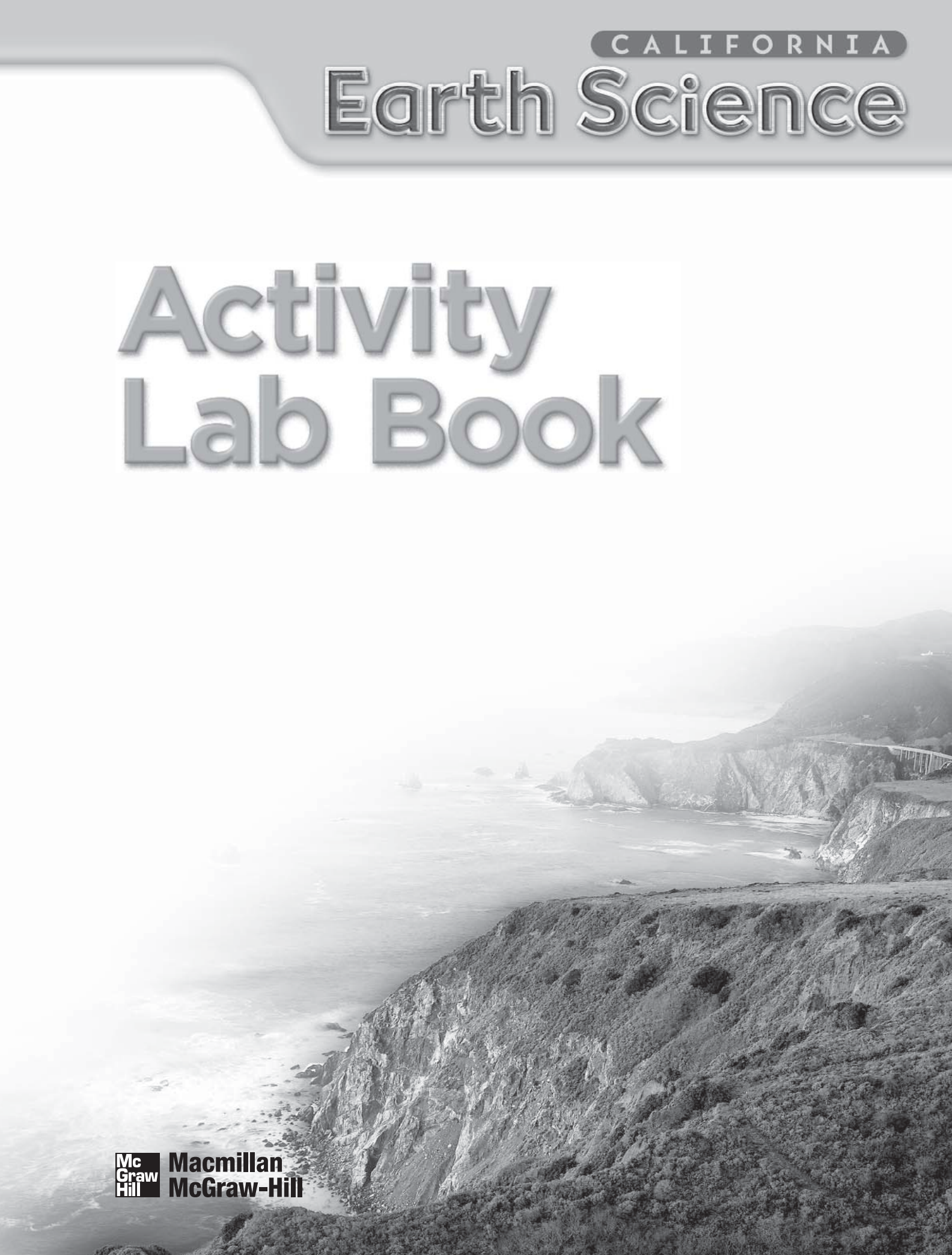
CALIFORNIA

Earth Science

Activity Lab Book



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Contents

California science standards are noted at the top of activity pages. For the text of the standards, please refer to the Reference section of the California Science Student Edition.

Name _____ Date _____

Explore

California Standard
6 IE 7.a., e.

Do different ecosystems contain different organisms?

Materials

- trowel or spade
- 4 small stakes
- meterstick
- string
- thermometer
- field guides
- graph paper
- safety goggles

Form a Hypothesis

Why do certain plants and animals live in certain places? How does the amount of sunlight affect different organisms? Write your answer as a hypothesis in the form *"If a plant needs lots of sunlight, then . . ."*

_____

_____

_____

Test Your Hypothesis

1. **Experiment** With your teacher select two areas on or near your school grounds to study. Choose one area that receives plenty of sunlight and another that receives very little. Mark off a 2-by-2-meter plot in each area with stakes and string.

2. **Measure** Measure the air temperature at ground level and at 1 meter above ground level in each area.

_____

_____

3. **Record Data** Using graph paper record the locations of the living things in each area. What kinds of organisms do you see? Use field guides to help you identify the organisms.

_____

Name _____ Date _____

Draw Conclusions

4 Compare your observations about the two areas. How do the temperatures differ? Which area contains more living things?

_____

_____

_____

5 **Infer** What statement can you make about the effect of sunlight on an ecosystem?

_____

_____

_____

_____

Explore More

How do you think the amount of water in an ecosystem affects living things? Make a prediction about this, and design a procedure to test it. How have people affected the ecosystem?

_____

_____

_____

_____

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_____

Name _____ Date _____

Alternative Explore

Can you identify an ecosystem outside your school?

Materials

- paper and pencil

Make a Prediction

Can you locate an ecosystem outside your school? Write your answer as a prediction in the form "*If I can find living and nonliving things interacting with each other in an area outside my school, then . . .*"

_____

_____

Test Your Prediction

1. Walk around outside your school. Take along some paper and a pencil, and take notes on your observations.

_____

_____

_____

2. Use your notes to identify an ecosystem.

3. Describe your ecosystem, and list at least two living things and two nonliving things.

_____

_____

_____

Name _____ Date _____

Draw Conclusions

4 **Classify** What criteria did you use to decide whether a location was an ecosystem?

_____

_____

_____

_____

_____

_____

5 Does an area have to be a certain size to qualify as an ecosystem?

_____

_____

_____

_____

_____

_____

Name _____ Date _____ **Quick Lab**

Testing Soil pH

Purpose

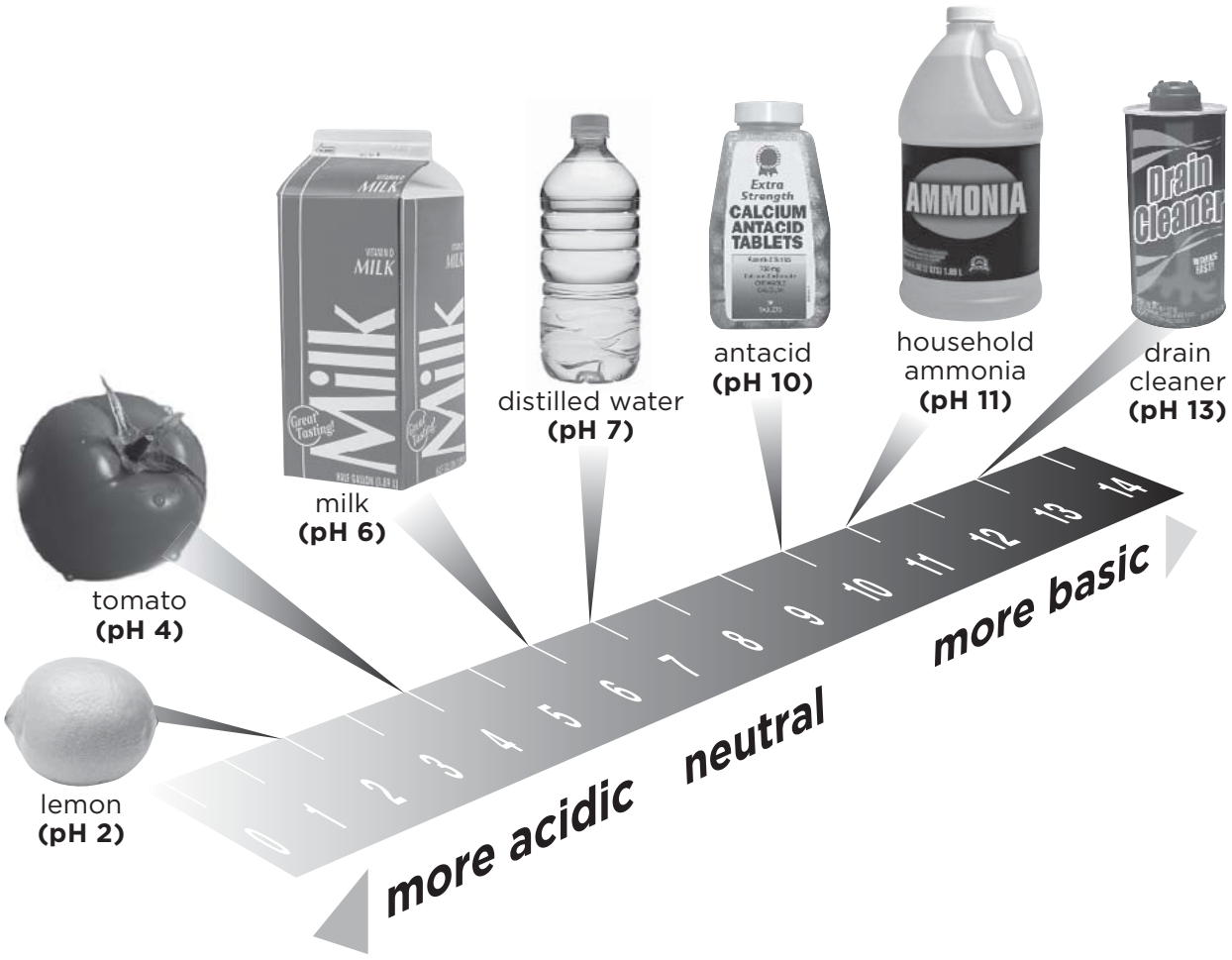
Your task is to determine whether the pH differs from one soil sample to another.

Materials

- pH test kit
- 3 soil samples

Procedure

1. Put three different soil samples in separate cups.
2. Using the soil-test kits provided by your teacher, test the pH of each sample. Record the pH of each.



Name _____ Date _____

Draw Conclusions

3 **Predict** What do you think would happen if you added an antacid to the soil samples? Design an experiment to test your prediction.

My prediction: _____

_____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

_____

_____

Name _____ Date _____

California Standard 6 IE 7.h.

Compare

When scientists **compare** they look for similarities among objects, materials, and data. As scientists study a particular ecosystem over time, they can make comparisons. They can compare the way the ecosystem functions in the present with the way that it functioned in the past. With this information they can predict what the ecosystem might be like in the future.

1 Learn It

When scientists study an ecosystem, they examine every change they can. Scientists study changes because one small change in an ecosystem can affect many biotic and abiotic factors.

Charts and Venn diagrams are tools used to **compare**. After you have collected and recorded data, you can see at a glance whether the data, objects, or materials are similar. Line graphs and bar graphs can also be used to analyze changing conditions over time.

2 Try It

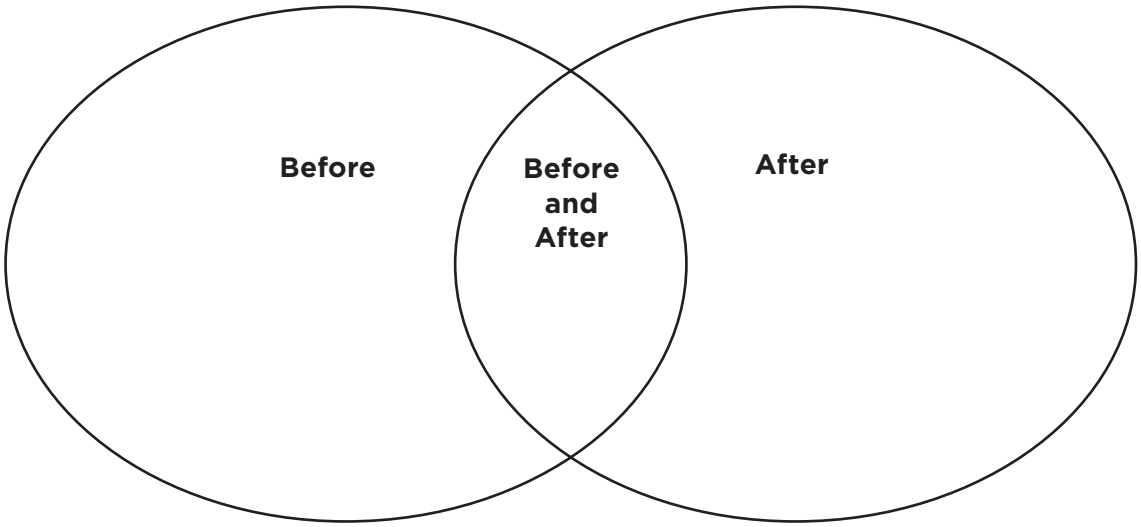
- Scientists monitor how sudden events such as floods and mudslides affect an ecosystem. In this activity you will **compare** a miniature landscape before and after a "flood." You will need a dishpan, soil, rocks, small twigs, water, and a watering can.
- Build a hill landscape of soil, rocks, and twig "trees" in a dishpan. Draw a picture of your landscape on the chart on the next page. Use the watering can to sprinkle water gently on your hills. Record your observations.
- Hold the can high, and continue to let water fall down on the hills. Record your observations. Pour the rest of the water quickly over the hills. Record your observations. Draw a picture of the way your landscape looks now.

Name _____ Date _____

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

3 Apply It

- Now use the information from your chart to create a Venn diagram like the one on this page. Draw two overlapping ovals. In one oval list the characteristics of your hill ecosystem before the "flood." In the other oval list the characteristics of your hill ecosystem after the "flood." Write the common characteristics in the area where the two ovals overlap.



- How did your hill ecosystem change?

_____

_____

_____

_____

- How did it stay the same?

_____

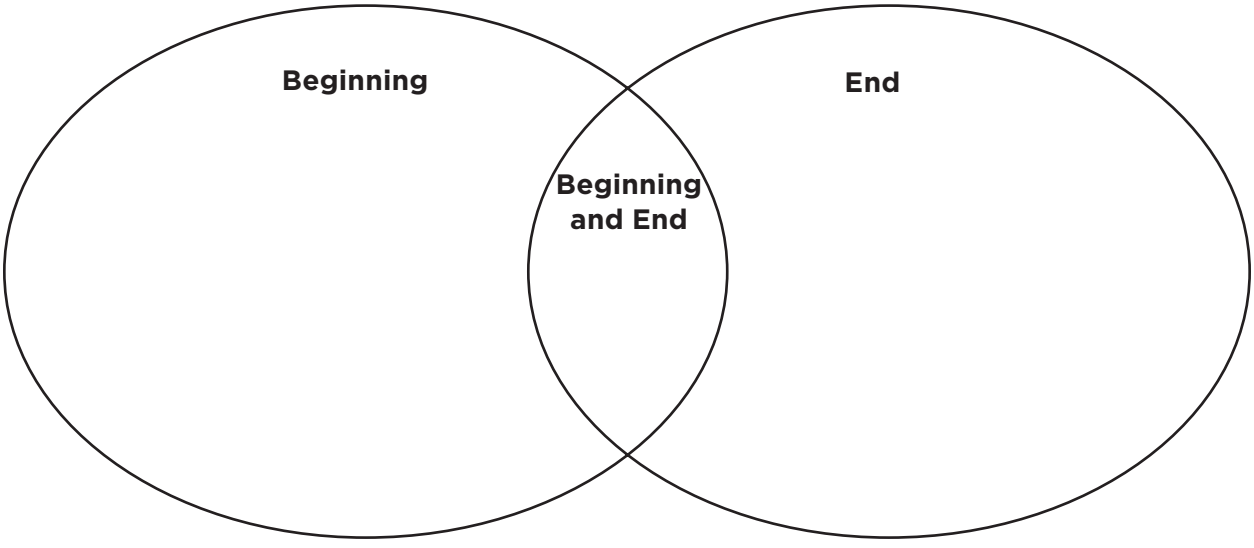
_____

Name _____ Date _____

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

Observations

Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1							
2							
3							
4							



Name _____ Date _____

Explore

California Standard
6 IE 7.a., d.

How does light affect plants?

Form a Hypothesis

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

_____

_____

_____

Materials

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

Test Your Hypothesis

1. Wrap small pieces of aluminum foil over parts of several leaves. Wash your hands after handling the plant.

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

3. Place the plant in a window where it will get lots of light. Water the plant with a measured amount of water.

4. **Experiment** After one day carefully lift the foil and check each leaf. Write down your observations. Gently replace the foil in the same position.

   _____

   _____

   _____

5. **Experiment** Continue your observations each day for one week. Replace the foil in the same position each time.

Name _____ Date _____

Draw Conclusions

6 **Compare** How did the areas covered by the foil differ from the other parts of the leaves?

_____

_____

7 **Interpret Data** How did the changes you observed progress after one day? After two days? After a week?

_____

_____

_____

8 **Infer** How do light and darkness affect the growth of leaves?

_____

_____

_____

Explore More

Remove the foil from the leaves. Water the plant with the same amount of water you used in the previous week, and observe it each day for another week. What happens when the leaves remain uncovered?

_____

_____

Name _____ Date _____

Alternative Explore

How do plants absorb water?

Form a Hypothesis

How does water travel from a plant's roots to its stem, leaves, and flowers? Write your answer as a hypothesis in the form *"If water travels through tubelike structures in a plant's stem, then . . ."*

_____

_____

_____

_____

Materials

- white carnation with stem split lengthwise
- 2 different colors of food coloring
- 2 glasses or narrow jars
- water

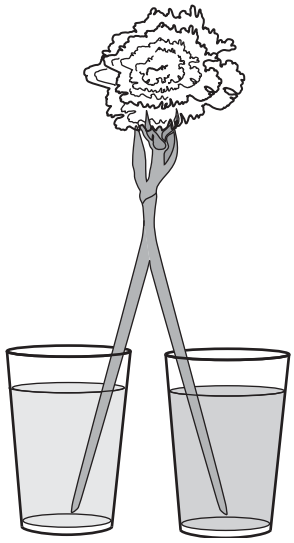
Test Your Hypothesis

1. Obtain from your teacher a white carnation that has its stem cut in half lengthwise.

2. Fill each glass with water. Add a few drops of food coloring to one. Add a few drops of food coloring in another color to the second glass. Place them next to each other.

3. Place one side of the flower stem in one glass and the other side of the flower stem in the second glass. Record your observations.

_____



Draw Conclusions

4. **Interpret Data** What does this tell you about the way water is transported in plants?

_____

_____

Quick Lab

Name _____ Date _____

Leaves

Purpose

Leaves are the food-making machines of plants, and they come in a wide variety of forms. Your task is to observe the ways in which plant leaves are alike and different.

Materials

- variety of leaves
- hand lens
- paper and pencil
- crayons

Procedure

1. Collect a variety of leaves.

2. **Observe** Examine each leaf with a hand lens, and write down each structure that you can identify.

_____

_____

_____

3. Place a piece of white paper over the leaf, and rub back and forth with a crayon, making a print of the leaf.

4. **Identify** On the rubbing, identify the leaf as simple or compound, and label each structure.

_____

_____

_____

5. Using two different-color crayons, trace the flow of water and food through the veins.

_____

_____

_____

_____

Draw Conclusions

6 **Infer** What is the role of veins in the leaf's food-making process?

_____

_____

_____

7 **Going Further** How does water move around plants? Do leaves help pull water upward through the plant? Write your answer as a hypothesis in the form *"If leaves help pull water upward through a plant, then . . ."*

My hypothesis: _____

_____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

Name _____ Date _____

California Standard
6 IE 7.b.

What can you see through a microscope?

Materials

- microscope
- 4 microscope slides
- dropper
- water
- toothpick
- small pieces of newspaper
- onion skin
- sand
- yeast

Make a Prediction

What do you think you will see if you look at an onion skin, sand, or yeast under a microscope? Will you see living organisms moving? Write your answer as a prediction in the form *"If I look at an onion skin, sand, or yeast under a microscope, then . . ."*

_____

_____

_____

Test Your Prediction

1. **Observe** Place a piece of newspaper on a microscope slide. Place the slide on the stage of the microscope, and observe it under low power. Draw what you see.

_____

_____

2. **Observe** Look at the newspaper again under high power. Record your observations.

_____

_____

3. **Observe** Select your own samples. Repeat steps 1 and 2 for each sample. Record what you see.

_____

_____

4 **Record Data** Make a data table to record the details of what you observed. How many organisms did you observe? How big were they? What colors were they?

_____

Draw Conclusions

5 **Observe** What did you learn about the way objects appear when viewed through a microscope?

_____

6 **Compare** What happened to your observations as you changed from low power to high power?

_____

_____

7 **Observe** Describe the appearance of each of the samples you observed.

_____

_____

_____

8 **Critical Thinking** Explain how your life might be different if the microscope had never been invented.

_____

_____

_____

Explore More

Did you see any differences among the samples under the microscope? Research the types of cells you looked at. Analyze and present your results.

_____

_____

Name _____ Date _____

What can you learn about your world through a microscope?

Materials

- microscope
- microscope slides
- coverslips
- tweezers
- cotton swabs

Form a Hypothesis

One of the joys of science is discovering the world around you. Do you think you can observe all of the organisms that you interact with every day? Do you think you will discover much larger numbers of organisms in your world if you use a microscope? Write your answer as a hypothesis in the form *"If I use a microscope to examine the world around me, then . . ."*

_____

_____

_____

Test Your Hypothesis

1. Collect some samples from your surroundings. Using tweezers or cotton swabs, collect samples such as dust particles, carpet fibers, hair strands from a comb or brush, sand from a beach or sandbox, and potting soil from a houseplant.

2. Place each sample on a microscope slide. Use a coverslip if needed.

3. **Observe** Starting with low power, observe your samples. Record your observations by drawing circles on a piece of paper to outline your field of view. Label each circle with the name of the sample, and draw what you see. Switch to high power, and record your observations.

Name _____ Date _____

Draw Conclusions

4 What did you observe?

_____

_____

5 Do you think microorganisms are all around you? Explain your reasoning.

_____

_____

_____

Inquiry: Open Do you think disinfectant sprays or antibacterial soaps kill microorganisms? Write your answer as a hypothesis in the form *"If I use a disinfectant spray or an antibacterial soap on a surface, then . . ."*

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

_____

_____

My results: _____

_____

_____

 Name _____ Date _____

Observing Protists

Purpose

Your task is to use a microscope to examine pond water and observe protists and other microorganisms.

Materials

- metric ruler
- pond-water sample
- microscope
- microscope slide
- coverslip

Procedure

1. Slide a metric ruler onto the stage of your microscope, and focus on it, using the highest power. Measure the field of view, and record your measurement in millimeters.

_____

_____

_____

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

3. **Observe** Starting with the lowest power, focus the microscope until you find microorganisms. Switch to high power, and focus. Draw what you see.

4. **Measure** Estimate how much area one microorganism you are observing takes up. Multiply that number by the size of your field of view to estimate the size of the organism in millimeters. For example, $\frac{1}{3} \times \frac{1}{2}$ mm $= \frac{1}{6}$ mm.

_____

_____

Name _____ Date _____ Quick Lab

Draw Conclusions

5 **Observe** What can you learn about microorganisms by observing them under a microscope?

_____

_____

_____

6 **Predict** How would your observations change if you used a more powerful microscope?

_____

_____

7 **Going Further** Is pond water safe for drinking? Write your answer as a hypothesis in the form *"If pond water contains many microorganisms, some of which may cause disease, then . . ."*

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.d.

How can you model a food chain?

Materials

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

Make a Prediction

What would a food chain of 20 organisms look like? Would it be linear? Write your answer as a prediction in the form *"If 20 organisms were made into a food chain, then it would look like . . ."*

_____

_____

_____

_____

Test Your Prediction

1. Cut construction paper into 20 rectangles. Write the names of eight producers, six animals that eat the producers, four animals that eat the plant eaters, and two animals that eat the animals that eat the plant eaters. Make a hole in each rectangle.

2. **Make a Model** Cover the top of the soda bottle with construction paper. This will be the Sun. Punch eight holes around the rim. Attach a piece of yarn to each of the eight producers. Attach the other ends to the soda bottle. Using yarn, link each plant-eating animal to a producer. Continue by linking the animals that eat the plant eaters to the plant-eating animals. Only one animal may be attached to a food source.

Draw Conclusions

3 **Observe** How many levels are in your model? What happens to the number of organisms in each level as you move away from the Sun?

_____

_____

_____

4 **Predict** What would happen to the number of plant eaters if a drought destroyed the plants? What would happen to the animal populations?

_____

_____

_____

_____

_____

Explore More

What changes might occur in an ecosystem into which the predators move? Make a prediction and test it. Then analyze and present your results.

_____

_____

_____

_____

Name _____ Date _____

What food chains are needed to provide various foods?

Materials

- different colors of construction paper
- scissors
- glue
- index cards

Make a Prediction

How many food chains does it take to make a pizza? Maybe you like your pizza with extra cheese and green peppers. Perhaps you prefer ziti pizza with meatballs. Get creative! Write your answer as a prediction in the form *"If I make a pizza using several ingredients, then . . ."*

_____

_____

_____

Test Your Prediction

1. Using different colors of construction paper, cut out the "ingredients" of your pizza. Begin with the crust. Add other ingredients by gluing them onto the pizza crust. You must include at least five ingredients.

2. For each ingredient in your pizza, draw on an index card a possible food chain that would provide that food, and attach the card to the ingredient.

3. **Classify** Look over each food chain, and classify each food as involving or coming from a producer, a primary consumer, a secondary consumer, or a tertiary consumer.

_____

_____

_____

_____

Draw Conclusions

4. From which level on the food chain did most of the ingredients on your pizza come?

_____

_____

5. How would you create a pizza made only of ingredients that are producers?

_____

_____

Inquiry: Open How do the levels in a food chain relate to the recommended daily servings of each food group? Write your answer as a prediction in the form *"If foods from producers provide fiber as well as important vitamins and minerals, then . . ."*

My prediction: _____

_____

_____

My research: _____

_____

_____

_____

My results: _____

_____

_____

Quick Lab

Name _____ Date _____

Your Food Chain

Purpose

Every organism that gets energy from a food is part of the food chain involving that food. Your task is to classify where you fall along the food chains you are part of.

