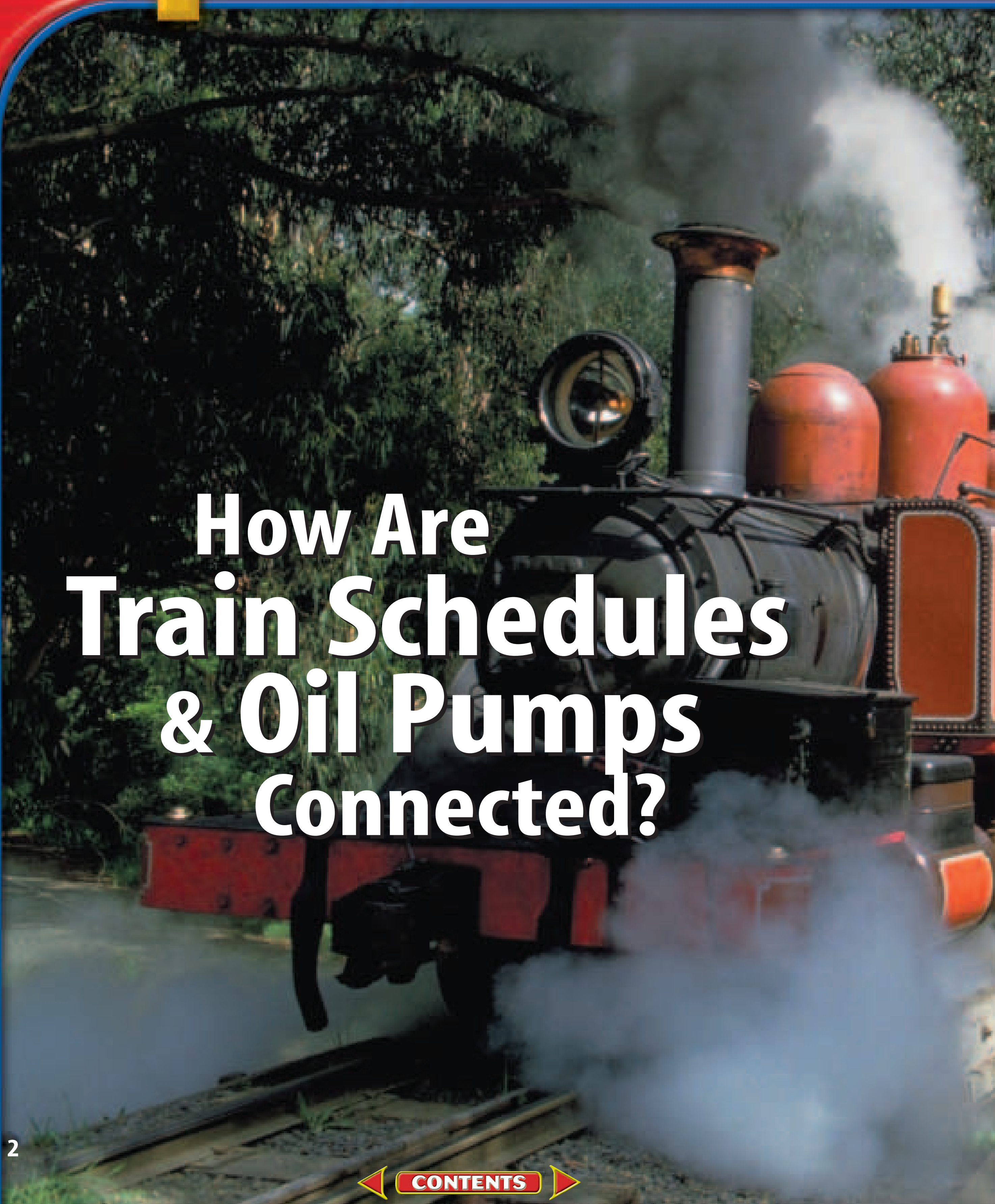
unit 1

Simple and Complex/ Compound Machines



How Are Train Schedules & Oil Pumps Connected?

NATIONAL GEOGRAPHIC

In the 1800s, trains had to make frequent stops so that their moving parts could be lubricated. Without lubrication, the parts would have worn out due to friction. When the train stopped, a worker had to get out and oil the parts by hand. The process was very time-consuming and made it hard for trains to stay on schedule. Around 1870, an engineer named Elijah McCoy developed the first automatic lubricating device, which oiled the engine while the train was running. (A later version of his automatic lubricator is seen at lower right.) Since then, many kinds of automatic lubricating devices have been developed. Today, automobiles have oil pumps that automatically circulate oil to the moving parts of the engine. When you go for a ride in a car, you can thank Elijah McCoy that you don't have to stop every few miles to oil the engine by hand!

unit projects

Visit unit projects at **glencoe.com** to find project ideas and resources. Projects include:

- **Career** As a class, design a chart of the many fields of engineering and how they relate to conserving and protecting the environment.
- **Technology** Design and construct miniature models of energy-producing devices. Explain how your model works.
- **Model** Analyze locations for a future city. Consider what characteristics will make the best location and make a model of a portion of your design.

WebQuest Using virtual programming, *Roller Coaster Physics* provides an opportunity to engineer, test, and evaluate roller coaster design, and then build your own 3-dimensional coaster.

chapter 1

AID **S1.1a:** formulate questions about natural phenomena. **S1.1c:** refine and clarify questions so that they are subject to scientific investigation. **Also covered:** S1.1b, S1.2a, S1.2b, S1.2c, S2.1a, S2.1b, S2.1d, S2.2a, S2.2b, S2.2c, S2.2d, S2.3c, S3.1a, S3.1b, S3.2a, S3.2b, S3.2c, S3.2f, S3.2h, T1.1a, M1.1c, PS 5.2a, 6: ICT 1.2, 1.4, 2.1, 2.2, 2.3, IPS 1.2, 2:IS 1.5

The Nature of Science

chapter preview

How is science a part of your everyday life?

Scientists studying desert ecosystems in California wondered how such a dry environment could produce such beautiful, prolific flowers. Scientists began asking questions and performing investigations.

Science Journal Write down three examples of science in your everyday life.

Start-Up Activities

Launch LAB

Observe How Gravity Accelerates Objects

Gravity is a familiar natural force that keeps you anchored on Earth, but how does it work? Scientists learn about gravity and other concepts by asking questions and making observations. By observing things in action scientists can study nature. Perform the lab below to see how gravity affects objects.

1. Collect three identical, unsharpened pencils.
2. Tape two of the pencils together.
3. Hold all the pencils at the same height as high as you can. Drop them together and observe what happens as they fall.
4. **Think Critically** Did the single pencil fall faster or slower than the pair? Predict in your Science Journal what would happen if you taped 30 pencils together and dropped them at the same time as you dropped a single pencil.

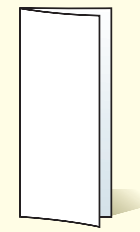
Science Online

Preview this chapter's content and activities at glencoe.com

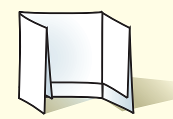
FOLDABLES™ Study Organizer

Science Make the following Foldable to help identify what you already know, what you want to know, and what you learned about science.

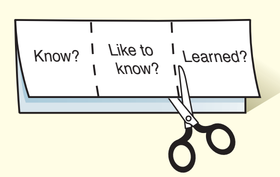
STEP 1 **Fold** a vertical sheet of paper from side to side. Make the front edge about 1/2 inch shorter than the back edge.



STEP 2 **Turn** lengthwise and fold into thirds.



STEP 3 **Unfold and cut** only the top layer along both folds to make three tabs. **Label** each tab.



Identify Questions Before you read the chapter, write what you already know about science under the left tab of your Foldable, and write questions about what you'd like to know under the center tab. After you read the chapter, list what you learned under the right tab.

section 1

What is science?

as you read

What You'll Learn

- **Define** science and identify questions that science cannot answer.
- **Compare** and contrast theories and laws.
- **Identify** a system and its components.
- **Identify** the three main branches of science.

Why It's Important

Science can be used to learn more about the world you live in.

Review Vocabulary
theory: explanation of things or events that is based on knowledge gained from many observations and experiments

New Vocabulary
- science
- scientific theory
- scientific law
- system
- life science
- Earth science
- physical science
- technology

Learning About the World

When you think of a scientist, do you imagine a person in a laboratory surrounded by charts, graphs, glass bottles, and bubbling test tubes? It might surprise you to learn that anyone who tries to learn something about the natural world is a scientist. **Science** is a way of learning more about the natural world. Scientists want to know why, how, or when something occurred. This learning process usually begins by keeping your eyes open and asking questions about what you see.

Asking Questions Scientists ask many questions. How do things work? What do things look like? What are they made of? Why does something take place? Science can attempt to answer many questions about the natural world, but some questions cannot be answered by science. Look at the situations in **Figure 1.** Who should you vote for? What does this poem mean? Who is your best friend? Questions about art, politics, personal preference, or morality can't be answered by science. Science can't tell you what is right, wrong, good, or bad.

Figure 1 Questions about politics, literature, and art cannot be answered by science.

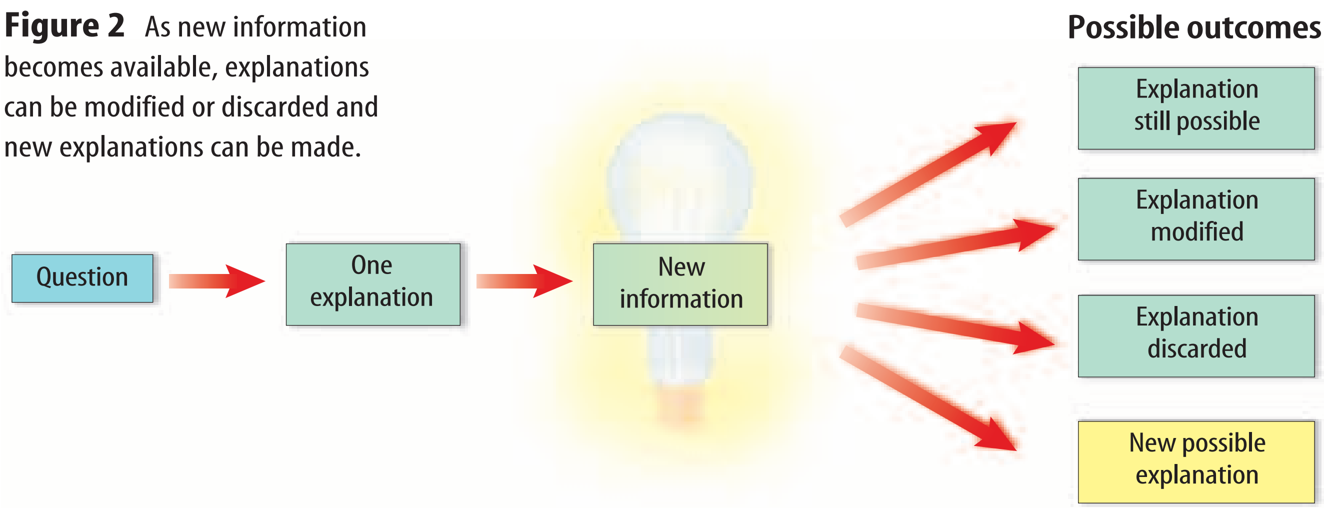


Figure 2 As new information becomes available, explanations can be modified or discarded and new explanations can be made.

