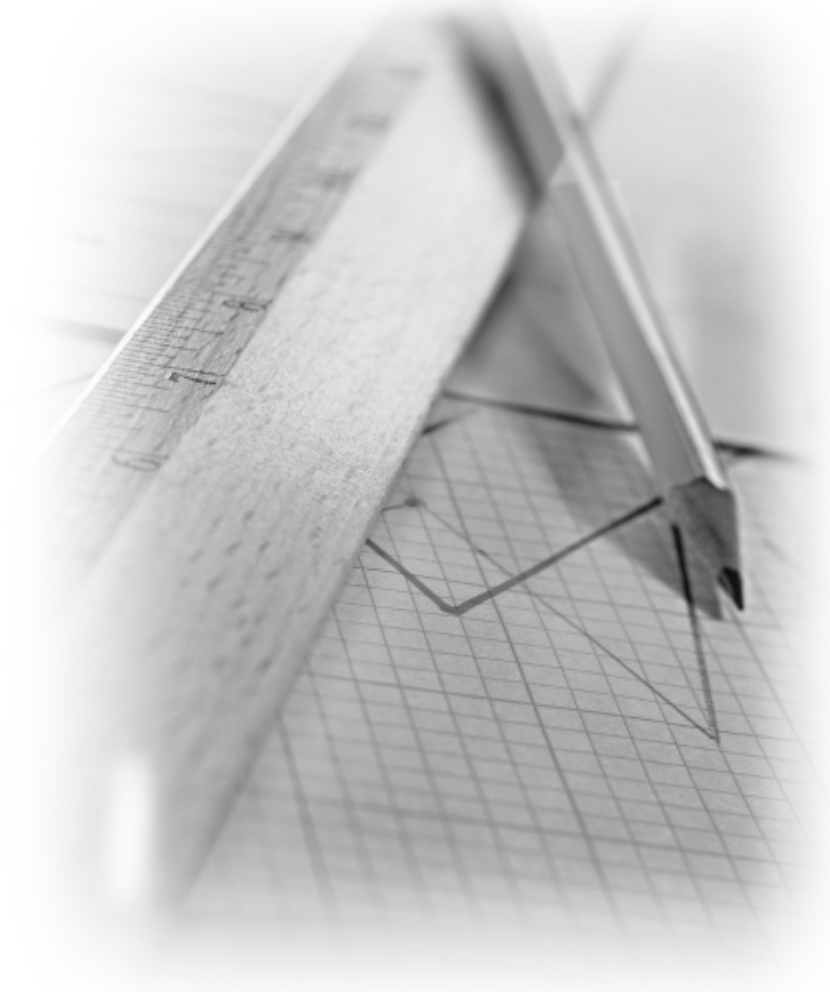


Glencoe Science

Science Inquiry Labs

Student Edition



New York, New York Columbus, Ohio Chicago, Illinois Peoria, Illinois Woodland Hills, California

Glencoe Science



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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—glassware breakage, chemical spills, injury, fire, and so forth.
- 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.
- Do NOT wear contact lenses in the laboratory.
- 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 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, and so forth—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 cutting equipment, always cut away from yourself and others.
- Handle living organisms or preserved specimens only when authorized by your teacher.
- Always wear heavy gloves when handling animals. If you are bitten, 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.

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**.

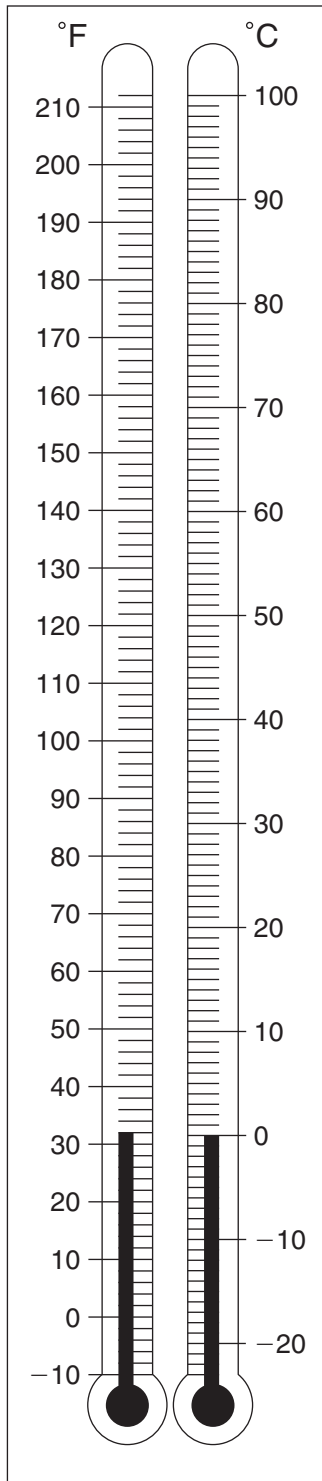
Table 2

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

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 ($^{\circ}\text{C}$) 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:

$$\text{K} = ^{\circ}\text{C} + 273$$

Figure 1



To convert from °F to °C, you can:

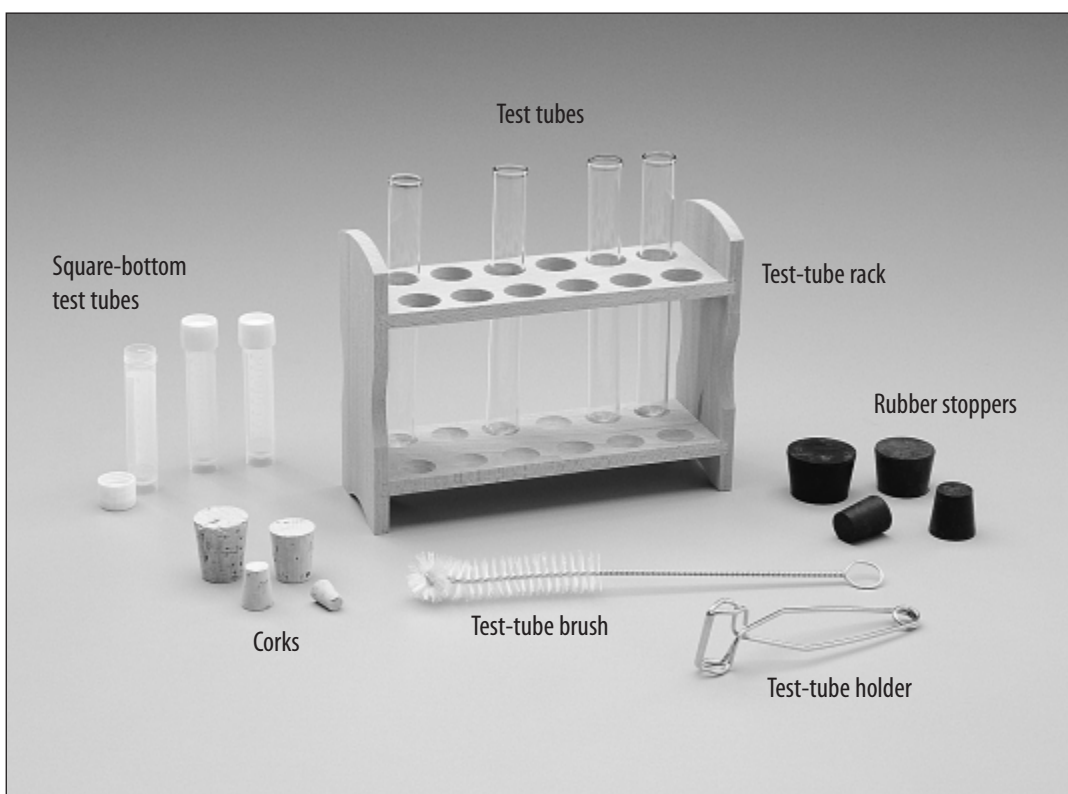
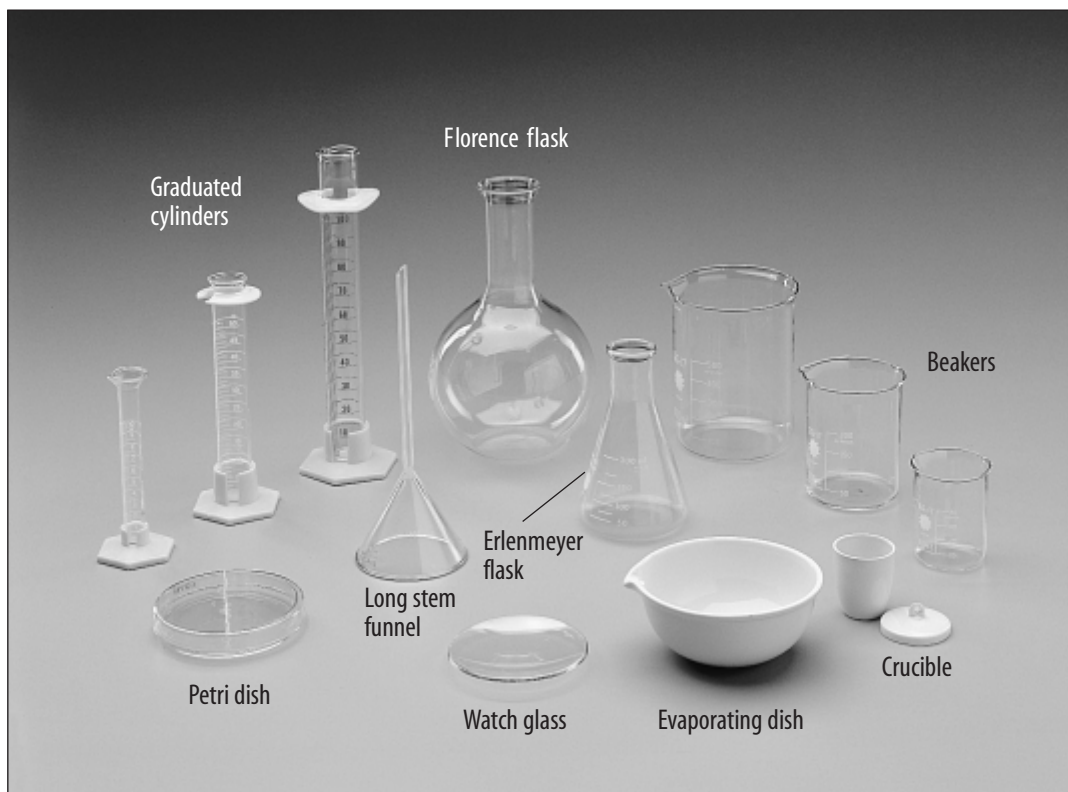
1. For exact amounts, use the equation at the bottom of **Table 3**
- OR**
2. For approximate amounts, find °F on the thermometer at the left of **Figure 1** and determine °C on the thermometer at the right.