Materials

- paper and pencil

Procedure

1. Keep a log of everything you eat for one day.

2. **Classify** For each food, determine whether it is a producer or a consumer.

_____

_____

_____

3. **Classify** Which foods did you list as producers?

_____

_____

4. **Classify** Which foods did you list as consumers?

_____

_____

_____

_____

5 **Communicate** Select two foods from the consumer group, and draw a possible food chain for each. Do not forget to include yourself. Did you include decomposers in your food chain? Where do they fit?

_____

_____

_____

6 **Going Further** Which part of a food chain takes the most energy to feed? Write your answer as a hypothesis in the form *"If each member of a higher level in a food chain eats many individuals from the level below, then . . ."*

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

_____

_____

Name _____ Date _____

How does water recycle itself?

California Standard
6 IE 7.e.

Make a Prediction

All living things rely on water, yet there is a limited supply of water on Earth. Water is recycled so that it can be used again and again. What will happen to soil if it is moistened with water and then placed under a heat source? Write your answer as a prediction in the form *"If moistened soil is allowed to sit under a heat source, then the water in the soil will . . ."*

_____

_____

Materials

- empty soda bottle with cap (cut into halves)
- soil
- water spray bottle
- lamp or window with sunlight

Test Your Prediction

1. Place about 4 inches of soil in the bottom half of the soda bottle.
2. Spray the soil with water so that it is moist but not wet.
3. Secure the top half of the soda bottle over the bottom half. Use tape if necessary.
4. **Observe** Place the bottle under a lamp or in direct sunlight. Observe it every 10 minutes for a class period. Write down your observations. Observe the bottle again on the second day. Write down your observations.

_____

_____

_____

Draw Conclusions

5 What did you see the first day? What did you see the second day?

_____

_____

_____

6 **Infer** What was the source of the water? What was the source of the energy that caused changes in the bottle?

_____

_____

7 **Observe** What happened to the water?

_____

_____

_____

Explore More

What might happen if you added some small plants to the bottle? Some small rocks? What might happen if you added more heat or placed the bottle in the shade?

_____

_____

_____

_____

_____

Name _____ Date _____

What does the carbon cycle look like?

Materials

- magazines and newspapers
- poster board
- glue
- markers

Form a Hypothesis

Carbon is constantly cycled through living organisms and the environment. When animals exhale they are getting rid of the waste products of their own cellular activity: carbon dioxide and water. What are some other sources of carbon dioxide? Are there organisms that absorb it? Write a hypothesis in the form *"If carbon is cycled through Earth's living things and the environment, then . . ."*

_____

_____

_____

Test Your Hypothesis

1. Gather information about the carbon cycle. Identify sources of carbon dioxide and ways in which carbon is absorbed.

_____

_____

_____

_____

_____

2. Cut out pictures from magazines and newspapers that represent sources of carbon and pictures of things that absorb and store carbon.

3. Use the pictures and a piece of poster board to make a collage that models the carbon cycle. Show the different pathways of carbon's journey through living things and the environment by drawing arrows to and from each picture.

Draw Conclusions

4 What role do living plants and animals play in the carbon cycle?

_____

_____

_____

5 Why does the burning of fossil fuels release carbon dioxide into the atmosphere? Where does this carbon dioxide come from?

_____

_____

_____

Inquiry: Open Think of your own question related to the cycles in nature.

My question: _____

_____

My research: _____

_____

My results: _____

_____

_____

 Name _____ Date _____

Fertilizers

Purpose

Your task is to determine whether plants given fertilizer grow faster than plants not given fertilizer.

Materials

- 2 plastic cups
- water plants, such as elodea
- pond water or aquarium water
- houseplant food
- protective gloves

Procedure

1. Fill two plastic cups with pond water or water from an aquarium.
2. Add a few water plants, such as elodea, to each cup.
3. Add a teaspoon of houseplant food to one cup, and label the cup. △ **Be Careful.** Always wear protective gloves when handling plant foods.
4. **Observe** Place both cups in a sunny window, and observe them each day for a week. Record your observations.

_____

_____

_____

Draw Conclusions

5 **Interpret Data** What effect did the plant food have on the plant growth in the cups? What is the independent variable in this lab? What is the dependent variable?

_____

_____

_____

_____

6 **Going Further** Can a plant get too much fertilizer? Write your answer as a hypothesis in the form *"If I add too much fertilizer to a plant, then . . ."*

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

Name _____ Date _____

California Standard 6 IE 7.a.

Inquiry: Structured

What factors affect the carbon, water, and nitrogen cycles?

Materials

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

Form a Hypothesis

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

_____

_____

△ **Be Careful.** Wash your hands with soap and water after the investigation. Immediately wash any area of skin that comes in contact with bromothymol blue.

Test Your Hypothesis

1. Use a straw to blow slowly into a small cup of bromothymol blue. Record your observations.

   △ **Be Careful.** Be sure to breathe out through the straw. Do not breathe in. Do not drink the liquid in the cup.

   _____

   _____

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

_____

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

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

_____

_____

Draw Conclusions

5. **Explain** What made the bromothymol blue change color in step 1?

_____

_____

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

_____

_____

_____

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

_____

_____

_____

_____

Name _____ Date _____

Inquiry: Guided

What factors affect the water cycle?

Form a Hypothesis

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

_____

_____

Test Your Hypothesis

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

_____

_____

_____

_____

_____

Draw Conclusions

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

_____

_____

_____

_____

_____

Name _____ Date _____

Inquiry: Open

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

Remember to follow the steps of the scientific process.

Ask a Question

_____

Form a Hypothesis

_____

_____

_____

Test Your Hypothesis

_____

_____

Draw Conclusions

_____

_____

_____

_____

Name _____ Date _____

What are Earth's biomes like?

California Standard
6 IE 7.d.

Make a Prediction

A biome is a land region that has a particular climate. Earth's biomes include taiga, tundra, tropical rain forest, deciduous forest, desert, and grassland. Do all biomes have the same kinds of plants and animals? Write your answer as a prediction in the form *"If each biome has a particular climate, then _____ plants and animals live in each."*

_____

_____

Materials

- long piece of white butcher paper
- crayons and color markers
- index cards

Test Your Prediction

1. Work in groups of four or five. Each group should select one biome.
2. Tape the paper to the walls of the classroom.
3. Research the biome you selected. Find out about its location, climate, soil, and its plants and animals.

_____

_____

_____

_____

_____

_____

4 **Make a Model** Draw a mural that represents your biome. Show at least two plants and two animals that live in the biome. Include a world map that shows the location of the biome.

5 **Communicate** List the information you collected on the index cards, and attach them to your mural. Indicate where you obtained the information.

Draw Conclusions

6 Compare the plants and animals in the biomes. What similarities and differences do you see?

7 Did your observations support your prediction?

Explore More

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

Name _____ Date _____

How can you recreate a biome?

Make a Prediction

When animals are kept in zoos, it is very important to recreate their native environments. Many animals come from biomes that are very different from those in which the zoos are located. Is it possible to recreate an animal's environment? Write your answer as a prediction in the form *"If you know the climate and characteristics of a biome, then . . ."*

Materials

- paper
- color pencils
- index card

_____

_____

Test Your Prediction

1. Select an animal from one of the world's six biomes.

   _____

2. Using color pencils draw a picture or series of pictures detailing how you would design a zoo exhibit for the animal to recreate its natural habitat.

3. **Communicate** On an index card, list each feature of the exhibit that helps recreate the biome from which the animal comes.

   _____

   _____

   _____

   _____

   _____

Name _____ Date_____

Draw Conclusions

4 Would it be easier to build your exhibit outdoors or indoors? Why?

_____

_____

5 Why do you think it is important to build zoo exhibits that are very similar to an animal's native environment?

_____

_____

_____

Inquiry:Open How closely did your exhibit match what has been done at major zoos around the country? Visit a zoo in person or online to check out their exhibits. How did your exhibit compare?

_____

_____

_____

_____

_____

_____

Name _____ Date _____

Endangered Species

Purpose

Your task is to study what happens when an animal species becomes extinct. How does the loss of its role affect other organisms in the biome?

Materials

- books, Web sites, and other sources
- paper and pencil

Procedure

1. Choose an endangered animal species to study.

_____

2. Use books, Web sites, and other sources to find information about this endangered species.

_____

_____

3. Identify the species' niche in its biome. Find out what it eats, where it lives, and how it interacts with plants and other animals in the biome.

_____

_____

4. Draw a food web that shows the interactions between the endangered species and the plants and other animals in the biome. Show how they depend on each other for resources such as food and shelter.

_____

_____

5 **Infer** What would happen if this animal became extinct?

_____

_____

_____

Draw Conclusions

6 What are some reasons that the animal you researched is in danger of extinction?

_____

_____

7 **Communicate** What can individuals do to help save endangered species? Design a poster to communicate your ideas.

_____

_____

_____

8 **Going Further** What animals in California are considered endangered species? How could you find out about them? Make a prediction in the form *"If there are endangered animal species in California, then . . ."*

My prediction: _____

_____

_____

My research: _____

_____

_____

My results: _____

_____

Name _____ Date _____

California Standard 6 IE 7.g.

Sequence

Many things on Earth occur in a **sequence.** Think about it. You cannot be 13 years old before you are 12, and leaves do not fall off deciduous trees until the leaves have matured. The same is true about the layers of soil in a land biome. By digging down to lower layers, scientists can learn more about a biome and any changes that have taken place over time. In general, in a soil sequence, the lowest layers are the oldest.

1 Learn It

When you put things in **sequence,** you put one thing after another in a fixed order. When you sequence events, you put them in the order in which they happened. This order helps you see patterns.

When scientists do experiments, they record their data in a time sequence showing what happened first, next, and last. Scientists need these data not only to verify what they discovered and when but also to be able to repeat the investigation or try it in a different way. A *sequence chart* is a useful tool for recording these kinds of data.

2 Try It

- Suppose scientists wanted to verify the soil layers in a biome. They would make a plan to dig into the ground and examine it. On the next page, there is a **sequence** chart they might keep, but it is not in the correct order. Write a number in front of each box to show the order in which each layer would be found. Use number 1 for the topmost layer.

☐	slightly broken-up bedrock, very little organic material
☐	organic soil, leaf litter, decomposed organic matter
☐	mostly light-colored sand & sediment, a few plant roots, some fossils
☐	bedrock
☐	dark-colored topsoil, humus, minerals, plant roots
☐	subsoil, clay, mineral deposits, some organic material, fossils

▶ Which level contained the newest soil materials?

_____

▶ What did scientists find at the oldest level?

_____

▶ How could knowing the sequence of soil and rock layers in a desert biome help scientists?

_____

_____

3 Apply It

▶ In this activity you will build a grassy environment. As you do this activity, make a **sequence** chart to show each step in your project and your observations. The overall growth of the plants will show whether you have built a healthy environment. You will need a 10-gallon fish tank, gravel, charcoal, sand, topsoil, grass seed, small seedlings, a plastic spoon, a mixing bowl, a watering can, plastic wrap, tape, a measuring cup, and a ruler.

Name _____ Date _____

1. Spread a 1-inch layer of gravel on the bottom of the tank with the spoon. Mix in a little charcoal, and then spread a 1-inch layer of sand over the gravel.

2. Measure 2 parts topsoil to 1 part sand in the bowl, and mix thoroughly. Spread a 2- to 3-inch layer of the mixture over the sand and gravel.

3. Sprinkle grass seed on half of the soil. Plant seedlings in the other half. Be sure to cover the roots and leave space between plants. Water the landscape gently until it is moist on top.

4. Cover the tank with plastic wrap. Use tape to secure the plastic tightly over the top. Place the tank in a sunny place.

5. Check the tank each day for a week, and record what you observe. Then answer the questions on the next page.

Grassy Environment Observations

Date	Time	Observations

Name _____ Date_____

Focus on Inquiry Skills

▶ Do the layers in your environment appear to be in the same order as they were in the Try It activity?

_____

_____

_____

▶ What did you observe in your environment?

_____

_____

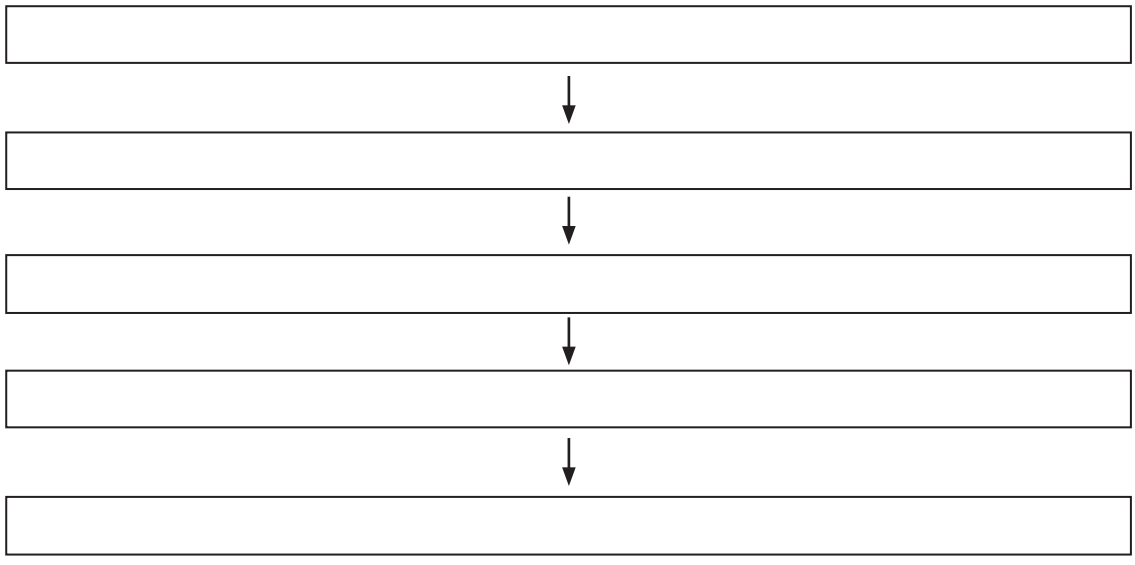
_____

_____

▶ Use the sequence chart below to describe the process that seeds go through as they germinate and grow.

_____

_____



Name _____ Date _____

What are water ecosystems like?

California Standard
6 IE 7.b., d.

Make a Prediction

What will you observe when you compare samples of water from different sources? Will the contents be alike or different? Write your answer as a prediction in the form *"If water samples come from different sources, then . . ."*

_____

_____

_____

Materials

- microscope
- slides with coverslips
- water samples from ponds, lakes, and the ocean
- safety goggles

Test Your Prediction

1. Obtain from your teacher samples of pond, lake, and ocean water. Place each sample in a different container. Label each container.

2. **Observe** Note the appearance of each water sample, and record your observations.

_____

_____

_____

_____

_____

3. For each sample, place a drop of the water on a slide, and carefully place a coverslip over it.

4. **Observe** Examine the slide under a microscope at low power and at high power.

5 **Communicate** Record what you see on each slide.

Draw Conclusions

6 **Interpret Data** Compare the samples. How are they alike and different? What do your observations tell you about water ecosystems?

7 Did your results support your prediction?

Explore More

What organisms did you observe in the water samples? Where do the organisms fit in the food chain? Draw a possible food chain for each sample.

Name _____ Date _____

How on Earth do we use water?

Make a Prediction

Water covers about 75% of Earth's surface. How much of that is available for use by humans and other animals? Write a prediction in the form *"If only about 3% of Earth's water is fresh water, then . . ."*

_____

_____

_____

_____

Materials

- seven 1-liter clear soda bottles
- blue food coloring
- water
- labels
- graduated cylinders
- calibrated droppers

Test Your Prediction

1. Add food coloring to 2.5 liters of water until the water is clearly blue.

2. Label the seven bottles as follows: *All of Earth's Water, All Salt Water, All Fresh Water, Fresh Water Locked Up in Ice Caps and Glaciers, Fresh Water in the Ground, Fresh Water on the Surface,* and *Water in Soil and Air.*

3 **Use Numbers** Add colored water to each bottle, using the volumes specified in the chart below.

Type of Water	Percent of Earth's Water	Amount of Water in Bottle
All of Earth's water	100%	1000 mL
All salt water	97.2%	972 mL
All fresh water	2.8%	28 mL
Fresh water locked up in ice caps and glaciers	2.3%	23 mL
Underground fresh water	0.4%	4 mL
Fresh water on Earth's surface	0.05%	0.5 mL
Water in soil and air	0.01%	0.1 mL

4 **Observe** When you line the bottles up, what do you observe?

_____

_____

Draw Conclusions

5 **Infer** How can you relate your observations in this activity to the need for water conservation?

_____

_____

_____

_____

Name _____ Date _____

Plants as Water Filters

Purpose

Your task is to study what happens when water containing various pollutants moves through the soil of a potted plant.

Materials

- 4 small potted houseplants with holes in the bottom of the pots
- 4 clear containers
- water
- soil
- colored, powdered drink mix
- plastic cups
- liquid soap

Procedure

1. Set four small potted houseplants, with their pots, into the tops of four clear containers.

2. Slowly pour clean water into one of the pots and watch it trickle through the pot into the container. Observe the liquid that comes out.

_____

_____

_____

3. Add about 1 g of soil to a cup of water and stir. Pour this mixture into a second pot. Again, observe the liquid that leaves the pot.

_____

_____

4. Add some colored, powdered drink mix to a cup of water and stir. Slowly pour the mixture through a third pot. Note the color of the water that drains from the pot.

_____

_____

5. Mix about 30 mL of liquid soap with a cup of water. Pour this mixture through the fourth pot. Does the soap flow through the soil?

_____

_____

6. **Observe** Empty the containers under the third and fourth pots. Then pour some clean water over both plants. What drains out?

_____

_____

Draw Conclusions

7. Based on your results, what can you conclude about the role of plants in wetlands?

_____

8. **Going Further** What do you think would happen if the concentration of pollutants were greater in this procedure? How could you test your prediction?

My prediction: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.a, d.

Inquiry: Structured

What is an estuary?

Materials

- plastic cups
- plastic spoons
- salt water made from ocean mix
- waterproof markers
- eggs
- graduated cylinder

Form a Hypothesis

Fresh water and salt water have many similarities and differences. Both saltwater ecosystems and freshwater ecosystems have food webs that exist because of the Sun's energy. Both types of ecosystems have animals and plants that thrive in all types of temperatures. Estuaries are areas where fresh water flows into the ocean. This creates an area that has a different salt content and is a haven for many types of creatures. What are some unique characteristics of estuary waters? Write your answer as a hypothesis in the form *"If estuary water is different from salt water and fresh water, then buoyancy . . ."*

_____

_____

_____

△ **Be Careful.** Wash your hands with soap and water after the activity.

Test Your Hypothesis

1. Label three cups *Fresh Water, Ocean Water,* and *Estuary Water.*

2. **Measure** Pour 200 milliliters of tap water into the cup labeled *Fresh Water*. Pour 200 milliliters of salt water into the cup labeled *Ocean Water.*

3. Place an egg in the salt water. Record your observations, and mark the egg with a marker at the water level.

_____

4. Place the same egg in the fresh water, and mark the egg again. Record your observations.

_____

5. Remove 100 milliliters of water from each cup, and pour it slowly into the cup labeled *Estuary Water.* Record what happens to the water as you pour the two together.

_____

_____

6. Place the egg in the estuary water, and record your observations.

_____

_____

Draw Conclusions

7. **Explain** What happened when you placed the egg in the salt water? In the fresh water?

_____

_____

8. **Analyze** Based on your experiment, what can you determine about water found in estuaries? What can you determine about the animals and plants in estuaries?

_____

_____

_____

_____

Name _____ Date _____

Inquiry: Guided

How do ocean salt levels affect living things?

Form a Hypothesis

What would happen to sea life if the ocean's salt levels changed? Write your answer as a hypothesis in the form *"If the ocean's salt levels change, then the organisms will . . ."* _____

_____

Test Your Hypothesis

Design an experiment to investigate what effect salt levels have on organisms such as brine shrimp. Write out the materials you will need and the steps you will follow. As you follow your plan, record your results and observations.

_____

_____

_____

_____

_____

Draw Conclusions

Did your results support your hypothesis? Why or why not? Present your results to your classmates.

_____

_____

Name _____ Date_____

Inquiry: Open

What else can you learn about estuaries and their inhabitants? For example, what types of animal life can be found in estuaries? Think of a question to investigate. Then design an experiment or write out a research strategy to answer your question. Carry out your experiment or your research, and present your results to your classmates.

Remember to follow the steps of the scientific process.

Ask a Question

Form a Hypothesis

Test Your Hypothesis

Draw Conclusions

Name _____ Date _____

What are California's ecosystems?

California Standard 6 IE 7.f.

Purpose

What are California's ecosystems like? How are they similar or different? Write a prediction in the form *"If California's ecosystems have different _____, then they will have different _____."*

_____

_____

_____

Materials

- modeling clay of different colors
- sturdy cardboard
- index cards

Procedure

1. Work in groups of four or five. Find various ecosystems on the map provided.

2. **Make a Model** Outline a map of California on a piece of cardboard. Using different colors of modeling clay, construct a state map showing the state's ecosystems. Include landforms and bodies of water.

Step 1

3 **Observe** Create an index card for each ecosystem. Use your clay map to find landforms and bodies of water that might affect plants and animals in the region. Record this information on the index cards. Think about the types of plants and animals you might find in each ecosystem.

Draw Conclusions

4 **Analyze** Using the information on your index cards, compare the ecosystems. How do the regions differ?

5 Did your observations support your prediction?

Explore More

Choose one ecosystem on your state map. What adaptations do you think plants and animals in that region would need to survive?

Name _____ Date _____

How do California biomes compare with biomes around the world?

Form a Hypothesis

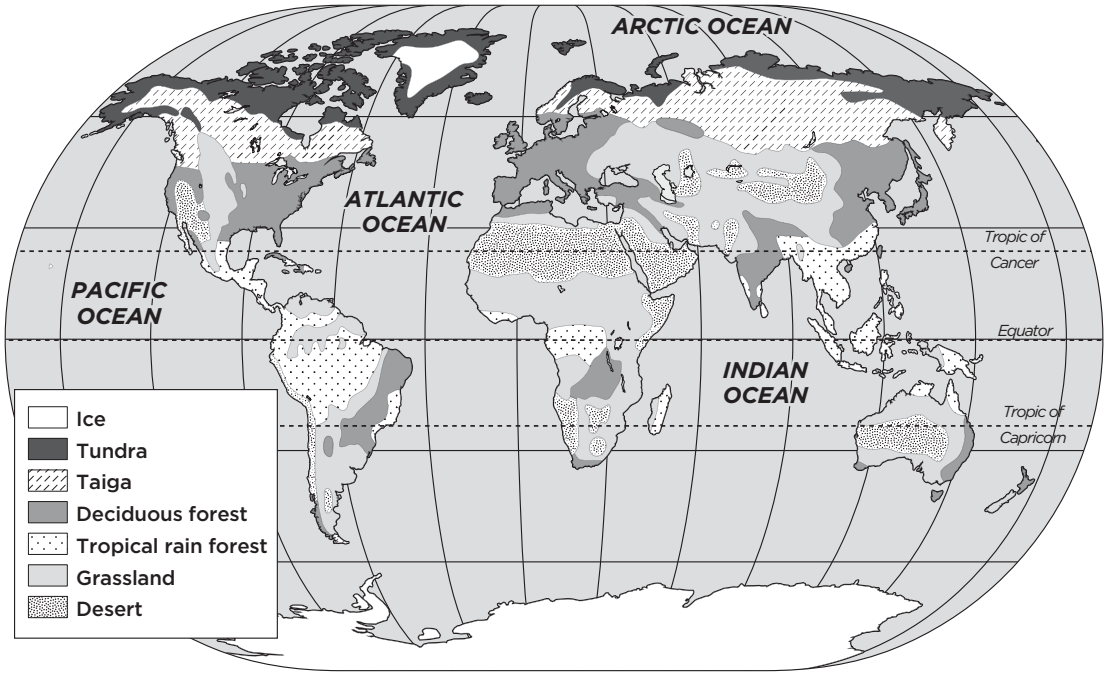
Distance from the equator is a major factor in determining which biomes are likely to occur in a particular location. How do California biomes compare with biomes around the world? Write your answer as a hypothesis in the form *"If a California biome is located at a particular latitude, or distance from the equator, then . . ."*

_____

_____

_____

_____



Name _____ Date_____

Alternative Explore

Test Your Hypothesis

1. Study the world biome map. Review the key, and identify each type of biome.

2. For each California biome, locate other areas around the world that are at about the same distance from the equator, both to the north and to the south. Identify any similar types of biomes in these locations.

_____

_____

Draw Conclusions

3. Did your observations support your hypothesis?

_____

_____

4. Can you explain why biomes do not simply occur in bands surrounding Earth at specific distances from the equator?

_____

_____

Inquiry: Open Which two biomes are virtually limited to the Northern Hemisphere? Why do you think this is so?

_____

_____

_____

Quick Lab

Name _____ Date _____

A California Food Web

Purpose

Your task is to identify what a desert or chaparral food web might look like.

Materials

- books, Web sites, or other resources
- paper and pencil

Procedure

1. Choose a large predator that lives in a desert or chaparral ecosystem in California.

_____

2. Do research to identify some of the prey, or animals that this predator eats.

_____

3. Choose one of the prey. Find out what organisms it eats.

_____

_____

4. Draw a food web that shows where the organisms you identified belong.

_____

_____

Draw Conclusions

5 **Infer** What types of organisms would you expect to find at the base of this food web?

_____

_____

_____

6 **Predict** How do you think food webs would differ in other California ecosystems? Give an example.

_____

_____

_____

7 **Going Further** What do you think would happen if one of the organisms in this food web were wiped out by disease? How could you test your prediction?

My prediction: _____

_____

_____

_____

_____

My experiment: _____

_____

_____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

How can you measure heat flow?

California Standard
6 IE 7.c., d.