Possible Explanations If learning about your world begins with asking questions, can science provide answers to these questions? Science can answer a question only with the information available at the time. Any answer is uncertain because people will never know everything about the world around them. With new knowledge, they might realize that some of the old explanations no longer fit the new information. As shown in **Figure 2,** some observations might force scientists to look at old ideas and think of new explanations. Science can only provide possible explanations.

Reading Check *Why can't science answer questions with certainty?*

Scientific Theories An attempt to explain a pattern observed repeatedly in the natural world is called a **scientific theory.** Theories are not simply guesses or someone's opinions, nor are theories vague ideas. Theories in science must be supported by observations and results from many investigations. They are the best explanations that have been found so far. However, theories can change. As new data become available, scientists evaluate how the new data fit the theory. If enough new data do not support the theory, the theory can be changed to fit the new observations better.

Scientific Laws A rule that describes a pattern in nature is a **scientific law.** For an observation to become a scientific law, it must be observed repeatedly. The law then stands until someone makes observations that do not follow the law. A law helps you predict that an apple dropped from arm's length will always fall to Earth. The law, however, does not explain why gravity exists or how it works. A law, unlike a theory, does not attempt to explain why something happens. It simply describes a pattern.

Analysis, Inquiry, and Design

S1.1a, S1.1c: Formulate three questions scientists might attempt to answer about the natural world. Rewrite your questions as a hypothesis that could be tested in scientific investigations.

Figure 3 Systems are a collection of structures, cycles, and processes.
Infer *What systems can you identify in this classroom?*

Interconnectedness: Common Themes

1.2: Compare and contrast an engineering system, natural system, and a social system using a three-circle Venn diagram.

Mini LAB

Classifying Parts of a System

Procedure
Think about how your school's cafeteria is run. Consider the physical structure of the cafeteria. How many people run it? Where does the food come from? How is it prepared? Where does it go? What other parts of the cafeteria system are necessary?

Analysis
Classify the parts of your school cafeteria's system as structures, cycles, or processes.

Try at Home

Systems in Science

Scientists can study many different things in nature. Some might study how the human body works or how planets move around the Sun. Others might study the energy carried in a lightning bolt. What do all of these things have in common? All of them are systems. A **system** is a collection of structures, cycles, and processes that relate to and interact with each other. The structures, cycles, and processes are the parts of a system, just like your stomach is one of the structures of your digestive system.

Reading Check *What is a system?*

Systems are not found just in science. Your school is a system with structures such as the school building, the tables and chairs, you, your teacher, the school bell, your pencil, and many other things. **Figure 3** shows some of these structures. Your school day also has cycles. Your daily class schedule and the calendar of holidays are examples of cycles. Many processes are at work during the school day. When you take a test, your teacher has a process. You might be asked to put your books and papers away and get out a pencil before the test is distributed. When the time is over, you are told to put your pencil down and pass your test to the front of the room.

Parts of a System Interact In a system, structures, cycles, and processes interact. Your daily schedule influences where you go and what time you go. The clock shows the teacher when the test is complete, and you couldn't complete the test without a pencil.

Parts of a Whole All systems are made up of other systems. For example, you are part of your school. The human body is a system—within your body are other systems. Your school is part of a system—district, state, and national. You have your regional school district. Your district is part of a statewide school system. Scientists often break down problems by studying just one part of a system. A scientist might want to learn about how construction of buildings affects the ecosystem. Because an ecosystem has many parts, one scientist might study a particular animal, and another might study the effect of construction on plant life.

The Branches of Science

Science often is divided into three main categories, or branches—life science, Earth science, and physical science. Each branch asks questions about different kinds of systems.

Life Science The study of living systems and the ways in which they interact is called **life science.** Life scientists attempt to answer questions like "How do whales navigate the ocean?" and "How do vaccines prevent disease?" Life scientists can study living organisms, where they live, and how they interact. Dian Fossey, **Figure 4,** was a life scientist who studied gorillas, their habitat, and their behaviors.

People who work in the health field know a lot about the life sciences. Physicians, nurses, physical therapists, dietitians, medical researchers, and others focus on the systems of the human body. Some other examples of careers that use life science include biologists, zookeepers, botanists, farmers, and beekeepers.

INTEGRATE Health

Health Integration
Systems The human body is composed of many different systems that all interact with one another to perform a function. The heart is like the control center. Even though not all systems report directly to the heart, they all interact with its function. If the heart is not working, the other systems fail as well. Research human body systems and explain how one system can affect another.

Figure 4 Over a span of 18 years, life scientist Dian Fossey spent much of her time observing mountain gorillas in Rwanda, Africa. She was able to interact with them as she learned about their behavior.

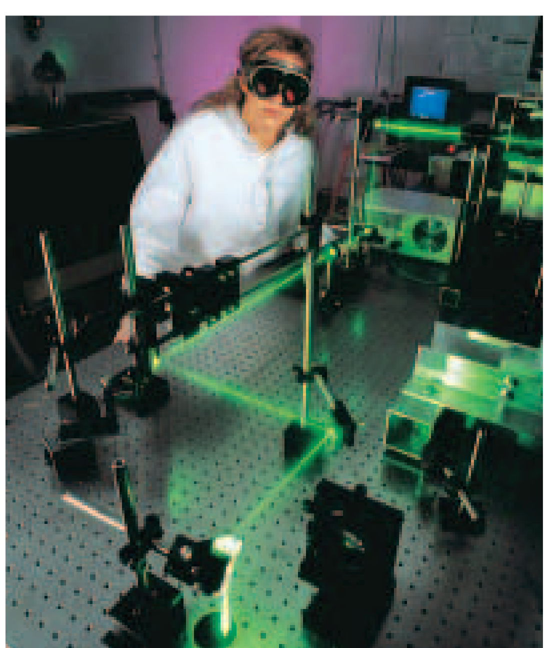
Figure 5 These volcanologists are studying the temperature of the lava flowing from a volcano.

Earth Science The study of Earth systems and the systems in space is **Earth science.** It includes the study of nonliving things such as rocks, soil, clouds, rivers, oceans, planets, stars, meteors, and black holes. Earth science also covers the weather and climate systems that affect Earth. Earth scientists ask questions like "How can an earthquake be detected?" or "Is water found on other planets?" They make maps and investigate how geologic features formed on land and in the oceans. They also use their knowledge to search for fuels and minerals. Meteorologists study weather and climate. Geologists study rocks and geologic features. **Figure 5** shows a volcanologist—a person who studies volcanoes—measuring the temperature of lava.

Reading Check ***What do Earth scientists study?***

Physical Science The study of matter and energy is **physical science.** Matter is anything that takes up space and has mass. The ability to cause change in matter is energy. Living and nonliving systems are made of matter. Examples include plants, animals, rocks, the atmosphere, and the water in oceans, lakes, and rivers. Physical science can be divided into two general fields—chemistry and physics. Chemistry is the study of matter and the interactions of matter. Physics is the study of energy and its ability to change matter. Figure 6 shows physical scientists at work.

Figure 6 Physical scientists study a wide range of subjects.



This chemist is studying the light emitted by certain compounds.

This physicist is studying light as it travels through optical fibers.

Careers Chemists ask questions such as "How can I make plastic stronger?" or "What can I do to make aspirin more effective?" Physicists might ask other types of questions, such as "How does light travel through glass fibers?" or "How can humans harness the energy of sunlight for their energy needs?"

Many careers are based on the physical sciences. Physicists and chemists are some obvious careers. Ultrasound and X-ray technicians working in the medical field study physical science because they study the energy in ultrasound or X rays and how it affects a living system.

Science and Technology Although learning the answers to scientific questions is important, these answers do not help people directly unless they can be applied in some way. **Technology** is the practical use of science, or applied science, as illustrated in **Figure 7.** Engineers apply science to develop technology. The study of how to use the energy of sunlight is science. Using this knowledge to create solar panels is technology. The study of the behavior of light as it travels through thin, glass, fiber-optic wires is science. The use of optical fibers to transmit information is technology. A scientist uses science to study how the skin of a shark repels water. The application of this knowledge to create a material that helps swimmers slip through the water faster is technology.

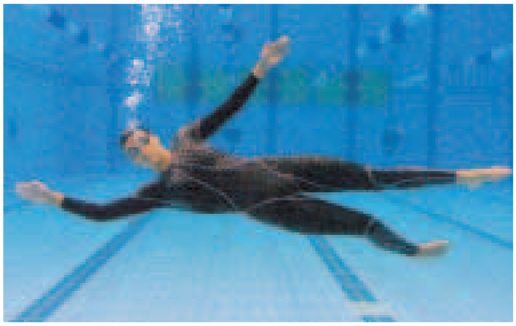


Figure 7 Solar-powered cars and the swimsuits worn in the Olympics are examples of technology—the application of science.

Analysis, Inquiry, and Design

1.1a: Identify one scientific or human need that can be solved through the use of technology.

section 1 review

Summary

Learning About the World

- Scientists ask questions to learn how, why, or when something occurred.
- A theory is a possible explanation for observations that is supported by many investigations.
- A scientific law describes a pattern but does not explain why things happen.

Systems in Science

- A system is composed of structures, cycles, and processes that interact with each other.

The Branches of Science

- Science is divided into three branches—life science, Earth science, and physical science.
- Technology is the application of science in our everyday lives.

