1 FOCUS

Objectives

1.1.1 **Explain** how science and technology are related.
1.1.2 **List** the major branches of natural science and **describe** how they overlap.
1.1.3 **Describe** the main ideas of physical science.

Reading Focus

Build Vocabulary

L2

Word-Part Analysis Tell students that many words in science consist of roots to which prefixes and/or suffixes are added. Explain that the root is the key to a word's meaning. Ask students to identify the roots in the vocabulary words and to name other words with the same root. Students may suggest *sci-, conscience; tech-, technique; phys-, physical; geo-, geography; astro-, astronaut;* and *bio-, biography.*

Reading Strategy

L2

a. Earth and space **b.** Life
c. The study of nonliving things
d. The study of Earth and the universe beyond Earth

2 INSTRUCT

Science From Curiosity

Build Science Skills

L2

Predicting Tell students that it can be difficult to prove the existence of something invisible. Place a large candle in a jar and light it. Ask, **What do you predict will happen if the jar is covered? Explain your prediction.** *(The candle will go out once the oxygen in the jar is used up.)* Cover the jar with aluminum foil so students can check their prediction. Ask, **What invisible substances did you assume in your explanation?** *(Oxygen, carbon dioxide)* **Visual, Group**

1.1 What Is Science?

Reading Focus

Key Concepts

- How does the process of science start and end?
- What is the relationship between science and technology?
- What are the branches of natural science?

Vocabulary

- science
- technology
- chemistry
- physics
- geology
- astronomy
- biology

Reading Strategy

Previewing Skim the section to find out what the main branches of natural science are. Copy the concept map below. As you read, complete the concept map based on what you have learned.

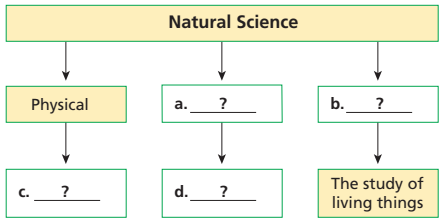
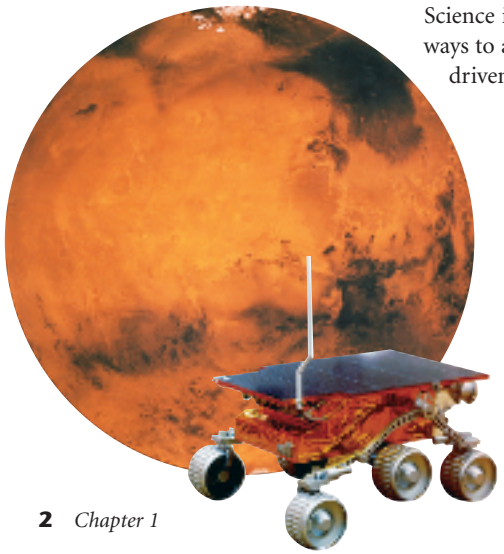


Figure 1 In July 1997, the six-wheeled Sojourner rover became the first robot to explore planet Mars. The next generation of Mars rovers will help scientists further study the planet's geology, geography, and climate.



Suppose you could send a robot to another planet. What kinds of experiments would you program the robot to carry out? Before you programmed the robot, you would need to figure out what information you wanted it to gather. Scientists are currently developing robots, like the one in Figure 1, that they plan to send to Mars. These robots are being designed to examine the atmosphere, rocks, gravity, and magnetic fields of the planet.

Science involves asking questions about nature and then finding ways to answer them. This process doesn't happen by itself—it is driven by the curiosity of scientists.

Science From Curiosity

Throughout history, human beings have had a strong sense of curiosity. Human curiosity led to the use of fire, the building of tools, and the development of languages. Have you ever checked what was living at the bottom of a pond? Taken off the cover of a baseball to see what was inside? Tried putting more chocolate or less in your milk to find out how much would give the best flavor? These are all examples of curiosity, and curiosity is the basis of science.

