Name _____ Class _____ Date _____

CHAPTER 1 The Nature of Physical Science

SECTION 1

Science and Scientists

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are three methods used by scientists to conduct investigations?
- How does science help people?
- What are five jobs available to people who want to be scientists?

California Science Standards

8.9.a

What Is Science?

Science is knowledge of the natural world. You gain this knowledge by observing and investigating the world around you. Science helps you discover facts and predict how things in the world will behave.

QUESTIONS

Asking a question is the first step in the process of gaining knowledge. The student pictured below is curious. She has thought up three questions about the world. ☑

Part of science is asking questions about the world around you.

You may have questions about different environments, such as deserts or the sea. You may wonder about the moon, the sun, and the whole universe. You may wonder how the food you eat keeps you healthy. These are all science questions.

STUDY TIP

Summarize As you read, keep a list of the different traits of good scientists. When you finish reading, write a paragraph telling why each trait is a good one for a scientist to have.

READING CHECK

1. Identify What is the first step in the process of gaining knowledge?

_____

Critical Thinking

2. Describe What are two things the girl in the figure can do to answer her questions?

_____

_____

How Do Scientists Search for Answers?

Scientists conduct careful investigations to find answers to questions about the natural world. As a scientist, you can use several methods to begin an investigation.

CALIFORNIA STANDARDS CHECK

8.9.a Plan and conduct a scientific investigation to test a hypothesis.

Word Help: conduct to carry out

3. Explain What are three methods scientists use to answer questions?

_____

_____

_____

RESEARCH

You can look up information in books, in scientific journals, and on the Internet. You can also ask experts. It is important to think about the value of the information you get from the Web page you check or the person you ask. Are they information sources you can trust?

OBSERVATION

You can find answers to some questions on your own, by observing what is going on around you. *Observing* means using your senses to study what is happening. For example, you may notice that before a storm, there are big, dark clouds in the sky. You also may notice that the wind is blowing from the west. These observations could lead you to research whether these two things are related.

EXPERIMENTATION

You can answer some of your questions by doing experiments. An *experiment* is a test of an idea. Before experimenting, you must come up with a prediction or a likely answer to your question. For example, you could suggest that the wind blows big, dark clouds from the west. Your prediction could be that storms come from the west. Then, you could make a plan to test your prediction.

Critical Thinking

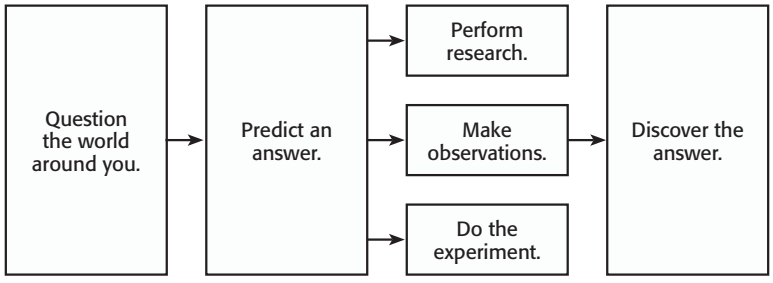
4. Explain How could you test your explanation that storms come from the west?

_____

_____

_____

_____



Research, observation, and experimentation are scientists' tools for searching for answers. Research and observation help scientists plan experiments. You can use these tools, too. A well-planned experiment may tell you the answer. It may even cause you to ask more questions.

How Do the Answers Affect Us?

Although scientists cannot answer every question, they do find many interesting and helpful facts. Some of the answers help save people's lives, save Earth's resources, and protect our environment.

SAVING LIVES

Because scientists study moving objects, they have been able to answer the question, "How can passengers be protected during automobile accidents?" Scientists performed tests. As a result, airbags are now installed in cars. Drivers and passengers are required to wear seat belts. Motorcyclists are encouraged to wear helmets. ☑

READING CHECK

5. List What are two results of scientists' study of moving objects?

_____

CONSERVING RESOURCES

Science has also helped answer the question, "How can Earth's resources be made to last longer?" Recycling is one answer. Examples of used things that can be recycled are paper, aluminum, steel, glass, batteries, and tires.

Recycling rates have increased over the past 40 years. The table below shows how recycling of waste material has risen in the United States.

