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# Integrated Science

United Arab Emirates Edition

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# Integrated Science

## United Arab Emirates Edition

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"Extensive knowledge and modern science must be acquired. The educational process we see today is in an ongoing and escalating challenge which requires hard work.
We succeeded in entering the third millennium, while we are more confident in ourselves."

**H.H. Sheikh Khalifa Bin Zayed Al Nahyan**
President of the United Arab Emirates

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# Be a Scientist

NATURE OF SCIENCE AND TECHNOLOGY

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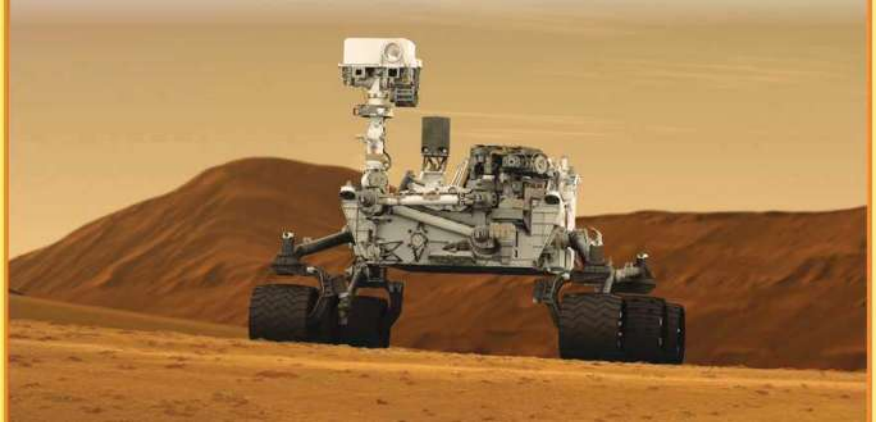

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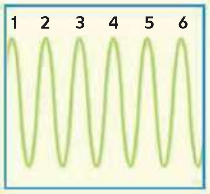
# CHAPTER 8

# Using Energy

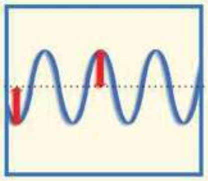
## What form does energy have?

Answers will vary. Accept reasonable responses.

## Vocabulary

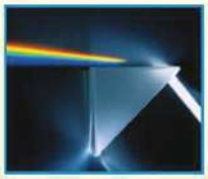


**Pitch** perceptual quality which allows the distinction between high and low frequency sound waves

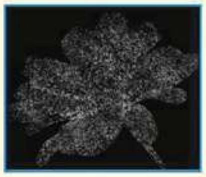


**Volume** the strength or weakness of sound

**sound wave** a series of rarefactions and compressions traveling through a substance



**Prism** a cut piece of clear glass or plastic in the form of a triangle or other geometric shape



**photon** a tiny bundle of energy by which light travels

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*Before reading this chapter, write down what you already know in the first column. In the second column, write down what you want to learn. After you have completed this chapter, write down what you learned in the third column.*

| Using Energy | | |
|---|---|---|
| What We **K**now | What We **W**ant to Know | What We **L**earned |
| There are different types of sounds. Some are high while others are low. | How is sound produced? | Sound travels as longitudinal waves through a medium. |
| Light comes from the Sun, fire, and lightbulbs. | What is light made of? | Light is made of vibrating electric and magnetic energy. |
| | | |

## Lesson 1

# Sound

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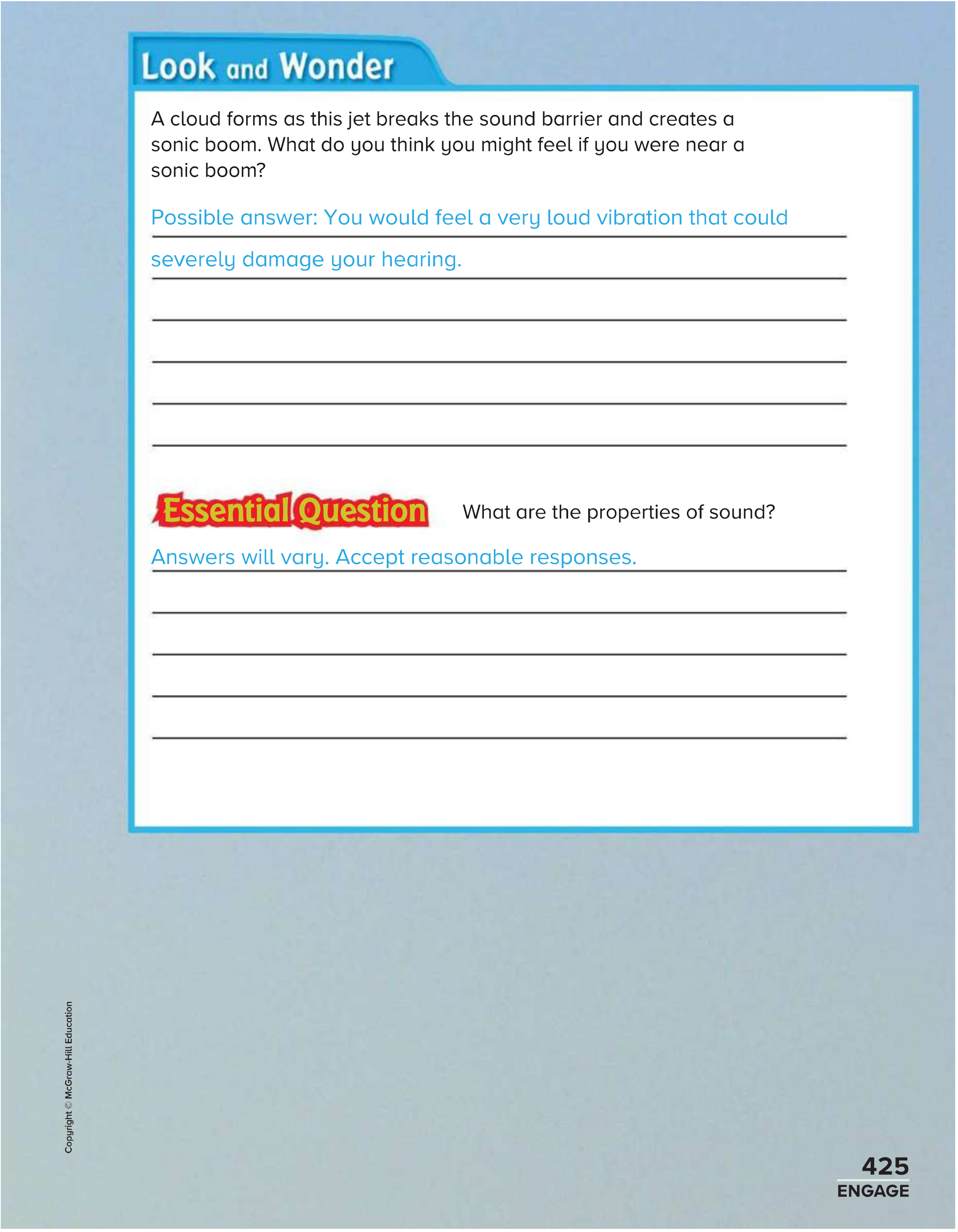

## Look and Wonder

A cloud forms as this jet breaks the sound barrier and creates a sonic boom. What do you think you might feel if you were near a sonic boom?

Possible answer: You would feel a very loud vibration that could severely damage your hearing.

**Essential Question** What are the properties of sound?

Answers will vary. Accept reasonable responses.

# What makes sound?

## Form a Hypothesis

When you pluck the rubber band on the "instrument" shown, it makes sound. How will this sound depend on the way you pluck the rubber band? Write your answer in the form "If the rubber band is plucked with increasing force, then the sound…"

Possible answer: If the rubber band is plucked with increasing force, then the sound will be louder.

**Materials**

- goggles
- paper cup
- toothpick
- rubber band
- wood or plastic ruler
- masking tape

## Test Your Hypothesis

1. ⚠ **Be Careful.** Wear goggles. Make a rubberband "instrument" as shown. Poke a small hole in the bottom of the cup with a toothpick. Tie one end of a cut rubber band to the toothpick. Thread the toothpick through the hole in the cup. Tie the stretched rubber band to the ruler and tape the ruler to the cup.

2. **Observe** Wrap one hand around the cup while you pluck the rubber band. What do you hear and feel? Record your observations.

The instrument makes sound. The cup vibrates.

3. Pluck the rubber band both gently and forcefully. Record how the sound is affected. Repeat your actions to verify your results.

The sound is softer when I pluck the rubber band gently. The sound is louder when I pluck the rubber band harder.

## Draw Conclusions

4 **Interpret Data** Did your observations support your hypothesis? Explain.

Possible answer: Yes, the sound got louder as I plucked the rubber band harder.

5 **Infer** How do you think your rubberband "instrument" made sound? Use your observations from step 2 to help you.

The instrument makes sound by having the vibrations of the rubber band transfer to the cup and move the air around the instrument.

## Explore More

How will stretching the plucked rubber band affect whether the pitch is high or low? Write out your hypothesis. Then carry out experiments to test it.

Possible answer: My hypothesis is that if the rubber band is stretched more, the pitch will be higher. I will stretch the rubber band three different ways: loosely, more tightly, and then very tight. I will listen for the sound it makes. My results show that my hypothesis is right: pitch increases when the rubber is stretched tightest.

## Read and Respond

# How is sound produced?

Have you ever noticed the sound from a low-flying jet rattling the dishes in the kitchen? Perhaps you've noticed something similar when someone plays a stereo system too loudly. What causes objects to shake when there are loud sounds nearby?

When an object makes sound, it vibrates back and forth. The vibrations of a drum alternately squeeze air particles and then spread them out. This creates regions of air that have many particles, called **compressions** (kum•PRE•shunz), and regions of air that have few particles, called **rarefactions** (rer•uh•FAK•shunz). The compressions and rarefactions move through the air, carrying sound energy. Each region of the air is only moved back and forth.

Regions of air that have many particles are called

A. rarefactions
B. vibrations
[✓ C.] compressions
D. energy

**Sound waves vibrate in the same direction that they travel.**

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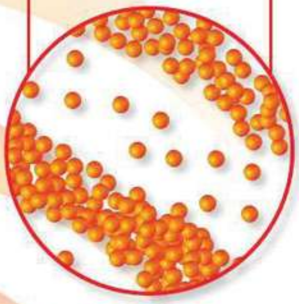
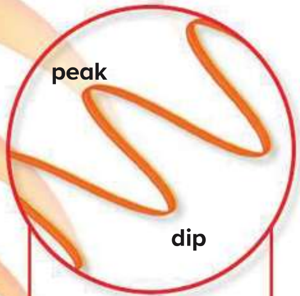
Vibrations caused by the helicopter blades produce loud sound waves.

The density of the air, but not the air itself, moves.





The density of the air can be shown as a series of peaks and dips.

A series of rarefactions and compressions traveling through a substance is called a **sound wave**. The substance through which the wave travels is called the **medium for the wave**. Like all waves, sound waves carry energy. When they pass through a medium, the medium is not permanently moved. Energy, however, is permanently moved from one place to another.

Sound waves vibrate the medium in the same direction that the energy moves. They are called *longitudinal* (lahn•juh•TEWD•nul) *waves*. We can also represent sound waves as a series of peaks and dips. The peaks show the high density of air in compressions. The dips show the low density of air in rarefactions. However, remember that air does not move up and down like the peaks and dips.

When sound waves hit an object, the object starts vibrating. The object is moved by the energy of the wave. This is how sound from a loud airplane or stereo rattles dishes. You can feel the vibrations caused by such loud sounds.

### ✓ *Quick Check*

**1. Describe the density of air in a closed room when music is played.**

Possible answer: As the sound waves pass any point in the room, the density of the air will alternately increase and decrease as compressions and rarefactions pass through.

## How does sound travel?

Sound can travel through solids, liquids, and gases. In fact, sound tends to travel with the greatest speeds in solids and the slowest speeds in gases. For example, sound travels through steel at almost 6,000 m/s. But sound travels through air at only 343 m/s.

These differences in the speed of sound result from how far apart the particles are. The particles carry sounds energy, and their collisions are how sound energy travels. In a solid, the particles are close together so they quickly collide and move sound. In gases, particles are far apart. Collisions are less frequent, so sound travels more slowly.

The temperature of the medium also affects the speed of sound. In warmer air, particles move faster. As a result they collide more often and transmit sound faster.

Can sound travel in an area without any particles? No, sound cannot travel without a medium. For example, outer space has few particles, so there is no medium for sound to travel through. Outer space is a **vacuum** (VA•kyewm), a region that contains few or no particles.

**FACT** Sound cannot travel through outer space.

**Water is a good medium for sounds like dolphin songs.**

## Changing How Sound Travels

Have you ever been in a soundproof room? The walls in these rooms are often covered with a soft, thick, uneven material. When a sound wave hits the material, the energy of the wave is absorbed. Absorption (ub•SORP•shun) is the transfer of energy when a wave disappears into a surface. Absorbed sound waves become thermal energy on that surface.

When sound waves hit a flat, firm surface, much of their energy bounces back. Have you ever heard an echo? **Echoes** are sound waves that have reflected back to the speaker (source). **Reflection** is the bouncing of a wave off a surface. Whenever a sound wave reflects off a surface, some of it is absorbed. This is why echoes are never as loud as the original sound wave.

**The walls of this room are made to absorb sound.**

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### Quick Lab

To learn more about how different mediums transmit sound, do the Quick Lab in the activity workbook.

### Quick Check

1. **A friend says echoes are scary because they sound softer than regular voices. Which part of this statement is fact, and which is opinion?**

That echoes are softer than regular voices is a fact. That they are scary is an opinion.

2. **How would putting your ear to the floor let you hear a sound sooner than you would hear it in the air?**

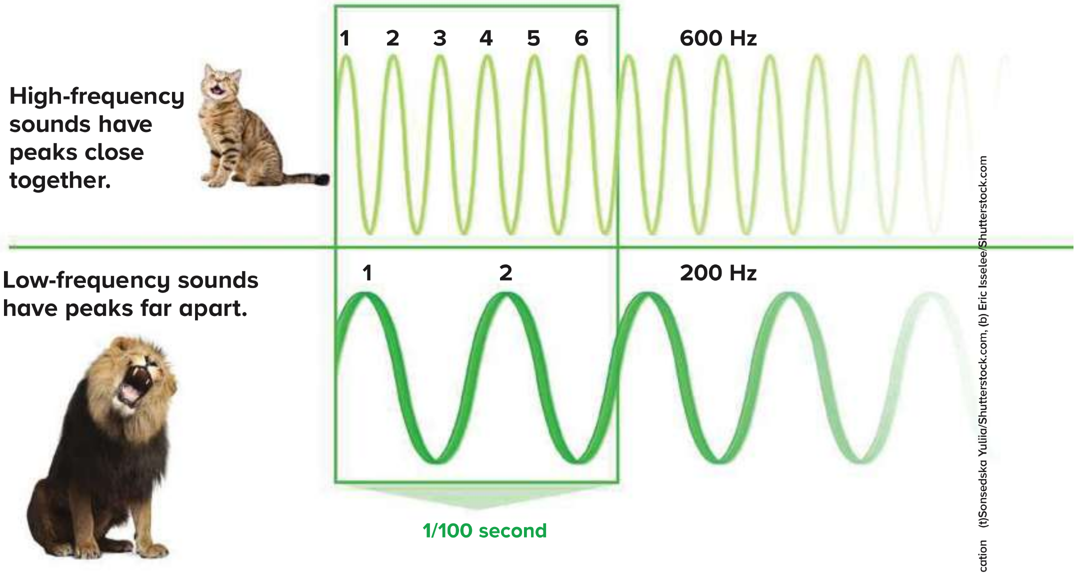
The speed of sound in a solid is generally faster than the speed of sound in air. So, listening through the solid floor may allow you to hear a sound sooner than listening through air.