Section Resources

Print
- ***Reading and Study Workbook With Math Support,*** Section 1.1
- ***Transparencies,*** Chapter Pretest and Section 1.1

Technology
- ***Interactive Textbook,*** Section 1.1
- ***Presentation Pro CD-ROM,*** Section 1.1
- ***Go Online,*** NSTA SciLinks, Motion

Science is a system of knowledge and the methods you use to find that knowledge. Part of the excitement of science is that you never know what you will find. For instance, when you flip over a rock, will you see crawling insects, a snake, or nothing at all? You won't know until you look. **Science begins with curiosity and often ends with discovery.**

Curiosity provides questions but is seldom enough to achieve scientific results. Methods such as observing and measuring provide ways to find the answers. In some experiments, observations are qualitative, or descriptive. In others, they are quantitative, or numerical. Some experiments are impossible to do, such as observing what happened at the start of the universe. Scientists cannot go back in time to observe the creation of the universe. However, they can use the evidence of the universe around them to envision how this event occurred.

Reading Checkpoint *What is science?*

Science and Technology

As scientific knowledge is discovered, it can be applied in ways that improve the lives of people. **Technology** is the use of knowledge to solve practical problems. While the goal of science is to expand knowledge, the goal of technology is to apply that knowledge. Imagine living in the late 1700s, when there were no televisions, cars, antibiotics, or electricity. In a relatively small amount of time, people's lives changed dramatically. Perhaps your grandparents were born at a time when there were no televisions, and your parents were born at a time when there were no personal computers. Technology will have also changed your world dramatically by the time the generation following yours comes along.

Figure 2 illustrates the rapid evolution of the telephone, a technology invented in 1876. Within two years, the first telephone operators were connecting calls by hand. The first coin-operated phones appeared in 1889. By 1927, it was possible to make a phone call from New York to London. World War II saw the development of the first mobile telephones, which paved the way for modern cellular phones. Today, you can communicate by telephone between almost any two places in the world.

Science and technology are interdependent. Advances in one lead to advances in the other. For example, advances in the study of physics led to the invention of the transistor. The use of transistors, in turn, led to advances in various other scientific fields, such as computer science and space science.

Figure 2 Telephones have quickly evolved from cumbersome, expensive machines to practical, cheap tools for communicating. **Classifying** ***How is a telephone an example of both science and technology?***

Customize for Inclusion Students

Learning Disabled

Reinforce the idea that technology plays an important role in the students' daily lives. Ask students to list several things they experience every day that depend on modern technology. Have students share their lists. Discuss each item and technology's role in it. Next, have students describe how modern technology affects them in the classroom. For example, students may mention that calculators and computers help them find and learn new information. Some students may point to the write-on boards that have replaced chalkboards, and other students may point out insulated glass, durable carpeting, an intercom system, or other parts of the classroom building as examples of technology at school. Students may also note that ballpoint pens and other writing instruments make writing much easier and much less messy than the quill pens used before the American Revolution.

Teacher Demo

The Compass L2

Purpose Students observe that a compass needle does not always point north.

Materials compass, magnet, chalk

Procedure Tell students that a compass is an instrument that is used to locate north. Show students where north is on the compass. Move around the room and show students that the compass needle continues to point toward north. Place the chalk near the east edge of the compass and ask students what happens. Replace the chalk with the magnet and show students that the needle has been deflected toward the east or west. Move the compass around the magnet to show that the compass needle continues to point toward or away from the magnet.

Expected Outcome The chalk has no effect on the compass, but the magnet deflects the compass needle toward the magnet. **Visual, Logical**

Science and Technology

Use Visuals L1

Figure 2 Ask students to look at the different phones. Ask, **Do you regularly use a phone with a rotary dial or push buttons?** *(Most students will use a push-button phone.)* **How do you think phones have changed between 1955 and 2003?** *(Push buttons replaced dials, phones became cordless, and cellular phones were invented.)* **What is the difference between cellular and cordless phones?** *(Cordless phones must be close to a base unit. Cellular phones work over a larger area.)* **How have cellular phones increased the area in which phone service is available?** *(Wires are not needed to carry the phone signals, so phone service is available in more places.)* **Visual**

Answer to . . .