Year	Percentage of waste recycled
1960	6.4
1970	6.6
1980	9.6
1990	16.2
2000	30.0

Math Focus

6. Analyze Data Between which two years did recycling increase the most? About how much did it increase?

_____

_____

_____

PROTECTING THE ENVIRONMENT

Through the study of Earth's atmosphere, scientists found a serious problem. They discovered that the ozone layer, which protects the Earth from harmful rays from the sun, was getting thinner. They asked, "How can we protect the ozone layer?" Scientists researched, observed, and experimented. They found that chemicals used widely in spray cans destroyed the ozone when they rose up into the atmosphere. Today, different chemicals are used in spray cans. In addition, many things that used to be sold in spray cans are packaged differently.

Where Are Scientists Found?

Scientists work in many different places. Some like to study weather. Some are interested in studying rocks. All scientists are curious about the world around them. They ask questions and investigate to find answers.

METEOROLOGISTS

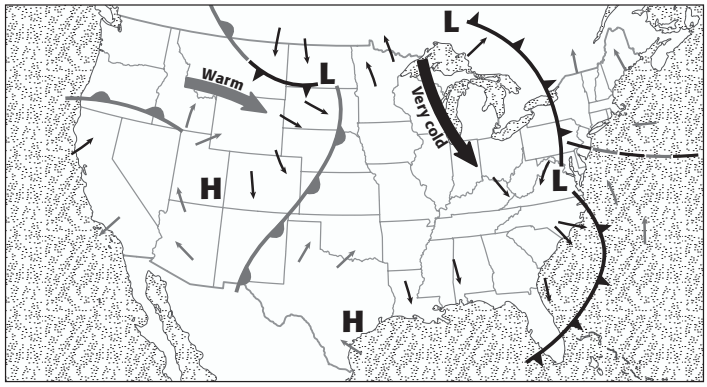
A meteorologist is a person who studies the changes in the atmosphere. (You might think they study meteors, but they don't.) Changes in the atmosphere cause our weather. Weather forecasters are often meteorologists. Some meteorologists study tornadoes. Some study hurricanes. They collect information about these violent storms. Meteorologists try to tell what areas storms will affect and how powerful they will be. ☑

READING CHECK

7. Describe How can meteorologists make people safer?

_____

_____



Meteorologists use weather maps to predict the weather.

GEOCHEMISTS

A geochemist is a scientist who studies rocks, minerals, and soil. Many geochemists work for mining companies. They look for gold, silver, diamonds, and iron ore. ☑

READING CHECK

8. Identify What do geochemists study?

_____

_____

Oil is also found buried in deep places under land and sea. Many geochemists work for oil companies to help them find, remove, and refine the oil.

This geochemist takes rock samples from the field. Then, she studies them in her laboratory.

ECOLOGISTS

An ecologist studies living things and their nonliving surroundings. Ecologists are interested in plants and animals, including humans, and how they affect one another. They work in wildlife management, farming, forestry, and resource protection. ☑

READING CHECK

9. Identify What fields do ecologists work in?

_____

_____

_____

_____

VOLCANOLOGISTS

Volcanologists study volcanoes and the chemistry of Earth and all its layers. They find where volcanoes are located. They gather information to learn how and why volcanoes erupt. Volcanoes can be so powerful that they affect people all over the world. When scientists predict an eruption, they can save lives.

Volcanologists study volcanoes. Many volcanologists study volcanic patterns in order to predict when volcanoes will erupt.

Say It

Research and Report
Choose a profession related to science, and research what people in that profession do on a daily basis. Report the results of your research to your class.

SCIENCE ILLUSTRATORS

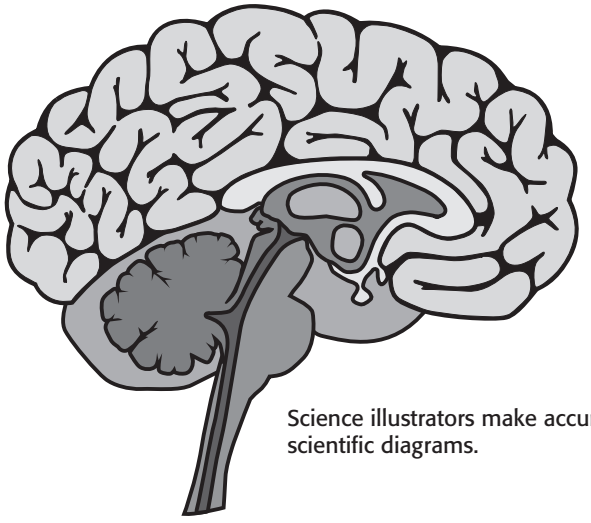
Science illustrators draw scientific diagrams. They use skills in art and science. They are needed in all areas of science, and especially in biology and medicine. ☑

READING CHECK

10. Identify What skills are needed by a science illustrator?

_____

_____



Science illustrators make accurate and clear scientific diagrams.