Self Check

1. **Compare and contrast** scientific theory and scientific law. Explain how a scientific theory can change.
2. **Explain** why science can answer some questions, but not others.
3. **Classify** the following statement as a theory or a law: Heating the air in a hot-air balloon causes the balloon to rise.
4. **Think Critically** Describe the importance of technology and how it relates to science.

Applying Skills

5. **Infer** Scientists ask questions and make observations. What types of questions and observations would you make if you were a scientist studying schools of fish in the ocean?

AID S2.2b: design scientific investigations, S2.2c: design a simple controlled experiment, S2.2d: identify independent variables, dependent variables, and constants in a simple controlled experiment.
Also covered: S1.1a, S1.1b, S1.1c, S1.2a, S1.2b, S1.2c, S2.1a, S2.1d, S2.2a, S3.1a.

section 2

Science in Action

as you read

What You'll Learn

- **Identify** some skills scientists use.
- **Define** hypothesis.
- **Recognize** the difference between observation and inference.

Why It's Important

Science can be used to learn more about the world you live in.

Review Vocabulary

observation: a record or description of an occurrence or pattern in nature

New Vocabulary

- hypothesis
- infer
- controlled experiment
- variable
- independent variable
- dependent variable
- constant

Science Skills

You know that science involves asking questions, but how does asking questions lead to learning? Because no single way to gain knowledge exists, a scientist doesn't start with step one, then go to step two, and so on. Instead, scientists have a huge collection of skills from which to choose. Some of these skills include thinking, observing, predicting, investigating, researching, modeling, measuring, analyzing, and inferring. Science also can advance with luck and creativity.

Science Methods Investigations often follow a general pattern. As illustrated in **Figure 8,** most investigations begin by seeing something and then asking a question about what was observed. Scientists often perform research by talking with other scientists. They read books and scientific magazines to learn as much as they can about what is already known about their question. Usually, scientists state a possible explanation for their observation. To collect more information, scientists almost always make more observations. They might build a model of what they study or they might perform investigations. Often, they do both. How might you combine some of these skills in an investigation?

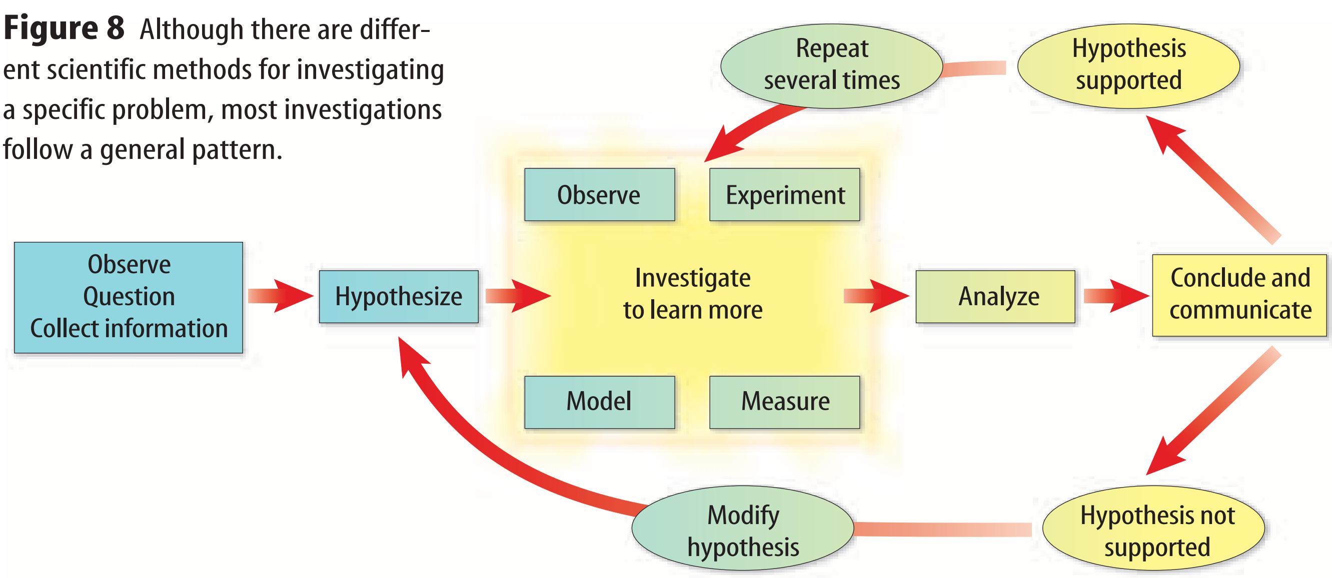


Figure 8 Although there are different scientific methods for investigating a specific problem, most investigations follow a general pattern.

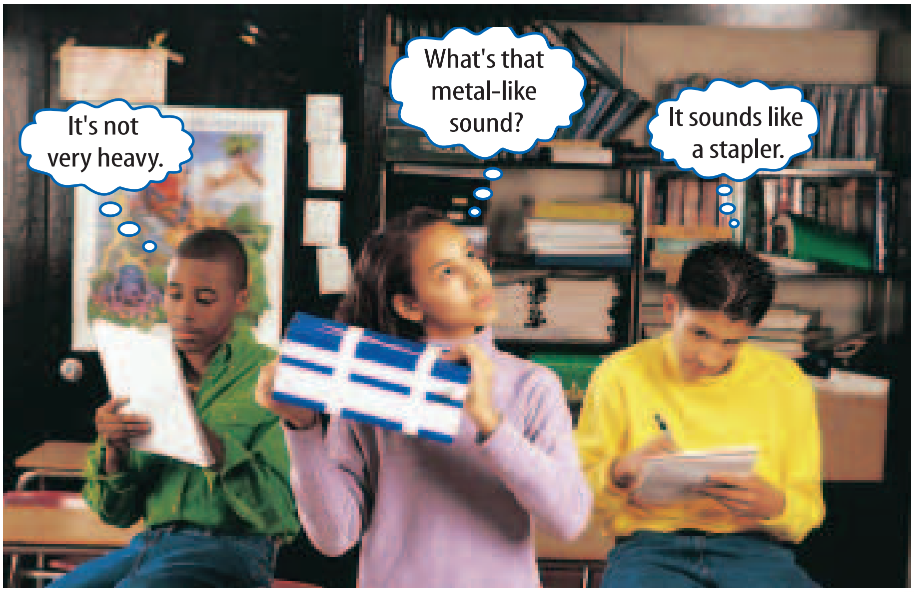


Figure 9 Investigations often begin by making observations and asking questions.

Questioning and Observing Ms. Clark placed a sealed shoe box on the table at the front of the laboratory. Everyone in the class noticed the box. Within seconds the questions flew. "What's in the box?" "Why is it there?"

Ms. Clark said she would like the class to see how they used some science skills without even realizing it.

"I think that she wants us to find out what's in it," Isabelle said to Marcus.

"Can we touch it?" asked Marcus.

"It's up to you," Ms. Clark said.

Marcus picked up the box and turned it over a few times.

"It's not heavy," Marcus observed. "Whatever is inside slides around." He handed the box to Isabelle.

Isabelle shook the box. The class heard the object strike the sides of the box. With every few shakes, the class heard a metallic sound. The box was passed around for each student to make observations and write them in his or her Science Journal. Some observations are shown in **Figure 9.**

Taking a Guess "I think it's a pair of scissors," said Marcus.

"Aren't scissors lighter than this?" asked Isabelle, while shaking the box. "I think it's a stapler."

"What makes you think so?" asked Ms. Clark.

"Well, staplers are small enough to fit inside a shoe box, and it seems to weigh about the same," said Isabelle.

"We can hear metal when we shake it," said Enrique.

"So, you are guessing that a stapler is in the box?"

"Yes," they agreed.

"You just stated a hypothesis," exclaimed Ms. Clark.

"A what?" asked Marcus.

Analysis, Inquiry, and Design

S2.2b: Design a simple scientific investigation using observation, description, comparison, sample collection, or construction of a model.

INTEGRATE Career

Biologist Some naturalists study the living world, using mostly their observational skills. They observe animals and plants in their natural environment, taking care not to disturb the organisms they are studying. Make observations of organisms in a nearby park or backyard. Record your observations in your Science Journal.

Mini LAB

Forming a Hypothesis

Procedure

1. Fill a large **pot** with **water.** Place an **unopened can of diet soda** and an **unopened can of regular soda** into the pot of water and observe what each can does.
2. In your **Science Journal,** make a list of the possible explanations for your observation. Select the best explanation and write a hypothesis.
3. Read the nutritional facts on the back of each can and compare their ingredients.
4. Revise your hypothesis based on this new information.

Analysis

1. What did you observe when you placed the cans in the water?
2. How did the nutritional information on the cans change your hypothesis?
3. Infer why the two cans behaved differently in the water.

Try at Home

The Hypothesis "A **hypothesis** is a reasonable and educated possible answer based on what you know and what you observe."

"We know that a stapler is small, it can be heavy, and it is made of metal," said Isabelle.

"We observed that what is in the box is small, heavier than a pair of scissors, and made of metal," continued Marcus.

Analyzing Hypotheses "What other possible explanations fit with what you observed?" asked Ms. Clark.

"Well, it has to be a stapler," said Enrique.

"What if it isn't?" asked Ms. Clark. "Maybe you're overlooking explanations because your minds are made up. A good scientist keeps an open mind to every idea and explanation. What if you learn new information that doesn't fit with your original hypothesis? What new information could you gather to verify or disprove your hypothesis?"

"Do you mean a test or something?" asked Marcus.

"I know," said Enrique, "We could get an empty shoe box that is the same size as the mystery box and put a stapler in it. Then we could shake it and see whether it feels and sounds the same." Enrique's test is shown in **Figure 10.**

Making a Prediction "If your hypothesis is correct, what would you expect to happen?" asked Ms. Clark.

"Well, it would be about the same weight and it would slide around a little, just like the other box," said Enrique.

"It would have that same metallic sound when we shake it," said Marcus.

"So, you predict that the test box will feel and sound the same as your mystery box. Go ahead and try it," said Ms. Clark.

Figure 10 Comparing the known information with the unknown information can be valuable even though you cannot see what is inside the closed box.

CONTENTS

Testing the Hypothesis Ms. Clark gave the class an empty shoe box that appeared to be identical to the mystery box. Isabelle found a metal stapler. Enrique put the stapler in the box and taped the box closed. Marcus shook the box.