## What is pitch?

How high can you sing a note? How low can you sing a note? What is changing when you go from singing a high note to a low note? The sound wave that reaches your ears is different. The series of peaks and dips in the wave get closer together as you sing higher notes. **Frequency** (FREE•kwun•see) is the number of times an object vibrates per second. Its units are cycles per second (1/s) or hertz (Hz). High notes have a greater frequency than low notes.

Pitch is the perceptual quality which permits the distinction between a low freuency sound and a high frequency sound. In music, pitch is often given a letter name of "C," "D," "E," "F," "G," "A," or "B." The series repeats itself so that the eighth note is "C" again. A series of eight notes is called an *octave* (OK•tiv).

Pitch and frequency are two different ways to describe sound waves. Pitch is the way our ears perceive frequency. It is closely related to the number of peaks in a sound wave.



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## Doppler Effect

### Read a Photo

**Would this train's whistle sound higher or lower in pitch than normal?**

**Clue:** Is this train moving toward or away from you?

The pitch of the train whistle would sound higher than normal because the train would be moving toward you. This is an example of the Doppler effect.

## Changing Pitch

To make a sound higher in pitch, increase the number of times it vibrates each second. On a string instrument, shortening the string increases pitch. On a wind instrument, shortening the tube increases pitch. A shorter tube produces a higher pitch because the air inside vibrates faster.

You can increase the frequency of a sound wave by moving toward it. Frequency is just the number of peaks of a wave per second. If you move toward a wave, you will hear the peaks quicker than if you were standing still. If you move away from a wave, the peaks arrive at your ear more slowly and the pitch is lower.

A change in frequency due to moving toward or away from a wave is called the *Doppler effect* (DAH•pluhr i•FEKT). Any movement can cause a Doppler effect, but only fast speeds will change a pitch enough to be noticed by you.

**The pitch of a trombone changes with the length of its tubes.**

### ✓ *Quick Check*

3. How do you think you change the pitch of your voice?

You change the pitch of your voice by tightening or relaxing the vocal cords. Tightening raises the pitch of the sound, and relaxing lowers it.

# What is volume?

Pretend you are in a room when someone turns up the volume on a radio too much. Is it easy to hear other noises? What makes a sound so loud?

**Volume** refers to the strength or weakness of sound. If you hit a drum with force, it produces a loud sound or noise, but if you hit it gently, the sound it produces will be lower.

Sound travels in air as a series of compressions and rarefactions. Compressions are represented by peaks while rarefactions are represented by dips.

The **amplitude** (AM•pluh•tewd) is the maximum displacement moved by particles of the medium away from their equilibrium position. The loudness, or volume, of a sound depends on the amplitude of the sound's waves.

Scientists measure the volume of sounds with **decibels (dB)**. Sounds above 85 decibels damage your hearing. Wear earplugs if you are near loud sounds!

## Volume of Sounds

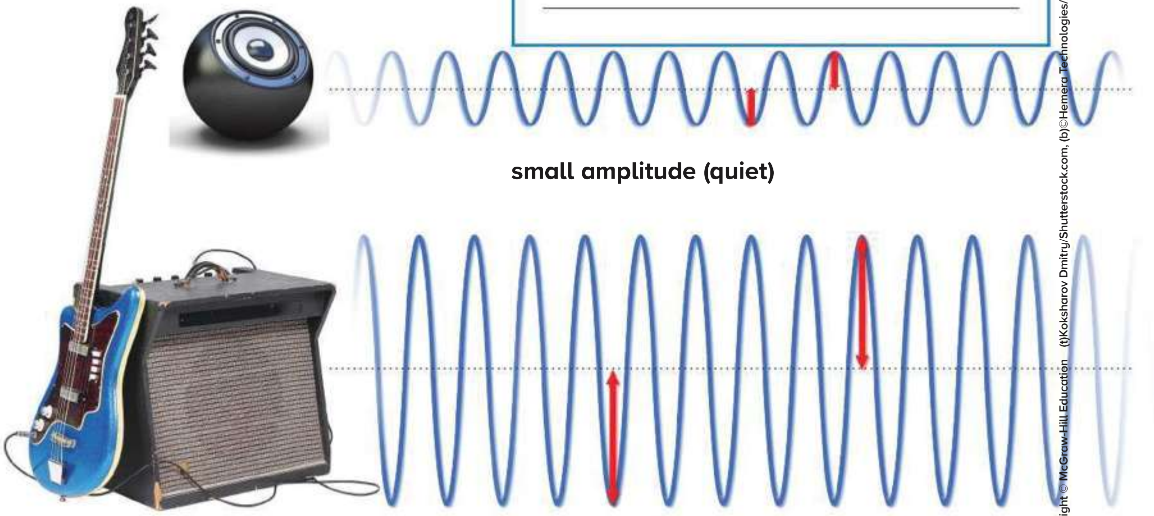
| Decibel Level | Sound |
|---|---|
| 180 dB | rocket engine at 30 m (98 feet) |
| 130 dB | threshold of pain, train horn at 10 m (33 feet) |
| 120 dB | rock concert |
| 110 dB | chainsaw at 1 m (3.3 feet) |
| 100 dB | jackhammer at 2 m (6.6 feet) |
| 85 dB | threshold of damaging hearing |
| 80 dB | vacuum cleaner at 1 m |
| 60 dB | normal conversation |
| 50 dB | rainfall |
| 30 dB | theater (without talking) |
| 10 dB | human breathing at 3 m (10 feet) |
| 0 dB | threshold of human hearing (with healthy ears) |

## Read a Table

**Could the sound from a rocket engine 30 m away cause pain in your ears?**

**Clue:** Compare the volume for the rocket engine and the threshold of pain.

Yes, because the volume of the sound of the rocket engine is 180 dB, and the threshold of pain is 130 dB, which is lower.



**small amplitude (quiet)**

**large amplitude (loud)**

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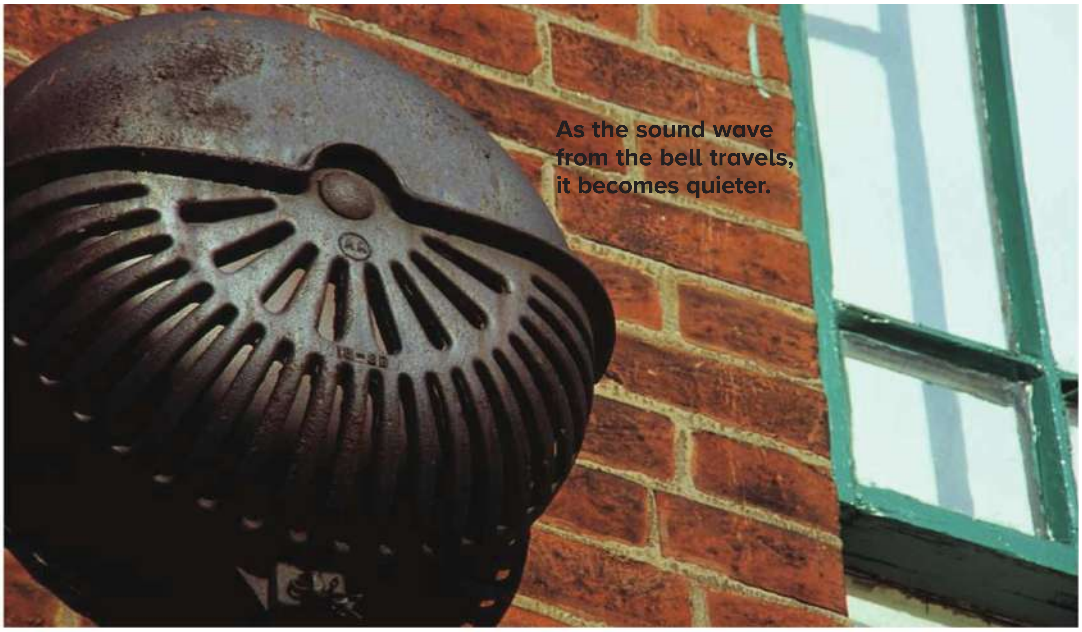


As the sound wave from the bell travels, it becomes quieter.

## Changing Volume

You can make sounds louder by using more energy. For example, you can pluck a string harder, use more air in your voice, or hit a drum with more force. The extra energy increases the density of the particles in the compressions. Also, the rarefactions will be less dense than before.

Changing the medium of a sound wave will also change its amplitude. A wave in a dense material will have a smaller amplitude than in air. The wave, however, will have the same amount of energy. Even though the amplitude is smaller, there are more particles moving in the wave.

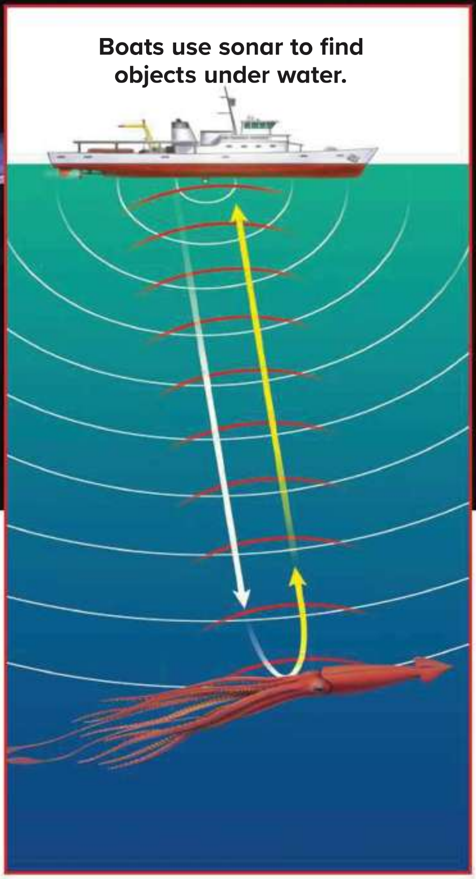
The volume of a sound will be smaller the farther you travel from its origin. Why? Think of ripples in a pond. At their center, the ripples are high, but as they expand outward, they get smaller. The same amount of energy in the wave is being spread out over an increasingly larger area. As you move away from the origin of a sound, the energy in the wave at any point gets smaller. Less energy means less volume, and you hear the difference.

✓ ***Quick Check***

**4. You hear the sound of a drum as 45 dB, then 55 dB, then 65 dB. How might this be happening?**

Possible answers: The drum might be beating harder to produce louder sound waves; the drum might be moving toward you.

Bats use echoed sound to locate insects.



Boats use sonar to find objects under water.

## What is echolocation?

Echoes can be useful. Bats, for example, make sounds that echo off of their prey. The returning echoes tell the bat where the prey is located. Finding food or other objects in this manner is known as **echolocation**. Whales and dolphins also use echolocation to orient themselves and to find food.

Scientists have developed a system called *sonar* that works like echolocation does for animals. Sonar stands for "sound navigation and ranging." It is used under water to find objects. The sonar system sends out sound waves that reflect off of objects. It then detects the reflected sound waves. The return time and direction of the sonar echoes are used to calculate the location of the object.

✓ ***Quick Check***

5. Could sonar work on land? Why or why not?

Possible answers: Sound waves travel through land as well as water, so sonar could work on land. Ultrasound, which uses technology similar to sonar, is used in medicine.

## My Notes

## Visual Summary

Complete the lesson summary in your own words.

**Vibrations** Possible answer: Vibrating objects produce sound waves in a medium.

**Sound Waves** Possible answer: Sound waves may be transmitted, absorbed, or reflected by materials or objects

**Pitch** Possible answer: As the frequency of a sound wave increases, the pitch becomes higher.

## Think, Talk, and Write

① **Vocabulary** The substance through which a wave travels is called a(n) medium.

② **Fact and Opinion** Should you wear earplugs while using a vacuum cleaner? Support your opinion with facts.

| Fact | Opinion |
|---|---|
| The sound of a vacuum cleaner is not loud enough to damage your ears. | Earplugs are not necessary when using a vacuum cleaner. |

③ **Critical Thinking** Is there more energy in a 30 dB or 40 dB sound wave? Why?

There is more energy in the 40 dB sound wave because decibels measure the volume of a sound wave and the louder a sound wave is, the more energy it has.

④ **Test Prep** **At what volume do sounds start damaging hearing?**

**A** 10 decibels
[✓ **C**] 85 decibels
B 65 decibels
**D** 150 decibels

⑤ **Test Prep** **An echo is an example of a sound wave being**

**A** transmitted.
[✓ **C**] reflected.
**B** absorbed.
**D** surfed.

**Essential Question** What are the properties of sound?

A sound wave is a series of rarefactions and compressions traveling through a medium. Pitch is the perceptual quality which permits the distinction between a low freuency sound and a high frequency sound. The volume of sound depends on the amplitude of the sound's waves.

# Be a Scientist

## Materials

scissors

10 straws

ruler

masking tape

**Structured Inquiry**

## How can you change a sound?

### Form a Hypothesis

Increasing or decreasing the number of vibrations per second changes the pitch of a sound. For example, the highest notes on a guitar are played when the strings vibrate the fastest. For instruments that have tubes, the length of each tube determines how quickly air inside it vibrates.

How does the length of a tube affect the pitch of sounds it makes? Write your answer as a hypothesis in the form "If the tube of a wind instrument is shortened, then the pitch… "

Possible hypothesis: If the tube of a wind instrument is shortened, then the pitch will get higher.

### Test Your Hypothesis

1. **Make a Model** Use scissors to cut a straw to a length of 15 centimeters.
2. Cut the next straw to be 1 cm shorter than the last one. Repeat this procedure until all of the straws are cut. The last straw should be 6 cm long.
3. Lay the straws on the table in order of size. Place a piece of tape over all the straws.

④ **Experiment** Hold the instrument to your mouth, and blow across the straws to create sound.