Figure 2 *Technology: It is an application of knowledge to solve the problem of long-distance communication. Science: It can be used to demonstrate various areas of study, including the physics of sound and of electricity, and the properties of materials.*

Reading Checkpoint *Science is a system of knowledge and the methods used to find that knowledge.*

Branches of Science

Integrate Biology

L2

The area of science that deals with the connections between biology and physics is biophysics. It is a very broad area that includes biomolecular systems, neural networks, immunology, evolution, and population biology. Each of these components of biophysics, as well as many others, studies how a biological response (from an organism or an ecosystem, for example) is determined by the laws of physics. Encourage students to learn about one of the areas of study within biophysics. Have students make a poster that shows how physics and biology contribute to understanding in that specialty.

Visual, Portfolio

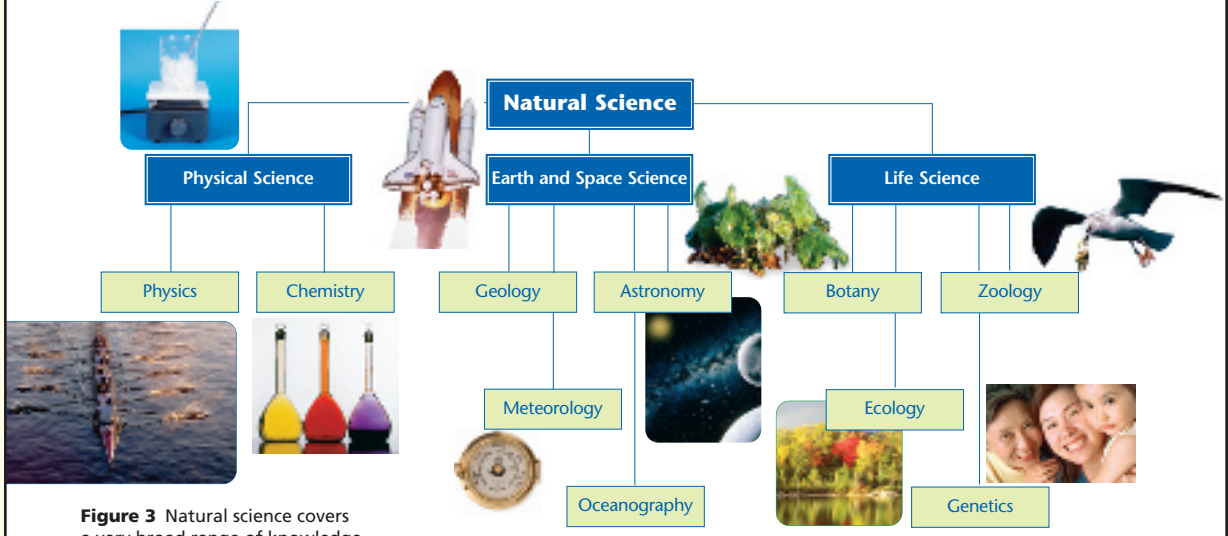


Figure 3 Natural science covers a very broad range of knowledge. **Interpreting Diagrams** *How could you change this diagram to show how the branches of science can overlap?*

Branches of Science

The study of science is divided into social science and natural science. **Natural science is generally divided into three branches: physical science, Earth and space science, and life science.** Each of these branches can be further divided, as shown in Figure 3.

Physical science covers a broad range of study that focuses on nonliving things. The two main areas of physical science are chemistry and physics. **Chemistry** is the study of the composition, structure, properties, and reactions of matter. **Physics** is the study of matter and energy and the interactions between the two through forces and motion.