Name _____ Class _____ Date _____

Section 1 Review

8.9.a 

SECTION VOCABULARY

science the knowledge obtained by observing natural events and conditions in order to discover facts and formulate laws or principles that can be verified or tested	

1. Identify What are three methods that scientists use for investigation?

_____

2. Describe What are three sources of information scientists use when they do research?

_____

_____

3. Match Draw an arrow from the definition of the job to the type of scientist.

Studies volcanic eruptions	Science illustrator
Measures wind speed of hurricanes	Volcanologist
Draws diagrams of body parts	Geochemist
Knows how plants and animals affect one another	Meteorologist
Knows how to remove oil from the ground	Ecologist

4. Explain Tell two ways that scientists can help people.

_____

_____

5. Apply Concepts Your friend wants to know how much salt is added to the fries at her favorite burger restaurant. What would you suggest that she do to find out?

_____

_____

_____

6. Use Data A scientist knows that a slow flow of lava travels at a rate of 3 m per day. Show how the scientist would determine how far the lava could travel in 30 days.

Name _____ Class _____ Date _____

CHAPTER 1 The Nature of Physical Science

SECTION 2

Scientific Methods

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What are the steps in the scientific method?
- How do scientists form a hypothesis?
- What do scientists do before telling others about their experimental results?

California Science Standards

8.9.a, 8.9.b, 8.9.c

What Are Scientific Methods?

Two scientists wanted to find a better way to move ships through the water. They thought that studying the way penguins swim might give them some ideas about how to improve ships. In this section, you will learn how these scientists used scientific methods to answer their questions.

Scientific methods are the ways in which scientists answer questions and solve problems. As scientists look for answers, they often use the same steps. However, there is more than one way to use the steps. Look at the figure below. ☑

This figure shows six steps that are part of most scientific methods. Scientists may use all of the steps or just a few steps during an investigation. They may repeat some of the steps or do the steps in a different order.

STUDY TIP

Outline As you read this section, make a chart showing how two scientists used the steps in scientific methods to improve ships.

READING CHECK

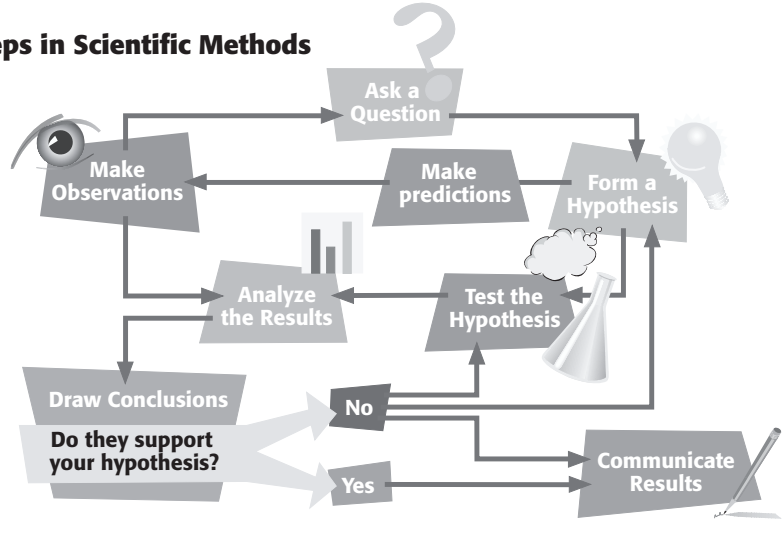
1. Describe What are scientific methods?

_____

_____

_____

Steps in Scientific Methods



There are many steps in scientific methods. Notice that there are many ways to move through the different steps.

TAKE A LOOK

2. Identify What is the usual next step after analyzing the results?

_____

Why Do Scientists Ask Questions?