Step ④

## Draw Conclusions

⑤ **Observe** What do the shortest and longest pipes sound like? Did your results support your hypothesis? Why or why not?

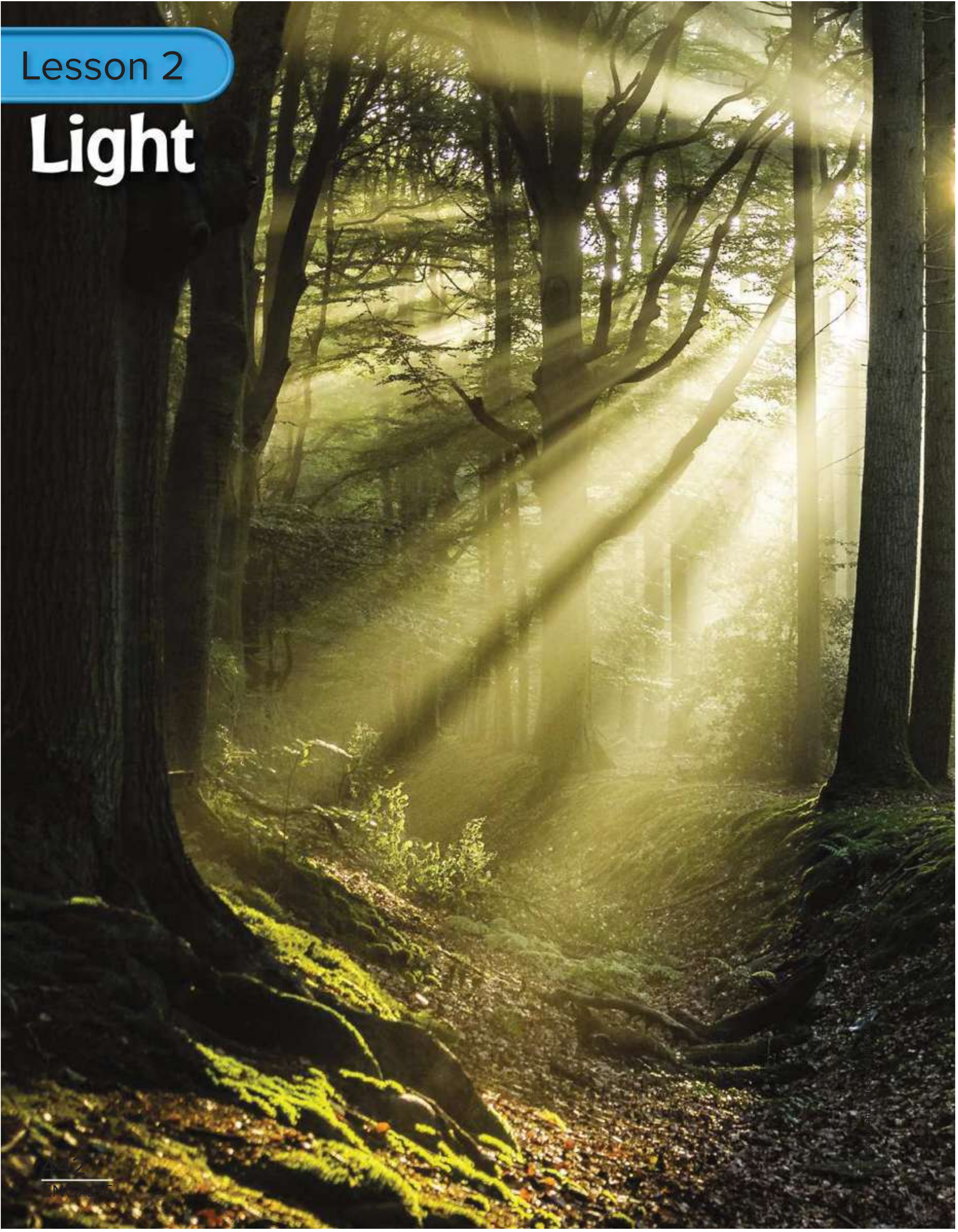
The shortest pipe has the highest pitch, the longest pipe has the lowest pitch.

⑥ **Infer** Would the 12 cm straw sound identical to the 6 cm straw if it was cut in half? Why or why not?

The straws should sound the same because they're now the same size and shape.

Lesson 2

# Light



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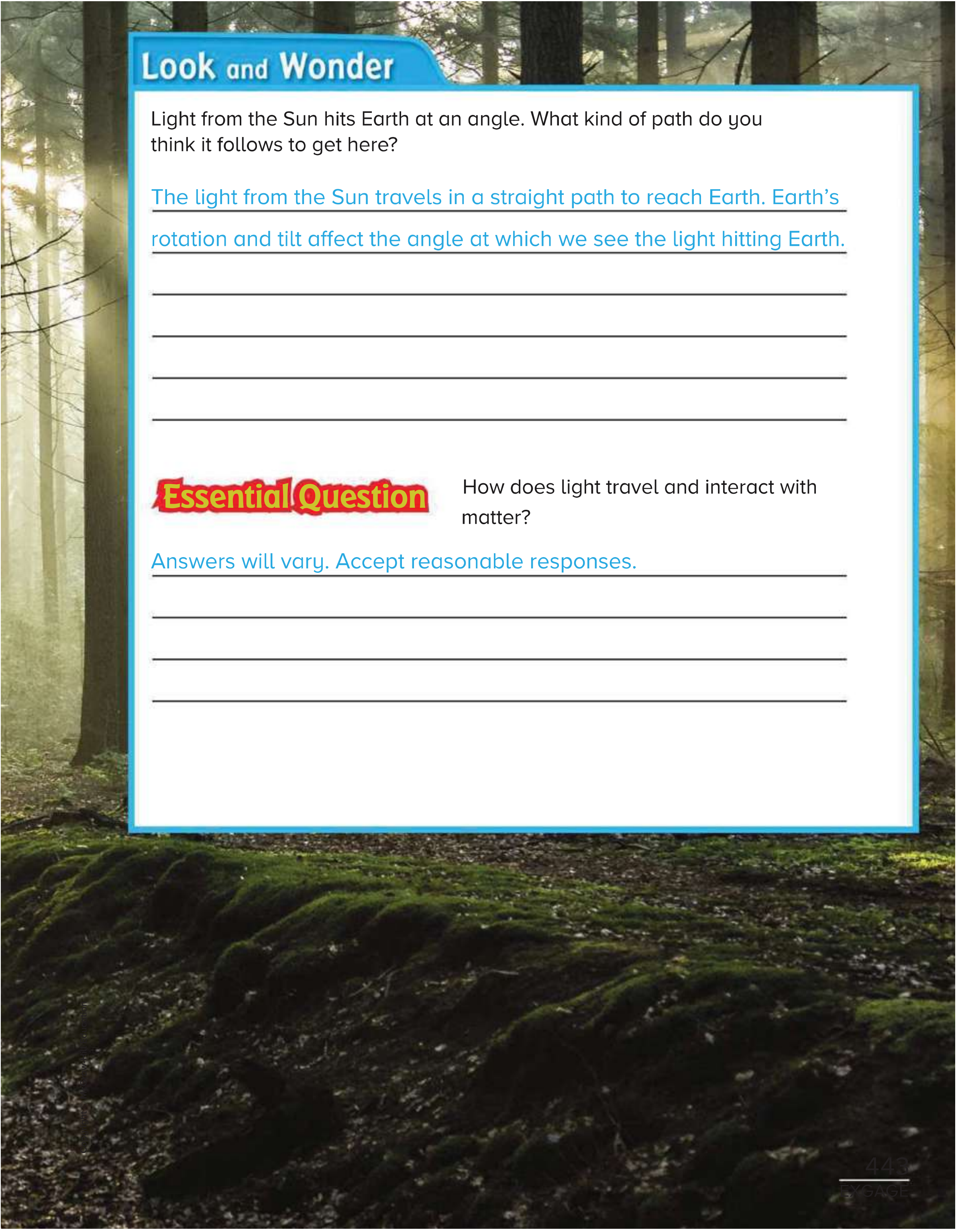


## Look and Wonder

Light from the Sun hits Earth at an angle. What kind of path do you think it follows to get here?

The light from the Sun travels in a straight path to reach Earth. Earth's rotation and tilt affect the angle at which we see the light hitting Earth.

**Essential Question** How does light travel and interact with matter?

Answers will vary. Accept reasonable responses.

## What path does the light follow?

### Form a Hypothesis

When you look in a mirror, you see light that travels to the mirror, bounces off, and travels to your eye. How does the angle of the light hitting the mirror compare to the angle of the light bouncing to your eye? Write your answer in the form "If the angle at which light strikes a mirror decreases, then..."

Possible hypothesis: If the angle at which light strikes a mirror decreases, then the angle of the light bouncing to your eye will also decrease.

### Test Your Hypothesis

① Using two pieces of tape, form a large letter T. Place the mirror upright at the top of the T. Stick each pencil, point down, into an eraser so that they can stand up on their own.

② Experiment Place a pencil on the left side of the T. Place your head on the right side. Move your head until the pencil appears to be in the center of the mirror at the top of the T. Now place the second pencil so that it completely blocks your view of the first pencil in the mirror.

**Materials**

- masking tape
- flat mirror
- 2 pencils
- 2 erasers
- protractor

Step ①

Step ②

## Draw Conclusions

3. **Measure** Move the mirror and place a protractor at the top of the T. Find the angle between the top left of the T and the first pencil. This is your independent variable. Find the angle between the top right of the T and the second pencil. This is your dependent variable.

4. Repeat steps 2 and 3 three more times, moving the first pencil farther from the T each time.

5. **Interpret Data** Look at the angles you measured. Did your data support your hypothesis? Why or why not?

   The angle between each pencil and the surface of the mirror was the same.

   The hypothesis was correct.

## Explore More

What would happen if one pencil was close to the mirror while another was far away? Would the angles change? Write a hypothesis and carry out an experiment to test it.

Possible hypothesis: The angles will not change if you change the distance to the mirror. Experiments will vary: check for clarity of procedure.

# Read and Respond

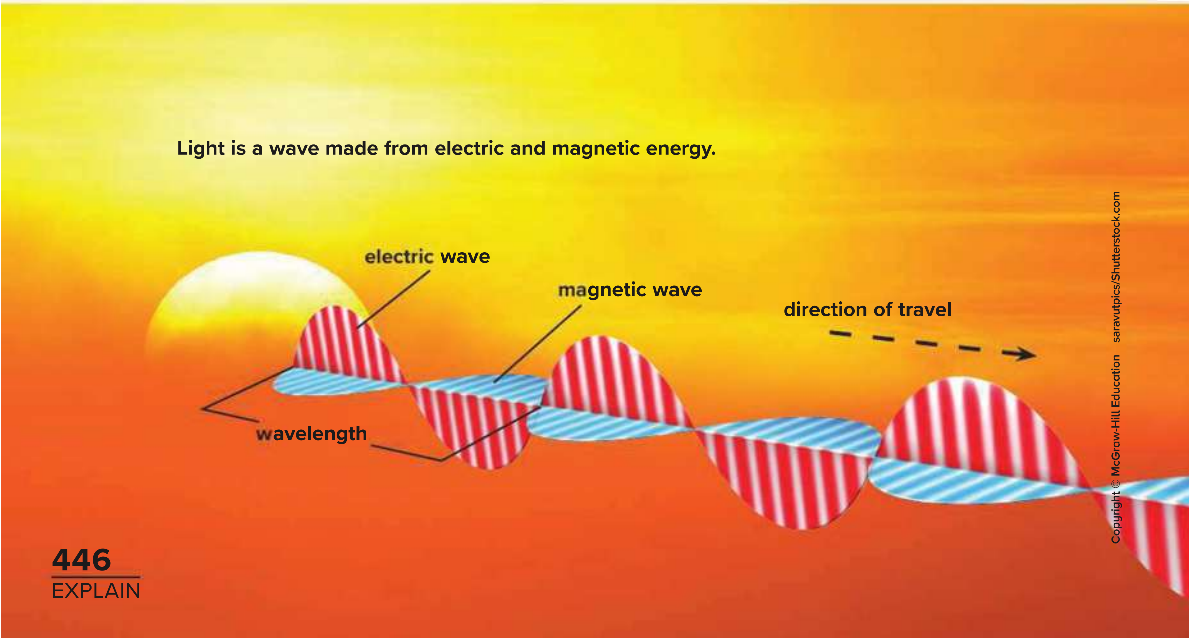
## Where do Light waves come from?

Light from the Sun travels to Earth (about 150 million km) in only $8\frac{1}{3}$ minutes! Light is made of vibrating electric and magnetic energy. This energy travels as a wave—it has both frequency and amplitude, and is called an electromagnetic wave. Light waves vibrate in the direction perpendicular to the direction of their motion.

In fact, light waves can travel with or without a medium. In a vacuum, light travels very fast—about 300,000 km/s. Light travels slightly slower through transparent mediums like air, water, or glass. In glass, for example, light travels about 197,000 km/s. The speed of light is so fast that some scientists think nothing travels faster.

Wavelength (WAYV•length) is the distance between one peak and the next in a wave. When you multiply the wavelength of a wave by its frequency, you get the speed of that wave.

Draw a circle around the word that is used to describe the distance between one peak and the next wave.



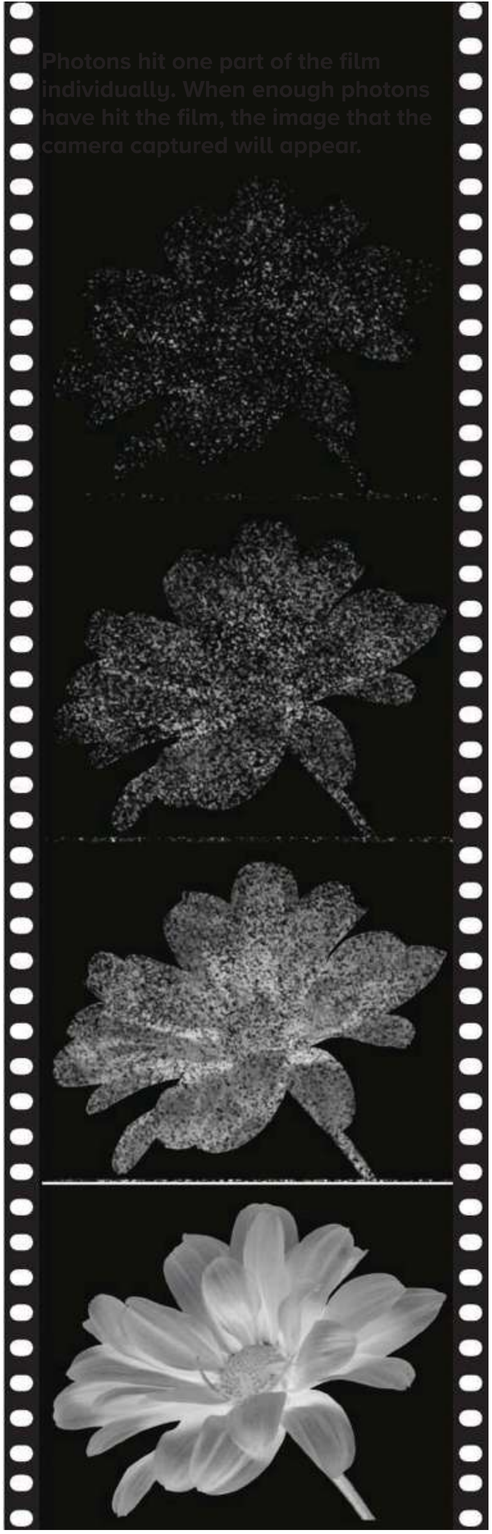
Light is a wave made from electric and magnetic energy.