Make a Prediction

Do you think heat flows between warm objects and cool objects? What will happen if a jar of cool water is set into a bowl of room-temperature water? Write your answer as a prediction in the form *"If a jar of warm water is set into a bowl of room-temperature water, then . . . If a jar of cool water is set into a bowl of room-temperature water, then . . ."*

Materials

- 2 large bowls
- 2 jars
- 4 thermometers
- watch or stopwatch
- water

_____

_____

_____

_____

_____

Test Your Prediction

1. Fill one jar with 30°C water. Fill second jar with 10°C water.

2. **Measure** Place each jar into a separate bowl of room temperature water 22°–24°C. Record the starting temperatures of the water in the bowls and jars.

   starting temperatures: warm jar 1 _____ bowl 1 _____

   starting temperatures: cool jar 2 _____ bowl 2 _____

3 **Experiment** Record the temperatures of the containers every 2 minutes for 20 minutes. Record your observations. When do you think the temperatures will stop changing?

Draw Conclusions

4 **Analyze** Make a line graph that shows how the temperature of the water in each jar and each bowl changed over time.

5 **Analyze** What happened to the temperature of the jar with warm water? Where did the heat go?

Explore More

What do you think would happen if you place a jar of warm water in a bowl of ice water? Make a prediction and test it. Then analyze and present your results.

Name _____ Date _____

How can you save a snowman?

Form a Hypothesis

What would you do if you lived in a colder climate and wanted to send a snowman to your friend in a warmer climate? Can you design the ultimate insulation to keep your snowman from melting during the trip? Write your answer as a hypothesis in the form *"If I insulate a container efficiently, then . . ."*

_____

_____

_____

Materials

- containers of different materials: cardboard, polystyrene foam, metal
- small containers with lids
- shaved ice or snowballs
- foam peanuts, air-bubble packaging, paper, cotton

Test Your Hypothesis

1. Working in pairs, make a snowman from shaved ice, or snow if available.
2. Pack your snowman in a small container, and seal it with a lid.
3. Select an outer container that is larger than the small container holding your snowman. Place the small container inside the larger container, leaving space for insulation.
4. Decide which type of insulation you will use, and stuff it in between the large container and the small inner container. Close your package tightly, but do not seal it.
5. **Observe** Open the outer container every hour and check on your snowman. Do not keep the container open for long. Record your observations.
6. Record the amount of time it took for your snowman to become a puddle. Share your results with the class.

Name _____ Date _____

Draw Conclusions

7 **Use Numbers** How long were you able to keep your snowman "alive"?

_____

_____

8 **Observe** Which materials used for insulation and packaging worked best for keeping the snowmen frozen?

_____

_____

9 **Infer** What kinds of materials would work best if you worked delivering pizzas and wanted to keep them hot?

_____

_____

 Name _____ Date _____

Different Objects, Different Temperatures

Materials

- metal objects, such as staplers
- wooden objects, such as rulers or desks

Purpose

Your task is to show whether objects made of different materials have different temperatures if they are in the same room.

Procedure

1. **Observe** Touch a metal object, such as a stapler. Then touch a wooden object, such as a ruler or a desk. What do you notice?

_____

_____

Draw Conclusions

2. **Predict** Do you think that the metal and the wood are the same temperature? How could you determine whether they are the same temperature?

_____

_____

_____

3. **Analyze** How would you explain what you observed?

_____

_____

4 **Infer** Why do you think wooden objects feel warmer and metal objects feel cooler?

5 **Going Further** What other materials could you classify as warm to the touch or cool to the touch?

My hypothesis: _____

My experiment: _____

My results: _____

Name _____ Date _____

Experiment

California Standard 6 IE 7.b.

Scientists **experiment** by performing procedures under controlled conditions that help them test a hypothesis, discover an unknown effect, or illustrate a known effect or scientific law.

Sometimes an experiment does not produce the expected result. Does this mean it was a failure? No. It just means that you have new data to lead to more experiments.

1 Learn It

When you **experiment** you perform a test that supports or does not support a hypothesis. You need to plan a procedure, make observations, and record data. Once you have enough data, you can draw a conclusion about whether or not your data supports your hypothesis. It may, or it may not. Either outcome is good. However, the more data you collect, the more accurate your conclusion will be. In the following experiment, you will collect data to test the following hypothesis: *If a rubber band is thick, then it will get hotter than a thin rubber band when both are stretched the same amount.*

2 Try It

- You will need a thick rubber band and a thin rubber band for comparison. Without stretching either rubber band, hold each to your forehead. Do the rubber bands feel warm or cool? Are they the same temperature as your skin? Record your observations in the chart on page 71.
- Hold the thin rubber band away from your face, and quickly stretch it and let it relax three times. Let it relax, and touch it to your forehead. Record your observation about its temperature in the chart. Repeat this procedure with the thick rubber band.

Name _____ Date _____

Rubber Band Experiment

Rubber Band Position	Thin Result	Thick Result
Relaxed		
Stretched		

▶ In an experiment variables are the things that change. To determine what caused the experiment's results, you need to change one variable at a time. The variable that changes is the *independent variable*. A dependent variable is one that changes because of the independent variable. In this experiment what is the independent variable? What is the dependent variable?

_____

_____

_____

Name _____ Date _____

3 Apply It

- Now analyze the results of your **experiment**. Do they support or refute the hypothesis: *If a rubber band is thick, then it will get hotter than a thin rubber band when both are stretched the same amount?* From your results, can you draw a conclusion about why the stretched rubber band felt warmer than, cooler than, or the same temperature as your skin? If you used a thicker rubber band, would the heat flow felt by your skin be greater, less, or the same?

_____

_____

_____

_____

_____

_____

_____

- Can you predict what would happen if you used a thinner rubber band? A thicker one? A longer one? If you stretched it five times before feeling it? Ten times? Plan and carry out an experiment that would prove or disprove one of your predictions. Share the results with your classmates.

Name _____ Date _____

My prediction: _____

_____

_____

_____

_____

Rubber Band Experiment

Rubber Band Position	Thinner Result	Thicker Result	Longer Result
Relaxed			
Stretched 3 times			
Relaxed			
Stretched 5 times			
Relaxed			
Stretched 10 times			

Name _____ Date _____

California Standard
6 IE 7.a., d.

How can you change the sound a string makes?

Materials

- 2 small buckets
- stones to fill each bucket
- 2 pencils
- string or fishing line
- safety scissors
- safety goggles

Form a Hypothesis

What do you think will happen when you stretch a string out across a desk and use pencils to lift the string off the desktop? Can you change the pitch of the sound by moving the pencils? Write your answer as a hypothesis in the form *"If the pencils are moved closer together, then the pitch of the sound will . . ."*

_____

_____

_____

Test Your Hypothesis

1. Cut a length of string about twice as long as your desk. Place the string across the desk, and tie each end to the handle of a bucket so that the buckets hang freely. Insert the pencils under the string at each edge of the desk. Fill each bucket one-quarter full with stones.

2. Near the center of the desk, pluck the string with your finger. Record what you hear.

   _____

3. Move the pencils closer together, and repeat step 2. Record your observations.

   _____

Draw Conclusions

4 **Analyze** How would you explain what you observed? Did your observations support your hypothesis?

_____

_____

_____

_____

5 **Infer** How does the tightness (tension) of a string affect the sound?

_____

_____

Explore More

What will happen to the sound if you fill each bucket half full with stones and repeat step 2? Develop a hypothesis and test it. Then analyze and present your results.

_____

_____

_____

_____

Name _____ Date _____

Why are men's voices lower pitched than women's voices?

Materials

- paper or ceramic cup
- long, sturdy rubber bands
- scissors

Form a Hypothesis

Why do you think men's voices are lower pitched than women's? Does the length of a rubber band affect the highness or lowness of the sound it makes when plucked? Write your answer as a two-part hypothesis in the form *"If a rubber band is short, then the sound it makes when plucked will be . . ." "If a rubber band is longer, then the sound it makes when plucked will be . . ."*

_____

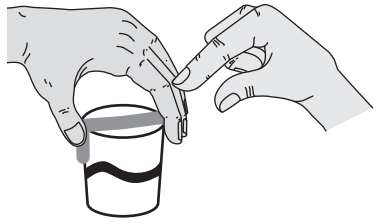
_____

_____

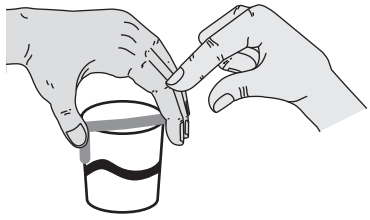
△ **Be Careful.** Use sharp instruments with care.

Test Your Hypothesis

1. Cut a rubber band into 2 pieces, one shorter than the other.



2. Place the longer piece over the center of the opening of the cup, and hold it in place on the outside of the cup, just below the rim. Pluck the rubber band, and record your observations.



_____

3. Repeat step 2 with the shorter piece of rubber band, placing it across a smaller section of the opening. Record your observations.

_____

_____

Draw Conclusions

4 **Analyze** How would you explain what you observed?

5 Did your observations support your hypothesis?

6 **Infer** Based on your observations, how can you explain the difference between men's and women's voices?

Quick Lab

Name _____ Date _____

Traveling Sound Waves

Purpose

Your task is to show how sound waves travel, causing objects to vibrate and move around.

Materials

- plastic wrap
- large bowl or pot
- uncooked rice
- tin cookie sheet
- spoon

Procedure

1. **Make a Model** Stretch a piece of plastic wrap over a large bowl or pot. Make sure the plastic is stretched tightly over the container.
2. Place 20–30 grains of uncooked rice on top of the plastic wrap.
3. Hold a tin cookie sheet close to the plastic wrap. Hit the sheet with a spoon to make a loud noise. What happens to the rice?

_____

Draw Conclusions

4. **Infer** What do you think caused the results you observed?

_____

_____

5. **Predict** What might happen if you hit an object that makes a sound different from a cookie sheet?

_____

_____

_____

6. **Analyze** How would you explain what you observed?

_____

_____

_____

7 **Infer** What does this experiment suggest about how people hear sounds? How does the eardrum work?

_____

_____

8 **Going Further** Sound waves travel from their source in all directions. How could you prove this using several bowls with rice on top?

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

_____

My results: _____

_____

Name _____ Date _____

California Standard
6 IE 7.d.

How can we use the energy of the Sun?

Purpose

The Sun gives off light and heat. Light is used by plants to make food and by people to see during the day. The heat of the Sun warms Earth. Can this heat be used as a source of energy?

Materials

- white construction paper
- black construction paper
- aluminum foil
- 3 unwaxed paper cups
- transparent tape
- peeled apple pieces

Procedure

1. Line the outside of one paper cup with black construction paper. Tape the paper to the cup. Insert this cup into the second paper cup. The black construction paper should be between the two cups. Place three small pieces of peeled apple in the bottom of the first cup.
2. Place a piece of aluminum foil on top of a piece of white construction paper. Tape the foil to the paper. Roll the paper and foil into a cone, with the paper on the outside. The narrow end should fit into the first paper cup. Insert the cone into the cup, and tape it in place.
3. Put three small pieces of peeled apple into a third paper cup. Place the cups in direct sunlight.

Draw Conclusions

4 **Observe** Look at the pieces of apple every half hour for 2 hours. Note your observations.

_____

_____

_____

5 **Analyze** What caused the differences you observed?

_____

_____

Explore More

In this activity you made a simple solar cooker. How can you make your solar cooker more efficient? Compare your design with solar cookers that are available in stores. Write a report about your findings, and present it to your class.

_____

_____

_____

_____

_____

Name _____ Date _____

How can you measure calories used?

Activity	Average Calorie Rate
Sleeping	1.1
Quiet activity (sitting, reading, playing chess)	1.5
Mild activity (washing dishes, brushing teeth)	3.1
Moderate activity (walking, cleaning your room, gardening)	4.4
Strenuous activity (dancing, roller skating, jogging, aerobics)	7.5
Very strenuous activity (running or swimming competitively, tennis)	10.5

Materials

- pencil and paper
- scale
- calorie rate chart (calories burned per hour per kilogram of body mass)

Form a Hypothesis

How can you measure the number of calories you burn in 24 hours? Write your answer as a hypothesis in the form *"If you determine your body mass and use the calorie rates for your daily activities, then . . ."*

_____

_____

_____

Test Your Hypothesis

1. **Measure** Use the scale to determine your body mass in kilograms.

_____

_____

2. Make a log of your daily activities and the amount of time you were involved in each.

_____

_____

3. **Use Numbers** For each activity multiply your body mass by the calorie rate given in the chart. Then multiply that number by the number of hours or parts of hours, in decimals, spent doing each. Total the amount for all activities.

_____

_____

_____

4. **Observe** How many calories did you use in a 24-hour period?

_____

Draw Conclusions

5. **Infer** How can you use this information to help develop a healthful nutrition program?

_____

_____

_____

_____

Quick Lab

Name _____ Date _____

What materials can reduce friction?

Purpose

Your task is to show which of two materials—hand lotion or talcum powder—will work to reduce friction.

Materials

- hand lotion
- talcum power

Procedure

1. **Observe** Rub your hands together quickly. What happens? What force causes your hands to heat up?

_____

_____

2. **Experiment** Put lotion on your hands, and try rubbing them together again. What happens? Do you think talcum powder will have the same effect as the lotion? Test your idea.

_____

_____

3. **Infer** Based on your observations, what effect does motor oil have on friction between engine parts?

_____

_____

_____

_____

Draw Conclusions

4 **Predict** How would ice on a sidewalk affect your ability to walk? How would spreading sand on the ice affect your ability to walk? What role might friction play?

_____

_____

5 **Going Further** One of the main events of county fairs used to be a contest to see who could catch a greased pig. Would it be easier to catch a greased pig or an ungreased pig? What is your reasoning? How could you demonstrate this using a coating of petroleum jelly on the palm of someone's hand?

_____

_____

_____

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

_____

_____

My results: _____

_____

_____

_____

Explore

Name _____ Date _____

California Standard
6 IE 7.b., e.

How does heat flow from one material to another?

Materials

- 2 liquid-crystal thermometer cards
- quarter
- cup of hot water
- ice cube

Make a Prediction

What will happen when two objects of different temperatures are placed together? Will heat be transferred? Write your answer as a prediction in the form *"If heat moves from hot to cold, then . . ."*

_____

_____

_____

Test Your Prediction

1. Hold a liquid-crystal thermometer card against the back of your hand, and observe what happens to the card as it warms up. Record color changes, if any.

_____

_____

2. Warm a quarter in your hands and place it on the table. Place a liquid-crystal thermometer card on top of the quarter. Record any changes.

_____

_____

_____

_____

3. Hold a liquid-crystal thermometer card above a cup of hot water. Note any changes. What shape is the colored region? How is this different from the colored regions in steps 1 and 2?

4. Hold an ice cube about 1 centimeter above a thermometer card. What happens now?

Draw Conclusions

5. **Analyze** How would you explain what you observed? Did your observations support your prediction?

6. **Infer** Does heat flow between two materials when they are touching? When they are not touching?

Explore More

What would happen if you repeated step 2 and placed a second card on top of the first? Make a prediction and test it. Then analyze and present your results.

Name _____ Date _____

How does heat travel?

Form a Hypothesis

What do you think will happen if you heat one end of a metal rod? Write your answer as a hypothesis in the form *"If a metal rod is heated at one end, then the heat will . . ."*

_____

_____

_____

_____

Materials

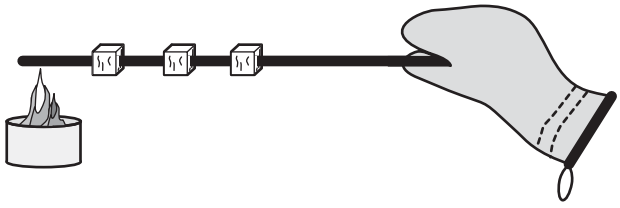
- chafing dish
- metal skewer (or coat hanger wire) about 30 centimeters long
- cubes of paraffin wax
- heat-resistant glove or oven mitt

Test Your Hypothesis

1. Thread three cubes of paraffin wax onto the metal skewer or wire, positioning the cubes at 6 centimeters, 9 centimeters, and 12 centimeters from the tip. Have your teacher open the chafing dish and light the fuel.

   △ **Be Careful.** Use the heat-resistant glove or oven mitt to hold the skewer.

2. Hold the tip of the skewer over the flame.



3. Observe what happens to the paraffin. Record your observations.

_____

_____

Draw Conclusions

4 **Analyze** How would you explain what you observed?

_____

_____

5 Did your observations support your hypothesis?

_____

_____

6 **Infer** What do you think would have happened if the metal skewer had been cut between the first and second wax cube and a piece of wood inserted?

_____

_____

_____

7 **Infer** Why do you think it is a good idea to have wooden handles on metal forks used to roast marshmallows?

_____

_____

 Name _____ Date _____

Which warms faster?

Purpose

Your task is to determine which material—water or plastic foam—will heat up more quickly.

Materials

- 2 beakers
- plastic-foam peanuts
- water
- 2 identical thermometers
- desk lamp

Procedure

1. Write a hypothesis about which material—water or plastic foam—you think will warm up more quickly. Make a list of variables that affect how rapidly the two materials warm up.

_____

_____

_____

_____

_____

2. Fill a beaker half full of water and another half full of plastic-foam peanuts. Place a thermometer in each beaker. Record the starting temperatures. Place both beakers under a desk lamp, and turn the lamp on.

_____

_____

_____

3. **Measure** Take the temperature of each beaker after 2, 4, 6, and 8 minutes.

Minutes	Temperature
2	
4	
6	
8	

Name _____ Date _____ Quick Lab

Draw Conclusions

4. **Infer** When did you observe changes in temperature? What was the result of your experiment?

_____

_____

5. Do your observations support your hypothesis?

_____

_____

6. What factors are held constant in this experiment?

_____

_____

_____

7. **Interpret Data** How can you explain the difference in temperature changes over time for the two substances?

_____

_____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.c.

Inquiry: Structured

What are conduction and convection?

Materials

- metal rod
- thermal strip
- ruler
- transparent tape
- graph paper
- marker

Make a Prediction

Heat energy can move through solids by a process called conduction. In fluids heat energy can move by conduction and through convection currents. Heat energy moves at different rates through different solids and fluids. Metals are considered good conductors because heat energy moves through them rapidly. How can you measure conduction of energy in a solid? Write your answer as a prediction in the form *"If heat moves through a solid by conduction, then you can measure the movement by . . ."*

_____

_____

_____

△ **Be Careful.** Be careful while handling warm water. Clean up spills immediately.

Test Your Prediction

1. **Measure** Use the ruler to measure the length of the metal rod. Use a marker to place a dot at each inch along the length of the metal rod. Record the length of the rod, and draw a picture of it.

   _____

   _____

2. Place your thumb on the thermal strip for 1 second. Record the color change.

   _____

3. Use transparent tape to attach the thermal strip to the rod. Line up the end of the strip with the first mark. You will need to be able to see the marks on the rod throughout the activity.

4. Place one end of the rod in a cup of warm water. Start a timer, and record how many seconds it takes the changing color on the thermal strip to travel to each mark.

5. Repeat step 4 two more times, and record your data.

Draw Conclusions

6. **Graph** Construct a line graph, and plot your three trials on the graph.

7. **Analyze** Using your data describe the process of conduction. Describe any trends or differences you saw among the three trials.

8. **Infer** What do you think would happen if the water you used were hotter?

Name _____ Date _____

Inquiry: Guided

What causes convection currents in water?

Form a Hypothesis

How do convection currents begin in a body of water? Write your answer as a hypothesis in the form *"If warm water is added to cooler water, then . . ."*

_____

_____

_____

Test Your Hypothesis

Design an experiment to investigate how heat energy moves through convection currents. Write out the materials you will need and the steps you will follow. Carry out your experiment, and record your results and observations.

_____

_____

_____

_____

_____

_____

Draw Conclusions

Did your experiment support your hypothesis? Why or why not? Present your results to your classmates.

_____

_____

Name _____ Date _____

Inquiry: Open

What are some conductive properties of metals? For example, are some metals better conductors than others? Think of a question, and design an experiment to investigate it. Plan your experiment to test one variable, or one item being changed. Write out the steps so another group could try it by following your instructions.

Remember to follow the steps of the scientific process.

Ask a Question

Form a Hypothesis

Test Your Hypothesis

Draw Conclusions

Name _____ Date _____

Which material best heats water?

California Standard
6 IE 7.d., e.

Make a Prediction

Which material—white paper, black construction paper, or aluminum foil—will most quickly raise the temperature of water when placed in direct sunlight? Write your answer as a prediction in the form *"If I wrap three jars using white paper, black construction paper, and aluminum foil, then . . ."*

_____

_____

_____

_____

_____

Materials

- 3 medium-size jars
- black construction paper
- white paper
- aluminum foil
- tape
- 3 thermometers

Test Your Prediction

1. **Experiment** Fill three jars with the same amount of water. Wrap one of the materials around each jar, and secure each with a piece of tape. Place the jars on a level surface in a location that receives direct sunlight.

2. Place a thermometer in each jar, and stir the water. Record the temperature of the water in each jar. Wait 30 minutes, stir the water, and record the temperature of the water in each jar again.

_____

_____

Draw Conclusions

3 **Use Numbers** For each jar, subtract the initial temperature of the water from the temperature recorded after 30 minutes in the sunlight. In which jar was the temperature of the water most increased? Was your prediction correct?

_____

_____

Wrapping Material	Initial Temperature	Temperature 30 Minutes Later	Temperature Difference
White paper			
Black construction paper			
Aluminum foil			

4 **Infer** What caused the water temperature in the jars to rise?

_____

_____

Explore More

Set the jars in a place that does not receive direct sunlight. Which jar will lose the most heat? Wait 30 minutes, stir the water, and record the temperature. Which jar lost the most heat? Analyze the data and present your results.

_____

_____

Name _____ Date _____

How are the regions of the electromagnetic spectrum alike and different?

Materials

- long sheet of white paper
- color pencils
- masking tape

Make a Prediction

How can you use a model to compare and contrast each region of the electromagnetic spectrum? Write your answer as a prediction in the form *"If I make a model of the electromagnetic spectrum, then . . ."*

_____

_____

Test Your Prediction

1. Tape a long sheet of white paper horizontally along the walls of your classroom. As a class, divide into six groups. Each group should be assigned one region of the electromagnetic spectrum.

2. Working as a group, find out the following characteristics of the waves in your region of the electromagnetic spectrum: frequency range, wavelength range, sources of waves, and applications of the waves in that region.

3. **Communicate** Divide the white paper into six sections. Draw the information you gathered on your section of the paper. Be sure to arrange the regions in the appropriate order.

Draw Conclusions

4. How are the regions of the electromagnetic spectrum similar? How are they different?

_____

_____

_____

_____

Name _____ Date _____

Alternative Explore

Inquiry: Open X rays can pass right through some materials but are absorbed to different degrees by others. This characteristic is what creates the image on an X-ray image. Can you use a shoe box, a screen, a cardboard bone, and sugar to model the effects of X rays? Write a prediction and test it.

My prediction: _____

My experiment: _____

My results: _____

Name _____ Date _____

Distance and Energy

Purpose

Your task is to demonstrate how distance from an energy source affects the amount of energy received at a particular location.

Materials

- flashlight
- graph paper
- metric ruler

Procedure

1. What happens to the light beam from a flashlight as you move the flashlight farther from a piece of paper? Tape a sheet of graph paper to the wall, and write an *x* in the middle of the paper.

2. **Measure** Hold a flashlight 2 centimeters away from the paper. Turn on the light, and keep the *x* in the middle of the beam. Trace a circle around the spot of light. Count and record the number of squares inside the circle.

_____

3. **Predict** What will happen to the size of the circle if you move the flashlight to 4 centimeters and then 8 centimeters from the paper? How will this affect the brightness of the light and the size of the circle? Why?

_____

_____

_____

_____

Draw Conclusions

4 **Infer** How does distance from the light source affect the amount of energy each square receives?

_____

_____

5 **Infer** If a planet were twice as far from the Sun as Earth is, would it receive half as much energy from the Sun as Earth does? Explain. What effect would this have on the planet's temperature?

_____

_____

_____

_____

6 **Going Further** Could you use this idea of energy versus distance to help determine how far stars are from Earth? Write a prediction, and describe how you could test it.

My prediction: _____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

Form a Hypothesis

California Standard 6 IE 7.a.

The Sun emits a huge amount of electromagnetic radiation, including wavelengths we can see and some we cannot. Waves with shorter wavelengths have higher energy. Scientists use information like this that they read, as well as the results of experiments they do, to help them **form a hypothesis**, or make an educated guess, about something. Then they read more, experiment more, and draw conclusions.

1 Learn It

When you **form a hypothesis**, you make a testable statement about what you think is true. You can test the statement to support or disprove the hypothesis. Record all your findings and observations. You are gathering the evidence you need to support or disprove the hypothesis.

2 Try It

- In this activity you will **form a hypothesis** about which part of the electromagnetic spectrum emits the most heat. You will test your hypothesis by measuring the temperatures in different parts of the spectrum. You will need a cardboard box, white paper, tape, a glass prism, 4 thermometers, and a watch or a clock.

- Tape white paper in the bottom of the box. Attach the prism to one top edge of the box. Place the box by a window so sunlight shines through the prism to make a spectrum. Tape the thermometers in the box so you can read the numbers. Tape one on the blue band of the spectrum, one on the yellow band, one just beyond the red band, and one in a shaded area. Form a hypothesis about which thermometer will register the highest temperature and what the order of the readings will be, from highest to lowest. Record your hypothesis on the chart below. Wait 1 minute, and then read each thermometer. Record the results on your chart. Continue to read the thermometers at 1-minute intervals for a total of 6 minutes, and record the data.

My Hypothesis:				
Minutes	**Thermometer 1: On Blue**	**Thermometer 2: On Yellow**	**Thermometer 3: Just Beyond Red**	**Thermometer 4: In Shade**
1				
2				
3				
4				
5				
6				

Name _____ Date _____

▶ Now use your data to answer these questions.

- What part of the spectrum emits the most heat?

_____

- What is the order of temperatures, from highest to lowest?

_____

- Do your data support your hypothesis?

