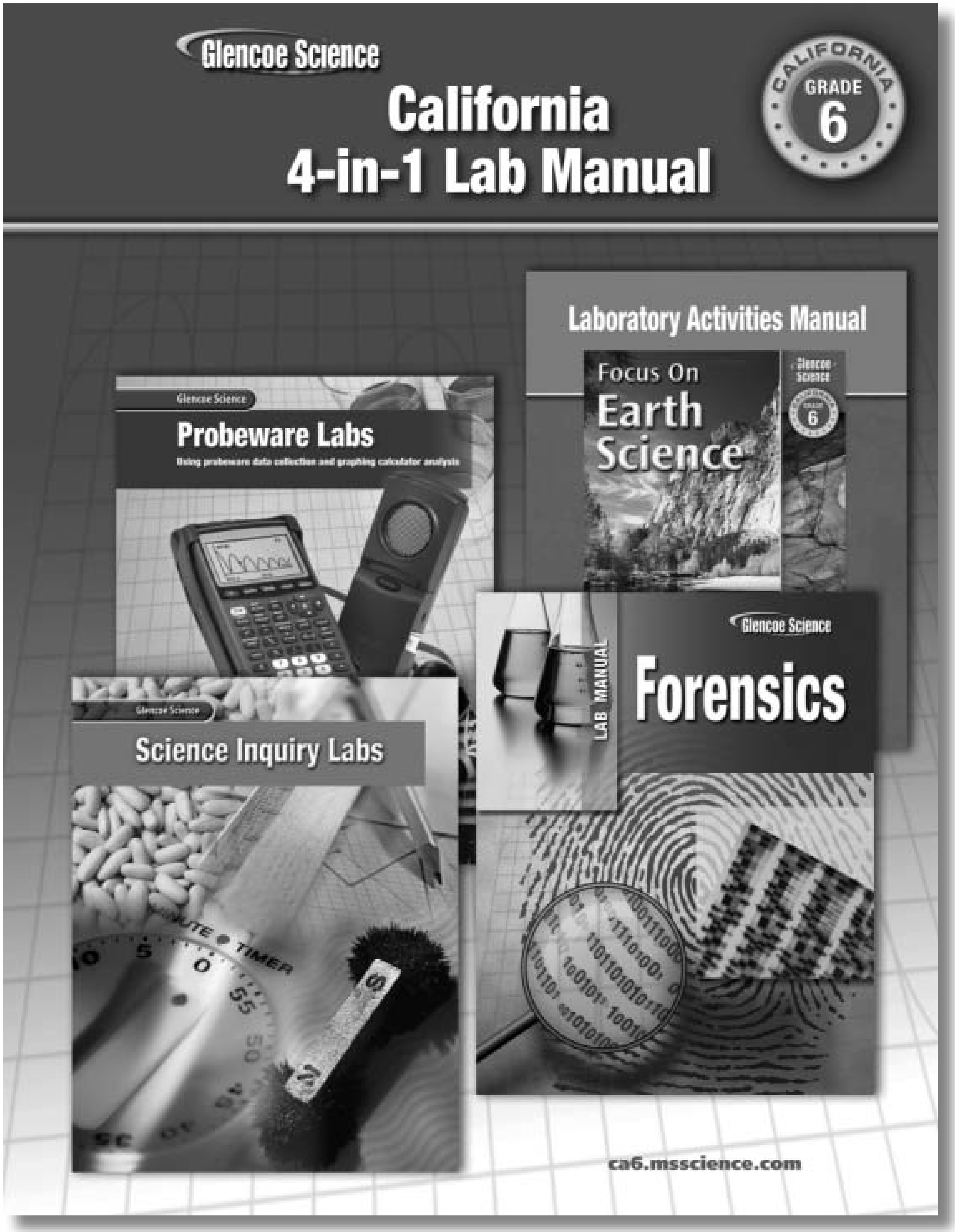

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Glencoe Science

Credits

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To the Student

Glencoe's 4-in-1 Lab Manual provides you with four separate sections of labs. While each section is unique, all the lab activities in this manual require your active participation. You will test hypotheses, collect and apply data, and discover new information. You will use many different skills to make connections between the lab activities and what you already know.

The *Laboratory Activities* will help you focus your efforts on gathering information, obtaining data from the environment, and making observations. You will also work on organizing your data so conclusions can be drawn in a way that is easily repeated by other scientists.

The *Inquiry Activities* will help you understand that no science works alone. A scientist cannot explain how a plant makes food just by knowing the parts of the leaf. Someone needs to know how the chemicals in the leaf work. Knowledge of Earth science, life science, and physical science is needed for a full explanation of how the leaf makes food. Today, teams of scientists solve problems. Each scientist uses his or her knowledge of Earth science, life science, or physical science to find solutions to problems in areas such as the environment or health.

The *Forensics Activities* provide in-depth investigations that deal with DNA, collecting and analyzing data, and interpreting evidence found at a crime or accident scene. You will use your knowledge of scientific inquiry and your problem-solving skills as you learn about forensics procedures. You will then apply these procedures to real-world scenarios.

The *Probeware Activities* are designed to help you study science using probeware technology. A probeware lab is different from other labs because it uses a probe or sensor to collect data, a data collection unit to interpret and store the data, and a graphing calculator or computer to analyze the data. These components are connected with a software program called DataMate that makes them work together in an easy-to-use, handheld system. These labs are designed specifically for the TI-73 or TI-83 Plus graphing calculators and a CBL 2™ (produced by Texas Instruments, Inc.) or LabPro® (produced by Vernier Software & Technology) data collection unit.

Getting Started

Science is the body of information including all the hypotheses and experiments that tell us about our environment. All people involved in scientific work use similar methods for gaining information. One important scientific skill is the ability to obtain data directly from the environment. Observations must be based on what occurs in the environment. Equally important is the ability to organize these data into a form from which valid conclusions can be drawn. These conclusions must be such that other scientists can achieve the same results in the laboratory.

To make the most of your laboratory experience, you need to continually work to increase your laboratory skills. These skills include the ability to recognize and use equipment properly and to measure and use SI units accurately. Safety must also be an ongoing concern. To help you get started in discovering many fascinating things about the world around you, the next few pages provide you with the following:

- a visual overview of basic **laboratory equipment** for you to label
- a reference sheet of **safety symbols**
- a list of your **safety responsibilities** in the laboratory
- a **safety contract**
- a reference sheet of **SI units**

Each lab activity in this manual includes the following sections:

- an investigation **title** and introductory section providing information about the problem under study
- a **strategy** section identifying the **objective(s)** of the activity
- a list of needed **materials**
- safety concerns identified with **safety icons** and **caution statements**
- a set of step-by-step **procedures**
- a section to help you record your **data and observations**
- a section to help you **analyze your data** and record your **conclusions**
- a closing **strategy check** so that you can review your achievement of the objectives of the activity

Name ____________ Date ____________ Class ____________

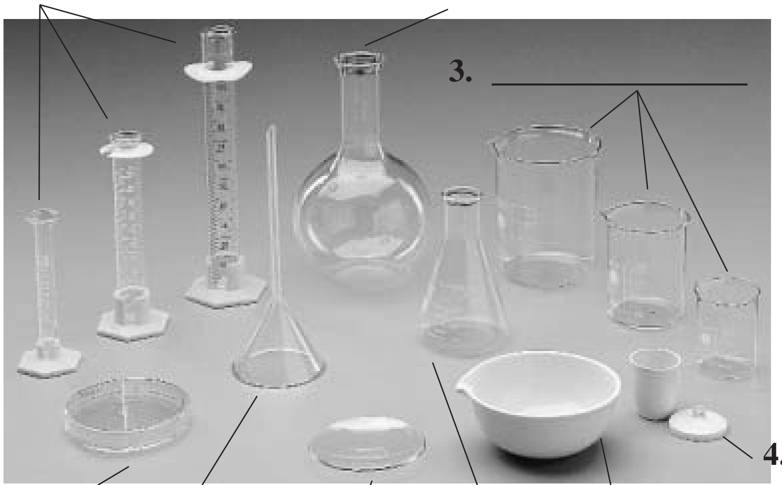
Laboratory Equipment

Figure 1

1. ____________

2. ____________

3. ____________



4. ____________

5. ____________

6. ____________

7. ____________

8. ____________

9. ____________

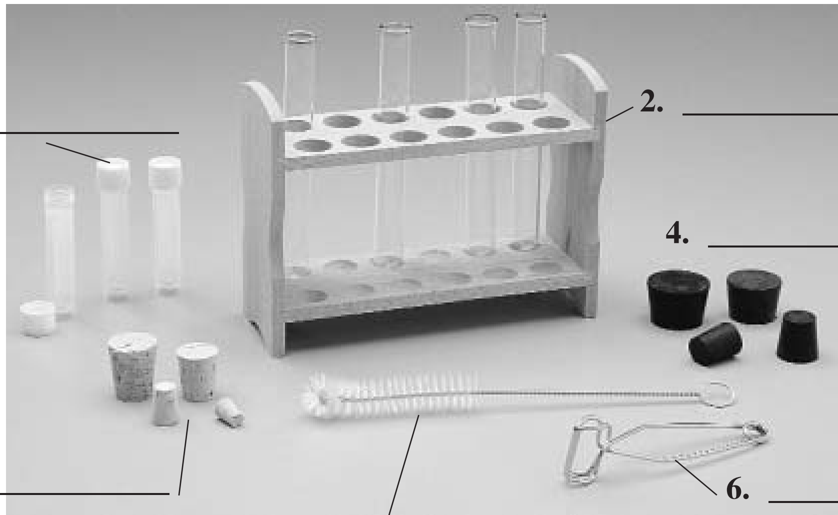
Figure 2

1. ____________

2. ____________

3. ____________

4. ____________



5. ____________

6. ____________

7. ____________

Name Date Class

Laboratory Equipment (continued)

Figure 3

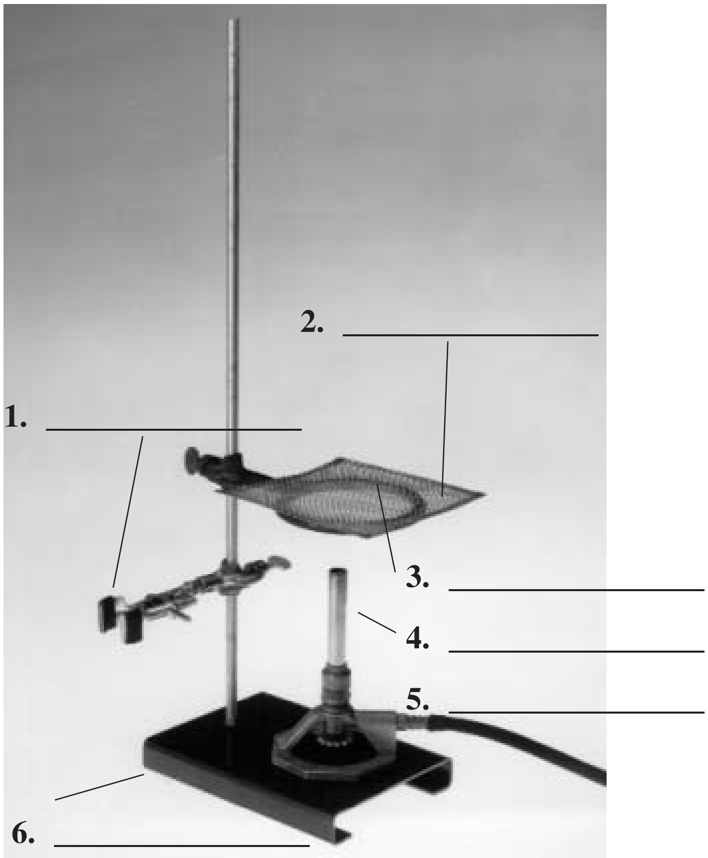


Figure 4

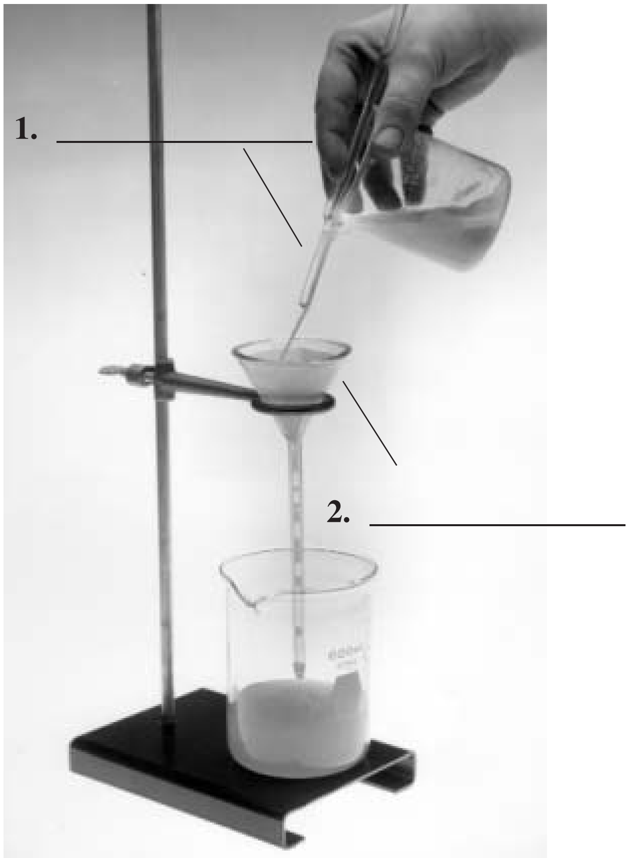
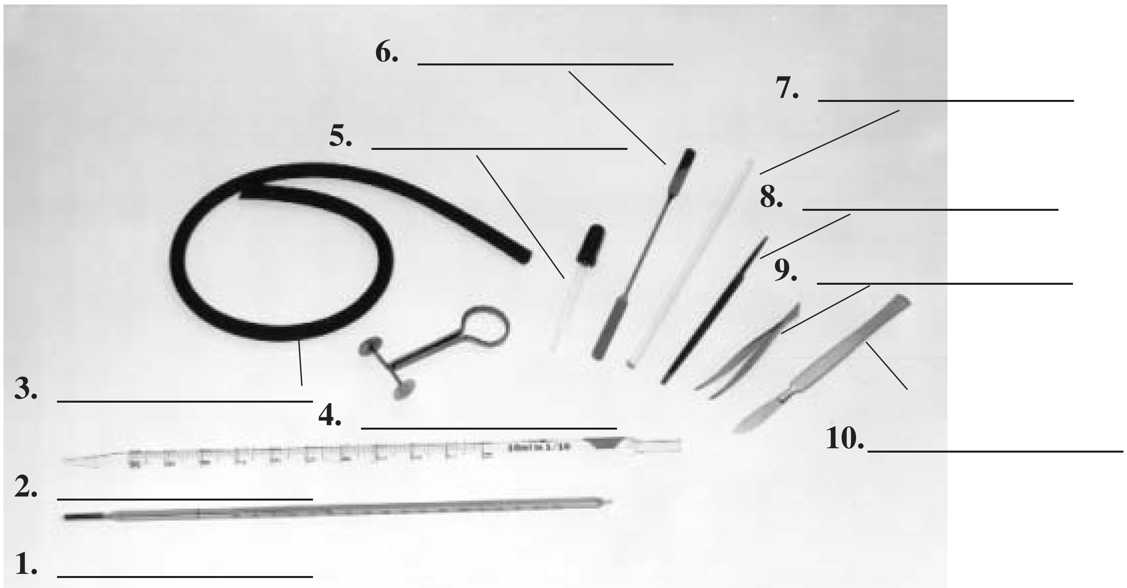
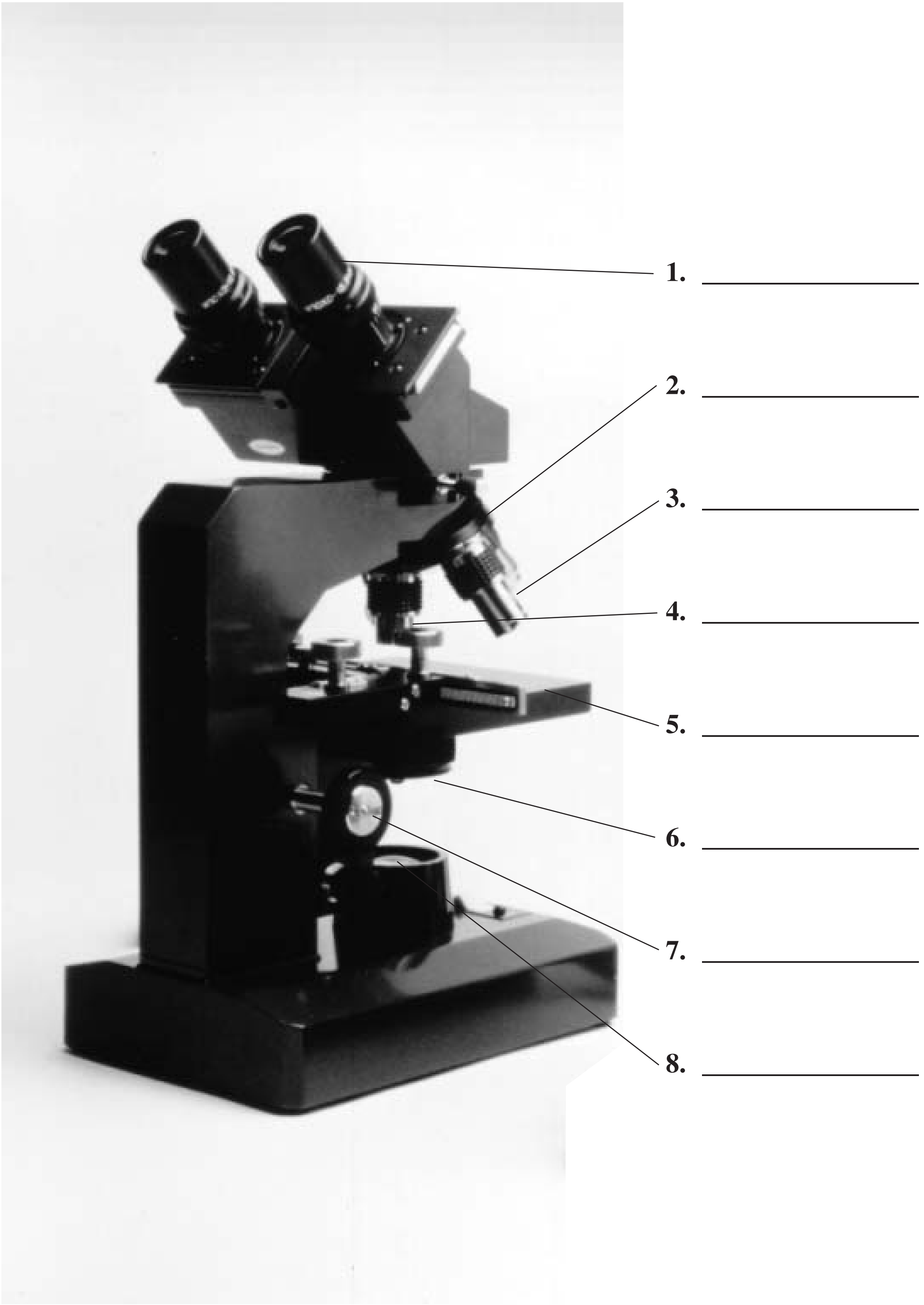


Figure 5



Laboratory Equipment (continued)

Figure 6



Name Date Class

Laboratory Equipment (continued)

Figure 7

1. ______
2. ______
3. ______
4. ______
5. ______
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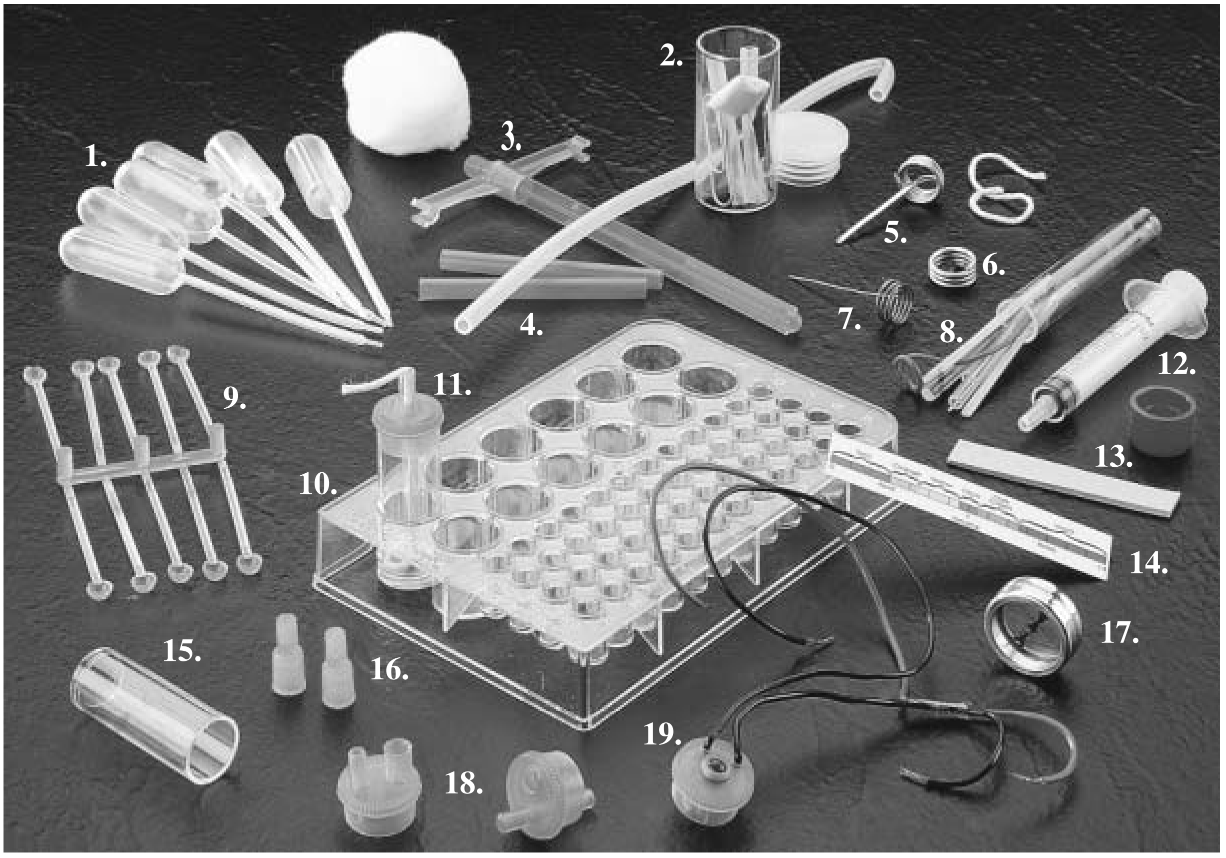
19. ______
20. ______
21. ______
22. ______

Name Date Class

Laboratory Equipment (continued)

Figure 8



1. ______________________
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16. ______________________
17. ______________________
18. ______________________
19. ______________________

Name Date Class

SAFETY SYMBOLS

SAFETY SYMBOLS	HAZARD	EXAMPLES	PRECAUTION	REMEDY
DISPOSAL	Special disposal procedures need to be followed.	certain chemicals, living organisms	Do not dispose of these materials in the sink or trash can.	Dispose of wastes as directed by your teacher.
BIOLOGICAL	Organisms or other biological materials that might be harmful to humans	bacteria, fungi, blood, unpreserved tissues, plant materials	Avoid skin contact with these materials. Wear mask or gloves.	Notify your teacher if you suspect contact with material. Wash hands thoroughly.
EXTREME TEMPERATURE	Objects that can burn skin by being too cold or too hot	boiling liquids, hot plates, dry ice, liquid nitrogen	Use proper protection when handling.	Go to your teacher for first aid.
SHARP OBJECT	Use of tools or glassware that can easily puncture or slice skin	razor blades, pins, scalpels, pointed tools, dissecting probes, broken glass	Practice common-sense behavior and follow guidelines for use of the tool.	Go to your teacher for first aid.
FUME	Possible danger to respiratory tract from fumes	ammonia, acetone, nail polish remover, heated sulfur, moth balls	Make sure there is good ventilation. Never smell fumes directly. Wear a mask.	Leave foul area and notify your teacher immediately.
ELECTRICAL	Possible danger from electrical shock or burn	improper grounding, liquid spills, short circuits, exposed wires	Double-check setup with teacher. Check condition of wires and apparatus.	Do not attempt to fix electrical problems. Notify your teacher immediately.
IRRITANT	Substances that can irritate the skin or mucous membranes of the respiratory tract	pollen, moth balls, steel wool, fiberglass, potassium permanganate	Wear dust mask and gloves. Practice extra care when handling these materials.	Go to your teacher for first aid.
CHEMICAL	Chemicals can react with and destroy tissue and other materials	bleaches such as hydrogen peroxide; acids such as sulfuric acid, hydrochloric acid; bases such as ammonia, sodium hydroxide	Wear goggles, gloves, and an apron.	Immediately flush the affected area with water and notify your teacher.
TOXIC	Substance may be poisonous if touched, inhaled, or swallowed.	mercury, many metal compounds, iodine, poinsettia plant parts	Follow your teacher's instructions.	Always wash hands thoroughly after use. Go to your teacher for first aid.
FLAMMABLE	Flammable chemicals may be ignited by open flame, spark, or exposed heat.	alcohol, kerosene, potassium permanganate	Avoid open flames and heat when using flammable chemicals.	Notify your teacher immediately. Use fire safety equipment if applicable.
OPEN FLAME	Open flame in use, may cause fire.	hair, clothing, paper, synthetic materials	Tie back hair and loose clothing. Follow teacher's instruction on lighting and extinguishing flames.	Notify your teacher immediately. Use fire safety equipment if applicable.

Eye Safety
Proper eye protection should be worn at all times by anyone performing or observing science activities.

Clothing Protection
This symbol appears when substances could stain or burn clothing.

Animal Safety
This symbol appears when safety of animals and students must be ensured.

Handwashing
After the lab, wash hands with soap and water before removing goggles.

Student Laboratory and Safety Guidelines

Regarding Emergencies

- Inform the teacher immediately of *any* mishap—fire, injury, glassware breakage, chemical spills, etc.
- Follow your teacher's instructions and your school's procedures in dealing with emergencies.

Regarding Your Person

- Do NOT wear clothing that is loose enough to catch on anything, and avoid sandals or open-toed shoes.
- Wear protective safety gloves, goggles, and aprons as instructed.
- Always wear safety goggles (not glasses) when using hazardous chemicals.
- Wear goggles throughout the entire activity, cleanup, and handwashing.
- Keep your hands away from your face while working in the laboratory.
- Remove synthetic fingernails before working in the lab (these are highly flammable).
- Do NOT use hair spray, mousse, or other flammable hair products just before or during laboratory work where an open flame is used (they can ignite easily).
- Tie back long hair and loose clothing to keep them away from flames and equipment.
- Remove loose jewelry—chains or bracelets—while doing lab work.
- NEVER eat or drink while in the lab or store food in lab equipment or the lab refrigerator.
- Do NOT inhale vapors or taste, touch, or smell any chemical or substance unless instructed to do so by your teacher.

Regarding Your Work

- Read all instructions before you begin a laboratory or field activity. Ask questions if you do not understand any part of the activity.
- Work ONLY on activities assigned by your teacher.
- Do NOT substitute other chemicals/substances for those listed in your activity.
- Do NOT begin any activity until directed to do so by your teacher.
- Do NOT handle any equipment without specific permission.
- Remain in your own work area unless given permission by your teacher to leave it.
- Do NOT point heated containers—test tubes, flasks, etc.—at yourself or anyone else.
- Do NOT take any materials or chemicals out of the classroom.
- Stay out of storage areas unless you are instructed to be there and are supervised by your teacher.
- NEVER work alone in the laboratory.
- When using dissection equipment, always cut away from yourself and others. Cut downward, never stabbing at the object.
- Handle living organisms or preserved specimens only when authorized by your teacher.
- Always wear heavy gloves when handling animals. If you are bitten or stung, notify your teacher immediately.

Regarding Cleanup

- Keep work and lab areas clean, limiting the amount of easily ignitable materials.
- Turn off all burners and other equipment before leaving the lab.
- Carefully dispose of waste materials as instructed by your teacher.
- Wash your hands thoroughly with soap and warm water after each activity.

Name ______________________ Date ______________ Class ______________

Student Science Laboratory Safety Contract

I agree to:

- Act responsibly at all times in the laboratory.
- Follow all instructions given, orally or in writing, by my teacher.
- Perform only those activities assigned and approved by my teacher.
- Protect my eyes, face, hands, and body by wearing proper clothing and using protective equipment provided by my school.
- Carry out good housekeeping practices as instructed by my teacher.
- Know the location of safety and first-aid equipment in the laboratory.
- Notify my teacher immediately of an emergency.
- NEVER work alone in the laboratory.
- NEVER eat or drink in the laboratory unless instructed to do so by my teacher.
- Handle living organisms or preserved specimens only when authorized by my teacher, and then, with respect.
- NEVER enter or work in a supply area unless instructed to do so and supervised by my teacher.

[This portion of the contract is to be kept by the student.]

[Return this portion to your teacher.]

I, ________________________________, [print name] have read each of the statements in the Student Science Laboratory Safety Contract and understand these safety rules. I agree to abide by the safety regulations and any additional written or verbal instructions provided by the school district or my teacher. I further agree to follow all other written and verbal instructions given in class.

____ ________________

Student Signature Date

I acknowledge that my child/ward has signed this contract in good faith.

____ ________________

Parent/Guardian Signature Date

SI Reference Sheet

The International System of Units (SI) is accepted as the standard for measurement throughout most of the world. Sometimes quantities are measured using different SI units. In order to use them together in an equation, you must convert all of the quantities into the same unit. To convert, you multiply by a conversion factor. A conversion factor is a ratio that is equal to one. Make a conversion factor by building a ratio of equivalent units. Place the new units in the numerator and the old units in the denominator. For example, to convert 1.255 L to mL, multiply 1.255 L by the appropriate ratio as follows:

$$1.255 \text{ L} \times 1{,}000 \text{ mL}/1 \text{ L} = 1{,}255 \text{ mL}$$

In this equation, the unit L cancels just as if it were a number.

Frequently used SI units are listed in **Table 1.**

Table 1

Frequently Used SI Units	
Length	1 millimeter (mm) = 100 micrometers (μm) 1 centimeter (cm) = 10 millimeters (mm) 1 meter (m) = 100 centimeters (cm) 1 kilometer (km) = 1,000 meters (m) 1 light-year = 9,460,000,000,000 kilometers (km)
Area	1 square meter (m^2) = 10,000 square centimeters (cm^2) 1 square kilometer (km^2) = 1,000,000 square meters (m^2)
Volume	1 milliliter (mL) = 1 cubic centimeter (cm^3) 1 liter (L) = 1,000 milliliters (mL)
Mass	1 gram (g) = 1,000 milligrams (mg) 1 kilogram (kg) = 1,000 grams (g) 1 metric ton = 1,000 kilograms (kg)
Time	1 s = 1 second

Several other supplementary SI units are listed in **Table 2.**

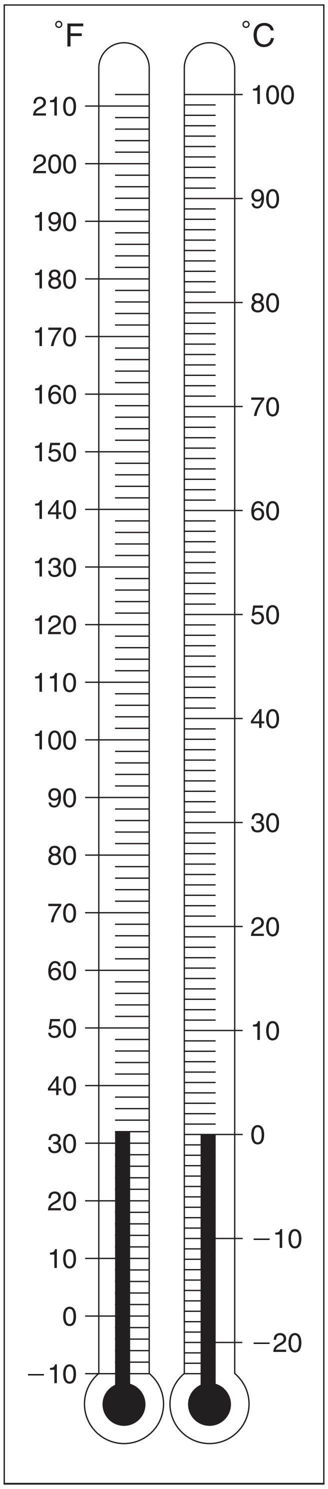
Table 2

Supplementary SI Units			
Measurement	**Unit**	**Symbol**	**Expressed in base units**
Energy	joule	J	$kg \cdot m^2/s^2$
Force	newton	N	$kg \cdot m/s^2$
Power	watt	W	$kg \cdot m^2/s^3$ or J/s
Pressure	pascal	Pa	$kg/m \cdot s^2$ or $N \cdot m$

Temperature measurements in SI often are made in degrees Celsius. Celsius temperature is a supplementary unit derived from the base unit kelvin. The Celsius scale (°C) has 100 equal graduations between the freezing temperature (0°C) and the boiling temperature of water (100°C). The following relationship exists between the Celsius and kelvin temperature scales:

$$K = °C + 273$$

Figure 1



To convert from °F to °C, you can:

1. For exact amounts, use the equation at the bottom of **Table 3**

OR

2. For approximate amounts, find °F on the thermometer at the left of **Figure 1** and determine °C on the thermometer at the right.