"The stapler does slide around but it feels just a little heavier than what's inside the mystery box," said Marcus. "What do you think?" he asked Isabelle as he handed her the box.

"It is heavier," said Isabelle "and as hard as I shake it, I can't get a metallic sound. What if we find the mass of both boxes? Then we'll know the exact mass difference between the two."

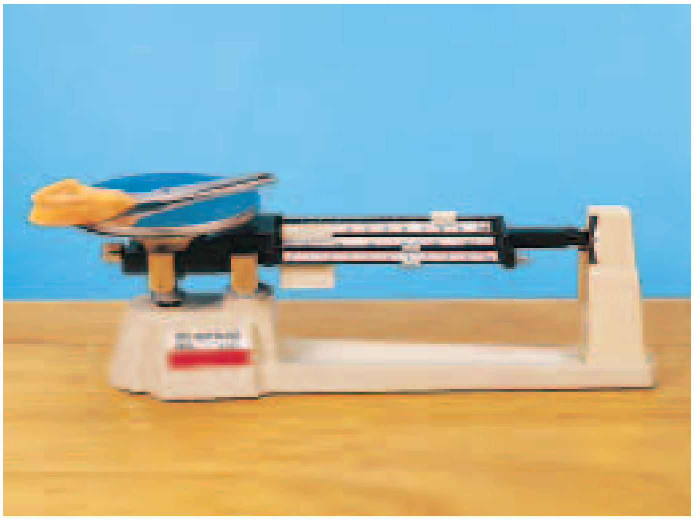


Figure 11 Laboratory balances are used to find the mass of objects.

Using a balance, as shown in **Figure 11,** the class found that the test box had a mass of 410 g, and the mystery box had a mass of 270 g.

Organizing Your Findings "Okay. Now you have some new information," said Ms. Clark. "But before you draw any conclusions, let's organize what we know. Then we'll have a summary of our observations and can refer back to them when we are drawing our conclusions."

"We could make a chart of our observations in our Science Journals," said Marcus.

"We could compare the observations of the mystery box with the observations of the test box," said Isabelle. The chart that the class made is shown in **Table 1.**

Table 1 Observation Chart

Questions	Mystery Box	Our Box
Does it roll or slide?	It slides and appears to be flat.	It slides and appears to be flat.
Does it make any sounds?	It makes a metallic sound when it strikes the sides of the box.	The stapler makes a thudding sound when it strikes the sides of the box.
Is the mass evenly distributed in the box?	No. The object doesn't completely fill the box.	No. The mass of the stapler is unevenly distributed.
What is the mass of the box?	270 g	410 g

Drawing Conclusions

"What have you learned from your investigation so far?" asked Ms. Clark.

"The first thing that we learned was that our hypothesis wasn't correct," answered Marcus.

"Would you say that your hypothesis was entirely wrong?" asked Ms. Clark.

"The boxes don't weigh the same, and the box with the stapler doesn't make the same sound as the mystery box. But there could be a difference in the kind of stapler in the box. It could be a different size or made of different materials."

"So you infer that the object in the mystery box is not exactly the same type of stapler, right?" asked Ms. Clark.

"What does *infer* mean?" asked Isabelle.

"To **infer** something means to draw a conclusion based on what you observe," answered Ms. Clark.

"So we inferred that the things in the boxes had to be different because our observations of the two boxes are different," said Marcus.

"I guess we're back to where we started," said Enrique. "We still don't know what's in the mystery box."

"Do you know more than you did before you started?" asked Ms. Clark.

"We eliminated one possibility," Isabelle added.

"Yes. We inferred that it's not a stapler, at least not like the one in the test box," said Marcus.

"So even if your observations don't support your hypothesis, you know more than you did when you started," said Ms. Clark.

Continuing to Learn "So when do we get to open the box and see what it is?" asked Marcus.

"Let me ask you this," said Ms. Clark. "Do you think scientists always get a chance to look inside to see if they are right?"

"If they are studying something too big or too small to see, I guess they can't," replied Isabelle. "What do they do in those cases?"

"As you learned, your first hypothesis might not be supported by your investigation. Instead of giving up, you continue to gather information by making more observations, making new hypotheses, and by investigating further. Some scientists have spent lifetimes researching their questions. Science takes patience and persistence," said Ms. Clark.

Figure 12 Observations can be used to draw inferences.
Infer *Looking at both of these photos, what do you infer has taken place?*

Communicating Your Findings It is not unusual for one scientist to continue the work of another or to try to duplicate the work of another scientist. It is important for scientists to communicate to others not only the results of the investigation, but also the methods by which the investigation was done. Scientists often publish reports in journals, books, and on the Internet to show other scientists the work that was completed. They also might attend meetings where they make speeches about their work.

Like the science-fair student in **Figure 13** demonstrates, an important part of doing science is the ability to communicate methods and results to others.

Reading Check *Why do scientists share information?*

Figure 13 Presentations are one way people in science communicate their findings.

Hot Words Hot Topics: Bk 1 pp. 89, 190

Applying Math — Make a Data Table

SEASONAL TEMPERATURES Suppose you were given the average temperatures in a city for the four seasons over a three-year period: spring 1997 was 11°C; summer 1997 was 25°C; fall 1997 was 5°C; winter 1997 was −5°C; spring 1998 was 9°C; summer 1998 was 36°C; fall 1998 was 10°C; winter 1998 was −3°C; spring 1999 was 10°C; summer 1999 was 30°C; fall 1999 was 9°C; and winter 1999 was −2°C. How can you tell in which of the years each season had its coldest average?

Solution

1. *This is what you know:* Temperatures were: 1997: 11°C, 25°C, 5°C, −5°C
   1998: 9°C, 36°C, 10°C, −3°C
   1999: 10°C, 30°C, 9°C, −2°C
2. *This is what you need to find out:* Which of the years each season had its coldest temperature?
3. *This is the procedure you need to use:*
   - Create a table with rows for seasons and columns for the years.
   - Insert the values you were given.
4. *Check your answer:* The four coldest seasons were spring 1998, summer 1997, fall 1997, and winter 1997.

Practice Problems

Use your table to find out which season had the greatest difference in temperatures over the three years from 1997 through 1999.

Science Online — For more practice, visit glencoe.com

> **Science Online**
> **Topic: Scientific Method**
> Visit glencoe.com for Web links to information about the scientific method.
>
> **Activity** Identify the three variables needed in every experiment and summarize the differences between them.

> **Analysis, Inquiry, and Design**
> **S2.2c, S2.2d: Design** a simple controlled experiment. Identify the independent variables, dependent variables, and constants in your experiment.

Experiments

Different types of questions call for different types of investigations. Ms. Clark's class made many observations about their mystery box and about their test box. They wanted to know what was inside. To answer their question, building a model—the test box—was an effective way to learn more about the mystery box. Some questions ask about the effects of one factor on another. One way to investigate these kinds of questions is by doing a controlled experiment. A **controlled experiment** involves changing one factor and observing its effect on another while keeping all other factors constant.

Variables and Constants Imagine a race in which the lengths of the lanes vary. Some lanes are 102 m long, some are 98 m long, and a few are 100 m long. When the first runner crosses the finish line, is he or she the fastest? Not necessarily. The lanes in the race have different lengths.

Variables are factors that can be changed in an experiment. Reliable experiments, like the race shown in **Figure 14,** attempt to change one variable and observe the effect of this change on another variable. The variable that is changed in an experiment is called the **independent variable.** The **dependent variable** changes as a result of a change in the independent variable. It usually is the dependent variable that is observed in an experiment. Scientists attempt to keep all other variables constant—or unchanged.

The variables that are not changed in an experiment are called **constants.** Examples of constants in the race include track material, wind speed, and distance. This way it is easier to determine exactly which variable is responsible for the runners' finish times. In this race, the runners' abilities were varied. The runners' finish times were observed.

Figure 14 The 400-m race is an example of a controlled experiment. The distance, track material, and wind speed are constants. The runners' abilities and their finish times are varied.

Figure 15 Safety is the most important aspect of any investigation.

Analysis, Inquiry, and Design

S2.2a: Analyze the simple controlled experiment you designed earlier. List all safety precautions and the safety symbol warnings for your experiment.

Laboratory Safety

In your science class, you will perform many types of investigations. However, performing scientific investigations involves more than just following specific steps. You also must learn how to keep yourself and those around you safe by obeying the safety symbol warnings, shown in **Figure 16.**

In a Laboratory When scientists work in a laboratory, as shown in **Figure 15,** they take many safety precautions.

The most important safety advice in a science lab is to think before you act. Always check with your teacher several times in the planning stage of any investigation. Also make sure you know the location of safety equipment in the laboratory room and how to use this equipment, including the eyewashes, thermal mitts, and fire extinguisher.

Good safety habits include the following suggestions. Before conducting any investigation, find and follow all safety symbols listed in your investigation. You always should wear an apron and goggles to protect yourself from chemicals, flames, and pointed objects. Keep goggles on until activity, cleanup, and handwashing are complete. Always slant test tubes away from yourself and others when heating them. Never eat, drink, or apply makeup in the lab. Report all accidents and injuries to your teacher and always wash your hands after working with lab materials.

In the Field Investigations also take place outside the lab, in streams, farm fields, and other places. Scientists must follow safety regulations there, as well, such as wearing eye goggles and any other special safety equipment that is needed. Never reach into holes or under rocks. Always wash your hands after you've finished your field work.

Figure 16 Safety symbols are present on nearly every investigation you will do this year.
List *the safety symbols that should be on the lab the student is preparing to do in* ***Figure 15.***

Figure 17 Accidents are not planned. Safety precautions must be followed to prevent injury.

Why have safety rules? Doing science in the class laboratory or in the field can be much more interesting than reading about it. However, safety rules must be strictly followed, so that the possibility of an accident greatly decreases. However, you can't predict when something will go wrong.

Think of a person taking a trip in a car. Most of the time when someone drives somewhere in a vehicle, an accident, like the one shown in **Figure 17,** does not occur. But to be safe, drivers and passengers always should wear safety belts. Likewise, you always should wear and use appropriate safety gear in the lab—whether you are conducting an investigation or just observing. The most important aspect of any investigation is to conduct it safely.

section 2 review

Summary

Science Skills

- The scientific method was developed to help scientists investigate their questions.
- Hypotheses are possible explanations for why something occurs.

Drawing Conclusions

- Scientists communicate with one another to share important information.

Experiments

- Controlled experiments test the effect of one factor on another.