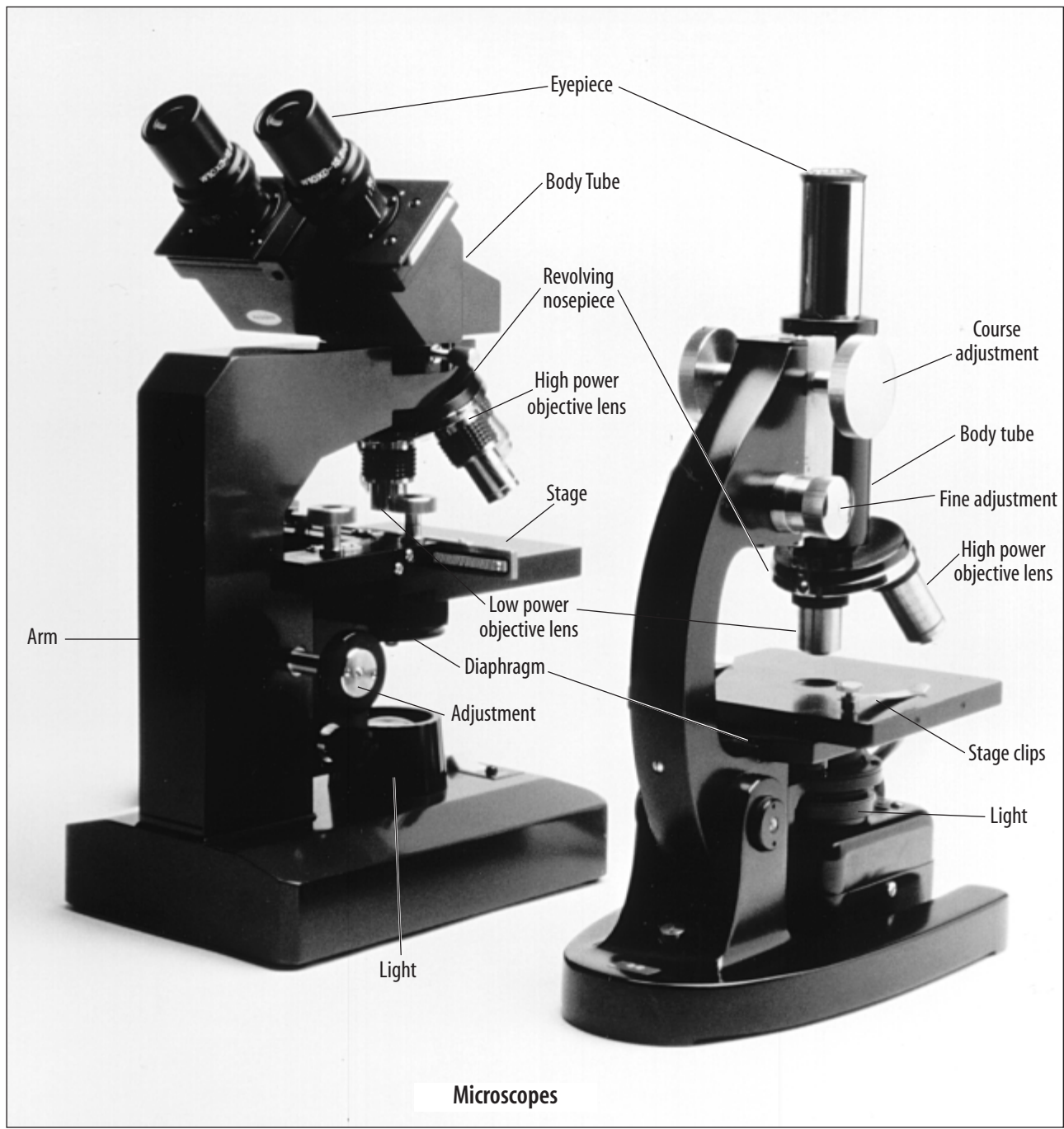
Table 3

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	$\frac{5}{9} (\text{°F} - 32)$ $\frac{9}{5} \text{°C} + 32$	Celsius Fahrenheit

* Weight as measured in standard Earth gravity

Laboratory Equipment





Science as Inquiry

Scientists learn about the natural world in many ways. As a young scientist, you also will want use many approaches to learn science and to learn how science is done. This science inquiry workbook will help you to learn science skills. It also will allow you to practice being a scientist. You will ask questions, form hypotheses, and design experiments. You'll analyze your own data and form your own conclusions. You will learn about the natural world just as a professional scientist would.

Inquiry Skills

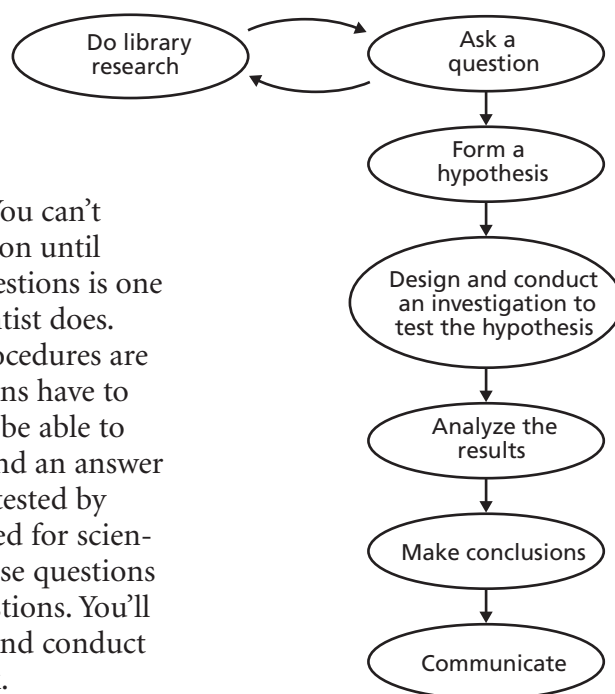
Softball and science have a lot in common. If you want to be a good softball player, you have to learn some skills and strategies. You have to learn how to pitch, hit, and slide. You need to know whether you should cover home plate or protect the third-base line. To be a good scientist, you also need to learn some skills and strategies. You have to learn how to ask good questions. You need to know how to make hypotheses and analyze data. You'll have to form conclusions. Forming conclusions can be as much fun as pitching a no-hitter. Then, in the bottom of the ninth (so to speak), you'll need to be able to communicate your conclusions to others. Continue reading to learn more about these important science skills.

Asking Questions

What comes before every answer? A question does. Questions focus attention on a particular problem. Because doing science is an attempt to find answers and solve problems, each scientific procedure must begin with a question, as shown in the figure. You can't form a hypothesis or begin an investigation until you've asked a question. Asking good questions is one of the most important things that a scientist does.

The questions that begin scientific procedures are special in some ways. First, these questions have to be testable. This means that you have to be able to perform some type of investigation to find an answer to the question. Questions that can't be tested by observing the natural world are not suited for scientific study. A second characteristic of these questions is that they often lead to even more questions. You'll discover this for yourself as you design and conduct the activities described in this workbook.

A Typical Scientific Procedure



Forming Hypotheses

Once you've asked a testable question, you'll probably try to answer it. When you suggest an answer to a scientific question, you are forming a hypothesis. A hypothesis is an educated guess that answers a testable question. It often is easier to form a good hypothesis after reading about the subject in the library. The next step in your scientific procedure is to test your hypothesis.

Testing Hypotheses

To test your hypothesis, you'll want to design an investigation. You'll need to consider what steps you will follow and what materials you will use. You'll also need to think about safety. When designing an investigation, make a list of all of the steps. You also will want to list all of the necessary materials and any needed safety precautions. After your lists are complete, have your teacher approve your plan.

Next, you will want to conduct your investigation. After gathering all of the materials, you follow the steps that you developed. While conducting your investigation, you'll want to carefully record data. Data can consist of numbers, or they can be descriptions of what you observe. You'll use the data later to help you form conclusions.

Analyzing Results

After an investigation is complete, there can be a lot of data. Fortunately, there are methods that can be used to help interpret and organize these data. A method that is useful for interpreting data is using math. For example, data can be calculated as percentages. The percentages then can be organized in a table. Using tables can make it easier to read and analyze data. The table below shows the percentages of different kinds of sand grains. These sand grains are from five widely separated sand bars along the Mississippi River in Louisiana. The table also shows the average composition of the sand from these five sand bars. Calculators and computers are useful for making calculations such as these.

Sand Composition in Mississippi River Bars

Sand Bar	Quartz (%)	Feldspar (%)	Rock Pieces (%)	Other (%)
1	67	22	9	2
2	74	16	9	1
3	69	20	10	1
4	69	20	9	2
5	63	20	16	1
Average	68.4	19.6	10.6	1.4

It's sometimes easier to visualize data when they are shown in a graph. Many different kinds of graphs are used to show scientific data. However, in the case of the Mississippi River sand data, a bar graph is a good choice. Bar graphs show how much of each data category is present. Each category of data is represented by a bar in the graph. The height of a bar shows the amount of that category. Try reading the bar graph shown here.

Making Conclusions

After the data have been gathered, organized, and analyzed it's time to make conclusions. This often is the most enjoyable part of an investigation. Making conclusions is fun because you find out what your data mean. You might learn something about the natural world. You also might make an important discovery. Imagine what it would be like to discover something completely new.

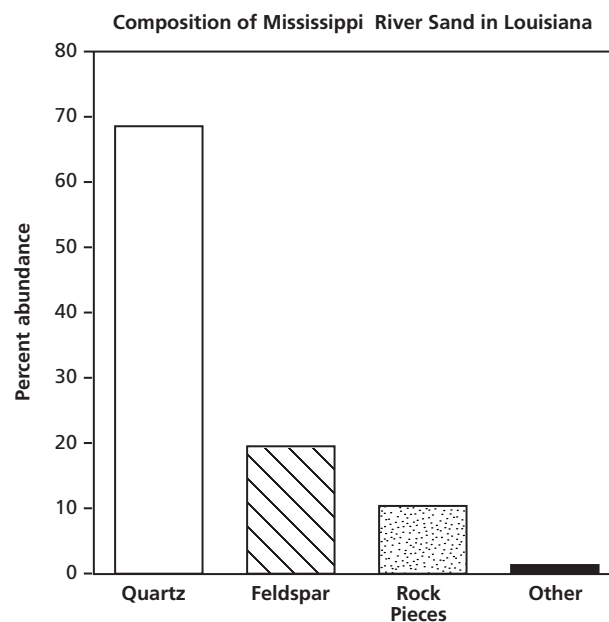
To make conclusions, look closely at your data and graphs. Write down any observations. Look for trends in the data, and decide whether the data show any relationships. For example, look at the Mississippi River sand data and graph. You'll notice that most of the sand grains are the mineral quartz. You might also notice that the sand composition is similar in all of the sand bars. This suggests that Mississippi River sand is similar throughout the state of Louisiana. It also suggests that the sand composition doesn't change much as it is carried along by the river.

The conclusions of a scientific investigation might or might not support the original hypothesis. If the conclusions support the hypothesis, the person doing the investigation has more confidence that the hypothesis is correct. If the conclusions do not support the hypothesis, the investigator has less confidence that the hypothesis is correct. When this occurs, new questions often are asked. These new questions can lead to new hypotheses and additional investigations.

Communicating

The last step in a scientific procedure is to communicate what you've learned to others. This can be done in many ways. One way is to make a poster. The poster could include data tables and graphs. It also might include a short summary of your procedures and conclusions. A second way to communicate is to give a short speech. You might even create your own slide show using a computer.

When scientists communicate conclusions, they often write a research paper. These papers then are read by other scientists, who comment on the research. This process is called peer review. You might want to have some of your peers review your work. They might have some helpful advice.



Inquiry Activity 1

It's A Small World

Ocean water and freshwater contain living things that are not visible to the unaided eye. These microorganisms are very important, and scientists have identified thousands of different kinds. In this activity, you will observe microorganisms in samples of water. You then will classify the organisms.

Possible Materials

- microscope
- slides and coverslips
- prepared slides of diatoms
- live specimens of mixed algae, mixed protozoa, and/or pond water

Question

How can microorganisms be classified?