The application of physics and chemistry to the study of Earth is called Earth science. The foundation of Earth science is **geology,** the study of the origin, history, and structure of Earth. Geology has traditionally focused on the study of Earth's rocks. However, modern Earth science also involves the study of systems that may include living organisms. The foundation of space science is **astronomy,** the study of the universe beyond Earth, including the sun, moon, planets, and stars.

The study of living things is known as **biology,** or life science. Biology is not only the physics and chemistry of living things, but the study of the origin and behavior of living things. Biologists study the different ways that organisms grow, survive, and reproduce.

The problem with subdividing science into different areas is that there is often overlap between them. The boundary around each area of science is not always clear. For instance, much of biology is also chemistry, while much of chemistry is also physics. And a rapidly growing area of physics is biophysics, the application of physics to biology.

Reading Checkpoint *What is physical science?*

Facts and Figures

Technological Advances During the twentieth century, rapid technological changes have occurred in areas other than communications. For example, advances in transportation, especially air travel, dramatically changed society. At the beginning of the century, the Wright brothers flew a propeller-powered airplane 120 feet in 12 seconds.

On October 4, 1957, the Soviet Union launched a basketball-sized satellite called *Sputnik I* into Earth's orbit, making it the first satellite. Another milestone occurred on July 29, 1969, when Neil Armstrong and his crew flew to the moon. Armstrong was the first person to walk on the moon.

The Big Ideas of Physical Science

What are the basic rules of nature? You can read this book to find out. As a sneak preview, some of these rules are summarized here. You can think of them as the big ideas of physical science. Keep in mind that there are also unknown rules of nature that are waiting to be discovered. In fact, you can take part in the search for these unknown laws if you become a scientist. Even though scientists have already discovered a great deal about the universe, there is still much to learn.

Space and Time The universe is both very old and very big. The age of the universe is about 13,700,000,000 (13.7 billion) years. The observable universe is about 700,000,000,000,000,000,000,000,000 (700 million billion billion) meters in diameter. The diameter of Earth is "only" 12,700,000 meters. To get an idea of how big this distance is, the diameter of a giant beach ball is about 1 meter.

Matter and Change A very small amount of the universe is matter. Matter has volume and mass, and on Earth usually takes the form of a solid, liquid, or gas. All matter that you are familiar with, from plants to stars to animals to humans, is made up of building blocks called atoms. Atoms consist of even smaller building blocks called electrons, protons, and neutrons.

Forces and Motion If you push on something that is sitting still, it starts to move. If you push on something that is already moving, you will change its motion. Forces cause changes in motion. As Figure 4 shows, your world is filled with motion and forces. Calculating these forces can sometimes be very challenging. For example, on a NASA mission to Mars, the Mars Exploration Rover must blast off from Earth with enough speed to escape Earth's gravity. The rocket must then travel a great distance through space and land delicately on a planet that is moving very rapidly around the Sun. The laws of physics allow these movements to be calculated exactly so that the NASA robots get to where scientists want them to go.

Go Online NSTA SCILINKS

For: Links on motion
Visit: www.SciLinks.org
Web Code: ccn-0011

Figure 4 The motion of cars on a city street is captured in this time-exposure photograph. Forces govern changes in the motion of each car.

The Big Ideas of Physical Science

Build Reading Literacy

L1

Outline Refer to page **156D** in **Chapter 6**, which provides the guidelines for an outline.

This part of the section provides students with an excellent opportunity to practice outlining skills. The paragraphs are parallel in construction and each one has a subhead. Tell students to write the subheads, leaving room between each one. As students read, they can list details under each subhead.

Visual, Logical

Go Online NSTA SCILINKS

Download a worksheet on motion for students to complete, and find additional teacher support from NSTA SciLinks.

Answer to . . .