_____

_____

_____

_____

3 Apply It

Would the temperatures in this kind of experiment be the same if the box were lined with black paper? With aluminum foil? If you used a desk lamp instead of sunlight? If you had a deeper box?

▶ Choose one of these variables, or make up one of your own, and **form a hypothesis** about what you believe would happen.

▶ Then test your idea, and record the results to either support or disprove your hypothesis.

Name _____ Date _____

My Hypothesis:				
Minutes	**Thermometer 1: On Blue**	**Thermometer 2: On Yellow**	**Thermometer 3: Just Beyond Red**	**Thermometer 4: In Shade**
1				
2				
3				
4				
5				
6				

Name _____ Date _____

California Standard
6 IE 7.a., b.

How can light energy create motion?

Materials

- radiometer
- light sources
- black cloth

Form a Hypothesis

A radiometer spins when exposed to sunlight. What do you think will happen if it is exposed to different sources of light? Write your answer as a hypothesis in the form *"If a radiometer is exposed to different light sources, then . . ."*

_____

_____

Test Your Hypothesis

1. Place the radiometer in bright, natural sunlight. Record your observations.

_____

_____

_____

2. Try using different light sources and light sources with different intensities. Record your observations. Does the radiometer speed up, slow down, or stay the same?

Light Source	Light Intensity	Observations

3 Place a black cloth over the radiometer. Look underneath and observe the vanes. Record your observations.

_____

Draw Conclusions

4 **Analyze** How would you explain what you observed?

_____

_____

_____

_____

_____

_____

_____

5 Did your observations support your hypothesis?

_____

_____

_____

6 **Infer** Do you think there is air inside the radiometer? Why or why not?

_____

_____

Explore More

How do you think the motion of the radiometer would change if it were placed in direct sunlight for a whole day? Form a hypothesis and test it. Then analyze and present your results.

_____

_____

Name _____ Date _____

Can gases in the atmosphere absorb energy from solar radiation?

Materials

- 2 small thermometers
- clear jar
- watch or clock
- location in direct sunlight

Form a Hypothesis

Sunlight warms Earth's surface. However, only about half of the Sun's energy that reaches the atmosphere reaches Earth's surface. Some of the energy is absorbed by the gases in Earth's atmosphere. What effect does this have on the temperature of Earth's air? Write your answer as a hypothesis in the form *"If gases in the atmosphere absorb energy from solar radiation, then trapped air in direct sunlight will . . ."*

_____

_____

Test Your Hypothesis

1. Place two thermometers in direct sunlight. After a few minutes, record the starting temperatures.

   _____

2. Place a clear jar over one of the thermometers. Record the temperature on both thermometers every minute for 10 minutes.

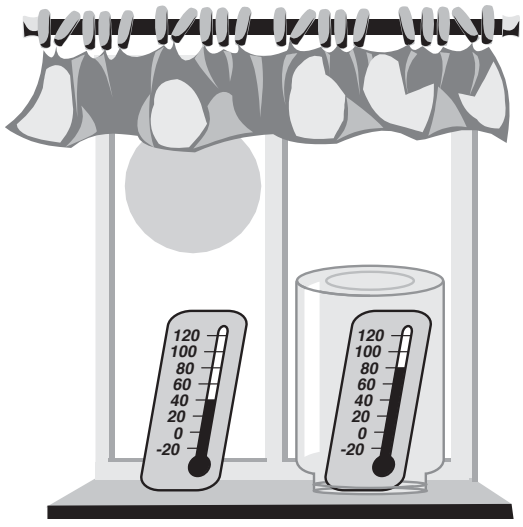
   _____

   _____

   _____

   _____

   _____



3 **Use Numbers** Compare the data from both thermometers to determine which showed a greater increase in temperature.

_____

_____

Draw Conclusions

4 **Infer** Why do you think the temperature inside of the jar was not the same as the temperature outside of the jar?

_____

_____

5 **Infer** How can you compare the jar to the atmosphere?

_____

_____

Inquiry: Open What do you think would happen if there were no heat-trapping gases in the atmosphere?

_____

Name _____ Date _____

Solar Still

Purpose

Your task is to separate salt from water in a saltwater solution.

Materials

- salt
- water
- large bowl
- 1 glass
- plastic wrap
- heavy object, such as a rock

Procedure

1. You can use the Sun's energy to separate a solution of salt and water. Make a saltwater solution by dissolving 2 tablespoons of salt per cup of fresh water. Fill a large bowl with salt water to a depth of about 2 inches.
2. Place an empty glass in the center of the bowl. The top of the glass should be below the edge of the bowl but above the surface of the salt water.
3. Cover the bowl with plastic wrap. Use tape, if necessary, to make a tight seal.
4. Place a heavy object, such as a rock, in the center of the plastic wrap over the glass.
5. Leave the still in direct sunlight for a few hours. Then remove the plastic wrap. Has water collected in the glass?

_____

6. **Predict** Do you think the water in the glass is salty or fresh? Why? How would you test your prediction?

_____

_____

_____

Name _____ Date _____ Quick Lab

Draw Conclusions

7 **Sequence** Explain the role of evaporation and condensation in transferring water to the glass.

_____

_____

_____

8 **Going Further** Do you think that separation of fresh water from salt water occurs in nature? How? Write your answer as a prediction in the form "*If there are large bodies of salt water on Earth's surface and evaporation occurs over these bodies of water, then . . .*"

My prediction: _____

_____

_____

_____

My research: _____

_____

My results: _____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.a., d.

How does heat move in liquids and gases?

Make a Prediction

When an ice cube melts in room-temperature water, what do you think happens to the melted water? Where does it go? Write your answer as a prediction in the form *"If an ice cube melts in room-temperature water, then . . ."*

_____

_____

_____

Materials

- clear plastic container
- ice cube dyed with blue food coloring
- red food coloring
- color pencils
- paper

Test Your Prediction

1. Fill the plastic container about two-thirds full of water. The water should be at room temperature and perfectly still. Gently place the blue ice cube in the water at one end of the container. Add two drops of red food coloring to the water at the opposite end of the container.

2. **Observe** Carefully observe where the blue water flows and where the red water flows. Use color pencils to draw the flows of the two different-color waters.

Draw Conclusions

3 **Analyze** How would you explain what you observed?

_____

_____

_____

_____

4 Did your observations support your prediction? What caused the behavior of the blue water? Why did the water in the tank appear to circulate? What happens when warm and cool water meet? Explain your answer.

_____

_____

_____

_____

_____

Explore More

What would happen if you placed a dyed ice cube in very cold water? Form a hypothesis and test it. Then analyze and present your results. Does circulation take place in air? What examples can you find to demonstrate warm air's rising or cold air's sinking?

_____

_____

_____

_____

Name _____ Date _____

How does a sea breeze form?

Form a Hypothesis

Which heats up faster: land or water? How does this difference affect the formation of land and sea breezes? Write your answer as a hypothesis in the form *"If land heats up faster than water, then . . ."*

_____

_____

_____

_____

Materials

- 2 beakers
- 2 thermometers
- water
- sand
- desk lamp
- watch or clock

Test Your Hypothesis

1. Fill one beaker half full of sand. Fill the other beaker half full of water. Place a thermometer in each beaker.

2. Place both beakers under the lamp. Record the temperature in each beaker every 10 minutes for 1 hour. Make a chart to record your data.

Minutes	Temperature of Sand	Temperature of Water
10		
20		
30		
40		
50		
60		

Draw Conclusions

3 **Observe** Which heats up faster: land or water?

_____

4 **Infer** On a sunny day, how would the temperature of the air over land compare with the temperature of the air over water?

_____

_____

5 Can you use this information to explain how a sea breeze, which flows from the water to the land, forms?

_____

_____

Inquiry: Open How would a land breeze, or a breeze that flows from the land to the sea, form?

_____

_____

_____

_____

Name _____ Date _____

Expanding and Contracting Air

Purpose

Your task is to show what happens to air if it is heated and cooled.

Materials

- balloon
- bottle
- pail
- warm water
- ice water

Procedure

1. Place a balloon over the opening of a bottle. What do you think will happen if you heat or cool the air in the bottle? Hold the bottle for a minute or two in a pail of warm water. Observe what happens to the balloon.

_____

_____

_____

2. **Infer** Explain what happened to the air in the bottle. What evidence do you have for your explanation? Now hold the bottle in a pail of ice water for a few minutes. What happens to the balloon?

_____

_____

_____

_____

_____

3. **Infer** Use your observations to answer these questions. As the bottle cooled, what happened to the air pressure inside? How did the pressure outside compare to the pressure inside? What caused the changes to the balloon?

_____

_____

_____

Draw Conclusions

4 Draw "before" and "after" pictures of the bottle. Use arrows to show what happened to the air pressure.

Before **After**

5 **Going Further** What do you think would happen if you cooled water to form ice? Would it expand or contract? Write a hypothesis and test it.

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

_____

My results: _____

_____

Be a Scientist

Name _____ Date _____

California Standard 6 IE 7.d.

Inquiry: Structured

What can convection currents do?

Materials

- 2 jars
- small piece of cardboard
- matches
- ice
- 2 plastic tubs (1 for ice, 1 for warm water)

Form a Hypothesis

Convection currents can be seen in air and in water. They even occur in Earth's mantle. The heating and cooling of air causes convection currents. A circular pattern is created, in which warm air rises and cooler air moves in to take the place of the warm air. Convection currents cause wind and other weather patterns. How does the temperature of the air affect the movement of convection currents? Write your answer as a hypothesis in the form *"If air is cooled, then . . ."*

_____

_____

Test Your Hypothesis

1. **Experiment** Place one jar in a plastic tub filled with ice. Place the other jar in a tub of warm water. Leave the jars for 10 minutes.

2. Remove the jar from the tub of ice. Have your teacher light a match and immediately blow it out. Hold the opening of the jar over the smoking match to trap some of the smoke. Place a piece of cardboard on the opening of the jar, and turn the jar right side up.

3. **Make a Model** Place the jar from the tub of warm water over the jar from the tub filled with ice. Remove the cardboard. Make sure to keep the jars together so the smoke cannot escape. Observe the movement of the smoke, and record your observations.

_____

_____

4 **Observe** While still keeping the jars together, flip the jars over. Observe the smoke, and record your observations.

_____

_____

Draw Conclusions

5 **Define Based on Observations** What did the smoke do when you first removed the cardboard in step 3? Why did that happen?

_____

_____

_____

6 **Communicate** What happened to the smoke when you flipped the jars over?

_____

_____

_____

7 **Infer** What do you think the smoke would do if you placed the model in a hot-water bath? Try it.

_____

_____

_____

Name _____ Date _____

Inquiry: Guided

What happens when cold air meets warm air?

Form a Hypothesis

How do convection currents behave in the atmosphere? Write your answer as a hypothesis in the form *"If warm air and cold air come together, then the warm air will . . ."*

_____

_____

Test Your Hypothesis

Design an experiment to create and test a model that demonstrates convection currents in the air. Write out the steps you will follow. Record your results and observations.

_____

_____

_____

_____

Draw Conclusions

Did your experiment support your hypothesis? Why or why not? What did you observe in your convection-current model? Could your observations explain how wind is created?

_____

_____

_____

_____

_____

_____

Name _____ Date _____

Inquiry: Open

What else can you learn about convection currents? For example, how can convection currents be affected by the rotation of Earth? 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 could complete the experiment by following your instructions.

Remember to follow the steps of the scientific process.

Ask a Question

_____

_____

Form a Hypothesis

_____

_____

_____

Test Your Hypothesis

_____

_____

_____

_____

Draw Conclusions

_____

_____

Name _____ Date _____

Are the continents moving?

California Standard
6 IE 7.a., e.

Form a Hypothesis

Were the separate continents we know today one huge supercontinent in the past? Do the outlines of the continents fit together? Write your answer as a hypothesis in the form "*If the continents were once a supercontinent, then . . .*"

_____

_____

_____

_____

Materials

- world map
- tracing paper
- pencil
- safety scissors
- safety goggles

Test Your Hypothesis

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

2. ⚠ **Be Careful.** Cut the traced continents along their coastlines, and label them.

3. Using the continent cutouts like pieces of a jigsaw puzzle, find ways the continents fit together. Draw a sketch showing ways you can fit them together.

Draw Conclusions

4 **Analyze** Which continents have coastlines that fit together most closely?

_____

_____

5 Did your results support your hypothesis?

_____

_____

_____

6 **Infer** Which of your sketches shows the greatest number of continents fitting together? Do all of the coastlines in the sketch fit together equally well?

_____

_____

Explore More

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

_____

_____

_____

_____

Name _____ Date _____

Can clues help you piece together a puzzle?

Materials

- paper and pencil
- safety scissors

Make a Prediction

Can clues help you piece together a puzzle more easily? Can they increase your confidence that the pieces are put together correctly? Write your answer as a prediction in the form "*If clues are available, then they _____ help me put a puzzle together and _____ my confidence that the pieces are put together correctly.*"

_____

_____

_____

Test Your Prediction

1. On a sheet of paper, design a puzzle with at least 8 pieces. Before you cut out the pieces, make a symbol on each side of the line between the pieces. Each set of symbols should be different.

2. ⚠ **Be Careful.** Carefully cut your puzzle into pieces.

3. Flip the pieces over so that your symbols do not show, and then mix up the pieces. Put the puzzle back together. Record the time it took you to put the puzzle together.

   _____

4. Now flip the pieces over so that you can see the symbols, and then mix up the pieces. Put the puzzle together again. Record the time it took you to put it together.

   _____

Draw Conclusions

5. Did the amount of time it took you to put your puzzle together when you could see the symbols differ from the amount of time it took when you could not see the symbols?

_____

_____

6. Did the symbols help verify that you put your puzzle together correctly?

_____

_____

7. **Communicate** What kind of "symbols" could scientists use to support the idea that the continents once fit together like pieces of a jigsaw puzzle?

_____

_____

_____

_____

Quick Lab

Name _____ Date _____

Model Plate Movement

Purpose

Your task is to show how converging tectonic plates form a mountain range.

Materials

- several sheets of paper

Procedure

1. Stack sheets of paper into two piles.
2. Slowly push the short ends of the two paper piles together.
3. **Observe** What happens? How is this model similar to the formation of a mountain range such as the Himalayas?

_____

_____

_____

_____

Draw Conclusions

4. **Evaluate** How is this model similar to a mountain range? How is it different?

_____

_____

_____

_____

_____

_____

_____

_____

5 **Going Further** When ocean plates converge, one slips under the other. How could you demonstrate what happens to two such plates?

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

_____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

Draw Conclusions

California Standard 6 IE 7.e.

Scientists read a lot of data and collect data themselves through exploration and experimentation. Then they study the data, analyze them, and **draw conclusions**, or decide what is and is not true. In the previous lesson, you learned about the evidence that helped scientists draw the conclusion that the continental drift theory was correct.

1 Learn It

When you **draw conclusions**, you have to look at all the data and facts before you can decide what is true. You have to be careful not to jump to conclusions. Here is an example: It's time to go home from school, but you discover that your new jacket is missing. Outside you see a student you don't know wearing a jacket just like yours. Can you draw the conclusion that this person took your jacket?

_____

_____

No, that assumption would be jumping to a conclusion. You need to ask questions and maybe even examine the jacket carefully to find all the facts. Suppose you do, and then you discover that the other person's jacket merely looks like yours. The only conclusion you can draw is that the other person has really good taste, just as you do.

2 Try It

- Use a hard-boiled egg as a model of Earth to gather evidence about moving plates. Use the evidence to **draw conclusions**. You will need a hard-boiled egg, a paper plate, and glue.
- Crack the egg. Pull off the pieces of eggshell, and pile them on the paper plate. They represent Earth's plates. Record the number of pieces on the chart below. Set the egg and the pieces of the shell aside for 20 minutes. Can you draw a conclusion at this time about whether the pieces of eggshell can be replaced to completely cover the egg?

_____

_____

_____

_____

_____

- Try to glue the eggshell pieces back on the egg. Use a light dab of glue on each piece. Then pick up the egg, and squeeze gently. What happens? Record your observations on the chart.

Number of Pieces	Observations	Conclusions

Name _____ Date _____

3 Apply It

Now use all the information you have gathered to **draw conclusions**, and answer these questions. Record your conclusions on the chart on the next page.

- How are Earth's plates similar to the pieces of the eggshell?

_____

_____

_____

_____

- Why did the pieces of eggshell push against each other when you picked the egg up?

_____

_____

_____

_____

Name _____ Date _____

▶ What might happen if Earth's plates broke into as many pieces as the eggshell?

_____

_____

_____

_____

Number of Pieces	Observations	Conclusions	Comparison

Name _____ Date _____

California Standard
6 IE 7.b.

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

Materials

- chalk
- measuring tape or meterstick
- string

Purpose

In this activity you will make a model to compare the thickness of Earth's layers.

Procedure

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

Draw Conclusions

4 **Analyze** The scale for your model is 1 cm = 35 km. How many real kilometers are presented by each layer in your model?

_____

_____

_____

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

_____

_____

_____

_____

Explore More

Research different ways to travel to the center of Earth, using different modes of transportation. Determine how long it would take to travel there. Analyze and present your results.

_____

_____

_____

Name _____ Date _____

Modeling Earth's Interior

Form a Hypothesis

Can you make a model of Earth's interior? What must your model include? Write your answer as a hypothesis in the form "*If I know the basic structure of Earth's interior, then I can make a model of it by using . . .*"

Materials

- oranges
- paper and pencil

_____

_____

_____

_____

Test Your Hypothesis

1. Obtain an orange from your teacher. Ask your teacher to cut the orange in half.

2. **Observe** Look at the cross section of the orange. Make a sketch of what you observe.

_____

_____

Draw Conclusions

3. **Evaluate** What layer of Earth does each layer of the orange represent? Label each layer as core, mantle, or crust.

_____

_____

Name _____ Date _____ Quick Lab

Measuring Density

Purpose

Your task is to show how materials that have different densities will tend to separate into different layers.

Materials

- 3 measuring cups
- large glass bowl
- vegetable oil
- water
- corn syrup
- 3 different shades of food coloring

Procedure

1. Measure 1 cup of vegetable oil, 1 cup of water, and 1 cup of corn syrup.
2. Add four drops of a different shade of food coloring to each cup. Stir each cup.
3. **Observe** Pour the three cups together into a large glass bowl. Record your observations.

_____

_____

_____

4. What happened? Why do you think you saw these results?

_____

_____

_____

_____

_____

_____

5. Which layer of Earth corresponds to the vegetable oil? The water? The corn syrup?

_____

_____

_____

Name _____ Date _____

Draw Conclusions

6 **Infer** As early Earth was forming, it was a swirling cloud of matter. As it cooled, some elements settled to the bottom, or center; other elements settled in the middle; and still others settled on the top. Can you explain why?

_____

_____

_____

_____

7 **Going Further** Saturn, a planet that is one of the outer gas giants, is less dense than water. In fact, if you could find a body of water large enough, Saturn could float on it. Can you make a model of how a planet larger than Earth could float on water? Write your answer as a hypothesis in the form "*If I know Saturn is less dense than Earth and could float on water, then I can make a model of Saturn's density using . . .*"

My hypothesis: _____

_____

_____

_____

My experiment: _____

_____

My results: _____

_____

Name _____ Date _____

Focus on Inquiry Skills

California Standard 6 IE 7.f.

Make a Model

A map is a useful tool that provides information, or data, about Earth. When scientists create a map, they **make a model** that shows information about a place or a region. To use a map, you need to learn how to interpret the information on it.

1 Learn It

Road maps show cities, towns, streets, roads, and highways. Other kinds of maps include different data, such as borders of states and countries or bodies of water. When you make a drawing showing streets in your neighborhood, you **make a model** of the area.

All maps have legends, which include additional information to help you read the maps. For example, the legend on a road map shows the map's scale. Knowing the scale lets you determine distances.

Name _____ Date _____

2 Try It

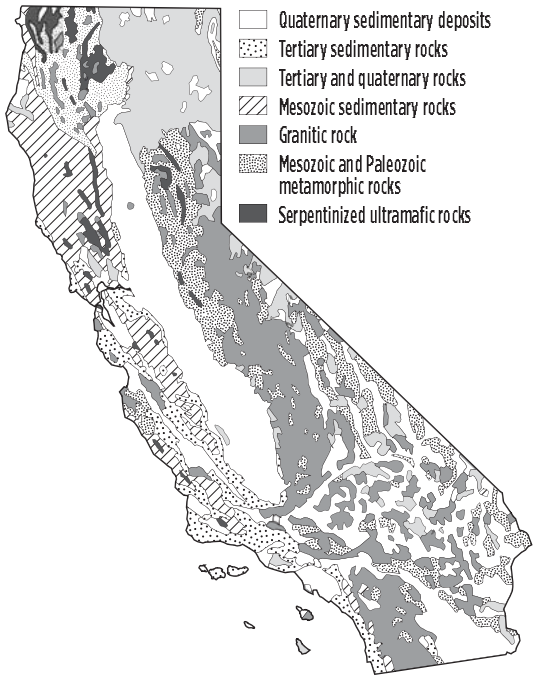
- Now you will examine two different kinds of maps. The first map is a *geologic map*. It shows the geological features of California, such as the kinds of rocks found in the state. A geologic map can also show features such as faults and volcanoes. Scientists include these kinds of information on maps in order to **make a model** that shows an area's geological features.
- Look at the map, and select one place to study. Use the legend to find out the meaning of the shade and pattern used in the place you chose. What information does the legend contribute to the map?

_____

_____

_____

_____



- The second map is a *topographic map*. This map shows only a small part of California, near San Francisco. Topographic maps show the shape of Earth's surface. They use special *contour lines*, which show points that are the same height. Contour lines allow scientists to **make a model** that tells the height of a hill above sea level or the depth of the ocean below its surface. When contour lines are far apart, they tell you that changes in altitude are gradual. When contour lines are close together, they tell you that changes in altitude are steeper.
- Select a point on one of the contour lines on the map. What is the height of Earth's surface at the point you chose?

_____

_____

Name _____ Date _____

3 Apply It

- How do geologic maps and topographic maps differ?

_____

_____

_____

- Of the two types of maps shown here, which would be a good type to use when planning a hike in the mountains? Why do you think so?

_____

_____

- **Make a model** by drawing a map of the area around your school. Find ways to indicate differences in height. In your legend include the scale you used and keys to any features on your map.

Map of the Area Around My School

Name _____ Date _____

Explore

California Standard
6 IE 7.d., e.

What happens when Earth's surface breaks?

Materials

- chocolate candy bar with caramel and nougat
- plastic knife

Make a Prediction

What would a scientist observe if Earth's surfaces were pushed together, pulled apart, or slid against each other? Write your answer as a prediction in the form "*If Earth's surfaces were pushed, pulled, or slid against each other, then . . .*"

_____

_____

_____

Test Your Prediction

1. ⚠ **Be Careful.** Place the candy bar on a flat surface, and cut it in half through the center.

2. Identify which layers of the bar represent the layers of Earth.

   _____

   _____

   _____

3. Then push the pieces together. Pull the pieces apart. Take one of those pieces and pull it into two pieces. Slide the pieces past each other. Move the pieces up and down in relation to each other.

Name _____ Date _____

Draw Conclusions

4 **Analyze** How would you explain what you observed?

_____

_____

_____

_____

_____

5 Did your observations support your prediction?

_____

_____

_____

6 **Infer** What layer of the candy bar ("layer of Earth") was deformed the most? Why do you think this happened?

_____

_____

_____

_____

Explore More

Try to relate each movement of the candy-bar pieces to an actual Earth event. Explain. Then analyze each and present your results.

_____

_____

_____

_____

Name _____ Date _____

Alternative Explore

Why do surface waves do more damage than body waves during an earthquake?

Materials

- coiled spring toy

Form a Hypothesis

Why do you think that surface waves do more damage than body waves during an earthquake? Write your answer as a hypothesis in the form "*If I know that surface waves move differently than body waves, then . . .*"

_____

_____

_____

Test Your Hypothesis

1. **Observe** Working with a partner, stretch one coiled spring toy between the two of you until it is about 5 meters long. Give a gentle push on your end of the toy. Record your observations.

_____

_____

_____

2. **Observe** Make sure the coiled spring toy has stopped moving after step 1. Remaining in your same positions, move your end of the toy up, then down. Record your observations.

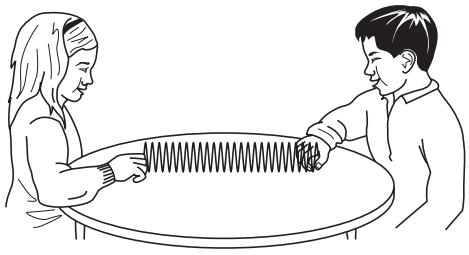
_____

_____

_____

Name _____ Date _____

3 **Observe** Make sure the coiled spring toy has stopped moving after step 2. Remaining in your same positions, move your end of the toy to the right, then to the left. Record your observations.



_____

_____

_____

Draw Conclusions

4 In which step(s) is the wave movement most similar to the movement of body waves during an earthquake?

_____

_____

_____

5 In which step(s) is the wave movement most similar to the movement of surface waves during an earthquake?

_____

_____

_____

6 Why do surface waves cause more damage than body waves during an earthquake?

_____

_____

_____

_____

_____

Name _____ Date _____ Quick Lab

Earthquake Safety

Purpose

Your task is to model what happens to buildings during an earthquake.

Materials

- sand
- deep pan
- brick
- hammer

Procedure

1. Add sand to a pan, filling it deeply and evenly.
2. Add water to the sand below its surface.
3. Place a brick on the sand on its shortest side, as if it were a building.
4. Gently tap the side of the pan with the hammer one time.
   ⚠ **Be Careful.**
5. **Observe** Write down what you saw happen to the brick and the surrounding sand. What would happen if you hit the pan a second time, but harder? Try it.

_____

_____

_____

_____

Name _____ Date _____

Draw Conclusions

6 **Predict** How do you think the magnitude of an earthquake affects buildings in the area?

_____

_____

7 **Going Further** How do you think the movement of a building during an earthquake is affected by the materials the building is made of? Write your answer as a hypothesis in the form "*If one structure is built of craft sticks and a second is built of sugar cubes, then* . . ." Conduct an experiment to test your hypothesis.