Laboratory Safety

- Safety precautions must be followed when conducting any investigation.

Self Check

1. **Explain** the difference between an inference and an observation.
2. **Explain** the differences between independent and dependent variables.
3. **Think Critically** A classroom investigation lists bleach as an ingredient. Bleach can irritate your skin, damage your eyes, and stain your clothes. What safety symbols should be listed with this investigation? Explain.

Applying Skills

4. **Describe** the different types of safety equipment found in a scientific laboratory. From your list, which equipment should you use when working with a flammable liquid in the lab?

More Section Review glencoe.com

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ICT 2.1: Select an appropriate model to begin the search for answers or solutions to a question or problem. **2.2:** Use models to study processes that cannot be studied directly. **Also covered:** AID M1.1c, S1.2b, 2: IS 1.5.

section 3

Models in Science

Why are models necessary?

Just as you can take many different paths in an investigation, you can test a hypothesis in many different ways. Ms. Clark's class tested their hypothesis by building a model of the mystery box. A model is one way to test a hypothesis. In science, a **model** is any representation of an object or an event used as a tool for understanding the natural world.

Models can help you visualize, or picture in your mind, something that is difficult to see or understand. Ms. Clark's class made a model because they couldn't see the item inside the box. Models can be of things that are too small or too big to see. They also can be of things that can't be seen because they don't exist anymore or they haven't been created yet. Models also can show events that occur too slowly or too quickly to see. **Figure 18** shows different kinds of models.

as you read

What You'll Learn

- **Describe** various types of models.
- **Discuss** limitations of models.

Why It's Important

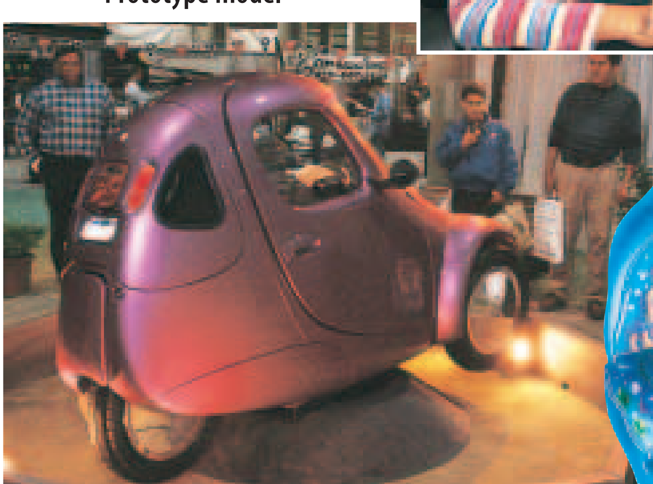
Models can be used to help understand difficult concepts.

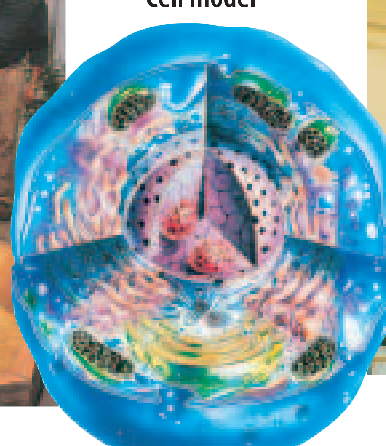
Review Vocabulary
scientific method: processes scientists use to collect information and answer questions

New Vocabulary
- model

Figure 18 Models help scientists visualize and study complex things and things that can't be seen.


Solar system model


Prototype model


Cell model


Dinosaur model

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Types of Models

Most models fall into three basic types—physical models, computer models, and idea models. Depending on the reason that a model is needed, scientists can choose to use one or more than one type of model.

Physical Models Models that you can see and touch are called physical models. Examples include things such as a tabletop solar system, a globe of Earth, a replica of the inside of a cell, or a gumdrop-toothpick model of a chemical compound. Models show how parts relate to one another. They also can be used to show how things appear when they change position or how they react when an outside force acts on them.

Computer Models Computer models are built using computer software. You can't touch them, but you can view them on a computer screen. Some computer models can model events that take a long time or take place too quickly to see. For example, a computer can model the movement of large plates in the Earth and might help predict earthquakes.

Computers also can model motions and positions of things that would take hours or days to calculate by hand or even using a calculator. They can also predict the effect of different systems or forces. **Figure 19** shows how computer models are used by scientists to help predict the weather based on the motion of air currents in the atmosphere.

Reading Check *What do computer models do?*

Science Online

Topic: Topographic Maps
Visit glencoe.com for Web links to information about topographic maps.

Activity List some of the different features found on topographic maps and explain their importance when reading and interpreting maps.

Interconnectedness: Common Themes

2.1, 2.2: Design a simple experiment that uses a model. Analyze which type of model would be best for the experiment.

Figure 19 A weather map is a computer model showing weather patterns over large areas. Scientists can use this information to predict the weather and to alert people to potentially dangerous weather on the way.

Figure 20 Models can be created using various types of tools.

Idea Models Some models are ideas or concepts that describe how someone thinks about something in the natural world. Albert Einstein is famous for his theory of relativity, which involves the relationship between matter and energy. One of the most famous models Einstein used for this theory is the mathematical equation $E = mc^2$. This explains that mass, m, can be changed into energy, E. Einstein's idea models never could be built as physical models, because they are basically ideas.

Making Models

The process of making a model is something like a sketch artist at work, as shown in **Figure 20.** The sketch artist attempts to draw a picture from the description given by someone. The more detailed the description is, the better the picture will be. Like a scientist who studies data from many sources, the sketch artist can make a sketch based on more than one person's observation. The final sketch isn't a photograph, but if the information is accurate, the sketch should look realistic. Scientific models are made much the same way. The more information a scientist gathers, the more accurate the model will be. The process of constructing a model of King Tutankhamun, who lived more than 3,000 years ago, is shown in **Figure 21.**

Reading Check *How are sketches like specific models?*

Using Models

When you think of a model, you might think of a model airplane or a model of a building. Not all models are for scientific purposes. You use models, and you might not realize it. Drawings, maps, recipes, and globes are all examples of models.

Mini LAB

Thinking Like a Scientist

Procedure

1. Pour 15 mL of **water** into a **test tube.**
2. Slowly pour 5 mL of **vegetable oil** into the test tube.
3. Add two drops of **food coloring** and observe the liquid for 5 min.

Analysis

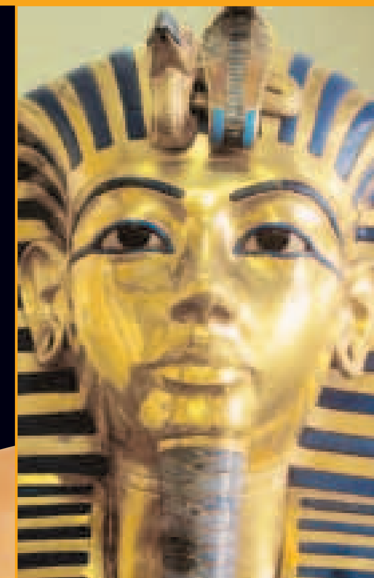
1. Record your observations of the test tube's contents before and after the oil and the food coloring were added to it.
2. Infer a scientific explanation for your observations.

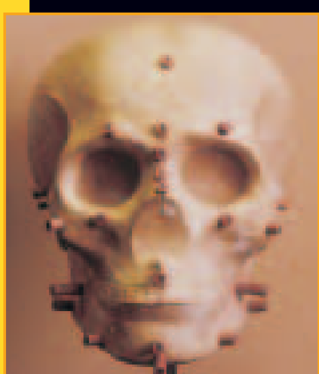
VISUALIZING THE MODELING OF KING TUT

Figure 21

More than 3,000 years ago, King Tutankhamun ruled over Egypt. His reign was a short one, and he died when he was just 18. In 1922, his mummified body was discovered, and in 1983 scientists recreated the face of this most famous of Egyptian kings. Some of the steps in building the model are shown here.

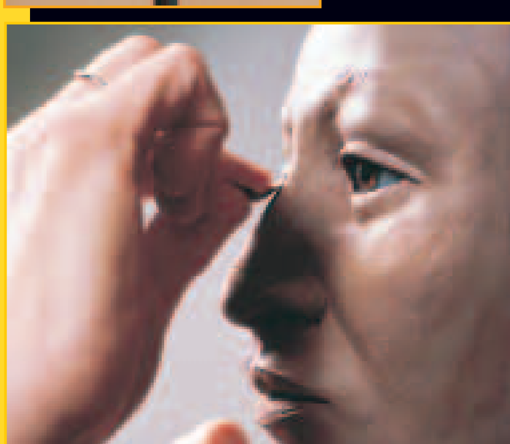
This is the most familiar image of the face of King Tut—the gold funerary mask that was found covering his skeletal face.