Asking questions helps scientists focus on the reason for an investigation. Questions arise after **observation**, which is collecting information by using the senses. A good example is the story of the two scientists who wanted to improve the way ships move through the water. This type of scientist is called an engineer. *Engineers* are scientists who build things based on scientific knowledge. ☑

READING CHECK

3. Describe Who are engineers?

_____

_____

_____

REAL-WORLD EXAMPLE

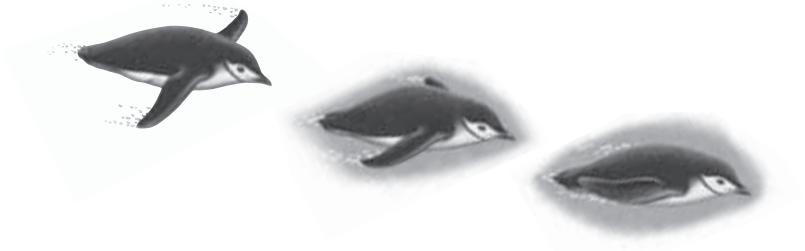
Two engineers were studying how the propellers on ships work. They found that ships used a lot of fuel to push themselves through the water. Their job was to find a way to make ships move faster while using less fuel.

The engineers looked to nature to find a method to improve the efficiency of ships. A ship that is *efficient* does not use as much fuel as other ships to travel a certain distance. They observed sea animals in order to investigate what made them swim fast. The engineers noticed that penguins are master swimmers. Penguins have stiff bodies just like ships. However, they are able to push themselves through the water with ease.

Now the scientists were ready to ask their question. They wanted to know, "How can a ship's propellers be built to push the ship through the water with ease?"

Say It

Investigate Find out how the propeller of a ship works. Present your findings to your class or a small group.



Penguins use their wings as flippers to "fly" underwater. As their wings are pulled inward, they push against the water. This movement pushes the penguins forward.

TAKE A LOOK

4. Identify How do penguins use their wings?

_____

How Do Scientists Form a Hypothesis?

Once a scientist has made observations and asked a question, he or she is ready to predict an answer. This is called forming a hypothesis. A **hypothesis** is a possible explanation or guess at an answer to a question. ☑

You must be able to test a hypothesis. A scientist tests a hypothesis by gathering more information or doing an experiment.

READING CHECK

5. Describe What is a hypothesis?

_____

_____

_____

POSSIBLE ANSWER FROM NATURE

The ship engineers had observed the slow movements of ships and the fast swimming of penguins. Their observations led them to make a hypothesis about how to propel a ship through water. They guessed, "A propulsion system that imitates the way a penguin swims works better than one that uses propellers."

ANOTHER WAY TO WORD PREDICTIONS

Before scientists test a hypothesis, they may say what they think will happen in an *if-then statement*. An if-then statement makes the results easier to measure. The engineers' prediction might have been: "If two flippers are attached to a boat, then the boat will be more efficient than a boat powered by propellers."

The following table gives some examples of if-then statements.

If car A uses less gasoline than car B while taking the same trip,	then Car A is more efficient than Car B.
If it takes more force to stop an object with a large mass,	then it will take _____ force to stop a compact car than a large truck.
If a grape and an orange fall at the same rate,	then they will hit the ground at the _____ time when they are dropped from the same height.

Critical Thinking

6. Infer In the table, complete the "then" statements that have a missing word. Write each missing word on the line provided.

Why Does a Scientist Test a Hypothesis?

After you form a hypothesis, you must test it. You must find out if it answers your question correctly. Testing helps you find out if your hypothesis is pointing you in the right direction. You test a hypothesis by doing experiments.

CALIFORNIA STANDARDS CHECK

8.9.c Distinguish between variable and controlled parameters in a test.

7. Identify Which of the parameters are both groups in an experiment exposed to?

_____

CONTROLLED EXPERIMENTS

When scientists working for drug companies invent a medicine, they have to find out if the medicine will work. They usually test the drug on a large group of animals. Often, they work with special laboratory mice. All of the mice in the experiment have the same disease.

They divide the large group of mice into two smaller groups. One is called the *control group*. The other is the *experimental group*. The results from the experimental group are compared with those of the control group. In this way, scientists see if the drug had the expected effect.

Both groups should be about the same size and age. Size and age are called *factors* or *parameters*. These factors are characteristics of the mice. All of the factors for each group must be the same. These factors are called the *controlled parameters* of the experiment.