Figure 3 *By drawing dotted lines to connect related areas of science, you could show how the branches of science overlap. Another way to illustrate these overlapping relationships would be to reconfigure the branched diagram as a Venn diagram.*

Reading Checkpoint *Physical science is a branch of natural science that focuses on nonliving things. The two main areas of physical science are physics and chemistry.*

Section 1.1 (continued)

Science and Your Perspective

Use Community Resources

L2

Ask a local scientist to talk to your class about how rapidly science changes, including changes so far during the students' lifetimes. **Interpersonal**

Address Misconceptions

L2

Some students may incorrectly think that all the major discoveries in science have been made, and that current scientific work is only filling in details. Point out that science still has many unknowns, including how to cure the common cold and predict the weather with certainty. **Logical, Verbal**

3 ASSESS

Evaluate Understanding

L2

Call on students to name and describe a branch of science. They may describe a main branch or an area shown in Figure 3, or another area.

Reteach

L1

Use Figure 2 to review the relationship between science and technology. Emphasize that over time advances in technology can lead to the use of new materials and the addition of new features to machines like the telephone.

Writing in Science

Possible answers: Students might describe how areas of life science overlap with physical science.

Interactive Textbook If your class subscribes to the Interactive Textbook, use it to review key concepts in Section 1.1.

Figure 5 Panels on a solar car convert energy from the sun into the mechanical energy of its moving parts.

Energy Energy exists in many forms. Moving objects have a kind of energy called kinetic energy. Objects moved against a force have another kind of energy called potential energy. Energy also exists in matter itself. When one form of matter changes into another form, energy is either absorbed or released. Matter itself can also be changed into energy.

Energy can be transferred from one form or object to another, but it can never be destroyed. If you push on a door and it swings open, you transfer energy from yourself to the door. Your cells are using the chemical energy stored in the food you have eaten to supply energy to your muscles, which then transfer energy to the door.

Science and Your Perspective

As you read this book, remember that science is both a process and a body of knowledge. The information in this book represents the best up-to-date models of how the universe works. However, like all models, some of these models will be rejected and replaced in the future. For instance, more moons revolving around Jupiter and Saturn will most likely be discovered as telescopes get better. It is therefore possible that by the time you read this book Saturn will be known to have more than the 30 moons currently identified. Be skeptical. Ask questions. Be aware that the scientific facts of today might change tomorrow. However, believe in the scientific process that has discovered them. And believe that you may be the one who makes the discoveries that will change scientific facts in the future.

Section 1.1 Assessment

Reviewing Concepts

1. How does the scientific process start and end?
2. How are science and technology related?
3. What are the branches of natural science?
4. Explain the advantages and disadvantages of subdividing science into many different areas.
5. Why do scientists seek to discover new laws of the universe?

Critical Thinking

6. **Evaluating** Why does the progress of science require both curiosity and methodology? Explain the role of each in scientific investigations.
7. **Making Judgments** Advances in science do not always immediately lead to advances in technology. Why are such scientific advances still valuable?
8. **Classifying** Is the study of the muscle movements in the human body an example of biology or of physics? Explain.

Writing in Science

Compare and Contrast Paragraph Write a paragraph comparing two branches of science. (*Hint:* Use an example that shows how these branches can overlap.)

Section 1.1 Assessment

1. The scientific process begins with curiosity and often ends with discovery.
2. Science and technology are interdependent. Advances in one lead to advances in the other.
3. Natural science is divided into physical science, Earth and space science, and life science.
4. Dividing science into branches makes it easier to understand such a broad subject. However, dividing science into "strict" branches neglects the fact that different areas of science frequently overlap.
5. Scientists seek to discover new laws of the universe because they are curious and wish to understand how the natural world is governed.
6. Scientific investigations are often initiated by curiosity. For example, an observed event might prompt you to ask a question. To answer that question, however, you need to use a systematic method that can provide evidence such as experimental or observational data.
7. Even if a scientific discovery does not immediately lead to advances in technology, that discovery is still useful because it adds to the overall body of scientific knowledge.
8. Both. Because muscle movements involve motion and forces, they fall under the study of physics. However, because muscle movements are specific to living things, they also fall under the study of biology.