Form a Hypothesis

1. Your teacher will give you slides to examine under a microscope. Your teacher also will show you how to prepare slides from different water samples.
2. Look briefly at your slides. How do you think the living things can be classified? What kinds of features will you look for?
3. In your Science Journal, make a hypothesis to answer the question above.

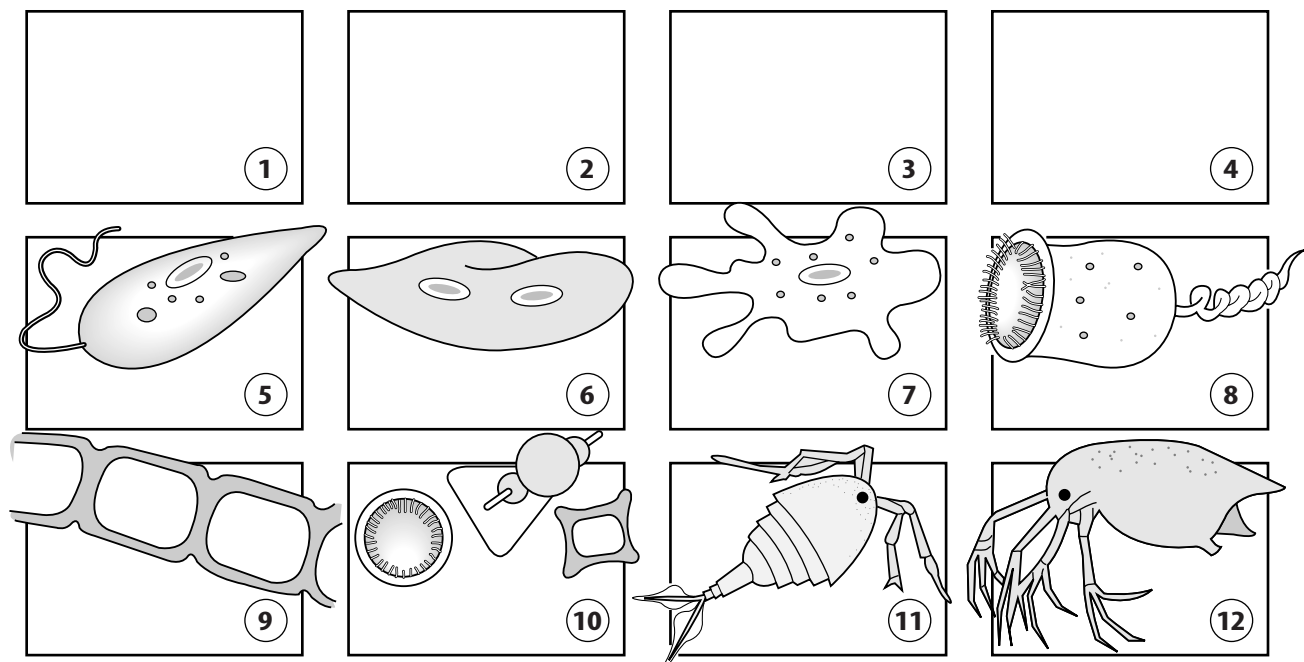
Safety 

Glass slides can break, and you might be cut. Be careful plugging in your microscope; make sure

that your hands are thoroughly dry before doing so. Wash your hands throughout this experiment, and after it. Follow your teacher's instructions for cleaning up.

Test Your Hypothesis

1. Develop a plan to test your hypothesis. Have your teacher approve your plan.
2. Using the chart below, draw or make a check next to at least seven organisms that you viewed under the microscope. You also may draw all of them in your Science Journal.
3. In a table like the one on the next page, carefully record your observations of these microorganisms.



Data Table

Microorganism	Physical Appearance (shape, color, appendages)	Pattern of Movement or Means of Locomotion

Interpret Your Data

1. What patterns can you see in your data? Do some microorganisms share certain features, such as color or shape?

2. Are any of the microorganisms that you observed capable of movement? If so, how do they move?

Conclude and Apply

1. In your Science Journal, organize at least seven of the microorganisms that you observed into groups or categories. The more microorganisms you classify, the better your chances of coming up with good conclusions. Be prepared to explain the main features of each of your categories.

2. Diatoms and protozoans are among the most abundant living things in the world. What useful functions do you think they have in nature?

Going Further

Research a specific group of microorganism. Explain its main characteristics and how it contributes to the natural world. Make models of species within this group and display your models for others to see.

Inquiry Activity 2

Designing a Classification System

What's the difference between a butterfly and an elephant? A butterfly and a moth? Being able to distinguish types of animals and plants allows scientists to organize information about them. It also allows scientists to assign each organism its own scientific name. Scientific classification is based on categories. Animals or plants in similar categories are grouped together. In this activity, you will observe pictures of 15 different animals. You then will design a classification system for the animals.

Possible Materials

- pictures of animals
- scissors
- small index cards
- tape
- glue
- pencil
- crayon

Question

How can physical characteristics be used to develop a classification system for animals?

Form a Hypothesis

Think about how characteristics can be similar or different. Suggest a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

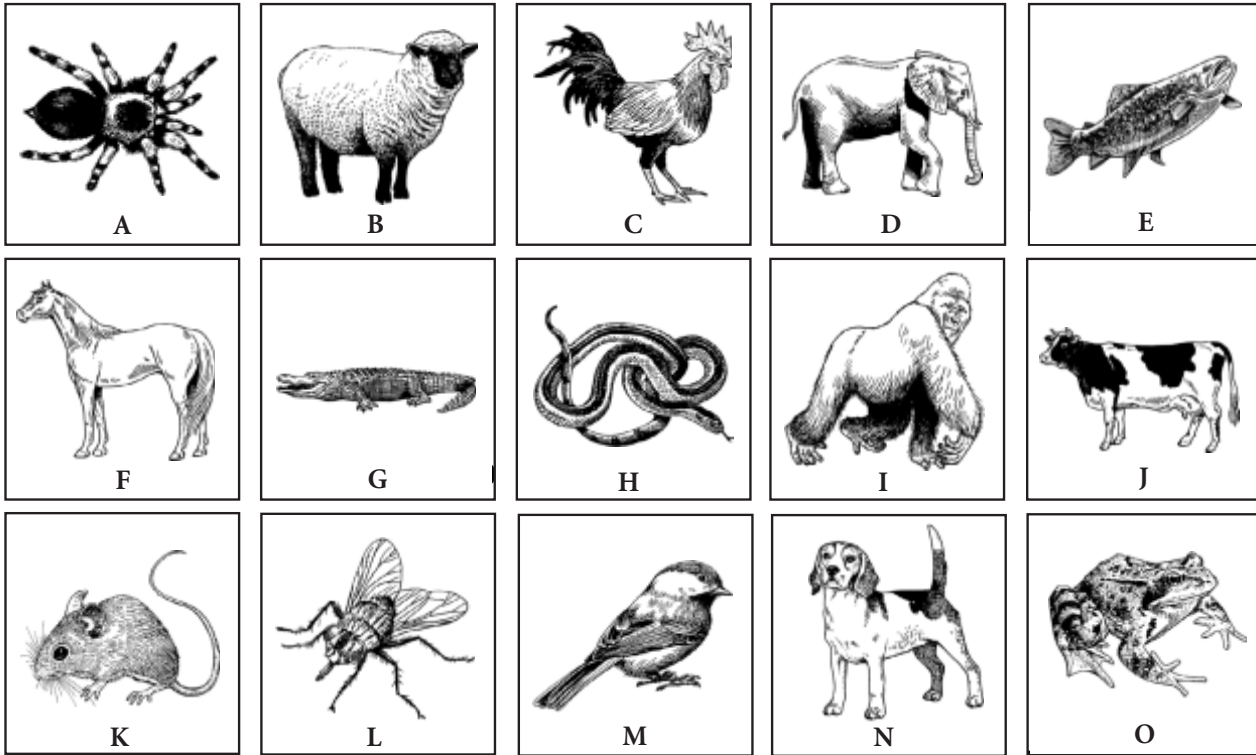
Safety

Always use caution when working with sharp objects.

Test Your Hypothesis

1. Thinking about the animal pictures provided for you, develop a plan to test your hypothesis. Feel free to change your hypothesis if necessary.
2. Make a list of the steps that you will take to design your classification system. Once you have completed your list, ask your teacher to approve your plan.
3. Begin your classification investigation. You might want to cut out the pictures of the 15 animals and attach them to index cards. You should record observations about each animal.
4. Make sure that you pay close attention to differences in physical characteristics among the animals. Important physical characteristics might include skeletal structure, skin and hair, and presence and number of limbs.





Interpret Your Data

1. Look at your list of animal observations. Do you notice any trends? For example, do all animals with 2 legs have wings? Use your data to make statements about how you grouped your animals.

2. On a piece of poster board, use your pictures and observations to show your classification system. Group similar animals and separate dissimilar animals. You might need to include important statements such as “Animals with four legs and hair” to make the selections clear.

Conclude and Apply

1. If an additional animal was added to your animal collection, would you be able to classify this new animal? Give an example.

Going Further

Choose 4–8 animals that you consider closely related to each other (example: lions, tigers, house cats, cheetahs, and leopards). Research their scientific names. How are the names similar? How are they different? Are you able to make any conclusions about which animals are most closely related?

Inquiry Activity 3

Effects of Acid Rain

Acid rain can harm plants and animals. When acid rain falls on forests, the trees can be damaged. Acid rain also can kill fish by making lakes more acidic. In this activity, you will find out how acid rain might affect crops such as corn.

Background

Before you begin your investigation, you'll need to know about pH values. These values can tell you about the acidity of water. When the pH value of water is less than 7, the water is acidic. The lower the pH value is, the more acidic the water is. When water has a pH value that is greater than 7, the water is basic. Water with a pH value equal to 7 is neutral. You can find the pH of water using pH paper or a computer probe.

Pollution can make rainwater more acidic than it normally is. Power plants and cars give off pollutants that can combine with water in the atmosphere to form acid. Acid rain occurs when this acidic water falls to Earth.

Possible Materials

- soil
- corn seeds
- planting pots
- metric ruler
- rainwater
- vinegar
- pH paper or pH probe
- 50-mL cylinder
- plant light or window

Question

What effect does acid rain have on corn plants?

Form a Hypothesis

Think about what you already know about acid rain. Now, make a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety 

Be careful with vinegar. It can irritate your eyes. Never touch a hot plant light. Wash your hands after working with vinegar or soil.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You probably will want to grow corn in two different pots. How will you use vinegar to model acid rain? How will you use pH paper or a pH probe? Will one pot receive normal rainwater? How often will you measure the height of your corn plants? Don't forget that some factors in an experiment must be held



constant. Once you have completed your list, ask your teacher to approve your plan.

3. Carry out your investigation. Take careful notes about the height of your corn plants. You might want to use a table like the one on the next page to organize your data.

Data Table

Corn Plants	Height (mm)							
	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12	Day 14	Day 16
Pot A (watered with normal rain)								
Pot B (watered with acid rain)								

Interpret Your Data

1. Make a line graph that shows how the corn plants grew through time. Label the horizontal axis *Time (days)* and the vertical axis *Height (mm)*. You should use one color to draw the line for the plant(s) that received normal rain. Then, use a different color to draw the line for the plant(s) that received acid rain. Make a legend that shows which color is for which plant(s).
2. Look at your table and your graph. What differences do you notice about how the plants in the different pots grew?

Conclude and Apply

1. What effect could acid rain have on a farmer's corn field?
2. Lime can increase the pH of water. Why do you think some farmers spread lime on their fields?

Going Further

Scientists often ask other scientists to review their work. Talk to some of your classmates about your data. Work together to understand your data better than you did before.