There is one factor that is different for each group. The control group will be given something called a *placebo*. It will not contain the drug being tested. The experimental group will be given the real drug. This difference is called the *variable parameter* of the experiment. ☑

READING CHECK

8. Describe When a new drug is being tested, what does the control group take instead of the real drug?

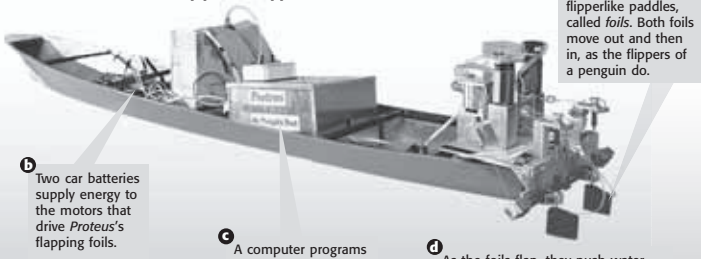
_____

The scientists watch carefully to see if the animals get better. It is important that the animals be treated exactly the same. The only difference is that the experimental group is given medicine.

BUILDING A TEST BOAT

The engineers who were trying to design an efficient boat thought they should test their hypothesis by building one. They built *Proteus*, the penguin boat. It had flippers like a penguin so that the scientists could test their hypothesis about propulsion through the water.

Proteus, 3.4 m long and 50 cm wide, was a specially built boat used to test the "flippers" hypothesis.



TAKE A LOOK

9. Identify Instead of a propeller, what is used by *Proteus* to move the boat through the water?

_____

How Did the Scientists Test *Proteus*?

Another way to have a controlled experiment is to repeat the test several times, changing one condition each time. That's what the engineers did with *Proteus*.

The engineers took *Proteus* to the Charles River in Boston. After putting the boat in the water, they were ready to collect data. **Data** are pieces of information collected from experiments. For each test, they paddled the boat across the river for the same distance with the same weather. ☑

Proteus, the "penguin boat," was tested in the Charles River in Boston.

READING CHECK

10. Identify What two conditions stayed the same when *Proteus* sailed across the river?

The engineers collected data on the speed of the boat and the amount of energy used to move the foils. The data recorded for the first trip were compared with the data from all of the other trips. The factor that was changed for each trip was the flapping rate of the foils. ☑

READING CHECK

11. Identify What factor was changed for each trip?

The experimental part of the test began with the second trip. The engineers increased the flapping rate, which was the variable parameter. Then they recorded the energy used and the speed. The engineers made several more experimental voyages. Each time, they set a different flapping rate and collected data on the energy used and the speed.

To find if the new design was efficient, they compared the amounts of energy used by the motors with the speeds of the boat on each trip. This step is called *analyzing* results.

How Do Scientists Analyze Results?

After you collect your data, you must analyze it. To *analyze* data means to interpret what the data mean. One way to analyze data is to organize them into tables and graphs. Tables and graphs make the relationships of the numbers easier to see. ☑

READING CHECK

12. Describe What does it mean to analyze data?

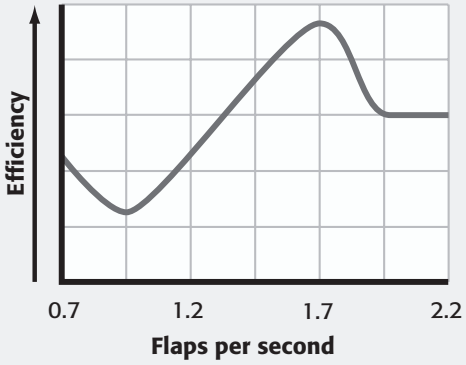
_____

_____

It's always a good idea to perform your experiment several times. Repeated tests tell you whether your data are accurate. If you get similar results every time and they support your hypothesis, then you know you are close to proving that your hypothesis is correct. Similar results on a number of tests show that your experimental data are *reproducible*. Reproducible data show other scientists that you designed a good experiment.

ANALYZING *PROTEUS*

The engineers calculated the data for energy used and the speed. They used the data to calculate *Proteus'* efficiency. Then they made the line graph below.