Table 3

SI Metric to English Conversions			
	When you want to convert:	**Multiply by:**	**To find:**
Length	inches centimeters feet meters yards meters miles kilometers	2.54 0.39 0.30 3.28 0.91 1.09 1.61 0.62	centimeters inches meters feet meters yards kilometers miles
Mass and weight*	ounces grams pounds kilograms tons metric tons pounds newtons	28.35 0.04 0.45 2.20 0.91 1.10 4.45 0.23	grams ounces kilograms pounds metric tons tons newtons pounds
Volume	cubic inches milliliters cubic feet cubic meters liters liters gallons	16.39 0.06 0.03 35.31 1.06 0.26 3.78	cubic centimeters cubic inches cubic meters cubic feet quarts gallons liters
Area	square inches square centimeters square feet square meters square miles square kilometers hectares acres	6.45 0.16 0.09 10.76 2.59 0.39 2.47 0.40	square centimeters square inches square meters square feet square kilometers square miles acres hectares
Temperature	Fahrenheit Celsius	$\frac{5}{9}(°F - 32)$ $\frac{9}{5}°C + 32$	Celsius Fahrenheit

* Weight as measured in standard Earth gravity

Laboratory Activities

LAB 1 Laboratory Activity

Determining Latitude

Throughout history people have used the stars to help them keep on course during journeys. In the early days of sailing ships, sailors also used the stars to help them steer a true course. The sailors used a simple instrument called a sextant and the North Star to determine their position. You can also determine your position in degrees of latitude using a simple sextant and the North Star.

Strategy

You will construct a simple sextant.
You will determine your approximate latitude in degrees.

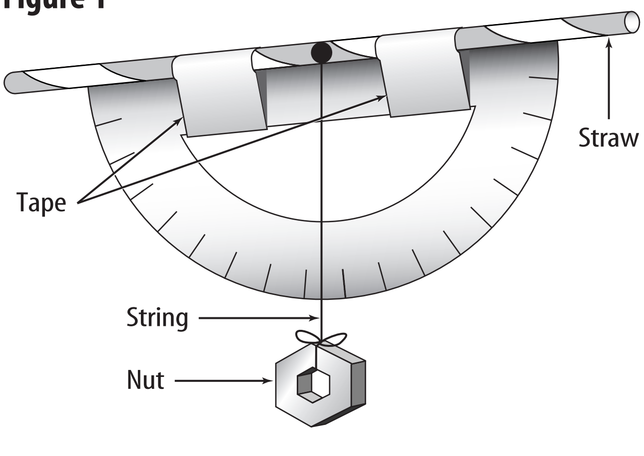
Materials

scissors
protractor, Figure 2
glue
cardboard, stiff
string, 20 cm
nut or metal washer
thumbtack
tape
plastic straw
map of the United States or world atlas

Procedure

1. Cut out the protractor in Figure 2. Glue the protractor to a piece of cardboard. **WARNING:** *Use care when handling sharp objects.*
2. Attach one end of the string to the nut.
3. Attach the free end of the string to the protractor's center hole, using the thumbtack.
4. Tape the plastic straw to the straight edge of the protractor. Your sextant should look like Figure 1.
5. Using a starchart provided by your teacher, locate the North Star. Then sight the North Star through the straw.
6. Looking at the North Star, anchor the string to the sextant using your thumb or fingers. The degree marking on the sextant is the latitude of the North Star. This is your approximate latitude.
7. Record your latitude in Table 1.
8. Repeat steps 5, 6, and 7 three times.

Figure 1



SCI 7.f. Read a topograpic map and a geologic map for evidence provided on the maps and construct and interpret a simple scale map.

Laboratory Activity 1 (continued)

Data and Observations

Table 1

	Latitude (°)
Trial 1	
Trial 2	
Trial 3	
Average	

Questions and Conclusions

1. Calculate the average latitude of your three trials. Show your work.

2. How does your observed latitude compare to the latitude given in the atlas for your location?

3. Explain any differences between your observed latitude and the latitude listed in the atlas.

4. What was the purpose of having three trials and finding an average?

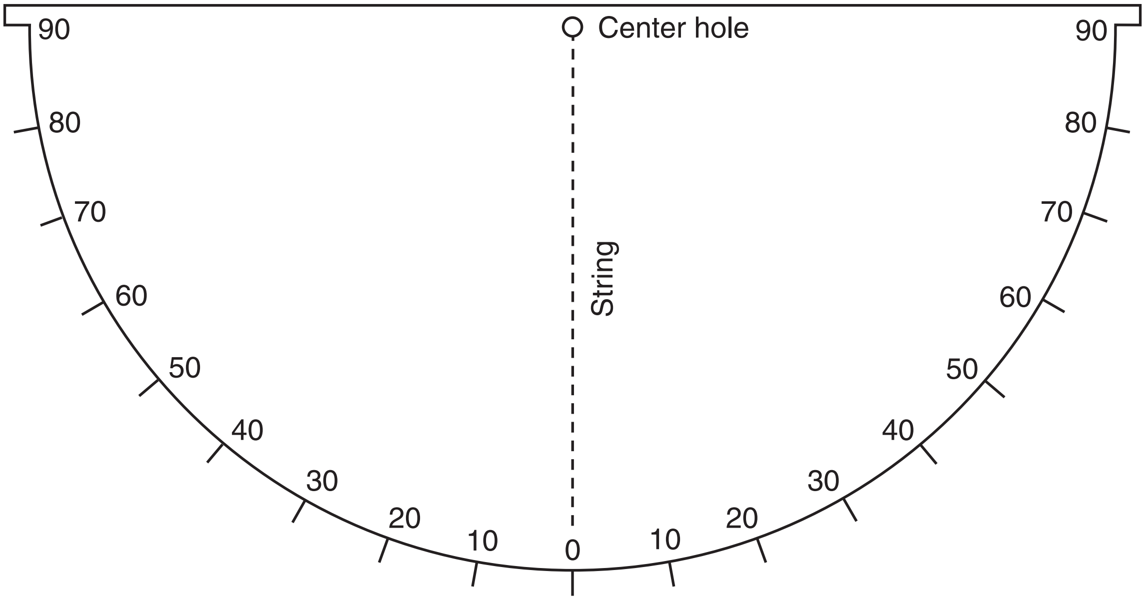
Strategy Check

_______ Can you construct a simple sextant?

_______ Can you determine your approximate latitude?

Laboratory Activity 1 (continued)

Figure 2



LAB 2 Laboratory Activity

Charting the Ocean Floor

Mapping an ocean or lake floor is much different from mapping a continent. Scientists can't observe and measure underwater the same way they do on land. One way people can find the depth of water is by lowering a weighted rope or chain. When the bottom of the rope or chain hits the ocean or lake floor, the rope or chain will become slack. By measuring how much of the rope or chain is in the water, a person can tell how deep the water is at that spot.

Strategy

You will make a model of the ocean floor, including all the major surface features.
You will make a map of a classmate's model.

Materials

large cardboard box with lid (box should be up to 22 cm wide and 36 cm long; dark paper can be used instead of lid as a cover)
cardboard tubes of various sizes (should be at least 15 cm long)
modeling clay
masking tape
knife or scissors
metric ruler
pen or pencil
string with weight at one end or small chain (should be at least 30 cm longer than depth of box)

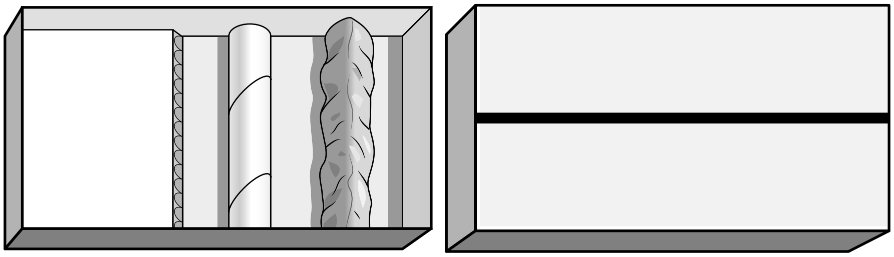
Procedure

1. Work with a partner to prepare a model of the ocean floor. First, choose what features you will show. Be sure to include a continental shelf, continental slope, abyssal plain, and mid-ocean ridge. Then use cardboard tubes, modeling clay, and masking tape to form the features of your model along the bottom of the box. Be sure each ocean feature runs from side to side in the box. See Figure 1.
2. After you finish making your model, cut a 1-cm slit in the center of the lid, down its full length. Write your names on the box.
3. Exchange boxes with another pair of classmates. Use your weighted string or chain to "map the ocean floor." At every 1-cm interval along the slit, lower your string or chain. When it hits the bottom of the "floor," pinch the string or chain gently even with the slit. Keeping your fingers in the same position, pull the string or chain out of the box and measure how deep the string or chain went before touching the bottom. This will give you the depth of the ocean floor at this spot. Record your data in Graph 1.
4. After completing your map, open the box and check your work. How accurate were you in mapping the ocean floor?

SCI 7.f. Read a topograpic map and a geologic map for evidence provided on the maps and construct and interpret a simple scale map.

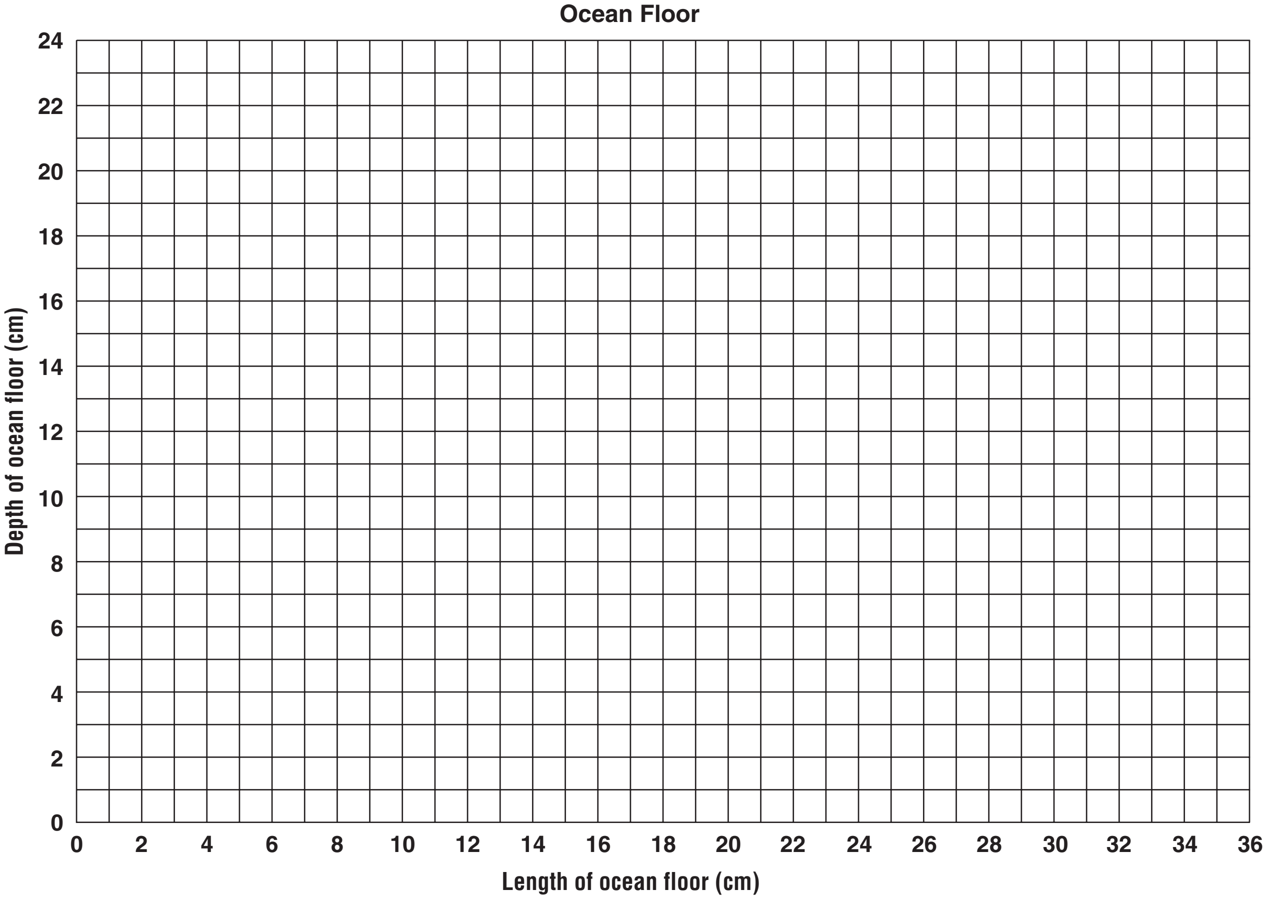
Laboratory Activity 2 (continued)

Figure 1



Data and Observations

Graph 1



Laboratory Activity 2 (continued)

Questions and Conclusions

1. How accurate was your map?

____

____

2. If readings were taken closer together, how would this affect the accuracy of your map?

____

____

3. Some error is probably brought about by using a string or chain to measure the ocean depth. How could you improve these readings while still using the same equipment?

____

____

____

4. Give at least two reasons it would be difficult to use these materials to measure distances for a map of the real ocean floor.

____

____

____

____

Strategy Check

_______ Can you make a realistic model of the ocean floor, including a continental shelf, continental slope, abyssal plain, and mid-ocean ridge?

_______ Can you fairly accurately map a model of the ocean floor?

LAB 1 Laboratory Activity

Concretions

Concretions are features found in sedimentary rocks. They may be spheres or flattened ovals. Concretions are formed when successive layers of cementing material are deposited and precipitated around a central core. Concretions may be harder than the surrounding rock. They are found as the surrounding rock is weathered.

Strategy

You will make a concretion.
You will observe the process of precipitation.
You will demonstrate the process by which some sedimentary rocks are formed.

Materials

waxed paper
cardboard (stiff)
pie pan (disposable)
spoon
patching plaster
water
rock with flat side
dropper
food coloring

Procedure

1. Place a piece of waxed paper on a piece of cardboard.
2. In the pie pan, mix some plaster with water. Add the water drop by drop until the plaster will spread but not run.
3. Place the rock flat side down on the waxed paper. Spread the plaster over its exposed sides. Record the color of the layer in Table 1.
4. Clean the pie pan thoroughly.
5. Place the rock in a location where it can dry undisturbed.
6. On the second day, repeat steps 3 through 5. Mix a drop of food coloring in the plaster. Record the color of the layer in Table 1. Let dry.
7. On the third day, add another layer using a different color. Record the color in the table.
8. On the fourth day, add another layer using a third color. Record. Contours may be thicker in some places since concretions are not always smooth.
9. On the fifth day, remove the cardboard and waxed paper. Sketch the bottom of the concretion on the next page.

Data and Observations

Table 1

Day	Color	Day	Color
1		3	
2		4	

SCI 1.a. Students know evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and midocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Laboratory Activity 1 (continued)

Sketch of concretion

Questions and Conclusions

1. What do the different layers represent?

2. What causes the different layers in naturally formed concretions?

3. Sometimes fossil hunters crack concretions open. Why do you think they do that?

Strategy Check

_______ Can you make a concretion?

_______ Can you observe the process of precipitation?

_______ Can you demonstrate how some sedimentary rocks are formed?

LAB 2 Laboratory Activity

Identifying Metamorphic Rocks

Metamorphic rocks are those which have been changed by heat, pressure, fluids, and chemical activity beneath Earth's surface. Each metamorphic rock can be identified and classified by its composition and texture. Foliated metamorphic rocks have a sheetlike or layering orientation of their minerals. Nonfoliated metamorphic rocks are composed of mineral grains that don't form layers. In this activity, you will examine and identify samples of both types of metamorphic rocks.

Strategy

You will describe the physical properties of various metamorphic rocks.
You will use a key to identify metamorphic rock samples.
You will group rocks into foliated and nonfoliated samples.

Materials

numbered rock samples: gneiss, hornfels, marble, phyllite, quartzite, schist, slate, and soapstone
magnifying lens
colored pencils

Procedure

1. Arrange your rock samples in numerical order. Begin by examining rock sample 1. In the table in the Data and Observations section, make a sketch of the rock sample. Use colored pencils to make your sketch as realistic as possible.
2. Next observe the rock's physical properties, such as the color and the size and arrangement of crystals. Write a description of the rock in the data table.
3. Use the identification key in Figure 1 to identify the name of the rock sample. Write the name in the data table.
4. Based on your observations and what you know about metamorphic rocks, classify the rock sample as foliated or nonfoliated. Record your classification in the data table.
5. Repeat steps 1 through 4 with rock samples 2 through 8.

Figure 1

Rock	Description
Gneiss	Alternating bands of light and dark minerals; bands may or may not be bent; often visible crystals; may contain thin, dark streaks
Hornfels	Usually dark in color, but may be pink, brown, violet, or green; fine-grained, dense, hard rock
Marble	Can be white, brown, red, green, or yellow; can be scratched with a nail; texture can be smooth or sugary; large interlocking cystals
Phyllite	Fine-grained rock; has a frosted sheen resembling frosted eye shadow
Quartzite	Made of interlocking quartz crystals; pure quartzite is white, but other minerals may color it gray or even black; scratches glass
Schist	Medium-grained rock; may have long, stretched crystals; may shimmer or look flaky
Slate	Usually gray or black; very fine-grained rock; individual grains difficult to see with hand lens; has obvious layers
Soapstone	Soft, easily carved rock; slippery feel; color varies from very pale to dark green

SCI 1.a. Students know evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and midocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Laboratory Activity 2 (continued)

Data and Observations

Sample Number	Drawing	Description	Rock Name	Foliated or Nonfoliated
1				
2				
3				
4				
5				
6				
7				
8				

Questions and Conclusions

1. Which rock samples were the most difficult to identify?

2. Suggest why two samples of the same type of metamorphic rock might look different from each other.

Strategy Check

_______ Can you describe the physical properties of various metamorphic rocks?

_______ Can you use a key to identify metamorphic rock samples?

_______ Can you group rocks into foliated and nonfoliated samples?

LAB 1 Laboratory Activity

Observing Radiation

Have you ever walked barefoot on asphalt on a sunny summer day? The black pavement is hot because heat from the sun transfers to the pavement through radiation. Radiation is the movement of energy in the form of waves. Different materials absorb radiant energy from the sun differently. In today's experiment, you will compare how light-colored materials and dark-colored materials differ in their ability to absorb energy from the sun.

Strategy

You will observe how energy from the sun can increase the temperature of water.
You will determine how color influences how much solar radiation is absorbed.

Materials

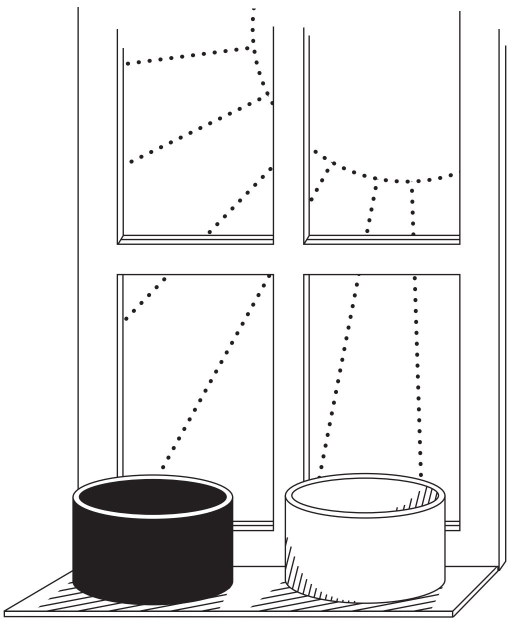
construction paper (black)
construction paper (white)
containers (2 plastic, 500-mL)
scissors
tape
graduated cylinder (100-mL)
water
thermometer (alcohol, Celsius)
timer
pencils (colored)

Procedure

WARNING: *Use care when handling sharp objects.*

1. Fasten black construction paper on the bottom and sides of one container.
2. Fasten white construction paper on the bottom and sides of the other container.
3. Add 250 mL of room-temperature water to each container.
4. Use a thermometer to find the temperature of the water in each container. Record your data in Table 1 in the Data and Observations section.
5. Place the containers side by side in direct sunlight outside on a sunny windowsill. Be sure both containers receive the same amount of sunshine.
6. Measure the temperature of the water in each container at 5-minute intervals for 30 minutes. Record your data in Table 1.
7. Using Figure 2, graph the data from the table, using a line graph. Use one colored pencil to show data for the light container and a different one to show data for the dark container. Draw lines to connect the temperature for each container of water.

Figure 1



SCI 3.a. Students know energy can be carried from one place to another by heat flow or by waves, including water, light and sound waves, or by moving objects. Also covers **SCI 3.d.**

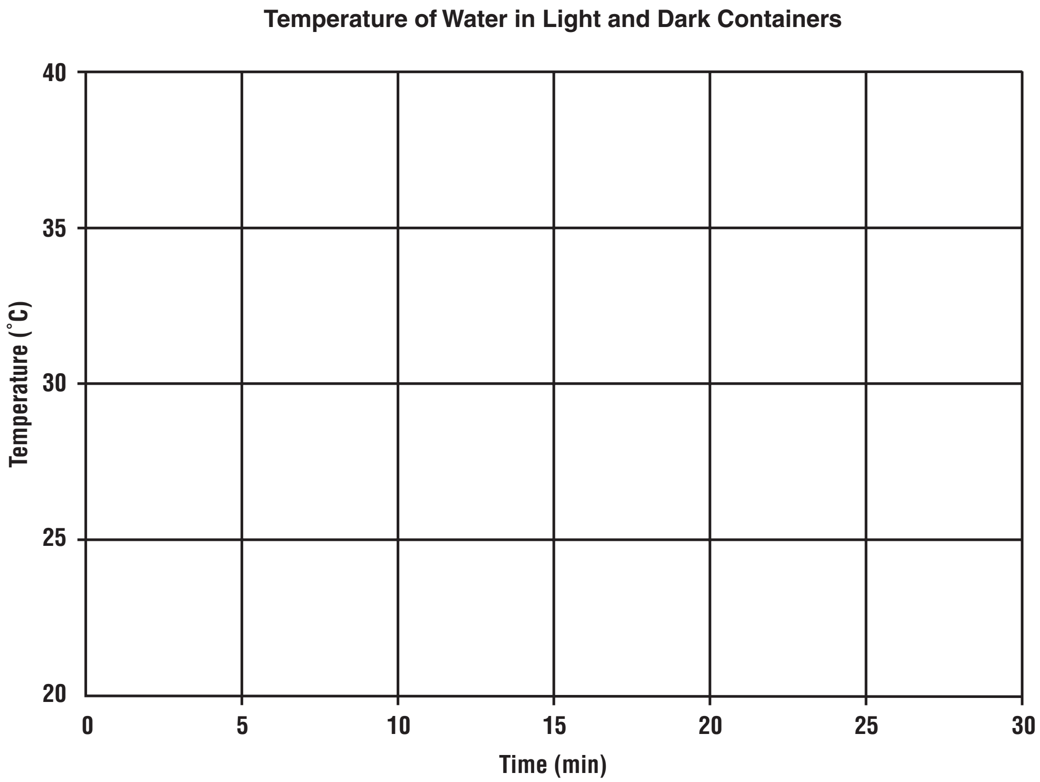
Laboratory Activity 1 (continued)

Data and Observations

Table 1

Color of container	Time (min)						
	0	5	10	15	20	25	30
Temp. (˚C)—Light							
Temp. (˚C)—Dark							

Figure 2



1. What was the final temperature of the water in the dark container?

2. What was the final temperature of the water in the light container?

3. How many degrees did the temperature of the dark container increase?

4. How many degrees did the temperature of the light container increase?

Laboratory Activity 1 (continued)

Questions and Conclusions

1. Did one container of water heat up more quickly? Which one?

2. How do you think color influences the ability of an object to absorb energy from the sun?

3. Would you get similar results if you placed the containers in the shade? Why or why not?

4. If you were stranded in a hot desert, would you rather be wearing a dark-colored or a light-colored T-shirt? Why?

Strategy Check

_______ Did you observe the influence of solar radiation on water temperature?

_______ Did you determine how color influences the absorption of solar radiation?

LAB 2 Laboratory Activity

Venus—The Greenhouse Effect

Because Venus is closer to the Sun, it receives almost twice the amount of solar radiation received by Earth. However, because of its clouds Venus reflects more radiation in to space than does Earth. We might expect Venus, therefore, to have surface temperatures similar to Earth's. However, the Pioneer vehicles to Venus have measured surface temperatures of 460°C. Some scientists explain this high temperature as the "greenhouse effect." When the solar energy strikes the surface of Venus, the energy is absorbed and changed into heat energy. This heat energy is reflected back to the atmosphere where it is trapped.

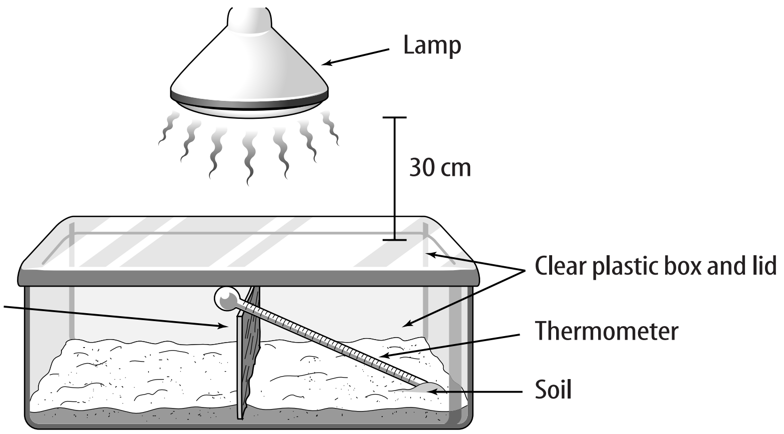
Strategy

You will build a model to show the greenhouse effect.
You will compare this model to Earth.
You will form a hypothesis about temperatures on Venus using data collected from this model and from the *Pioneer* spacecraft.

Materials

soil
clear plastic storage box and lid
cardboard (stiff)
thermometer
heat lamp (mounted)
watch
graph paper
pencils (colored)

Figure 1



Procedure

1. Place about 3 cm of soil in the bottom of the clear plastic box.
2. Thoroughly moisten the soil with water.
3. Cut the piece of cardboard so that it makes a divider for the box. The cardboard should not quite reach the top of the box. Insert the divider into the box.
4. Lean the thermometer against the divider with the bulb end up. (See Figure 1) Put the lid on the box.
5. Position the box and lamp in an area of the room where no direct sunlight reaches. **WARNING:** *Use care handling heat lamp.*
6. Place the heat lamp about 30 cm above the box and direct the light so it shines on the thermometer bulb.
7. Turn off the lamp and allow the thermometer to return to room temperature. Record room temperature under Data and Observations.

SCI 3.d. Students know heat energy is also transferred between objects by radiation (radiation can travel through space).

Laboratory Activity 2 (continued)

8. Turn on the lamp and measure the temperature every minute for 20 min. Record the temperatures in Table 1.

9. Turn off the lamp and allow the thermometer to return to room temperature. Remoisten the soil and repeat step 8 without the lid. Record your data in Table 1.

Data and Observations

Room temperature: ______

Table 1

Time (min)	Temperature (°C) Lid On	Temperature (°C) Lid Off
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

On a separate piece of paper, graph the data using two different colors. Plot Temperature on the vertical axis and Time on the horizontal axis.

Laboratory Activity 2 (continued)

Questions and Conclusions

1. Did the temperature increase the most with the lid on or off? Why?

2. Draw a diagram of Earth showing its atmosphere and what occurs due to solar radiation in the atmosphere. List the components of Earth's atmosphere on your diagram. Write a brief explanation of the greenhouse effect on Earth.

3. Compare the greenhouse effect of the activity to the greenhouse effect on Earth. How are they similar? How are they different?

Laboratory Activity 2 (continued)

4. Venus's atmosphere is composed mainly of carbon dioxide, carbon monoxide, water, nitrogen, and sulfuric acid. Venus's atmosphere is 100 times more dense than Earth's atmosphere. From the surface of Venus up to 20 km, there appears to be a clear region of atmosphere. A thick layer of clouds extends from about 50 km to 80 km above the surface of Venus. These clouds are composed of drops of sulfuric acid. Above and below these clouds are other, thinner layers of haze. Venus's ionosphere extends from 100 km to 200 km above the surface. Like the ionosphere of Earth, it has layers. The temperature in the ionosphere of Venus is cooler than the temperature in Earth's ionosphere.

Draw a diagram of Venus showing its atmosphere and what happens to solar radiation in the atmosphere. List the components of Venus's atmosphere on your diagram. Write a brief explanation of the greenhouse effect on Venus.

____

____

____

____

5. Compare the greenhouse effect on Earth and Venus. Can you think of a reason why the surface of Venus is so much hotter than the surface of Earth?

____

____

____

____

Strategy Check

_______ Can you build a model to show the greenhouse effect?

_______ Can you compare this model to Earth?

LAB 1 Laboratory Activity

Index Fossils

Fossils found in the deepest layer of undisturbed rocks in an area represent the oldest forms of life in that particular rock formation. When reading Earth history, these layers would be "read" from bottom to top, or oldest to most recent. If a specific fossil is typically found only in a particular type of rock and is found in many places worldwide, the fossil might be useful as index fossil. The index fossil can be useful in determining the age of layers of rock or soil. By comparing this type of information from rock formations in various parts of the world, scientists have been able to establish the geologic time scale.

Strategy

You will make trace fossils from several objects.
You will distinguish between index fossils and other fossils.

Materials

newspaper
objects to use in making trace fossils (3)
clay
container, at least 25 cm × 20 cm × 15 cm (or approximately shoe-box size)
varieties of "soil" (3)
**sand*
**potting soil*
**pea gravel*
**mulch*
**shredded dried leaves*
**fresh grass cuttings*
small shovel
**scoop*
**Alternate materials*

Procedure

1. Cover your desk or table with several layers of newspaper. Select three objects to use to make your trace fossils. Label these objects *A, B,* and *C.*
2. Make trace fossils of the three objects by pressing clay onto each of them. Carefully remove the clay from the objects. Label your trace fossils *A, B,* and *C,* and set your fossils aside. Make a second trace fossil from objects A and C. Label these.
3. Choose three different types of soil. You can have different amounts of each type of soil, but together the three soils should almost fill your container.
4. Layer one type of soil into your container. Bury one trace fossil A in this layer of soil. Sketch this layer in Figure 1 in the Data and Observations section. Be sure to note the location of the fossil.
5. Repeat step 4 twice using a different type of soil for each layer. In the second layer, bury trace fossils A, B, and C. Place only trace fossil C in the third layer. Fossil B is your index fossil.

SCI 1.a. Students know evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and midocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Laboratory Activity 1 (continued)

6. Choose a time period that each of your soil layers represents, and add this information to Figure 1. Consider the distribution of fossils in the layers of soil when you select the time span for each object. Also, because fossil B is your index fossil, it must represent a unique time period. Be sure that the time period you select for the middle layer does not overlap with the other time spans.
7. Exchange containers with another group. Tell the group when object B, your index fossil, existed.
8. Carefully excavate your new container. Sketch each layer in Figure 2 as you proceed with the excavation. Carefully note where each fossil is found. Compare your sketches with the sketches made by the group who made the container.
9. Based on the age of the index fossil, determine what you can know about a time line for the second container. Add details on what you can tell about the time line to Figure 2.

Data and Observations

Figure 1—First Container

Layer	Bottom	Middle	Top
Time period			
Sketch			

Figure 2—Excavated Container

Layer	Bottom	Middle	Top
Time period			
Sketch			

Laboratory Activity 1 (continued)

Questions and Conclusions

1. Explain why an index fossil must represent a unique time period.

2. Are the three fossils in the middle layer from the same time period?

3. Is fossil A in the deepest layer from the same type of organism as fossil A in the middle layer?

4. Are the two fossils from object A from the same time period? What do you know about the duration of organism A in the geologic time line?

5. What is important to note while you are excavating?

6. Compare your sketch of the container you excavated with the sketch made by the makers of that container? Explain any important differences.

7. Explain how an index fossil is used to determine the age of surrounding fossils.

Strategy Check

_______ Can you make trace fossils from a variety of objects?

_______ Can you determine the index fossil in the excavation?

Name Date Class

LAB 2 Laboratory Activity

How do continental plates move?

One of the models that helps explain how tectonic plates move is the convection model. In this hypothesis, the molten magma of the mantle boils like water in a pot. The pattern of the moving water forms a circular wave or current as hot water rises to the top and cooler surface water is forced to the side of the pot and back down to be heated again. Inside the Earth it is believed there are many convection cells, or regions in the mantle, that boil like this. The different cells have their own currents and constantly move independently of one another. The crust of the Earth has a much lighter mass and density than the magma. As a result, the plates of crust are moved by convection currents and broken up on the boiling surface of the mantle.

Strategy

You will model convection currents and the movement of tectonic plates.
You will predict what will happen to tectonic plates at the margins of convection cells.

Materials

hot plate
scissors
tongs
water
medium to large–mouthed pot
sheets of plastic foam wrap for padding packages (not made from corn or organic materials)

Procedure

1. The hot plates should be turned on high. Carefully fill the pot 2/3 full of water and place it on the hot plate. It will take a while for the water to boil.
2. Obtain a piece of flat plastic foam wrap. Use scissors to cut several shapes that represent tectonic plates. If you are working in a group you may mark your tectonic plates with a pencil or pen if you wish so that you can recognize it when the water boils.
3. Carefully place your pieces of foam on the surface of the water. If the water has any steam or tiny bubbles at the bottom of the pan, ask your teacher to place the foam in the pot for you.
4. As the water heats, watch the action of the bubbles as they rise from the bottom of the pot. Observe everything you can about what happens to them when they rise under a piece of foam. Record your observation in the table provided.
5. Once the water begins to boil, watch your pieces of foam. How do they move? In what direction do they go? Do they stay in one place in the pot or do they move ? Do they crash into other pieces of foam?

Figure 1

SCI 4.c. Students know heat from Earth's interior reaches the surface primarily through convection. Also covers **SCI 1.c.**

Laboratory Activity 2 (continued)

Record the answers to these observations in the data table. Be sure to observe the boiling pot for a while. It may first seem there is no pattern to the action in the pot, but careful observation will reveal certain movements in the boiling water.

6. When the experiment is over, your teacher will turn off the hot plates and remove the foam with tongs for cooling. DO NOT remove the pieces yourself. They will cool quickly. When they are cooled, find your pieces and return to your lab station or seat.

7. In your data table write down any observed changes in your foam. Does it still have water in it? Have any of the corners been melted or damaged? Write down any other observations in your table.

Data and Observations

Action of bubbles	**1.**
Movement of foam pieces in boiling water	**2.**
Condition of foam after experiment	**3.**

Questions and Conclusions

1. How did you describe what happened to the bubbles as they gathered under the foam? What happened at the sides of the foam?