Inquiry Activity 4

Growth Rings as Indicators of Climate

Tree rings are used to learn what the climate of a region was like in the past. Scientists can tell whether a region was wet or dry or cold or warm. By studying past climates, scientists can better understand how Earth's climate might change in the future. In this activity, you will interpret past climatic conditions from tree rings.

Background

New wood is added to tree trunks each year. In the spring, a tree produces earlywood. The cells in earlywood are comparatively large. In the summer, much smaller cells are produced to form latewood. The boundary between one year's latewood and the next year's earlywood separates the rings of wood added to a tree trunk each year.

The number and thickness of tree rings are important information. You can find the age of a tree by counting its rings. The thickness of tree rings is related to climate. When climatic conditions are good, tree rings are thick. When climatic conditions are bad, tree rings are thin.

Possible Materials

- metric ruler

Question

How can tree rings be used to learn how much rainfall occurred in past years?

Form a Hypothesis

Form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety

Test Your Hypothesis

1. Look at Figures 2, 3, and 4 on the next page. These figures are drawings of tree trunks from trees that grew in relatively mild climates. How will these drawings allow you to test your hypothesis?
2. Make a list of the steps that you will follow to determine the age of each tree represented by the drawings. Make a list of the steps that you will use to infer past rainfall amounts received by each tree. You might want to use a table like the one on the next page to organize your data. Once you have completed your lists, ask your teacher to approve your plan.

3. Carry out your investigation. Use care when making measurements. You'll want your data to be as accurate as possible.

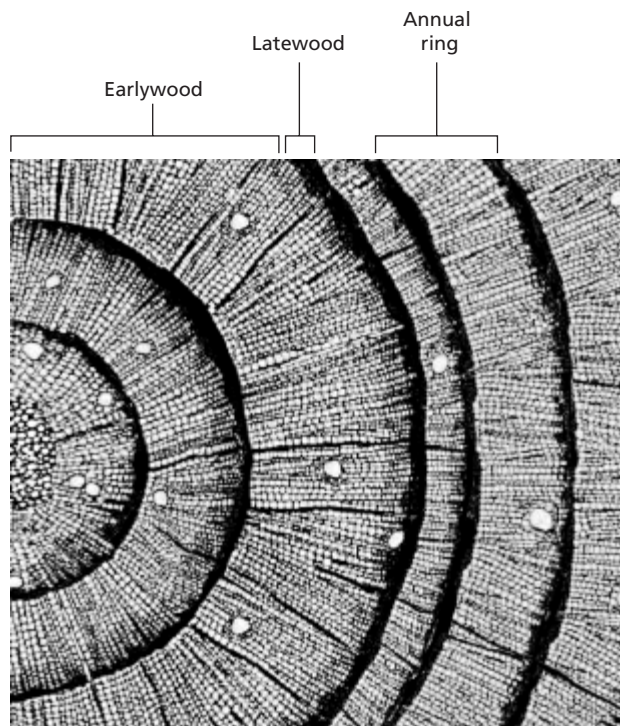
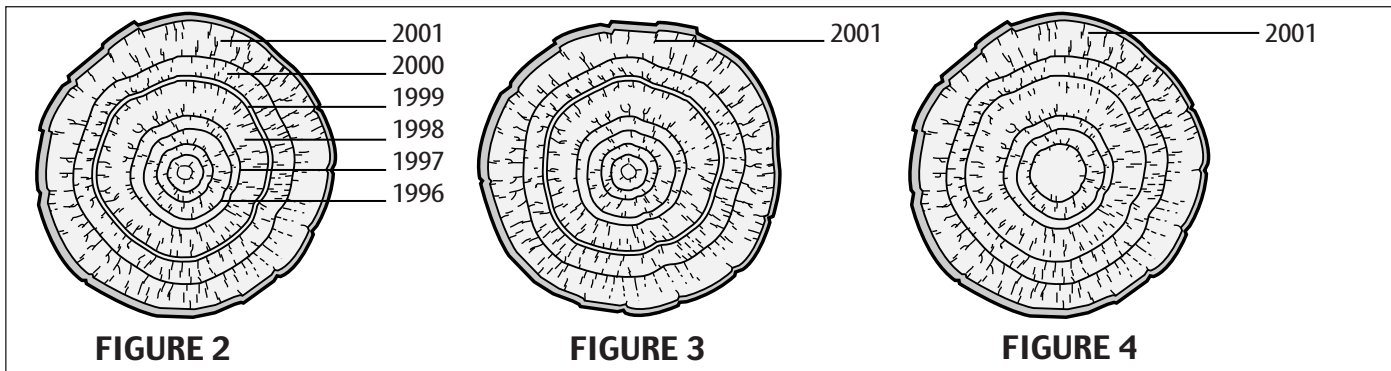


FIGURE 1



Data and Conclusions

Tree	Number of Rings	Age of Tree	Widest Ring (year)	Narrowest Ring (year)
Figure 2				
Figure 3				
Figure 4				

Interpret Your Data

1. Look at the data that you gathered about the number of rings in each tree trunk. What was the age of each tree? How do you know? Complete the *Age of Tree* column of your table.

Conclude and Apply

1. During which year did the tree in Figure 2 receive the most rain? The least? During which years did the trees in Figures 3 and 4 receive the most rain? The least? How do you know?

2. The trees represented by Figures 2, 3, and 4 grew in different locations. In which of these locations do you think conditions were most suited for growth? Why?

Going Further

Research to find out how scientists use a technique called crossdating to extend tree ring information back in time. Make a poster to show what you learn.

Inquiry Activity 5

Radiation and Its Effects on Seeds

When seeds are exposed to nuclear radiation, changes occur. Seeds contain genetic material called DNA. The DNA in seeds determines the characteristics of the plants that grow from them. Radiation can change DNA. The type of seeds and the amount of radiation absorbed determine the extent of the change. In this investigation, you will observe plants grown from irradiated seeds.

Possible Materials

- containers for planting (boxes, pots, or plastic cups)
- potting soil
- seeds that have not been irradiated
- seeds that have received different doses of radiation
- graph paper
- metric ruler
- water
- plant light or window

Question

How are plants grown from irradiated seeds different from plants grown from normal seeds?

Form a Hypothesis

Think about what you already know about radiation. Suggest a hypothesis to the question above. Write your hypothesis in your Science Journal.

Safety

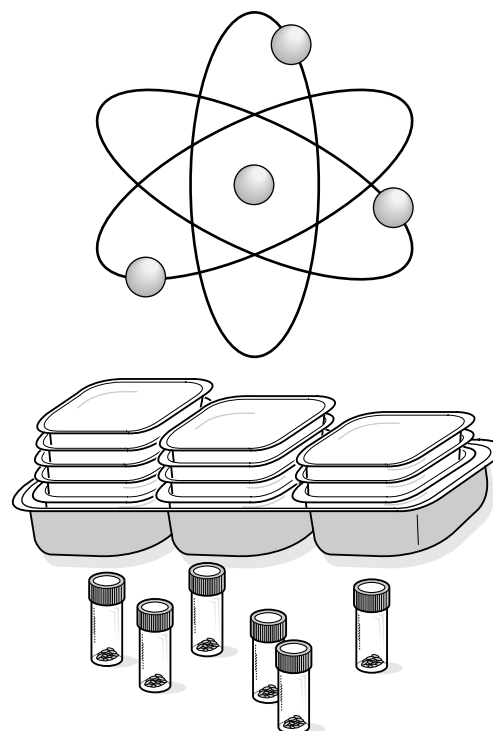


Keep potting soil away from your face. It can irritate your eyes.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You probably will want to grow seeds exposed to different amounts of radiation in different pots. What labels will you use? Will all seeds have the same amount of soil, water and sunlight? How often will you observe the seedlings? Height is just one way to measure plant growth. What other features might you observe to notice the effects of radiation? Once you have completed your list, ask your teacher to approve your plan.

3. Carry out your investigation. Take careful notes about your observations. You might find that making a table in which to record your descriptions is a good way to manage data.
4. Make certain that you pay close attention to differences among the plants grown from different seeds. Important things to notice include sprouting and growth rates; differences in size, color, and shape; and number and location of stems and leaves.



Data Table

Container Number	Amount of Radiation	Observations					
		Day ____	Day ____	Day ____	Day ____	Day ____	Day ____

Interpret Your Data

1. Using graph paper, make a line graph that shows the height of the plants in each pot through time. Label the horizontal axis *Time (days)* and the vertical axis *Height (mm)*. You should use one color to draw the line for the plants that grew from the seeds that received no radiation. Then, use different colors to draw lines for the plants that grew from seeds that received varying amounts of radiation. Make a legend that shows which color represents which plants. Be sure to give your graph a title.
2. Look at your table and your graph. Compare and contrast the growth rates of the plants grown from the different types of seed. Describe your observations.

Conclude and Apply

1. Which characteristics of your seedlings seemed to be most affected by the radiation? Which characteristics were least affected?
2. Based on your observations of irradiated plant growth, what differences would you expect to find in the root structure and growth of these same plants? How could you test your expectation?

Going Further

Many Americans use microwave ovens in their homes. Design an experiment to determine the effects of exposing seeds to different amounts of microwaves. How do these results compare with the results that you obtained earlier?

Inquiry Activity 6

Survival in Extreme Climates

In this activity, you will learn how cactus plants are able to survive in desert climates.

Background

Desert plants and animals are adapted to an extreme environment. The daily change of air temperature can be more than 30°C. Summer high temperatures can be 50°C, and winter low temperatures can be less than 0°C. Deserts are also the driest environments on Earth. They often get less than 25 cm of rainfall in a year.

Possible Materials

- plastic covering or newspaper
- 3–5 different types of house plants, such as ferns or flowering plants; and at least one type of small cactus plant
- medium-size bowl
- toothpicks
- craft stick
- small paintbrush
- ruler

Question

What characteristics of cactus plants make them better suited than other plants to survive in desert conditions?

Form a Hypothesis

Think about specific differences between the cactus plants and the other plants you have been given. How are they shaped? How are the leaves different? In your Science Journal, write a hypothesis to answer to the question above.

Safety



Needles on the cactus plants can puncture and irritate your skin. Use gloves and, whenever possible, a toothpick or craft stick when examining a cactus.

Test Your Hypothesis

1. Make a list of specific procedures that you will use to test your hypothesis. Don't limit your investigation. You may examine any part of the plants, even the roots, to test your hypothesis.
2. In your Science Journal, you might want to make a table like the one on the next page to organize your observations.



Data Table

Plant Type	Stem	Leaves	Roots
1.			
2.			
3.			
4.			
5.			
6.			
7.			

Interpret Your Data

1. How do cactus plant structures differ from those of the other plants?

Conclude and Apply

1. Think about the advantages that cactus plant structures might offer in a desert environment. What do your observations tell you about how cactus plants are adapted to survive in the desert?

Going Further

Research another unusual type of environment, such as a rain forest or inland mountain range. Find out what types of plants inhabit that environment and explain how they are adapted to survive there. Compare your conclusions with those of your classmates.

Inquiry Activity 7

Upfolds and Downfolds

The movement of Earth's plates can cause rock layers to fold. This often occurs when two plates collide to form mountains. Through time, erosion can lower the mountains and expose the folded rock. In this activity, you'll learn how rock layers are arranged in folds.

Background

You might remember the principle of superposition. It states that the oldest rock layer in a stack of rock layers is at the bottom. However, the principle of superposition might not apply to rock layers that have been folded or faulted.