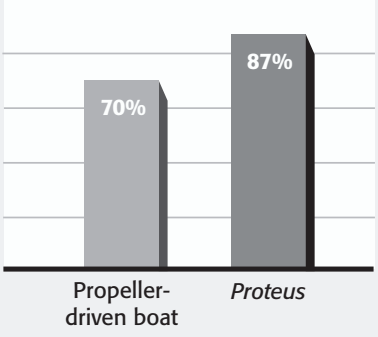
This graph shows the efficiency of *Proteus* when the flippers are moving at different rates.

Math Focus

13. Analyze When did *Proteus* show the highest efficiency?

_____

They also used the data to compare *Proteus'* efficiency with the average efficiency of a propeller-driven boat. You can see the analysis of the results in the bar graph below.



This graph shows the efficiency of *Proteus* compared with the efficiency of propeller-driven boats.

Math Focus

14. Compare Which boat was the more efficient?

_____

How much more efficient was it?

_____

Was Your Hypothesis Correct?

At the end of the investigation, you must draw a conclusion. You do this by looking at your analysis. The results tell you if your hypothesis was correct. This is the same as saying that your results support your hypothesis.

It's also possible that you will come to a different conclusion. You may decide that your results do not support your hypothesis. If so, you can change the procedure, gather more information, or ask new questions. Whether your hypothesis is supported or not, the results are always important.

PROTEUS CONCLUSION

The engineers found that penguin propulsion was more efficient than propeller propulsion. They concluded that the results supported their hypothesis. ☑

The scientists were able to reach this conclusion because they did many tests. They were careful to have controlled parameters with only one variable parameter. They measured everything accurately. This proved that their results were not accidental. Their data showed the same relationship many times. Therefore, their results were reproducible.

Drawing a conclusion to support your hypothesis usually leads to more questions. More questions lead to more investigations. This is how scientific progress continues.

READING CHECK

15. Explain Why did the engineers feel that their hypothesis was correct?

_____

_____

How Do You Tell Others About Your Results?

Other scientists will want to conduct their own tests based on your results. There are three ways to communicate the results of your investigation to them. You can use any or all of them. ☑

Ways to communicate the results of an investigation	Audience
Write a paper for a scientific journal.	scientists and others who read the journal
Give a talk.	scientists and others who are interested in the work
Create a Web site.	anyone interested in the work

READING CHECK

16. Identify What are three ways scientists communicate the results of their investigations?

_____

_____

_____

Sharing your results allows other scientists to continue your work. Sharing also makes it possible for others to do your experiments and prove you were right.

Name _____ Class _____ Date _____

Section 2 Review

8.9.a, 8.9.b, 8.9.c

SECTION VOCABULARY

data any pieces of information acquired through observation or experimentation

hypothesis a testable idea or explanation that leads to scientific investigation

Wordwise The prefix *hypo-* means "under." The root *thesis* means "proposition." Other examples are *hypodermic* and *hypoallergenic*.

observation the process of obtaining information by using the senses

scientific methods a series of steps used to solve problems

1. Complete What are the steps that most scientific methods use?

Steps in Scientific Methods

2. Describe Why do scientists use scientific methods?

3. Explain A synonym is a word that has the same meaning as another word. What are two synonyms for *hypothesis*?

4. Explain Why must an experiment have a control group?

5. Explain What is a variable parameter?

6. List What was the variable parameter in the laboratory mice experiment? In the *Proteus* experiment?

Name _____ Class _____ Date _____

CHAPTER 1 The Nature of Physical Science

SECTION 3

Safety in Science

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What can you do to make the lab safe?
- What special precautions are necessary for working in a science lab?
- What is the safest way to respond to accidents?

California Science Standards

8.9.a

How Do You Keep Yourself Safe in the Lab?

You must be careful when you work in a science lab. It contains fragile glassware, liquids that can spill, and dangerous equipment. Accidents can happen to anyone, but you can take simple safety steps to avoid mishaps.

STUDY TIP

List As you read this section, write down a list of mistakes that may be made in a lab. Also write down ways to correct or prevent them.

AVOIDING ACCIDENTS

Be aware of what is going on around you. Pay attention, follow directions, and watch what you are doing. When you put materials on the lab bench, be sure that they will not tip over. Learn to use all lab materials safely and correctly. Lab materials could include chemicals, heat sources, animals, and plants. ☑

Walk carefully around the lab area. Take care not to bump into anyone. Look out for others who are carrying liquids or breakable glassware.

Wear the right safety equipment. This equipment may include lab coats or aprons, goggles, and gloves. Some of the items pictured below are used for personal safety.