Laboratory Activity 2 (continued)

2. What type of natural feature is similar to the action of the bubbles? Explain your answer.

____

____

____

3. Describe the movement of the plastic pieces when the water started to boil. Could you see a pattern?

____

____

____

4. How does this experiment model the moving tectonic plates?

____

____

5. How is this experiment different from the real world in terms of tectonic plates? (Hint: What were your foam pieces like after the experiment?)

____

____

____

6. Predict what would happen if the convection currents of the molten magma changed direction or stopped altogether?

____

____

____

Strategy Check

_______ Can you model convection currents and the movement of tectonic plates?

_______ Can you predict what will happen to tectonic plates at the margins of convection cells?

LAB 1 Laboratory Activity

Paleogeographic Mapping

Paleo- means old as in paleontology, the study of old life (fossils). *Geo-* means Earth, as in geology, the study of Earth. *Graphic* refers to a drawing or painting. Therefore, paleogeographic could be translated as "Old Earth Picture." Scientists often use fossil evidence to help them develop a picture of how Earth was long ago. By examining and dating rock formations and fossils of various plants and animals, scientists are able to formulate hypotheses about what Earth's surface might have looked like during a particular period in history. For example, similar rock formations and certain types of plant and animal fossils of a particular age could indicate whether two, now separate, land areas might have been connected during that period. Further analysis of the samples and data could also provide clues to the climate of that area or whether it was dry land or covered by an ocean. To classify events in the geologic past, scientists have divided the millions of years of Earth's history into segments, called *eras*. In this activity, you will examine evidence from the fossil record relative to a current map of an imaginary continent and develop a map of what the continent and the surrounding area might have looked like during the Mesozoic Era (248 million to 65 million years ago).

Strategy

You will determine how fossil evidence can be used to infer information about a continent during the geologic past.

You will interpret fossil evidence to draw a map showing how a continent appeared during the Mesozoic Era.

Materials

colored pencils or markers

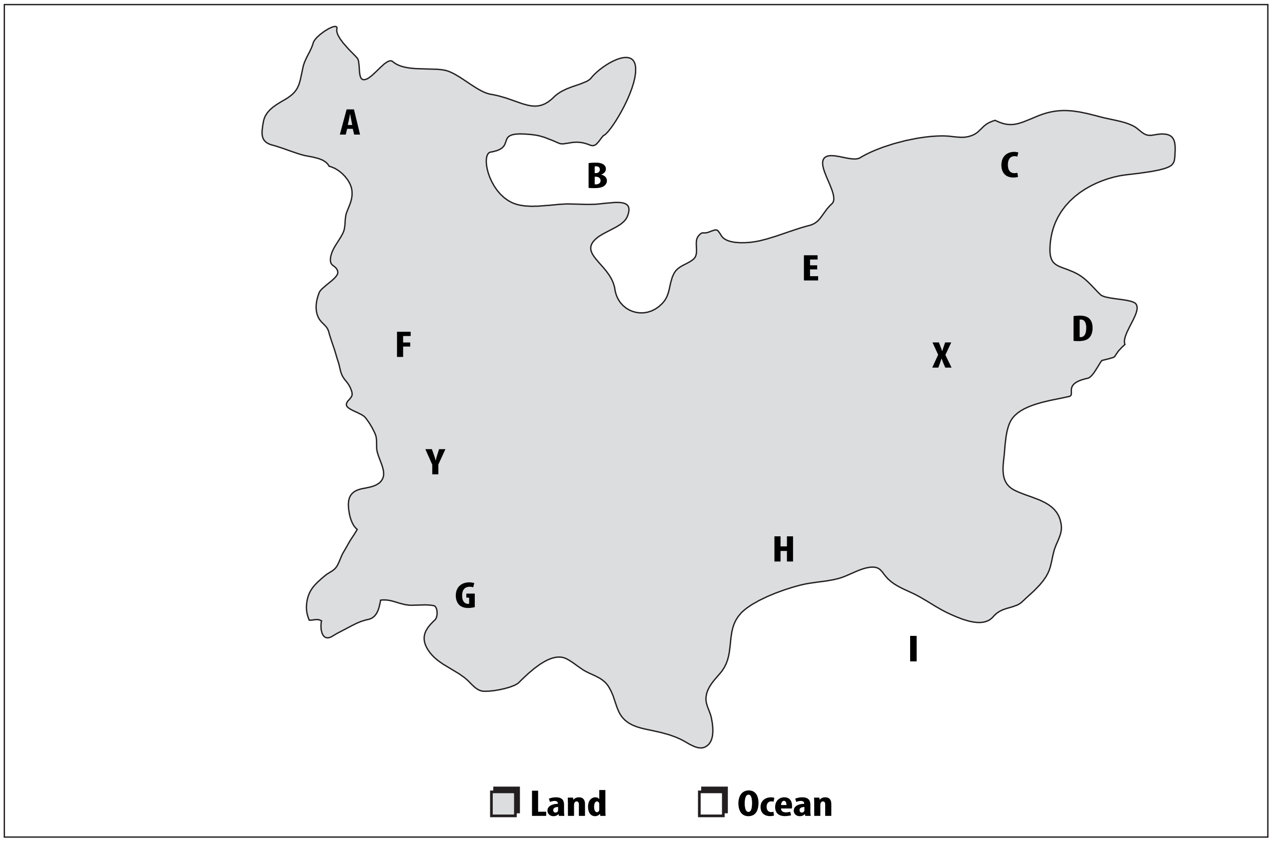
Procedure

1. Figure 1 shows a map of a present-day imaginary continent. Locations *A* through *I* are places where fossils have been found in rocks dating to the Mesozoic Era. Study the map and look at the fossils key below the map.
2. From the locations of the different fossils, infer where the land areas were at the time the fossil organisms lived. Keep in mind that the way the modern continent looks may have no relationship to where the land/ocean boundaries were during the Mesozoic Era.
3. Use one color of pencil or marker to color in the land areas on the map in Figure 1. Fill in the block labeled Land with the same color. Use a different color of pencil or marker to color in the ocean areas on the map in Figure 1. Fill in the block labeled Ocean with this color.
4. In the space provided under Data and Observations, draw a map showing land and water areas during the Mesozoic Era. Use the color boundaries you added to Figure 1 as your guideline. Based on these boundaries, add all of the symbols from the map key in Figure 1 to your map.
5. Color all the areas around and between the labeled areas on your map as either land or ocean. Fill in the blocks labeled Land and Ocean with the colors you used.

SCI 1.a. Students know evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes, and midocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.

Laboratory Activity 1 (continued)

Figure 1



Fossils found in Mesozoic rocks

A (shark teeth)
B (petrified wood)
C (sea stars)
D (leaf and fern imprints)
E (seashell fragments)
F (teeth/bones of small mammals)
G (dinosaur bones)
H (corals)
I (dinosaur footprints)
X, Y (Areas to be identified after completing your map)

Laboratory Activity 1 (continued)

Data and Observations

Mesozoic Map

❒ **Land** ❒ **Ocean**

Questions and Conclusions

1. According to your map, was location Y land or water during the Mesozoic Era? Explain how you decided.

2. According to your map, was location X land or water during the Mesozoic Era? Explain how you decided.

3. Compare your map with those of other students. Why do you think that not everyone agreed on whether location X was land or water? How could you find out which interpretation was correct?

Laboratory Activity 1 (continued)

4. Corals grow only in warm, shallow oceans near the coastlines of continents that are relatively near the equator. Would knowing this fact make you revise your map? Why or why not?

____

____

____

5. Suppose the modern continent shown in Figure 1 was located in an area that is extremely cold. Using the evidence you have, plus the information in Question 4, what could you infer about the continent?

____

____

____

Strategy Check

_______ Can you determine how fossil evidence can be used to infer information about a continent during the geologic past?

_______ Can you interpret fossil evidence to draw a map showing how a continent appeared during the Mesozoic Era?

LAB 2 Laboratory Activity

Earth's Plates

Earth's lithosphere is divided into about 30 sections, or plates, that fit together like a puzzle. The plates extend below Earth's surface to a depth of about 100 km; each plate includes crust that is above sea level and crust that is below sea level. With a few exceptions, each continent is contained within one plate, but the plates do not necessarily resemble the continents in shape or size.

Strategy

You will construct a puzzle to show how Earth's lithosphere is broken into plates that fit together.

Materials

scissors
map showing Earth's plates (Figure 1)
1/2-in foam board
sharp knife or tool for cutting foam board
glue
map showing Earth's continents (Figure 2)
black marker
red marker

Procedure

Part A

1. Use the scissors to cut out each of the plates in Figure 1.
2. Trace the shape of each plate onto the foam board.
3. Cut out each piece of foam board and glue to the back of each paper plate piece. Allow the pieces to dry.
4. Now try to fit the plates together as they were on the worksheet.

Part B

5. Cut out each of the continents in Figure 2.
6. Place them over the plate puzzle where you think they would go.
7. Use Figure 5 in the text to check the position of the plates and continents.
8. Use the black marker and Figure 5 in your text to label each of the plates.

Part C

9. Research earthquakes and volcanic eruptions in the last 10 years. On your plate puzzle, mark the location of each earthquake/eruption with a red dot.

SCI 1.e. Students know major geologic events, such as earthquakes, volcanic eruptions, and mountain building, result from plate motions. Also covers **SCI 1.f.**

Laboratory Activity 2 (continued)

Questions and Conclusions

1. Using only the shape of the plates, how many ways were you able to fit the plates together until you reached their final configuration?

2. What clues other than shape did you use to fit the plate pieces together?

3. How do you think the plates will look millions of years from now?

4. Which plates include sections of today's continents?

5. Why does California experience many earthquakes?

6. If the plates, and therefore the continents, are constantly moving, what effect does this have on the oceans?

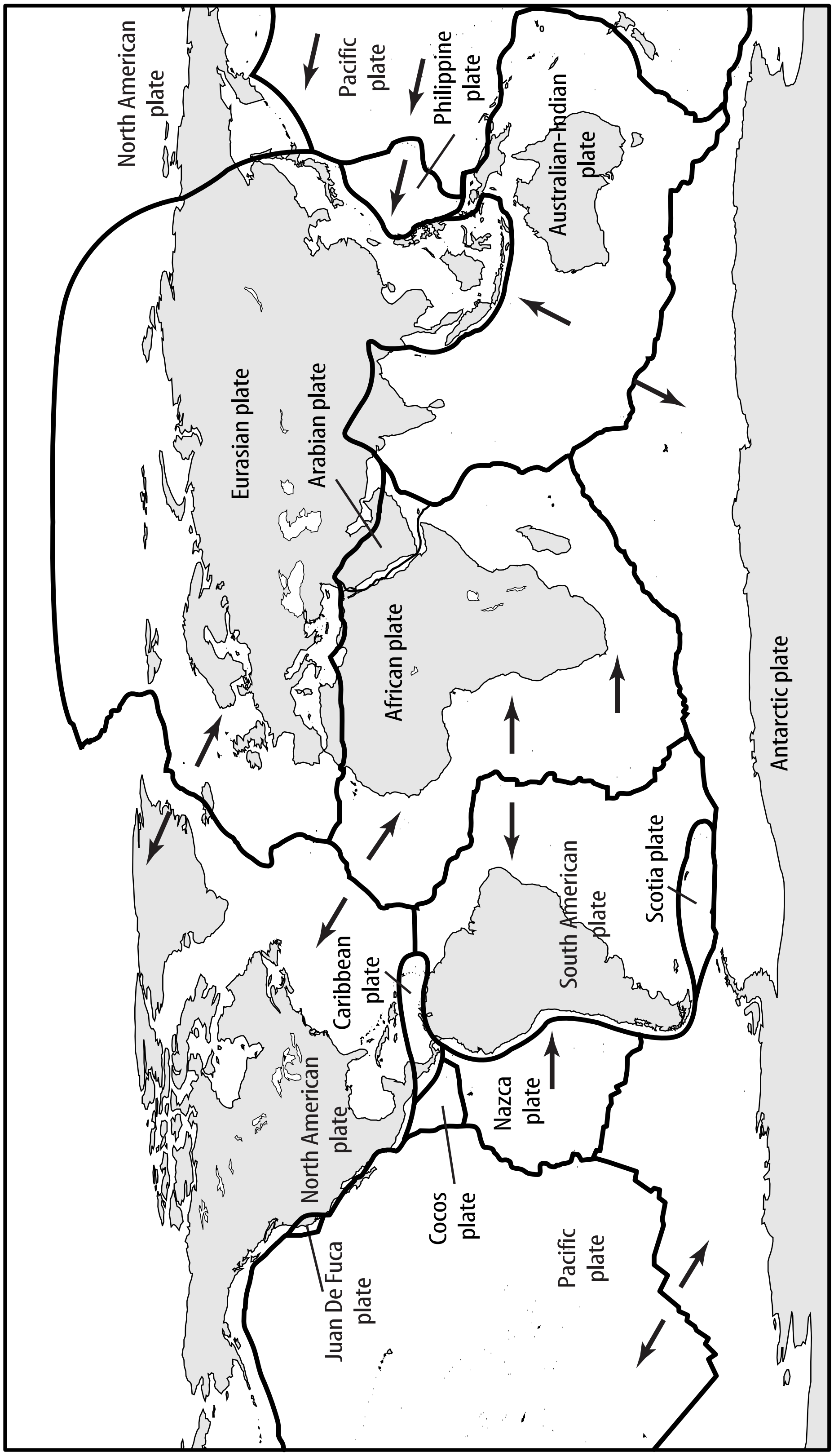
7. Do you see any relationship between the earthquakes and volcanoes you marked on your puzzle and the plates? Explain.

Strategy Check

_______ Can you construct a puzzle to show how Earth's lithosphere is broken into plates that fit together?

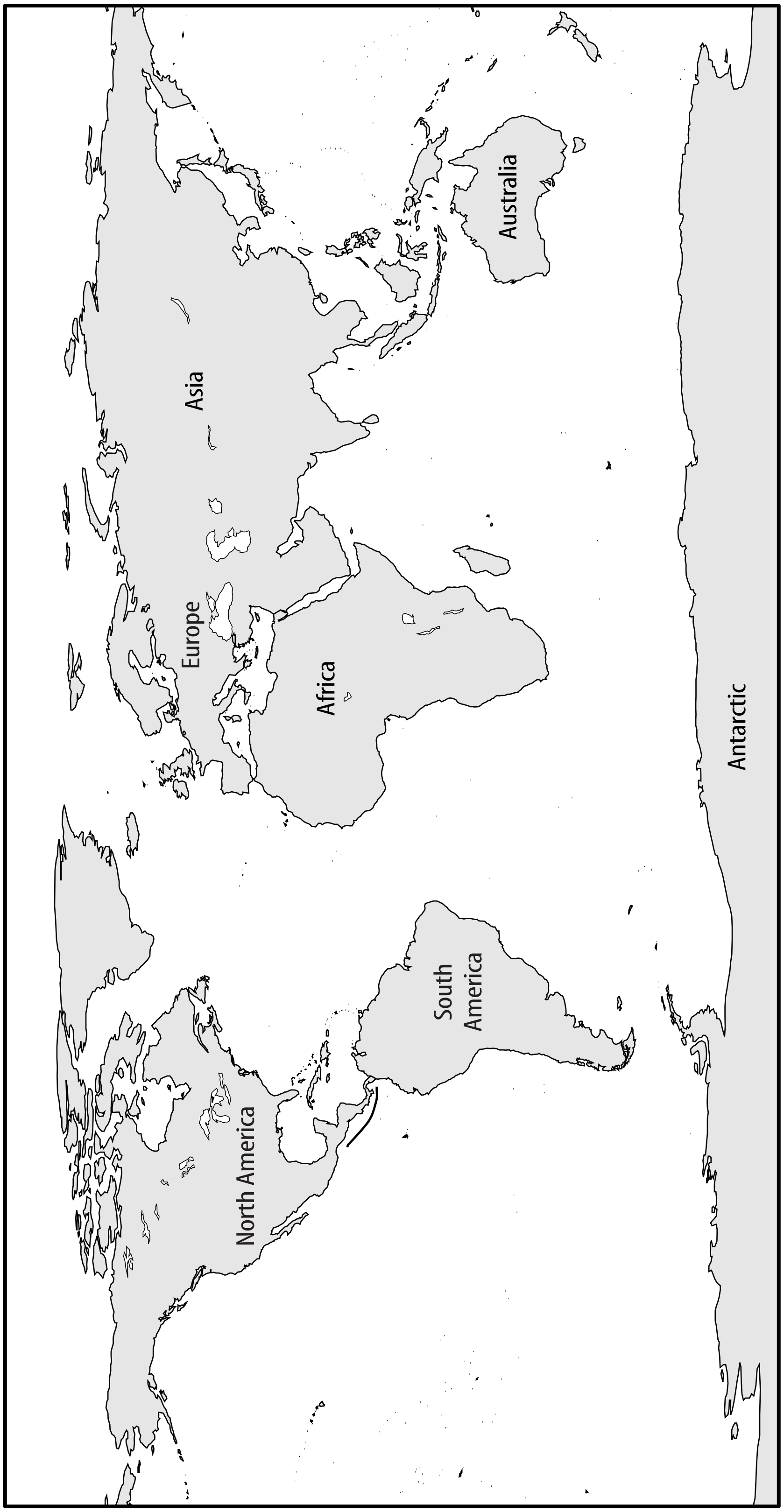
Laboratory Activity 2 (continued)

Figure 1



Laboratory Activity 2 (continued)

Figure 2



LAB 1 Laboratory Activity

Using the Modified Mercalli Scale to Locate an Epicenter

Earthquakes are classified using different scales. The Richter scale is a measure of the energy released during the earthquake. The Modified Mercalli scale is a measure of the amount of damage done by the earthquake. Scientists record responses from many people who experience the earthquake and assign a value from I (1) to XII (12). These numbers are plotted on a map and used to locate the epicenter of the earthquake. This method is based on the idea that the area closest to the epicenter will suffer the most damage.

Strategy

You will read simulated reports of people's earthquake experiences and then assign Modified Mercalli scale values to these reports.

You will plot these values on a map and locate the epicenter of the earthquake.

Materials

colored pencils

Procedure

1. Read the Modified Mercalli scale in Table 1 so you become familiar with the descriptions.
2. Read the list of experiences from the various cities in Table 2. Assign a Mercalli value to each of the descriptions. Then write each value on the map (Figure 1) next to the corresponding city.
3. Use colored pencils to draw lines that connect cities having the same Mercalli value.
4. Use the pattern you have drawn to estimate where the epicenter is located.

SCI 1.g. Students know how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction in the region.

Data and Observations

Table 1

		Modified Mercalli Scale
I.	(1)	Earth movement is not felt by people.
II.	(2)	A few people may feel movement if they are sitting still. Hanging objects may sway.
III.	(3)	Felt noticeably indoors, especially on upper floors. May not be recognized as an earthquake.
IV.	(4)	During the day, felt indoors by many people, outdoors by few. At night, some are awakened. Dishes, windows, and doors rattle.
V.	(5)	Felt by almost everyone. Sleeping people are awakened. Some windows are broken and plaster cracked. Some unstable objects are overturned. Bells ring.
VI.	(6)	Felt by everyone. Many people are frightened and run outdoors. Some heavy furniture is moved, and some plaster may fall. Overall damage is slight.
VII.	(7)	People run outdoors. Earth movement is noticed by people driving cars. Damage is slight in well-built buildings and considerable in poorly built structures. Some chimneys are broken.
VIII.	(8)	Damage is slight in well-designed buildings and extreme in poorly built structures. Chimneys and walls may fall.
IX.	(9)	Damage is considerable in well-designed buildings. Buildings shift from their foundations and partly collapse. Ground may crack, and underground pipes are broken.
X.	(10)	Some well-built wooden structures are destroyed. Most masonry structures destroyed. Ground is badly cracked.
XI.	(11)	Few, if any, structures remain standing. Broad open cracks in the ground.
XII.	(12)	Complete destruction. Waves are seen on the ground surface.

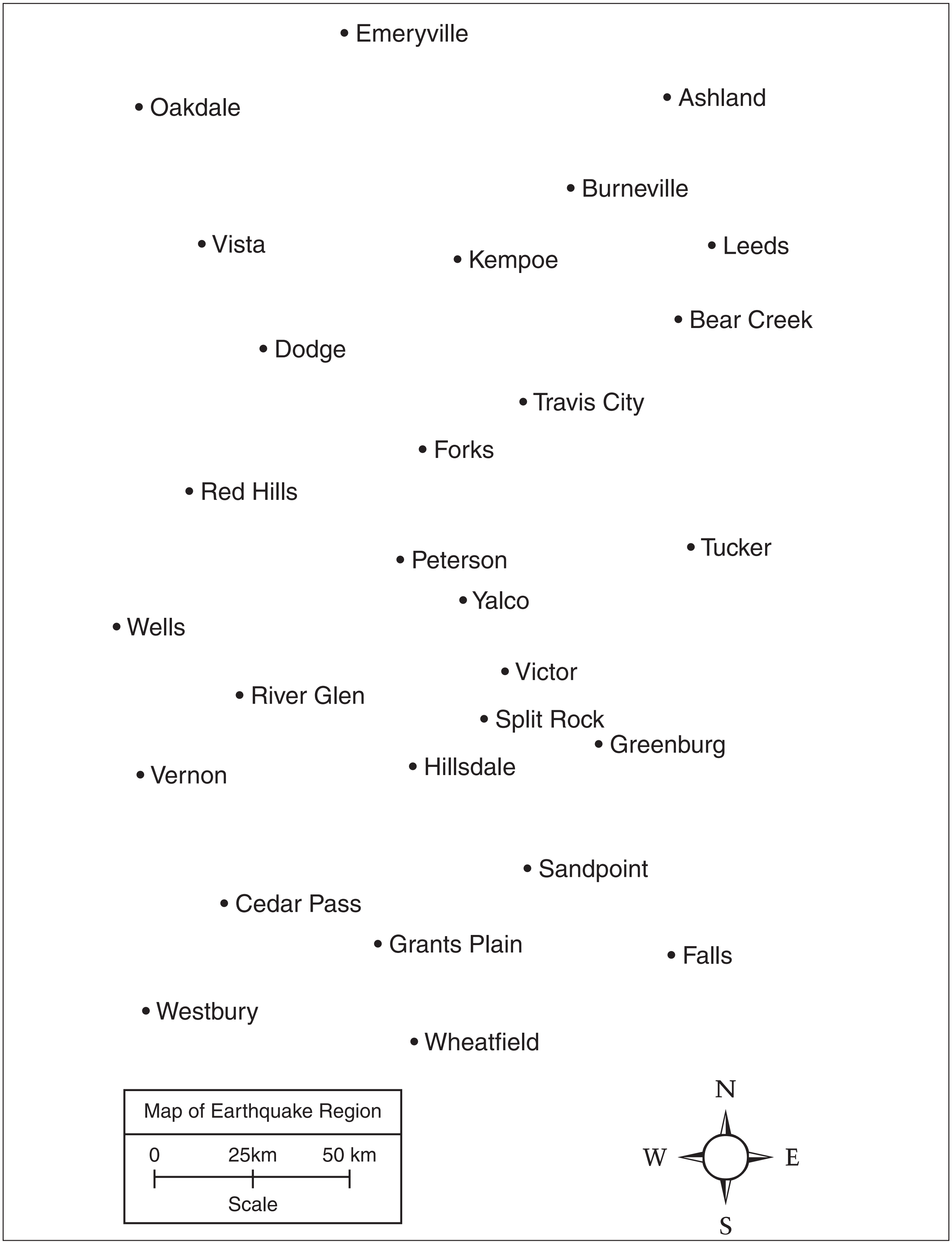
Laboratory Activity 1 (continued)

Table 2

Earthquake Observations and Data		
1.	Ashland	Hanging lamps swayed.
2.	Bear Creek	People outdoors did not notice anything, but windows and doors rattled.
3.	Burneville	Felt by people sitting at dinner.
4.	Cedar Pass	Families sitting at dinner noticed the dishes rattling.
5.	Dodge	Dishes, windows, and doors rattled.
6.	Emeryville	Not felt.
7.	Falls	Felt by nearly everybody. A few windows were broken.
8.	Forks	Big windows in stores downtown were broken.
9.	Grants Plain	Church bells rang all over town. Plaster walls developed cracks. Candlesticks fell off the mantel.
10.	Greenburg	Not much damage but felt by everyone.
11.	Hillsdale	Some plaster ceilings fell. Many people were scared.
12.	Kempoe	Felt by some people on upper floors. Some windows rattled.
13.	Leeds	Noticed by many people working late in tall buildings.
14.	Oakdale	Felt by a few people.
15.	Peterson	Felt by almost everyone. Some plaster ceilings fell down.
16.	Red Hills	Some people are awakened out of their sleep.
17.	River Glen	Felt by almost everybody in town.
18.	Sandpoint	Many windows were broken. Some people were scared.
19.	Split Rock	Poorly built structures were badly damaged. A few drivers noticed their cars moving strangely for a moment.
20.	Travis City	Almost everyone felt it. Church bells rang.
21.	Tucker	Books fell off the shelves in the main library, and some windows were broken.
22.	Vernon	Dishes in the cupboard rattled. Felt by people indoors.
23.	Victor	Most people were alarmed and ran outside. Chimneys were broken.
24.	Vista	Felt by people in upper floors of tall buildings.
25.	Wells	Noticed by people on the third floor. Some windows rattled.
26.	Westbury	Some people noticed the vibration but thought it was a freight train.
27.	Wheatfield	People sitting at the dinner table noticed doors and windows rattling.
28.	Yalco	Many people ran outside. Many windows were broken.

Laboratory Activity 1 (continued)

Figure 1



Laboratory Activity 1 (continued)

Questions and Conclusions

1. What cities were closest to the epicenter of the earthquake? How did you determine this?

____

____

2. Approximately how wide was the zone with a rating of V or higher?

____

3. What are some possible sources of error when using the Modified Mercalli scale to locate the epicenter of an earthquake?

____

____

____

____

Strategy Check

_______ Can you determine Mercalli values?

_______ Can you locate earthquake epicenters?

Name Date Class

LAB 2 Laboratory Activity

Earthquakes

Seismologists—the scientists who study earthquakes—have found that certain areas are more likely to have earthquakes than others. The risk is greater in these areas because they lie over active geologic faults. Maps that pinpoint earthquakes all over the world show that the greatest seismic belt borders the Pacific Ocean. Every state in the United States has had at least one earthquake, but some states have had stronger and more frequent earthquakes than others.

A magnitude-5 earthquake is classified as moderate, a magnitude-6 earthquake is large, and a magnitude-7 earthquake is major. An earthquake with a magnitude of 8 or larger is classified as great.

Strategy

You will study the occurrence of strong earthquakes in the United States by plotting earthquakes on a map.

You will determine which areas of the United States are most likely to have strong earthquakes.

Procedure

1. Plot the data from Table 1 in the Data and Observations section on Map 1. Place one dot in the state for each recorded earthquake. Use an atlas or other reference to help you locate the states.
2. Count the number of dots within each state and write that number within the state's borders.

SCI 1.d. Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface.

Data and Observations

Table 1

Some Earthquakes in the United States with a Magnitude of 7 and Above

State	Year	Magnitude	State	Year	Magnitude
Alaska	1964	9.2	California	1872	7.8
Alaska	1957	8.8	California	1892	7.8
Alaska	1965	8.7	Missouri	1811	7.7
Alaska	1938	8.3	California	1906	7.7
Alaska	1958	8.3	Nevada	1915	7.7
Alaska	1899	8.2	Missouri	1812	7.6
Alaska	1899	8.2	California	1992	7.6
Alaska	1986	8.0	California	1952	7.5
Missouri	1812	7.9	California	1927	7.3
California	1857	7.9	Nevada	1954	7.3
Hawaii	1868	7.9	Montana	1959	7.3
Alaska	1900	7.9	Idaho	1983	7.3
Alaska	1987	7.9	California	1922	7.3

Laboratory Activity 2 (continued)

Questions and Conclusions

1. In what regions have damaging earthquakes been concentrated?

2. From the table, which earthquake(s) can be classified as great?

3. What does a concentration of damaging earthquakes indicate about the underlying rock structure of the area?

4. Can you be sure that an earthquake could not occur in any area?

5. According to the map, is it likely that a damaging earthquake will occur in your state?

6. The earthquakes in 1811 and 1812 in Missouri occurred near the Mississippi River. The soil near the river tends to be wet. Do you think liquefaction took place during the earthquakes? Why or why not?

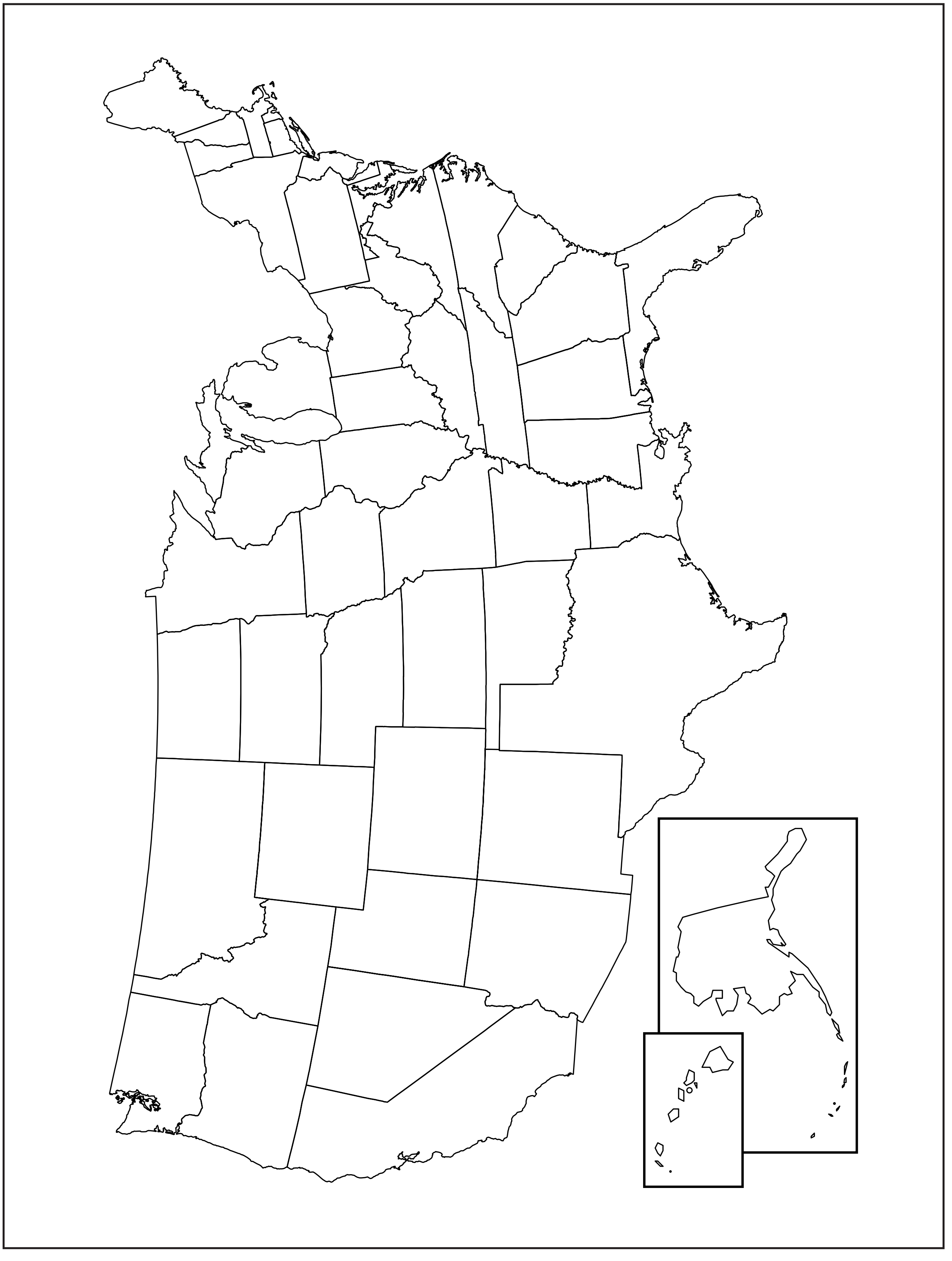
Strategy Check

_______ Can you observe where most damaging earthquakes have occurred in the United States?

_______ Can you predict the parts of the United States most likely to experience strong earthquakes?

Laboratory Activity 2 (continued)

Map 1



LAB 1 Laboratory Activity

Volcanic Eruptions

SCI 2.d. Students know earthquakes, volcanic eruptions, landslides, and floods change human and wildlife habitats.

Some volcanic eruptions consist of violent explosions of gases and tephra, while others involve a relatively quiet flow of lava around a vent. The type of eruption that occurs depends on both the composition of the magma and the amount of gas trapped in it. Thick magma that is rich in silica tends to trap steam and other gases. The more gas in the magma, the greater the pressure that builds up in the volcano. The tremendous pressure that builds in silica-rich magma is released when the volcano erupts explosively.

By contrast, magma that contains less silica tends to be less explosive and flow more easily. This type of magma is rich in iron and magnesium and traps smaller amounts of gas. It produces basaltic lava that flows from a volcano in broad, flat layers. In this lab, you will model both basaltic lava flows and explosive eruptions.

Strategy

You will model and observe how the buildup of pressure in a volcano can lead to an explosive eruption.

You will determine how layers of basaltic lava accumulate.