## Light Is Also a Particle

Although light is a wave of energy, it is also a particle. How can something be both a wave and a particle? Scientists were confused about this question for a very long time. They performed many experiments and found that light has properties of bothwaves and particles, so they concluded it was both.

Light is like a particle in several ways. It travels in straight lines called light rays. Light does not have mass like a particle, but it does have momentum like a particle. Another way that light acts as a particle can be seen in camera film. When light hits camera film, it produces little dots. Over time, those dots will eventually form the original image.

Particles of light are called **photons** (FOH•tahnz). A photon is a tiny bundle of energy by which light travels. The energy of a single photon is very small: a photon of red light has only about 0.0000000000000000003 J of energy! Each photon also acts like a wave with a frequency. If a photon has a higher frequency, it also has more energy.



Photons hit one part of the film individually. When enough photons have hit the film, the image that the camera captured will appear.

***Quick Check***

1. What properties of particles does light have?

It travels in a straight line, it has momentum, and it hits objects.

## How does light make shadows?

When light strikes an object's surface, photons bounce off at random angles. This is called *scattering* (SKA•tuh•ring) light. We see objects because light has scattered off them and entered our eyes.

Sometimes when light hits an object, a photon is absorbed. These objects gain energy. The light that is absorbed is usually transformed into heat energy. Darker objects absorb more light than lighter objects.

Light may also pass through objects. Objects that allow most light through are called ***transparent*** (trans•PER•unt). Objects that blur light as it passes through are called **translucent** (trans•LEW•sunt). If an object allows little to no light through, it is called ***opaque*** (oh•PAYK).

Whether an object is opaque, translucent, or transparent depends on its material, its thickness, and the color of the light. Thicker objects have more particles to absorb photons, so they are more likely to be opaque. Someobjects will be opaque, transparent, or translucent in only one color of light.

Opaque and translucent objects block light. The area behind these objects is darker—they have a shadow.Shadows are the absence of light.

**Opaque objects let little to no light pass through.**

**Translucent objects blur light that passes through.**

**Transparent objects allow almost all light through.**

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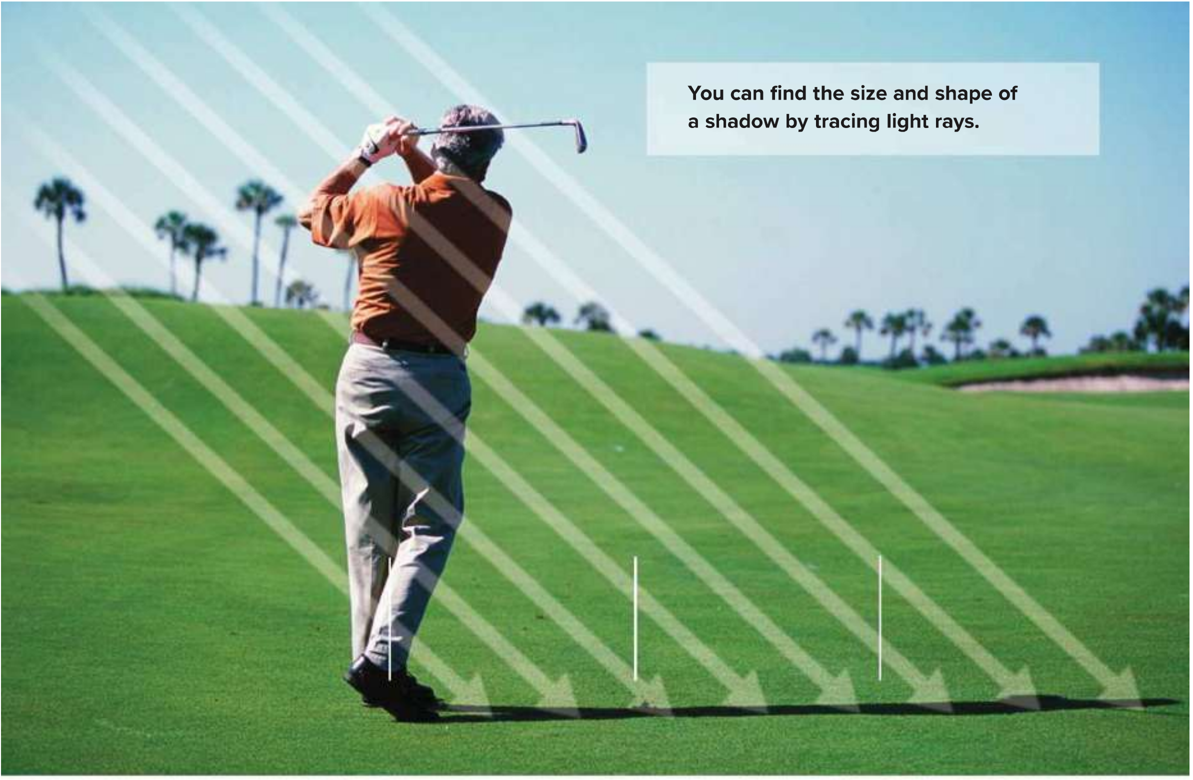

You can find the size and shape of a shadow by tracing light rays.

When an object is between a light source and another object, it will cast a shadow on the other object. Light sources can be natural, such as the Sun, or artificial, such as a flashlight.

You cast shadows on the ground when the Sun shines. Have you ever seen how long your shadow is at sunrise? The Sun is low in the sky. Light from the Sun travels toward you at a small angle. At this angle, there is a long distance before the sunlight hits the ground behind you. As the Sun rises, the angle of the sunlightincreases. This shortens your shadow.

Shadows depends on the angle and the distance between a light source and an object, and between the object and the place where the shadow is cast. Drawing light rays helps you trace the outline of a shadow. The closer a light source is to an object, the larger theshadow an object will cast.

***Quick Check***

2. What are the ways in which light interacts with matter?

It can scatter; it can be absorbed

(opaque); it can be allowed

through partially (translucent) or

almost completely (transparent).

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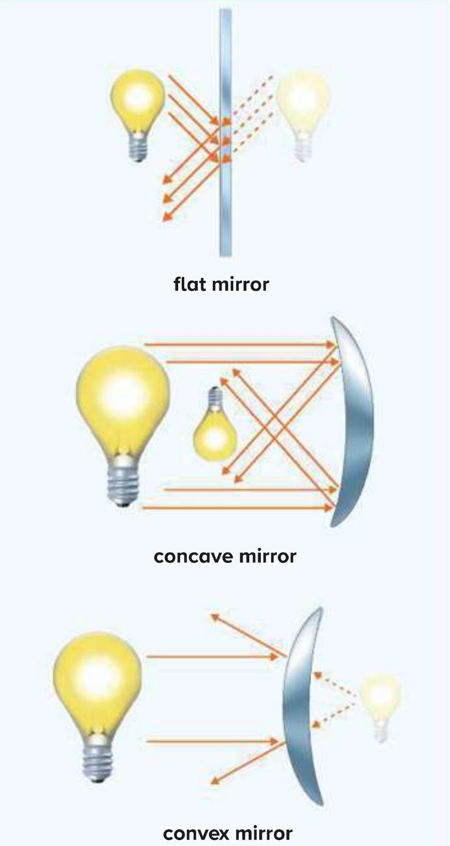
## How does light bounce and bend?

When you look into a mirror, you see an image. An **image** is a “picture” of the light source that light makes when it bounces off a shiny surface. Light reflects off a mirror the way sound echoes off a cliff. The image in a mirror is clear because most of the light wave reflects the same way off the mirror’s smooth surface. Reflection is the organized scattering of a wave.

When light hits a mirror, it obeys the *law of reflection:* the angle of an incoming light ray equals the angle of the reflected light ray. An image in a flat mirror appears to be behind the mirror. The distance to the image is equal to the distance the light traveled from the object to the mirror.

**This girl’s image was enlarged and reversed by using a convex mirror.**



**Reflected images may appear behind the mirror (faded bulbs) or be projected in front of the mirror (bright bulbs).**

Mirrors can also be made with curved surfaces. If they curve in, they are *concave* (kahn•KAYV). If they curve out, they are *convex* (kahn•VEKS). Curved mirrors can form many kinds of images. They may be upright or upside down. They may also be enlarged or reduced. Convex mirrors always produce images that are upright and reduced.

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## Overlapping Colors

Whether an object scatters, absorbs, or transmits light may depend on the wavelength of the light. When light hits an opaque object, it is scattered or absorbed. Opaque objects appear the color of light that they scatter. They absorb all other colors of light.

When light hits a translucent object, some colors are absorbed and others pass through. Translucent objects appear the color of the light that passes through them. They absorb all other colors of light.

The picture on a color television is made of red, green, and blue dots of light. Why are these colors used? Any color of light can be created by mixing red, green, and blue light in the right amounts.

When equal parts of red, green, and blue light rays are mixed, they form white light.

When equal parts of magenta, cyan, and yellow materials are mixed, they absorb all light and appear black.

**Quick Lab**

To learn more about how colors of light mix to form white light, do the Quick Lab in the activity workbook.

For this reason, red, green, and blue are called the primary colors of light. If mixed equally, red, green, and blue light produce white light.

Magenta, cyan, and yellow are often used to create color by scattering. For example, you may want part of a picture to look blue when white light strikes it. You could mix equal amounts of magenta and cyan paint. Magenta scatters only red and blue. Cyan scatters only blue and green. When the two are mixed, magenta absorbs cyan's green, and cyan absorbs magenta's red. Together they only scatter blue.

✓ ***Quick Check***

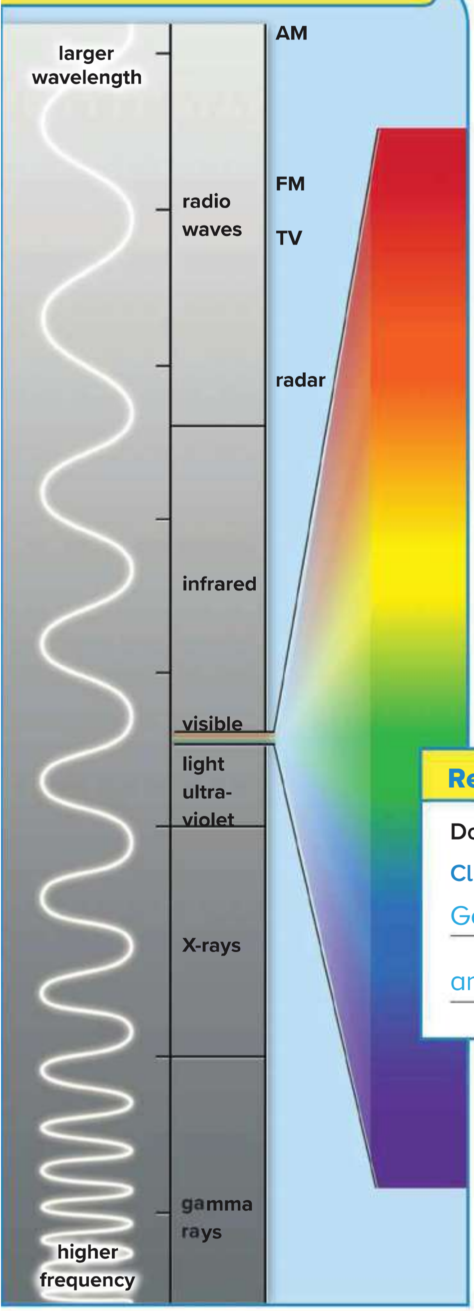
**4. What colors are made by mixing red, green, and blue light two at a time in equal amounts?**

magenta (red and blue), cyan (blue and green), and yellow (green and red)

**5. What would happen if you shone yellow light on a blue opaque object?**

Blue opaque objects only scatter blue light. Yellow light has no blue light in it, so the blue object would not scatter any light and would appear black or very dark.

## Electromagnetic Spectrum



## Is all light visible?

The way in which electric and magnetic forces interact is called **electromagnetism** (i•lek•troh•MAG•nuh•ti•zum). You know that light is made of electric and magnetic waves that can move through space. Light is just a form of electromagnetic radiation.

Scientists know of many forms of electromagnetic radiation besides visible light. All travel at the speed of light and can move through a vacuum. They differ, however, in wavelength and energy. Together, they make up the electromagnetic spectrum.

What single source can produce all forms of electromagnetic radiation? If you said the Sun, you're right! Most of the radiation from the Sun is infrared, visible, and ultraviolet light. Solar flares, however, give off all forms of electromagnetic radiation when they erupt.

### Read a Diagram

**Do radio or gamma-ray photons have more energy?**

Clue: **Higher frequency photons have more energy.**

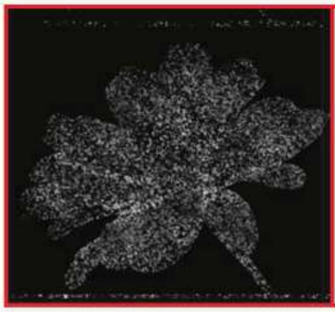
Gamma-ray photons have a higher frequency

and more energy.

## My Notes

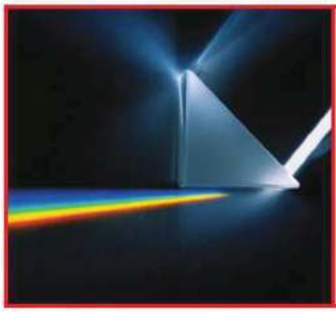
## Visual Summary

Complete the lesson summary in your own words.



**Photons** Possible answer: Light travels as electromagnetic waves, but it can also be thought of as particles called photons.

**Light Reflection and Refraction** Possible answer: Light reflects off of surfaces and refracts when entering a new material.