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

Explore

California Standard
6 IE 7.d.

How can you make a model volcano erupt?

Make a Prediction

What do you think will happen if you try to make a volcano with baking soda and vinegar? Will it behave like a real volcano? Write your answer as a prediction in the form "*If a model of a volcano is made out of baking soda and vinegar, then . . .*"

_____

_____

_____

Materials

- deep-sided plastic tray
- $\frac{1}{2}$ cup clear vinegar
- red food coloring
- narrow plastic container
- sand
- baking soda
- safety goggles

Test Your Prediction

1. Fill the plastic container with a few inches of baking soda, and place it in the middle of the tray. ⚠ **Be Careful.** Wear goggles.
2. Build the sand up around the container, leaving the top of the jar exposed.
3. Add a few drops of food coloring to the vinegar.
4. Slowly and carefully pour the colored vinegar into the container. Observe and record what happens.

_____

_____

_____

_____

Name _____ Date _____

Draw Conclusions

5 **Analyze** How would you explain what you observed? Was it like a real volcano?

_____

_____

_____

6 Did your observations support your prediction?

_____

_____

7 **Infer** What do you think would have happened if there had been a lid on the container?

_____

_____

Explore More

What would happen if the opening of the container were larger? If it were smaller? Make a prediction, and test it. Then analyze and present your results.

_____

_____

_____

_____

Name _____ Date _____

Alternative Explore

How can you model different types of volcanoes?

Materials

- different colors of modeling clay
- large pieces of cardboard

Form a Hypothesis

There are descriptive names for three types of volcanoes: shield volcanoes, cinder cone volcanoes, and composite volcanoes. Based on their names, how can you model these different types of volcanoes? Write your answer as a hypothesis in the form "*If I know that the terms* shield volcano, cinder cone volcano, *and* composite volcano *are descriptive, then* . . ."

_____

_____

_____

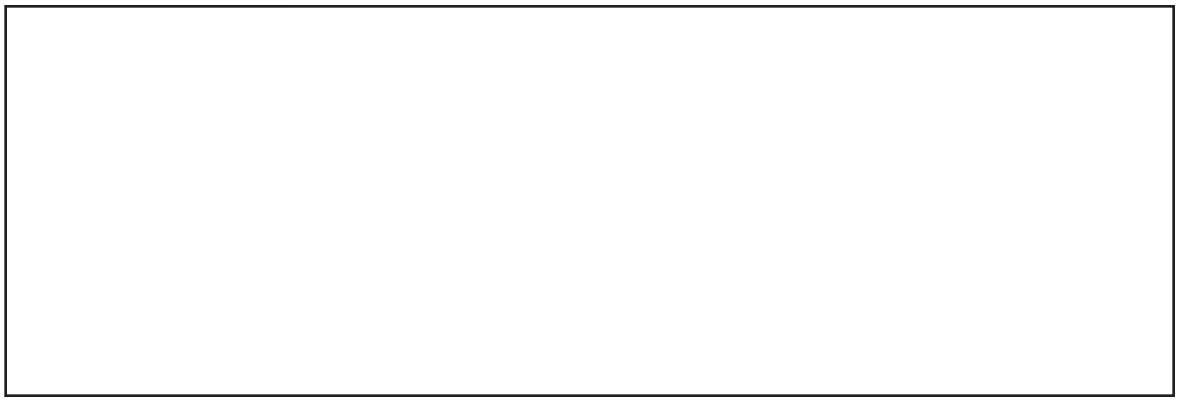
Test Your Hypothesis

1. Using modeling clay, make a model of a shield volcano, a composite volcano, and a cinder cone volcano. Use a different color clay for each kind of material the volcanoes are made from. Use a piece of cardboard as the base for each model.

2. When you have completed each model, draw a picture of how the inside might look in the assigned space below.

Shield Volcano **Cinder Cone Volcano**

Name _____ Date _____



Composite Volcano

3 Why do you think each type of volcano was given its name?

Shield volcano: _____

_____

_____

Cinder cone volcano: _____

_____

_____

Composite volcano: _____

_____

_____

Draw Conclusions

4 **Infer** Other than shape, what is one way in which these three types of volcanoes differ?

_____

_____

_____

Name _____ Date _____ Quick Lab

Cooling Candle Lava

Purpose

Your task is to show how the height from which lava falls affects the shape of the lava when it cools.

Materials

- candle
- tray

Procedure

1. Watch while your teacher holds a lighted candle about 1 ft above the tray so that a drop of melted wax falls on the tray.

2. **Observe** This procedure will be repeated several times, with your teacher holding the candle at different heights. Observe the cooled drops.

_____

_____

_____

3. From which height did the molten wax spatter the most? The least? What shape did the cooled wax take?

_____

_____

_____

4. How does this experiment explain the cooled shapes of lava from a volcanic eruption?

_____

_____

Name _____ Date _____

Draw Conclusions

5 Shield volcanoes have very broad, gently sloping sides. Use your observations of the candle wax to explain how they form.

_____

_____

_____

6 **Going Further** Do you think the rate at which hot lava cools has an effect on its shape? Design an experiment to test your idea.

My hypothesis: _____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

Be a Scientist

California Standard 6 IE 7.e.

Inquiry: Structured

What are some characteristics of volcanic rock?

Materials

- hand lens
- igneous rock samples
- cup of water

Purpose

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

_____

_____

Test Your Hypothesis

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

Name _____ Date _____

3 **Define Based on Observations** Feel each rock. Describe the texture.

_____

_____

4 **Classify** Record the color and coarseness of the grains for each sample.

_____

_____

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

_____

_____

Draw Conclusions

6 **Analyze** Are any of the characteristics the same in all of your samples? Why do you think the similarities or differences occurred?

_____

_____

_____

_____

7 **Explain** What factors influenced the color of the rocks that you observed?

_____

_____

Name _____ Date _____

Inquiry: Guided

What happens when the pressure changes inside a volcano?

Form a Hypothesis

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

Test Your Hypothesis

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

Draw Conclusions

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

Name _____ Date _____

Inquiry: Open

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

Remember to follow the steps of the scientific process.

Ask a Question

_____

Form a Hypothesis

_____

_____

_____

Test Your Hypothesis

_____

_____

Draw Conclusions

_____

_____

Name _____ Date _____

Explore

California Standard
6 IE 7.b.

How do plate movements affect California?

Materials

- two pieces of cardboard
- sand or flour

Make a Prediction

Can you make a model of the forces that have shaped California? Write your answer as a prediction in the form "*If two plates slide past each other, then . . .*"

_____

_____

Test Your Prediction

1. Place the pieces of cardboard on a flat surface, and cover each with a layer of sand or flour.
2. Without disturbing the sand or flour, push the two pieces of cardboard together so that the edges line up.
3. Slowly slide one piece of cardboard along the edge of the other.
4. **Observe** What happens as one piece of cardboard slides past the other? Record your observations.

_____

_____

Draw Conclusions

5. How does this model show what happens when two plates move against each other? Place two markers, such as lumps of clay or sugar cubes, on either side of the fault. Describe their relationship to each other after movement along the fault. Draw a line through the sand across the fault to represent a river. How is the river affected by movement along the fault?

_____

_____

Name _____ Date _____

Explore More

How do the effects of movement compare when the two sides slide past each other slowly and quickly? Design an experiment that would compare the effects of two plates sliding past each other at different rates.

_____

_____

_____

_____

Inquiry: Open Ask your own questions about plate movements in California.

My question: _____

_____

How I can find out: _____

_____

My results: _____

_____

_____

Name _____ Date _____

Alternative Explore

Can you model what happens during an earthquake event?

Materials

- block of wood
- 2 pieces of sandpaper
- rubber band
- thumbtack

Form a Hypothesis

Areas of Earth's crust along slowly moving plate boundaries are subject to increasing tension, or stored energy, that is released during an earthquake. How can you model that increasing tension and release of energy? Write your answer as a hypothesis in the form "*If increasing tension in Earth's crust along slowly moving plate boundaries is released suddenly during an earthquake, then . . .*"

_____

_____

_____

Test Your Hypothesis

1. Tape one piece of sandpaper around a block of wood. Tape another piece of sandpaper to a tabletop.
2. Tack a rubber band to the wooden block.
3. Place the wooden block on the table with both sides of the sandpaper in contact. Very slowly pull on the block with the rubber band. What do you observe?

_____

_____

Draw Conclusions

4. **Infer** How can you compare your results with what actually happens along a fault?

_____

_____

Quick Lab

Name _____ Date _____

Folded Mountains

Purpose

Your task is to model what happens to Earth's surface when tectonic plates slowly move toward one another.

Materials

- 3 different colors of modeling clay
- plastic wrap
- 2 bricks

Procedure

1. Make a model by stacking three layers of clay on top of one another, placing a piece of plastic wrap between layers.
2. Place the clay stack on a tabletop between two bricks.
3. Slowly push the bricks toward each other until the clay bends, or folds.
4. **Observe** What happened? Did you create a fold?

_____

_____

_____

Name _____ Date _____ Quick Lab

Draw Conclusions

5 How does a fold compare with a fault?

_____

_____

_____

6 **Infer** What factors do you think influence whether a rock will fault or fold?

_____

_____

_____

7 **Going Further** Do you think temperature affects whether a rock will fault or fold? How could you use crayons and a desk lamp to test your hypothesis?

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Explore

Name _____ Date _____

Where does precipitation come from?

California Standard
6 IE 7.a., d.

Materials

- room-temperature water
- plastic water bottle
- match

Form a Hypothesis

When pressure is increased on a volume of air, its temperature increases. When pressure is decreased, the volume of air expands and cools. How do temperature and humidity affect the formation of fog? Write your answer as a hypothesis in the form *"If moist air in a bottle is cooled, then . . ."*

_____

_____

Test Your Hypothesis

1. Put a small amount of room-temperature water in a plastic water bottle.
2. Have your teacher add smoke by lighting a match, blowing it out, and holding the smoking match inside the bottle.
3. After a few seconds, have your teacher take the match out and screw on the bottle's cap.
4. **Experiment** Squeeze the bottle to increase the pressure on the air inside. Release the pressure on the bottle.

Draw Conclusions

5 **Analyze** What happened when you released the pressure on the air in the bottle? How is this related to the temperature of the air inside the bottle?

6 **Infer** How does moist air's temperature affect a change from water vapor to water droplets? How is this model similar to the formation of fog?

Explore More

What would you see if you did this experiment first with warm water and then with cold water? Form hypotheses and then test them with your teacher or another adult. Analyze and present your results.

Name _____ Date _____

Where does water vapor come from?

Materials

- plastic bag
- twist tie
- live tree branch in leaf

Form a Hypothesis

Where do you think the water vapor that eventually condenses into rain comes from? Do you think some of it comes from plants? How could you prove this? Write your answer as a hypothesis in the form "*If water vapor comes from plants, then . . .*"

_____

_____

_____

Test Your Hypothesis

1. Locate a tree in your schoolyard that is in leaf.
2. Tie a plastic bag around a tree branch, including its leaves, and close with a twist tie.
3. **Observe** Wait a few hours, and go back to observe the tree branch and the plastic bag. Record your observations.

_____

_____

_____

Draw Conclusions

4 **Infer** Where did the water droplets inside the bag come from?

_____

_____

_____

Inquiry: Open Do our bodies give off water vapor? Write and conduct an experiment.

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Quick Lab

Name _____ Date _____

Measuring Humidity

Purpose

Your task is to demonstrate how humidity varies from one location to another.

Materials

- paper and pencil
- cobalt chloride strips
- tape
- white paper

Procedure

1. Make a map of the inside and the outside of your school. Choose places to measure the humidity in the air.
2. Obtain cobalt chloride strips from your teacher. These strips measure humidity in the air by turning pink.
3. Tape each cobalt chloride strip to a piece of white paper.
4. **Observe** Hang the papers in the chosen locations. Wait at least 30 minutes. Then collect the papers and examine the colors of the strips.

Draw Conclusions

5. Which location had the highest humidity? Which one had the lowest? Explain your results.

_____

_____

_____

_____

6 **Going Further** If you were hanging laundry on a clothesline to dry, would it dry faster on a humid day or a drier day? Make a prediction, and design an experiment to test it.

My prediction: _____

_____

_____

My experiment: _____

_____

_____

_____

My results: _____

_____

_____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.c., f.

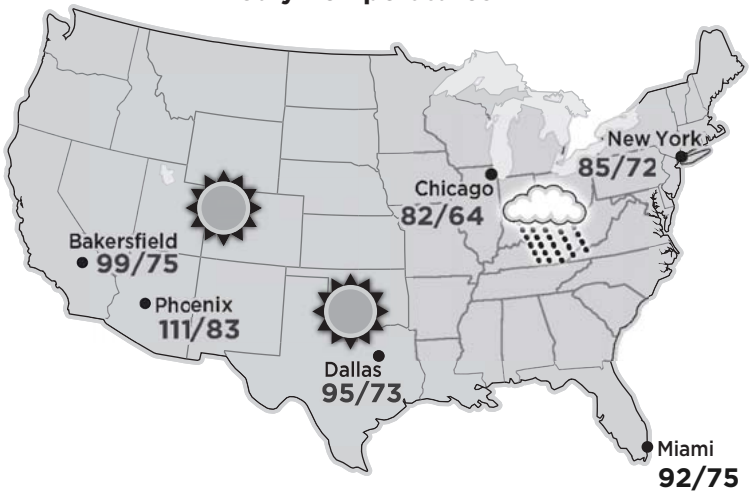
Analyze Data

Scientists study weather maps and **analyze data** from them. They look at temperature patterns in order to predict future weather in an area. They also look for fronts where cold and warm air meet. Then they analyze the data to draw conclusions and explain why things happen.

1 Learn It

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

July Temperatures



2 Try It

▶ Look at the map. It shows high and low temperatures for six cities for one day in July. Then look at the chart on the next page. It lists the average high and low temperatures and the rainfall for these U.S. cities during July in past years. **Analyze data** from the map and the chart to help you answer the questions.

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

- How did the high and low temperatures for Bakersfield shown on the map differ from its average high and low temperatures?

_____

_____

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

_____

_____

- Which city had temperatures cooler than its average high and low temperatures?

_____

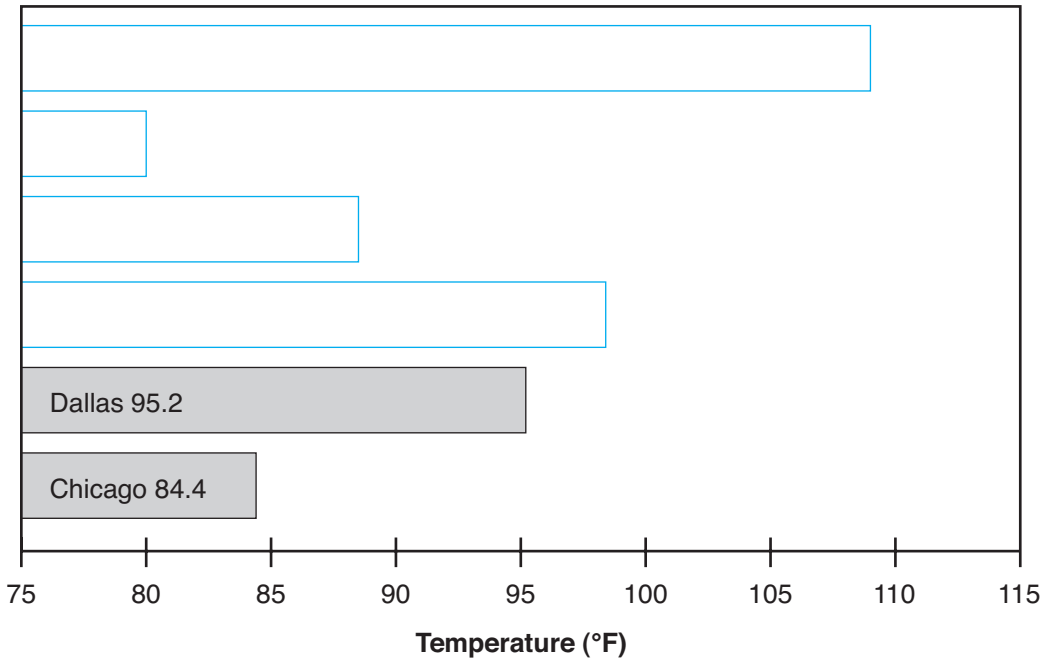
_____

Name _____ Date _____

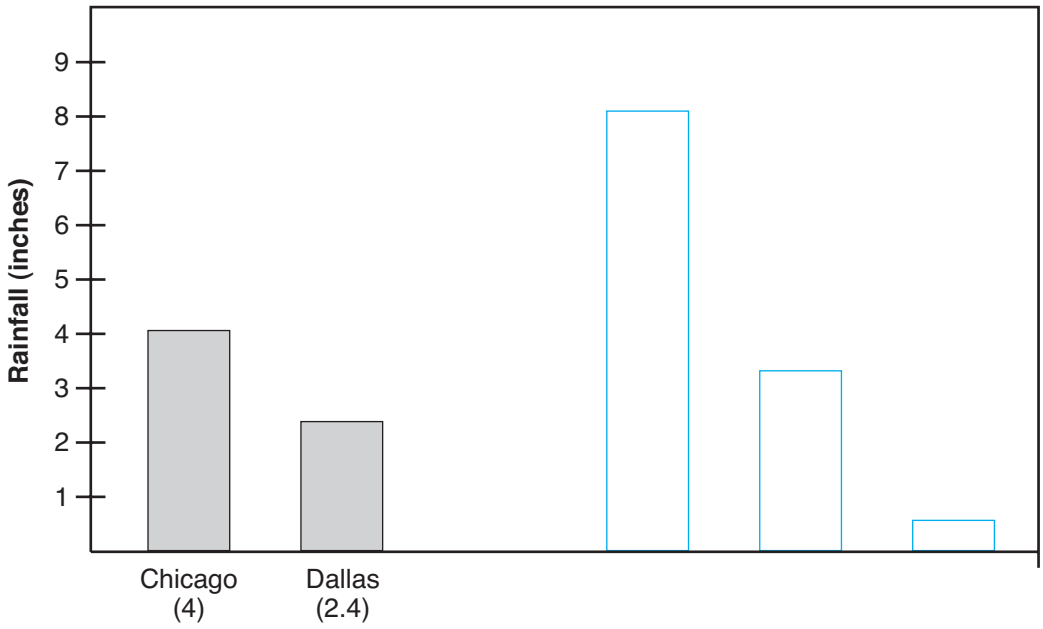
3 Apply It

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

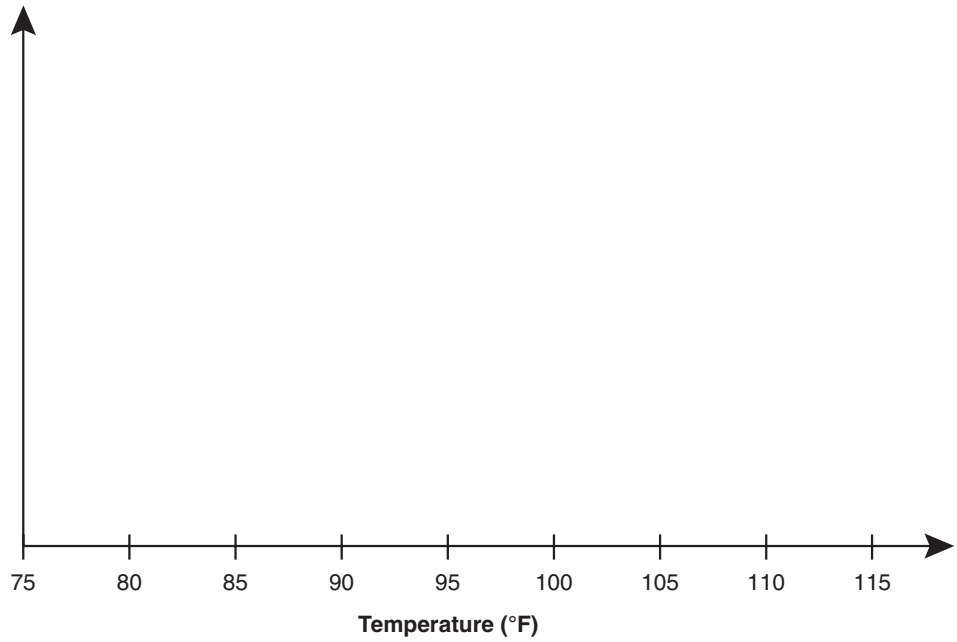
July Average High Temperatures for Some Cities

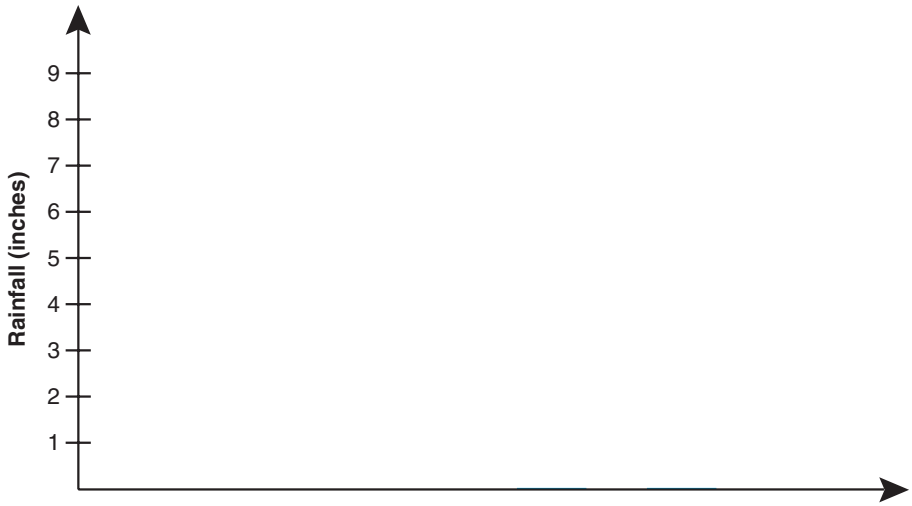


July Average Rainfall in Some Cities



- Finally, look at a weather map from your local newspaper. Compile data from the map and make two bar graphs. Include temperatures and precipitation for cities in California. **Analyze data** in your graph to predict what the weather may be in your area tomorrow. Share your findings with your classmates.





My prediction for the weather in my area tomorrow is:

_____

_____

Name _____ Date _____

California Standard
6 IE 7.a., h.

How does the steepness of a slope affect stream erosion?

Form a Hypothesis

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

_____

_____

_____

Materials

- dishpan or plastic bin
- mixture of sand, gravel, and pebbles
- small watering can
- books or wood blocks
- toothpicks

Test Your Hypothesis

1. **Make a Model** Fill the dishpan or bin with the mixture of sand, gravel, and pebbles to model a streambed.

2. Use the watering can to pour a thin stream of water down the middle of the model. What happens?

_____

_____

3. Smooth out the streambed, and use a book or wood block to prop up the dishpan or bin and make the streambed slightly steeper. Pour water down the middle of the model. What happens now? Stick about two dozen toothpicks into the slope to represent trees. Pour water again. Do the trees make a difference?

_____

_____

_____

Draw Conclusions

4 **Analyze** Make a chart to organize your data. Did your observations support your hypothesis?

5 **Infer** What do you think would happen if there were many plants or trees along a stream's banks?

Explore More

What would happen if you used two books or wood blocks to make the streambed steeper? Form a hypothesis and test it. Then analyze and present your results.

Name _____ Date _____

How do glaciers change the land?

Form a Hypothesis

How do glaciers reshape Earth's surface? Write your answer as a hypothesis in the form "*If glaciers drag loose rocks and soil with them as they move over Earth's surface, then . . .*"

_____

_____

_____

_____

_____

Materials

- 2 small milk cartons
- sand
- water
- safety scissors
- modeling clay
- paper towels

Test Your Hypothesis

1. Fill one milk carton with plain water. Place a layer of sand in the other milk carton, and fill it with water. Place both in a freezer, and allow them to freeze solid.
2. Use scissors to cut open the carton and remove the ice.
3. With a paper towel, pick up the block of ice without sand. Press it against a smooth piece of clay, and rub it back and forth several times. Use firm pressure, but not too much. Record your observations.

_____

_____

_____

4 Repeat step 3 using the block of ice with sand. Record your observations.

Draw Conclusions

5 **Observe** What did the surface of the clay look like after you rubbed it with the second block of ice? If there were changes, what caused them?

6 **Infer** How does this relate to the way glaciers change Earth's surface?

 Name _____ Date _____

Layers of Sediment

Purpose

Your task is to model the effects of different particle sizes in the formation of sediment.

Materials

- 2 widemouthed jars
- water
- flour
- dry rice
- dry red beans

Procedure

1. **Make a Model** You can use a sediment jar to model how sediment is deposited in layers. Pour 1 cup of water into a widemouthed jar. Put another cup of water into another jar along with $\frac{1}{2}$ cup each of flour, dry rice, and dry red beans. Close the lid of the second jar, and shake the mixture you made.

2. **Observe** Pour the mixture into the water in the first jar. Record what you see. You may wish to draw a diagram. Continue recording what you see every 20 minutes for 1 hour and again in 24 hours.

Time After Start	Observations
0 minutes	
20 minutes	
40 minutes	
60 minutes	
24 hours	

Draw Conclusions

3 **Infer** How does particle size affect the order in which particles settle? Why?

_____

_____

_____

4 **Going Further** If you placed a mixture of different-sized particles in running water, such as a stream, how do you think the speed of the water would affect the rate at which the sediment was laid down? Write a hypothesis and test it.

My hypothesis: _____

_____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

_____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.e., f.

How can you map a watershed?

Purpose

What information will you need to map a watershed? Write your answer in the form "*If I want to map my area's watershed, then I will need . . .*"

_____

_____

_____

_____

Materials

- topographic map of your area
- road map of your area
- clear sheet of plastic (acetate) as large as the map
- piece of cardboard the same size as the map
- thumbtacks
- dry-erase markers
- tissues

Procedure

1. Choose a site to map: a stream, pond, or other small body of water. Place the plastic sheet over the topographic map, and tack both to the cardboard. Mark your site on the topographic map, using the road map to help you.