Materials

newspaper
balloons (9)
empty coffee can
measuring cup
plaster of paris
water
1 lb. plastic margarine tubs (2)
red, blue, and green food coloring
wooden paint stirrers (3)
old paintbrushes (3)
sponge
marker
meterstick
scissors
piece of thick cardboard (approximately 50 cm × 50 cm)
textbooks
small tubes of toothpaste in different colors (white, green, striped)

CAUTION: *Never put anything you use in a laboratory experiment into your mouth.*

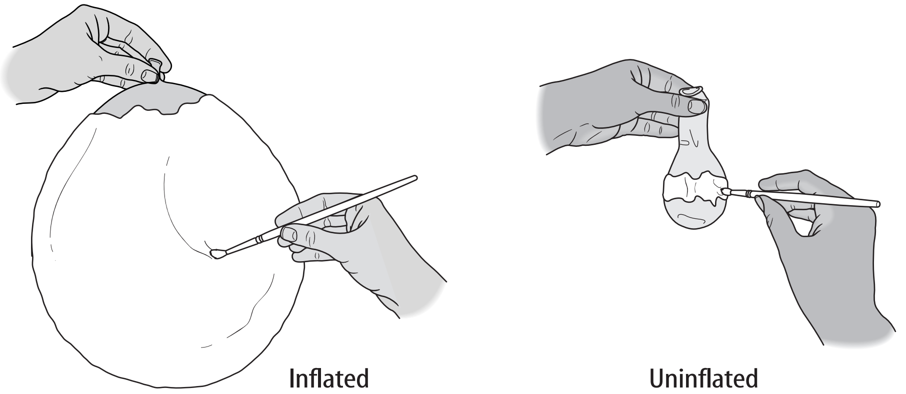
Procedure

Part A—Modeling Explosive Eruptions

1. Work in a group of five or six students. Put on your apron and goggles, and cover your work area with sheets of newspaper.
2. Inflate six of the balloons. Put less air in some of the balloons than in others. You'll need two small balloons, two medium, and two large. Leave the remaining balloons uninflated.
3. In the coffee can, combine 1 L of plaster mix with 2 L of water. Stir the mixture with a wooden stirrer until the mixture is smooth. You should use a bit more water than the directions on the box suggest. Thinner plaster will be easier to work with.
4. Pour about one-third of the mixture into each of the plastic tubs, leaving the final third in the can. Add several drops of food coloring to each container, and stir. You should end up with three colors of plaster: red, green, and blue. Do this step as quickly as possible since the plaster mix will begin to harden.
5. Using paintbrushes, coat the entire surface of each of the inflated balloons with a thin layer of plaster. Paint the two small balloons blue, the medium balloons green, and the large balloons red. Using any color, paint a band around the center of each of the empty balloons, leaving the ends unpainted (Figure 1). Set the balloons on sheets of newspaper to dry. If you spill any plaster while you are painting, wipe it up with a damp sponge.

Laboratory Activity 1 (continued)

Figure 1

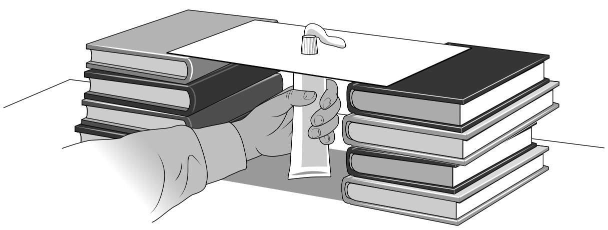


6. While the plaster is drying, skip to Part B of the procedure.
7. To model the buildup of pressure inside magma, try to inflate the empty balloons. What do you observe? Record your observation in the Data and Observations section.
8. Spread newspapers on an open area of the floor. With the marker, draw a large X on the center of the paper. To model an explosive eruption, take one of the small, blue balloons and place it on the X. Pop the balloon by stepping on it. Leave the pieces of the plaster in place and pop the second small balloon in the same way. **CAUTION:** *Wear your safety goggles throughout this experiment.*
9. With the meterstick, measure the distance from the X to the piece of plaster that landed the farthest from it. This distance represents the radius of the debris field. Record this measurement in Table 1 the Data and Observations section.
10. Repeat step 8 using the medium balloons. Measure and record the distance from the X to the piece of *green* plaster that landed farthest from it.
11. Repeat step 8 using the large balloons. Measure and record the distance from the X to the piece of *red* plaster that landed farthest from it.

Part B—Modeling Basaltic Lava Flows

1. Use the scissors to poke a hole near the center of the piece of cardboard. Widen the hole until it is just large enough for the cap of a tube of toothpaste to fit through it.
2. Make two stacks of books and place the cardboard on top of them so that the hole is suspended about 30 cm above your work surface (Figure 2).
3. Remove the cap from one of the tubes of toothpaste. Stick the cap end of the tube through the hole so that the tube is upright and just the mouth is sticking out the top of the cardboard. Model a basaltic lava flow by slowly squeezing out the contents of the tube.
4. Measure the height and diameter of your "lava" flow and record your measurements in Table 2 in the Data and Observations section.
5. To model additional eruptions, repeat steps 3 and 4 using the other two tubes of toothpaste to add to your "lava" flow.
6. Return to step 7 of Part A.

Figure 2



Laboratory Activity 1 (continued)

Data and Observations

What did you observe when you inflated the plaster-coated balloons?

Table 1

Balloon size	Radius of debris field (cm)
Small 1	
Small 2	
Medium 1	
Medium 2	
Large 1	
Large 2	

Table 2

Eruption	Diameter (cm)	Height (cm)
1		
2		
3		

Questions and Conclusions

1. The air in your balloons modeled the gases that build up in silica-rich magma. Which balloons (small, medium, or large) modeled magma under the greatest pressure? Explain.

2. What do your results from Part A tell you about the relationship between pressure and the force of an explosive volcanic eruption?

3. What type or types of volcano did you model in Part A? Explain your answer.

Laboratory Activity 1 (continued)

4. What were you modeling when you inflated the plaster-coated balloons in step 7 of Part A?

5. a. In Part B, how did the layers of toothpaste accumulate? Did the second and third layers form on top of the first layer or beneath it?

b. What does this result tell you about the age of the top layer of basaltic lava on a volcano compared with lower layers?

6. How did the height of the volcano you modeled in Part B compare with its width? What type of volcano has this shape?

7. How did the two types of eruptions you modeled differ from one another? How were they alike?

Strategy Check

_______ Can you model an explosive eruption due to the buildup of gas pressure?

_______ Can you describe how layers of basaltic lava accumulate?

LAB 2 Laboratory Activity

Volcanic Preservation

On May 18, 1980, Mount St. Helens in Washington erupted for the first time in 123 years. Volcanologists, people who study volcanoes, estimated that Mount St. Helens spewed enough rock and ash to cover an area of 2.6 km^2 to a depth of 172.8 m. This amount of ash is almost as much as Mt. Vesuvius poured onto Pompeii in 79 A.D. Organisms rapidly buried by the ash from volcanic eruptions may be preserved as fossils. Many examples were found in the excavation of Pompeii.

Strategy

You will form a "fossil" by drying.
You will compare the fossil to a living sample.

Materials

brush (soft)
silica powder or borax
cake tin with lid
flowers (several different kinds)
pencils (colored)
metric ruler

Procedure

1. Draw each flower specimen and record its properties in Table 1.
2. Pour silica powder into the tin to a depth of 5 cm.
3. Arrange fresh flowers on the silica powder. Carefully sprinkle silica powder over the flowers to a depth of 5 to 8 cm.
4. Put the lid on the tin and allow the tin to stand undisturbed for three weeks.
5. Carefully pour off the silica powder and examine the flowers.
6. Compare the appearance of the dried flowers to that of the fresh specimens.

Data and Observations

Table 1

Property	Fresh	Dried
Color		
Size		
Other		

SCI 1.d. Students know that earthquakes are sudden motions along breaks in the crust called faults and that volcanoes and fissures are locations where magma reaches the surface. Also covers **SCI 1.c.**

Laboratory Activity 2 (continued)

Questions and Conclusions

1. How does the appearance of the dried flowers compare to that of the fresh flowers?

2. What was the purpose in using silica powder?

3. How is silica powder like volcanic ash?

4. What other natural agent might preserve fossils in the same way as volcanic ash?

5. Is your dried flower a true fossil? What else would have to happen to it?

Strategy Check

_______ Can you form a "fossil" by drying?

_______ Can you compare this fossil to a living sample?

LAB 1 Laboratory Activity

Mass Movements

The force of gravity causes loose material to move down slope. Sometimes water helps to move the material. Water makes the material heavier and more slippery.

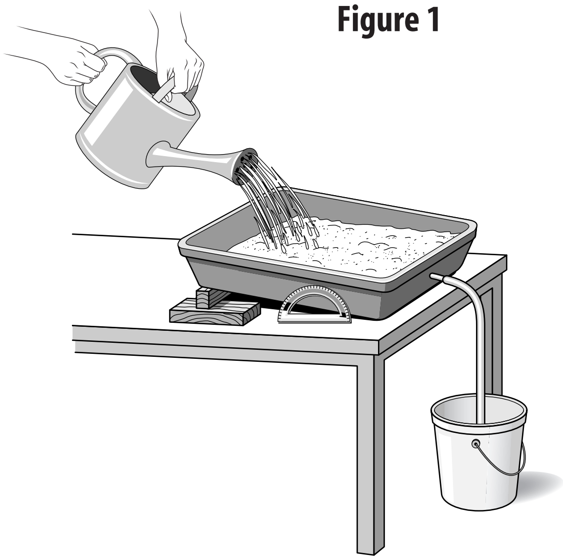
Down slope movements of earth materials may be sudden or slow. Landslides and mudflows are sudden movements. Rocky slopes tend to move as landslides; clay and sand materials may become mudflows.

Creep is an example of slow earth movement. Even when a slope is covered by vegetation, the soil may creep to a lower level.

Strategy

You will cause mass movements.
You will classify the mass movements.

Figure 1



Materials

stream table with hose
4 wood blocks
plastic bucket
protractor
1 L clay
1 L sand
sprinkling can
water
1 L gravel
meterstick

Procedure

1. Set up the stream table as shown in Figure 1.
2. Place the protractor with its flat edge down on the table that is supporting the stream table. Position the protractor next to the lower end of the stream table. Use the protractor to measure the slope angle of the stream table. Record the angle in Table 1.
3. Place the clay in the upper end of the stream table.
4. Pour the sand over the clay. Wet the sand and clay thoroughly until it moves.
5. Observe and record in Table 1 how the mass moves.
6. Add two more blocks under the stream table. Measure and record the new slope angle of the stream table.
7. Move the sand and clay back to the upper end of the stream table.
8. Pour water over the sand and clay until it moves. Record how the mass moves.
9. Remove the sand and clay. Spread a thin layer of clay in the upper end of the table.
10. Spread gravel over the clay. Pour water over the clay and gravel and observe the motion. Record your observations.

SCI 2.a. Students know water running downhill is the dominant process in shaping the landscape, including California's landscape.

Laboratory Activity 1 (continued)

Data and Observations

Table 1

Material	Slope angle (°)	Speed of movement
Sand, clay		
Sand, clay		
Clay, gravel		

Questions and Conclusions

1. What type of mass movement did you cause in steps 3 and 4?

2. What type of mass movement did you cause in steps 7 and 8?

3. What caused the difference in speed between these two mass movements?

4. What type of mass movement did you cause in steps 9 and 10?

5. Which type of mass movement would occur during an extended period of heavy rain on a filled area? Explain.

6. Which type of mass movement, creep or mudflow, is most destructive? Explain.

7. In an area that receives abundant rainfall, how are steep slopes kept from moving downhill?

Strategy Check

_______ Can you cause mass movements?

_______ Can you classify mass movements?

LAB 2 Laboratory Activity

Modeling a Glacier

Valley glaciers start in the mountains where snow collects and remains year after year. When the amount of snow accumulation exceeds the amount of snow melting and the snow mass is thick enough, gravity starts the glacier moving downslope. The glacier can take over a river valley as it moves toward a lower elevation. The glacier gouges and scrapes the surface beneath the ice and changes the landscape in many ways.

Strategy

You will construct a model of a valley glacier.
You will show the rugged features a valley glacier forms as it moves and melts.

Materials

cardboard base (21.5 cm × 28 cm)
4 colors of modeling clay
paper for labels
tape (clear)
toothpicks

Procedure

1. On the cardboard base, form a mountain from the darkest piece of clay.
2. Use white clay to show the position of a glacier on your mountain.
3. Show the erosional features of the glacier. Use the toothpicks and paper to make little flags.
4. You might wish to use a thin layer of green clay to show where vegetation has begun to appear.
5. Be sure to model each of the following features: U-shaped valley, cirque, terminal moraine, horn, and outwash plain.
6. Draw a diagram of your model under Data and Observations on the next page. Label the features.

Questions and Conclusions

Write a summary explaining how valley glaciers form and move and how they change the landscape.

____

____

____

____

____

SCI 2.a. Students know water running downhill is the dominant process in shaping the landscape, including California's landscape.

Laboratory Activity 2 (continued)

Data and Observations

Draw glacier diagram here.

Strategy Check

_______ Can you construct a model of a valley glacier?

_______ Can you correctly model and label the features left by a valley glacier?

LAB 1 Laboratory Activity

Air Volume and Pressure

You can't always see the air in Earth's atmosphere, but air is real. Like any other form of matter, air has definite physical properties. As you work through this activity, you will observe two of the properties of air—volume and pressure.

Strategy

You will demonstrate that air has volume (occupies space).
You will demonstrate that air exerts pressure.

Materials

water
beaker (500-ml)
bicycle pump
air mattress
meterstick

Procedure

1. Put 250 ml of water in the beaker.
2. Insert the hose of the bicycle pump so it is below the surface of the water.
3. To demonstrate that air occupies space, pump air into the water. Record your observations. Remove the pump hose.
4. To demonstrate that air exerts pressure, place the air mattress on the floor. Press the mattress flat to be sure it contains very little air. Feel the floor through the mattress.
5. Measure in centimeters the length, width, and thickness of the air mattress. Record your measurements in Table 1.
6. Inflate the mattress using the bicycle pump. Measure and record the dimensions of the mattress again.
7. Push down with your hand on one area of the inflated air mattress. Note how the dimensions of the area you are pushing on change. How does the part of the mattress surrounding your hands change?

Data and Observations

Observations:

1. Air pumped into beaker:

____

____

2. Pushing down on mattress:

____

____

Table 1

Air mattress	Before pumping	After pumping
1. Length (cm)		
2. Width (cm)		
3. Thickness (cm)		

SCI 4.e. Students know differences in pressure, heat, air movement, and humidity result in changes of weather.

Laboratory Activity 1 (continued)

Questions and Conclusions

1. What happened in the beaker of water when you pumped air into it?

2. What property of air does this demonstrate?

3. Calculate the volume of air in the air mattress. Show your work below. If you need more room, use the back of this page.

4. What happened to the thickness of the air mattress in the area where you pushed on it?

5. What happened to the area of the air mattress surrounding the area you pushed? What property of air does this show?

6. Does air exert pressure? Defend your answer.

Strategy Check

_______ Can you demonstrate that air has volume?

_______ Can you demonstrate that air exerts pressure?

LAB 2 Laboratory Activity

Temperature of the Air

Air temperature is an important factor in the scientific study of weather. Air temperature affects air pressure and, thus, the type of weather that may occur. Differences in air temperature also cause winds. By studying the air temperature and weather at different times during the day, you may be able to predict how the air temperature will affect local weather.

Strategy

You will measure air temperature at different times during the day.
You will measure air temperature at the same location each time.
You will graph your results and compare your graph with those of your classmates.

Materials

Celsius thermometer (metal backed)
graph paper

Procedure

1. Select an outdoor site for taking air temperature readings. Make sure the site is an open shaded area.
2. Record the air temperature at this site three times each day for a week. Be careful to read the thermometer at the same times each day. Record data in Table 1.
3. Record additional weather factors, such as cloud cover, precipitation, and winds.

Data and Observations

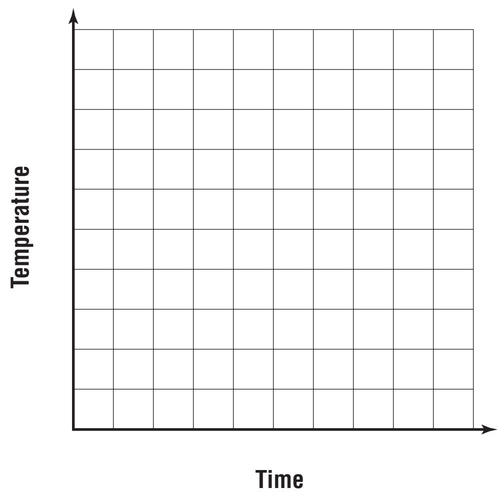
Table 1

Date	Time	Temp (˚C)	Other
	1.		
	2.		
	3.		
	1.		
	2.		
	3.		
	1.		
	2.		
	3.		
	1.		
	2.		
	3.		
	1.		
	2.		
	3.		

SCI 4.e. Students know differences in pressure, heat, air movement, and humidity result in changes of weather.

Laboratory Activity 2 (continued)

Graph your data showing temperature and time. Graph temperature on the vertical axis and time on the horizontal axis.



Questions and Conclusions

1. Why did you take your air temperature readings in the shade instead of the Sun?

2. Describe any patterns in your air temperature graph.

3. Do these patterns agree with patterns observed by your classmates? Explain.

4. How can you explain the patterns in terms of solar energy absorbed by the land?

Strategy Check

_______ Can you measure air temperature?

_______ Can you collect data for a week?

_______ Can you graph your data?

Name Date Class

LAB 1 Laboratory Activity

How do the oceans affect climate?

SCI 4.e. Students know differences in pressure, heat, air movement, and humidity result in changes of weather.

Meteorologists, people who study weather and climate, are always looking at what happens in the oceans. Most of the climate we experience on land is a result of winds and evaporated water at sea. One of the effects of the oceans is to keep the climate near their shores fairly constant. This happens because the water maintains a relatively even temperature. As a result of the weak attractions that form between the hydrogen atoms of one molecule of water and the oxygen atoms of nearby water molecules, a large amount of heat energy can be absorbed by water before its temperature rises. Air molecules do not have this type of attraction between them; therefore the temperature rises more quickly with heat input from the Sun. Volume is also an important consideration in looking at the effects of the Sun's energy on water molecules. It is much easier for the Sun to heat or cool a small pond than it is for the Sun to heat or cool the ocean. In this laboratory exercise, you will compare the effect of the Sun's energy on water with its effect on the atmosphere. From your data, you will make conclusions about climate in different regions.

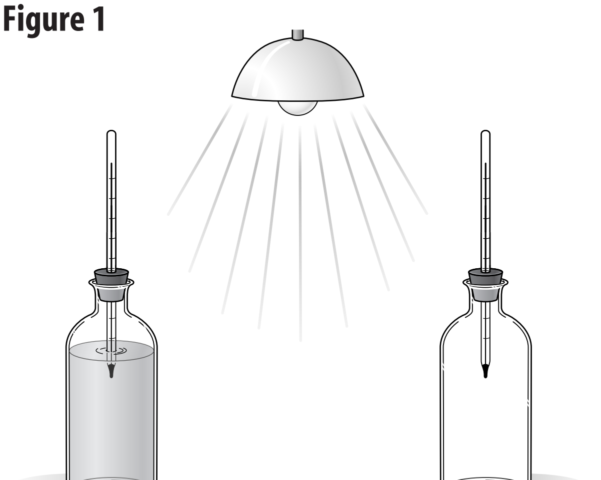
Strategy

You will model and observe the effect of energy from the Sun on water and on air.
You will infer how oceans and energy from the Sun affect climate.

Materials

2 plastic soda bottles (labels removed)
2 cork or rubber stoppers with center holes
2 long, chemistry-type thermometers
water
paper towels
**100-watt light source (if no sunlight is available)*
**apparatus for holding light source stationary*
**Alternate materials*

Figure 1



Procedure

1. Work with a partner. Obtain two bottles, stoppers, and thermometers from your instructor. (The thermometers might be fitted into the stopper holes already.)
2. Place the thermometer GENTLY through the stopper hole. The fit should be snug so the stopper will hold the thermometer, but not so tight that it breaks. If your thermometer breaks, DO NOT pick up the pieces of glass yourself. Tell your instructor what happened. If you are uncomfortable doing this step, ask for help from your instructor.
3. Pour water that has reached room temperature into one of your bottles. You do not need to fill the bottle all the way to the top. You need just enough water to insert the thermometer about 8–10 cm into the water. Use paper towels to wipe up any water spills.
4. Check the temperatures on your thermometers and record them on the table provided. They should both be about the same since they are room temperature.
5. If you have a sunny window in your classroom, place your bottles side by side in the window. If possible, it is even better to place your bottles outside in the Sun. If no sunshine is available, place your bottles under a light bulb, as shown in Figure 1.

Laboratory Activity 1 (continued)

6. After 10 min, observe and record the temperatures inside your bottles. If you need to remove the stoppers and thermometers to read the temperature, replace the stoppers quickly or you will lose heat from the bottles.

7. Repeat step 6 two times, so you have a total of four temperature readings for each bottle.

Data and Observations

Table 1

Time of observation in minutes	Temperature of air bottle (°C)	Temperature of water bottle (°C)
Initial time 0		
10		
20		
30		

Questions and Conclusions

1. Which bottle had the greatest amount of temperature change?

2. How do you explain this based on the idea that weak attractions exist between water molecules?

3. How would you relate this temperature change to warm, coastal climates? To flat, inland landscapes, like deserts?

Laboratory Activity 1 (continued)

4. The climate at the North and South Poles is never warm even though they are surrounded by oceans. How do you explain this? [Hint: Think about the angles of the sun's rays.]

____

____

____

____

____

Strategy Check

_______ Can you explain how water and air are affected differently by the Sun's energy?

_______ Can you explain how oceans influence climate?

LAB 2 Laboratory Activity

Photosynthesis and Sunlight

Green plants on land, in freshwater, and in salt water all share the very special property of being able to manufacture food. All green plants contain chlorophyll, which absorbs light and enables the plant to store energy. If sunlight reaches green plants, they can use two ordinary substances—water and carbon dioxide—to make their own food. Another important product of this reaction is the oxygen that green plants give off when they make food. Plants support all the animals in the world by providing food to eat and oxygen for respiration. This process of taking in water and carbon dioxide, changing light energy into stored energy, and giving off oxygen is called photosynthesis. In ocean waters, photosynthesis usually takes place in the upper 100 meters that sunlight reaches. Scientists interested in knowing how much photosynthesis occurs can measure the amount of oxygen that plants produce under specified conditions and during a defined period of time. They can use this information to calculate how much photosynthesis takes place.

Strategy

You will place one plant under a plant light and a second in the dark, both for 24 hours.
You will measure the amount of oxygen each plant produces.
You will use the amount of oxygen produced to compare the amount of photosynthesis that takes place in plants with and without exposure to light.

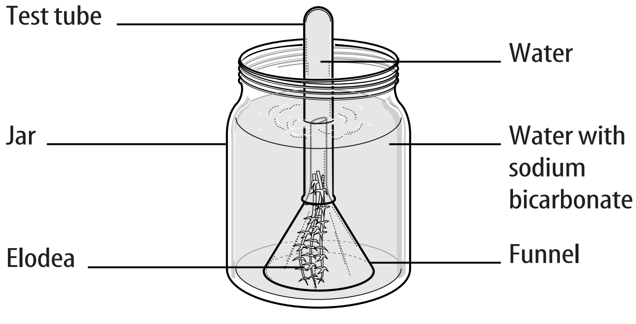
Materials

glass jars, each large enough to hold a funnel (2)
water that has stood at room temperature for at least 24 h
balance
sodium bicarbonate (baking soda)
Elodea (aquarium plant)
scissors
metric ruler
glass funnels, small (2)
test tubes, 18 × 150 mm (2)
labels
plant light
**gooseneck lamp with 150-watt bulb*
**Alternate materials*

Procedure

1. Fill each jar with water that has been standing for at least one day. Add 1 g sodium bicarbonate to the water in each jar.
2. Obtain two *Elodea* plants. Cut about 1 or 2 cm from the bottom of the stem. Throw away the part you cut off.
   WARNING: *Always be careful when using scissors.* Using your fingers, lightly crush about 2.5 cm of the cut end of the stem.
3. Place an *Elodea* plant into the water in each jar and cover it with a funnel. Position the plants so that the crushed ends are up. See Figure 1.

Figure 1



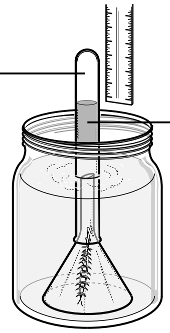
4. Fill a test tube completely with water. Hold your index finger over the mouth of the test tube and invert it over the stem of the funnel. Do not let any water escape from the test tube. NOTE: The test tube must be completely filled with water at the beginning of the experiment. If some water pours out before the test tube is in place, start over again. Place a test tube over each funnel. See **Figure 1.** Label each jar with your name or identifying symbol.

SCI 4.a. Students know the sun is the major source of energy for phenomena on Earth's surface; it powers winds, ocean currents, and the water cycle.

Laboratory Activity 2 (continued)

5. Place one jar near a plant light and leave the light on for 24 hours. Place the other jar in the dark but in a place that has the same conditions, such as temperature, as the jar near the plant light. The plant in the dark is the control.
6. After 24 hours, measure the height in centimeters of the gas column that collected in each test tube. See **Figure 2**. Record this data in **Table 1**.
7. With the other students, copy **Table 2** on the board. Make this table large enough so that every group of students can enter their results in it. Add your results from step 6 to this table.
8. Calculate the average height of the gas column for all of the lab groups. Record this data in **Table 1** in the Data and Observations section.

Figure 2



Data and Observations

Table 1

Height of Gas Column (mm)				
Light Conditions	**My Results**	**Class Low**	**Class High**	**Class Average**
Under plant light				
In the dark				

Table 2

Class Data for Height of Gas Column (mm)		
Student's Name	**Under Plant Light**	**In the Dark**

Questions and Conclusions

1. Examine the class data in the table written on the board.
   a. What are the highest and lowest amounts of oxygen produced by the plants in the dark?
   b. What are the highest and lowest amounts of oxygen produced by the plants in the light?
   c. Compare the average results of the plants in the dark and of the plants in the light.

Laboratory Activity 2 (continued)

2. What information from this experiment shows that light is needed for photosynthesis?

3. What proof do you have that oxygen is being given off during this experiment? Before you answer, carefully review what you observed during this experiment.

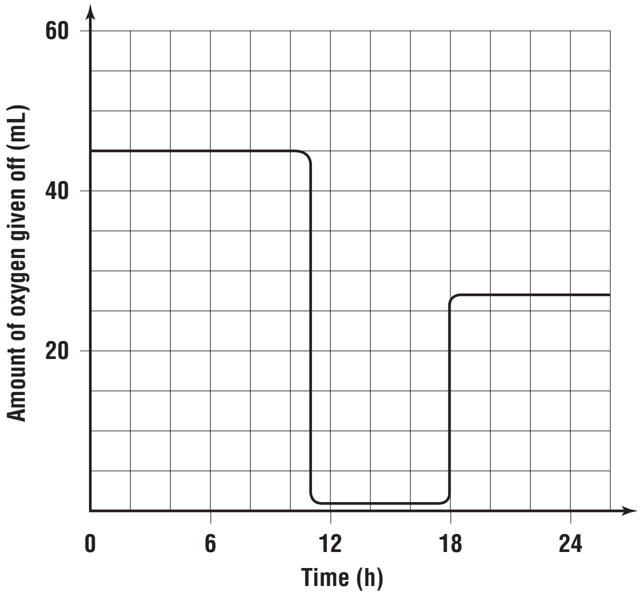
4. Why was sodium bicarbonate added to the water? HINT: Sodium bicarbonate gives off carbon dioxide when mixed with water.

5. Identify the substances in this activity that the *Elodea* plant used for photosynthesis.

6. Identify where the two products of photosynthesis accumulated in this experiment.

The graph in **Figure 3** shows the total amount of oxygen given off by a green plant during a 24-h period. Use the graph to answer questions 7 and 8.

Figure 3



7. a. How many hours during the first 24 hours did the plant receive light? Explain.

b. How many hours was the plant in the dark? Explain.

Laboratory Activity 2 (continued)

8. a. Describe the difference in the amount of oxygen the plant produced per hour from hours 1 through 11 and from hours 18 through 24.

______

______

b. What difference in light conditions might explain this difference?

______

______

c. What might produce a similar difference between the production of two of the same kind of green plants in the ocean?

______

______

______

9. What role do green plants play in the ocean waters?

______

______

______

Strategy Check

______ Can you measure the amount of oxygen produced by a plant in light and a plant in the dark?

______ Can you compare the amount of photosynthesis that takes place in each plant?

LAB 1 Laboratory Activity

Effect of Temperature on Cloud Formation

Clouds are groups of tiny water droplets that are suspended in the air. They form when water condenses around particles in the air. The temperature of the air is one of the factors that affects the type of cloud that forms.

Strategy

You will simulate the formation of a "cloud" inside a soft drink bottle.
You will form a hypothesis that predicts which clouds are denser, those formed by hot air and hot water, or those formed by cold air and cold water.

Materials

large clear plastic bottle with cap (2 L soft drink bottle)
graduated cylinder
thermometer
water (cold)
water (very hot, but not boiling)
matches

Procedure

1. Use the graduated cylinder to measure 60 mL of very cold water. Measure the temperature of the water and record it in the Data and Observations section table. Pour the water into the plastic bottle.
2. Replace and secure the cap. Shake the bottle vigorously for about 10 s. Place the bottle on a firm flat surface.
3. Remove the cap and drop a lighted match into the mouth of the bottle. **WARNING:** *Handle matches carefully.*
4. Replace the cap. Now squeeze the bottle with both hands to increase the internal pressure and observe what happens. Stop squeezing and observe what happens. Squeeze and release the bottle one more time.
5. Record your observations in the Data and Observations section table.
6. Empty the plastic bottle. Measure 60 mL of very hot water. Measure the temperature of the water and record in the Data and Observations section table. Pour the water into the bottle.
7. Hypothesize how your observations will differ using hot water.
8. Repeat steps 3, 4, and 5.

SCI 4.e. Students know differences in pressure, heat, air movement, and humidity result in changes of weather.

Laboratory Activity 1 (continued)

Data and Observations

Water Temperature	Observations When Pressure Increased	Observations When Pressure Decreased
1. Cold water		
2. Hot water		

Questions and Conclusions

1. What happened when the match was dropped into the bottle?

2. What happened when the bottle with cold water was squeezed?

3. What happened when the bottle with cold water was released?

4. How did the results obtained using cold and hot water compare? How can you explain these results?

5. Why did a “cloud” form when you stopped squeezing the bottle?

6. What was the purpose of dropping a lighted match into the bottle?

Laboratory Activity 1 (continued)

7. How did your hypothesis compare with the results of this activity?

____

____

8. Summarize the process of cloud formation.

____

____

____

____

____

____

Strategy Check

_______ Can you simulate the formation of a cloud inside a soft drink bottle?

_______ Can you predict which clouds are denser, those formed by hot air and hot water, or those formed by cold air and cold water?

LAB 2 Laboratory Activity

Carbon Dioxide and Earth's Temperatures

Since the Industrial Revolution in the 1800s, humans have burned greater and greater amounts of fossil fuels in order to produce more energy. As the burning of fossil fuels increases, so does the amount of carbon dioxide released into the atmosphere. Historical data from ice cores and modern data from the Mauna Loa Observatory in Hawaii show that carbon dioxide levels in the atmosphere have increased 30 percent since 1860. Growing evidence suggests that increases in atmospheric carbon dioxide may contribute to an increase in average temperatures on Earth. In this activity, you will examine the effects of an increased level of carbon dioxide, produced by fizzing antacid tablets, on air temperature.

Strategy

You will measure the air temperatures in two air samples containing different amounts of carbon dioxide.
You will graph the air-temperature data and compare the graphs.
You will infer how an increased level of carbon dioxide could affect temperatures in Earth's atmosphere.

Materials

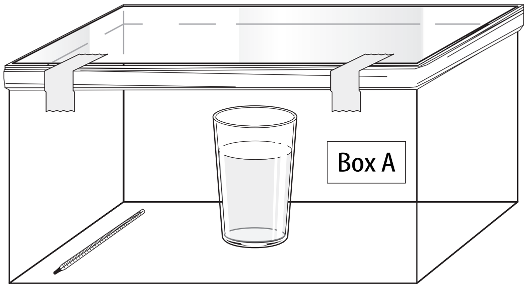
graduated cylinder or metric measuring cup
2 clear-plastic cups
water
2 clear-plastic boxes with lids
masking tape
marking pen
2 thermometers
6 fizzing antacid tablets
sunlight or bright lamp
clock with second hand or timer
2 different colors of pencils or pens

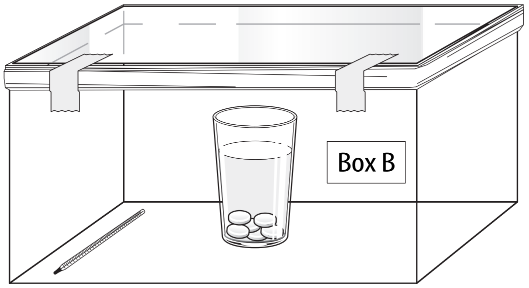
Procedure

1. Using a graduated cylinder, measure and pour 100 mL of water into each of the two plastic cups.
2. Set one cup in the center of each plastic box.
3. Use masking tape and a marking pen to label one of the boxes *A* and the other *B*.
4. Place one thermometer in each of the boxes. Put the lids on the boxes. Check to make sure you can read the thermometers when looking into the boxes through the lids. If necessary, reposition the thermometers. Be sure the thermometers are located in the same positions in both boxes.