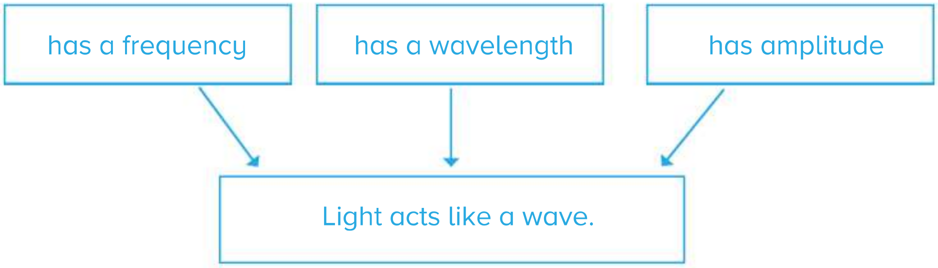


**Color of Light** Possible answer: The color of light depends on its wavelength.

## Think, Talk, and Write

① **Vocabulary** A material or an object that blocks light completely is opaque.

② **Summarize** How does light act like a wave?



③ **Critical Thinking** How does light change when it enters a new medium?

Possible answer: It changes speed and direction.

④ **Test Prep** **The law of reflection states that incoming and outgoing angles are**

[✓ **A**] always the same.

**B** never the same.

**C** always large.

**D** always small.

⑤ **Test Prep** **Which kind of light has a wavelength shorter than green light?**

**A** red light

**B** radio waves

[✓ **C**] X-rays

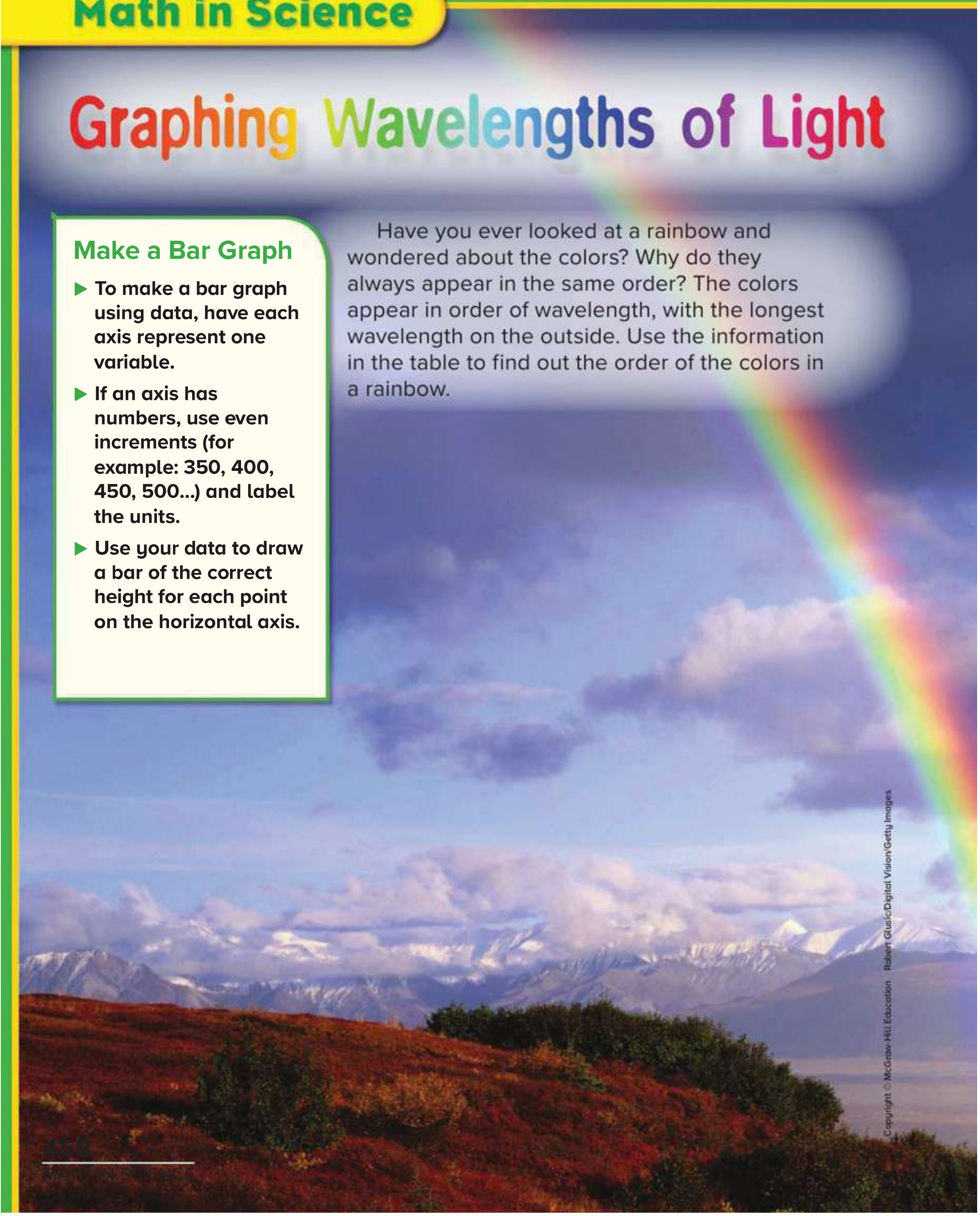
**D** yellow light

**Essential Question** How are nutrients cycled through ecosystems?

Light travels as a wave in a straight line. It interacts with matter as a particle. As a particle, light has momentum and can hit matter.

## Math in Science

# Graphing Wavelengths of Light



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### Make a Bar Graph

- **To make a bar graph using data, have each axis represent one variable.**
- **If an axis has numbers, use even increments (for example: 350, 400, 450, 500...) and label the units.**
- **Use your data to draw a bar of the correct height for each point on the horizontal axis.**

Have you ever looked at a rainbow and wondered about the colors? Why do they always appear in the same order? The colors appear in order of wavelength, with the longest wavelength on the outside. Use the information in the table to find out the order of the colors in a rainbow.

## Solve It

**1.** Which color has the longest wavelength? What is it?

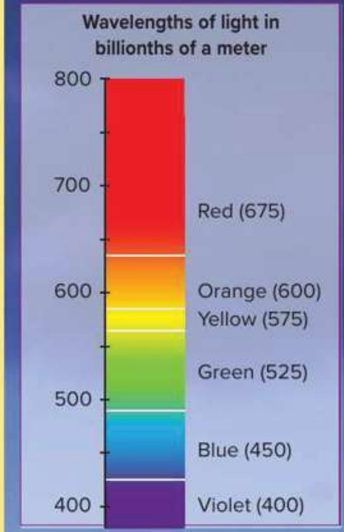
red; 675 billionths of a meter

**2.** What is the difference in wavelength between yellow and orange light?

25 billionths of a meter difference

**3.** Make a bar graph using the colors and wavelengths listed in the chart.

Check students' bar graphs for accuracy.



# CHAPTER 8 Review

## Visual Summary

Summarize each lesson in your own words

**Lesson 1** Sounds are produced by vibrating objects.

**Lesson 2** Light travels as waves, but it can also be described as particles.

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## Vocabulary

**Fill each blank with the best term from the list.**

amplitude
doppler effect
decibel
transparent objects
spectrum

photon
pitch
refraction
wavelength
opaque objects

**1.** A tiny bundle of energy by which light travels is called a(n) photon.

**2.** Change in frequency due to moving towards or away from a wave is called doupler effect .

**3.** Perceptual quality which permits distinction between high and low frequency sounds pitch.

**4.** The unit used for measuring loudness is decibel.

**5.** Objects that allow no light to pass through are opaque objects.

**6.** The band of color in a rainbow, or from light passing through a prism, is called a spectrum.

**7.** The maximum displacement of medium particles away from their equilibrium position is called amplitude .

**8.** The bending of waves as they pass from one substance to another is called refraction.

**9.** Objects that allow most light through transparent objects.

**10.** Distance between one peak and the next in a wave is wavelength.

# CHAPTER 8 Review

## Skills and Concepts

**11.** **Summarize** How are the colors created in the rainbow below?

When it rains, droplets of water refract white light in the sky. The colors contained in white light separate into a spectrum, or rainbow.

**12.** **True or False** *Lenses in eyeglasses use reflection to make objects appear in focus.* **Is this statement true or false? Explain.**

False. As light passes through a lens, it is bent. This is refraction, not reflection.

**13.** **Expository Writing** Write a paragraph explaining how echolocation works and provide an example.

Echoes are sound waves that are bounced back to a speaker. Some animals use echoes to orient themselves or to find food.

The Big Idea

**14.** What form does energy have?

Its forms include sound and light.

# Test Preparation

**1.** The original sound is louder than its echo because some of the energy from the original sound wave is

**A** reflected.
B compressed.
C amplified.
[✓ **D**] absorbed.

**2.** Unlike sound waves, light waves can travel through a

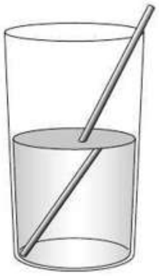
[✓ **A**] vacuum.
B liquid.
C solid.
**D** gas.

**3.** Which unit is used to measure the volume of sound?

**A** hertz (Hz)
B ohm (Ω)
[✓ C] decibel (dB)
**D** ampere (A)

**4.** Which process causes the straw below to appear broken?

**A** reflection
B absorption
[✓ C] refraction
**D** electromagnetism



**5.** Visible light and Gamma rays are two different types of electromagnetic rays. What common characteristics do these two forms of rays have?

**A** They have the same wavelength.
B They have the same frequency.
**C** They have the same color.
[✓ **D**] They travel at the same speed.

# My Notes

# CHAPTER 9

# Minerals, Rocks, and Soil

## What are minerals, rocks, and soil?

Answers will vary. Accept reasonable responses.

## Vocabulary

**mineral** a solid material of Earth's crust with a distinct composition

**streak** the color of a mineral's powder

**hardness** a property measured by observing how easily an object is scratched or how easily the object scratches something else

**cleavage** a property described by a mineral's tendency to break along flat surfaces

**rock** a solid object made naturally in Earth's crust that contains one or more minerals

**soil** a mixture of bits of rock and bits of once-living things

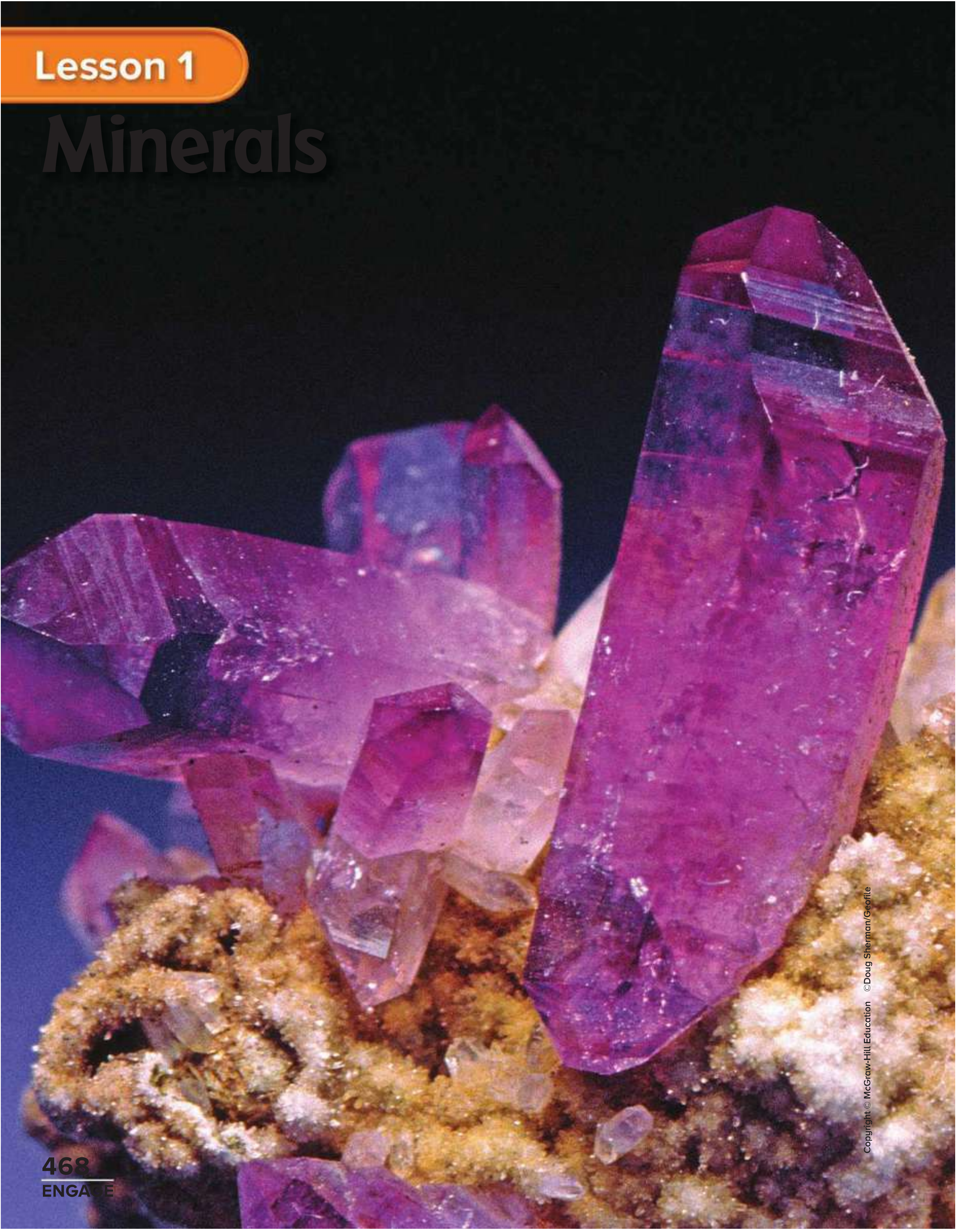
Before reading this chapter, write down what you already know in the first column. In the second column, write down what you want to learn. After you have completed this chapter, write down what you learned in the third column.