2. Mark the bodies of water near your site on the topographic map. Use the map's contour lines to find the highest and lowest points around your site. Mark each hilltop with an *x*.

3. Use *x*'s to label the directions in which the local ditches and streams flow. On your map find the highest ground between two bodies of water. Draw a line to connect highest points (the *x*'s) around your site, including its mouth—the place where it drains into another body of water.

Draw Conclusions

4 **Analyze** What can you tell about how water flows in the watershed? Use the topographic map to explain.

_____

_____

_____

Explore More

How could this watershed map be used to serve your community? What information does it provide? Make a prediction and test it. Then analyze and present your results.

_____

_____

_____

_____

Inquiry: Open Think of your own question related to watersheds.

My question: _____

_____

My research: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

Can humans control the natural flow of rivers?

Materials

- large plastic box or deep aluminum pan
- large tub
- sand, soil, and gravel
- watering can
- modeling clay
- 2 or 3 books

Form a Hypothesis

Throughout Earth's history rivers have flooded, depositing rich sediment on the surrounding lands. They have cut new paths through the land on the way to the oceans, lakes, and other bodies of water into which they drain. Humans have the ability to control the natural flow of rivers to the benefit of society. However, do these changes have other consequences? Write your answer as a hypothesis in the form "*If humans control the natural flow of rivers, then . . .*"

_____

_____

Test Your Hypothesis

1. Using a deep aluminum pan or large plastic box, create a riverbed. Lay down a layer of soil, sand, and gravel, and carve out your river in the center. At one end of your river, flatten out the area, creating a delta at the river's mouth. Cut a hole in the end of the pan by the mouth, and place a tub directly beneath it.

2. Create a slope by placing the end of the pan opposite the mouth on a stack of two or three books.

3. **Observe** Starting at the high end of the pan, pour a gentle stream of water into your river for about 30 seconds. Record your observations.

_____

_____

_____

4. Using the modeling clay, build a wall along each bank of your river all the way down to the mouth. Repeat step 3, and record your observations.

Draw Conclusions

5. How did the walls affect the speed of the water flowing in your river? How did the speed affect the rate of erosion and deposition?

6. **Infer** How do levees affect the flow of water in a river? How does this affect the deposition of sediment in delta areas?

 Name _____ Date _____

Changing the Land

Purpose

Your task is to model how a river flows over the land and changes the shape of the land.

Materials

- long plastic box
- soil or sand
- pebbles
- hose or watering can

Procedure

1. **Make a Model** Model a river by placing soil or sand in a long plastic box. Make the soil or sand at one end higher than the other. Use pebbles to build up higher areas. At the other end of the box, make a large depression in the soil to model an ocean.
2. Using a hose or a watering can, pour a thin stream of water onto the "mountain."
3. **Observe** What happens as the water flows down from higher areas to lower areas? What happens at the river's mouth when the river reaches the "ocean"? Report your findings.

_____

_____

_____

_____

_____

_____

Draw Conclusions

4. How does the slope of a river affect the rate of erosion?

_____

_____

5. Why is sediment deposited at the mouth of a river?

_____

_____

_____

6. **Going Further** Does erosion occur more rapidly in a younger river or an older river? Write a hypothesis and test it.

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.b., c., d.

What is sand?

Make a Prediction

Do you think that all beaches have the same kind of sand? Write your answer as a prediction in the form "*If you look at sand samples from different beaches, then you will see . . .*"

_____

_____

_____

Materials

- samples of sand from different beaches
- hand lens
- samples or photos of common minerals (quartz, feldspar, magnetite)
- shell fragments
- petri dish

Test Your Prediction

1. **Observe** Use a hand lens to examine grains of sand from several beaches. Describe the grains in each sample. Make a chart to organize your observations.

_____

_____

_____

2. **Classify** Compare the properties of the different grains of sand to the properties of the mineral samples provided by your teacher. Group the sand samples whose grains are made of the same minerals.

3. **Use Numbers** Choose one sand sample. Estimate the percent of each type of particle in the sample. Display your results in a circle graph. What is the most common type of particle in the sample?

_____

_____

Draw Conclusions

4 **Analyze** How would you explain what you observed? Compare the grains of sand within one sample. Are they all the same size? The same shape? What might cause them to be different?

_____

_____

_____

_____

Explore More

Some beaches in Hawaii have black sand. There are beaches in the Bahamas where the sand is pink. What might you see through a hand lens if you looked at samples of these types of sand? Why do you think beach sand has different colors in different places?

_____

_____

_____

Name _____ Date _____

Why are plants important to a dune?

Materials

- sand
- small plastic aquarium plants
- plastic box or aluminum pan
- watering can

Form a Hypothesis

Many beaches have beautiful dunes that look inviting to walk on. However, in most places there are signs posted asking people to stay off the dunes. There are also signs asking people not to pick the dune plants. Why do you think these plants are so important? Write your answer as a hypothesis in the form "*If the dune plants disappear, then . . .*"

_____

_____

Test Your Hypothesis

1. Using a plastic box or aluminum pan, build a sand dune. You may want to moisten the sand slightly to make it stick together.

2. **Observe** Using the watering can, pour a stream of water over your dune, and observe what happens.

_____

_____

3. **Observe** Rebuild your sand dune. This time add some plants. Repeat step 2, and record your observations.

_____

_____

Draw Conclusions

4 Why do beach communities ask people not to pick the dune plants?

_____

_____

_____

Inquiry: Open Do plants protect sand dunes from erosion by wind as well as water? Write a hypothesis and test it.

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

How Waves Affect Beaches

Purpose

Your task is to create a model that demonstrates how waves affect a beach.

Materials

- paint-roller pan
- 4 cups of sand
- water
- pencil

Procedure

1. You can make a model of how waves affect a beach. Cover the bottom of a paint-roller pan with 4 cups of sand. Build a small "beach" at the pan's shallow end.

2. Pour 8.5 cups of water into the deep end of the pan. Note the appearance of the sand and water.

_____

_____

3. **Observe** Hold a pencil sideways in the water at the deep end of the pan. Use the pencil to make waves. What happens when the waves hit the sand?

_____

_____

4. How do the height and frequency of waves affect the beach? Experiment with using the pencil to make different kinds of waves, and observe the results.

_____

_____

Name _____ Date _____ Quick Lab

Draw Conclusions

5 **Infer** What affects the rate of erosion along a shoreline?

_____

_____

6 What other actions can change the shape of a shoreline?

_____

_____

7 **Going Further** Along many coastlines there are barrier islands. How do you think these islands affect the rate of erosion along the shoreline?

My hypothesis: _____

_____

_____

My experiment: _____

_____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

California Standard 6 IE 7.a.

Inquiry: Structured

What can change a river?

Materials

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

Form a Hypothesis

Rivers and streams can be found all over the United States. People have changed rivers and streams to accomplish different tasks, such as irrigating fields and powering turbines for electricity. The flow of water down a stream or river can be influenced by various factors. Rain and snowfall can increase the flow of water. Drought and human-made structures can slow or stop the flow of water. What effect does the makeup of the land have on the formation of a storm? How does the size of the land particles affect how a stream forms? Write your answer as a hypothesis in the form "*If the land a stream is forming in is made from soil, sand, or gravel, then the stream will look like . . .*"

_____

_____

_____

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

Test Your Hypothesis

1. Use potting soil to make a mound at one end of the aluminum pan. This will represent a mountain.
2. Use a cup to pour a small amount of water onto the top of your soil mountain. Draw and record in the chart on the next page what happens to the mountain.
3. Repeat steps 1 and 2 with gravel and sand. What differences did you see among the soil, sand, and gravel mountains?
4. Repeat the activity again, using a mixture of the three materials. Record your results in the chart.

Name _____ Date _____ **Be a Scientist**

	Soil	Gravel	Sand	Mixture
Drawings				
Observations				

Draw Conclusions

5 **Explain** What happened to the water flow when you poured the water on the soil mountain?

_____

_____

6 **Explain** What differences did you see among the soil, the sand, and the gravel mountains?

_____

_____

_____

_____

_____

7 **Infer** What type of mountains or land would create the deepest streams and rivers?

_____

_____

Name _____ Date _____

Inquiry: Guided

What affects the speed of flowing water?

Form a Hypothesis

What can you do to change the speed at which water flows in a stream? Write your answer as a hypothesis in the form "*If a streambed is made narrower, then the speed of the water will . . .*"

_____

_____

Test Your Hypothesis

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

_____

_____

_____

_____

Draw Conclusions

Did your experiment support your hypothesis? Why or why not? What factors contributed most to the speed of water flowing in a stream?

_____

_____

_____

_____

_____

Name _____ Date _____

Be a Scientist

Inquiry: Open

What else can you learn about rivers and streams? For example, what effects do dams have on river speed and flow? Think of a question to investigate, and design an experiment to answer your question. Then carry out your experiment.

Remember to follow the steps of the scientific process.

Ask a Question

_____

_____

Form a Hypothesis

_____

_____

Test Your Hypothesis

_____

_____

_____

Draw Conclusions

_____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.g., h.

How do volcanic eruptions affect habitats?

Materials

- photo of Mount St. Helens before the eruption of 1980
- photo of Mount St. Helens after the eruption of 1980
- map showing extent of damage

Make a Prediction

If a volcano erupts, what do you think happens to the area around it? Write your answer as a prediction in the form "*If a volcano erupts, then . . .*"

_____

_____

Test Your Prediction

1. **Observe** Study the photos of Mount St. Helens before and after the volcanic eruption of 1980.

2. What changes to the mountain and its vegetation do you see?

_____

_____

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

_____

_____

_____

Draw Conclusions

4 Do you think it would have been necessary to redraw a topographic map of this area after the volcano erupted? Why or why not?

_____

_____

5 **Analyze** How would you explain what you observed? Did your observations support your prediction? How does an erupting volcano affect its surrounding area?

_____

_____

_____

_____

_____

_____

Explore More

Choose another natural disaster to study, such as the 1993 flooding of the Mississippi River area or the 2004 tsunami in Asia. Find photos taken before and after the disaster. Describe any changes you see in the landforms and the local vegetation. Analyze and present your results.

_____

_____

_____

Name _____ Date _____

Where in the world do disasters occur?

Materials

- research resources such as newspapers or the Internet
- map of the United States
- red pencils or markers

Form a Hypothesis

Does location affect the types of natural disasters that typically occur in an area? Write your answer as a hypothesis in the form "*If I find that certain types of natural disasters occur more frequently in specific parts of the United States, then . . .*"

_____

_____

_____

_____

_____

_____

Test Your Hypothesis

1. As a class divide into five groups: the earthquake team, the volcano team, the hurricane team, the tornado team, and the fire team.
2. Obtain one copy of a map of the United States and one red pencil or marker for each team.
3. Using library or Internet resources, investigate the occurrences of the natural disaster assigned to your team. Draw red *x*'s on the map to indicate places where the disaster has occurred.

Draw Conclusions

4 Did you find a pattern to the locations where the natural disaster assigned to your group has occurred? Present your results to the class.

_____

_____

_____

_____

Inquiry: Open Is there at least one factor in the geographic areas where you found the highest frequency of your natural disaster that might contribute to its occurrence? Write a prediction and research it.

My prediction: _____

_____

_____

_____

How I can find out: _____

_____

_____

My results: _____

_____

_____

 Name _____ Date _____

Local Natural Disaster

Purpose

Your task is to investigate a natural disaster in your area and determine its effects on Earth's surface and the people, plants, and animals in the area.

Materials

- newspapers, maps, and other resources

Procedure

1. Investigate a natural disaster that occurred in your area. It may be a flood, a landslide, a volcanic eruption, an earthquake, a storm, or a fire.

2. **Research** Use newspaper articles, interviews with local residents, topographic maps, and other sources of information to answer these questions:
   - Did the natural disaster change Earth's surface? If yes, how?
   - Were any people harmed? Explain.
   - Were any plants and animals harmed? Explain.

Local Natural Disaster: _____		
Changes to Earth's Surface	**Harm to People**	**Harm to Plants and Animals**

Name _____ Date _____ Quick Lab

Draw Conclusions

3 **Communicate** Write a short report describing how the natural disaster affected your area. Include a map, photos, diagrams, or other appropriate visuals.

_____

_____

_____

4 **Going Further** Can some natural disasters be beneficial to the environment? Write a prediction and research it.

My prediction: _____

_____

My research: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

California Standard
6 IE 7.b.

What factors affect the efficiency of a solar oven?

Make a Prediction

What will happen to water in a solar oven? Write your answer as a prediction in the form "*If water is placed inside a solar oven, then . . .*"

_____

_____

Materials

- pizza box
- black construction paper
- aluminum foil
- clear plastic wrap
- newspapers
- glue
- tape
- safety scissors
- marker
- ruler or wooden dowel
- small bowl containing 100 milliliters of water
- thermometer

Test Your Prediction

1. **Measure** Draw a 2.5-centimeter border around the top of a pizza box. ⚠ **Be Careful.** Cut the three outer sides, Fold the flap up along the back edge.

2. Glue foil under the flap, shiny side out. Glue another piece of foil inside the box, shiny side up. Tape black construction paper over the foil.

3. Roll up the newspapers, and place them inside the edges of the box. Tape them in place. Tape plastic wrap under the box lid over the first piece of foil. Add plastic wrap to the top of the lid.

4. Put the bowl of water in the center of the box. Record the temperature of the water.

_____

5 Position the oven with the flap facing the Sun. Prop the flap open with a dowel or ruler. After 10 minutes measure the temperature of the water.

Draw Conclusions

6 **Analyze** How would you explain what happened? Did your observations support your prediction?

7 **Infer** Did the temperature in the box change?

Explore More

What other factors might affect the efficiency of the oven? What would happen if you used white paper instead of black paper? Form a hypothesis and test it.

Name _____ Date _____

Can you catch some rays?

Make a Prediction

Light rays are one way that the Sun gives off energy. How can you capture this energy and use it to heat water? Write your answer as a prediction in the form "*If I want to capture and use the Sun's energy, then . . .*"

_____

_____

_____

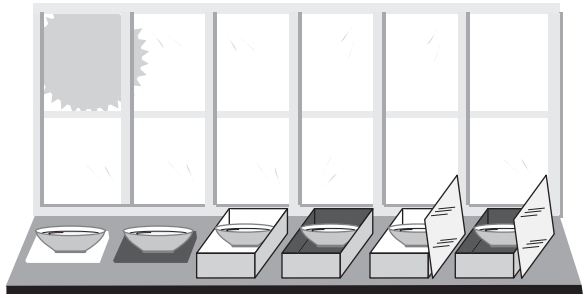
Materials

- 3 sheets of white paper
- 3 sheets of black construction paper
- 4 shoe boxes
- 2 large pieces of foil-wrapped cardboard
- 6 small bowls
- thermometers

Test Your Prediction

1. Place a sheet of white paper inside each of two shoe boxes. Place a sheet of black construction paper inside each of the other two shoe boxes.

2. Position the following side by side in direct sunlight: a sheet of white paper, a sheet of black construction paper, a shoe box lined with white paper, a shoe box lined with black construction paper, another shoe box lined with white paper, and another shoe box lined with black construction paper. Position a piece of foil-wrapped cardboard against each of the last two shoe boxes, with the cardboard propped against the side of the shoe box away from the sunlight and leaning slightly over the inside of the shoe box.



3. Put 100 milliliters of water in each of the six bowls. Record the temperature of the water in each bowl.

_____

_____

_____

4. Place a bowl in the center of each of the items positioned in direct sunlight.

5. **Measure** After 10 minutes record the temperature of the water in each bowl.

Draw Conclusions

6. **Interpret Data** In general did the solar collectors using white paper or black paper heat the water to a higher temperature? Why?

7. **Interpret Data** Did the solar collectors with or without shoe boxes heat the water to a higher temperature? Why?

8. **Communicate** Which solar collector worked best at raising the temperature of the water? What features of this solar collector do you think helped it heat well? Share your answers with your classmates.

Name _____ Date _____

The Power of Water

Purpose

Your task is to show how a waterwheel works and to examine factors that affect how well it works.

Materials

- plastic cup
- scissors
- pencil
- running water

Procedure

1. What factors do you think affect how well a waterwheel works? How can you design the blades on a waterwheel so that they turn as fast as possible?

_____

_____

_____

2. Cut eight equally spaced slits from the rim to the base of a plastic cup. Fan the sections out to form eight "blades."

3. Poke a hole through the center of the bottom of the cup, and insert a pencil as an axle.

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

_____

_____

5. Will your waterwheel turn faster with more blades? With fewer blades? Experiment to find out.

_____

_____

_____

Draw Conclusions

6 **Infer** How can the energy from the turning blades of a waterwheel be used for work?

_____

_____

7 **Going Further** How does the speed of falling water affect the energy produced by a waterwheel?

My prediction: _____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

Communicate

California Standard 6 IE 7.d.

When you **communicate** you share information with others. You may do this by speaking, writing, drawing, or using sign language. First, you gather some information to share with others. Then, you share your information.

1 Learn It

Scientists look for ways to reduce energy waste. They **communicate** their findings to others by writing books and articles, giving interviews, and making presentations.

Heating and cooling buildings takes a lot of energy. In fact, heating and cooling are two of our biggest uses of energy. They are also sources of many air pollutants. To avoid wasting energy, people can use insulation to retain heat in winter and keep air cool in summer.

2 Try It

- Some materials are better insulators than others. In the following activity, you will test the insulating qualities of six different materials. You will need down from an old jacket or glove, a cotton sock, a wool sock, sand, shredded newspaper, plastic air-bubble packing material, coffee cans with snap-on lids, baby food jars with screw-on lids, a graduated cylinder, warm water, and a thermometer.
- Fill each jar carefully with the same amount of warm water. Measure the temperature in each jar, and write it on the chart on the next page. Put a lid on each jar, and place each jar in the center of a can. Fill the space between each jar and can with one kind of insulating material. Stuff the can to completely surround the jar. Label each can to identify the material used. Record this on your chart. Put the lids on the cans, and wait 1 hour. Open each can and then each jar to measure the temperature of the water. Record the temperatures on your chart.
- Analyze the data in your chart. Which material(s) kept the water about the same temperature it was when the test started?

_____

_____

Name _____ Date _____

Material	Starting Temperature	Temperature after 1 Hour
Down		
Cotton Sock		
Wool Sock		
Sand		
Shredded Newspaper		
Plastic Bubble-wrap Packing Material		

▶ **Communicate** your actions and the results to your classmates in a written or oral report.

_____

_____

_____

_____

_____

_____

_____

_____

3 Apply It

- Which insulating material do you think would best keep the air in a building cool when the weather is hot outside?

_____

- Repeat the experiment, but this time use very cold water and one ice cube in each jar.

Material	Starting Temperature	Temperature after 1 Hour
Down		
Cotton Sock		
Wool Sock		
Sand		
Shredded Newspaper		
Plastic Bubble-wrap Packing Material		

- Analyze your results. **Communicate** your findings to the class by writing a report, drawing a cartoon strip, or composing a song in the space below.

 Name _____ Date _____

California Standard
6 IE 7.a., b., d.

How energy efficient are different types of light bulbs?

Materials

- gooseneck lamp
- extension cord if needed
- 60-watt incandescent light bulb
- 13-watt compact fluorescent light bulb
- thermometer
- ruler or yardstick
- white towel
- watch or stopwatch

Form a Hypothesis

Are some kinds of light bulbs more efficient than others? A light bulb gives off light and heat. This heat is wasted energy. Do some types of bulbs give off more heat than others? Develop a hypothesis in the form "*If one type of light bulb is more efficient than another type, then it will give off . . .*"

_____

_____

⚠ **Be careful.** Let light bulbs cool before touching them.

Test Your Hypothesis

1. Lay the towel out on a table. Place the lamp at one end of the towel. Put the thermometer at the other end of the towel where the light from the lamp will shine on it. Measure the distance between the thermometer and the bulb.

   _____

2. **Experiment** Unplug the lamp, and screw in the incandescent light bulb. Record the starting temperature. Angle the lamp over the thermometer, plug in the lamp, and turn it on.

3 **Measure** Shine the lamp on the thermometer for 5 minutes. Record the temperature. Repeat steps 2 and 3 for the fluorescent light bulb. Allow the lamp and the table to cool between the trials.

Type of Light Bulb	Starting Temperature	Temperature After 5 Minutes
60-watt incandescent		
13-watt compact fluorescent		

Draw Conclusions

4 **Infer** What conclusion can you draw about which kind of bulb produces less heat?

_____

_____

Explore More

How do you think the use of incandescent lights in a home would affect the use of air conditioning in the summer? Make a prediction and test it.

_____

_____

_____

Name _____ Date _____

Can sunlight be used to heat water for use in homes?

Materials

- paper cups
- water
- thermometer
- watch or clock

Form a Hypothesis

Every home needs hot water, and hot water systems in most homes rely on electricity, fuel oil, or natural gas. If the Sun can warm oceans, lakes, and streams, can sunlight heat water for home use? Write your answer as a hypothesis in the form "*If I place a cup of water in direct sunlight, then the temperature of the water . . .*"

_____

_____

Test Your Hypothesis

1. Fill a cup with water. Record the temperature of the water in the table below.
2. Place the cup of water in direct sunlight.
3. Measure and record the temperature of the water every 5 minutes for 30 minutes.

Time in Sunlight	Temperature
0 minutes	
5 minutes	
10 minutes	
15 minutes	
20 minutes	
25 minutes	
30 minutes	

4 What was the total increase in temperature?

_____

Draw Conclusions

5 **Interpret Data** Did your data support your hypothesis?

_____

_____

6 **Infer** Besides raising the temperature of water, what other factors would be important in providing hot water for homes?

_____

_____

_____

7 **Infer** Besides placing water in direct sunlight, are there other ways to use sunlight to heat water for home use?

_____

_____

 Name _____ Date _____

Fuel Supply

Purpose

Your task is to determine how long the world's supplies of oil and natural gas will last. This table shows how quickly people are using up oil and natural gas.

Materials

- graph paper
- pen or pencil

Fuel Use		
Type of Energy Source	**Proved Reserves (as of January 1, 2004)**	**Amount Used (for 2003)**
Oil	1,265 billion barrels	about 80 million barrels per day
Natural gas	6,079 trillion cubic feet	about 96 trillion cubic feet per year

Source: U.S. Energy Information Administration

Procedure

1. **Analyze** Examine the data in the table.

2. **Communicate** Based on the data in the table, make a line graph that shows how long the world's supplies of oil and natural gas will last. Assume that the rate of use will remain the same over time.

3. **Infer** How much time will pass until supplies of oil and natural gas run out?

_____

_____

Name _____ Date _____ Quick Lab

Draw Conclusions

4 **Interpret Data** What do your results suggest about the need to conserve natural resources, such as oil and natural gas?

_____

_____

_____

5 **Going Further** What sector is the biggest consumer of energy in the United States? How can you find out? Write a prediction, research your answer, and communicate the information in a circle graph.

My prediction: _____

_____

_____

_____

My research: _____

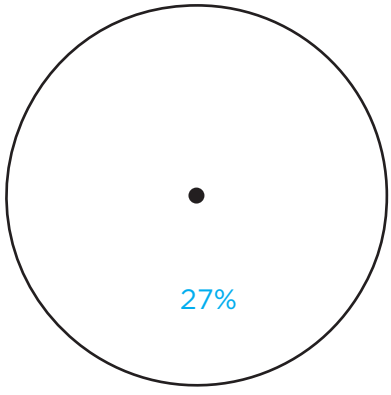
_____

_____

My results: _____

_____

_____



Name _____ Date _____

California Standard 6 IE 7.b.

Inquiry: Structured

How can you classify a renewable resource?

Materials

- solar kit with motor
- additional motor
- battery
- battery holder
- stopwatch or clock

Purpose

Renewable resources are becoming more important as nonrenewable materials become depleted. Renewable energy sources are making an impact on the kinds of cars people drive and the ways in which people generate electricity. Wind, sunlight, and water are all renewable resources. They are sometimes used as energy sources in place of coal, oil, and natural gas in the United States. How can you determine whether a source of energy is renewable or nonrenewable? What are the advantages of each type of resource?

△ **Be Careful.** Be careful when handling electrical items.

Procedure

1. For the first setup, connect one wire from the solar panel to one wire on the motor. Connect the other two wires. Draw your setup in the chart on the next page, and describe what happened to the motor when you connected the wires.

2. For the second setup, connect one wire from the other motor to the positive end of the battery. Connect the other wire to the negative end of the battery. Draw this setup in the chart, and describe what happened to the motor.

3. Record the time in the chart.

4. **Observe** Once per hour observe both motors. Compare the speeds at which the motors are running. Continue your observations until one motor is no longer working. Then record the time in the chart along with your observations.

	Solar Power	Battery Power
Drawings		
Observations		
Time	**Start:** **Finish:**	**Start:** **Finish:**

Draw Conclusions

5 **Explain** What did you observe concerning the speed at which the motors were running at the beginning and at the end of the experiment?

_____

_____

6 **Explain** Which type of energy, battery or solar, is renewable? Explain your answer.

_____

_____

7 **Infer** If you were the owner of a company, which type of energy would you want to use to power your manufacturing plant? Why?

_____

_____

_____

Name _____ Date _____

Inquiry: Guided

How does insulation affect energy use?

Form a Hypothesis

How can insulation help reduce the amount of energy needed to heat and cool your home? Are some insulation materials more efficient than others? Write your answer as a hypothesis in the form "*If proper insulation is used in a building, then the amount of heating and cooling needed will . . .*"

_____

_____

Test Your Hypothesis

Design an experiment to identify the most efficient insulation material. Write out the steps you will follow. Then carry out your plan, and record your results and observations.

_____

_____

_____

_____

Draw Conclusions

Did your experiment support your hypothesis? Why or why not? Present your results to your classmates.

_____

_____

_____

_____

Name _____ Date _____

Be a Scientist

Inquiry: Open

What else can you learn about renewable and nonrenewable energy sources? For example, are some energy sources more efficient than others? Think of a question to investigate. Then design an experiment to answer your question, and carry out your experiment.

Remember to follow the steps of the scientific process.

Ask a Question

_____

Form a Hypothesis

_____

_____

_____

Test Your Hypothesis

_____

_____

_____

Draw Conclusions

_____

_____

_____

Name _____ Date _____

What are objects made of?