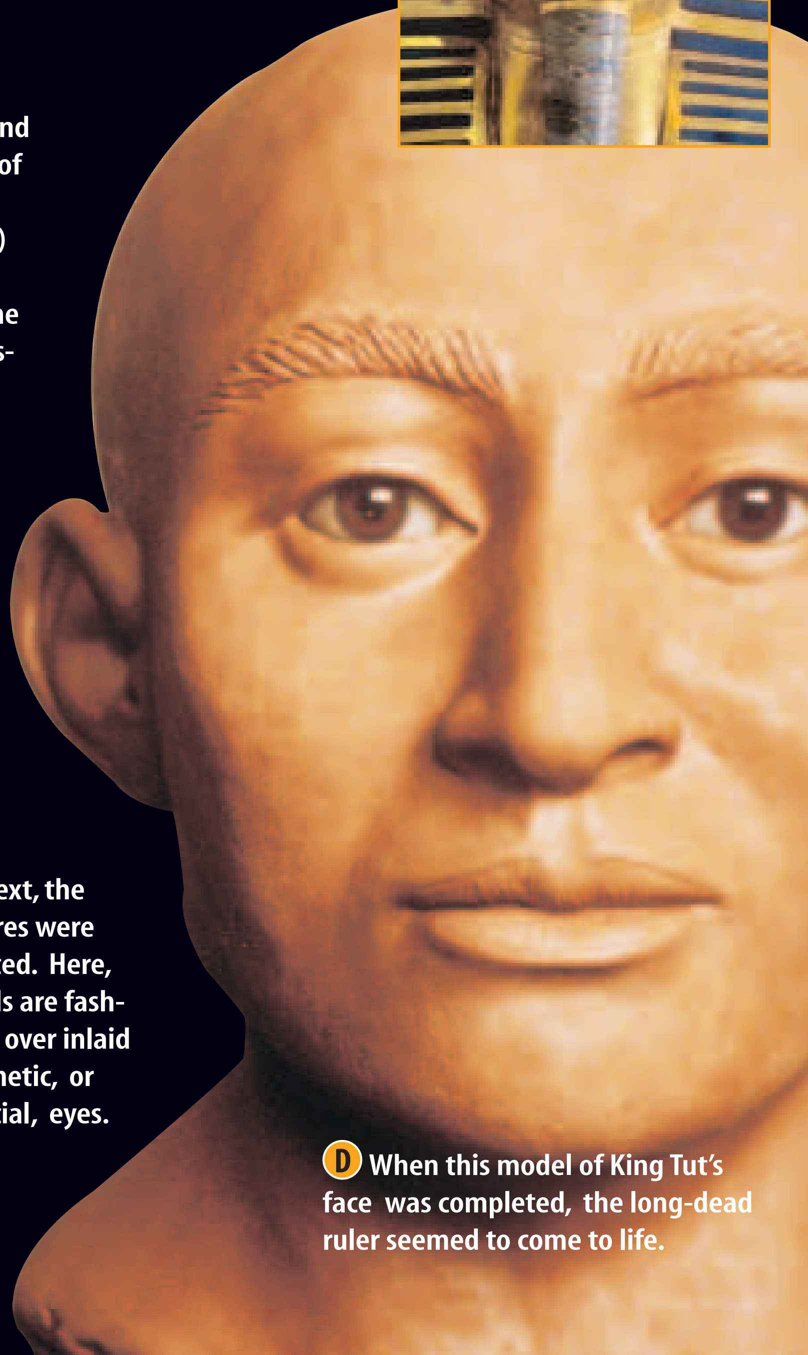


A First, a scientist used measurements and X rays to create a cast of the young king's skull. Depth markers (in red) were then glued onto the skull to indicate the likely thickness of muscle and other tissue.

B Clay was applied to fill in the area between the markers.



C Next, the features were sculpted. Here, eyelids are fashioned over inlaid prosthetic, or artificial, eyes.



D When this model of King Tut's face was completed, the long-dead ruler seemed to come to life.

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Models Communicate Some models are used to communicate observations and ideas to other people. Often, it is easier to communicate ideas you have by making a model instead of writing your ideas in words. This way others can visualize them, too.

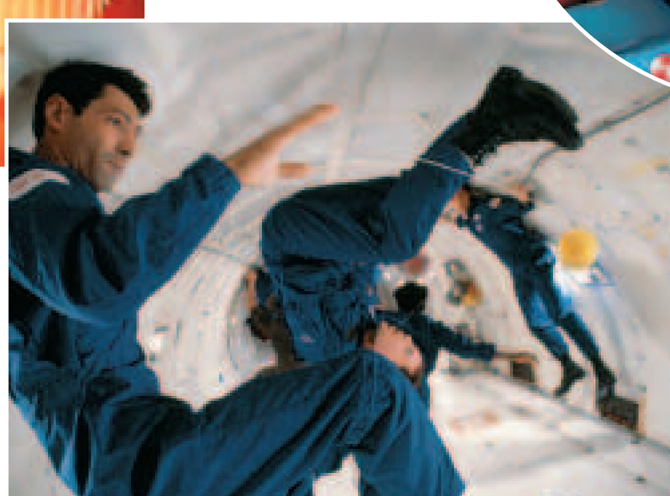
Models Test Predictions Some models are used to test predictions. Ms. Clark's class predicted that a box with a stapler in it would have characteristics similar to their mystery box. To test this prediction, the class made a model. Automobile and airplane engineers use wind tunnels to test predictions about how air will interact with their products.

Models Save Time, Money, and Lives Other models are used because working with and testing a model can be safer and less expensive than using the real thing. For example, the crash-test dummies shown in **Figure 22** are used in place of people when testing the effects of automobile crashes. To help train astronaunts in the conditions they will encounter in space, NASA has built a special airplane. This airplane flies in an arc that creates the condition of freefall for 20 to 25 seconds. Making several trips in the airplane is easier, safer, and less expensive than making a trip into space.

Figure 22 Models are a safe and relatively inexpensive way to test ideas.

Wind tunnels can be used to test new airplane designs or changes made to existing airplanes.

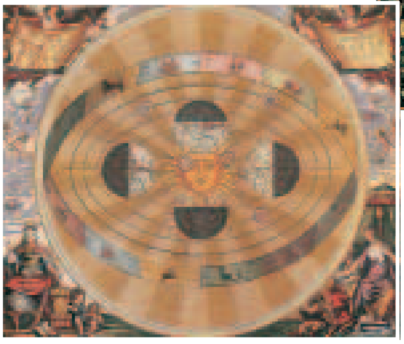
Crash-test dummies are used to test vehicles without putting people in danger.



Astronauts train in a special aircraft that models the conditions of space.

Figure 23 The model of Earth's solar system changed as new information was gathered.

An early model of the solar system had Earth in the center with everything revolving around it.



Later on, a new model had the Sun in the center with everything revolving around it.

Limitations of Models

The solar system is too large to be viewed all at once, so models are made to understand it. Many years ago, scientists thought that Earth was the center of the universe and the sky was a blanket that covered the planet.

Later, through observation, it was discovered that the objects you see in the sky are the Sun, the Moon, stars, and other planets. This new model explained the solar system differently. Earth was still the center, but everything else orbited it as shown in **Figure 23.**

Models Change Still later, through more observation, it was discovered that the Sun is the center of the solar system. Earth, along with the other planets, orbits the Sun. In addition, it was discovered that other planets also have moons that orbit them. A new model was developed to show this.

Earlier models of the solar system were not meant to be misleading. Scientists made the best models they could with the information they had. More importantly, their models gave future scientists information to build upon. Models are not necessarily perfect, but they provide a visual tool to learn from.

section 3 review

Summary

Why are models necessary?

- Scientists develop models to help them visualize complex concepts.

Types of Models

- There are three types of models—physical models, computer models, and idea models.

Making Models

- The more information you have when creating a model, the more accurate the model will be.

Using Models

- Models are used to convey important information such as maps and schedules.

Limitations of Models

- Models can be changed over time as new information becomes available.

Self Check

1. **Infer** what types of models can be used to model weather. How are they used to predict weather patterns?
2. **Explain** how models are used in science.
3. **Describe** how consumer product testing services use models to ensure the safety of the final products produced.
4. **Describe** the advantages and limitations of the three types of models.
5. **Think Critically** Explain why some models are better than others for certain situations. Give one example.

Hot Words Hot Topics: Bk 1 pp. 274-276, 369

Applying Math

6. **Use Proportions** On a map of a state, the scale shows that 1 cm is approximately 5 km. If the distance between two cities is 1.7 cm on the map, how many kilometers separate them?

AID S3.2b: identify sources of error and the limitations of data collected. IPS 1.2: Make informed consumer decisions by seeking answers to appropriate questions about products, services, and systems; determining the cost/benefit and risk/benefit tradeoffs; and applying this knowledge to a potential purchase.

section 4

Evaluating Scientific Explanation

Believe it or not?

Look at the photo in **Figure 24.** Do you believe what you see? Do you believe everything you read or hear? Think of something that someone told you that you didn't believe. Why didn't you believe it? Chances are you looked at the facts you were given and decided that there wasn't enough proof to make you believe it. What you did was evaluate, or judge the reliability of what you heard. When you hear a statement, you ask the question "How do you know?" If you decide that what you are told is reliable, then you believe it. If it seems unreliable, then you don't believe it.

Critical Thinking When you evaluate something, you use critical thinking. **Critical thinking** means combining what you already know with the new facts that you are given to decide if you should agree with something. You can evaluate an explanation by breaking it down into two parts. First you can look at and evaluate the observations. Based upon what you know, are the observations accurate? Then you can evaluate the inferences—or conclusions made about the observations. Do the conclusions made from the observations make sense?

as you read

What You'll Learn

- **Evaluate** scientific explanations.
- **Evaluate** promotional claims.

Why It's Important

Evaluating scientific claims can help you make better decisions.

Review Vocabulary

prediction: an educated guess as to what is going to happen based on observation

New Vocabulary

- critical thinking
- data

Figure 24 In science, observations and inferences are not always agreed upon by everyone.
Compare *Do you see the same things your classmates see in this photo?*

Table 2 Favorite Foods

People's Preference	Tally	Frequency
Pepperoni pizza	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	37
Hamburgers with ketchup	𝍸 𝍸 𝍸 𝍸 𝍸 |||	28

Analysis, Inquiry, and Design

S3.2b: Discuss why it is important to list specific data that shows multiple trials and whether other scientists have repeated the data.

Evaluating the Data

A scientific investigation always contains observations—often called **data.** Data are gathered during a scientific investigation and can be recorded in the form of descriptions, tables, graphs, or drawings. When evaluating a scientific claim, you might first look to see whether any data are given. You should be cautious about believing any claim that is not supported by data.

Are the data specific? The data given to back up a claim should be specific. That means they need to be exact. What if your friend tells you that many people like pizza more than they like hamburgers? What else do you need to know before you agree with your friend? You might want to hear about a specific number of people rather than unspecific words like *many* and *more*. You might want to know how many people like pizza more than hamburgers. How many people were asked about which kind of food they liked more? When you are given specific data, a statement is more reliable and you are more likely to believe it. An example of data in the form of a frequency table is shown in **Table 2.** A frequency table shows how many times types of data occur. Scientists must back up their scientific statements with specific data.

Take Good Notes Scientists must take thorough notes at the time of an investigation, as the scientists shown in **Figure 25** are doing. Important details can be forgotten if you wait several hours or days before you write down your observations. It is also important for you to write down every observation, including ones that you don't expect. Often, great discoveries are made when something unexpected happens in an investigation.