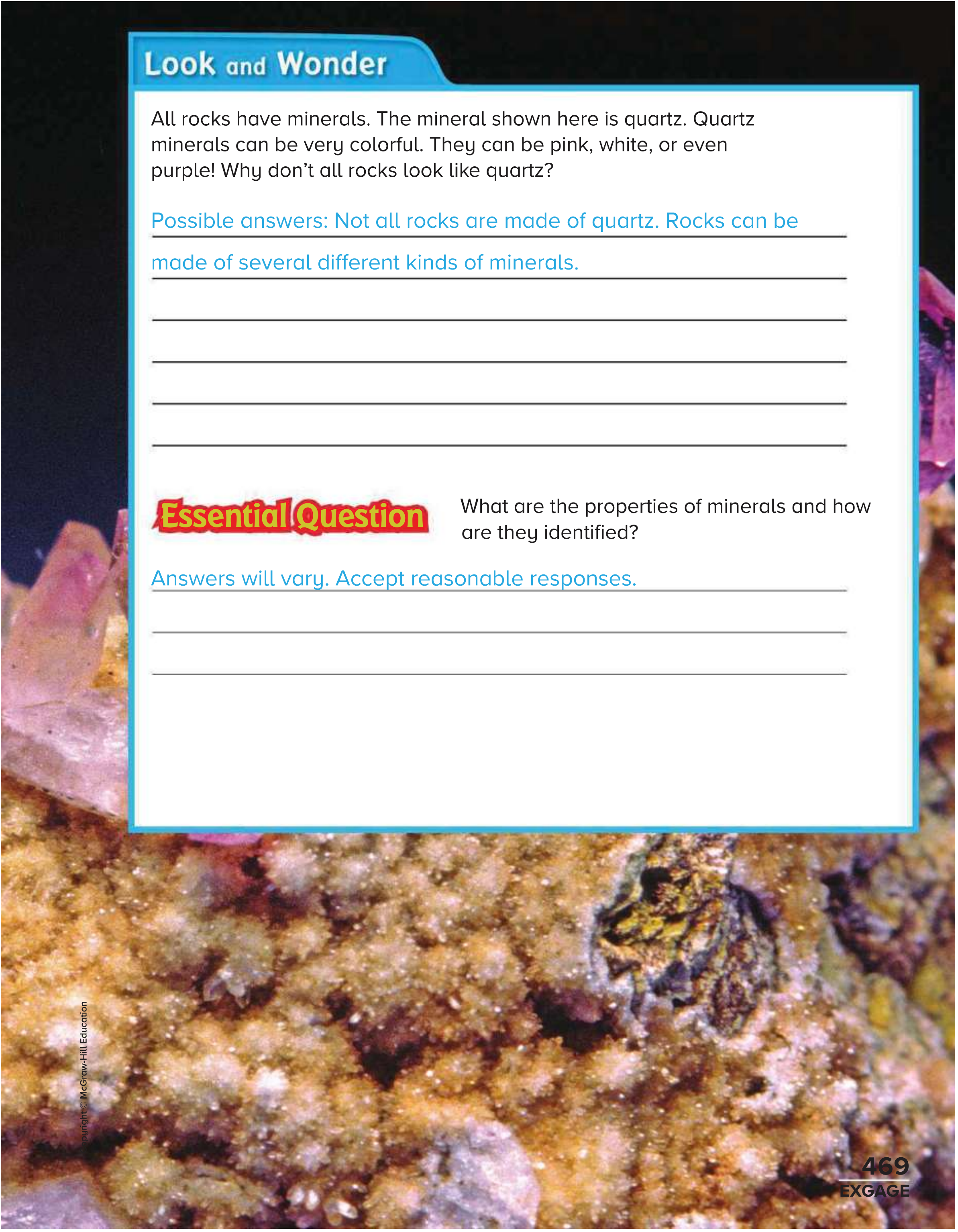
## Minerals, Rocks, and Soil

| What We Know | What We Want to Know | What We Learned |
|---|---|---|
| Rocks can be divided into three main types. | How are the kinds of rock different from one another? | |
| Farmers have to protect their soil from erosion. | | |
| Rocks are made up of minerals. | | |

## Lesson 1

# Minerals





## Look and Wonder

All rocks have minerals. The mineral shown here is quartz. Quartz minerals can be very colorful. They can be pink, white, or even purple! Why don't all rocks look like quartz?

Possible answers: Not all rocks are made of quartz. Rocks can be made of several different kinds of minerals.

**Essential Question** What are the properties of minerals and how are they identified?

Answers will vary. Accept reasonable responses.

## What are properties of minerals?

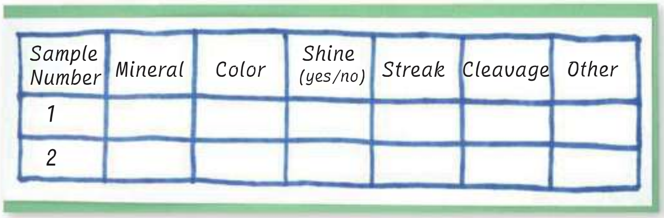
### Purpose

Observe the properties of minerals.

### Procedure

1. Use the clear tape and the marker to label each mineral with a different sample number.

2. Examine the chart below or make one on another sheet of paper.



| Sample Number | Mineral | Color | Shine (yes/no) | Streak | Cleavage | Other |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |

3. Fill in the columns of the chart for *Color* and *Shine*.

4. **Observe** Rub the mineral across the porcelain tile. Record the color that you see on the tile under *Streak*.

5. ⚠ **Be Careful.** Scratch the mineral on a copper coin and a steel file. Record whether the mineral scratches the coin or the file.

**Materials**

- clear tape
- marker
- mineral sample
- porcelain tile
- copper coin
- steel file

## Draw Conclusions

6 **Infer** Examine your data. What can you say about the properties of different minerals?

Possible answer: Each mineral has a set of properties not possessed by any other mineral.

7 How could the properties of minerals help you classify minerals?

Because each mineral has a unique set of properties, minerals can be classified by their properties.

## Explore More

Using reference sources, identify the minerals. Then label and display them.

Answers will vary based on the minerals used.

## Open Inquiry

How would you classify minerals with many similar properties?

Answers will vary. Accept reasonable responses.

# Read and Respond

## What are minerals?

If you collect rocks, you might find a rock with red chunks in it. The red chunks are minerals. A **mineral** is a solid, natural material made from nonliving substances in Earth's crust.

Draw a circle around the minerals that are made of two or more elements.

Minerals, like all kinds of matter, are made up of elements. An element is a pure substance that cannot be broken down into a simpler substance. Gold is an element, as are aluminum, oxygen, sulfur, and iron. Some minerals, such as copper, are made of a single element. Other minerals are made of two or more elements. For example, the mineral pyrite is made of iron and sulfur. Topaz, feldspar, and quartz are examples of other minerals that are made up of two or more elements.

Minerals form naturally. Materials made by people are not considered minerals. Diamonds that form deep beneath Earth's surface are minerals. However, people can make diamonds in a laboratory. These diamonds are not minerals.

Although minerals are found in nature, they do not contain anything that was once alive, such as plant parts. Coal, for example, is made of ancient compressed plant material. Because the plants that turned into the coal were once alive, coal is not a mineral.

Emeralds are minerals that occur naturally in some rocks. Emeralds are cut and polished to be used for jewelry.

## Streak

Pyrite, or fool's gold, has a yellow color, a shiny metallic luster, and a greenish-black streak.

**Read a Photo**

How do you determine a mineral's streak?

Scrape it on a porcelain tile or other rough surface.

## Properties of Minerals

Every mineral has a unique set of properties, or characteristics. These properties are used to identify minerals. It is usually necessary to test several properties in order to distinguish between similar minerals.

Some minerals have a unique color that can be used for identification. The mineral malachite always has a distinctive green color. But the colors of most minerals vary. Feldspar is a mineral that occurs in a variety of colors, such as white, pink, gray, or blue. Different elements in the mineral can affect its color.

The color of a mineral's powder is called **streak**. It is observed by scratching the mineral across a tile or porcelain plate.

Sometimes, the color of a mineral and the color of its streak are different. However, a mineral's streak is always the same, even if the mineral varies in color. Hematite can have a red, brown, or black color, but its streak is always a dark, rusty red.

Gold and iron pyrite are two minerals that look very similar. Because they look so similar, iron pyrite is called "fool's gold." However, gold has a yellow streak and iron pyrite has a greenish-black streak.

***Quick Check***

1. **Distinguish between a mineral's streak and its color.**

   Possible answer: Minerals can be different colors, but the powder left by the mineral, its streak, is always the same color.

## What are some other properties of minerals?

Hardness is another important property used to identify minerals. The **hardness** of a mineral is measured by observing how easily it is scratched or how easily it scratches something else. Soft minerals are easily scratched, and hard minerals are more difficult to scratch.

Friedrich Mohs, a German scientist, devised a scale of hardness to compare minerals to one another. This has come to be known as Mohs' hardness scale. On Mohs' hardness scale, minerals are ranked from 1, which is the softest, to 10, which is the hardest.

Talc, a soft mineral, is number 1 on the scale. Diamond, the hardest known mineral, is number 10. A mineral with a higher number will scratch a mineral with a lower number. By scratching an unknown mineral with materials that have a known hardness, you can find the hardness of an unknown mineral.

When a mineral is broken, the appearance of the surfaces of the mineral can help identify it. If a mineral breaks along smooth, flat surfaces, it displays **cleavage** (KLEE•vij). Cleavage is described by the number of planes along which the mineral breaks. A mineral that breaks along rough or uneven surfaces displays **fracture** (FRAK•chur).

### Mohs' Hardness Scale

| Hardness | Mineral | Can be scratched by |
|---|---|---|
| 1 | talc | |
| 2 | gypsum | fingernail |
| 3 | calcite | copper (coin) |
| 4 | fluorite | |
| 5 | apatite | steel (knife blade) |
| 6 | feldspar | porcelain (streak plate) |
| 7 | quartz | |
| 8 | topaz | |
| 9 | corundum | |
| 10 | diamond | |

### Read a Table

**Which mineral is scratched by copper but not by a fingernail?**

calcite

talc

diamond

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**Properties of Minerals**

| Mineral or Mineral Group | Color (more common colors) | Luster (type of shine) | Streak (porcelain-plate test) | Cleavage (number of planes) | Hardness (on Mohs' scale) | Density (compared to water) |
|---|---|---|---|---|---|---|
| Gypsum | colorless, gray, white, brown | pearly | white | varies | 2 | 2.3 |
| Quartz | colorless, various colors | glassy or greasy | white | none | 7 | 2.6 |
| Pyrite | brassy, yellow | metallic | greenish black | none | 6 | 5.0 |
| Calcite | varies widely: colorless, white, pale blue, green | glassy | colorless, white | 3 | 3 | 2.7 |
| Galena | steel gray | metallic | gray to black | 3 | 2.5 | 7.5 |
| Feldspar | pink, gray, green, yellow, white | glassy or pearly | colorless | 2 | 6 | 2.6 |
| Mica | colorless, silver, black | pearly or metallic | white | 1 (thin sheets) | 2–3 | 3.0 |
| Hornblende | green to black | glassy or pearly | gray to white | 2 | 5–6 | 3.4 |
| Bauxite rock | gray, red, brown, white | none | gray | none | 1–3 | 2.0–2.5 |
| Hematite | black, gray, reddish brown | metallic | red, reddish brown | none | 5–6 | 5.3 |

**Luster** (LUS•tur) is the way a mineral reflects light. Minerals with a metallic luster appear shiny, like metal. Minerals with a nonmetallic luster look dull. These minerals can be described as glassy, pearly, oily, earthy, waxy, or silky. Graphite has a metallic luster. Quartz has a glassy luster, and talc has an oily luster.

Some minerals have other special properties that can be used to help identity them. For example, arsenic gives off an odor of garlic when it is heated. Calcite fluoresces, or glows, when it is exposed to ultraviolet light. Copper is a good conductor of electricity and heat. Quartz gives off sparks when its surface is scratched with a steel pin. Calcite fizzes when acid is dropped on it. Magnetite is magnetic and attracts steel objects.

**Magnetite, or lodestone, attracts these metal objects.**

### *Quick Check*

**2. Why should you test several properties when identifying minerals?**

Two different minerals might share more than one property.

You should test several properties to make sure you can

properly distinguish the minerals.

## What are the shapes of a mineral?

As minerals form, the elements they are made from form patterns. These patterns cause minerals to form geometric shapes called crystals (KRIS•tulz). A **crystal** is a solid whose shape forms a fixed pattern. Different minerals have different crystal shapes. A crystal's shape depends on the way its structure is arranged. The minerals shown on this page have different crystal structures.

**Quick Lab**

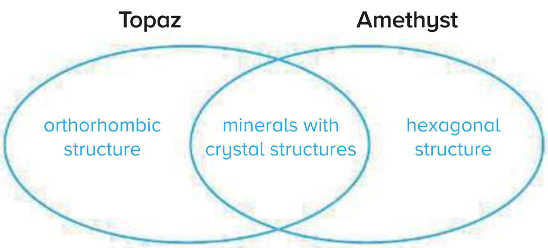
To learn more about crystal shapes, do the Quick Lab in the activity workbook.

Sometimes the larger structure of the mineral shows the same shape as the crystal structure. For example, if you look at crystals of table salt with hand lens, you will observe that the salt crystals look like tiny cubes. In other minerals, the crystal structure can be seen only with a microscope.

**Topaz is an example of a mineral with an orthorhombic structure.**

### Quick Check

3. How does a topaz crystal compare to an amethyst crystal?



**Amethyst is an example of a mineral with a hexagonal structure.**

### Quick Check

4. Why is it useful to examine the crystal structure of an unfamiliar mineral?

Possible answer: The outward shape may not reflect the crystal itself. In many minerals, the crystal structure can be seen only with a microscope.

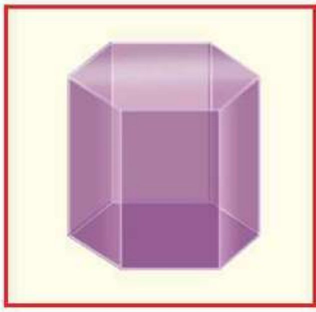
## My Notes

## Visual Summary

Complete the lesson summary in your own words.

**Properties of Minerals** Possible answer: Minerals have properties, such as color and streak, by which they can be identified.

**Hardness of Minerals** Possible answer: Hardness is a measure of how well a mineral resists scratching.



**Crystals** Possible answer: Minerals exhibit many different crystal shapes.

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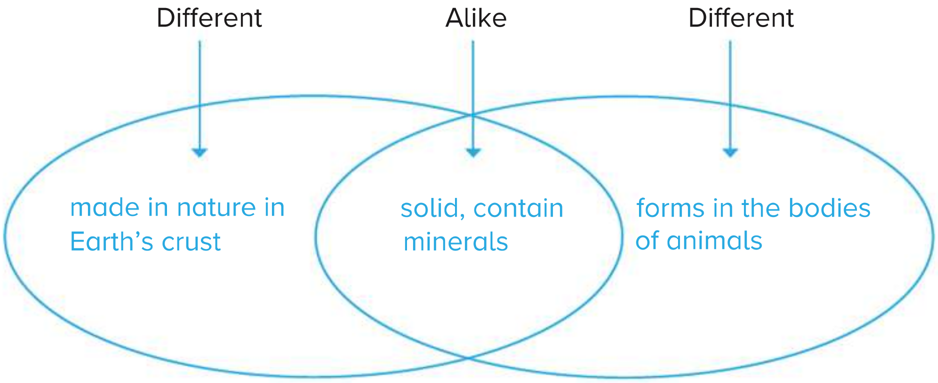
## Think, Talk, and Write

1. **Vocabulary** The color of a mineral's powder is called its streak.

2. **Compare and Contrast** Bones contain elements found in minerals. Why is bone not considered a mineral?