California Standard
6 IE 7.d.

Make a Prediction

From which natural resources are most common objects made? Do such objects come from plants, animals, rocks, soil, minerals, oil, water, or metals? Make a prediction in the form "*Most objects in the classroom are made from . . .*"

_____

_____

Materials

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

Test Your Prediction

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

2. Have your teacher assign a small group to each section of the paper. One group will identify every object in the classroom made from plant materials, another will identify objects made from animals, and so on.

3. **Classify** Draw each object on the mural, and identify the natural resource from which it is made. Indicate whether the natural resource is renewable or nonrenewable.

_____

Draw Conclusions

4 **Analyze** How would you explain what you observed? Were some objects made from several natural resources?

_____

_____

5 Did your observations support your prediction?

_____

_____

6 **Infer** Identify the type of energy required to produce each object.

_____

_____

_____

Explore More

What types of pollution were generated in making these items? Make a prediction, and do research. Then analyze and present your results.

_____

_____

_____

Name _____ Date _____

How do we handle our trash?

Form a Hypothesis

Sometimes the way we handle problems comes down to simple choices. What options do we have for making the best waste-management choices? How can we make those decisions? Write your answer as a hypothesis in the form "*If we analyze what we throw away, then . . .*"

_____

_____

Materials

- 5 boxes labeled *Reduce, Reuse, Recycle, Landfill,* and *Compost*
- 40 index cards per team
- graph paper

Test Your Hypothesis

1. With a partner write down one item that you typically throw away on each of the index cards. You should end up with 40 items.

_____

_____

2. With your partner place each index card in the box that represents the best option for getting rid of the item listed.

3. **Use Numbers** When each team has placed all of its cards in the boxes, tally up the number of cards in each box. Record the data, and organize it into a graph.

Draw Conclusions

4. Which waste-management option contained the most cards?

_____

5. As a class select some of the cards from each box. Discuss whether the waste-management option selected was the best choice. Were better alternatives available?

_____

_____

Name _____ Date _____ Quick Lab

Sources of Clothes

Purpose

Your task is to identify, for a wide variety of clothing items, the materials of which they are made, the original sources used to make those materials, and the care requirements for each item.

Materials

- paper and pencil

Procedure

1. **Collect Data** Prepare an inventory of the different types of clothing, including shoes, in your classroom.

2. **Communicate** Make a chart that includes each item of clothing. Identify the type of material each item is made of, and add the type of material to the chart. Look at the labels if you need help.

Clothing Item	Material				

3. Use the information you have to trace the textiles back to their original sources.

_____

_____

_____

Name _____ Date _____

Draw Conclusions

4 **Infer** Read the care instructions for each type of material used, or look on the Internet. Which are easiest to care for? Why do you think this is so?

_____

_____

_____

5 **Going Further** Blue jeans were first manufactured in San Francisco in 1873. A man named Levi Strauss recognized the need for durable, rugged work wear. What made these pants, originally called "waist overalls," the perfect work wear? What did Strauss do to increase the durability of these pants? Write a prediction, and then research the answer.

My prediction: _____

_____

My research: _____

_____

_____

_____

My results: _____

_____

_____

_____

Growing Bacteria

Background

Bacteria are everywhere. They are found in the foods you eat, in the places where you study and play, and inside your body. Many bacteria are good for you, but there are also bacteria that can cause illnesses. Most food poisoning is caused by bacteria. Bacteria can also cause cavities, strep throat, and ear infections. Many of these illnesses can be cured by taking an antibiotic. Antibiotics kill the bacteria that cause many kinds of disease.

Materials

- sterile plastic petri dish
- sliced beets
- permanent marker
- plastic forceps
- antibiotic cream
- cotton swabs
- tape

Purpose

Your task is to grow bacteria on a beet slice, one half of which has antibiotic on it.

Form a Hypothesis

How would you grow bacteria on a beet slice? What will happen to the beet? Write your answer as a hypothesis in the form *"If an antibiotic is placed on half of the beet slice, then . . ."*

_____

_____

Name _____ Date _____

Test Your Hypothesis

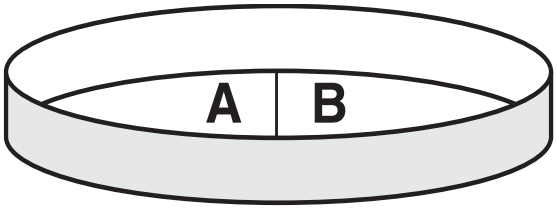
1. Turn the petri dish upside down, and use a marker to divide the dish in half. Label the sides A and B.
2. Use the forceps to pick up the beet slice. Slightly lift the lid of the petri dish with your other hand and place the beet slice in the center of the dish. Replace the cover.
3. Rub a cotton swab over the fingers of one hand, slightly lift the cover of the petri dish, and gently rub the swab over the surface of the beet slice. Make sure that you touch the entire surface of the beet slice.
4. Use another cotton swab to add antibiotic cream to the half of the beet slice on side B of the dish.
5. Replace the cover, and tape the lid to the dish.
6. Place the petri dish where it will not be disturbed.
7. **Observe** Count colonies of bacteria and check for their growth every day for 4 days. What happens to the beet slice? Do you see any pattern in the growth?

_____

_____

_____

Name _____ Date _____



Day 1

Number of colonies: A _____

B _____

Observations: _____

_____

Day 2

Number of colonies: A _____

B _____

Observations: _____

_____

Day 3

Number of colonies: A _____

B _____

Observations: _____

_____

Day 4

Number of colonies: A _____

B _____

Observations: _____

_____

Name _____ Date _____

Draw Conclusions

8 Based on your results, what is your conclusion?

_____

_____

_____

Critical Thinking

1 Why are refrigerators and freezers used to store food for long periods of time?

_____

_____

_____

2 What is antibiotic cream useful for?

_____

_____

_____

_____

Did You Know?

Bacteria in the mouth feed on leftover food and can cause bad breath.

What is a carnivore?

Background

Food chains and food webs show how energy is passed from one living thing to the next. At the bottom of the food chain are plants, because they make their own energy using the Sun. Herbivores (animals that eat plants) are the next group in the food chain, or first-level consumers. Then come carnivores (meat eaters) and omnivores (meat and plant eaters), or second-, third-, and fourth-level consumers. When an animal at the top of the food chain dies, it is then eaten by decomposers. Decomposers are small organisms that break dead plants and animals down into very small pieces that are then returned to the soil and used as nutrients by plants. Every living thing gets recycled in this way.

Purpose

Your task is to conduct an experiment that will determine whether an owl is a carnivore.

Form a Hypothesis

How can you use an owl pellet (undigested material that an owl regurgitates) to determine whether an owl is a carnivore? Write your answer as a hypothesis in the form *"If the pellet contains _____, then the owl is a carnivore."*

_____

_____

Name _____ Date _____

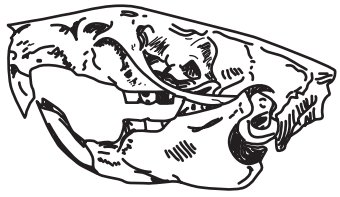
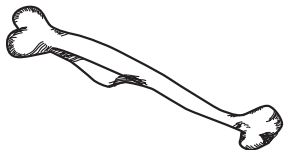
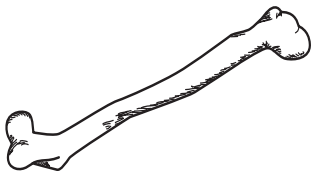
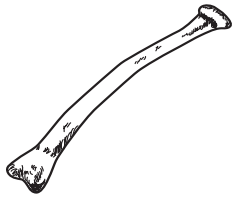
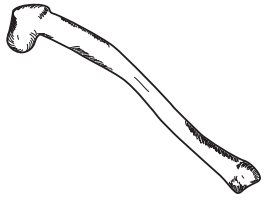
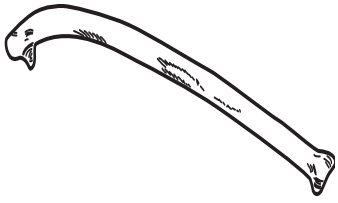
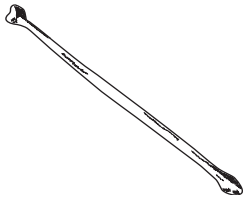
Test Your Hypothesis

1. Cover a workspace with newspaper, unwrap the owl pellet, and place it on a piece of black construction paper.
2. Using toothpicks, carefully take the owl pellet apart, and look for bones. (The bones are very fragile and need to be removed gently to avoid breaking.)
3. Once you have removed any bones, put them in the bowl of bleach solution for about 5 minutes or until the bones are thoroughly cleaned and whitened.
4. Put the screen over the top of a plastic cup, and gently pour the solution through the screen. You will now have any bones on the screen. Gently remove the bones with plastic forceps, and put them on a paper towel to dry.
5. Sort the bones, using the bone-sorting chart on the next page.
6. Glue the appropriate bones on the rodent-skeleton diagram on the next page.

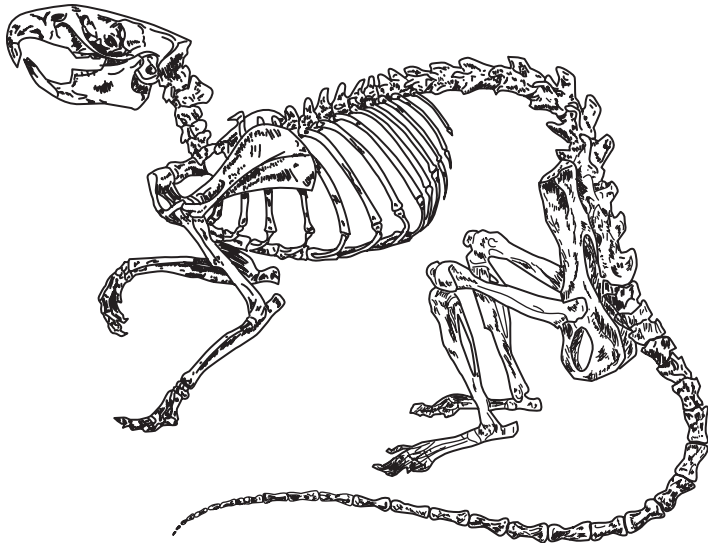
Materials

- black construction paper
- sterilized owl pellet
- toothpicks
- plastic bowl with bleach solution and plastic cup
- piece of screen
- plastic forceps
- bone-sorting chart
- rodent-skeleton diagram

Bone-Sorting Chart

 skull	 humerus	 femur
 vertebra	 radius	 tibia
 rib	 ulna	 fibula

Rodent-Skeleton Diagram



Name _____ Date _____

Draw Conclusions

7 **Observe** What did you observe?

_____

_____

_____

8 Based on your results, what is your conclusion? Is the owl a carnivore? Why? What evidence leads you to your conclusion?

_____

_____

Critical Thinking

1 Why is it important to protect owls and their habitats?

_____

_____

2 What would happen if all the owls in a large farming area died?

_____

_____

_____

_____

Did You Know?

Rodents (including mice, beavers, hamsters, gerbils, and groundhogs) are mammals that have a pair of front teeth that never stop growing; this causes them to gnaw constantly to grind their teeth down.

Potential to Kinetic Energy

Background

Potential energy is energy stored in an object. Kinetic energy is the energy of motion. Fuel such as wood, oil, and gas contains potential energy. When fuel is burned, heat is released. This heat is used to do work such as moving a car or heating a stove. Chemical reactions also involve the conversion of potential energy to kinetic energy. For example, food contains chemical bonds that contain potential energy. Digestive enzymes break down these bonds and release the potential energy. This energy is eventually converted into kinetic energy—energy used for activities such as running, jumping, and breathing.

Purpose

Your task is to devise an experiment that converts potential energy to kinetic energy, using an effervescent tablet as a test material.

Form a Hypothesis

How can you use an effervescent tablet and water to demonstrate how potential energy is converted to kinetic energy? Write your answer as a hypothesis in the form *"If an effervescent tablet is added to water in a film canister and the top is put on the film canister, then the canister will . . ."*

_____

_____

_____

Name _____ Date _____

Test Your Hypothesis

This experiment must be done outdoors.

1. Put on your safety goggles.
2. Fill the film canister half full with water.
3. Put half of an effervescent tablet in the water. Immediately snap the top on the canister.
4. Hold two fingers on the top and your thumb on the bottom of the canister to prevent the cap from coming off.
5. Shake the canister briskly, and walk to a clear spot, away from people. **(Hold the canister away from your body and face.)**

Materials

- safety goggles
- effervescent tablet
- a film canister with a snap-on lid (a lid that snaps inside the canister, not outside)
- water

Step 3

Step 5

6 Put the canister cap-down on a hard surface on the ground.
Move back.

Step 6

Draw Conclusions

7 What did you observe?

_____

_____

_____

_____

_____

8 Based on your results, what is your conclusion?

_____

_____

_____

Name _____ Date _____

Critical Thinking

1. How is the launch of a space shuttle similar to your effervescent-tablet "rocket"?

_____

_____

_____

_____

_____

_____

_____

2. Why does the space shuttle not fly to the Moon?

_____

_____

_____

_____

Did You Know?

To maintain an orbit in space, the **Shuttle** must reach at least a speed of about 17,000 miles per hour.

The Light We Cannot See

Background

The electromagnetic spectrum is made up of electromagnetic radiation of different wavelengths. These include radio waves, microwaves, infrared rays, visible light, ultraviolet (UV) light, X rays, and gamma rays. Humans cannot see ultraviolet light, but some animals can. Exposing skin to ultraviolet light without using sunscreen can damage the skin.

Purpose

Your task is to design an experiment using UV beads that will determine how to protect yourself from damaging ultraviolet light. UV beads are special beads that contain a pigment that changes color when exposed to sunlight.

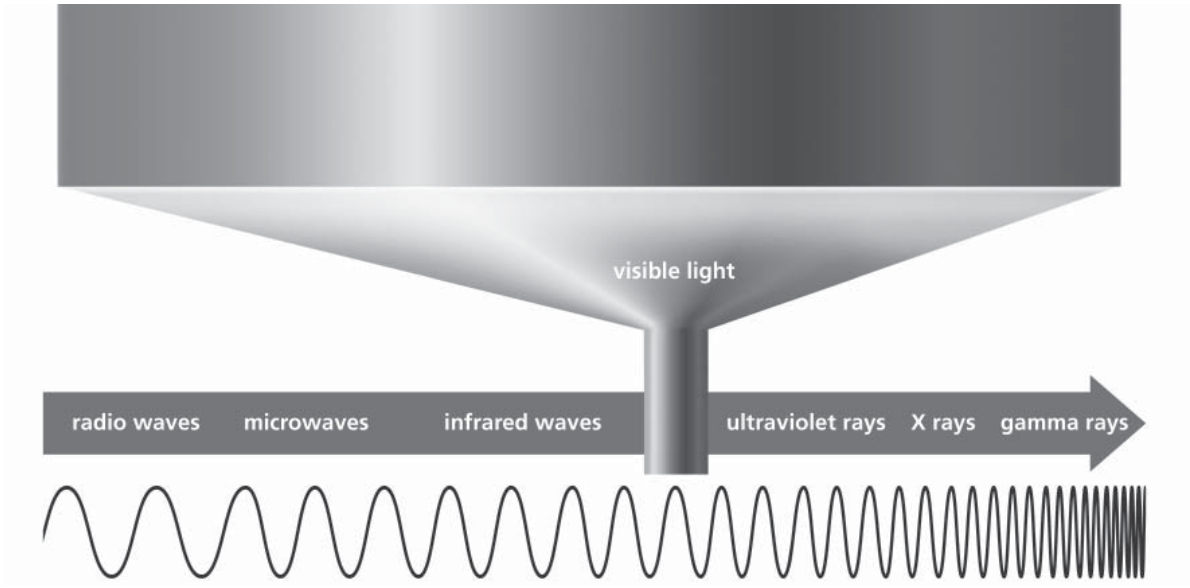
Form a Hypothesis

How can you determine whether UV-protective lenses block ultraviolet light from the Sun? Write your answer as a hypothesis in the form *"If UV-protective lenses block ultraviolet light from the Sun, then UV beads under such sunglasses in sunlight will . . ."*

_____

_____

_____



Name _____ Date _____

Test Your Hypothesis

1. Put the UV beads in sunlight, and see if they change color.

_____

_____

_____

Materials

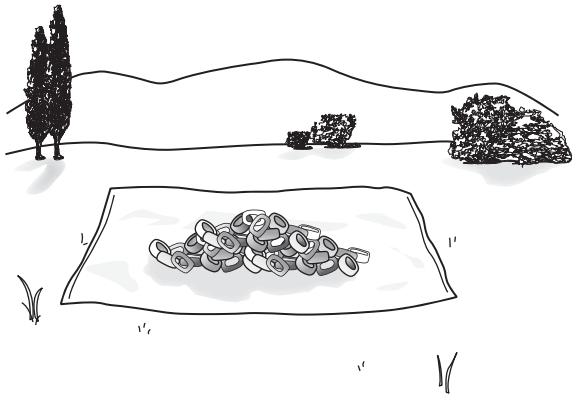
- UV beads
- pair of sunglasses with UV-protective lenses

2. Take the UV beads out of the sunlight, and see if they change color.

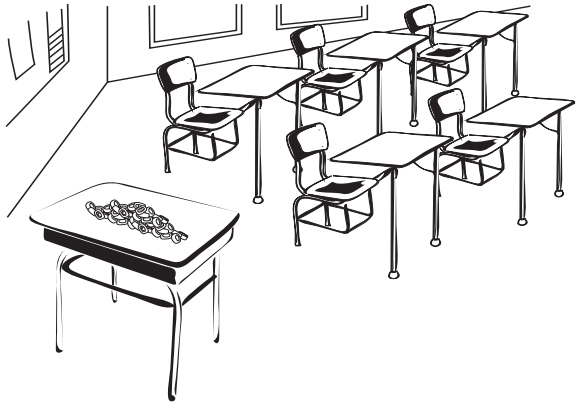
_____

_____

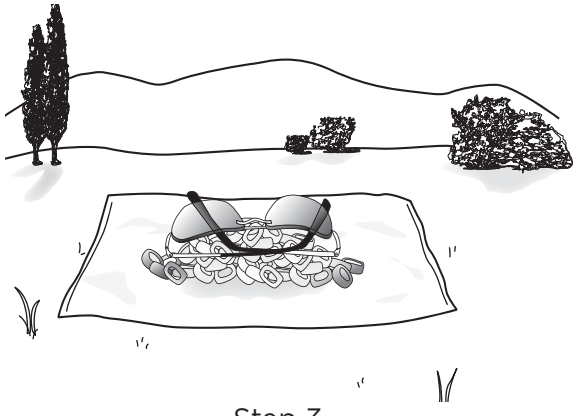
3. Cover the UV beads with the lenses of the sunglasses, and place them in sunlight.



Step 1



Step 2



Step 3

4 What color are the UV beads?

_____

_____

Draw Conclusions

5 What did you observe?

_____

_____

_____

_____

6 Based on your results, what is your conclusion?

_____

_____

_____

_____

Critical Thinking

1 What would happen if you covered the UV beads with sunscreen lotion and then put them in sunlight?

_____

_____

_____

Name _____ Date _____

2 The ozone layer around Earth acts like a large layer of sunscreen, protecting the planet from most ultraviolet light coming from the Sun. What do you think would happen to Earth if the ozone layer were damaged or weakened?

_____

_____

_____

_____

Did You Know?

Ultraviolet light is necessary for your body to produce Vitamin D.

Electricity from the Sun

Background

A solar panel is made up of photovoltaic cells. These cells work together to convert sunlight (*photo-*) into electricity (*-voltaic*). Photovoltaic cells are commonly made of silicon. When silicon is exposed to sunlight, its electrons start flowing. The flowing of electrons is called an electric current. The current from the silicon of the photovoltaic cells is directed toward the metal wires attached to the solar panel. In this way the energy of the Sun is converted into electricity. Electricity will continue to be generated by the solar panel's cells as long as sunlight is available.

Purpose

Your task is to show that a solar panel can produce electricity.

Form a Hypothesis

How can you use a small, homemade motor to prove that a solar panel produces an electric current? Write your answer as a hypothesis in the form *"If a solar panel produces an electric current and I connect it to a motor, then the motor will . . ."*

_____

_____

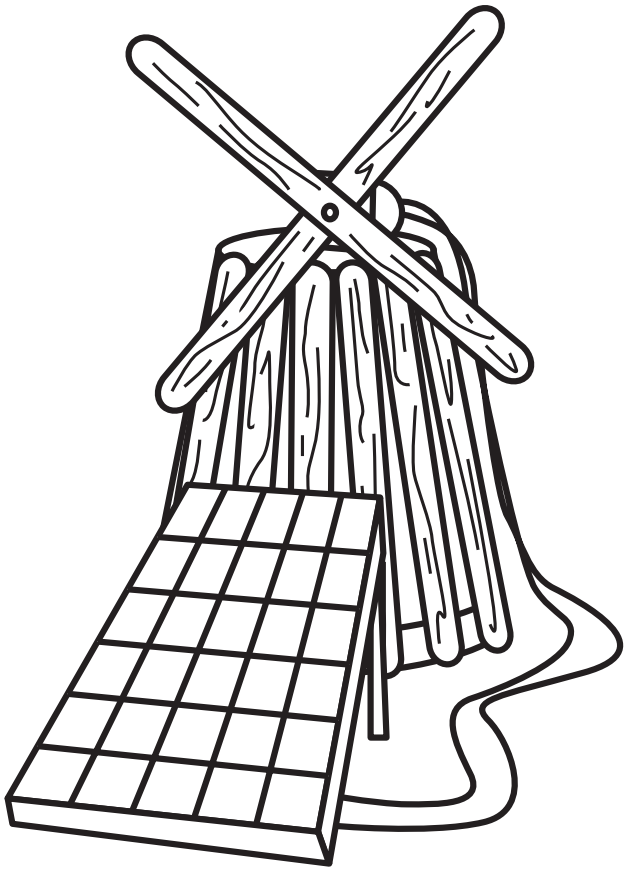
Name _____ Date _____

Test Your Hypothesis

1. Use craft sticks to make a structure such as a windmill, a Ferris wheel, a helicopter, or a merry-go-round.
2. Attach the moving parts of your structure (such as windmill blades or helicopter blades) to the motor with the glue or tape.
3. Attach the wires from the solar panel to the leads on the motor.

Materials

- 50–100 craft sticks
- small solar panel
- small motor
- glue or double-stick tape



4. Place the solar panel in sunlight or under a very bright light.
5. Observe what happens.

Draw Conclusions

6. What did you observe?

_____

_____

_____

_____

7. Based on your results, what is your conclusion?

_____

_____

_____

_____

Critical Thinking

1. How can you stop the motor from running without moving your structure?

_____

_____

_____

Name _____ Date _____

2 Do you think that solar panels could work in very cold climates?

_____

_____

_____

_____

Did You Know?

The amount of **energy** that Earth receives from the Sun in one hour is more energy than people throughout the world use in a year.

Rocks That Float, Rocks That Sink

Background

When a volcano erupts, hot molten lava can be thrown into the air or can flow from fissures and cracks and flow over Earth's surface. When the lava cools and hardens, it forms igneous rocks. These rocks are called *extrusive* igneous rocks, because they form by cooling and hardening on Earth's surface. *Intrusive* igneous rocks are formed deep within Earth. They are often exposed by an earthquake or other natural event.

Purpose

Your task is to design an experiment that will determine whether pumice, an extrusive igneous rock, will sink or float when put in water.

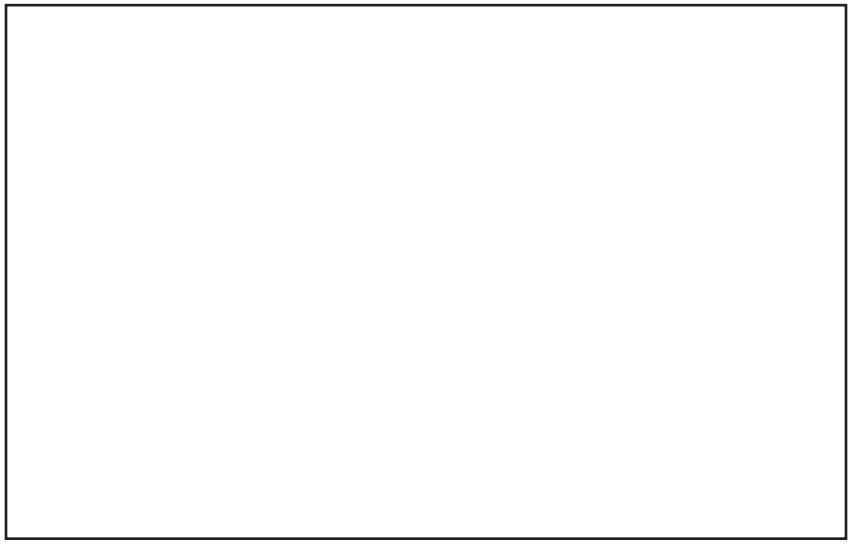
Form a Hypothesis

Examine the pumice, and make a sketch of it in the space on the next page. What do you think will happen if you put a piece of pumice in a bowl of water? Will it sink or float? What would happen if you did this with other rocks? State your hypothesis in the form *"If I place a piece of pumice in water, then the pumice will . . ."*

_____

_____

Name _____ Date _____



Sketch of Pumice

Materials

- piece of pumice
- bowl
- water

Appearance of pumice:

_____

_____

Texture of pumice:

_____

_____

_____

Test Your Hypothesis

1. Fill your bowl with water.
2. Place a piece of pumice in the water, and make a sketch of what you see in the space on the next page.

Sketch of Pumice in Water

Draw Conclusions

3 What did you observe?

_____

_____

_____

_____

4 Based on your results, what is your conclusion?

_____

_____

_____

_____

Name _____ Date _____

Critical Thinking

1. Why do you think the surface of pumice is full of holes or pores? How does this affect its buoyancy?

_____

_____

_____

_____

2. Feel the surface of the pumice. Why do you think pumice is added to some soaps?

_____

_____

_____

Did You Know?

Pumice is really a form of glass. It cools before crystals can form.