SCI 4.a. Students know the sun is the major source of energy for phenomena on Earth's surface; it powers winds, ocean currents, and the water cycle. Also covers **SCI 4.e.**

Laboratory Activity 2 (continued)





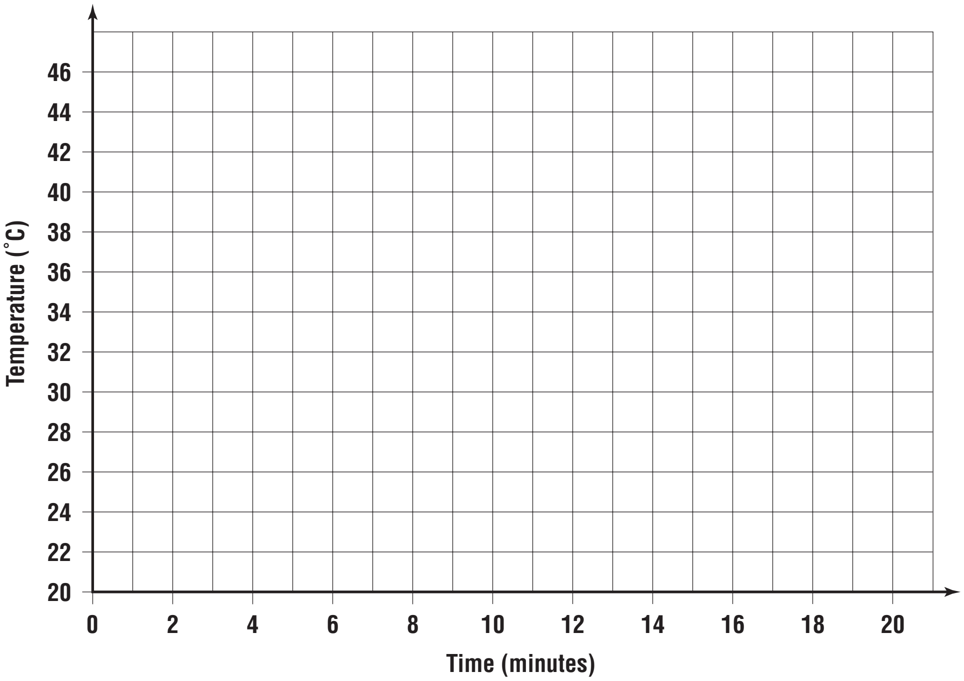
5. Remove the lids from both boxes.
6. Place the lid on Box A and seal it with tape.
7. Add six antacid tablets to the water in the plastic cup in Box B. Immediately place the lid on the box and seal the lid to the box with masking tape. Observe what happens in the cup.
8. Being careful not to disturb the contents of the boxes, place both boxes, side by side, in an area where they will receive bright sunlight. If that is not possible, place both boxes the same distance from a single, bright light source.
9. Once the boxes are in place, begin taking temperature readings. Measure the temperatures in both boxes every minute for 20 minutes. Record the temperatures in the table in the Data and Observations section.
10. After you have collected your data, plot your data from Box A on the graph in the Data and Observations section. Then plot your data from Box B on the same graph with a different color of pencil or pen.

Laboratory Activity 2 (continued)

Data and Observations

Time (min)	Temperature in Box A (°C)	Temperature in Box B (°C)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Laboratory Activity 2 (continued)



Questions and Conclusions

1. What evidence did you have that carbon dioxide was being released into the air in one of the boxes?

____

____

2. Was there any difference in the graphs of the air temperature in the two boxes? If so, describe it.

____

____

3. What can you infer about how increased levels of carbon dioxide might affect average temperatures in Earth's atmosphere?

____

____

Strategy Check

_______ Can you measure the air temperatures in two air samples containing different amounts of carbon dioxide?

_______ Can you graph the air-temperature data and compare the graphs?

_______ Can you infer how an increased level of carbon dioxide could affect temperatures in Earth's atmosphere?

LAB 1 Laboratory Activity

Changes in Predator and Prey Populations

A predator is an animal that kills and eats another animal. A fox is an example of a predator. The prey is the animal killed by a predator. A rabbit is an example of an animal that is prey for the fox.

The sizes of the predator and prey populations can change with time. Biologists sometimes need to know the sizes of certain predator and prey populations. They can sample the population by trapping and/or counting the animals. The result of the samplings changes as the populations change.

Strategy

You will set up a model of predator and prey populations and observe changes in the results you get from sampling as the populations change.
You will construct a graph showing your results.

Materials

101 brown beans
17 white beans
small paper bag
colored pencils

Procedure

Part A—Sampling a Population

1. Read this report about animals on the abandoned Linworth farm.
   The Linworth farm was abandoned in 1990, when an interstate highway was built through it. In April 1997, two biologists decided to study how the fox and rabbit populations on the 40 hectares of farmland were changing. The scientists counted rabbits by trapping and releasing them and counted foxes with binoculars. The biologists trapped and released 23 rabbits; they saw 2 foxes. The scientist continued their observations in the spring and fall for several years.
2. Put 92 brown beans and 8 white beans into a bag. The brown beans represent rabbits, and the white beans represent foxes. Note that these numbers are four times the observed number of animals in the example above. The observed animals are the sample. The larger numbers represent the numbers of rabbits and foxes in the actual populations.
3. Shake the bag with the beans. Select a bean without looking. Record your results in Table 1 in the Data and Observations section. If you picked a brown bean, put a mark under "observed" in the rabbit column. If you picked a white bean, put a mark in the fox column.
4. Return the bean to the bag. Select another bean, record the result in Table 1 and return the bean to the bag. Repeat this procedure until you have results recorded for 25 beans, which is 25 percent of the actual numbers in the populations.
5. Add together the numbers of brown beans selected. Record the number in Table 1. Repeat for the white beans.

Part B—Recording Changes in Populations

1. Examine Table 2, which explains how to change numbers of beans to show how the rabbit and fox populations changed as a result of changes in environmental factors.

SCI 5.e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition. Also coves **SCI 5.b.**

Laboratory Activity 1 (continued)

2. Use the information in Table 2 and the method described in Part A to sample the populations of rabbits and foxes nine more times. Enter your data in Table 3.
   a. Start with the information for the first date in Table 2, October 1997. Add and remove beans as directed to represent the changes described.
   b. Select 25 more beans, returning them to the bag each time. Make marks in the appropriate columns in Table 3, and fill in the total number of brown beans and white beans selected.
   c. Repeat this procedure for every date in Table 3. When you come to a date in Table 3 that is not included in Table 2, assume there was no change in the populations. However, conduct a new sampling even though the total populations were unchanged.
3. Fill in the graph on the next page using the data from the population samplings that you recorded in Table 3. Use two different colored columns for each date, one for rabbits and one for foxes.

Data and Observations

Table 1

Sampling Data

Date	Rabbits (brown beans)		Foxes (white beans)	
	Observed	Total	Observed	Total
April 1997				

Table 2

Changes in Population

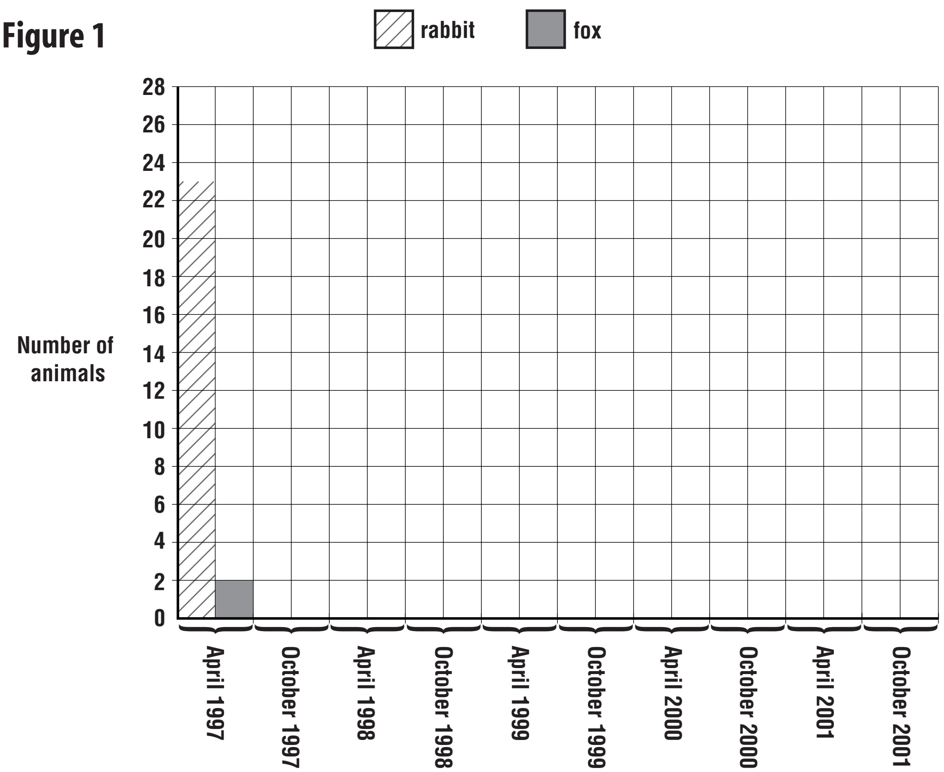
Sampling date	Rabbit population	Fox population
October 1997	The winter was harsh, and food was inadequate. Many rabbits died. Remove 10 brown beans.	Foxes ate pheasants as well as rabbits. Fox numbers increased. Add 2 white beans.
October 1998	Food was plentiful. Rabbits moved into the area. Add 15 brown beans.	Foxes had larger litters than usual. Add 2 white beans.
April 1999	Disease killed many rabbits. Remove 8 brown beans.	Food supply was low due to disease among the rabbits. Some foxes left the area. Remove 3 white beans.
October 1999	Spring came early. Rabbits could breed earlier. Add 12 brown beans.	Food was plentiful. Foxes moved into the area. Add 8 white beans.
April 2000	No change in population.	Inadequate food to feed the increased fox population. Some foxes moved out. Remove 4 white beans.
October 2000	The farm was opened to hunters, who killed pheasants. Foxes ate more rabbits. Remove 14 brown beans.	Hunters shot some foxes. Remove 2 white beans.

Laboratory Activity 1 (continued)

Table 3

Population Sampling				
Date	Rabbits (brown beans)		Foxes (white beans)	
	Observed	Total	Observed	Total
October 1997				
April 1998				
October 1998				
April 1999				
October 1999				
April 2000				
October 2000				
April 2001				
October 2001				

Figure 1



Laboratory Activity 1 (continued)

Questions and Conclusions

1. In this example, which animal is the predator and which is the prey?

2. How did the data from your sampling in Part A compare with those of the two biologists in April 1997?

3. Give two factors that caused a decrease in the rabbit population.

4. Give two factors that caused an increase in the rabbit population.

5. Give three factors that caused a decrease in the fox population.

6. Give three factors that caused an increase in the fox population.

7. What happened to the rabbits when the pheasant population decreased?

Strategy Check

_______ Can you sample populations without counting each individual?

_______ Can you demonstrate that populations change over time and seasons?

LAB 2 Laboratory Activity

Exploring Life in Pond Water

Looking through a microscope, you can see a miniature world of many, many microorganisms. In a single drop of pond water, you might be able to see protists, bacteria, plants, and tiny animals. Because the ecosystem of a pond is not uniform throughout, different organisms live in different parts of the pond. Water collected from the surface and from near the sediment will contain some of the same organisms, but there will be some organisms that live in only one area or the other.

Strategy

You will examine two samples of pond water under the microscope.
You will identify some of the organisms that exist in each sample of pond water.
You will compare the organisms found near the surface to those found near the bottom of the pond.

Materials

water collected from the surface of a pond
droppers (2)
microscope slides (2)
coverslips (2)
microscope
water collected near the bottom of a pond

Procedure

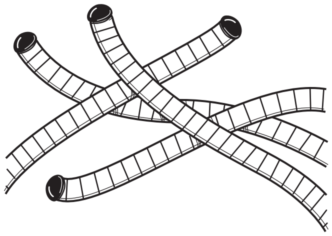
1. Use the dropper to place one drop of surface pond water on a clean microscope slide. Carefully put the coverslip on the drop.
2. Examine the surface pond water under low and high power magnification of the microscope. Carefully move the slide so that you are able to examine all areas of the slide.
3. Use the drawings in the Data and Observations section to identify the organisms you observe. On the lines under the drawings, indicate which organisms were observed in the surface pond water.
4. Repeat steps 1 through 3 for a drop of water from the bottom of the pond.
5. Complete Table 1 in the Data and Observations section by entering the microorganisms that you observe in the water from the surface and the bottom of the pond.
6. Enter your data in the table your teacher has prepared on the board by putting a mark by each organism that you observed in your samples. When all students have entered their data, complete Table 2 by summarizing the data from the table on the board.

SCI 5.a. Students know energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs. Also covers **SCI 5.d.**

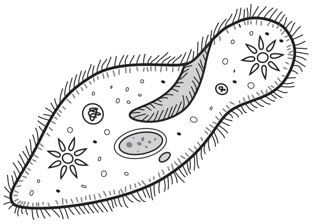
Laboratory Activity 2 (continued)

Data and Observations

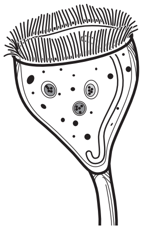
1. *Oscillatoria*



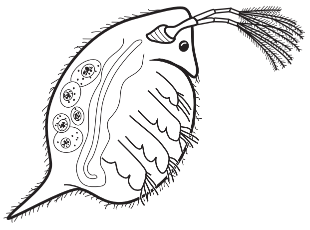
2. *Paramecium*



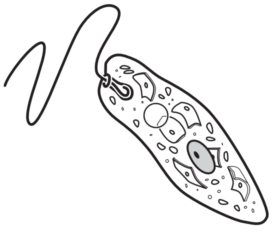
3. *Vorticella*



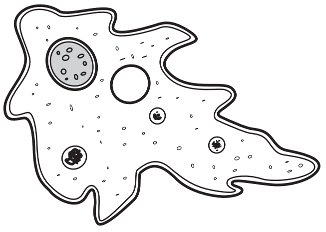
4. *Daphnia* (waterflea)



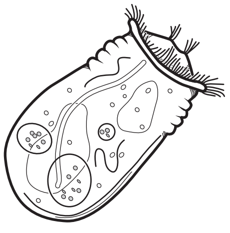
5. *Euglena*



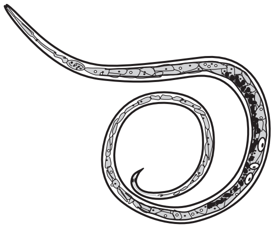
6. *Amoeba*



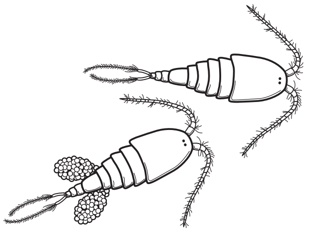
7. Rotifers



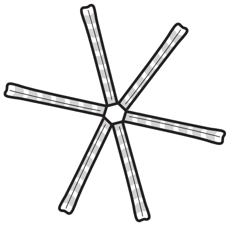
8. Nematodes



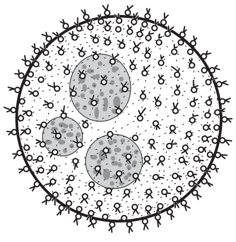
9. *Cyclops*



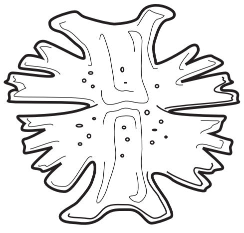
10. Diatoms



11. *Volvox*



12. Desmids



Laboratory Activity 2 (continued)

Table 1

Individual Data	
Organisms found in surface pond water	**Organisms found near pond bottom**

Table 2

Group Data		
Organism	**Near surface**	**Near bottom**
Oscillatoria		
Paramecium		
Vorticella		
Daphnia		
Euglena		
Amoeba		
Rotifers		
Nematodes		
Cyclops		
Diatoms		
Volvox		
Desmids		

Laboratory Activity 2 (continued)

Questions and Conclusions

1. Did you find different organisms in the surface and deep pond water samples? Explain.

2. What factors might influence why some organisms are found only in surface pond water or only in deep pond water?

3. Because a pond is an ecosystem that changes all the time, experimental variables might have an impact on your observations. Explain how each of the following might influence the organisms observed:
   a. season of the year

   b. delay between when the sample was collected and the experiment was performed

   c. depth of collection site for water from the bottom of the pond

   d. distance from shore that the surface water was collected

4. In what ways might human activity impact the pond water ecosystem?

Strategy Check

_______ Can you examine samples of pond water under the microscope?

_______ Can you identify the organisms that exist in each sample of pond water?

_______ Can you compare the organisms found on the surface of a pond to those found near the bottom?

Name Date Class

LAB 1 Laboratory Activity

Communities

The human population of an area is made up of all the people who live there. The community in which people live includes other populations as well, populations that might include squirrels, honey bees, and maple trees. All the populations living together in a certain area make up a community. The producers in a community make the energy-rich molecules that can be used as food. The consumers obtain food by eating other organisms, either living or dead, that contain the energy-rich molecules. All the organisms in a community interact with each other.

Strategy

You will study a community.
You will identify organisms in the community that are producers or consumers.

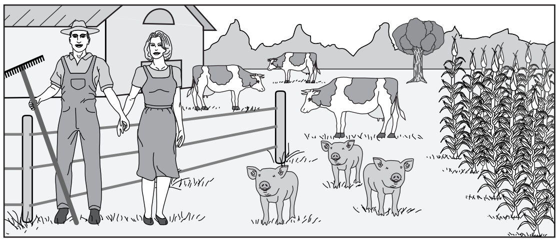
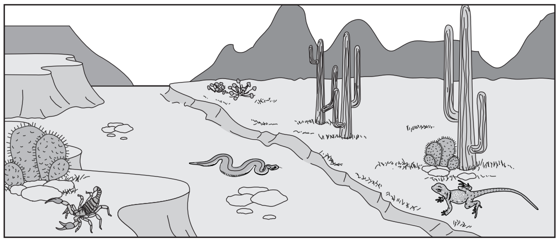
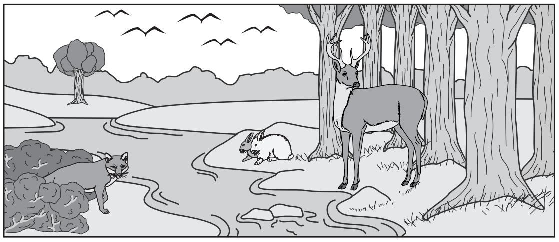
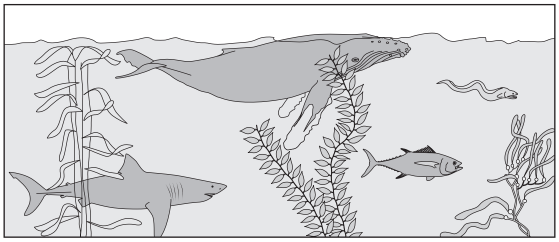
Materials

thermometer
paper
pencil

Procedure

Part A

1. In Table 1 in the Data and Observations section, list four living things commonly found in each type of community shown below. For example, a farm community might have humans, cows, horses, chickens, wheat, corn, and soybeans.
2. Classify the living things listed in Table 1 as producers or consumers. Producers can make their own food and are usually green. Consumers cannot make their own food and usually are not green. Circle the producers and underline the consumers.

SCI 5.c. Students know populations of organsims can be categorized by the functions they serve in an ecosystem. Also covers **SCI 5.a.**

Laboratory Activity 1 (continued)

Part B

1. With your teacher's help, choose a nearby community to study.
2. Record in Table 2 the common names of the consumers and producers that you observed in your selected community. Note the approximate number of each type of organism. Continue your list on a separate sheet of paper, if needed.
3. Moisture, light, season of the year, and temperature can influence communities. Observe these conditions in the community you are studying. Then record your observations below in the Data and Observations section.

Data and Observations

Table 1

Type of community	Names of organisms
Farm	
Forest	
Desert	
Ocean	

Table 2

Producers		Consumers	
Type	Number	Type	Number
Example: Grass		Example: Mice	

1. Location: ____________________
2. Date of observation: ____________________
3. Amount of direct sunlight: ____________________
4. Evidence of moisture: ____________________
5. Air temperature: ____________________

Laboratory Activity 1 (continued)

Questions and Conclusions

1. Define community.

2. What is a producer?

3. What is a consumer?

4. Do all communities have both consumers and producers? Explain.

5. How many kinds of producers did you find in the community you studied?

6. How many kinds of consumers did you find?

7. Did you find more producers than consumers? Explain why there would be more of one than the other.

8. What do producers provide consumers?

Strategy Check

_______ Can you study a community?

_______ Can you identify the producers and consumers in the community?

LAB 2 Laboratory Activity

Human Impact on the Environment

Human beings are changing the environment, and the rate at which they are changing it is increasing rapidly as the population increases. Only recently have people become aware of their impact on the atmosphere, water, and the crust of Earth.

Strategy

You will make a survey of your neighborhood or town to observe people's impact on the environment.

You will use the accompanying matrix to estimate the ways in which humans have affected your local environment.

You will suggest some ways people can change their impact on the environment.

Materials

clipboard
pencil

Procedure

1. Look over the check sheet on the next two pages. A, B, C, and D are general categories for the way people change the environment. Across the top are the various areas of the environment that may be affected by the processes and materials that people use.
2. Walk through your neighborhood (in the city, at least a 10-block square) taking the sheet with you.
3. Place a check after each type of environmental influence found in your neighborhood. For example, if new houses are being built, put a check after "houses," category A.
4. In the boxes to the right, put a diagonal slash under the area(s) affected by this influence. If the effect is good, put a plus in the lower right part of the box. If you think the effect is bad, place a minus in this position.
5. In the upper left of the box, place a number from 1 to 10 to indicate how much impact you think the change has had or will have. If you think the change is small, write in 1; if you think it is or will be very large, write in 10. Use your judgment and observations to assign numbers 2 through 9 on this impact scale.
6. Find your total for each influence and for each affected area. Record your totals in the chart.
7. Find the class total for each influence and for each affected area. Record those totals in the chart.

SCI 5.e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

Laboratory Activity 2 (continued)

Data and Observations

Table 1

	Biological	Scenic	Recreation	Temperature	Air	Water	Eutrophi-cation	Other	Totals
A. Construction									
(Example)		2 / +				3 / -	1 / -		2 / -
Houses									
Roads									
Transmission Lines									
Fences or other barriers									
Canals									
Dams									
Shore structures									
Cut and fill									
Tunnels									
Mines									
Industrial plants									
Landscaped lawns									
B. Traffic									
On roads									
Pipelines									
C. Chemicals									
Fertilization									
Weed and insect control									
Deicing highways									

Laboratory Activity 2 (continued)

Table 2

	Biological	Scenic	Recreation	Temperature	Air	Water	Eutrophi-cation	Other	Totals
D. Waste Disposal									
Litter and dumps									
Sewage									
Stack and exhaust emissions									
Cooling water discharge									
Used lubricant									
Totals									
Class Totals									

Questions and Conclusions

1. List three ways in which the construction of concrete pavement (roads) changes the environment.

2. How does an automobile affect the atmosphere?

3. What other methods of travel, other than automobile would have less adverse effects on the environment?

4. If there is smog in your local area, what is its source?

5. What can be done to reduce or eliminate the smog?

6. What resources are being used in local construction?

Laboratory Activity 2 (continued)

7. What resources are lost to humans when cities move into the surrounding countryside?

____

____

8. Are there alternatives?

____

____

____

____

9. Discuss the drawbacks of the alternatives you have listed in the questions above.

____

____

____

____

____

Strategy Check

_______ Can you recognize human influence on your local environment?

_______ Can you estimate the impact, good or bad, using the matrix?

_______ Can you suggest and evaluate alternatives?

LAB 1 Laboratory Activity

Efficiency of Fossil Fuels

Plants use light energy from the Sun to produce energy-containing molecules. While some plants are burned directly to release that energy, other plants have undergone changes. Charcoal is made from wood that has been heated without the presence of oxygen, and it retains its energy-containing molecules. Plants that die and are covered by more plants, water, and sediment change first from peat to lignite, then to bituminous coal, and finally to anthracite coal. Heat and pressure cause these changes. The more heat and pressure that have been applied, the more concentrated the carbon content and the greater the energy-producing content of the deposit is. In this activity, you will examine how the properties of charcoal and bituminous coal compare.

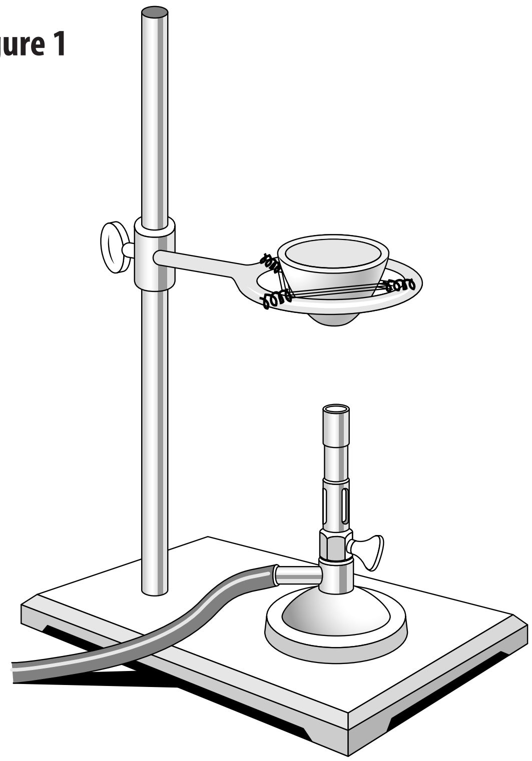
Strategy

You will compare the burning times of charcoal and bituminous coal.
You will compare the amounts of residue produced from the burning of charcoal and bituminous coal.
You will infer which fuel is more efficient.

Materials

ring stand with ring
pipe-stem triangle
crucibles (2)
Bunsen burner
balance
metric ruler
bituminous coal, small piece
newspaper
hammer
matches or striker
timer
tongs
hot pad
charcoal briquette

Figure 1



Procedure

1. Set up the ring stand, ring, pipe-stem triangle, a crucible, and Bunsen burner as shown in Figure 1. The top of the Bunsen burner should be about 5 cm below the bottom of the crucible.
2. Remove the crucible from the set-up. Use the balance to determine the mass of the crucible. Record its mass in the Data and Observations table.
3. Wrap the piece of coal in several layers of newspapers. Use a hammer to crush the sample. **WARNING:** *Be sure your fingers are not in the way when using the hammer.*
4. Add crushed coal to the massed crucible until it is about one-fourth full.
5. Use the balance to determine the combined mass of the crucible and the crushed coal (fuel). Record this mass in the table.

SCI 6.a. Students know the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process. Also covers **SCI 6.b.**

Laboratory Activity 1 (continued)

6. Calculate the mass of the coal by subtracting the mass of the crucible from the combined mass of the crucible and fuel. Record this mass in the table.
7. Place the crucible containing the crushed coal in the triangle. Light the Bunsen burner and start the timer.
8. As the coal burns, it should give off a red-hot glow. When all the crushed coal is gone and you can no longer see red-hot embers, turn off the Bunsen burner and stop the timer. Record in the table the time it took to completely burn the coal.
9. Allow the crucible to cool for 5 minutes. With the tongs, remove the crucible from the triangle and place it on a hot pad to continue cooling. **WARNING:** *The crucible will still be very hot.*
10. Repeat Steps 2 through 9 using the second crucible and the charcoal briquette.
11. Allow both crucibles to cool completely. Be sure you keep track of which sample is which.
12. Use the balance to determine the mass of each crucible and the residue it contains. Record this mass in the table.
13. Calculate the percentage of residue from each sample by dividing the mass of the residue by the mass of the sample, then multiplying the result by 100.

Data and Observations

	Charcoal	Bituminous Coal
Mass of crucible (g)		
Mass of crucible and fuel (g)		
Mass of fuel (g)		
Mass of crucible and residue after burning (g)		
Mass of residue (g)		
Percentage of residue		
Burning time (min)		

Questions and Conclusions

1. Which sample took longer to burn?

Laboratory Activity 1 (continued)

2. Which sample produced the greater percentage of residue?

____

3. Which sample—coal or charcoal—was the more efficient fuel? Explain your answer.

____

____

____

4. Predict how you think the efficiency of a sample of anthracite coal would compare to the samples you tested. Explain your answer.

____

____

____

Strategy Check

_______ Can you compare the burning times of charcoal and bituminous coal?

_______ Can you compare the amounts of residue produced from the burning of charcoal and bituminous coal?

_______ Can you infer which fuel is more efficient?

Name Date Class

Lab 2 Laboratory Activity: Using Biomass

Organic materials contain stored energy. When organic materials are used as biomass fuels, the stored energy is released as heat energy. For example, a power plant in Hawaii burns sugarcane waste to produce electricity. In other states, power plants burn wood chips or trash. In this activity, you will compare the amount of heat given off by burning several examples of biomass.

Strategy

You will compare how biomass fuels burn.
You will compare the amounts of heat produced when different biomass fuels burn.

Materials

30-cm piece of uninsulated, heavy copper wire
test tube
metric ruler
clay
large straight pins (3)
peanut, shelled
water
graduated cylinder
thermometer
aluminum foil
scissors
fireplace matches
mini-marshmallow
half of a wood splint

Procedure

1. Twist the copper wire into a spiral as shown in Figure 1. The top of the spiral should be able to securely hold the test tube.
2. Adjust the height of the spiral so that the bottom of the test tube is about 8 cm above the bottom of the spiral. See Figure 1.
3. Place a small piece of clay in the center of the spiral.
4. Stick the pointed end of a straight pin into a peanut. Stick the other end of the pin into the clay so the pin stands upright, as shown in Figure 2. The bottom of the test tube should not touch the pin.
5. Pour 10 mL of water into the test tube. Place a thermometer in the water and record the water temperature. Record this figure in the Data and Observations section.
6. Wrap the spiral of wire with aluminum foil and cut an opening, as shown in Figure 3.

Figure 1

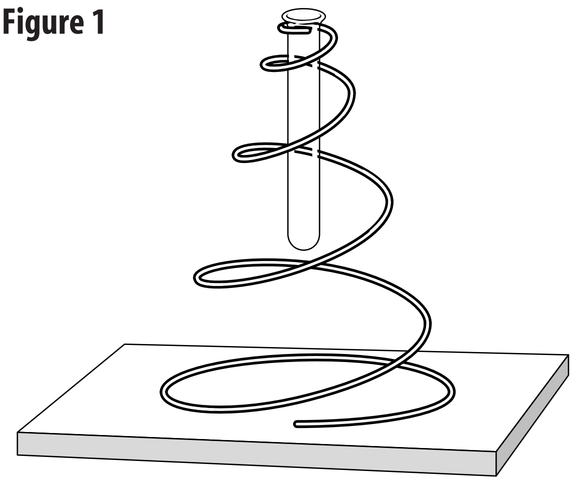
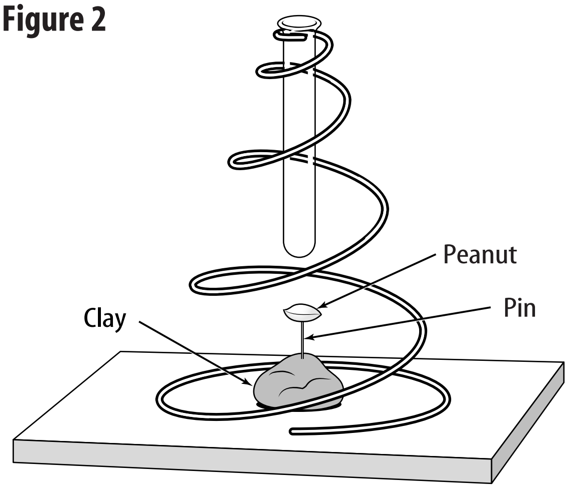


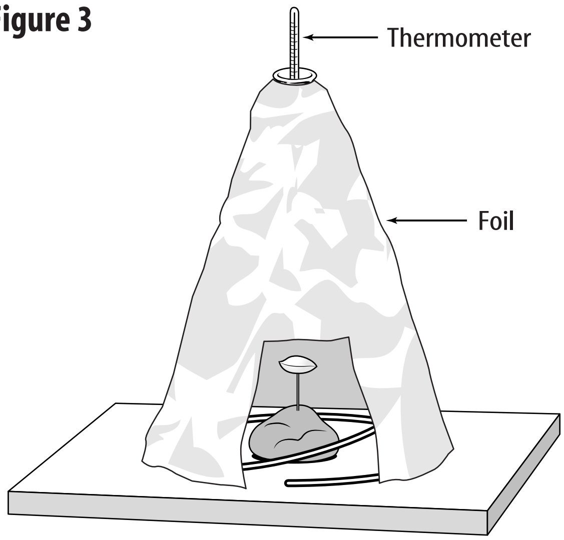
Figure 2



SCI 6.a. Students know the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.

Laboratory Activity 2 (continued)

Figure 3



7. Light the peanut with a match. As the peanut burns, observe any odors or smoke produced. Record your observations in the table.
8. After the peanut is finished burning, measure and record the water temperature. Record the temperature in the table. Observe and describe any residue left behind. Record your observations in the table.
9. Allow the materials to cool for 5 minutes. Then, carefully unwrap the foil covering and remove the pin containing the peanut. Pour out the water in the test tube.
10. Repeat steps 4 through 9 two more times, first using the mini-marshmallow in place of the peanut, then using the piece of wood splint.

Data and Observations

Sample	Start temperature (°C)	Final temperature (°C)	Change in temperature (°C)	Observations
Peanut				
Marshmallow				
Wood splint				

Laboratory Activity 2 (continued)

Questions and Conclusions

1. Did all three samples raise the water temperature an equal amount? Explain.

____

____

2. Which sample caused the most smoke? Which caused the least?

____

____

____

3. Did any of the samples cause less odor than the others? Explain.

____

____

____

4. Compare the amounts of residue left after burning the samples.

____

____

____

5. Which sample would you least like to use as a biomass fuel? Explain.

____

____

Strategy Check

_______ Can you compare how biomass fuels burn?

_______ Can you compare the amounts of heat given off when different biomass fuels burn?

Inquiry Activities

LAB 1 Inquiry Activity

Lemon Power

SCI 6.a. Students know the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.

Water power, wind power, and solar power can be transferred into electrical power. Chemical cells, such as those used in batteries, use chemical reactions to produce electricity. Some animals, such as the electric eel and the electric catfish, are able to produce electricity. Even your body could conduct electricity. Foods such as fruits also have energy. Do you think these can produce electricity?

Materials

- 2 alligator clips
- 2 wires, 25 cm each
- galvanometer
- lemon, apple, lime, banana
- paring knife
- metric ruler
- steel wool or fine sandpaper
- zinc strip
- copper strip

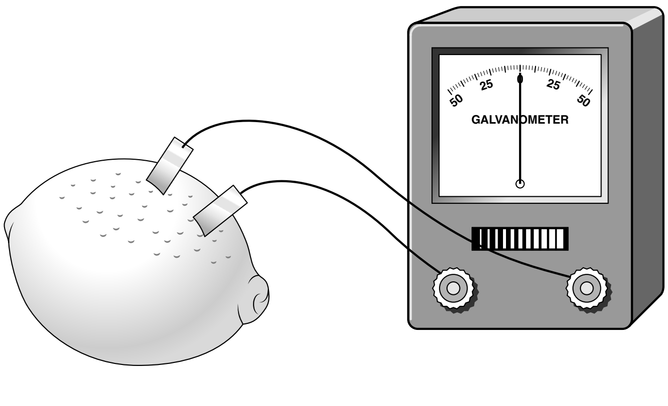
What You'll Investigate

In this activity, you will determine whether plants can be used in the production of electricity.