3. **Critical Thinking** Give an example of an object you use daily that is made from a mineral.

Answers will vary. Students might mention items made from metals, gemstones, talc, gold, and so on.

4. **Test Prep** Which property describes minerals that break along smooth surfaces?

**A** hardness
**B** color
**C** fracture
[✓ **D**] cleavage

**Essential Question** What are the properties of minerals and how are they identified?

Minerals have different properties that can be used to identify them: color, luster, hardness, cleavage, fracture, and streak.

# Focus on Skills

## Inquiry Skill: Use Variables

Can you grow small mineral crystals into larger ones? How does the concentration of a mineral affect a crystal's growth rate? To answer questions such as these, scientists **use variables** by doing a series of experiments, using a different procedure each time. Then they put together the results of all their experiments, like pieces of a g puzzle, to answer questions.

### ▶ Learn It

When you **use variables**, you identify factors in an experiment that can be changed. To make sure the results are valid, scientists try to test each variable one at a time. First, scientists perform an experiment. Then, they repeat the test while changing only one variable. So that it is a fair test, they make sure all other factors remain exactly the same.

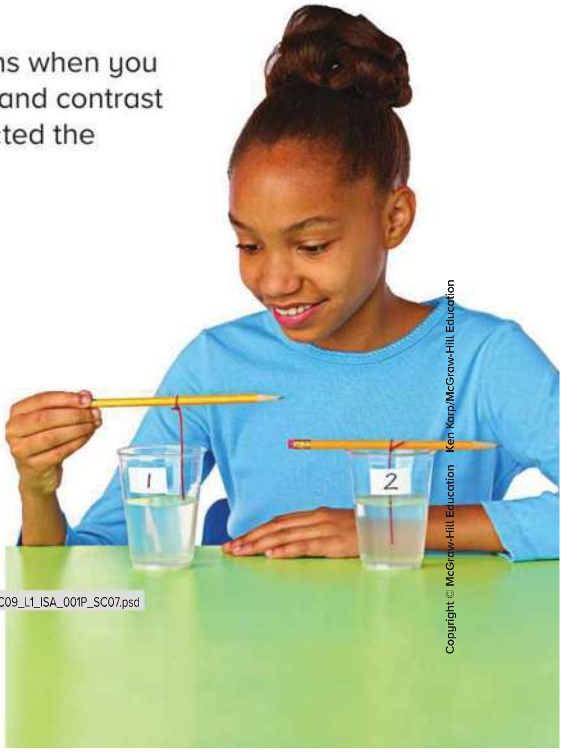
It is important to record your observations when you change a variable. Then you can compare and contrast the results to learn how each variable affected the outcome of your original experiment.

### ▶ Try It

**Materials** **2 clear plastic cups, water, salt, 100-mL graduated cylinder, 2 plastic spoons, 2 pieces of string, 2 pencils**

① Label one cup *Cup 1* and the other *Cup 2*. Fill each cup halfway with warm water. Pour 50 mL of salt into cup 1 and 100 mL of salt into cup 2. Stir the water in each cup until the salt dissolves.

② Tie a string around the middle of each pencil. Balance a pencil across the top of each cup so the string hangs down into the water without touching the sides or bottom.



Ken Karp/McGraw-Hill Education

3. Observe the cups for several days. Write your observations on the chart below.
4. **Use variables** by repeating this experiment using ice-cold water instead of warm water. Record the results.
5. Do the experiment again. This time, change a different variable, such as the size of the cups, the amount of water, the length of the strings, or the amount of time before you check the strings. Record the results.
6. In which cup did the lump of crystals form faster? Why? Did changing your variable in step 4 change your results? In step 5? Explain.

Answers will vary. The cup with the higher

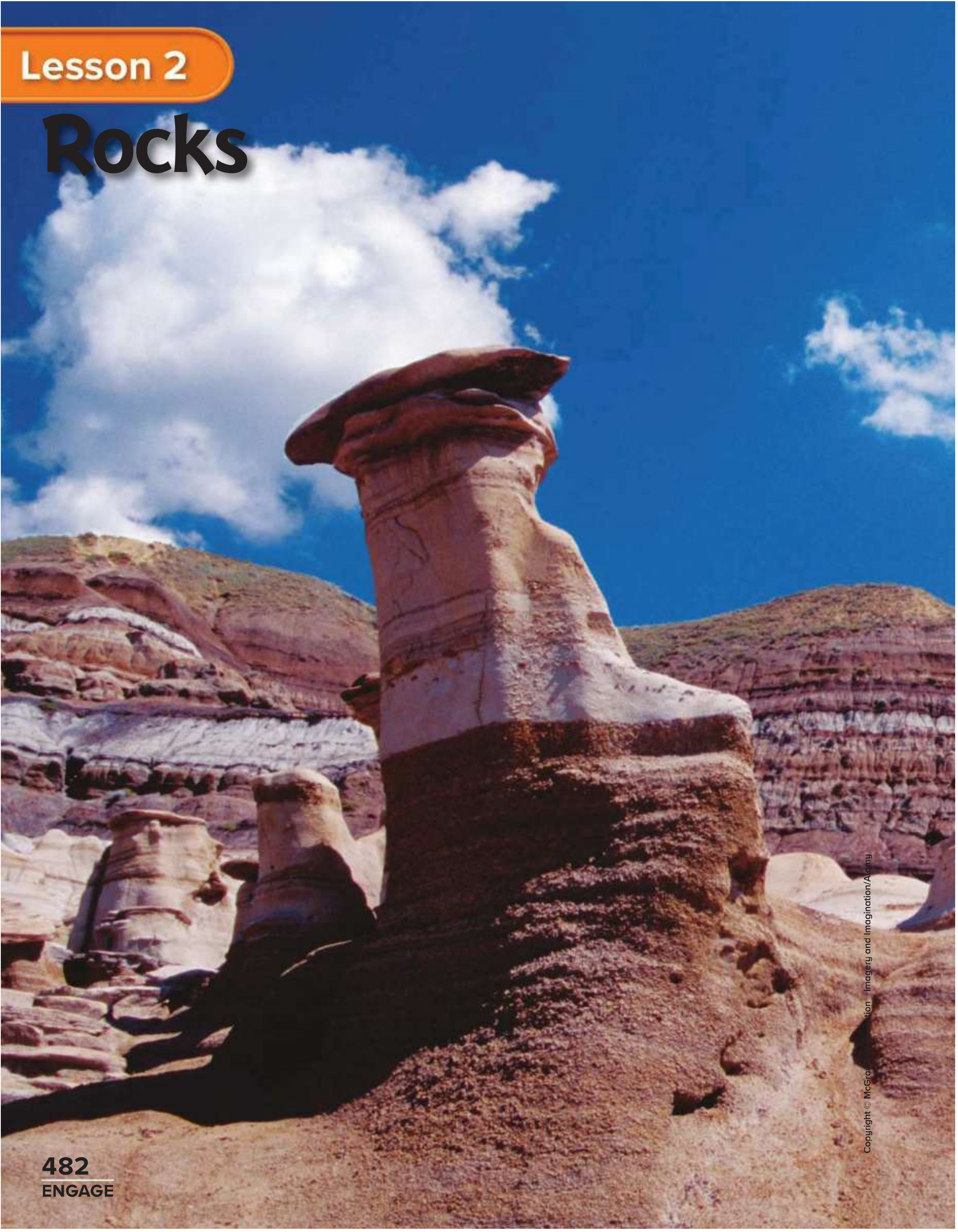
concentration of salt should form larger crystals faster

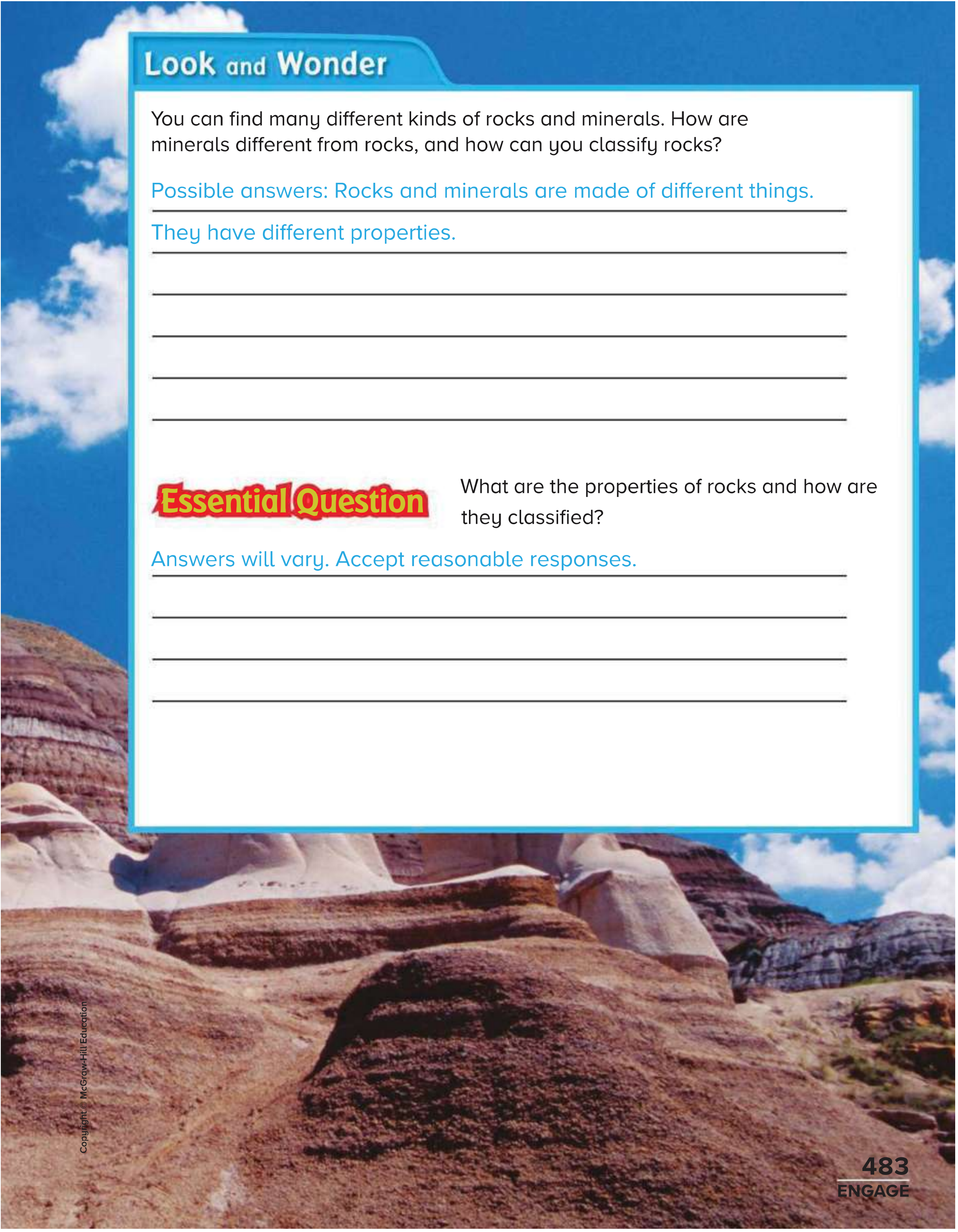
than the cup with a lower concentration of salt.

| ***Variable*** | | ***My Observations*** |
|---|---|---|
| **Test 1: Warm Water**<br>**Cup 1**<br>**Cup 2** | **(50 mL salt)**<br>**(100 mL salt)** | |
| **Test 2: Icy, Cold Water**<br>**Cup 1**<br>**Cup 2** | **(50 mL salt)**<br>**(100 mL salt)** | |
| **Test 3:** ____<br>**Cup 1** ____<br>**Cup 2** ____ | | |
| **Test 4:** ____<br>**Cup 1** ____<br>**Cup 2** ____ | | |

Lesson 2

# Rocks





## Look and Wonder

You can find many different kinds of rocks and minerals. How are minerals different from rocks, and how can you classify rocks?

Possible answers: Rocks and minerals are made of different things.

They have different properties.

**Essential Question** What are the properties of rocks and how are they classified?

Answers will vary. Accept reasonable responses.

# Explore

## What makes rocks different from one another?

### Purpose

Explore the properties of different rocks.

### Procedure

1. Look at each rock. What color is the rock? What is its shape? How does it feel?

2. **Communicate** Record your observations in this chart.

| Type of Rock | Color | Shape | Texture |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

3. **Observe** Choose a rock that has more than one color. Using a hand lens, compare the parts that are the same color. Are those parts shiny or dull? Rough or smooth? Record your observations in your chart.

4. Choose another color in the same rock. How do the parts with this color compare?

Answers will vary.

### Materials

- several different rocks
- hand lens

Joe Polillio/McGraw-Hill Education

## Draw Conclusions

⑤ **Infer** Are the differently colored parts of the rock made of the same or different materials? Explain your answer.

Possible answer: Likely different colored parts of the same rock are different materials because the properties of color, luster, and so on will differ.

⑥ What do you think makes these rocks different from one another?

Possible answer: Rocks are made of minerals and different minerals have different properties.

## Explore More

Choose one of the rocks. How could you identify the rock and tell what it is made of? Do some research. Report your findings.

Possible answers: Look up the rock in a book about rocks. Compare rocks to samples of known rocks. Do scientific test on the rock.

## Open Inquiry

How are rocks like the ones you've studied used by humans?

Answers will vary. Accept reasonable responses.

# Read and Respond

## What are rocks?

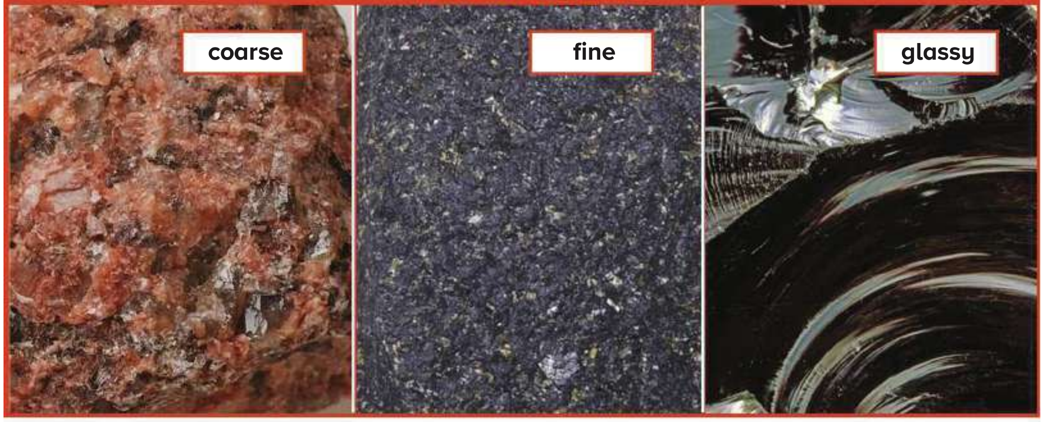
Circle the name for a person who studies rocks.