The Pressure Is On

Background

Though we are not aware of it, air pressure is pushing on us from every direction all the time. Usually we are only aware of sudden changes in air pressure—for example, when our ears pop in an airplane or when traveling to high altitudes in a car or bus. Air pressure and changes in air pressure have far-reaching effects on our environment. Changes in air pressure even affect the weather, as when air moving from a high-pressure area to a low-pressure area creates wind.

Purpose

Your task is to design an experiment that will prove or disprove Bernoulli's principle: If the movement of a fluid increases in speed, the pressure, or force, of that fluid pushing against an object will decrease. (Fluids include both liquids and gases.)

Form a Hypothesis

How can you use a simple strip of paper to prove Bernoulli's principle? Write your answer as a hypothesis in the form *"If I take a strip of paper and blow hard over the top of it, then . . ."*

_____

_____

Name _____ Date _____

Test Your Hypothesis

1. Hold one end of the strip of paper just below your lower lip.
2. Blow hard over the top of the paper.

Materials

- strip of paper 15 cm long and 1 cm wide

Draw Conclusions

3. What did you observe?

_____

_____

_____

_____

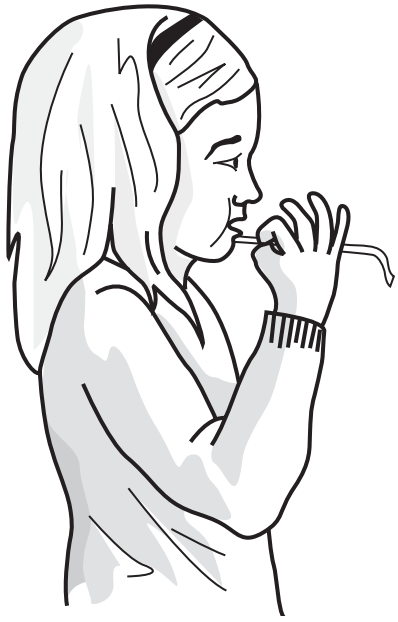
4. Based on your results, what is your conclusion?

_____

_____

_____

_____



Further Inquiry

You can also test this principle using a piece of string and 2 balloons.

1. Measure a 30-centimeter piece of string, and tie a balloon on each end.
2. Lightly support the undersides of the balloons, holding them about 6 centimeters apart, and blow very hard between the balloons.
3. What did you observe?

_____

_____

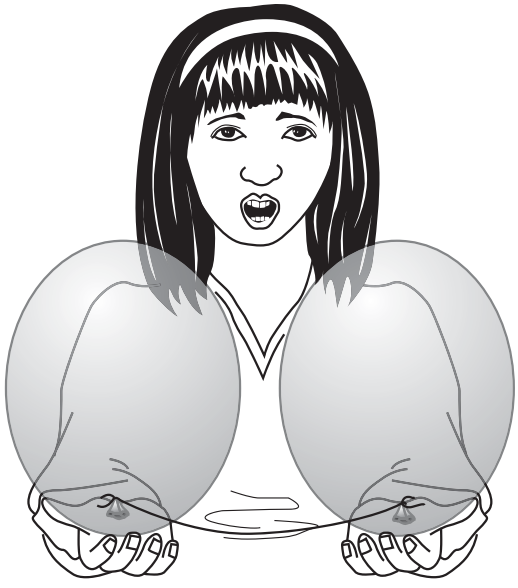
4. Explain your observations.

_____

_____

_____

_____



Name _____ Date _____

Critical Thinking

1. How does Bernoulli's principle apply to an airplane taking off?

_____

_____

_____

_____

_____

2. Why does low air pressure mean bad weather?

_____

_____

_____

_____

Did You Know?

The first part of the word **barometer** comes from the Greek word **baros**, which is related to the Greek word for "heavy." A barometer measures the heaviness, or weight, or pressure, of the air.

Sponges from Oil

Background

Polymers are formed when many molecules are linked together. Some polymers, such as plastic, are created from petroleum. Petroleum, or crude oil, is a black liquid pumped out of the ground. Superabsorbent polymers can be made from a by-product of petroleum refining. These polymers attract water and are linked in such a way that there are many "pockets" within the linkages that hold water molecules.

Materials

- ultrathin diapers
- plastic cups
- small garbage bag with twist tie
- scissors

Purpose

Your task is to design an experiment that will show how superabsorbent polymers work.

Form a Hypothesis

How can you use water and disposable baby diapers to demonstrate how superabsorbent polymers work? Write your answer as a hypothesis in the form *"If disposable diapers work because they contain superabsorbent polymers, then these polymers will . . ."*

_____

_____

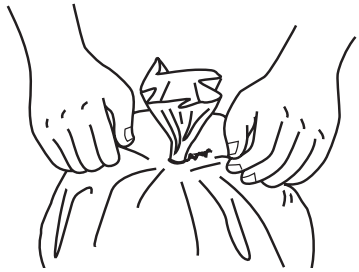
_____

Name _____ Date _____

Test Your Hypothesis

1. Cut open a diaper, and put the cottonlike filling into the garbage bag.
2. Feel inside the bag, and note that the filling feels gritty.
3. Close the bag with the twist tie.
4. By manipulating the closed bag, tear the filling into small pieces.
5. Rub the filling between your fingers (still holding the bag closed).
6. Shake the bag.
7. Open the bag, and see whether there is powder at the bottom of the bag. If the filling still feels gritty and there is not enough powder, repeat steps 3–6.
8. Once enough powder has been collected, remove the filling from the bag and pour the powder into a plastic cup.

Step 1



Step 4

Step 8

9. Fill a second cup with water.
10. Add the water from the second cup to the cup with the powder.
11. Pour the mixture from one cup into the other several times.


Step 11

Draw Conclusions

12. What did you observe?

_____

_____

_____

_____

13. Based on your results, what is your conclusion?

_____

_____

_____

_____

Name _____ Date _____

Critical Thinking

1. What is the advantage of putting superabsorbent polymers in diapers?

_____

_____

_____

2. Why do you think farmers use superabsorbent polymers in the soil?

_____

_____

_____

Name _____ Date _____

How can you build a living ecosystem in a container?

Inquiry: Structured

Create a Producer Habitat

Materials

- shoebox-size transparent plastic or glass container
- cover for the container (with holes for air circulation)
- natural loam soil
- water mister
- leaves, twigs, and small stones
- several small plants and seeds

Ask Questions

Can you build a plant habitat in a small container? What will you need to put in it? Where do plants get the food and energy they need to grow? How will your plant habitat grow?

Make a Prediction

Write your answer as a prediction in the form *"If I build a plant habitat in a small container, the habitat will . . ."*

_____

_____

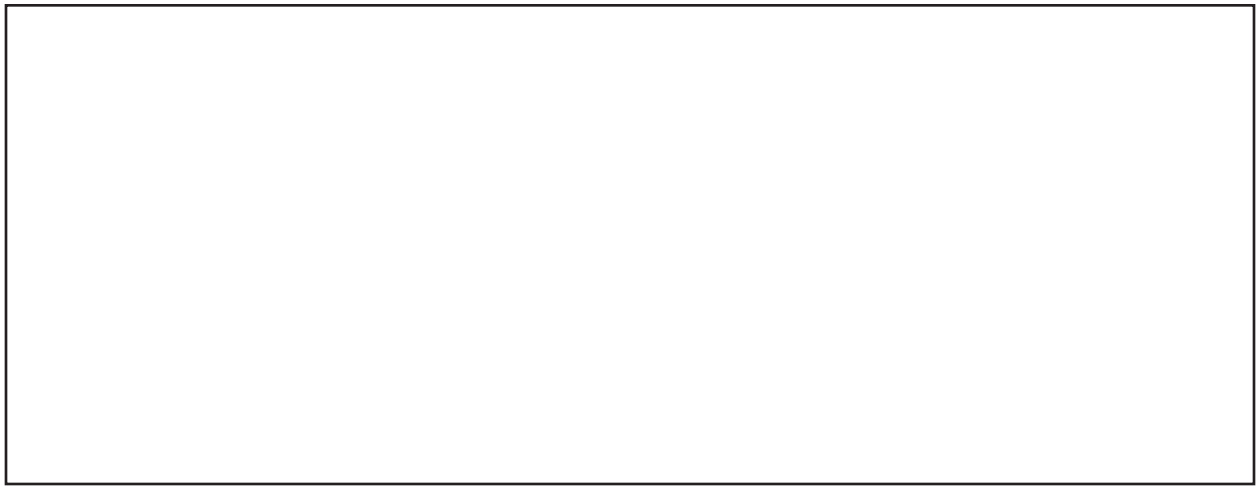
_____

Test Your Prediction

1. Place the soil in the container to a depth of 5 centimeters, and use the mister to add water. The soil should be damp but not soaking wet. Place the leaves, twigs, and stones on top of the soil. Plant the plants and seeds in the soil, and cover the container.
2. Place your plant habitat where it will get plenty of light but will not get too hot. Make a detailed drawing of the habitat in the space on the next page. Predict what you think it will look like in 2 to 3 weeks. Write your prediction below your drawing.

Name _____ Date _____

My Habitat on the First Day



_____

_____

3 **Observe** The next day check your plant habitat, and add water as needed to keep the soil moist. Compare your habitat to the drawing you made on the first day.

4 **Record Data** What changes are occurring on top of the soil? What changes are occurring beneath the soil?

Habitat Data Sheet

	Week 1		Week 2		Week 3	
	Watered Soil	Observations	Watered Soil	Observations	Watered Soil	Observations
M						
T						
W						
TH						
F						
S						
SUN						

Conclusions/observable changes after 3 weeks:

_____

_____

_____

5 Repeat steps 3 and 4 for 2 to 3 weeks. Do the changes support your prediction?

_____

_____

Communicate Your Results

Have a class discussion, and share your drawings and data. What did you learn? What caused the changes over time in the plant habitat? Use your data to answer these questions:

- How were the needs of the plants in your habitat met? How did the plants get light, water, air, and food?

_____

_____

_____

_____

_____

- How did the habitat grow and change? What abiotic factor might limit the growth of the plants?

_____

_____

_____

_____

- What could you do to turn your producer habitat into an ecosystem?

_____

_____

Name _____ Date _____

Inquiry: Guided

Building an Ecosystem

Ask Questions

How will the plant habitat change if you introduce worms and other small animals? How will the worms interact with the soil? Will interaction between the producers and the consumers benefit all of the organisms? What constitutes an ecosystem?

Materials

- a plant habitat
- worms, insects and small animals
- cardboard
- tape

Make a Prediction

Write your answer as a prediction in the form *"If I introduce worms, insects and other small animals into the plant habitat, then . . ."*

_____

_____

_____

_____

_____

Test Your Prediction

1. Tape the cardboard in place around three sides of the habitat.
2. Gently and carefully add the worms and other small animals to the container. Replace the cover.
3. **Observe** Note where each animal goes once it is inside the container.

   _____

   _____

   _____

4. **Observe** The next day check the container, and add water as needed to keep the soil moist.

5 **Record Data** Write down the location and activities of each animal. Describe any plant and animal interactions you observe. What changes are occurring on top of the soil? Beneath the soil? Record your data in the chart below.

Habitat Data Sheet						
	Week 1		Week 2		Week 3	
	Watered Soil	Observations	Watered Soil	Observations	Watered Soil	Observations
M						
T						
W						
TH						
F						
S						
SUN						

6 Repeat steps 4 and 5 for 2 to 3 weeks. Did the changes you recorded support your prediction?

_____

_____

Communicate Your Results

Have a class discussion, and share your results with the other students. What did you find out? Use your data to answer these questions.

▶ What changes did the animals cause in the plant habitat over time?

_____

_____

_____

Name _____ Date _____

- Were the worms, the soil, the plants, and other animals beneficial to each other? Explain.

_____

_____

_____

_____

- Did you build an ecosystem? Why or why not?

_____

_____

_____

- If you built an ecosystem, identify the producers, consumers, and decomposers. What abiotic factors are important in your ecosystem?

_____

_____

_____

Inquiry: Open

Design Your Own Ecosystem

Invent and test other ways to build an ecosystem. Make a prediction, and design an experiment to test your prediction. Record your data, and communicate your findings.

Make a poster that illustrates what you found out. Here are some ideas to get you started.

- Use a different kind of soil. How well does a plant habitat work with soil that is sandy or high in clay content? What types of plants will grow in these soils?
- Use different plants and animals. How do these organisms interact? Do these plants need more water? Less light?
- Use fish and plants to make a water ecosystem in an aquarium. What types of fish can share this ecosystem? What types of plants provide food for the fish? Can you add decomposers to your ecosystem?

Name _____ Date _____

Learning Lab

My question: _____

_____

My prediction: _____

_____

_____

_____

My experiment: _____

_____

_____

My results: _____

_____

_____

Name _____ Date _____

How can you find out what happens to thermal energy?

Inquiry: Structured

Mixing Warm and Cold Water

⚠ **Be Careful.** Wear safety goggles.

Ask Questions

How does the temperature of cold and warm water change when they are mixed together? Can you predict the result?

Make a Prediction

What will happen to the temperature of water that was mixed from warm and cold water? Write your answer as a prediction in the form *"If warm and cold water are mixed together, then the temperature of the mixed water will . . ."*

_____

_____

_____

_____

Materials

- measuring cup or beaker calibrated in milliliters (capacity of 100 milliliters or more)
- two clear 20-ounce plastic cups or two 500-milliliter beakers
- plastic spoon
- 2 thermometers
- warm tap water and cold (refrigerated) tap water
- safety goggles

Test Your Prediction

1. Measure and pour water into the plastic cups or beakers as indicated in the investigation guide, and measure and record the temperatures on the chart on the next page.
2. Pour the water from one cup or beaker into the other, and stir for a few seconds with the spoon.
3. Measure and record the temperature of the mixed water on the investigation guide. (It may take a minute for the thermometer to show the correct temperature.)

Mixing Warm and Cold Water Investigation Guide

Test A		
Beaker #1: +	**Beaker #2:** =	**Beaker #3:**
100 mL COLD water Temperature: _____	100 mL WARM water Temperature: _____	200 mL MIXED water Temperature: _____
Test B		
100 mL COLD water Temperature: _____	200 mL WARM water Temperature: _____	300 mL MIXED water Temperature: _____
Test C		
100 mL COLD water Temperature: _____	300 mL WARM water Temperature: _____	400 mL MIXED water Temperature: _____
Test D (invent your own test)		
_____ mL COLD water Temperature: _____	_____ mL WARM water Temperature: _____	_____ mL MIXED water Temperature: _____

4 **Record Data** Repeat steps 2 and 3 for Tests B, C, and D, writing down your data in the chart. Do you see any patterns?

_____

_____

Communicate Your Results

Have a class discussion, and share your results. What did you find out? Use your data to answer these questions:

- What do your results tell you about temperature changes when warm and cold water are mixed together?

_____

_____

- Based on the test results, can you state a general rule about what happens when liquids of different temperatures are mixed? Share your rule with the class.

_____

_____

Name _____ Date _____

Inquiry: Guided

Warming Up or Cooling Down

Ask Questions

How does wrapping a cup of warm or cold water in different materials affect how quickly the water in the cup cools down or warms up?

Make a Prediction

Write your answer as a prediction in the form *"If a glass is wrapped in aluminum foil (or another material of your choice), then the temperature of the water it contains will heat (or cool) _____ than water at the same temperature in an unwrapped glass."*

_____

_____

_____

Materials

- two clear 20-ounce plastic cups or two 500-milliliter beakers
- 2 thermometers
- warm tap water and cold (refrigerated) tap water
- enough aluminum foil, bubble wrap, or other material to wrap a 20-ounce cup

Test Your Prediction

1. Refer to *Cooling or Warming Water,* Test #1, on the next page.
2. Decide whether you want to use warm or cold water. Circle *Cooling* on the table if you decide to start with warm water; circle *Warming* if you decide to start with cold water.
3. Fill two cups with the same amount of water. Measure and record the starting temperatures on the chart on the next page, making sure the temperatures are the same.
4. Choose a material, and wrap one cup in it. (The unwrapped cup is the control.)
5. **Record** Write down your choice of covering material on the chart.
6. Place the cups side by side in a safe place. Measure and record their temperatures on the chart every 3 minutes for 30 minutes.

7 **Use Numbers** Use your data to create a line graph. Put the temperature on the vertical axis and the time on the horizontal axis. Plot the changes in both cups of water on the same graph, using 2 colors or 2 types of lines (for example, solid and dotted) to distinguish between the covered cup and the (uncovered) control.

8 Repeat steps 2 through 7 for Test #2. You might start with cold water instead of warm water or vice versa, or you might use a different material to wrap one cup.

Cooling or Warming Water

Test #1:	**What I Wrapped My Cup In:**	
Time After Start	**Control-Cup Temperature**	**Variable-Cup Temperature**
0 minutes		
3 minutes		
6 minutes		
9 minutes		
12 minutes		
15 minutes		
18 minutes		
21 minutes		
24 minutes		
27 minutes		
30 minutes		

Cooling or Warming Water

Test #2:	**What I Wrapped My Cup In:**	
Time After Start	**Control-Cup Temperature**	**Variable-Cup Temperature**
0 minutes		
3 minutes		
6 minutes		
9 minutes		
12 minutes		
15 minutes		
18 minutes		
21 minutes		
24 minutes		
27 minutes		
30 minutes		

Name _____ Date _____

Communicate Your Results

Work in groups of four to eight, and discuss what you found out about the cooling or warming of the water.

- What did you observe? How did the temperatures change? Did different students have different results?

_____

_____

_____

_____

- Compare your data to your predictions. How do you explain what happened? Was there a difference between keeping the water cold and keeping the water warm? What is the difference?

_____

_____

_____

_____

Inquiry: Open

More Cool (and Hot) Experiments

Invent other ways to explore cooling off and heating up. Ask a question, make a prediction, design and perform an experiment to test your prediction, record your data, and communicate your findings. Make a poster to show what you did and what you found out. What did you observe? Here are some ideas to get you started.

- Where do ice cubes melt the fastest? Find out by having each student in your class place some ice cubes in a different container or on a different surface. For example, place ice in a cup of room-temperature tap water, in a cup of salt water, on a paper plate, on a metal pie plate, or in a glass with no water.
- Do different materials feel warmer, colder, or the same if subjected to the same temperature? Place a cotton towel and a metal spoon in a refrigerator for 2 hours. Take them out of the refrigerator. Which one of them feels coldest? Is the one that feels coldest really colder? Explain.

Name _____ Date _____ Learning Lab

▶ Would a cup of warm water cool faster if you put two metal spoons in the water? What if you put two plastic spoons in the water? Does it make a difference, and if so, why?

My question: _____

_____

My prediction: _____

_____

_____

My experiment: _____

_____

_____

_____

_____

My results: _____

_____

_____

_____

_____

_____

Name _____ Date _____

How can you model the energy of moving fluids?

Inquiry: Structured

Tracking the Movement of Wind

Materials

- 50 centimeters of string
- helium balloon
- 5 to 10 3-inch by 5-inch index cards
- hole punch

Ask Questions

Can a helium balloon be used as a tool for tracking moving air?

Make a Prediction

Write your answer as a prediction in the form *"If the air in a classroom is moving, then a helium balloon will . . ."*

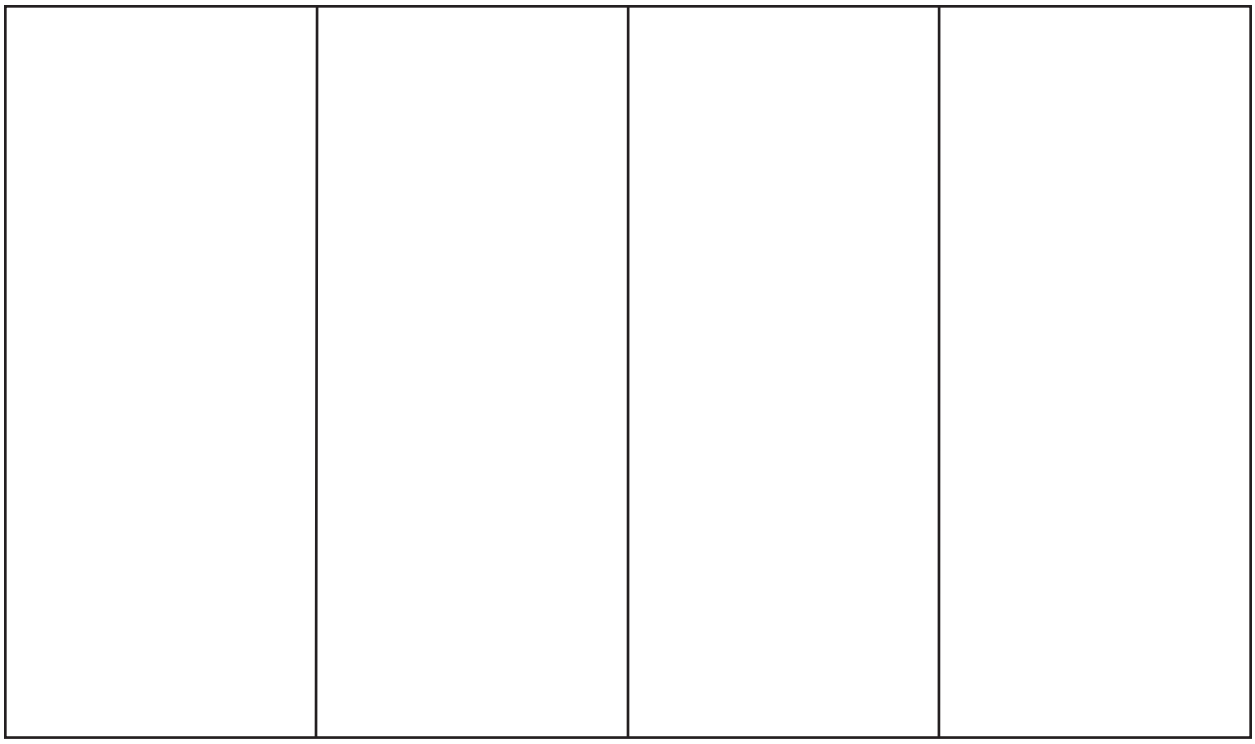
_____

_____

Test Your Prediction

1. Tie one end of the string to the helium balloon. Punch a hole near the corner of each 3-inch by 5-inch index card, and tie the cards to the other end of the string, one at a time, until the balloon just begins to sink. Tear small pieces off the index cards until the balloon neither rises nor sinks.
2. Bring the balloon into a large room where it can float sideways or up and down. Choose a location, and let the balloon hang freely in the air.
3. **Observe** Keep your eye on the balloon. As the air in the room moves, the balloon will move with the air.
4. **Record Data** In the space on the next page, draw a picture of the room, and show the path the balloon has taken around the room.

Room and Balloon Paths



5. The air may be moving in different directions at different speeds in various locations in the room. Choose three more locations in the room, let the balloon hang freely in the air, and repeat steps 3 and 4, showing the path of each balloon in a different color or a different style of line.

Communicate Your Results

Have a class discussion, and share your drawings. With other students create a map that shows air movement in your classroom. Use your data to answer these questions:

- Is the air in the room moving? How did you reach your conclusion?

_____

_____

- If the air in the room is moving, what causes the air to move?

_____

_____

Name _____ Date _____

▶ Does a balloon move at different speeds and in different directions at different locations in the room? How can you explain your observations?

_____

_____

_____

_____

▶ Did your observations confirm your prediction?

_____

_____

Materials

- 2 empty, 35-millimeter film containers with smooth lids
- paper punch
- clear, 2-liter soda bottle with top 10 centimeters cut off
- room-temperature water
- thermometer
- hot tap water and cold (refrigerated) tap water
- red and blue food coloring
- 2 large beakers or cups

Inquiry: Guided

Warm and Cold Water

Ask Questions

How can you use warm and cold water in a container to explain how mixing hot and cold fluids can make the fluids move?

Make a Prediction

Write your answer as a prediction in the form *"If I mix warm and cold water, the warm water will _____ and the cold water will _____."*

_____

_____

Test Your Prediction

1. Use the paper punch to make two holes side by side in each film canister lid.
2. Fill the clear soda bottle with room-temperature water to within 5 centimeters of the top. Use the thermometer to determine the temperature of the water, and write it down on the chart on the next page.

3. Fill one beaker with warm tap water, and add a few drops of red food coloring. Use the thermometer to determine the temperature of the water, and write it down on the chart.
4. Pour the red-colored water into the film container, and secure the lid.
5. Gently push the sealed film canister into the room-temperature water in the clear soda bottle to about halfway between the surface and the bottom, then turn the canister sideways.
6. **Observe** What happened to the colored water? Where did it go? Record your observations on the chart.
7. Repeat steps 2 through 6, substituting refrigerated water for the warm tap water and blue food coloring for red food coloring.

Starting Temperature of Room-Temperature Water: _____	
Red-Colored Water Starting temperature: _____ Observations:	**Blue-Colored Water** Starting temperature: _____ Observations:

Communicate Your Results

Work in groups of four to eight, and discuss your findings.

- How did the warm, red-colored water move once it was in the room-temperature, clear water? Draw a picture that shows the path of the red-colored water within the soda bottle in the space at the right.

_____

_____

Path of red-colored water:

Name _____ Date _____

- How did the blue-colored water move once it was in the room-temperature, clear water? Draw a picture that shows the path of the blue-colored water within the soda bottle in the space at the right.

Path of blue-colored water:

- Develop a hypothesis that explains how hot and cold water or air causes ocean currents or wind to form.

- How can this model help explain the way energy from the Sun gets distributed on Earth?

Inquiry: Open

Keep It Moving

Invent and test other ways to explore the movement of fluids. Design and perform an experiment. Ask a question, make a prediction, do an experiment to test your prediction, record your data, and communicate your findings. Make a poster to show what you did and what you found out. Here are some ideas to get you started:

- If you filled a balloon with warm water, would it float or sink in cold water? Would a balloon filled with cold water float or sink in warm water?
- Would a helium balloon that neither floats nor sinks move differently in a moving stream of warm air and one of cold air? Could you find out using a handheld hair dryer?
- What other experiments can you do with balloons to explore air currents?

My question: _____

_____

My prediction: _____

_____

_____

My experiment: _____

_____

My results: _____

_____

_____