Procedure

WARNING: *The citric acid in the lemon is an eye irritant.*

1. Consider some fruits you think may be able to produce electricity or not. Write a hypothesis for an exploration of electrical energy in fruit.
2. Design an experiment by choosing two fruits: one you think will conduct or produce electricity and one you think will not.
3. Connect an alligator clip to one end of each piece of wire. Connect the other end of wire to terminals on the galvanometer.
4. Roll the fruit on the table, pressing firmly with your hand to break up some of the pulp inside to make it juicy.
5. Carefully make two incisions, each 1 cm long, through the skin of the fruit. The incisions should be 3 cm apart and parallel to each other.
6. Use the fine steel wool or sandpaper to polish the oxide layer off the zinc and copper strips.
   WARNING: *Wash your hands after completing this step.*
7. Insert the zinc strip into one incision and the copper strip into the other incision. Be sure the strips do not touch each other.
8. Attach one alligator clip to the zinc strip and the other clip to the copper strip. Observe the needle on the galvanometer. Record your observations in the *Data and Observations* table.
9. Repeat steps 4 through 8, using the other fruit. Record your observations in the *Data and Observations* table.



Name Date Class

Inquiry Activity 1 (continued)

Data and Observations

Item	Galvanometer reading	Observations
1st Choice		
2nd Choice		

Conclude and Apply

1. What happened to the needle on the galvanometer when you connected it to the first choice of fruit?

2. What happened with the other choice, the one you thought would not produce electricity?

3. Was there any difference in how far the needle deflected between the first and the second choice? Explain.

Going Further

Form a hypothesis for what will happen to the needle deflection if the metal strips are placed farther apart than they were in the first trial. Test your hypothesis. Test several other fruits and vegetables to find out if they could be used in this way.

LAB 2 Inquiry Activity

Tornado in a Bottle

SCI 4.e. Students know differences in pressure, heat, air movement, and humidity result in changes of weather.

What does a spinning ice skater have in common with a tornado? They both demonstrate the conservation of angular momentum. Angular momentum describes the movement of an object around an axis. Skaters begin to spin with their arms out, then draw them in close to their body, spinning faster and faster. Even though the mass is the same, as it gets closer to the axis of rotation, it spins faster, keeping the momentum the same. The same thing happens in tornadoes. The winds at the center of tornadoes average 480 km per hour. The tremendous speeds are due to the conservation of angular momentum.

Materials

- 1-quart plastic or glass jar (a large peanut butter jar works well)
- water
- dish soap
- vinegar (acetic acid)
- a few drops of food coloring

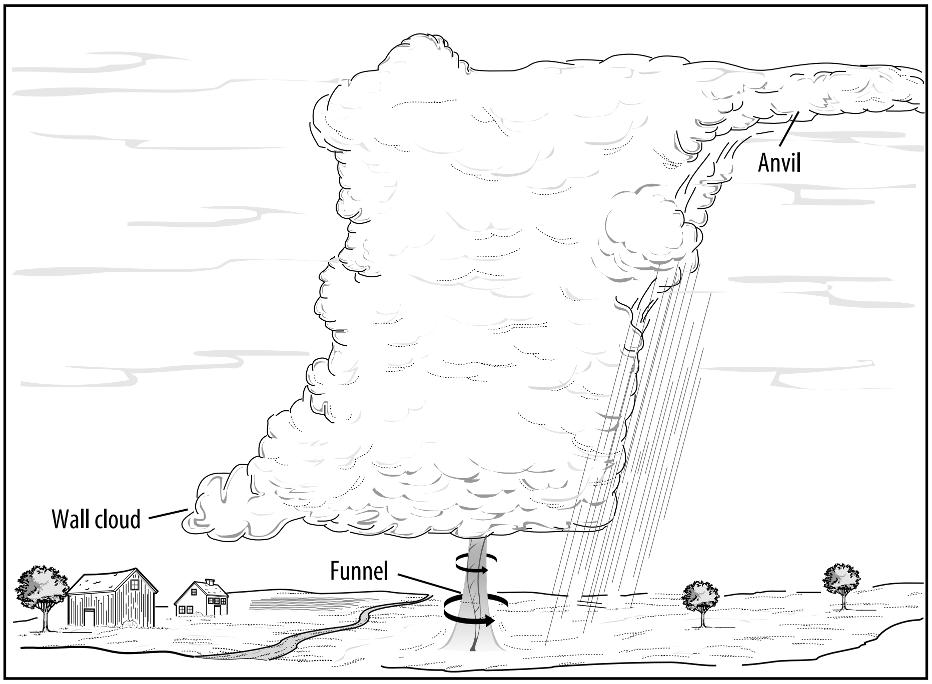
What You'll Investigate

In this activity, you will make a model tornado in a jar to help you determine the most dangerous part of a tornado.

Procedure

WARNING: *Vinegar and detergent are eye irritants. Wear goggles when handling these substances.*

1. Think about the information given in the background about spinning. If you wanted to model this angular momentum, what factors would be important? Write two or three questions considering these factors.
2. Decide which of your questions you could investigate with a simple model. Write a hypothesis related to what you can show about a real tornado using your model.
3. Plan an investigation that will show evidence to support your hypothesis. Explore possibilities with the materials listed. Make decisions about amounts and procedures to make an observable whirlpool.



Inquiry Activity 2 (continued)

4. Test your model, and analyze the outcomes. Make any changes you think will improve it to bring about better observations.

5. You might want to add small pieces of paper or glitter to help you observe the spinning motion of the whirlpool. Record your observations. Include a drawing of what you observe.

Data and Observations

Observations:

Drawing:

Conclude and Apply

1. Were you able to determine differences in spinning motion in your model? Explain.

2. Did your observations add more questions or support your hypothesis? Explain.

Going Further

What do gymnasts and divers do in order to do more flips? Observe some videotape clips of a gymnastics meet, diving competition, or other sporting event and look for instances of conservation of angular momentum.

LAB 3 Inquiry Activity

Making Waves

SCI 2.c. Students know beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of the waves.

Waves are periodic disturbances that carry energy through matter or space. The characteristics of wave motion are similar whether the waves are traveling through air, space, or water. One obvious example can be seen in the transfer of energy from ocean waves to coastal beaches. Most of the waves that you see along the seashore are the result of wind blowing over the open ocean. Waves in open ocean are called deep water waves. As the waves approach the shoreline and shallower water, the waves begin to touch bottom and are then called shallow water waves. These shallow waves slow down and crowd together, causing surf.

Materials

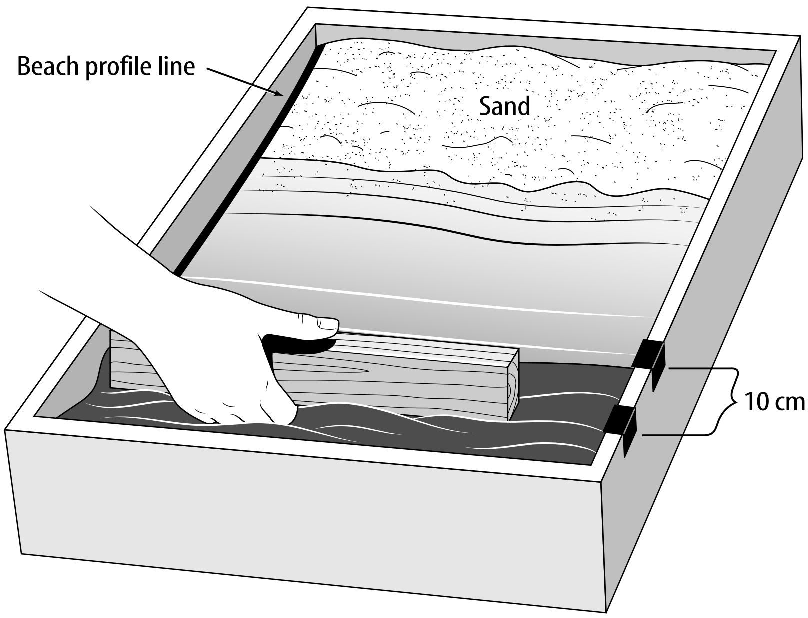
- wave tank or wooden frame, plastic storage box, cover for greenhouse flats, painting pan
- plastic sheet for lining tank
- sand (mixed sizes and clean)
- grease pencil
- metric ruler
- water
- wooden block or wallpaper edging tool
- clock or watch

What You'll Investigate

In this activity, you will investigate the effect of the energy transported by waves onto the beach.

Procedure

1. Pretend you are standing on an ocean beach looking out toward the water. List all the forms of energy, connected to waves, you perceive using your senses.
2. If you designed a model of a beach, could you investigate any of these forms of energy? Think of some questions you could answer.
3. Write a hypothesis stating the effect of energy you can observe with your model.
4. Place a protective plastic sheet under your model, and build it according to your plan for investigating the effect you chose to study.
5. Follow the procedure as outlined in your plan. Practice making waves before you begin your observations.
6. Sketch your profile before you begin and after each scheduled trial.



Inquiry Activity 3 (continued)

Data and Observations

Original Beach Profile | **New Beach Profile**

Conclude and Apply

1. Did your observations support the effect of wave energy on your beach as stated in your hypothesis?

2. How could you improve your procedure to get better results or to extend what you have learned?

3. Make a prediction about what would happen if the effect on the beach you investigated continued over an extended period of time.

Going Further

Form a hypothesis about what will happen to the beach profile if you change the length of the waves from 10 cm to 5 cm. What would happen if you changed the frequency from one cycle per second to two cycles per second? Test your hypotheses.

LAB 4 Inquiry Activity

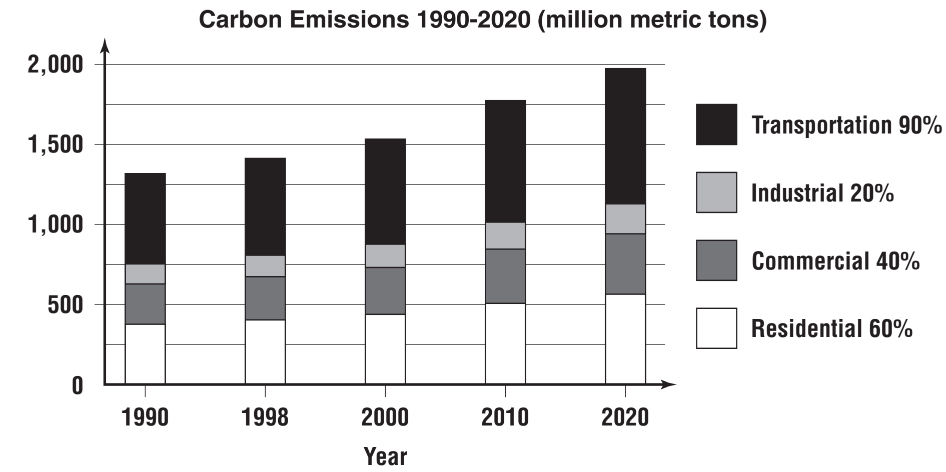
The Effects of Acid Precipitation

Fossil fuels help us to generate electricity and power our automobiles. However, burning fossil fuels can harm the environment. Car exhaust and gases from burning coal can create acid precipitation. Acid precipitation forms when waste gases, such as sulfur dioxide and nitrogen oxides, combine with moisture in the air creating sulfuric and nitric acids. These acids fall to the ground in rain, snow, or fog.

In some parts of the world, the precipitation is as acidic as lemon juice or vinegar. Acid can be measured using the pH scale. The scale ranges from 0 to 14. The lower the number, the greater the acidity. A high level of acidity can kill living organisms in lakes and streams. Lake water with a pH level of about 6 can kill crustaceans, insects, and plankton. When that number drops below 5, fish begin to die. Acid rain also is harmful to natural vegetation and crops.

Materials

- potting soil
- corn seeds
- metric ruler
- vinegar
- water
- pH paper
- 50-mL graduated cylinder
- plant light or window



What You'll Investigate

In this activity, you will investigate how much acidity new corn plants are able to tolerate through their roots.

Procedure

WARNING: *Vinegar is an eye irritant.*

1. Start the corn seeds in pots of potting soil five days before you start the experiment. Plant two seeds per pot.
2. Label the pots *acid* and *water.* Measure the heights of the plants, and describe the general condition of each plant before watering. Record observations in the appropriate *Data and Observations* table.
3. Decide how diluted to make your acid solution by testing mixtures with the pH paper.
4. Predict the effect of the acid solution on the plants.
5. Water one plant daily with acid solution and the other with regular tap water.
6. Water the plants every day for seven days with 10 mL of water or acid, and record the height and general condition of the plants (wilting, leaf condition, etc.).

SCI 6.a. Students know the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.

Name ______________________ Date ______________ Class ______________

Inquiry Activity 4 (continued)

Data and Observations

Table 1	Corn with acid	pH of solution ____________
	Height	**Description**
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Table 2	**Corn with water**	**pH of solution ____________**
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		

Conclude and Apply

1. Describe the difference between the plants. Compare your results with the results of other students.

____

____

2. What was the variable? The control?

____

3. In what ways did you control the variables?

____

4. Write a hypothesis for an experiment that tests the effect of rainwater that is more acidic or less acidic than natural precipitation. Write your hypothesis on a separate sheet of paper.

Going Further

What is the pH of rainwater in your area? Collect rainwater (or melted snow) and test it with pH paper. Find out what laws have been passed that will help with this problem. Brainstorm ways to help reduce acid precipitation in the United States.

Name Date Class

LAB 5 Inquiry Activity

The Greenhouse Effect on Venus

Although Earth and Venus are almost the same size, they are extremely different. The planet Venus orbits the Sun between Mercury and Earth. Earth is about 150 million km away from the Sun and Mercury is about 108 million km from the Sun. Venus is shrouded in a thick layer of poisonous gases. Its atmosphere allows sunlight in, but when the heat radiated from the planet tries to escape, it is trapped by the thick cloud of gases. As a result, the temperatures on the surface of Venus can climb as high as 460° C, making it the hottest planet in our solar system.

Venus's greenhouse effect serves as a model of what might happen on Earth if we continue to release large amounts of carbon dioxide and other waste gases into the atmosphere. Carbon dioxide is released when fuels containing carbon are burned. When it builds up in the atmosphere, it absorbs the heat energy that Earth reflects. As a result, heat that normally would be reflected back into the atmosphere is reflected back to Earth. Over a period of time, this can change Earth's climate. Warmer temperatures could melt polar ice caps, cause sea levels to rise, and result in flooding along the coasts.

Materials

- plastic storage box and lid (clear)
- soil
- water
- cardboard (stiff)
- thermometer
- heat lamp (mounted)
- watch
- pencils
- graph paper

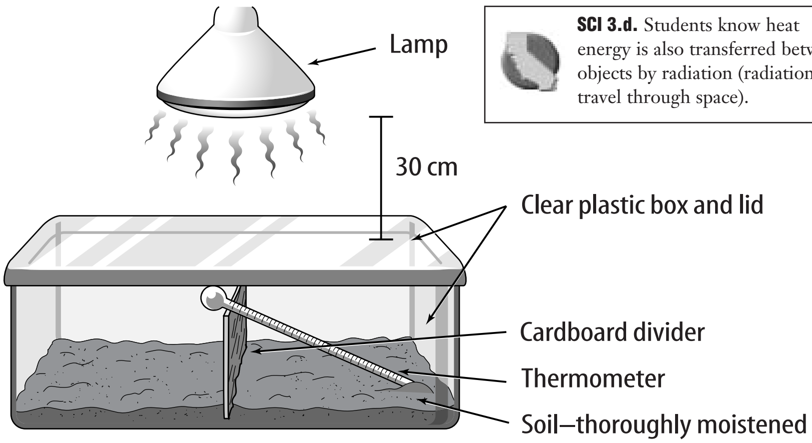
What You'll Investigate

In this activity, you will investigate the effect of radiated heat on a sealed system as a model of the greenhouse effect on Earth.

Procedure

1. Look over the materials listed for making a possible model of an Earth-atmosphere system.
2. Design a model that could show the effect of heat being sent directly on a sealed or partially closed system, on a dry system, or on one that has moisture. Be sure you can explain why each component is necessary and how it compares to Earth and its atmosphere.
3. Write three questions your model could answer. For example, if one side of the system had dry soil and one had wet soil, would the dry side have a more rapid increase in heat? If the system were partially closed, would the temperature increase faster in a sealed sytem?
4. Use the *Data and Observations* table to record your data.
5. Make a graph, plotting temperature on the vertical axis and time on the horizontal axis. Graph your data using two different colors.

SCI 3.d. Students know heat energy is also transferred between objects by radiation (radiation can travel through space).



Inquiry Activity 5 (continued)

Data and Observations

Time (min)	Temperature (˚C)	
	Lid off	Lid on
1		
2		
3		

Conclude and Apply

1. Did the temperature increase more with the lid on or off? Suggest an explanation related to your hypothesis.

2. Draw a diagram of Earth showing its atmosphere and what happens to solar radiation in the atmosphere.

3. How is the activity similar to the greenhouse effect on Earth?

Going Further

Do research to find examples of how the greenhouse effect already is altering our climate.

Name Date Class

LAB 6 Inquiry Activity

A Trip Around the World

SCI 4.a. Students know the sun is the major source of energy for phenomena on Earth's surface; it powers winds, ocean currents, and the water cycle.

Every point on Earth rotates as the planet spins on its axis. You don't notice this motion directly. The only evidence you can detect from Earth's surface is the apparent movement of Sun, Moon, and stars. But you are moving, even if you can't feel this movement. *Linear speed* is the term that describes the rate of motion of any point on Earth's surface at a given point in time.

Materials

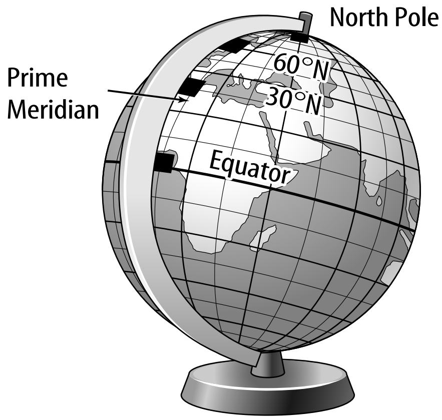
- a globe that is mounted on an axis
- masking tape
- stopwatch
- string
- meterstick

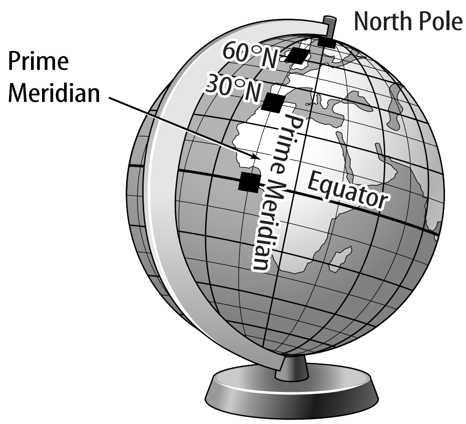
What You'll Investigate

In this activity, you will determine the linear speed of some points on the surface of a globe. You will also compare the linear speeds of points at different locations on the globe.

Procedure

1. Find three geographical places that lie on the same longitude but in three different latitudes. Choose one in the northern hemisphere, one in the southern hemisphere, and one near the equator. List these along with their latitude and longitude.
2. Design a plan for comparing the linear speeds of each of these points on a globe. Recall that the formula to determine speed is $s = d/t$. Decide the number of seconds you will move the globe and the measurement you will use to record the distance.
3. Mark the points and move the globe for the given time increments. Measure the distance traveled in that time from the starting point. Record your observations in the table.
4. Double your original time and triple it in subsequent trials to have a base for comparison. Record each trial, and complete a comparative analysis. Draw a conclusion.
5. Apply what you learned to the rotation of Earth. Do your actual geographical locations travel at different times as the earth turns? Explain.
6. Investigate the linear speeds of actual locations on Earth. Predict what you think you will find.





Inquiry Activity 6 (continued)

Data and Observations

Table 1

Latitude	Distance moved (cm)		
	1 s	2 s	3 s
Equator			
30˚N			
60˚N			
North pole			

Table 2

Latitude	Speed (cm/s)		
	Trial 1	Trial 2	Trial 3
Equator			
30˚N			
60˚N			
North pole			

Conclude and Apply

1. Which point moved the farthest distance for all three trials?

2. Which point moved the least distance for all three trials? Which point did not move at all for all three trials?

3. On what does the linear speed of a point depend?

4. What happens to linear speed as you move from the equator to the pole?

Going Further

Name some examples of cases where there would be different linear speeds in rotating objects.

Name Date Class

LAB 7 Inquiry Activity

A Survey of Your Own Environment

Humans are agents of change, and the rate at which they are changing the environment increases as the world's population increases. Industrial waste, chemical runoff from farms, oil spills, and sewage are polluting many of the world's waterways. Vehicle exhaust, emissions from factories, and chlorofluorocarbons are polluting the atmosphere and damaging its ozone layer. The destruction of habitats threatens many of the world's plants and animals.

Materials

- clipboard
- paper
- pencil

What You'll Investigate

In this activity, you will observe and classify how human activity affects where you live.

Procedure

1. As part of a group of three students, develop an environmental impact checklist that shows how various factors affect the environment. Divide these factors into four categories—construction, traffic, chemicals, and waste disposal.
2. Divide each category into smaller lists. For example, under construction, your list might include houses, roads, and landscaped lawns. List these from the top to the bottom of your chart. Across the page, include areas affected by the four categories listed above. These might include recreation, scenery, living things, temperature, water, and air.
3. Walk through your neighborhood (in the city, a four-block square, for example).
4. Place a check after each factor that could be having an environmental effect on your neighborhood. For example, if new houses are being built, put a check after "houses" in the construction category.
5. Devise a method to evaluate the impact of each factor on the environment. The impact on the environment of the various factors could be positive or negative. For example, landscaping might improve an otherwise eroded and weed-filled lot. Or, the builders of a housing development might first bulldoze a beautiful forest before landscaping yards. You might choose to rank the effects. A one (1) would indicate very little impact or change, and a ten (10) could indicate a very large impact or change.
6. When you have completed your checklist, summarize your findings and evaluate each factor's effect on the area where you live.

SCI 6.b. Students know different natural energy and material resources, including air, soil, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable.

Inquiry Activity 7 (continued)

Conclude and Apply

1. If new homes were constructed, which of the following seemed to occur?
   _______ more noise pollution
   _______ not enough ball fields or playground area
   _______ more bicycle and skating traffic
   _______ more cars driving and parking on the streets
   _______ more litter on streets and sidewalks

2. If new streets were constructed, which of the following seemed to occur?
   _______ more cars giving off exhaust
   _______ larger vehicles, such as trucks, giving off more pollution
   _______ less traffic on some streets
   _______ bicycle paths were added

3. If there are business districts or factories in your area, which of the following seemed to be true?
   _______ dark pollution in the air from smokestacks
   _______ unpleasant odors at different times of the day
   _______ noise pollution from traffic and businesses
   _______ light pollution from neon signs and bright street lamps near malls

4. If there are woods, parks, or recreational areas around your neighborhood, which of the following seemed to be true?
   _______ parks and playgrounds are kept clean and well-maintained
   _______ streams and woods have litter or are used as waste areas
   _______ flowers and trees are planted and grass is mowed
   _______ waste receptacles and recycling containers are present and emptied regularly

5. Weigh the pros and cons of your area, and determine if there are more positive or negative environmental factors. Explain.

   ____

   ____

6. If there are things that should be changed, what plan of action could you take? Whom could you contact?

   ____

7. What is your role in keeping your neighborhood safe and clean?

   ____

   ____

Going Further

Develop another environmental checklist that shows how various everyday factors affect your environment. Put these in a table or chart similar to the one you made for Activity 19. Divide these factors into four categories: home, school, entertainment, and family.

Forensics Activities

LAB 1 Forensics Activity

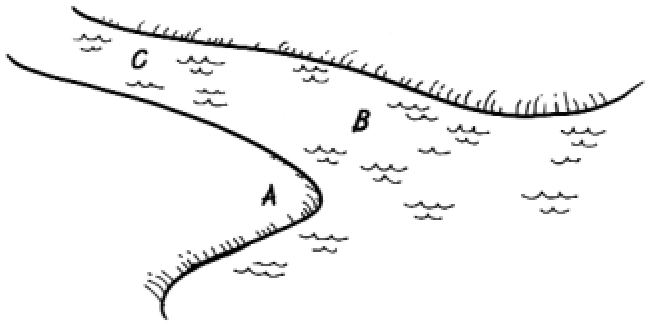
Where is the money?

The Problem

Recently, a vehicle belonging to an armored car company was robbed of $250,000 in cash and checks. Investigators had no leads until a young woman discovered an empty money bag along the shoreline of a lake. She unzippered the bag and found it partly filled with sand. The bag read *Liberty Security* across the front. The woman had recently heard about an armored car robbery in the area, so she immediately called the police. The investigators believe the robber might have placed some sand in the bag and then thrown it into the water, thinking the bag would sink. But there is also a river that feeds into the lake not far from where the bag was found. Investigators think the bag might have been dropped in the water from one of the following locations:

- Location A, which is an area of the lake directly in front of where the bag was found
- Location B, which is downriver, or closer to the mouth of the river
- Location C, which is upriver, or closer to the source of the river

Police have made the following map of the area:



Your job is to examine the sand and sediment samples in order to determine from which of the three locations the bag might have originated.

Background

Soil, sediment, and sand samples can provide general information about the area from which they came.

Rounding The longer a rock fragment stays in water, the more rounded it will become. For example, if a rock fragment with a lot of sharp edges is placed in a river, the water will gradually round out the sharp edges. As the rock fragment tumbles and moves along with the water across the bottom of the river channel, the sharp edges will be smoothed out. The same is true for the action of waves. Often, rock fragments and sand grains along a shoreline are smooth because of the constant movement of the water over them.

SCI 2.b. Students know rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns. Also covers **SCI 2.c.**

Forensics Activity 1 (continued)

Sorting Sediment is loose material such as rock fragments, mineral grains, and bits of shell. Grains of sand can vary in size and shape. The longer sand or sediment stays in moving water, the more sorted the material becomes. Sorted sediment means that grains of about the same size and shape are deposited together. Sediment found in an upstream section of a river, where the energy is greater, tends to be unsorted. As the river winds its way downstream, it loses energy. Sediment drops from the water because the river does not have enough energy to carry it. This means that the sediment will become more sorted as it moves downstream.

Size Typically, well-sorted and well-rounded sediment is small. The action of rolling along the bottom of a river or being constantly moved by waves gradually breaks down sediment into smaller pieces.

Analyzing the Evidence

In this lab, you will examine the sediment found in the money bag. You will compare the samples with the ones taken from Locations A, B, and C. You will then determine where the bag was dropped before it was discovered on the shoreline.

Everyday Materials

- ❑ tweezers
- ❑ paper plates

Lab Materials

- ❑ sediment samples from the bag
- ❑ sediment samples from Locations A, B, and C
- ❑ magnifying lens
- ❑ metric ruler

Safety

- Always wear safety goggles and a lab apron.
- Wash your hands thoroughly after each lab.

Procedure

1. Put on your lab apron and safety goggles, and wear them for the entire experiment.
2. Examine the sediment samples found in the money bag. Use your magnifying lens to examine the general size and shape of the grains. Use **Table 1** to record the general grain size (in millimeters) and a brief description of the grain shape. Include in your description whether the grains have sharp edges or are rounded. Also note whether or not the grains are generally the same size and shape.
3. Examine the three sediment samples from locations A, B, and C. Working with one sample at a time, pour a small amount of the sediment onto a paper plate. Use the magnifying lens to examine each sample, indicating the general grain size (in millimeters) and general grain shape. Record this information in **Table 1.** Include in your description whether the grains have sharp edges or are rounded. Also note whether or not the grains are generally the same size and shape.

Table 1

Sample	Grain Size (mm)	Grain Shape
Bag		
Location A		
Location B		
Location C		

Forensics Activity 1 (continued)

4. Use **Table 2** to make a sketch of typical grains taken from the bag, Location A, Location B, and Location C. Be sure to consider the relative size and uniformity of the grains as well as their general appearance. Use the information from **Table 1** for help.

Table 2

Bag	
Location A (lake)	
Location B (downriver)	
Location C (upriver)	

Conclude and Apply

1. Compare the sediment from the money bag to the sediment found at Location A. Do they appear to be the same? Be sure to include grain size, shape, and uniformity in your answer. Refer to your data tables in the *Procedure* section for help.

2. Compare the sediment from the money bag to the sediment found at Location B. Do they appear to be the same? Be sure to include grain size, shape, and uniformity in your answer. Refer to your data table under Procedure and your sketches under Data and Observations for help.

Forensics Activity 1 (continued)

3. Compare the sediment from the money bag to the sediment found at Location C. Do they appear to be the same? Be sure to include grain size, shape, and uniformity in your answer. Refer to your data table under *Procedure* and your sketches under *Data and Observations* for help.

Analyze and Conclude

4. Did you find that any of the three locations had similar sediment? Explain.

5. Based on your analysis of sediment samples from the money bag and Locations A, B, and C, where do you think the bag was dropped? Explain your reasoning.

6. How were you able to eliminate the other two locations? Explain your reasoning.

Name Date Class

LAB 2 Forensics Activity

A Salty Situation

The Problem

Some of the residents of Watertown Village have a water problem. When they turn on the faucets in their sinks and tubs, the water tastes salty. The residents in question all have private wells and live near Claire's Hand-Cooked Potato Chip Factory. The residents suspect the salt is coming from the potato chip factory.

A spokesperson for Claire's has admitted that some salt does enter the soil around the plant. However, the spokesperson was quick to add that the salt gets filtered through the soil and never reaches the groundwater underneath. The soil in the area is generally sandy.

In this lab, you will create a model of the soil in the vicinity of the potato chip factory. Your job will be to contaminate the groundwater and observe the filtering process. Instead of using salt in your model, you will use potato starch because its granules are similar to salt but can be colored more easily. You will use the model to determine whether or not it is likely that the salt from the potato chip factory is being filtered by the soil beneath it.

Background

Soil as a Filter Soil can act as a filter to remove biological and physical materials from groundwater. Whether or not a soil is an effective filter depends on the soil's porosity and permeability.

Porosity The porosity of a soil is the amount of water it can hold. Porosity refers to the percentage of open space in a given volume of soil or rock. Porosity is influenced by the sorting of the grains of soil. When a soil is well sorted, most of the particles are about the same size and shape. This means that there are fewer smaller grains to fill in between the larger grains, so there is more pore space. It is also true that loosely packed soil is more porous than tightly packed soil.

Permeability The permeability of a soil indicates how freely water can pass through its open spaces. If a soil is permeable, the open spaces, or pores, must be connected. For example, a rock can be porous but not permeable because water cannot freely pass through its open spaces.

Soil Examples In general, sandy soils are quite porous and permeable. The grain size and sorting in a sandy soil allow for this. A soil with an abundance of clay is an impermeable soil. The grain size and shape of clay make it much more difficult for water to pass through in a reasonable amount of time.

SCI 5.e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

Forensics Activity 2 (continued)

Everyday Materials

- ❏ potato starch
- ❏ coffee filter
- ❏ stopwatch
- ❏ iodine antiseptic
- ❏ water
- ❏ pie plate
- ❏ paper cup (one small, one large)
- ❏ pencil

Lab Materials

- ❏ soil samples
- ❏ funnel
- ❏ 100 mL graduated cylinder
- ❏ stirring rod
- ❏ magnifying lens

Safety

- Be careful when handling the stirring rod and magnifying lens because the glass is fragile.
- Always wear safety goggles and an apron.
- Wash your hands thoroughly after each lab.

Procedure

1. Put on your lab apron and eye goggles, and wear them for the entire experiment.
2. Fill the graduated cylinder with 150 mL of water. Add about 5 mL of potato starch and four drops of iodine. The solution should turn a purplish color.
3. Use the stirring rod to stir the water gently in the cylinder until the starch dissolves. Remember not to taste any of the materials in your lab.
4. Poke a series of holes in the bottom of the smaller paper cup. Gently place the smaller paper cup inside the larger cup. Make sure that the bottom of the smaller cup does not touch the bottom of the larger cup; there should be some space between the two. If the smaller cup is resting on the bottom of the larger cup, remove the smaller cup and poke a hole through the sides; then pass a pencil through the holes, and hang the smaller cup from the top of the larger cup so that the bottoms do not touch.
5. Use the spoon to scoop the soil sample into the smaller cup. Gently pack down the soil, but do not pack it too tightly.
6. As one person in your group starts the stopwatch, slowly pour 70 mL of the potato starch solution onto the surface of the soil sample.
7. Make sure all the water has passed through the soil. Measure the volume of water that passed through. Record your results in the data table below.
8. Carefully pour the water into the coffee filter that has been placed on the pie plate. Set aside the coffee filter and pie plate in a warm, sunny place to allow the water to evaporate. In you next lab period, check to see how much starch passed through.
9. Repeat steps 6–8 one more time to get a better idea of how the soil is filtering the water. After you have examined the coffee filter with a magnifying lens in your next lab period, answer the *Analyze and Conclude* questions.
10. Before leaving the lab today, answer questions 1–3 in the *Conclude and Apply* section.

Trial	Volume of Water Before	Volume of Water After
1		
2		

Forensics Activity 2 (continued)

Conclude and Apply

1. Would you describe your soil sample as porous? Explain.

2. Would you describe your soil sample as permeable? Explain.

3. Refer to the table in the *Procedure* section. Were your results for the two trials similar? If not, how could this be explained?

4. Based on the results of your soil model, do you think that the potato chip factory is responsible for the contamination of the nearby groundwater? Explain your reasoning.

Forensics Activity 2 (continued)

5. If your findings indicate that the potato chip factory is not responsible, what step should the residents take next? If you think the factory is responsible, what steps should be taken?

6. Consider other filtration systems that are common in our everyday lives. Describe one of these systems.

Name Date Class

LAB 3 Forensics Activity

What happened to the Wild Stream?

The Problem

Aunt Marta has just passed away. Because you were her favorite relative, she left you a piece of land next to what locals call the Wild Stream. In a note she left behind, Aunt Marta explains her decision: “I am passing to you a property that I own along the Wild Stream. I have never seen this land, as it is far away from my home. It has been in our family for about six generations. I know how much you love to fly fish, and the Wild Stream will be perfect for you. The property includes riverside land in case you ever decide to build a home on it.”

