the balloon and the top of the jar so the balloon forms a tight seal.
4. Clap a dusty chalkboard eraser over the top of the second jar, so some dust falls down on the center of the bottom of the jar. Then seal the jar with the second balloon and more rubber bands. Label this jar.
5. Place both jars in a cool place for about 10 minutes.
6. **Observe**  Remove the jars and compare them. Then pull on each of the two balloons. What do you see?

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Draw Conclusions

1. Where did you see clouds form? Which was the most visible cloud?

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2. Predict What would happen if you repeated this experiment with room temperature or cold water in the container?

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Inquiry: Open

Clouds Can be Found Almost Anywhere

What other questions do you have about cloud formation? What other ways can clouds form? Come up with a testable question and do an experiment to answer the question. Here are some ideas to get you started.

▲ What happens if you put a 2-liter bottle with water and smoke in a refrigerator?

▲ Can you make a cloud in your bathroom at home?

▲ Look at a weather map and find places where warm and cold air meet. Predict how often you would observe clouds in those places. Then compare your prediction with the cloudiness that was observed.
Use this page for any notes you made about the experiments.

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What changes take place during a fizzing reaction?

Inquiry: Structured
Exploring a Fizzing Reaction

Ask Questions
Only chemical changes form new materials, physical changes do not. You can look for changes of state or color when deciding if a new material has formed. What happens when an antacid fizzing tablet is placed in tap water? Are there any changes? Are they chemical or physical? Are new materials formed or not?

Make a Prediction
What do you think will happen when you put an antacid tablet into water with phenol red.

Materials
- antacid tablet
- clear plastic cup
- pH indicator (Phenol Red) with eyedropper
- graduated cylinder or measuring cup
- plastic spoon
Test Your Prediction

1. Put 25 mL of cold tap water into a plastic cup. Add 5 drops of phenol red (or other pH indicator) to the water. Add enough phenol red so that there is a noticeable color to the water.

2. Drop an antacid tablet into the water. Do you observe any changes of color or changes of state? What can you infer about the formation of new materials? What kind of changes took place?
Draw Conclusions

▲ How did the fizzing antacid tablet change?

▲ How did the pH change when the tablet was added?

▲ How would the pH change if you stirred the solution with a spoon 10 minutes after the reaction?

▲ After the reaction ends, pour the liquid into a plate and allow the water to evaporate. Is the residue the same as the original tablet? How would you know? Where did the tablet go?

▲ Infer Was this a chemical or physical reaction? What are the reasons for your inference?
Communicate Your Results
Have a class discussion and share your results with the other students. Use your data to answer the questions.

► What type of reaction took place?

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► How can you support your conclusions?

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► What were your classmates conclusions? How are they the same or different from yours?

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Inquiry: Guided
How Long Can It Fizz?

Ask Questions
Would crushing the tablet into powder make the amount of time the reaction takes place increase, decrease, or remain the same? What other factors might change the amount of time the reaction fizzes?

Make a Prediction
Predict what will happen to the length of the fizzing reaction when you put a crushed fizzing antacid tablet into water with phenol red.

Materials
- 1 antacid tablet
- clear plastic cup
- pH indicator (Phenol Red) with eyedropper
- graduated cylinder or measuring cup
- stopwatch
- thermometer
Test Your Prediction

1. Work with a partner. Break an antacid tablet in half. Wrap one half-tablet in a sheet of paper and crush it into powder. Leave the remaining half uncrushed.

2. Add 15 mL of cold tap water and 2 drops of pH indicator to each cup. Start timing as you drop the crushed tablet into one cup and the uncrushed tablet into the other cup. The cup with the uncrushed tablet is the experimental control.

3. How does crushing affect the fizzing time? Identify the controlled and dependent variables.

4. What factor would you like to check next? Does water temperature affect fizz time? Does the pH indicator affect the fizz?

5. Devise an experiment to test your question. Identify the controlled and dependent variables.
Communicate Your Results
Work in groups of 4 to 8 and discuss what you found out about fizzing times.

- Write a report of one of your investigations. Discuss how your results compared to your classmates.
Inquiry: Open

More Fun with Fizzing

Design and do an experiment to answer a question of yours. Make a prediction, do an experiment to test it, record your data, and communicate your findings. What are the independent and dependent variables, and what is your control? Write a report of your experiment. Include step-by-step directions so others can follow. Here are some ideas to get you started:

▲ How much fizz will we get if we use only 6 drops of water?
▲ Does the temperature of the liquid in the cup change when the mixture fizzes?
▲ Is the gas given off like bubbles in soda pop? How could we test our idea?

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