Rock layers can be folded in two basic ways. The layers can be folded down, or the layers can be folded up. Downfolds are called synclines. Upfolds are called anticlines. In some mountain regions, the rock layers have been folded into alternating anticlines and synclines.

Possible Materials

- modeling clay (4 colors)
- plastic knife
- paper
- colored pencils

Question

Where are the oldest rock layers in anticlines and synclines that are exposed at Earth's surface?

Form a Hypothesis

Form a hypothesis to answer the question above. You might find that drawing sketches is helpful.

Safety



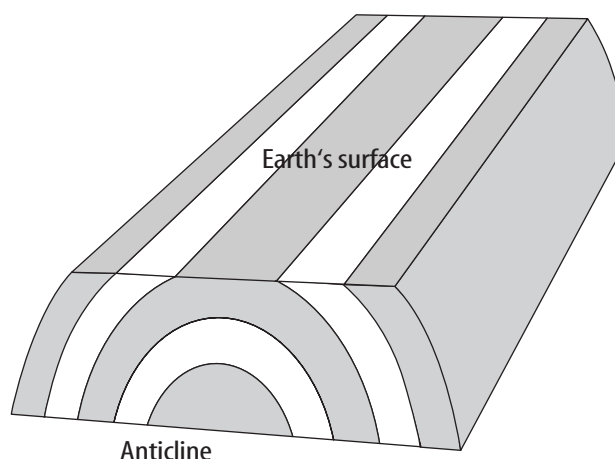
Be careful with plastic knives. Wash your hands after making your models.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You'll probably want to make two flat stacks, each having four different-colored layers of clay. How will you know which colors represent older rock layers and which represent younger rock layers? You might want to write the order from oldest to youngest in the table on the next page.
3. How will you form an anticline and a syncline? How will you use the plastic knife to model erosion of the folds? Once you have

completed your list, ask your teacher to approve your plan.

4. Carry out your investigation. Make sketches of what you observe.



Layer Color	Stack for Anticline	Stack for Syncline
Color of youngest rock layer		
Color of next-to-youngest rock layer		
Color of next-to-oldest rock layer		
Color of oldest rock layer		

Interpret Your Data

1. Look at the tops and sides of the anticline and syncline models that you made. How are the rock layers arranged?

Conclude and Apply

1. In your own words, describe an anticline and a syncline. Where is the oldest rock layer at Earth's surface in each case?

2. Imagine that a friend gave you a map that showed folded rock layers at Earth's surface. If you knew the ages of the rock layers, how could you identify whether a fold was an anticline or a syncline?

Going Further

Research to learn about the relationship between anticlines and oil. Create a poster to illustrate what you discover. Why do think it is important for scientists to be able to recognize anticlines?

Inquiry Activity 8 Making Waves

Beaches are affected by the waves that come ashore. However, all beaches are not affected in the same way. Waves cause beaches with coarse sand to have different slopes than beaches with fine sand. In this activity, you will learn about the relationship between sand grain size and beach slope.

Possible Materials

- wave tank or plastic tub (1 m × 0.5 m × 15 cm) (2)
- coarse sand (dry)
- fine sand (dry)
- wooden board (about 30 cm long)
- water
- clock or watch
- grease pencil
- protractor
- metric ruler
- pitcher
- sandbox shovel

Question

How does the size of beach sand grains affect the slope of the beach?

Form a Hypothesis

Think about beaches that you have seen. Now, make a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety



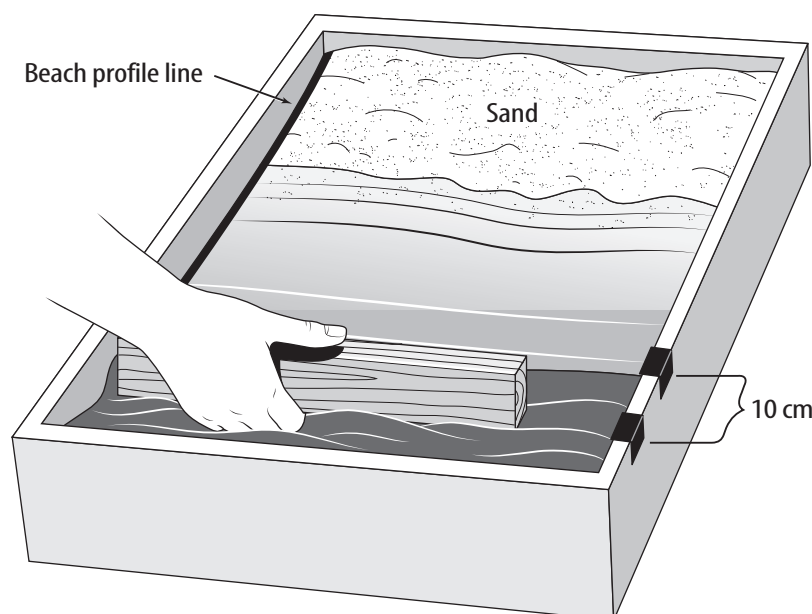
Do not use water near any type of electrical appliance. Do not put sand in the sink. It might plug the drain. Your teacher will tell you how to dispose of used sand.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You probably will want to put coarse sand in one tub and fine sand in the other. How will you model a beach? How will you model waves? How long will

you produce waves? What will you use to measure the slope of the beaches? Don't forget that some factors must be held constant in an experiment. Once you have completed your list, ask your teacher to approve your plan.

3. Carry out your experiment. Make careful measurements of beach slope. You might want to make a table in which to record your data.



Interpret Your Data

1. Look carefully at the data that you obtained. Which beach (coarse or fine) had the higher slope angle? Which had the lower angle? How much is the difference?

2. Use your metric ruler and a calculator to find the average size of the fine sand grains and the average size of the coarse sand grains. To do this, you should measure ten grains of each type of sand. Then, average the sizes of the ten fine sand grains. Also average the sizes of the ten coarse sand grains. Record your data.

	Grain Measurements (mm)										Average (mm)	
	1	2	3	4	5	6	7	8	9	10		
Fine												
Coarse												

3. Make a graph showing the relationship between beach slope and grain size. Label the x -axis of your graph *Grain size (mm)*. Label the y -axis *Beach slope (degrees)*. Use the average grain sizes and the beach slope angles that you measured to complete your graph. Plot the point for fine sand. Plot the point for coarse sand. Connect these points with a straight line.

Conclude and Apply

1. How does the slope of a beach vary with grain size? (Hint: the graph that you made should help you answer this question.)

2. If a friend gave you a sample of sand from an unknown beach, how could you predict the approximate slope of that beach?

Going Further

Do research to find out why the government has paid for studies of beaches. Why are beaches important? What problems can occur on beach-front property?

Inquiry Activity 9

A Trip Around the World

Because Earth rotates from west to east, points on Earth's surface are in constant motion. This west to east motion is called linear motion. Speed is the rate at which motion occurs. Speed is calculated using the following formula: $\text{speed} = \text{distance} \div \text{time}$. In this investigation, you will discover how linear speed varies with Earth's latitude.

Background

Latitude is used to measure position north or south of Earth's equator. The equator has a latitude of 0° . The north pole has a latitude of 90° north, because it is 90° away from the equator toward the north. The south pole is 90° south latitude. Places in between the poles and the equator have latitudes that are in between 0° and 90° , north or south.

Longitude is used to measure position east or west of the prime meridian. The prime meridian is an imaginary line on Earth's surface that connects Earth's poles and runs through Greenwich, England. The prime meridian has a longitude of 0° . Other places have longitude values that are between 0° and 180° , either east or west of the prime meridian.

Possible Materials

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

Question

How does linear speed vary with latitude?

Form a Hypothesis

Look at your globe and think about the meaning of linear speed. Now, make a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You probably will want to find the linear speed at the equator, 30°N latitude, 60°N latitude, and the north pole. How will you determine distance? How will you measure time? How will you use the string and the tape? Once you have completed your list, ask your teacher to approve your plan.
3. Carry out your investigation. You might want to record your data in tables like those on the next page.

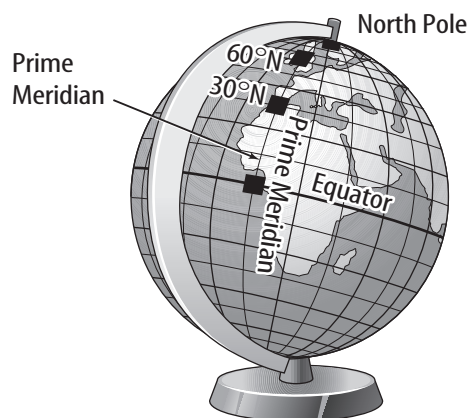
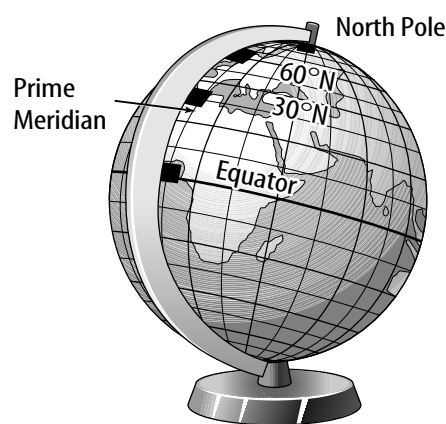


Table 1

Latitude	Distance Moved (cm)		
	1 second	2 seconds	3 seconds
Equator			
30°N			
60°N			
North pole			

Table 2

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

Interpret Your Data

1. Look at the speeds that you calculated. How does linear speed vary with latitude?

Conclude and Apply

1. Use the scale on your globe to determine the true distance around Earth at the equator, 30°N latitude, 60°N latitude, and at the north pole. Record these distances.

2. Earth rotates once in about 24 hours. Using the distances that you determined in question 1, calculate the actual linear speeds for Earth at each latitude. Show your work.

Going Further

Do research to learn about the Coriolis effect. How did an understanding of Earth's rotation allow scientists to better understand the flow of air and ocean water on Earth? Give a speech to the class explaining what you learn.

Inquiry Activity 10 Investigating Diatomite

Fossils occur in many sizes. You're familiar with large fossils such as dinosaur bones. You also might have seen fossils of trilobites, snails, or leaves. But many fossils, called microfossils, are too small to be seen with the unaided eye. In this activity, you will observe a common type of microfossil.

Background

Some microscopic organisms produce shells. These organisms are common in oceans and lakes. Some float near the surface, and others live at greater depths. When these organisms die, their shells accumulate on the bottom to form sediment.

Diatomite is a kind of sedimentary rock. It forms from sediment that consists of the shells of a particular type of algae. The algae are called diatoms, and their shells are made from silica. Diatom-shell sediment occurs at many places on the ocean floor today. It also occurs on some lake bottoms.

Possible Materials

- stereomicroscope
- microscope lamp
- diatomite
- fine artist's paintbrush
- square of black construction paper
- small laboratory spatula

Question

What does diatomite look like under a microscope?

Form a Hypothesis

Form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

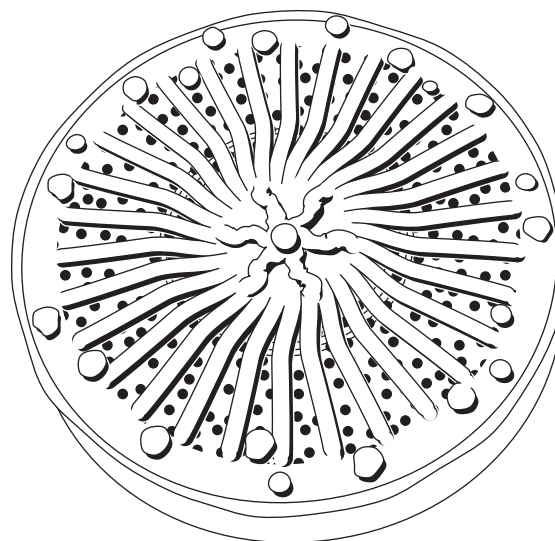
Safety



Do not inhale or swallow diatomite. Don't rub your eyes with diatomite-soiled hands. Wash your hands after the activity. Your teacher will tell you how to dispose of your sample.