Figure 25 These scientists are writing down their observations during their investigation rather than waiting until they are back on land.
Draw Conclusions *Do you think this will increase or decrease the reliability of their data?*

Your Science Journal During this course, you will be keeping a science journal. You will write down what you do and see during your investigations. Your observations should be detailed enough that another person could read what you wrote and repeat the investigation exactly as you performed it. Instead of writing "the stuff changed color," you might say "the clear liquid turned to bright red when I added a drop of food coloring." Detailed observations written down during an investigation are more reliable than sketchy observations written from memory. Practice your observation skills by describing what you see in **Figure 26.**

Figure 26 Detailed observations are important in order to get reliable data.
Observe *Use ten descriptive words to describe what you see happening in this photo.*

Can the data be repeated? If your friend told you he could hit a baseball 100 m, but couldn't do it when you were around, you probably wouldn't believe him. Scientists also require repeatable evidence. When a scientist describes an investigation, as shown in **Figure 27,** other scientists should be able to do the investigation and get the same results. The results must be repeatable. When evaluating scientific data, look to see whether other scientists have repeated the data. If not, the data might not be reliable.

Evaluating the Conclusions

When you think about a conclusion that someone has made, you can ask yourself two questions. First, does the conclusion make sense? Second, are there any other possible explanations? Suppose you hear on the radio that your school will be running on a two-hour delay in the morning because of snow. You look outside. The roads are clear of snow. Does the conclusion that snow is the cause for the delay make sense? What else could cause the delay? Maybe it is too foggy or icy for the buses to run. Maybe there is a problem with the school building. The original conclusion is not reliable unless the other possible explanations are proven unlikely.

Interdisciplinary: Problem Solving

1.2: Design a creative advertisement that is intentionally misleading or an exaggeration of data. Supply three examples of how the information is not correct.

Figure 27 Working together is an important part of science. Several scientists must repeat an experiment and obtain the same results before data are considered reliable.

CONTENTS

Evaluating Promotional Materials

Scientific processes are not used only in the laboratory. Suppose you saw an advertisement in the newspaper like the one in **Figure 28.** What would you think? First, you might ask, "Does this make sense?" It seems unbelievable. You would probably want to hear some of the scientific data supporting the claim before you would believe it. How was this claim tested? How is the amount of wrinkling in skin measured? You might also want to know if an independent laboratory repeated the results. An independent laboratory is one that is not related in any way to the company that is selling the product or service. It has nothing to gain from the sales of the product. Results from an independent laboratory usually are more reliable than results from a laboratory paid by the selling company. Advertising materials are designed to get you to buy a product or service. It is important that you carefully evaluate advertising claims and the data that support them before making a quick decision to spend your money.

Figure 28 All material should be read with an analytical mind. **Explain** *what this advertisement means.*

section 4 review

Summary

Believe it or not?

- By combining what you already know with new information as it becomes available, you can decide whether something is fact or fiction.
- Explanations should be evaluated by looking at both the observations and the conclusions the explanation is based on.

Evaluating the Data

- It is important to take thorough notes during any investigation.

Evaluating the Conclusions

- In order for a conclusion to be reliable, it must make sense.

Evaluating Promotional Materials

- Independent laboratories test products in order to provide more reliable results.

Self Check

1. **Describe** why it is important that scientific experiments be repeated.
2. **List** what types of scientific claims should be verified.
3. **Explain** how vague claims in advertising can be misleading.
4. **Think Critically** An advertisement on a food package claims it contains Glistain, a safe taste enhancer. Make a list of ten questions you would ask when evaluating this claim.

Applying Skills

5. **Classify** Watch three television commercials and read three magazine advertisements. Record the claims that each advertisement made. Classify each claim as being vague, misleading, reliable, and/or scientific.

More Section Review glencoe.com

LAB

What is the right answer?

Scientists sometimes develop more than one explanation for observations. Can more than one explanation be correct? Do scientific explanations depend on judgment?

Real-World Question

Can more than one explanation apply to the same observation?

Goals

- **Make a hypothesis** to explain an observation.
- **Construct** a model to support your hypothesis.
- **Refine** your model based on testing.

Materials

cardboard mailing tubes	length of rope
**empty shoe boxes*	scissors

**Alternate materials*

Safety Precautions

WARNING: *Be careful when punching holes with sharp tools.*

Procedure

1. You will be shown a cardboard tube with four ropes coming out of it, one longer than the others. Your teacher will show you that when any of the three short ropes—A, C, or D—are pulled, the longer rope, B, gets shorter. Pulling on rope B returns the other ropes to their original lengths.
2. Make a hypothesis as to how the teacher's model works.
3. **Sketch** a model of a tube with ropes based on your hypothesis. Using a cardboard tube and two lengths of rope, build a model according to your design. Test your model by pulling each of the ropes. If it does not perform as planned, modify your hypothesis and your model to make it work like your teacher's model.

Conclude and Apply

1. **Compare** your model with those made by others in your class.
2. Can more than one design give the same result? Can more than one explanation apply to the same observation? Explain.
3. Without opening the tube, can you tell which model is exactly like your teacher's?

Communicating Your Data

Make a display of your working model. Include sketches of your designs. **For more help, refer to the Science Skill Handbook.**

LAB

Identifying Parts of an Investigation

Goals

- **Identify** parts of an experiment.
- **Identify** constants, variables, and controls in the experiment.
- **Graph** the results of the experiment and draw appropriate conclusions.

Materials

description of fertilizer experiment

Real-World Question

Science investigations contain many parts. How can you identify the various parts of an investigation? In addition to variables and constants, many experiments contain a control. A control is one test, or trial, where everything is held constant. A scientist compares the control trial to the other trials. What are the various parts of an experiment to test which fertilizer helps a plant grow best?

Procedure

1. **Read** the description of the fertilizer experiment.
2. **List** factors that remained constant in the experiment.
3. **Identify** any variables in the experiment.
4. **Identify** the control in the experiment.
5. **Identify** one possible hypothesis that the gardener could have tested in her investigation.
6. **Describe** how the gardener went about testing her hypothesis using different types of fertilizers.
7. **Graph** the data that the gardener collected in a line graph.

A gardener was interested in helping her plants grow faster. When she went to the nursery, she found three fertilizers available for her plants. One of those fertilizers, fertilizer A, was recommended to her. However, she decided to conduct a test to determine which of the three fertilizers, if any, helped her plants grow fastest. The gardener planted four seeds, each in a separate pot. She used the same type of pot and the same type of soil in each pot. She fertilized one seed with fertilizer A, one with fertilizer B, and one with fertilizer C. She did not fertilize the fourth seed. She placed the four pots near one another in her garden. She made sure to give each plant the same amount of water each day. She measured the height of the plants each week and recorded her data. After eight weeks of careful observation and record keeping, she had the following table of data.

Plant Height (cm)

Week	Fertilizer A	Fertilizer B	Fertilizer C	No Fertilizer
1	0	0	0	0
2	2	4	1	1
3	5	8	5	4
4	9	13	8	7
5	14	18	12	10
6	20	24	15	13
7	27	31	19	16
8	35	39	22	20

Analyze Your Data

1. **Describe** the results indicated by your graph. What part of an investigation have you just done?
2. **Infer** Based on the results in the table and your graph, which fertilizer do you think the gardener should use if she wants her plants to grow the fastest? What part of an investigation have you just done?
3. **Define** Suppose the gardener told a friend who also grows these plants about her results. What is this an example of?

Conclude and Apply

1. **Interpret Data** Suppose fertilizer B is much more expensive than fertilizers A and C. Would this affect which fertilizer you think the gardener should buy? Why or why not?
2. **Explain** Does every researcher need the same hypothesis for an experiment? What is a second possible hypothesis for this experiment (different from the one you wrote in step 5 in the Procedure section)?
3. **Explain** if the gardener conducted an adequate test of her hypothesis.

Communicating Your Data

Compare your conclusions with those of other students in your class. **For more help, refer to the Science Skill Handbook.**

Women in Science

Is your family doctor a man or a woman? To your great-grandparents, such a question would likely have seemed odd. Why? Because 100 years ago, women weren't encouraged to study science as they are today. But that does not mean that there were no female scientists back in your great-grandparents' day. Many women managed to overcome great barriers and made discoveries that changed the world.

Maria Goeppert Mayer

"To my surprise, winning the prize wasn't half as exciting as doing the work itself. That was the fun—seeing it work out." Dr. Maria Goeppert Mayer won the Nobel Prize in Physics in 1963 for her work on the structure of an atom. Her model greatly increased human understanding of atoms, which make up all forms of matter.

Rita Levi-Montalcini

In 1986, Dr. Rita Levi-Montalcini was awarded the Nobel Prize in Medicine for her discovery of growth factors. Growth factors regulate the growth of cells and organs in the body. Because of her work, doctors are better able to understand why tumors form and wounds heal.

Rosalyn Sussman Yalow

"The world cannot afford the loss of the talents of half its people if we are to solve the many problems which beset us," Dr. Rosalyn Sussman Yalow said upon winning the Nobel Prize in Medicine in 1977 for discovering a way to measure tiny substances in the blood, such as hormones and drugs.

Her discovery made it possible for doctors to diagnose problems that they could not detect before.

Research Visit the link to the right to research some recent female Nobel prizewinners in physics, chemistry, and medicine. Write a short biography about their lives. How did their discoveries impact their scientific fields or people in general?

Science Online
For more information, visit glencoe.com

chapter 1 Study Guide

Reviewing Main Ideas

Section 1 What is science?

1. Science is a way of learning more about the natural world. It can provide possible explanations for why and how things happen.
2. Systems are made up of structures, cycles, and processes that interact with one another.

Section 2 Science in Action

1. A hypothesis is a possible explanation based on what you know and what you observe.
2. It is important to always follow laboratory safety symbols and to wear and use appropriate gear during an experiment.