READING CHECK

1. Identify Name four lab materials that need to be used carefully.

_____

_____

_____

When you work in a science lab, your lab materials can include chemicals, heat sources, animals, and plants. All must be handled safely.

TAKE A LOOK

2. Identify In the figure, circle the piece of safety equipment that will protect your eyes.

REPORTING ACCIDENTS

If you have an accident, no matter how small, tell the teacher right away.

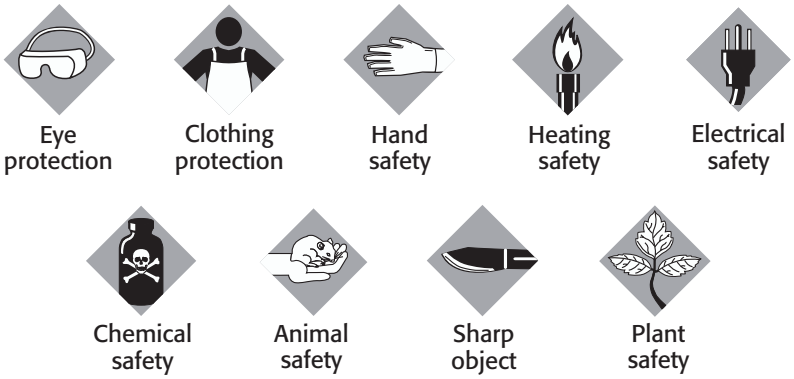
What Special Precautions Do You Take in a Science Lab?

You will find special materials and equipment in the lab. Before you do experiments, you need to learn the correct ways to use the equipment.

UNDERSTANDING SAFETY SYMBOLS

Scientists use symbols to alert themselves. The symbols remind them to use certain precautions. The chart below lists the safety symbols.

Safety Symbols



Say It

Identify On a blank piece of paper, draw several safety symbols. Have members of the class identify what the symbols represent.

FOLLOWING SAFETY SYMBOLS

Each symbol requires that you use specific precautions. For example, the symbol for heating safety has three safety measures. You need to clear your work area of materials that can catch fire. If you are wearing long sleeves, you need to roll them up. If you have long hair, you need to tie it back.

Your teacher will explain the meaning of each safety symbol. He or she will also tell you what preparations you must make.

FOLLOWING DIRECTIONS

Be sure to follow lab procedures exactly. Failure to follow directions is the most common cause of accidents. Your teacher has carefully planned directions to produce the best and safest results. Follow these rules: ☑

- Read all procedures before beginning a lab activity.
- Ask for help on anything you don't understand.
- Ask your teacher if there is something you think should be done differently.
- Measure chemicals precisely (don't take more than you need).

READING CHECK

3. Identify What is the most common cause of accidents?

_____

NEATNESS

Working in a cluttered area is unsafe and unorganized. Clear your work area. Remove unnecessary books, backpacks, hats, and coats.

Clean up any chemical spill right away. Keep flammable objects away from Bunsen burners and other heat sources. ☑

READING CHECK

4. Define What should you keep flammable objects away from in the lab ?

PROPER SAFETY EQUIPMENT

Safety equipment prevents accidents in the lab.

Eye Protection You need to wear safety goggles whenever you are handling liquids. The goggles should fit snugly. You can adjust them to fit your size. Eyeglasses are not enough. You need to have eye protection on the sides also.

Hand and Clothing Protection You need to wear gloves if you are handling plants, small animals, or certain chemicals. When handling warm objects, or using a hot plate or open flame, wear heat-resistant gloves.

Aprons Lab coats and aprons protect your clothing. Spills from certain chemicals can stain your clothes. Other chemicals can eat holes in your clothes.

Proper safety equipment should be used in a science laboratory.

Critical Thinking

5. Explain Why is it dangerous to wear contact lenses when you are working with chemicals that are gases?

TAKE A LOOK

6. Identify Circle two sources of danger that goggles, heat-resistant gloves, and aprons protected you from.

CLEANING UP

When you have finished, you should do the following:

- Return all materials and chemicals to the proper place.
- Give damaged glassware to your teacher.
- Turn off all burners and hot plates.
- Wipe your work area with a damp paper towel.
- Wash your hands.

How Do You Respond to Accidents?

Always tell your teacher if an accident happens. You should know where the safety equipment can be found.