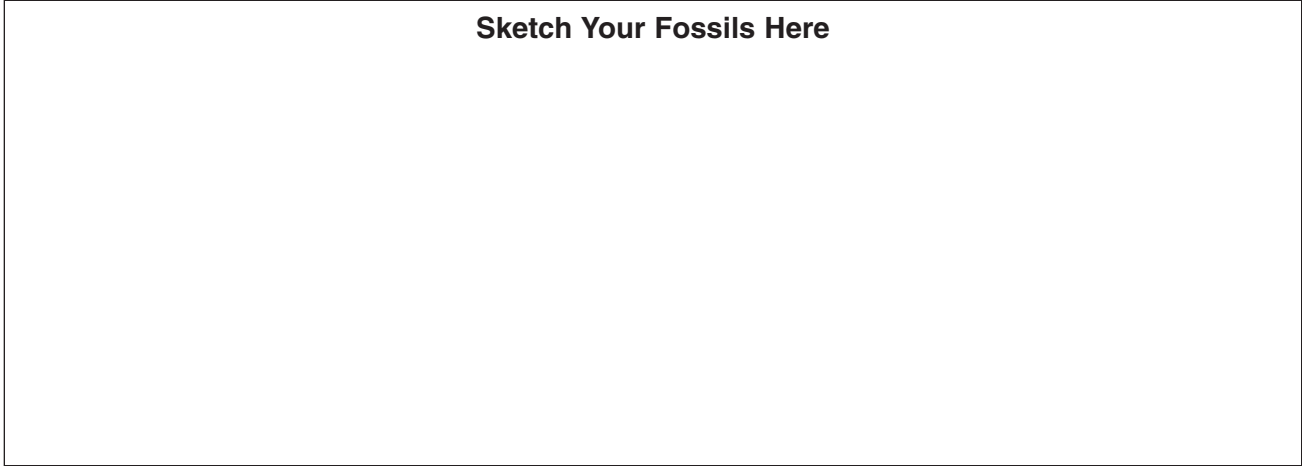
Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. How will you observe your sample? What procedures will you follow? After you have completed your list, have your teacher approve your plan.
3. Carry out your investigation. Take careful notes about what you observe through the microscope. You might want to draw some sketches of what you see.



Diatom shell

Sketch Your Fossils Here



Interpret Your Data

1. Write descriptions of the different microfossils that you observed on the lines below.

Conclude and Apply

1. In your own words, explain how diatomite forms.

2. What do you think scientists learn by studying microfossils?

Going Further

Research other types of microfossils. What types of sediments do they produce? What types of rocks can these sediments form? Communicate what you learn by making and displaying a poster.

Inquiry Activity 11 Coal: What's My Rank?

Although some people joke about getting a lump of coal as a gift, coal is a valuable rock. Much of this country's electricity is generated by burning coal. The coal formed from plants that lived in ancient swamps. Through millions of years and under the influence of heat and pressure, the plant matter gradually changed into rock. In this activity, you will learn about the properties of coal. You also will learn about how coal is classified according to its rank.

Possible Materials

- anthracite coal
- bituminous coal
- subbituminous coal (optional)
- lignite coal
- hand lens
- penny

Question

What are the physical properties of the different types of coal? What changes occur through time as coal is subjected to more heat and pressure?

Form a Hypothesis

Based on your research or what you already know about coal, suggest a hypothesis, or possible answer, to the questions above. Write your hypothesis in your Science Journal.

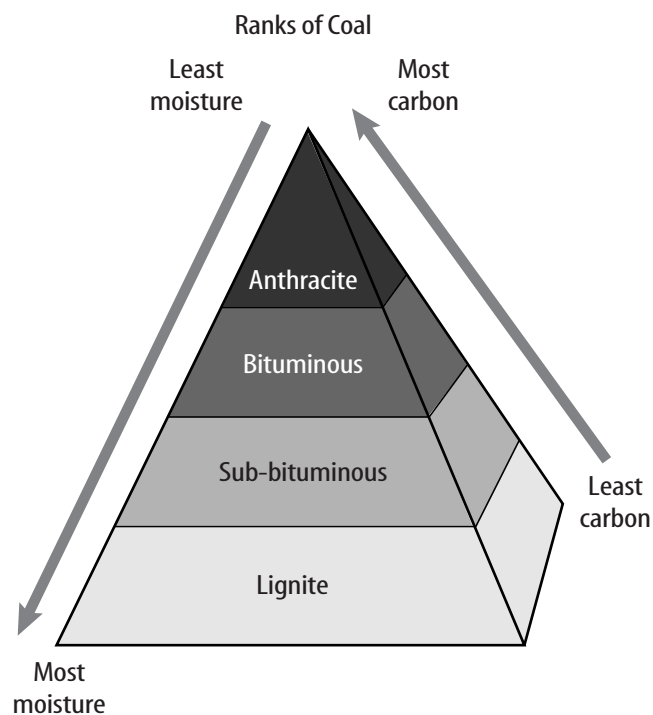
Safety

Don't hit rocks against the table. You can see how coal breaks by looking at the already broken edges. Wash your hands after the activity.

Test Your Hypothesis

1. Considering the rock samples and equipment that are provided for you, develop a plan to test your hypothesis. Feel free to change your hypothesis if necessary.
2. Make a list of the steps that you will take during this investigation. Once you have completed the list, ask your teacher to approve your plan.
3. Carry out your investigation as planned. Take careful notes about your observations as you work. You might find that making a table in which to record descriptions of the different types of coal is a good way to manage data.

4. Make certain that you pay close attention to differences in physical properties among the different samples. Important physical properties are hardness and the way the rocks break.



Interpret Your Data

1. Look at the data that you acquired about the different types of coal. Do you notice any trends? For example, are some samples of coal harder than other samples or do some samples break in a different way than others do?

2. Coal changes as it is subjected to increasing amounts of heat and pressure within Earth. The rank of coal depends upon the highest amount of heat and pressure to which it was exposed. Anthracite coal was subjected to the most heat and pressure, and lignite coal was subjected to the least. Using the figure on the previous page, identify the rank of each of your coal samples.

Conclude and Apply

1. What properties of coal change as the coal is exposed to more heat and pressure within Earth? Describe the changes that occur.

2. Predict what will happen to a layer of lignite coal as it is buried under more sediment and rock and then finally undergoes metamorphism at high temperature and pressure.

Going Further

Make a poster showing how plants in a swamp might become anthracite coal after millions of years. Display your poster for others to see.

Inquiry Activity 12 Tornado in a Jar

A tornado is a violently rotating column of air that extends from a cloud to the ground. Most tornadoes form because of wind shear in a cloud. Wind shear means that air is moving in different directions at different heights. Wind shear can cause air in a cloud to spin around in circles. If this spinning air gets tilted down toward the ground, a tornado might occur. In this activity, you will model a tornado.

Possible Materials

- 1-quart plastic or glass jar with lid
- water
- 10 mL of liquid dish soap
- 10 mL of vinegar
- a few drops of food coloring

Question

How does the air move in a tornado?

Form a Hypothesis

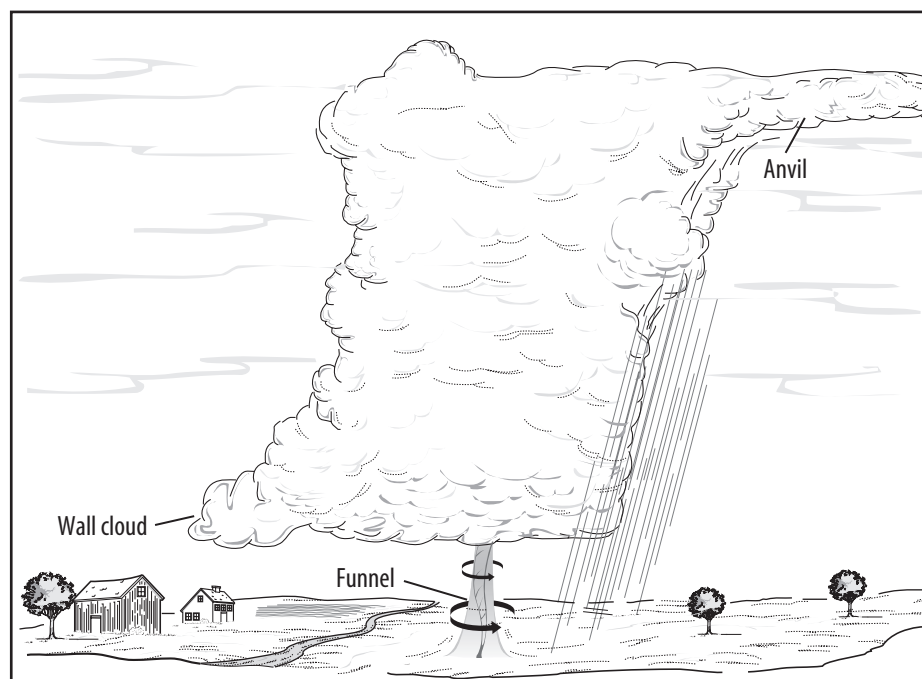
Form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety

Be careful with vinegar and dish soap. They can irritate your eyes. Wash your hands after using them.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You'll probably want to put the dish soap, vinegar, and food coloring in the jar with water. How will you model a tornado? How will you keep the water from spilling? Once you have completed your list, ask your teacher to approve your plan.
3. Carry out your investigation. Take careful notes about what you observe.



Interpret Your Data

1. Describe and sketch what you observed during your experiment.

Drawing:

Conclude and Apply

1. How was the model that you made similar to a tornado? How was it different?

2. During the formation of a tornado, a column of rotating air becomes narrower and a funnel reaches down to the ground. Thinking about what happens when a spinning ice skater pulls her arms close to her body, describe what you think happens to the column of air when it becomes narrower.

Going Further

Research to find out what scientists are doing to better understand how tornadoes develop. Why is this research important? How is the research being funded?

Inquiry Activity 13 Identifying Metals and Nonmetals

An electric current can flow through a metal. An electric current will not flow through a nonmetal. In this activity, you will make a conductivity tester. Then you will test samples with it.

Background

Metals are good conductors of electricity because they have low resistance. Electrons flow freely in them. Nonmetals are not good conductors because they have high resistance to the movement of electrons. A metal sample can complete an electric circuit and cause a lightbulb to light. A nonmetal sample can not.

Possible Materials

- 1.5-V dry cell
- 1.5-V lightbulb
- insulated wires (3)
- tape
- battery holder (optional)
- bulb socket (optional)
- zinc strip
- glass rod
- copper strip
- rubber sample
- wood sample
- iron sample
- unknown sample

Question

How can you determine whether an unknown is a metal or a nonmetal?