Section 3 Models in Science

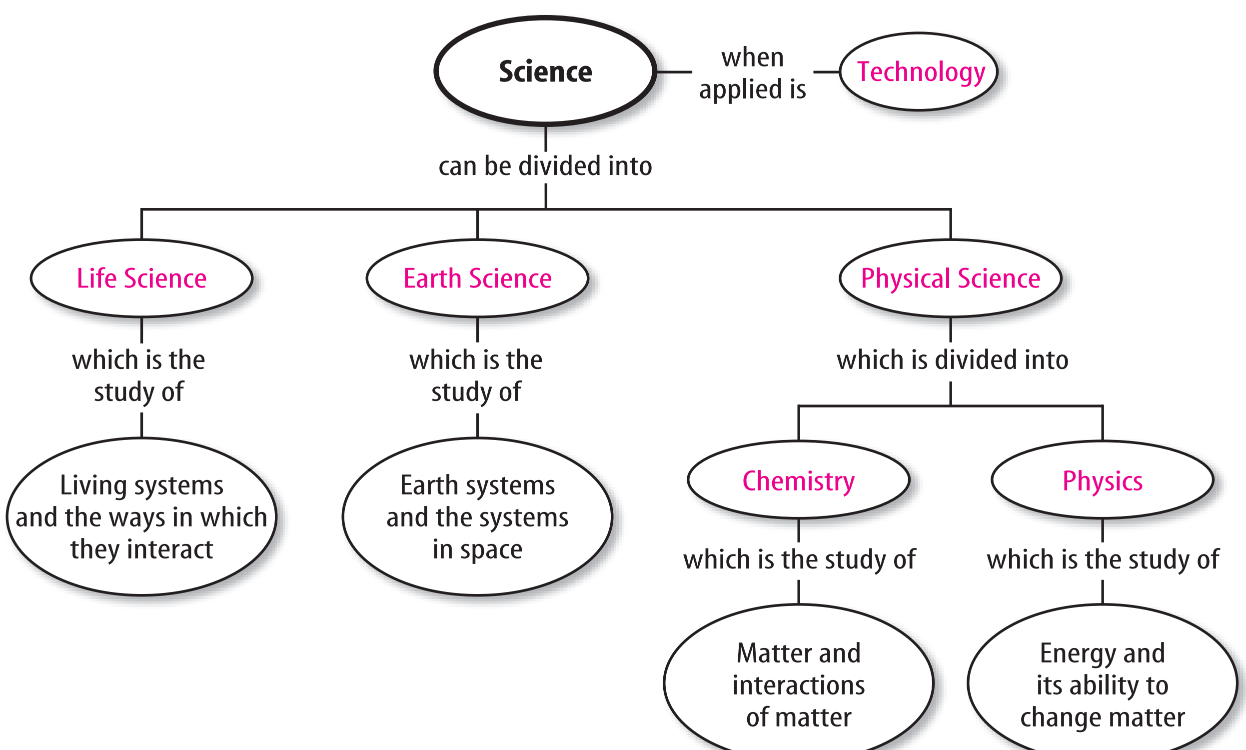
1. Models are a graphic representation of an object or an event used to communicate ideas; test predictions; and save time, money, and lives.

Section 4 Evaluating Scientific Explanation

1. Reliable data are specific and repeatable by other scientists.
2. In order for a conclusion to be considered reliable, it must make sense and be the most likely explanation.

Visualizing Main Ideas

Copy and complete the following concept map.



Using Vocabulary

constant p. 18	life science p. 9
controlled experiment p. 18	model p. 21
critical thinking p. 27	physical science p. 10
data p. 28	science p. 6
dependent variable p. 18	scientific law p. 7
Earth science p. 10	scientific theory p. 7
hypothesis p. 14	system p. 8
independent variable p. 18	technology p. 11
infer p. 16	variable p. 18

Explain the relationship between the words in the following sets.

1. hypothesis—scientific theory
2. constant—variable
3. science—technology
4. science—system
5. Earth science—physical science
6. critical thinking—infer
7. scientific law—observation
8. model—system
9. controlled experiment—variable
10. scientific theory—scientific law

Checking Concepts

Choose the word or phrase that best answers the question.

11. What does it mean to make an inference?
    A) make observations
    B) draw a conclusion
    C) replace
    D) test

12. Which of the following CANNOT protect you from splashing acid?
    A) goggles **C)** fire extinguisher
    B) apron **D)** gloves

13. If the results from your investigation do not support your hypothesis, what should you do?
    A) Should not do anything.
    B) Repeat the investigation until it agrees with the hypothesis.
    C) Modify your hypothesis.
    D) Change your data to fit your hypothesis.

14. Which of the following is NOT an example of a scientific hypothesis?
    A) Earthquakes happen because of stresses along continental plates.
    B) Some animals can detect ultrasound frequencies caused by earthquakes.
    C) Paintings are prettier than sculptures.
    D) Lava takes different forms depending on how it cools.

15. Using a computer to make a three-dimensional picture of a building is a type of which of the following?
    A) model **C)** constant
    B) hypothesis **D)** variable

16. Which of the following increases the reliability of a scientific explanation?
    A) vague statements
    B) notes taken after an investigation
    C) repeatable data
    D) several likely explanations

17. Which is an example of technology?
    A) a squirt bottle **C)** a cat
    B) a poem **D)** physical science

18. What explains something that takes place in the natural world?
    A) scientific law **C)** scientific theory
    B) technology **D)** experiments

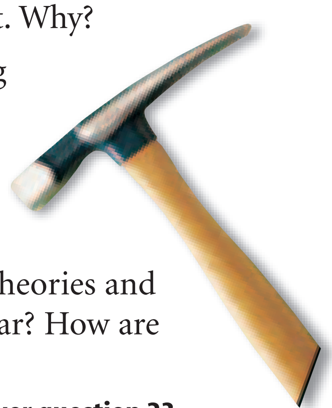
19. An airplane model is an example of what type of model?
    A) physical **C)** idea
    B) computer **D)** mental

Vocabulary Puzzlemaker glencoe.com

Thinking Critically

20. Draw Conclusions When scientists study how well new medicines work, one group of patients receives the medicine while a second group does not. Why?

21. Predict How is using a rock hammer an example of technology?



22. Compare and Contrast How are scientific theories and scientific laws similar? How are they different?

Use the table below to answer question 23.

Hardness	
Object	**Mohs Scale**
copper	3.5
diamond	10
fingernail	2.5
glass	5.5
quartz	7
steel file	6.5

23. Use Tables Mohs hardness scale measures how easily an object can be scratched. The higher the number, the harder the material is. Use the table above to identify which material is the hardest and which is the softest.

24. Make Operational Definitions How does a scientific law differ from a state law? Give some examples of both types of laws.

25. Infer Why it is important to record and measure data accurately during an experiment?

26. Predict the quickest way to get to school in the morning. List some ways you could test your prediction.

Performance Activities

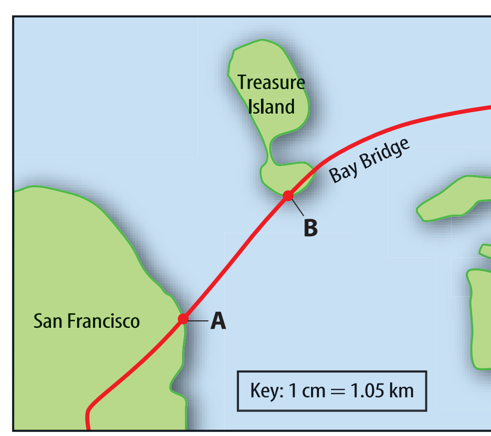
27. Hypothesize Using a basketball and a tennis ball, make a hypothesis about the number of times each ball will bounce when it hits the ground. Drop each ball from shoulder height five times, recording the number of bounces in a table. Which ball bounced more? Make a hypothesis to explain why.

28. Observe Pour some water in a small dish and sprinkle some pepper on top. Notice how the pepper floats on the water. Now add a few drops of liquid soap to the water. Write down your observations as you watch what happens to the pepper.

Hot Words Hot Topics: Bk 1 pp. 274-276, 369

Applying Math

Use the illustration below to answer question 29.



29. Use Proportions The map above shows the distance between two points. The scale shows that 1 cm is approximately 1.05 km. What is the approximate distance between Point A and Point B?

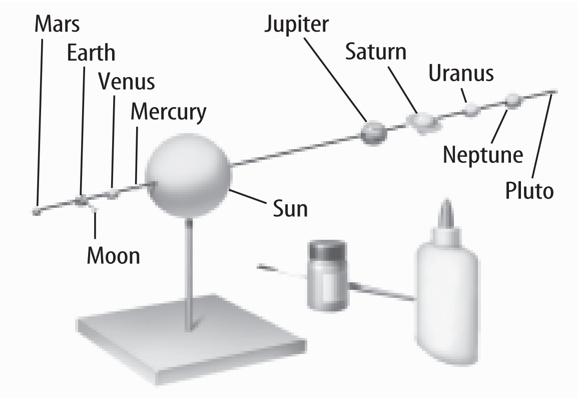
Intermediate-Level Science Examination Practice

Part I

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1 What is a rule describing a pattern in nature called?
(1) possible explanation
(2) scientific law
(3) scientific theory
(4) technology

Use the illustration below to answer questions 2–3.



2 The model of the solar system best represents which kind of scientific model?
(1) idea (3) physical
(2) computer (4) realistic

3 All of the following are represented in the model EXCEPT which of the following?
(1) the sun (3) planets
(2) the moon (4) stars

4 Which of the following is not an example of a model?
(1) CD (3) recipe
(2) map (4) drawing

5 Which of the following questions can science NOT answer?
(1) Why do the leaves on trees change colors in the fall?
(2) Why do bears hibernate in the winter?
(3) Where do waves in the ocean form?
(4) What is the most popular book?

6 What is it called when you combine what you already know with new facts?
(1) estimate (3) inference
(2) hypothesis (4) critical thinking

7 What are the variables that do not change in an experiment called?
(1) independent variables
(2) dependent variables
(3) constants
(4) inferences

8 An educated guess based on what you know and what you observe is called which of the following?
(1) prediction (3) conclusion
(2) hypothesis (4) data

Use the photo below to answer question 9.

9 What type of scientist could the person above be classified as?
(1) life scientist
(2) physical scientist
(3) Earth scientist
(4) medical doctor

Part II

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Use the photo below to answer questions 10 and 11.

10 Look at the photo above and write down your immediate observations.

11 What safety precautions might this student want to take?

12 Explain why science can only provide possible explanations for occurrences in nature.

13 Explain the relationship between science and technology.

14 List the three branches of science and give examples of questions that they ask.

15 You want to know whether plants grow faster if there is music playing in their environment. How would you conduct this experiment? Be sure to identify the independent and dependent variables, and the constants.

16 Many outdoor clothing products are coated in a special waterproofing agent to protect the material from rain and snow. The manufacturers of the waterproofing agent hire independent field-testers to use their product in the field before marketing it to the public. Why would you want to know the results of the field-testers tests?

17 Body systems interact with one another in order to function. What would happen if one system failed?

18 Make a frequency table from the following data. Make two observations about the data. 15 students prefer cold pizza for lunch; 10 students enjoy peanut butter with jelly; 3 students bring ham and cheese; and 5 students eat hot dogs and chips.