However, when you arrive on the property, you are quite surprised. The Wild Stream appears to be the gentle, slow-moving stream you passed on your way out to the property.

Why is it so different from Aunt Marta’s description? In this lab, you will decide if she was playing one last trick on you or if there is another reason the area has changed so much since it was described to Aunt Marta long ago.

Background

Rivers and Streams Some streams have a great deal of energy. These streams move fast, follow a straight path, and can carry things like large rocks. As time passes, the movement of a stream starts to slow. It often develops a series of bends called meanders. Streams are also more likely to flatten and become shallow.

Stream Erosion When a stream forms, it erodes soil and rock to form a channel. A stream’s channel is the path that the stream follows most of the time. Three things control a stream’s erosion—gradient, discharge, and load.

Stream gradient is a measure of the change in elevation over a certain distance. A stream with a high gradient is strong and has a great deal of energy to erode rock and soil. A stream with a low gradient is not as strong and has less energy for erosion.

Discharge is the amount of water in the stream that passes by a certain point in a given amount of time. The higher the discharge of a stream, the more energy it has to erode material.

Load is the amount of material a stream can carry. The size of the material depends on the velocity and volume of the stream.

Floodplains A floodplain is a broad, flat area found next to a stream. It is the area that is most likely to flood when the water spills over the banks of the stream. The soil in a floodplain is often fertile because of the new sediment that is washed up during a flood. Meanders can form in the floodplain. If one of these meanders, or bends, becomes cut off from the rest of the stream channel, it forms an oxbow. If the oxbow still contains water, it is known as an oxbow lake.

SCI 2.b. Students know rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns.

Forensics Activity 3 (continued)

Everyday Materials

- ❏ garden hose
- ❏ water
- ❏ soil
- ❏ several textbooks
- ❏ stopwatch
- ❏ paper towels
- ❏ bucket

Lab Materials

- ❏ stream table

Safety

- Always use safety goggles and a lab apron.
- Wash your hands thoroughly after each lab activity.
- Clean up spills immediately.

Procedure

1. Put on your lab apron and safety goggles, and wear them for the entire experiment.
2. Set up your stream. Place several books under one end of the stream table. You do not want the stream to be too steep, so only use two or three textbooks.
3. Fill the stream table with soil. If the soil slips down and piles up at the bottom end of the table, the stream is too steep. Remove one book and try again.
4. Set the bucket at the end of the stream table, centered under the drain spout. Open the spout so the water that moves through the soil will empty into the bucket.
5. Position the top of the garden hose in the center of the top end of the stream table. Attach the other end to a faucet. Draw a diagram of your setup in the *Data and Observations* section.
6. Turn on the faucet to just a trickle. You need a gradual stream of water so the features have time to form. Watch as the water creates a stream channel. Once a stream channel has been established, remove one of the books to simulate a slower-moving stream.
7. Observe the formation of meanders and how the behavior of the stream changes. Record your observations using **Table 1** in the *Data and Observations* section.
8. Remove another book so that you are now looking at a slower-moving stream. Again, observe what features are formed. Record your observations using **Table 1** in the *Data and Observations* section.
9. Clean up your lab materials as instructed by your teacher. Then return to your seat and answer the follow questions.

Forensics Activity 3 (continued)

Data and Observations

Draw a diagram of your lab setup in the space below.

Table 1

Trial	Number of Books	Observations	Time Elapsed
1			
2			
3			

Conclude and Apply

1. Describe the first stream you modeled. What features were evident?

2. Describe the second stream you modeled. What features were evident?

3. Describe the third stream you modeled. What features were evident?

Forensics Activity 3 (continued)

4. As you know, there are three variables that determine how a stream erodes material. Which of the three variables did you change during the lab? Describe how you could have changed the other two variables.

5. Draw a diagram of the last stream you modeled, and label the following: *stream channel*, *floodplain*, *meander*, and *oxbow*.

Analyze and Conclude

6. Based on what you now know about streams, why do you think Aunt Marta's description of the Wild Stream was so different from what you saw? Was it one of Aunt Marta's jokes, or is there another explanation? Explain your reasoning.

7. Your land and stream are different from what Aunt Marta described to you. Describe one way that this change might be beneficial in terms of the usefulness of your property.

LAB 4 Forensics Activity

Rena's Folly?

The Problem

Rena buys an old jewelry box at a yard sale. After she gets it home, she discovers a hidden compartment in the bottom. Inside she finds what looks like a treasure map. Rena determines that the map is a detailed section of the California coast near her home. She researches the area on the Internet and learns that there is evidence that a group of Spanish explorers took an expedition to the nearby shores in 1632.

Rena thinks that the map might be authentic. She decides to find the location marked with an *X* and dig to find out if anything is there. Taking along a shovel, pickax, and rope, she goes to this location. She digs but finds nothing. She is about to give up when she remembers something she learned in science class. Smiling to herself, she picks up the map and her equipment and heads home. Rena has some research to do, but she is confident that if she works her calculations correctly, she might be able to find Location X.

In this lab, you will help Rena try to find Location X by using your knowledge of plate tectonics. You will calculate the distance of the North American Plate movement to determine a more accurate present-day location of her map.

Background

Plate Tectonics The theory of plate tectonics is a widely accepted theory that describes the features and characteristics of the visible surface of Earth. According to the theory, the surface of Earth is made up of plates of crust that are slowly moving around the surface of Earth, creating mountain ranges and causing earthquakes and volcanoes. A good deal of evidence has been gathered that supports this idea. For example, some of the continents look like they would fit together like the pieces of a puzzle. Fossils have been found in parts of the world where similar organisms do not exist today. Evidence of glaciers is found in areas that are currently located near the equator.

How fast do the plates move? Through the use of satellites and the study of fossil and rock evidence, scientists estimate that the plates move at an average rate of 2.5 cm/y. This is about the same rate that your fingernails grow. However, there are times when the plates might move faster; for example, this can happen during an earthquake.

Where do they move? Tectonic plates move all over the surface of Earth. Currently, the plate containing India is moving north into the Eurasian Plate. The Atlantic Ocean is getting bigger as the North American Plate and the Eurasian Plate move apart. This means that the Pacific Ocean must be getting smaller as the Pacific Plate slides under the western edge of the Eurasian Plate. The Pacific Plate is actually moving northwest. The west coast of the United States, located on the North American Plate, is moving slightly south.

SCI 1.c. Students know lithospheric plates the size of continents and oceans move at rates of centimeters per year in response to movements in the mantle.

Forensics Activity 4 (continued)

Everyday Materials

- ❏ pen
- ❏ pencil
- ❏ ruler
- ❏ calculator

Lab Materials

- ❏ map of the western United States
- ❏ clue card for Points A, B, C, and D

Procedure

1. Obtain the directions to the treasure's four possible locations from your teacher.
2. Working with one set of directions at a time, plot each location on your map. Label each point.
3. Determine the length of time that would have passed in order for Location X to move to each point. Record your results in the data table below.
4. Using the information from the cards and the results from your data table, answer the questions that follow.

Point	Distance from Location X	Estimated Time	Direction from Location X
A			
B			
C			
D			

Forensics Activity 4 (continued)

Conclude and Apply

1. How many years would have passed for the plate to move Location X to Point A? Show your calculations in the space below.

2. How many years would have passed for the plate to move Location X to Point B? Show your calculations in the space below.

3. How many years would have passed for the plate to move Location X to Point C? Show your calculations in the space below.

4. How many years would have passed for the plate to move Location X to Point D? Show your calculations in the space below.

Forensics Activity 4 (continued)

5. Why is it necessary to know the compass direction of the four points when determining where to dig? Explain your answer.

Analyze and Conclude

6. Based on your calculations and examination of the map, where do you think Rena should start digging? Explain your answer.

7. Describe two examples of other objects that might be influenced over hundreds of years by the slow, gradual movement of plate tectonics.

Name Date Class

LAB 5 Forensics Activity

Fact or Fraud?

The Problem

An Iowa corn farmer wakes to find that acres of his corn are flat on the ground. The night before, a powerful storm front swept through the area. Upon viewing the damage, the farmer immediately calls his insurance agent. The farmer's insurance policy covers hail damage but not wind damage. The farmer informs his agent that he will be filing a claim, stating that his crops were destroyed by hail. Is this accurate, or is the farmer attempting to commit insurance fraud in order to be reimbursed for his crop damage?

In this lab, you will be the agent representing the insurance company. Your job is to determine if the crops were destroyed by hail or if the damage was caused by high winds from the storm. The farmer has claimed that there was hail covering his cornfields in the morning, but by the time you arrive, there is no sign of the hail. It is possible that the hail melted as the morning temperatures rose. You will examine weather data from a weather balloon and listen to the testimonials of neighbors in the area. You will use this information to determine if there is strong evidence that the crop damage was caused by hail.

Background

Hail starts as falling rain, usually within a cumulonimbus cloud. As the rain is falling, an updraft of air pushes it back up into the cloud. The temperatures in the cloud are colder, and the rain freezes as a result. The hail then experiences a series of melting and refreezing events, growing larger as each new layer of ice is added. To form hail the size of a golf ball, the updrafts within the clouds need to be at least 25 m/s. To create hail the size of a baseball, the updrafts need to be at least 40 m/s.

If ground temperatures are warm enough, hail can melt quickly; however, other evidence of hail might remain. For example, there might be pockmarks in the soil where the hail landed. Hail can even cause dents and paint chipping in vehicles. Hail stones can strip the leaves off plants but generally does not knock them down.

Wind shear is a natural phenomenon that involves sudden changes in wind speed and/or direction over short distances. Dangerous wind shear is generally associated with a frontal system, especially one that includes a thunderstorm.

During a thunderstorm, a large column of cold, dense air rapidly descends to the surface of Earth. This fast-moving column can be described as a downburst. Once the downburst reaches the surface of Earth, it expands horizontally, or across, in all directions. Once the downbursts spread out horizontally, they undercut the warmer air outside the storm. This mixing of air produces a rolling vortex of wind. A vortex resembles a whirlpool. The vortex then causes high-velocity winds to surge in opposing directions. These strong winds also are known as horizontal wind shear.

Weather balloons carry electronic equipment that is used to measure weather conditions as high as 30 km above Earth's surface. They are used to measure conditions such as temperature, air pressure, and relative humidity. Meteorologists also use these balloons to track wind speed and direction.

Information from weather balloons can accurately describe conditions in a general area; however, weather conditions on the ground can vary from location to location.

SCI 3.c. Students know heat flows in solids by conduction (which involves no flow of matter) and in fluids by conduction and by convection (which involves flow of matter).

Forensics Activity 5 (continued)

Materials

- ❑ pen
- ❑ pencil ruler
- ❑ tape recorder

Safety

- Always wear safety goggles and a lab apron.
- Never eat or drink anything in the lab.
- Wash your hands thoroughly after each lab activity.

Procedure

1. Examine **Table 1,** which summarizes the weather data from the areas surrounding the location of the insurance claim. Complete the table by providing a conclusion for each row. The second one has been done for you.

Table 1

Weather Balloon	Position	Temperature	Wind Conditions	Conclusions
1	5 km above farm	−20°C	winds moving east at 22 m/s	
2	10 km above farm	−60°C	winds moving up at 9 m/s	updraft; hail forming
3	20 km above farm	−55°C	winds moving up at 16 m/s	
4	25 km above farm	−30°C	winds moving down at 22 m/s	

Forensics Activity 5 (continued)

2. Collect the cards containing the statements from the neighbors and the hail samples from your teacher. Examine each one, then complete **Table 2**.

3. The four farmers describe the location of their farms in relation to the farm in question. Use the space below **Table 2** to make a map of the farms.

Table 2

Witness	Statement	Hail found? Size?	Damage?
1			
2			
3			
4			

Conclude and Apply

1. Briefly describe the weather conditions during the time that some of the crops were damaged.

____

____

____

____

Forensics Activity 5 (continued)

2. Why do you think two farmers reported hail, but the other two did not?

3. Was the size of the hail that you measured a good indication of the size of the hail when it fell? Explain your answer.

Analyze and Conclude

4. How reliable is the data from the weather balloon? From the interviews? Explain.

5. Based on your analysis of the available data and interviews, will you report to your supervisor that there is strong evidence that hail caused the crop damage? Explain your answer.

Probeware Activities

Getting Started with Probeware

The following instructions will guide you through the setup process for the data collection unit and the graphing calculator. The activities are compatible with either the CBL 2 or the LabPro unit. Each activity was written for use with TI-73 or TI-83 Plus graphing calculators. These activities can be adapted for use with other graphing calculators or other data collection units, if desired.

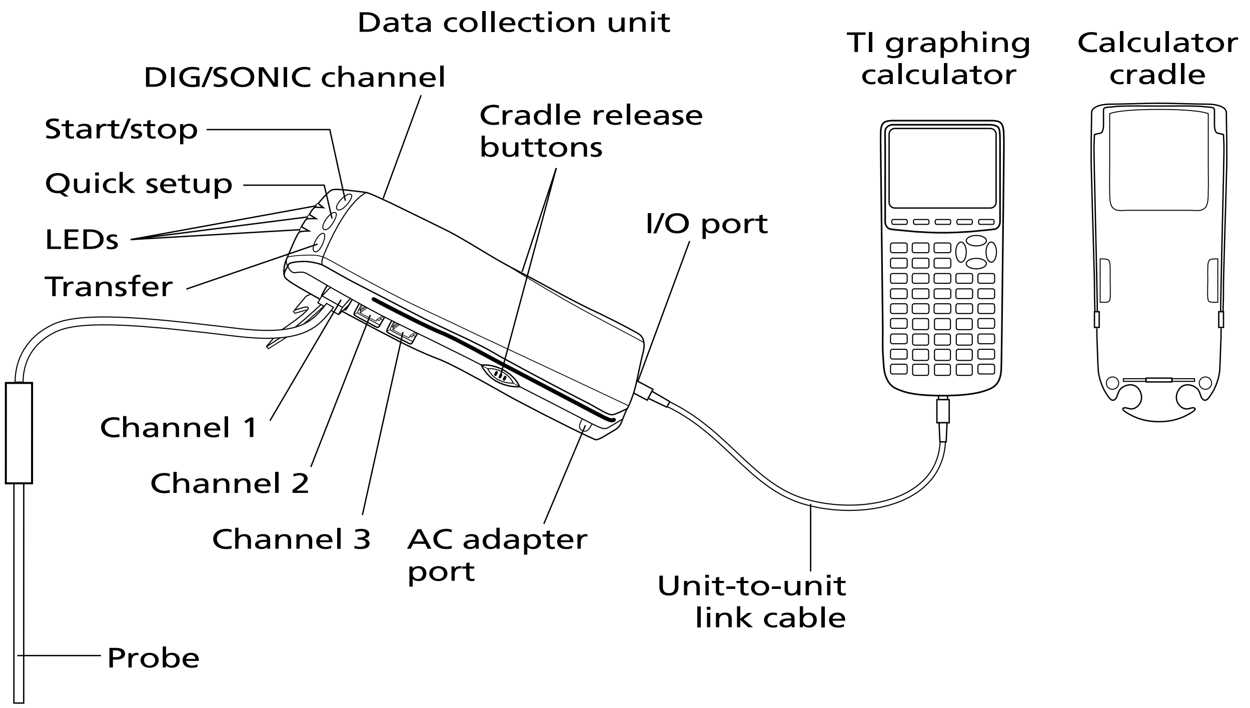
Connecting a Graphing Calculator to the CBL 2 or LabPro Unit

1. Insert batteries into the CBL 2 or LabPro unit and graphing calculator.

2. The cradle is an optional accessory that conveniently connects the two units. Slide the back of the cradle onto the front of the CBL 2 or LabPro unit until it clicks into place.

3. Insert the upper end of the calculator into the cradle and press down on the lower end until it locks into place.

4. Connect the CBL 2 or LabPro unit to the graphing calculator using the unit-to-unit link cable. Plug the cable into the I/O port at the end of the CBL 2 or LabPro unit and the other end into the I/O port at the end of the calculator. Make sure that the unit-to-unit link cable is securely in place.



Resetting the Calculator Memory

It is recommended that the memory of the calculator be cleared before the DataMate data collection program is transferred.

1. Press 2nd **[MEM].**

2. Select **Reset.**

3. Select **ALL RAM…**

4. Select **Reset.** The calculator screen will display **RAM cleared.**

Transferring DataMate to the Calculator

The DataMate program is stored on the CBL 2 or LabPro unit and is transferred to the graphing calculator for use. Once DataMate is transferred to the graphing calculator, it will remain there until the calculator memory is reset using the instructions above.

1. For the TI-73, press APPS. Select **Link…**

For the TI-83 Plus, press 2nd **[LINK].**

2. Use the right arrow to highlight **RECEIVE.** Press ENTER.

3. The screen will display **Waiting...** Press the large **TRANSFER** key found on the upper left-hand side of the CBL 2 or LabPro unit. When the transfer is complete, the screen will display the transferred programs followed by the word **Done.**

4. Press 2nd **[QUIT].**

Starting DataMate

When you are ready to collect data, use the following instructions to start DataMate.

For the TI-73:

1. Press PRGM.

2. Select **DataMate.**

3. Press ENTER.

For the TI-83 Plus:

1. Press APPS.

2. Select **DataMate.**

Setting up Probes Manually

The CBL 2 and LabPro unit should recognize the probe attached automatically. If this does not happen, follow these instructions.

1. Select **SETUP** from the DataMate main screen.

2. Press ENTER to select channel 1, or select the channel where the probe is inserted.

3. Select the correct sensor number from the SELECT SENSOR menu.

4. If requested, select the type of probe used.

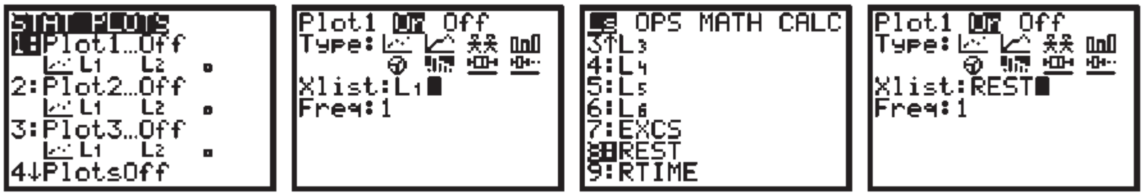
5. Select **OK** to return to the DataMate main screen.

Using the TI-73 Graphing Calculator to Create a Histogram

A histogram is a graph that shows data divided into equal ranges and the number of data points that fall into each range. The following instructions explain how to make a histogram for the heart rate data in *Exercise and Heart Rate.*

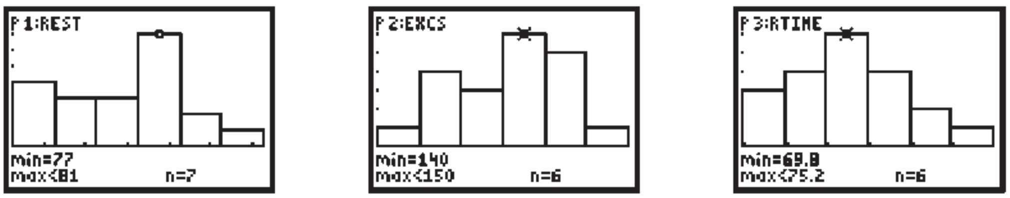
1. **Resetting Calculator Memory** Turn on your graphing calculator and press 2nd **[MEM].** Select **Clr All Lists.** Press ENTER.
2. **Creating and Entering Data Into Lists** Press LIST to access an empty data table. Name your lists before entering data. Scroll up to the title bar (the "top shelf") and over to the first empty list beyond L6 (lists L1–L6 cannot be renamed). Press 2nd **[TEXT].** Scroll to the desired letters, pressing ENTER after each. Choose a title of 5 or fewer letters. Then scroll down to **DONE.** Press ENTER twice to title your new list. Repeat for the other two variables. Enter your class data in all three lists.

3. **Setting up Graphs** Press 2nd **[PLOT].** Select **Plot 1** by pressing ENTER. Use the arrow keys and ENTER to turn the plot on and to select the sixth graph icon, a histogram. For the Xlist, press 2nd LIST and scroll down to find the resting heart rate list. Press ENTER twice. Ignore Freq.



4. Repeat **Step 3** to set up Plot 2 and Plot 3, but do not turn them ON yet. The Xlists will be your exercise heart rate and recovery time lists.

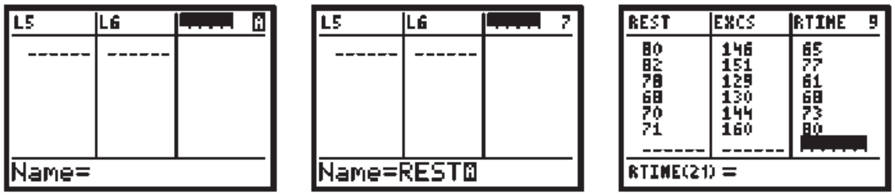
5. **Plotting Data** Press ZOOM. Then select **ZoomStat** to see your first histogram for resting heart rate. Use the TRACE and arrow keys to find the heart rate range that occurred in the class most often and the number of students that were in this range.
6. Press 2nd **[PLOT]** to turn off Plot 1, and turn on Plot 2. Repeat step 5 for Plot 3 to see the class histogram for exercise heart rate and recovery time.



Using the TI-83 Plus Graphing Calculator to Create a Histogram

1. **Resetting Calculator Memory** Turn on your graphing calculator and press 2nd **[MEM].** Select **Clr All Lists.** Press ENTER.

2. **Creating and Entering Data into Lists** Name your lists before entering data. Press STAT and select **Edit.** Scroll up to the title bar (the "top shelf") and over to the first empty list beyond L6 (lists L1–L6 cannot be renamed). The highlighted "A" in the upper corner indicates that you are already in locked-alpha mode. Find and press the desired letters on the keypad. Press ENTER to title your new list for the resting heart rate data. Repeat for exercise heart rate and recovery time. Choose abbreviations that make sense to you—the names are limited to five letters. Enter all data.

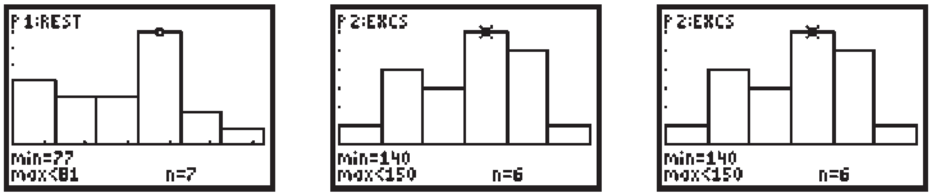


3. **Setting up Graphs** Set up your calculator for graphing your data. Press 2nd **[STAT PLOT].** Select **Plot 1** by pressing ENTER. Use the arrow keys and ENTER to turn the plot on and select the third graph icon, a histogram. For the Xlist, press 2nd LIST and scroll down to find your resting heart rate list. Press ENTER twice. Leave Freq. at 1.

4. Repeat **Step 3** to set up Plot 2 and then Plot 3, but do not turn Plot 2 and Plot 3 ON yet. The Xlists will be your exercise heart rate and recovery time lists.

5. **Plotting Data** Press ZOOM. Then select **ZoomStat** to see the first histogram, for resting heart rate. Use the TRACE and arrow keys to find the heart rate range that occurred in the class most often and the number of students that were in this range.

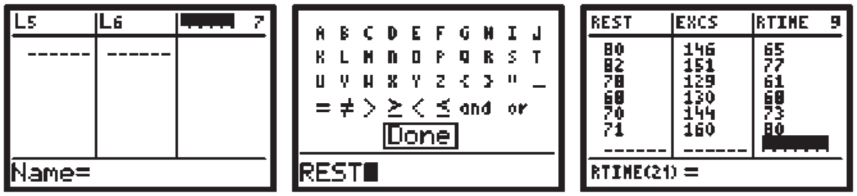
6. Press 2nd STAT **[PLOT]** to turn off Plot 1, and turn on Plot 2. Press ZOOM. Then select **ZoomStat** again to see the class histogram for exercise heart rate. Then turn off Plot 2 and turn on Plot 3 to see the class histogram for recovery time.



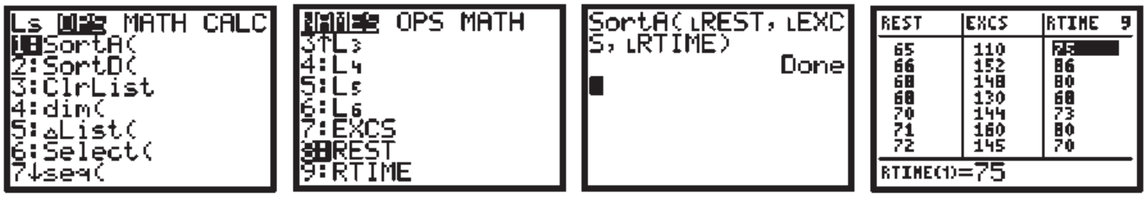
Using the TI-73 Graphing Calculator to Create a Box Plot and Display Statistics

***Note:** If you have already used the calculator to make histograms, skip to step #4.*

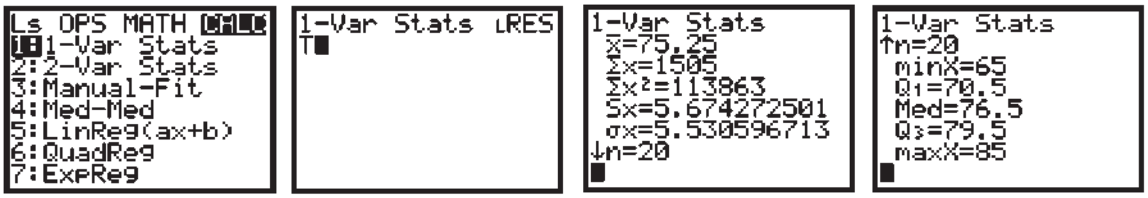
1. **Resetting Calculator Memory** Turn on your graphing calculator and press 2nd [**MEM**]. Select **Clr All Lists.** Press ENTER.
2. Press LIST to access an empty data table. Name your lists before entering data. Scroll up to the title bar (the "top shelf") and over to the first empty list beyond L6 (lists L1–L6 cannot be renamed). Press 2nd [**TEXT**]. Use the arrow keys to select the desired letters, pressing ENTER after each. List names are limited to five letters. Go to **DONE** when you are finished entering the name. Press ENTER twice to title your new list for the resting heart rate data.



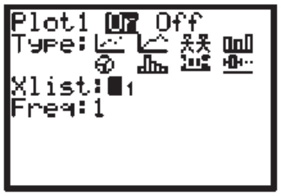
3. Repeat for the other two variables, choosing abbreviations for exercise heart rate and recovery time with 5 or fewer letters. Enter your class data in all three lists.
4. Order the data in your lists. Press 2nd [**STAT**]. Use the right arrow key to select **OPS.** Select the default, **Sort A,** by pressing ENTER. The blinking cursor is a signal to insert your list names. Press 2nd LIST and scroll down to select your first list. Then enter a comma. Repeat to select the second and third data lists. The commas will keep the lists separated so you can later investigate any relationship between variables. Press ENTER. With data sorted (in ascending order), you can easily determine the minimum, maximum, mode, and median.

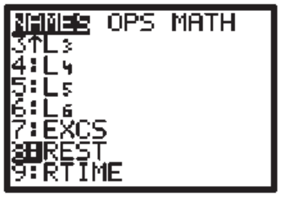


5. For statistical analysis, access the one-variable statistics for each list. Press 2nd [**STAT**]. Use the right arrow key to select **CALC.** Select the default, **1–Var Stats.** Press ENTER. Press 2nd LIST to retrieve one of your lists. Press ENTER. The mean (x) is the first entry. Scroll down to find the minimum (minX), median (Med), and maximum (maxX).



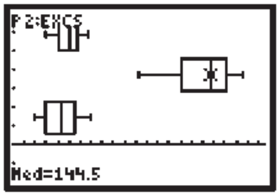
6. Set up your calculator for graphing your data. Press 2nd [**PLOT**]. Select the default, **Plot 1,** by pressing ENTER. Use the arrow keys and ENTER to turn the plot on and select the seventh graph icon, a standard box plot. For the Xlist, press 2nd LIST and scroll down to find your resting heart rate list. Press ENTER twice. Leave Freq. at 1.

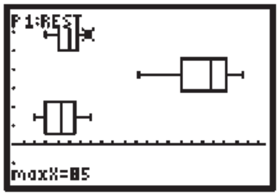


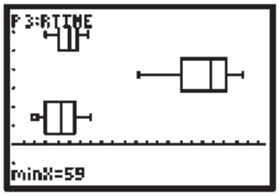


7. Repeat **Step 5** to set up and turn on Plot 2 and then Plot 3. The Xlists will be your exercise heart rate and recovery time lists. Because the data for all three lists is in the same range (about 60–160), all three box plots can be viewed on the calculator screen simultaneously. Remember that the first two plots are heart rates measured in beats per minute while the last plot, recovery time, is measured in seconds.

8. Press ZOOM. Select **ZoomStat** to see all three box plots, for resting heart rate. Using the TRACE and arrow keys find the median exercise heart rate. The left and right arrows will give you the minimum, maximum, median, and quartiles. The up and down arrows allow you to trace the three plots—Plot 1 is at the top of the screen. You also can see that the maximum the minimum heart rates and recovery times.



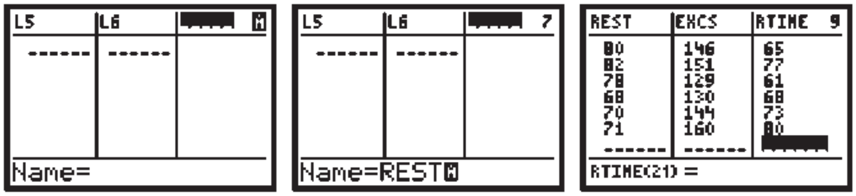




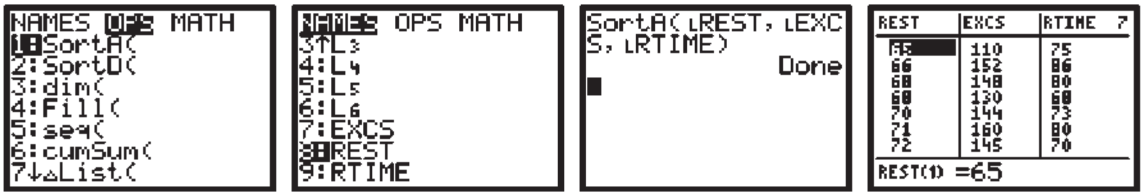
Using the TI-83 Plus Graphing Calculator to Box Plot and Display Statistics

Note: *If you have already used the calculator to make histograms, skip to step #3.*

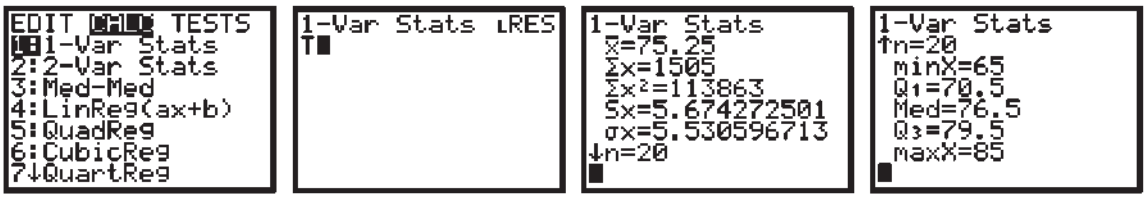
1. **Resetting Calculator Memory** Turn on your graphing calculator and press 2nd **[MEM].** Select **Clr All Lists.** Press ENTER.
2. Name your lists. Press STAT and select **Edit.** Scroll up to the title bar (the "top shelf") and over to the first empty list beyond L6 (lists L1–L6 cannot be renamed). The highlighted "A" in the upper corner indicates that you are already in locked-alpha mode. Find and press the desired letters. Press ENTER to title your new list for the resting heart rate data. Repeat for the other two variables, exercise heart rate and recovery time. Choose abbreviations that make sense to you—list names are limited to five letters. Then enter all data.



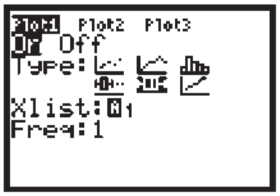
3. Order the data in your lists. Press 2nd LIST and use the right arrow key to select **OPS.** Select the default, **Sort A,** by pressing ENTER. The blinking cursor is a signal to insert your list names. Press 2nd LIST and scroll down to select your first list. Then enter a comma. Repeat to select the second and third data lists. Then put a right parentheses ")" after the lists. The commas will keep the lists separated so you can later investigate any relationship between variables if you like. Press ENTER. With data sorted (in ascending order here) you can easily determine the minimum, maximum, mode, and median.

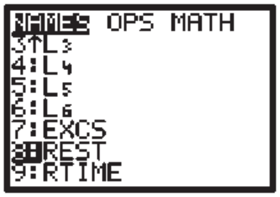


4. For statistical analysis, access the one-variable statistics for each list. Press STAT and arrow right to **CALC.** Select the default, **1-Var Stats.** Press ENTER. Press 2nd LIST and scroll down to retrieve one of your lists. Press ENTER twice. The mean (x) is the first entry, then scroll down to find the minimum (minX), median (Med), and maximum (maxX).



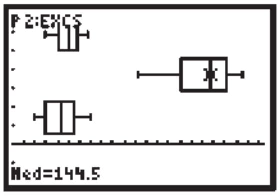
5. Set up your calculator for graphing your data. Press 2nd [**STAT PLOT**]. Select the default, **Plot 1,** by pressing ENTER. Use the arrow and ENTER keys to turn the plot on and select the fifth graph icon, a standard box plot. For the Xlist, press 2nd LIST and scroll down to find your resting heart rate list. Press ENTER twice. Leave Freq at 1.

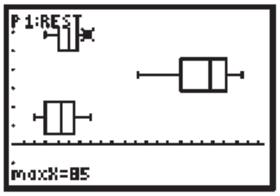


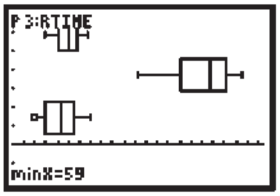


6. Repeat **Step 5** to set up and turn on Plot 2 and Plot 3. The Xlists will be your exercise heart rate and recovery time lists. Because the data for all three lists is in the same range (about 60–160), all three box plots can be viewed on the calculator screen simultaneously. Remember that the first two plots are heart rates measured in beats per minute while the last plot, recovery time, is measured in seconds.