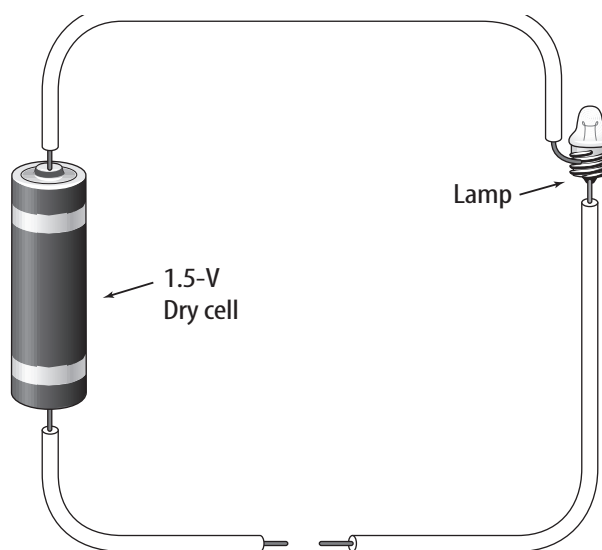
Form a Hypothesis

Based on the background, form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety 

Test Your Hypothesis

1. Think about the materials that have been provided for you. Design an electrical circuit in which the bulb will light if the sample conducts electricity and will not light if the sample does not conduct electricity. When you have completed your setup, ask your teacher to approve it. Then sketch it in your Science Journal.
2. Carefully test each sample. Enter your data in a table like the one on the next page.



Sample Tested	Did the bulb light?	Does it conduct electricity?	Is it a metal or a nonmetal?	Other Observations

Interpret Your Data

1. Which samples are metals? How do you know?

2. Which samples are nonmetals? How do you know?

3. What physical properties do all of the metals have in common?

Conclude and Apply

1. Is your unknown sample a metal or a nonmetal? What is your evidence?

Going Further

Explain why the electrical conductivity of metals makes them useful. Then list some situations in which metals might be unsafe because of their ability to conduct electric current. Create a poster to communicate what you learn.

Inquiry Activity 14 The Inside Story of Packaging

In this activity, you will investigate why different types of plastic packages are used for different products.

Background

When you buy an item at a supermarket, you purchase two things—the item and its package. The package allows you to carry and store the product. A good package also protects its contents from damage, contamination, or spoilage. The properties of a package must be well suited to the properties of the product that it contains.

Many packages are made from plastics. To aid in recycling, the packaging industry uses a code to indicate the main component of a plastic container. This code is found on the bottom of a package, inside a triangle of arrows. It is a number between 1 and 6. The code allows plastic to be sorted for recycling.

Possible Materials

- at least ten different plastic packages (These should include a wide variety of packages, such as ones for food, detergents, shampoo, and other consumer goods.)

Question

Why and how do the properties of plastic packages differ from one product to another?

Form a Hypothesis

Think about the products that your packages would contain. What qualities would the packages need to have? Then, in your Science Journal, write a hypothesis to answer the question above.

Safety



Do not open any of the packages. Your teacher will make sure that the outside of each package has been washed. It is still a good idea to wash your hands after handling the packages.

Test Your Hypothesis

- Write out a plan for examining and categorizing your packages. What qualities will you look for to test your hypothesis?
- Make a table in your Science Journal to organize your observations. The table on the next page shows one possible strategy.



Data Table

Package Code	Product	Physical Properties

Interpret Your Data

1. What properties do the products in containers marked with the same codes share?

2. How do containers with different codes compare? How were some same-coded containers different from each other?

Conclude and Apply

1. What kind of product is a container coded “1” suited for? A container coded “2”?

2. Why would manufacturers add colored pigment to the plastic used in some containers? When wouldn't they add colored pigment?

Going Further

Do research to determine what types of materials are made from recycled plastic with different codes. List several ways plastic has aided the packaging industry, and how recycling of plastic has benefited our society.

Inquiry Activity 15 Lenses that Magnify

You probably have used a magnifying glass to make objects appear larger. A magnifying glass is a convex lens. Parallel light rays passing through a convex lens are bent toward a single point called the focal point. The distance between the center of the lens and the focal point is called the focal length. In this activity you will discover the relationship between the curvature of a lens and its focal length.

Possible Materials

- masking tape
- white index card
- flashlight
- convex lenses with different curvature (3)
- metric ruler

Question

How are lens curvature and focal length related?

Form a Hypothesis

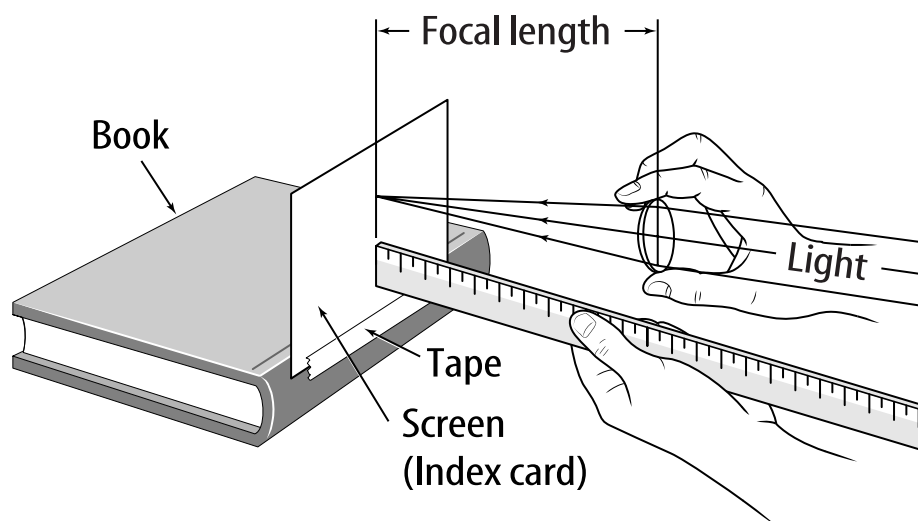
Form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety  

Do not focus the light from a lens at other people because it can damage eyes. Do not focus sunlight on objects because it can start a fire.

Test Your Hypothesis

1. Think about the materials that have been provided for you and study the figure on this page. What will you measure to determine focal length? Light from a flashlight several meters away from the lens is close enough to parallel to find the focal length. The light is focused when the spot on the screen is as small as possible.
2. Make a list of the steps that you will follow. Once you have completed your list, ask your teacher to approve your plan.
3. Carry out your experiment. You might want to record your data in a table like the one on the next page.



Data Table

Curvature of Lens	Focal Length (cm)
Least curvature	
Intermediate curvature	
Most curvature	

Interpret Your Data

1. Look at the data that you acquired. How is the curvature of a lens related to its focal length?

2. Select the lens with the least curvature and the lens with the most curvature. Use these two lenses to look at the print on this page. Which lens has the higher magnification? How is the curvature of a lens related to its magnification?

Conclude and Apply

1. You are given two lenses. One lens has a focal length of 5 cm. The other has a focal length of 10 cm. Which lens has the greater curvature?

2. Can a drop of water resting on a surface act as a magnifying glass? Explain.

Going Further

Do research to learn about Fresnel lenses. Learn how this design saves weight (and material) compared to other lenses. Maybe you can find a “flat” magnifier.

Inquiry Activity 16 Electrolytes and Conductivity

Introduction

In this activity, you will create an electric current in salt water. This will be part of a circuit that includes a flashlight bulb. Commercially, an electric current in a liquid is used to refine aluminum.

Background

Materials that carry an electric current are called conductors. Pure water is not a conductor. Tap water and sports drinks are conductors. Salt water is a better conductor. A solution that conducts an electric current is called an electrolyte.

Possible Materials

- metric ruler
- 2 pieces of household aluminum foil (about 30 cm × 14 cm)
- pencil
- 250-mL beaker
- water
- 5 g table salt (sodium chloride)
- stirring rod
- flashlight batteries (2)
- battery holders (optional) (2)
- flashlight bulb
- alligator clips (4)
- wire (about 15 cm long) (4)

Question

How does electrode size affect conductivity?

Form a Hypothesis

Form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety

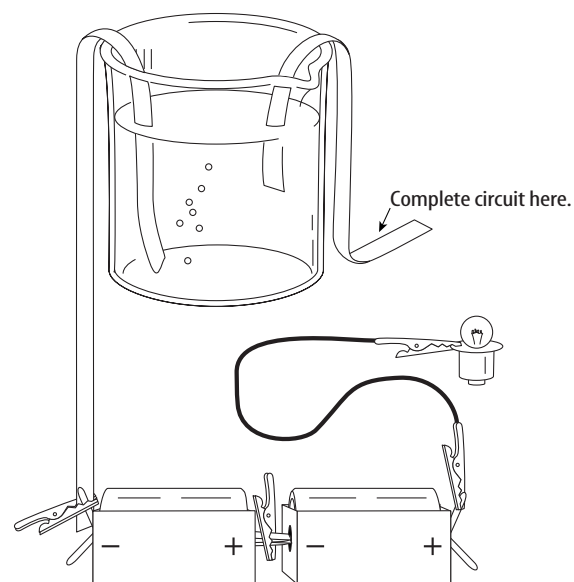


Use care when handling alligator clips and wires.

Test Your Hypothesis

1. Think about the materials that have been provided for you. Design an electrical circuit that includes the beaker of salt water. One setup is shown in the drawing. You will complete the circuit by touching the base of the flashlight bulb to the dry end of the marked electrode. The electrodes are made by folding each piece of aluminum foil into a 30 cm × 2 cm strip. When you have completed your setup, ask your teacher to approve it. Then sketch it in your Science Journal.

2. In the setup shown below, you can test your electrical connections by briefly touching the base of the flashlight bulb to the dry part of the unmarked electrode. What would you expect to see? Test your electrical connections.
3. Plan what data to take to test your hypothesis. Carry out your experiment and record your observations in your Science Journal.



Interpret Your Data

1. Look carefully at your data. Which electrode length produced the brightest light?

Conclude and Apply

1. How did you know that there was a closed circuit?

2. What happened to the conductivity of the solution as the amount of submerged electrode increased?

3. Which data inform you about the conductivity?

Going Further

Do you think the distance between two electrodes in a conducting solution affects the conductivity of the solution? Form a hypothesis and test it.

Inquiry Activity 17 **Curds and Whey**

The pH scale is a measure of how acidic or basic a substance is. The pH value can determine whether a chemical reaction will occur. For example, the pH of milk determines whether curds will form, as in the production of cottage cheese. In this activity, you will observe what happens when different substances are added to milk.

Background

The pH of a substance can be measured with pH paper. This method can determine whether a solution is acidic or basic. Acids have a pH of less than 7, and bases have a pH of more than 7. Pure water is neutral and has a pH of 7. Milk curdles when the pH approaches 4.6. The remaining liquid is called whey.

Possible Materials

- pH paper
- vinegar
- lemon juice
- tea
- diluted chocolate syrup
- milk
- graduated cylinder
- plastic cups (4)
- stirring rod

Question

Which of the following substances will cause milk to curdle: lemon juice, tea, vinegar, chocolate syrup?

Form a Hypothesis

Use pH paper to find the pH values of lemon juice, tea, vinegar, and chocolate syrup. Form a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety

Use care when handling vinegar and lemon juice. Don't get it in your eyes. Do not eat or drink any of the materials. Wash your hands as necessary.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. How will you observe your sample? After you have completed your list, have your teacher approve your plan.
3. Carry out your experiment. Take careful notes about what you observe. You might want to organize your observations in a table like the one on the next page.