EMERGENCY EQUIPMENT

Science labs have special emergency equipment. Your lab should have a fire extinguisher, a fire blanket, an eye bath, and a first aid kit.

Your teacher will know how to use them.

Make sure that you can locate and use the first-aid supplies and special safety equipment in your science lab. Your teacher can tell you the location of these supplies and the equipment and show you how to use them.

PROPER ACCIDENT PROCEDURES

Make sure that you are safe. If there has been a spill, be careful that you don't slip on the floor. If some glassware has been broken, don't touch the glass.

Tell your teacher about any accident. He or she will take care of any injured students. Your teacher may have to perform first aid. **First aid** is an emergency care for someone who is hurt or sick. Sometimes, the student may need more serious medical help. A nurse or doctor is trained to help with serious injuries. ☑

PROCEDURES FOR ACCIDENTAL INJURIES

Care for an injury depends on the type of injury. Always tell the teacher. If you burn your hand, place it in cold water for 15 minutes. If you get a burn from a chemical, rinse the chemical off your skin. Then, place the burned area under cold, running water for 15 minutes.

If a chemical gets in your eyes, wash your eyes in the eye bath for 15 minutes. Then cover your eyes with a clean cloth.

If you cut yourself, rinse the cut gently. Then apply slight pressure with a clean cloth.

TAKE A LOOK

7. Identify Circle the first-aid kit, fire extinguisher, fire blanket, and eye bath in the figure.

☑ ***READING CHECK***

8. Describe What is first aid?

_____

_____

_____

Critical Thinking

9. Identify What three pieces of safety equipment can probably prevent all the injuries described in the text?

_____

_____

Name _____ Class _____ Date _____

Section 3 Review

8.9.a

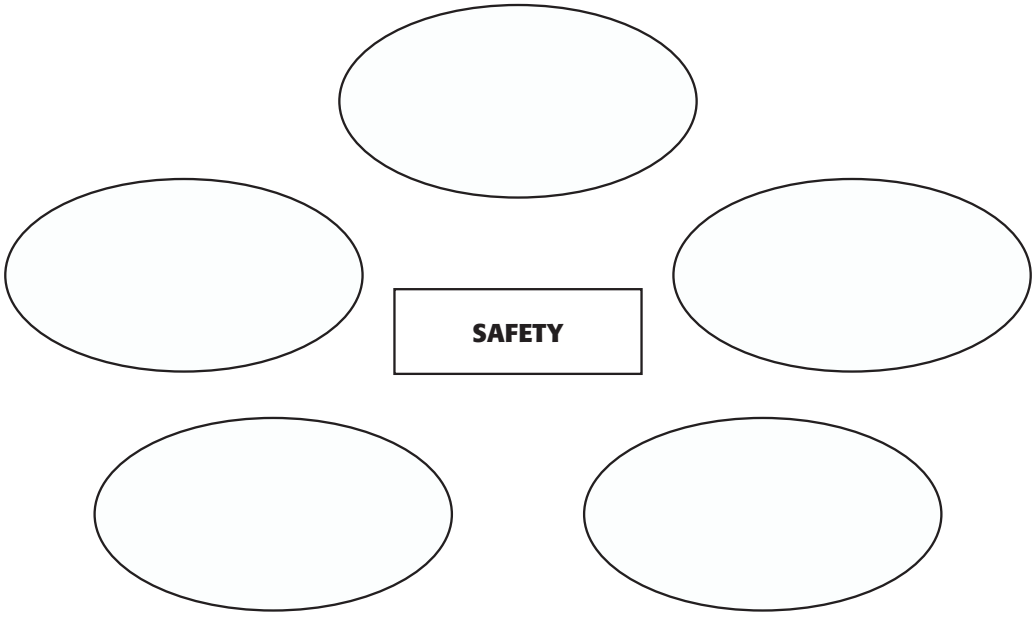
SECTION VOCABULARY

first aid emergency medical care for someone who has been hurt or who is sick	

1. Explain What is the first important rule when following directions?

_____

2. Complete Fill in the ovals in the Process Chart with the procedures that help keep you safe in the lab. Draw arrows from the procedures to the safety box.



3. List What types of safety equipment are found in your lab?

_____

_____

4. Explain After you tell your teacher, what should you do if you burn your hand?

_____

5. Complete Under each safety symbol, write what it means.