7. Press ZOOM and select **ZoomStat** to see all three box plots for resting heart rate. Using the TRACE and arrow keys, find the median exercise heart rate. The left and right arrows will give you the minimum, maximum, median, and quartiles. The up and down arrows allow you to trace the three plots—Plot 1 is at the top of the screen. You can find the maximum and minimum heart rates and recovery times.



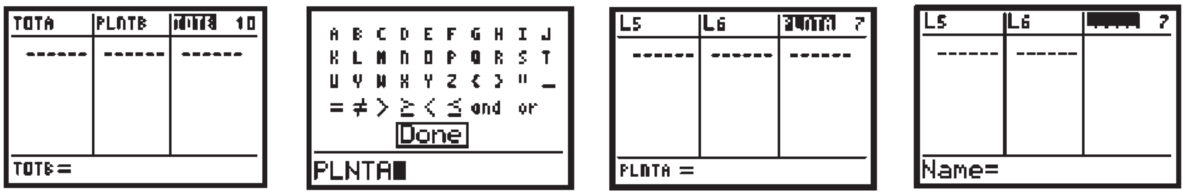




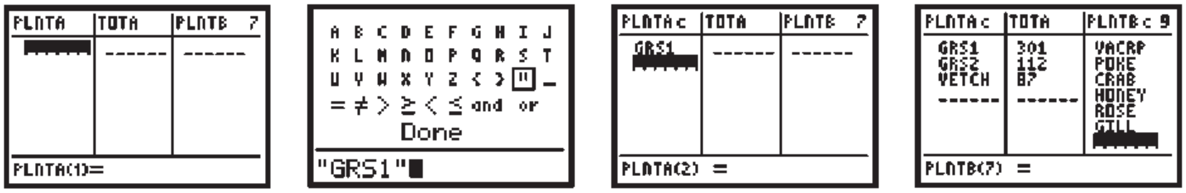
Using the TI-73 Graphing Calculator to Create a Circle Graph

1. **Resetting Calculator Memory** Turn on your graphing calculator and press 2nd [**MEM**]. Select **ClrAllLists.** Press ENTER.

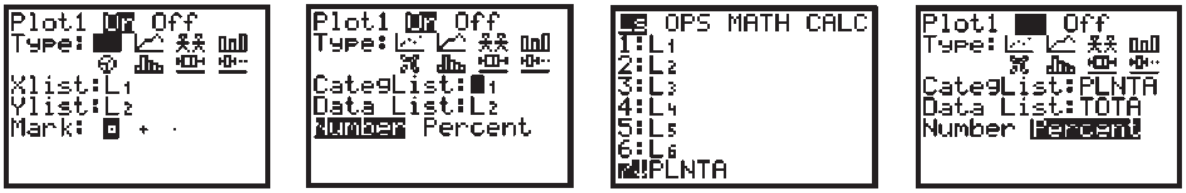
2. Press LIST to access an empty data table. Name your lists before entering data. Scroll up to the title bar (the "top shelf") and over to the first empty list beyond L6 (lists L1–L6 cannot be renamed). Press 2nd [**TEXT**]. Use the arrow keys to select the desired letters, pressing ENTER after each. Your title can only have 5 or fewer letters. Select **DONE** when you are finished. Press ENTER twice to title your new list for the plant type data at Site A. Make three more lists, naming them TOTA, PLNTB, and TOTB.



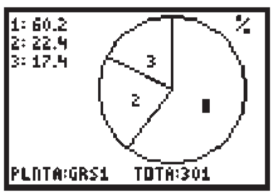
3. Enter your plant data. Because this data is "categorical" instead of numerical, you must use quotation marks around the first entry only. Place your cursor at the first entry for the list named PLNTA. Press 2nd [**TEXT**] and scroll first to the quotes and press ENTER. Choose your letters, ending with quotes. Notice that a small "c" appears next to the title of a categorical list. Enter the rest of your plant types—you do not need quotes for the rest. Enter the total number of each plant in the next list. Enter data for Site B as well.



4. Set up your calculator for graphing your data. Press 2nd [**PLOT**]. Select **Plot 1** by pressing ENTER. Use the arrow keys and ENTER to turn the plot on and select the fifth graph icon, a circle graph. For the CategList, press 2nd [**STAT**] and scroll down to find your list named PLNTA. Press ENTER twice. Insert TOTA for Data List. Choose **PERCENT.** Always press ENTER to make your choices. Press GRAPH.



5. Use TRACE and the arrow keys to view the labels and numbers for each sector. Notice that the calculator has calculated the percentage for you.



6. Repeat steps 4 and 5 to set up Plot 2 for Site B.

LAB 1 Probeware Activity

Biodiversity and Ecosystems

What lives in your home or on your school lawn? What lives in the wooded areas at the local park? You probably have noticed that some organisms' habitats include both a grassland and a wooded area while other organisms live only in one type of area. In this activity you will play the role of an ecologist in the field. You will observe plant and animal organisms at two different sample sites and collect data using a graphing calculator and a temperature probe.

What You'll Investigate

- What plants and animals live in two ecosystems?
- What is the effect of plant diversity on temperature?

Goals

Observe living organisms in a measured area.
Count the plant types observed using percentages.
Collect temperature data.
Compare the temperature data for two different sites.

Materials

CBL 2 or LabPro unit
TI graphing calculator
link cable
DataMate program
temperature probe
meterstick
string
8 wooden dowels or craft sticks
10 acetate grids (10 cm × 10 cm)
colored transparency markers
trowel
drawing compass
protractor

Safety Precautions

CAUTION: Do not touch or harass animals in the field. Do not eat any fruits, berries, or plant material from the site. Beware of poisonous and thorny plants.

- Wash your hands before leaving the lab area.

Pre-Lab

1. Predict the type of living organisms you might find in a small plot of lawn.

2. Predict the types of animals you might find in a small plot with more diverse vegetation.

3. List any abiotic factors you could observe at a small site in the field.

4. Describe how you could measure one of the abiotic factors.

SCI 5.e. Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

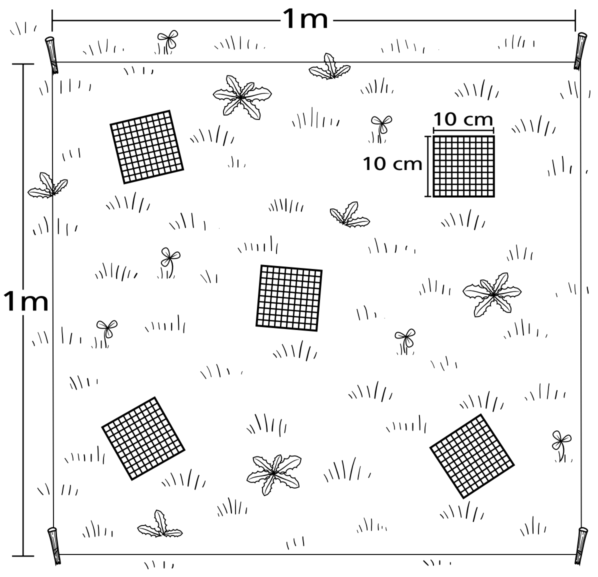
Probeware Activity 1 (continued)

Procedure

Part A: Collecting Plant and Animal Data

1. At your assigned site, measure a one-meter square area and mark it with string and sticks as demonstrated by your teacher.
2. Examine your area carefully. Count the different types of plants. Look for any animals or signs of animal life. Record your observations in **Data Table 1.** You do not need to know the exact name of the plants and animals, but include measurements. A description such as "short (4 cm), thin, yellowish-green grass" is acceptable.
3. Use a trowel to carefully lift out a section of soil. Describe how much effort was needed to remove the soil. Observe the humus layer and record its depth in **Data Table 1.** Replace the soil.
4. Randomly lay five of your 10-cm × 10-cm acetate grids on the ground within your square meter, as shown in **Figure 1.**
5. Using transparency markers, code each small square with a color, number, or symbol to represent the type of plant visible within that square.
6. Repeat steps 1–5 for your second assigned site.

Figure 1



Part B: Collecting Temperature Data

1. Plug the temperature probe into channel 1 of the CBL 2.
2. Turn on the graphing calculator and start DataMate. Press CLEAR to reset the program. The temperature probe should be recognized automatically. If not, turn to page *vi* for instructions on how to set up the probe manually.
3. To investigate the effect of height above the ground on temperature, stand a meterstick in the middle of your sample site. Place the "zero" end on the ground.
4. Put the temperature probe on the ground next to the meterstick. The temperature reading is located in the upper right-hand corner of the calculator screen. Allow enough time for the temperature reading to stabilize. After 30 seconds have passed, record the temperature in **Data Table 3.**
5. Move the probe to the 10-cm mark and repeat the procedure. Measure and record the temperature at each 10-cm increment. Your last reading will be at 100 cm.
6. Repeat steps 1–5 for your second assigned site.
7. After all of your data is collected, select **QUIT.** Follow the directions on the calculator screen.

Cleanup and Disposal

1. Turn off the calculator and disconnect the temperature probe and CBL 2.
2. Return all lab materials to the appropriate location as directed by your teacher.
3. Collect personal belongings and pick up any trash at your site.

Probeware Activity 1 (continued)

Data Table 1: Soil Conditions and Organisms

	Site A	Site B
Plants found		
Animals/Animal signs found		
Depth of humus (cm)		
Ease of penetrating ground		

Data Table 2A: Plant Analysis at Site A

Plant Type	Number of Squares out of 100					Total (of 500)	Percent (%)
	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5		

Data Table 2B: Plant Analysis at Site B

Plant Type	Number of Squares out of 100					Total (of 500)	Percent (%)
	Grid 1	Grid 2	Grid 3	Grid 4	Grid 5		

Probeware Activity 1 (continued)

Data Table 3: Temperature vs. Height

Height (cm)	Temperature (°C)	
	Site A	Site B
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		

Part C: Analyzing Data

1. Count the number of small squares for each plant type and record it in **Data Table 2A** or **2B.** Convert the total count from the five grids to percentages.
2. Construct two circle graphs to compare the plant percentages for Site A and Site B. If you have a TI-73 your teacher may want you to make your circle graphs on the graphing calculator. See **Appendix E** for directions.
3. Construct a graph that shows the relationship between temperature and height for each site. Place the independent variable on the *x*-axis and the dependent variable on the *y*-axis. Include a key.

Conclude and Apply

1. Compare the diversity of organisms in your two ecosystems. List at least two similarities and three differences between Site A and Site B. Be specific.

2. In your temperature-height graph, what was your independent variable? What was your dependent (responding) variable? Why does the graph need a key?

3. Describe any differences in the temperature vs. height at Sites A and B. Explain how this factor might affect the plants and animals found there.

Name Date Class

LAB 2 Probeware Activity

The Effect of Acid Rain on Limestone

Acid rain is harming some of the world's most beautiful structures. Ancient Mayan pyramids in Mexico are crumbling because the acidic rainwater slowly dissolves minerals in the rocks. The Taj Mahal in India has undergone extensive and costly reconstruction to repair damage from acid rain. Buildings and monuments in Washington, D.C. are slowly weathering because precipitation in the area is ten times more acidic than unpolluted rainwater. In this activity, you will observe the effect that acid rain has on limestone. Limestone is the type of rock that was used in the construction of many of the damaged structures. It is composed primarily of calcite (calcium carbonate), a mineral that is dissolved easily by weak acids.

What You'll Investigate

- What is the pH of rain in your area?
- How does the pH of acid rain change when limestone is added to it?
- What effect does acid rain have on limestone?

Goals

Measure the pH of rainwater.
Observe the effect that limestone has on the pH of acid rain.
Infer the effect that acid rain has on limestone buildings and monuments.

Materials

CBL 2 or LabPro unit
TI graphing calculator
link cable
DataMate program
pH probe
150-mL beaker
400-mL beaker
distilled water
1-L glass jar
pea-sized limestone pebbles (5)

Safety Precautions

- Wear safety goggles and a lab apron during this lab activity.
- Wash your hands before leaving the lab area.

Pre-Lab

1. Explain the pH scale.

2. If the pH of an acidic solution rises, does this indicate that the solution is becoming more acidic or less acidic?

3. What effect would adding a basic substance have on the pH of an acidic solution?

4. The pH scale is logarithmic. How does a pH of 3 compare to a pH of 4?

SCI 7.b. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

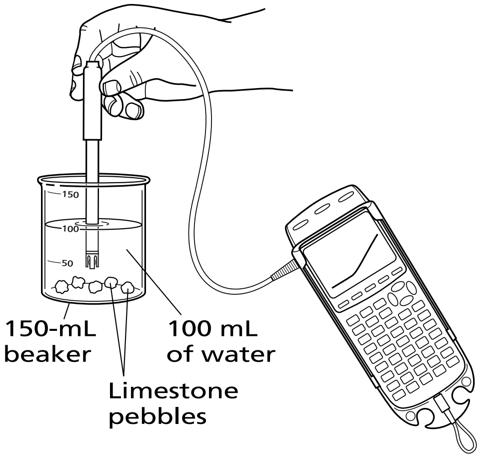
Probeware Activity 2 (continued)

Procedure

Part A: Preparing the CBL System

1. Place a glass jar outside, away from trees and buildings, during a rain shower. Collect at least 100 mL of rainwater. Cover the jar until you are ready to use it.
2. Connect the pH probe into channel 1 of the CBL 2 unit, as shown in **Figure 1.** Connect the CBL 2 unit to the graphing calculator.

Figure 1



3. Turn on the graphing calculator and start the DataMate program. Press CLEAR to reset the program. The pH probe should be recognized automatically. If not, turn to page *vi* for instructions on how to set up the probe manually.
4. Select **SETUP.** Press the up arrow once to select **MODE: TIMEGRAPH.** Press ENTER.
5. Select **TIME GRAPH.** Select **CHANGE TIME SETTINGS.** The screen will display "Enter the time interval between samples in seconds."
6. Press 1 5 ENTER.
7. The screen will display "Enter number of samples." Press 4 0 ENTER. The CBL 2 unit will collect data every 15 seconds for 10 minutes. Select **OK** twice.

Part B: Collecting Data

1. Partially fill a 400-mL beaker with distilled water. This will be the soaking solution.
2. Carefully unscrew the pH sensor from the storage-solution bottle sliding the cap and o-ring up the barrel of the sensor. Set the storage bottle aside. Over a sink, rinse the sensor with distilled water and place it in the soaking solution.
3. Pour 100 mL of rainwater into a 150-mL beaker. Insert the pH probe and watch the pH reading at the top right of the calculator screen. When the reading has stabilized, select **START.**
4. Gently swirl the pH probe in the rainwater. After about 2 minutes, add the limestone pebbles to the rainwater.
5. Gently swirl the pH probe until the recording period ends. Remember that the probe is fragile. Be sure the recording tip remains submerged but do not allow it to hit the pebbles or the side of the beaker.
6. At the end of 10 minutes, the CBL 2 unit will make a tone. Remove the pH probe from the rainwater, rinse it over a sink, and place it in the soaking solution.
7. Sketch and label your graph in the space below.

Probeware Activity 2 (continued)

Part C: Examining the Data

1. Observe the graph, noting what happened to the graph when the limestone was added.
2. Determine the initial pH of the rainwater before the limestone was added.
   a. Return to the main screen by pressing ENTER. Select **ANALYZE.** Select **STATISTICS.**
   b. Press ENTER to select the beginning of the graph.
   c. Use the right arrow key to select a point just before the limestone was added. Press ENTER.
   d. Record the mean, which is the initial pH, in the **Data Table**. Press ENTER.
3. Determine the pH after adding the limestone pebbles.
   a. Select **RETURN TO THE MAIN SCREEN.** Select **GRAPH.**
   b. Use the right arrow to select the last point on the graph. In the table below, record the *y*-value shown in the lower right corner of the screen. This is the final pH.
4. When you are finished with the graph, press ENTER. Select **QUIT.**

Data Table: pH Change

Initial pH	
Final pH	
pH Change	

Cleanup and Disposal

1. Remove the pH probe from the soaking beaker. Carefully place it in the storage-solution bottle.
2. Turn off the calculator and disconnect the pH probe and CBL 2 unit.
3. Follow your teacher's instructions for disposing of the contents of the beakers and returning all equipment to its proper location.

Conclude and Apply

1. Look at the graph of your data. What was the approximate time (x) when you added the limestone? How can you tell?

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2 Why did the graph change after you added the limestone? Calculate the change in pH.

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3. What would you expect your graph to look like if you continued taking data for 10 additional minutes? How would this affect your final pH and the change in pH? How could you test this?

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4. Infer from your experiment how acid rain would affect a monument made of limestone.

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Notes

LAB 3 Probeware Activity

Measuring Earthquakes

A seismograph is an instrument that is used to measure the ground's movement during an earthquake. One type of seismograph has a pen attached to a pendulum. During an earthquake, a roll of paper moves beneath a pen creating lines that correspond to the motion of the ground. Many modern seismographs use a freely swinging magnet. The magnet is positioned inside a casing surrounded by coiled wire. When the ground moves, the casing moves relative to the magnet. Recall that a magnet is surrounded by a magnetic field. If a magnet moves in the coil, the magnetic field moves, and a current is generated in the wire. By measuring how this current changes, seismologists obtain a record of the ground's movement. In this activity, you will create a model seismograph with a magnet and coiled wire.

What You'll Investigate

- What is a seismograph?
- How does a seismograph register motion during an earthquake?
- What do the lines on a seismogram indicate about the strength of seismic waves?

Goals

Build a model seismograph.
Observe how a seismograph records motion.
Measure movement using a seismograph.
Create a seismogram.

Materials

CBL 2 or LabPro unit
TI graphing calculator
DataMate program
link cable
current probe
strong bar magnet
enameled copper magnet wire
cardboard or plastic tube
sandpaper
masking tape
ruler
string
table
chair

Safety Precautions

- Wear safety goggles and a lab apron during this lab activity.
- Wash your hands before leaving the lab area.

Pre-Lab

1. What are some reasons why seismologists measure Earth's movement during an earthquake?

2. What is a seismograph?

3. How can you use a magnet to produce a current in a coiled wire?

SCI 1.g. Students know how to determine the epicenter of an earthquake and know that the effects of an earthquake on any region vary, depending on the size of the earthquake, the distance of the region from the epicenter, the local geology, and the type of construction in the region.

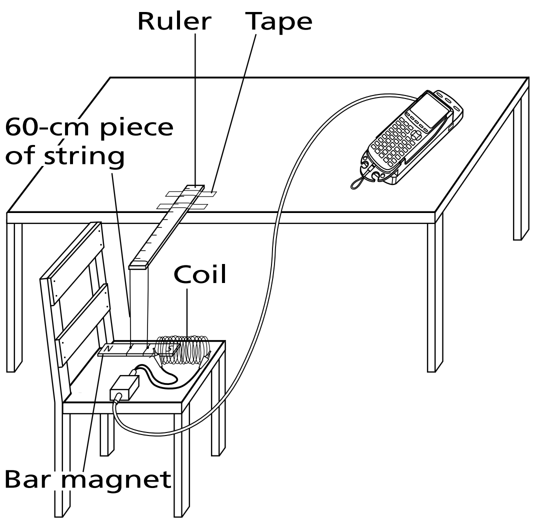
Probeware Activity 3 (continued)

Procedure

Part A: Preparing the CBL System

1. Connect the current probe to channel 1 of the CBL 2 unit, as shown in **Figure 1.**

Figure 1



2. Use a link cable to connect the CBL 2 unit to the graphing calculator. Turn on the graphing calculator. Start the DataMate program. Press CLEAR to reset the program. The current probe should be recognized automatically. If not, turn to page *vi* for instructions on how to set up the probe manually.
3. Select **SETUP.** Press the up arrow once until the cursor is beside the **MODE: TIME GRAPH** line. Press ENTER.
4. Select **TIME GRAPH.** Select **CHANGE TIME SETTINGS.** The calculator will display "Enter time between samples in seconds." Press 0 . 2 ENTER.
5. The calculator will display "Enter number of samples." Press 1 2 0 ENTER.
6. Select **OK.** Select **OK** again. The calculator and CBL 2 unit are now ready to record changes in the current every 0.2 seconds for 24 seconds.

Part B: Collecting Data

1. To create a model seismograph, first make a coil of wire. Starting at one end of a sturdy tube, begin winding the wire securely around it, leaving about 20 cm of wire free at the beginning. Do not cut the wire from the spool until you have completed making the coil. Tape the wire at the place where you begin so it won't unwind. The windings should be close together. Make at least 50 windings before you get to the other end of the tube. Tape the wire at the end, leaving about 20 cm of wire free.
2. Use sandpaper to completely strip the coating off the ends of the wire. The coating on the wire doesn't conduct electricity, so it must be removed to ensure a good connection to the current probe. Be careful when doing this so that the coil does not unwind.
3. Connect each of the stripped ends of the wire coming from your wire coil to the red and black connectors of the current probe.
4. Cut a 60-cm piece of string. Tie each end around the ends of the bar magnet and slide the knots near the center of the magnet until they are about 2 cm apart. Tape the ruler to a table so that one end hangs over the edge. Use the string to hang the magnet from the ruler, as shown in **Figure 1.**
5. Tape your wire coil to the seat of a chair placed near the table. Position it so that the magnet swings freely through the end of the coil. You may have to adjust the length of the magnet's string by wrapping the string around the magnet.

Probeware Activity 3 (continued)

6. You are now ready to record movement with your seismograph. Select **START** to begin the 24-second measurement.
7. During this time, gently bump the table that suspends the magnet so that the magnet moves in and out of the wire coil. Allow it to stop moving, then bump it again. Do this repeatedly until the measurement period ends.
8. At the end of the measurement period, a graph of the movement will appear on the graphing calculator screen. Sketch and label the graph in your **Science Journal.** Use the graph to answer questions in the **Conclude and Apply** section. If you wish to repeat the measurement, press ENTER. Then select **START** again.
9. When you are finished, press ENTER. Select **RETURN TO MAIN SCREEN.** Select **QUIT.** Follow the directions on the screen.

Cleanup and Disposal

1. Turn off the graphing calculator and disconnect the CBL 2 unit and current probe. Disconnect the current probe wires from the wire coil. Remove the ruler from the table and the coil from the chair.
2. Dispose of or recycle the lab materials as directed by your teacher.
3. Return all equipment as directed by your teacher.

Conclude and Apply

1. To what do the up-and-down lines and the flat parts on the graph correspond?

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2. How do you think your graph would differ if you had shaken the table harder? How does this relate to what a real seismogram shows about seismic waves?

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3. In this lab, your wire coil remained still and the magnet moved inside it. In a real seismograph, the magnet remains still and the wire coil moves around it, even though the magnet can swing freely and the coil is attached firmly to the ground. Explain how this can be true.

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4. Would you have obtained a similar or a different seismogram if you had moved the chair instead of the table? Explain.

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Notes

LAB 4 Probeware Activity

Predicting the Weather

What will the weather be like tomorrow? You could watch the weather forecast on television, but you probably know more about predicting the weather than you realize. If you look outside early in the morning and see high, wispy clouds in a bright blue sky, you know it will be a beautiful day. But if you see low, dark clouds and a strong wind blowing, you know a storm is on the way. In this activity you will learn more about predicting the weather and use probes to monitor atmospheric pressure, relative humidity, and temperature. You will make daily observations of clouds and weather conditions.

What You'll Investigate

- What do changes in atmospheric pressure indicate about upcoming weather conditions?
- How can you use clouds to predict clear or stormy weather?
- How is relative humidity related to temperature changes?

Goals

Create a weather station.
Measure changes in atmospheric pressure, temperature, and relative humidity.
Observe changing weather conditions.
Predict the next day's weather based on data and observations.

Materials

CBL 2 or LabPro units (2)
TI graphing calculators (2)
DataMate program
AC adapter (2)
link cables (2)
barometer
relative-humidity sensor
temperature probe
cloud chart
Beaufort wind scale

Safety Precautions

- Wear safety goggles during this lab activity.
- Wash your hands before leaving the lab area.

Pre-Lab

1. What does a barometer measure?

2. What is humidity?

3. What is relative humidity?

4. Predict what increasing and decreasing atmospheric pressure indicate about upcoming weather.

SCI 4.e. Students know differences in pressure, heat, air movement, and humidity result in changes of weather.

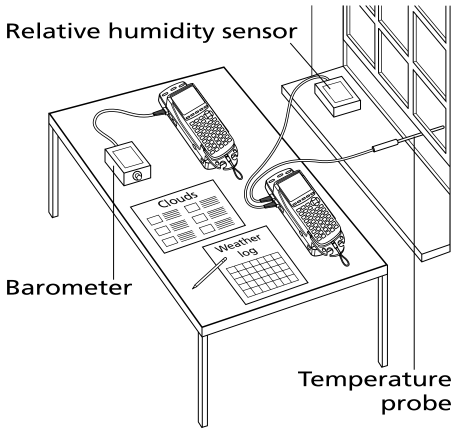
Probeware Activity 4 (continued)

Procedure

Part A: Preparing the First CBL System

1. Connect the barometer into channel 1 of the CBL 2 unit. Use a link cable to connect the CBL 2 unit to the graphing calculator as shown in **Figure 1.** Connect the AC adapter to the CBL 2 unit and plug the adapter into an outlet near the monitoring location.

Figure 1



2. Turn on the calculator and start DataMate. Press CLEAR to reset the program. The barometer should be recognized automatically. If not, turn to page *vi* for instructions on how to set up the probe manually.
3. Select **SETUP** on the DataMate main screen to set up the time interval between data points and the length of time the data will be collected.
4. Press the up arrow once until the cursor is beside the **MODE** line. Press ENTER.
5. Select **TIME GRAPH.** Select **CHANGE TIME SETTINGS.** The screen will display "Enter time between samples in seconds."
6. Press 7 2 0 0 ENTER. The screen will display "Enter number of samples." Press 6 0.
7. Select **OK.** Select **OK** again. The calculator and CBL 2 unit are ready to obtain atmospheric pressure readings every two hours for five days.

Part B: Preparing the Second CBL System

1. Connect the temperature probe into channel 1 and the relative humidity probe into channel 2 of the other CBL 2 unit. Use a link cable to connect the CBL 2 unit to the graphing calculator. Connect the AC adapter to the CBL 2 unit and plug the adapter into an outlet near the monitoring location.
2. Turn on the calculator and start DataMate. Press CLEAR to reset the program. The temperature and relative humidity probes should be recognized automatically. If not, turn to page *vi* for instructions on how to set up the probes manually.
3. Select **SETUP.** Press the up arrow once to select **MODE: TIMEGRAPH.** Press ENTER.
4. Select **TIME GRAPH.** Select **CHANGE TIME SETTINGS.** The screen will display "Enter time between samples in seconds."
5. Press 7 2 0 0 ENTER. The screen will display "Enter number of samples." Press 6 0 ENTER.
6. Select **OK.** Select **OK** again. The calculator and CBL 2 are now ready to collect temperature and relative humidity readings every two hours for five days.
7. Select **START** on both calculators at the same time. A screen will appear that tells you to press "enter" to continue. Press ENTER on each calculator at the same time. The calculators now can be disconnected and the CBL 2 units will continue to collect data.

Probeware Activity 4 (continued)

Part C: Collecting Data

1. During the five-day period, you will maintain a weather table. Prepare a chart similar to the one in the **Data Table.** Each day, record your weather observations. Use the cloud chart when recording cloud observations. Use the Beaufort wind scale when recording wind observations. Precipitation should be described by type (such as rain or snow) and amount (light, medium, or heavy).
2. After the data collection is complete, reattach the calculators. Press ON to turn them on.
3. On both calculators, start DataMate. A screen will appear indicating that data has been collected. Press ENTER. Select **TOOLS,** and select **RETRIEVE DATA.** The calculator connected to the CBL 2 and barometer will display a pressure-time graph. Sketch and label this graph in the space provided. When you are finished, press ENTER. Select **QUIT.** Follow the directions on the screen.
4. On the calculator connected to the temperature and relative-humidity probes, you are given the option to plot temperature or relative humidity. To plot both, select **MORE.** Then select **L2 and L3 vs L1.** A graph with both sets of data plotted on one axis will be displayed. Use the left/right arrow keys to trace the graph and the up/down arrow keys to select the graphs. Sketch and label this graph in the space provided.
5. When you are finished with the graph, press ENTER. Select **RETURN TO GRAPH SCREEN.** Then select **MAIN SCREEN.** Select **QUIT.** Follow the directions on the screen.

Experimental Graph: Atmospheric Pressure

Experimental Graph: Temperature and Relative Humidity

Cleanup and Disposal

1. Turn off the graphing calculators and disconnect the probes and CBL 2 units.
2. Return all equipment as directed by your teacher.

Probeware Activity 4 (continued)

Data Table: Weather Observations

Day	Time	Clouds	Precipitation	Wind
1				
2				
3				
4				
5				

Conclude and Apply

1. What did changes in air pressure indicate about the next day's weather?

2. What cloud types did you find were useful weather indicators during the measurement period?

3. In general, what happens to the relative humidity as temperature decreases? Explain.

4. From the data you obtained, what relationship did you notice between barometric pressure and cloud cover?

5. What do you think would have made your model weather station more efficient for predicting weather?

6. Use the information you obtained from the graphs and observations to predict what the weather will be like tomorrow.

LAB 5 Probeware Activity

Thermal Conductivity

Heat is thermal energy that flows from a warmer material to a cooler material. One way that thermal energy is transferred is by a process called conduction. Conduction occurs because the particles in a warmer material are moving faster than the particles in a cooler material. When these materials are in contact, the particles collide with one another and some of the kinetic energy of the faster-moving particles is transferred to the slower-moving particles. When the warm material looses some kinetic energy, its temperature drops. When the cool material gains kinetic energy, its temperature rises. A material that is a thermal conductor transfers thermal energy more rapidly than a material that is a thermal insulator. In this lab you will observe and compare the thermal conduction of several different materials.

What You'll Investigate

- How do materials vary in thermal conductivity?
- Do similar materials have similar thermal conductivity?

Goals

Collect temperature data.
Compare the thermal conductivity of various materials.
Analyze temperature data and look for trends in various materials.

Materials

CBL 2 or LabPro unit
TI graphing calculator
temperature probe
link cable
DataMate program
hot mitt or thermal glove
test strips of various materials
400-mL beaker
masking tape
hot plate
tap water

Safety Precautions

- Wear safety goggles and a lab apron during this lab activity.
- Observe laboratory rules.
- Use care near heat sources and when handling hot objects.
- Wash your hands before leaving the lab area.

Pre-Lab

1. What is the difference between a thermal conductor and a thermal insulator?
2. Form a hypothesis about what types of materials are conductors. What types of materials do you think are insulators?
3. If the bottom half of a long strip of material is placed in hot water, how would you determine if it was a thermal conductor or insulator?
4. Describe the direction of heat flow between two objects.

SCI 3.c. Students know heat flows in solids by conduction (which involves no flow of matter) and in fluids by conduction and by convection (which involves flow of matter).

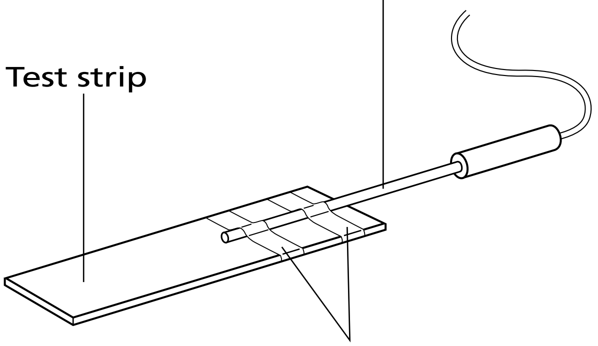
Probeware Activity 5 (continued)

Procedure

Part A: Preparing the CBL System

1. Set up the calculator and CBL 2 unit, as shown in **Figure 1.** Plug the temperature probe into channel 1 of the CBL 2 unit.
2. Turn on the calculator and start DataMate. Press CLEAR to reset the program. The temperature probe should be recognized automatically. If not, turn to page *vi* for instructions on how to set up the probe manually.

Figure 1



Part B: Collecting Data

1. Put on your lab apron and safety goggles.
2. Lay the temperature probe over the metal strip so the bottom of the probe is 7 cm from the end, as shown in **Figure 1.** Tape the probe to the metal strip.
3. Fill the 400-mL beaker to the 150–mL mark with hot water obtained from your teacher.
4. Select **START** on your calculator to begin data collection. Using a gloved hand, place your test strip into the beaker of hot water being careful not to splash water onto the probes. The probe should not touch the hot water and should sit above the water line.
5. Data will be collected for 180 seconds. When the calculator stops, it will display a time-temperature graph with temperature on the *y*-axis and time on the *x*-axis. Sketch and label this graph in your **Science Journal.**

Part C: Examining Data

1. Return to the main screen by pressing ENTER.
2. Select **ANALYZE.**
3. Select **STATISTICS.**
4. Press ENTER to select the beginning of the temperature graph. Use the right arrow key to select the end of the temperature graph. Press ENTER.
5. Record the maximum and minimum temperatures in the **Data Table.**
6. Write your data in the group table provided by your teacher for data sharing. Fill in the remaining lines on the **Data Table** using the data from the group table.
7. When you are finished, press ENTER. Select **RETURN TO MAIN SCREEN.**
8. If time permits, test another sample. If not, select **QUIT.** Follow the directions on the screen.

Cleanup and Disposal

1. Turn off the graphing calculator and disconnect the temperature probes and CBL 2 unit.
2. Return all equipment as directed by your teacher.

Probeware Activity 5 (continued)

Data Table: Temperature Change of Different Materials

Type of Test Material	Minimum Temperature (°C)	Maximum Temperature (°C)	Change in Temperature (°C)

Conclude and Apply

1. Find the change in temperature for each material tested by subtracting the minimum temperature from the maximum temperature. Record the difference in the **Data Table.**

2. What are some similarities of materials that are thermal insulators? What are some similarities of materials that are thermal conductors?

3. On a temperature-time graph, the steeper the slope of the line is, the faster the temperature change is in a given amount of time. The graph of which material had the steepest slope and, therefore, the fastest change of temperature?

4. Find a student group that tested the same material that you tested. How do your temperature changes compare? If the temperature changes were not the same, what are possible reasons that they were different?

Notes