Data and Observations

Substance	pH	Observations (when added to milk)
Vinegar		
Lemon juice		
Tea		
Chocolate syrup		

Interpret Your Data

1. Write a description of each of the different solutions that you observed.

Conclude and Apply

1. What was the common factor that caused some solutions to curdle?

2. Was your hypothesis supported? Explain.

Going Further

Do research to find out how allowing milk to curdle is important in the production of both cottage cheese and hard cheese. Write a short research paper about what you learn.

Inquiry Activity 18

Cabbage Chemistry

Some materials change color when exposed to an acid or a base. These materials are called indicators. For example, blue litmus paper turns pink in acids. The water in which a red or purple cabbage was cooked also changes color when exposed to an acid or a base. In this activity, you will use cabbage juice as an indicator. The color of cabbage juice will vary from greenish-yellow when mixed with a very strong base to bright red when mixed with a very strong acid.

Possible Materials

- test-tube rack
- test tubes (4)
- labels and pencil
- 25-mL graduated cylinders (4)
- 40 mL red/purple cabbage juice
- stirring rods (3)
- droppers (3)
- vinegar
- dilute ammonia solution
- baking soda solution
- lemon juice

Question

What happens to cabbage juice when each of the following solutions is added to it: vinegar, dilute ammonia solution, baking soda solution?

Form a Hypothesis

Research the properties of vinegar, ammonia, and baking soda. What might cabbage juice do when exposed to them? Make a hypothesis to answer the question. Write your hypothesis in your Science Journal.

Safety



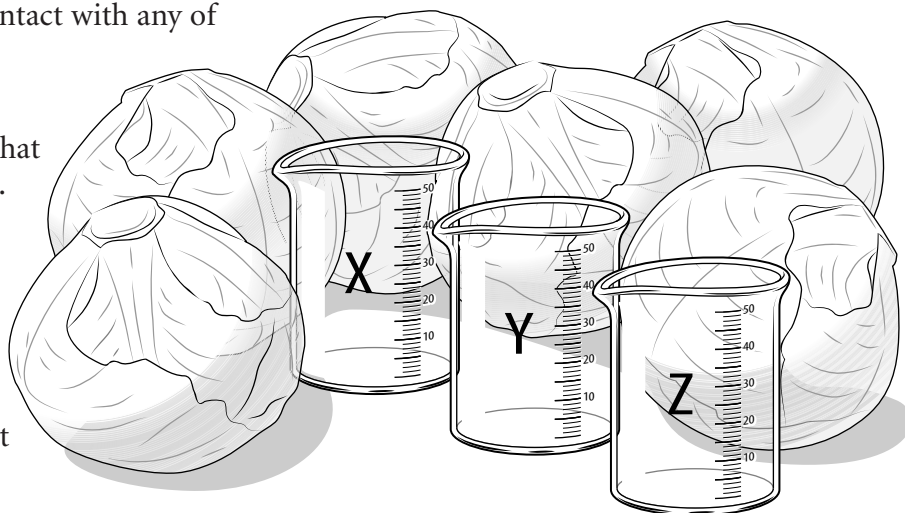
Some of these solutions are poisonous. Do not taste, eat, or drink any materials used in the lab. Do not inhale vapors from the solutions. These solutions can stain your clothes. Inform your teacher if you come in contact with any of the solutions.

Test Your Hypothesis

1. Think about the materials that have been provided for you. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You'll probably want to put the same amount of cabbage juice in each test tube. What

solutions will you add to different tubes? Label each test tube. Remember to keep a control, that is, a sample of cabbage juice to which you do nothing. Once you have completed your list, ask your teacher to approve your plan.

3. Carry out your experiment. Make careful observations and write them in a table like the one on the next page. After you finish, wash your hands with soap and water. Dispose of all solutions as instructed by your teacher.



Data Table

Test Tube	Solution Added to Cabbage Juice	Observations
X	Vinegar	
Y	Ammonia solution	
Z	Baking soda solution	
Control	None	

Interpret Your Data

1. What color did the cabbage juice in each test tube become when the different solutions were added?

2. What was the independent variable in your experiment? What was the dependent variable? What was held constant?

Conclude and Apply

1. Arrange your test tubes according to color (from most red to most green). Include the control as one of the center test tubes. What does this color change represent?

2. Repeat your cabbage juice experiment using lemon juice. Is lemon juice an acid or a base? How do you know?

Going Further

Slowly add some of the ammonia solution to the test tube that you previously used for vinegar and cabbage juice. What happens to the color of the indicator? How can you explain these color changes?

Inquiry Activity 19 States of Matter

Water exists in three states—solid, liquid, and gas. Solid water is ice. The water molecules in ice vibrate but cannot change position relative to other water molecules. In liquid water, molecules are free to move around each other. However, the molecules remain close together. Gaseous water is called water vapor. Water molecules in vapor have so much energy that they escape the attractions of the other water molecules. Water vapor spreads out into the available space. In this activity, you will investigate the three states of water.

Possible Materials

- 500-mL beaker
- crushed ice
- hot plate
- Celsius thermometer
- graph paper
- ring stand
- thermometer clamp

Question

How does water behave as its temperature is increased?

Form a Hypothesis

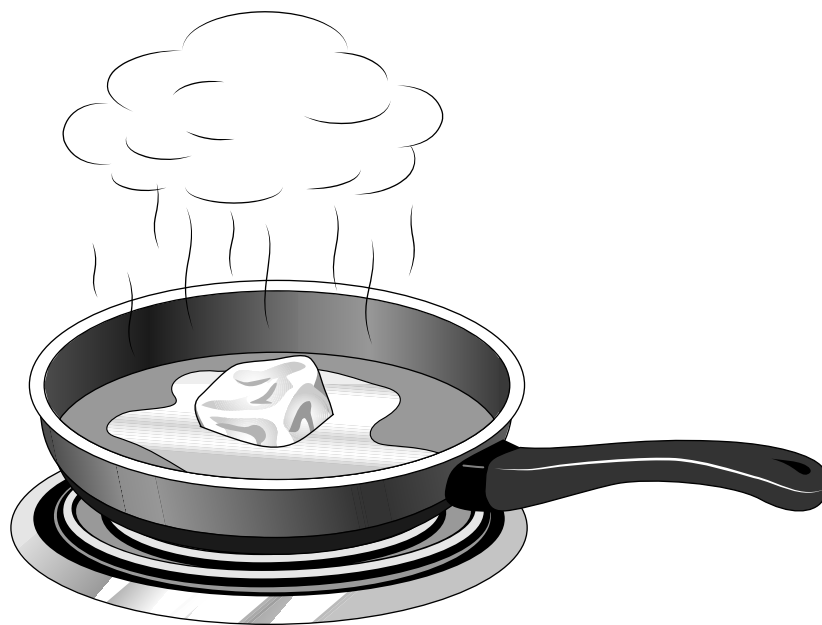
Think about the experiences that you've had with the different states of water. Now, make a hypothesis to answer the question above. Write your hypothesis in your Science Journal.

Safety 

The hot plate and beaker will be very hot. Do not touch them until after they have cooled.

Test Your Hypothesis

1. Think about the materials that you have been given. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You'll probably want to put crushed ice into the beaker. How will you heat the beaker? How will you measure temperature? How slowly do you need to heat the beaker in order to observe the temperature at which the state changes? Once you have designed your experiment, ask your teacher to approve your plan.
3. Carry out your experiment. Make careful temperature readings at regular time intervals as the water is heated. Note the time when the last piece of ice melts. Also note the time when the water first begins to boil. You might want to record your data in a table like the one on the next page.



Data and Observations

Time (minutes)																			
Temperature (°C)																			
Observations																			

Interpret Your Data

1. Look carefully at your data. At what temperature did the last bit of ice melt? At what temperature did the water first begin to boil?

2. Make a graph showing how the water temperature changed through time. Label the x -axis of your graph *Time (min)* and the y -axis *Temperature (Celsius)*.

Conclude and Apply

1. Examine the graph that you made. Write a description of how the water temperature changed through the experiment. What was the temperature when the ice was melting? How did the temperature change after the last bit of ice melted? How did the temperature behave when the water began to boil?

2. In this activity, you saw how water changes state. Give some other examples of matter changing state.

Going Further

Research to find out why water is a good substance to use to cool machinery. What is specific heat? Give a short speech to communicate what you learn.

Inquiry Activity 20 Isotopes And Atomic Mass

In this activity, you will find out how scientists determine the atomic mass of an element.

Background

Atomic mass is the sum of the number of protons and neutrons in the nucleus of an atom. All of the atoms of an element have the same number of protons in their nuclei, but the number of neutrons can vary. Atoms of the same element with different numbers of neutrons are called isotopes. Most elements have more than one isotope. Isotopes are identified by using the name of the element followed by the mass number of the isotope. Some isotopes also have special names. For example, the three isotopes of hydrogen are hydrogen-1, called protium; hydrogen-2, called deuterium; and hydrogen-3, called tritium. On the periodic table, the atomic mass of an element takes into account all of the isotopes of that element, and how much of each isotope is found in nature.

Possible Materials

- 10 small plastic or paper cups
- black beans
- white beans
- calculator
- periodic table

Question

How can you determine the atomic mass of boron, which is 20% boron-10 and 80% boron-11?

Form a Hypothesis

Think about the number of protons and neutrons in each isotope. How could you use that information to help you make a model of boron? Then, in your Science Journal, write a hypothesis to answer the question above.

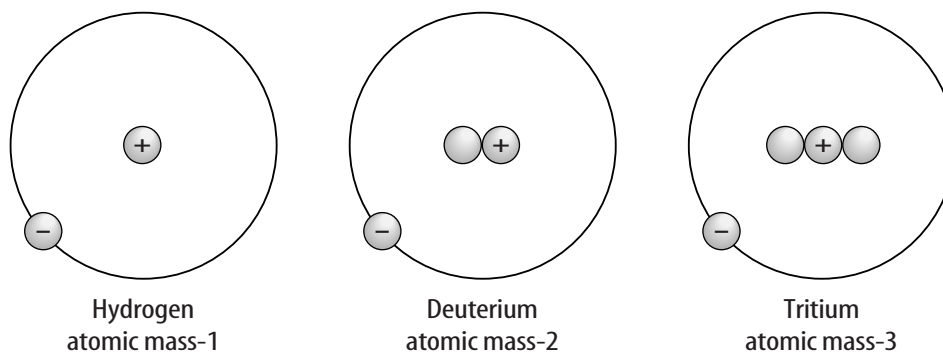
Safety

Do not eat or throw your beans.

Test Your Hypothesis

1. Think about the materials that you have been given. How will you test your hypothesis?
2. Make a list of the steps that you will follow. You'll probably want to use 2 cups to represent boron-10 and eight cups to represent boron-11. How will you use the two different colors of beans? What will each white bean represent? What will each black bean represent? How much mass will one bean represent? Have your teacher approve your plan.
3. Build your model and get your data from it. You might want to use a table like the one on the next page to organize your data.

The Three Isotopes of Hydrogen



Data Table

Isotope of boron	Number of atoms represented	Mass number
Boron-10		
Boron-11		

Interpret Your Data

1. With your teacher's help, calculate the atomic mass of boron using a weighted average. Show your work.

2. How does your calculated atomic mass compare to the atomic mass found on the periodic table?

Conclude and Apply

1. If your calculated atomic mass is different from the one in the periodic table, list at least one possible reason for the difference.

2. Write a general procedure for how a scientist would calculate the atomic mass of any element.

Going Further

Some elements have radioactive isotopes. Radioactive isotopes often are used as tracers in scientific experiments. Use research materials to find out what a tracer is and what isotopes are commonly used as tracers. Explain why some isotopes are not suitable for use as tracers in some scientific experiments.