A **rock** is a solid substance naturally occurring in Earth's crust that contains one or more minerals. When you look at a piece of granite with a hand lens, you may be able to see the minerals quartz, feldspar, and biotite. There are hundreds of different types of rocks. The properties of rocks come from their composition and the way they formed.

Some rocks, like granite, are made of several minerals. Some rocks, like limestone, are made of mostly one mineral. Most rocks consist of a mixture of minerals. A rock's color gives clues about the minerals that make it up.

Rocks are made of mineral pieces called grains. To a geologist, or a person who studies rocks, a rock's texture is how its grains look. Texture depends on the size, shape, and arrangement of the grains. Some rocks have large grains you can easily see. These rocks have a coarse texture. Some rocks have grains that are too small to see. These rocks have a fine texture.

**Texture of Rock**

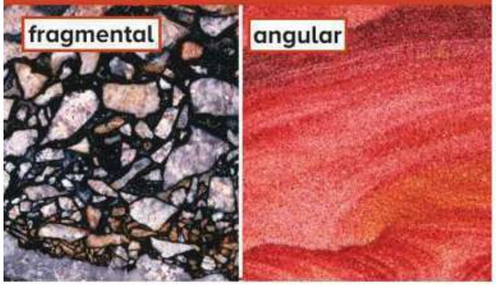


A geologist can tell how a rock was formed just by looking at it. The formation process is the basis for classifying rocks into three main groups: sedimentary, igneous (IG•nee•us), and metamorphic.

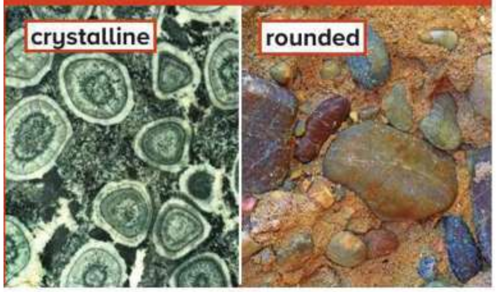
## Quick Lab

To practice classifying rocks, do the Quick Lab in the activity workbook.

**Shape of Rock**



**Structure of Rock**



## ✓ *Quick Check*

1. **What are the steps you would take to place an assortment of rocks into different categories?**

   Possible answer: I would look at the grains first. Then I would look at the colors.

2. **Why do you think rocks have different characteristics?**

   Possible answer: Rocks have different characteristics because they are made of different materials.

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## What is the rock cycle?

As you have learned, weathering and erosion on Earth's surface move particles of dust, sand, and soil. As time passes, layers of these sediments are deposited. The upper layers press down on the lower layers. The pressure compacts, or squeezes, the sediments together. Over time, the pressure cements the sediments, or makes the minerals stick together. A rock that forms from sediments is called **sedimentary rock**.

As sedimentary rocks are pushed underneath Earth's crust, heat and pressure melt them into magma. The magma may erupt through a volcano. If it does, an **igneous rock** forms as the lava cools and hardens.

As time passes, sedimentary and igneous rocks may be buried deep beneath Earth's surface. There they are under pressure from the weight of the rock above them. The temperature is also much hotter. Metamorphic rocks usually form no deeper than 20 kilometers below the surface and at temperatures between 200°C and 800°C. A **metamorphic rock** is a rock that forms when sedimentary and igneous rocks change under heat and pressure without melting.

Sedimentary rocks can change into igneous or metamorphic rocks. Igneous rocks can change into sedimentary or metamorphic rocks. Metamorphic rocks can change into sedimentary or igneous rocks.

A change from one type of rock to another is caused by changes in conditions on and underneath Earth's surface. The changing of rocks over time from one type to another is called the **rock cycle**.

### *Quick Check*

**3. What are the steps by which an igneous rock turns into a sedimentary rock?**

Weathering and erosion break down and move rocks.

↓

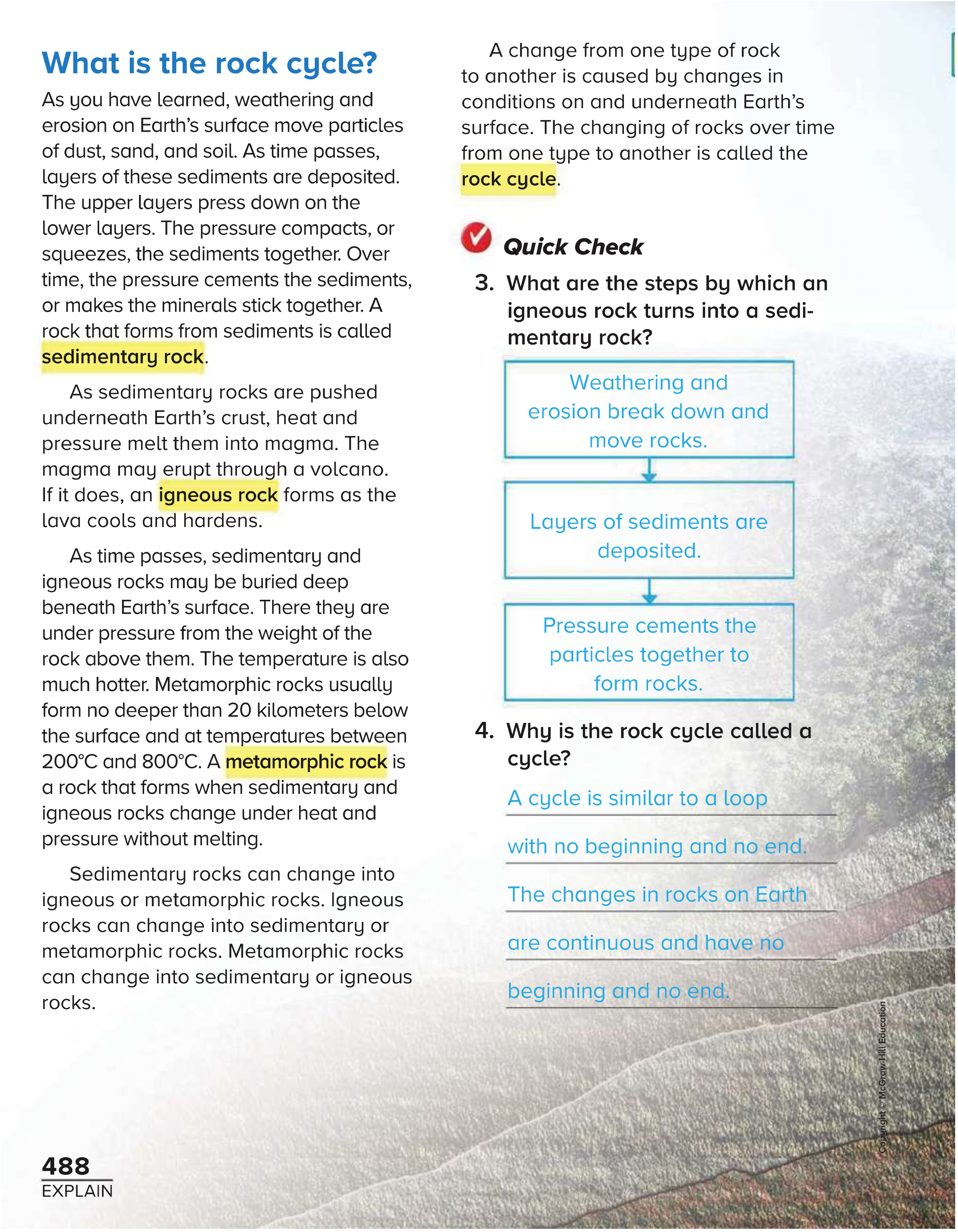
Layers of sediments are deposited.

↓

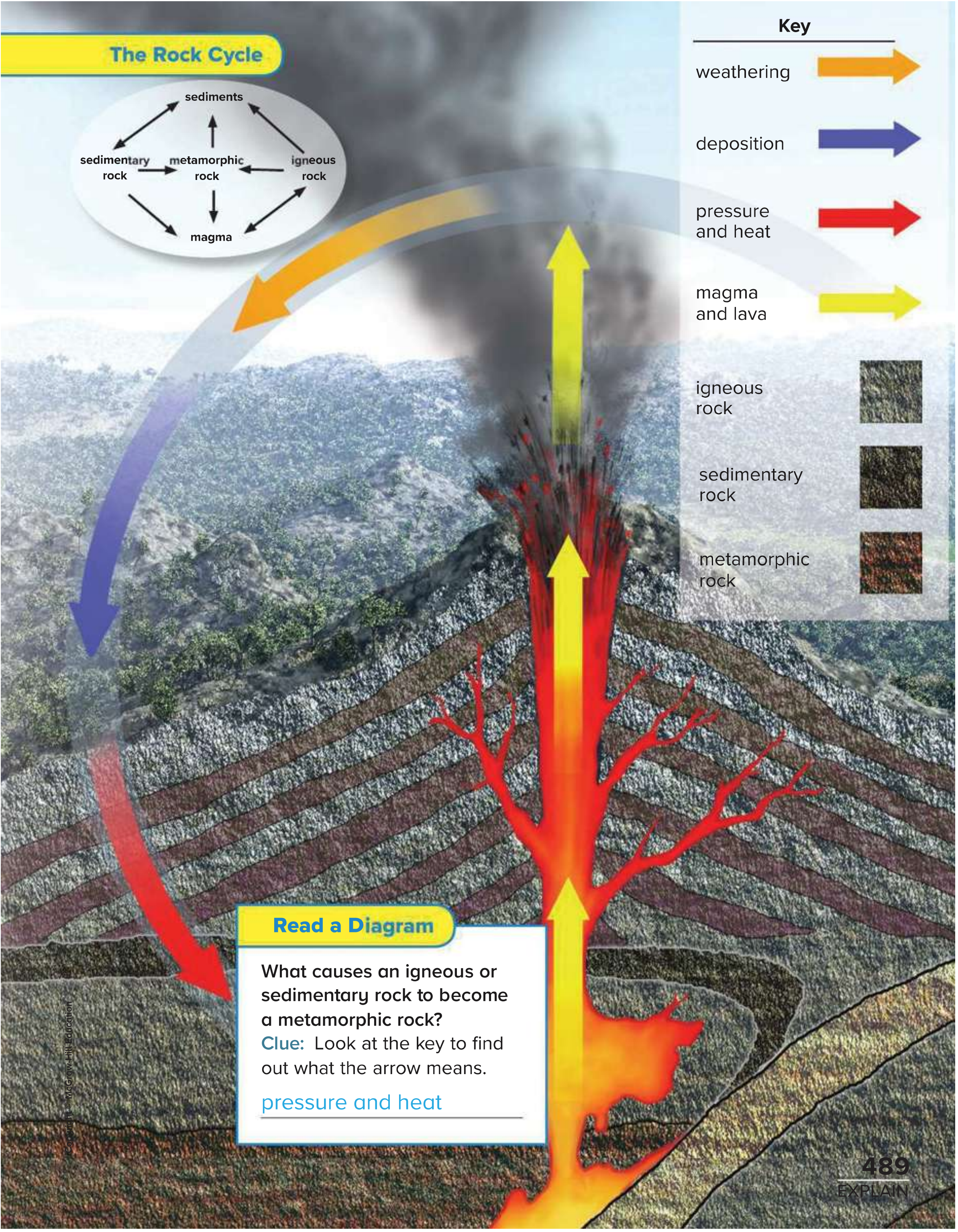
Pressure cements the particles together to form rocks.

**4. Why is the rock cycle called a cycle?**

A cycle is similar to a loop with no beginning and no end. The changes in rocks on Earth are continuous and have no beginning and no end.



## The Rock Cycle



### Read a Diagram

**What causes an igneous or sedimentary rock to become a metamorphic rock?**

**Clue:** Look at the key to find out what the arrow means.

pressure and heat

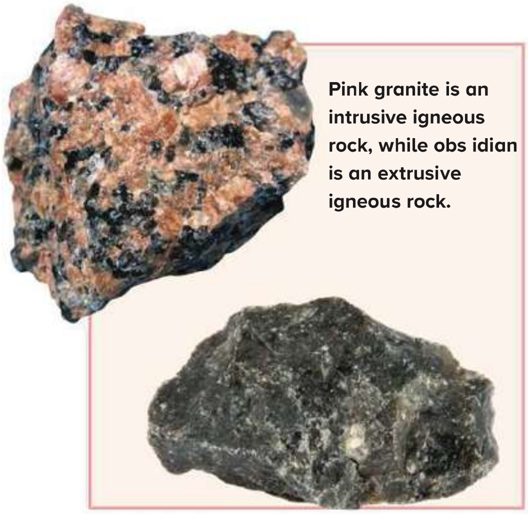
## What are igneous and sedimentary rocks?

Since at least 50,000 years ago, people have used rocks to make weapons and start fires. How did these rocks form? What other uses have people found for rocks?

### Igneous Rocks

When an igneous rock forms from magma inside Earth, it is called an ***intrusive*** (in•TREW•siv) *rock*. Below Earth's surface, intrusive rocks cool slowly. They may take 100 years or more to cool a few degrees. This often produces large crystals. If you find an igneous rock with large crystals in it, you can conclude that the rock is intrusive.

Granite is a common intrusive rock. It is often used as a building material. The minerals that make up gems, such as rubies, may form in intrusive rocks. They can also be used to make jewelry.

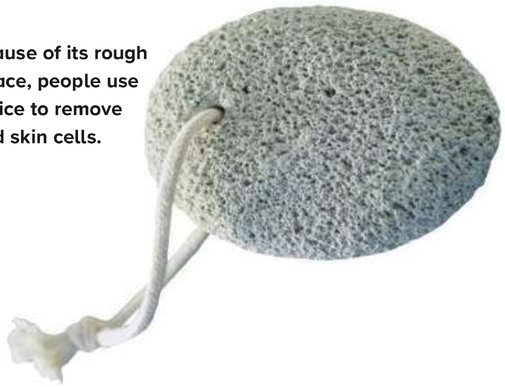


**Pink granite is an intrusive igneous rock, while obs idian is an extrusive igneous rock.**

An igneous rock that forms from lava on Earth's surface is called an ***extrusive*** (ik•STREW•siv) *rock*. On Earth's surface, lava is exposed to air or water, causing it to cool and harden very rapidly. Lava may cool in minutes when it spills into the sea or in a number of days as it flows over land. Large crystals do not have time to form. The crystals that form in these rocks are very small and difficult to see. **Basalt,** the most common extrusive rock, is made of many small crystals.

Some extrusive rocks develop so quickly that they do not contain any crystals. **Obsidian,** which is also called volcanic glass, is an example of an extrusive rock that has no crystals. Its surface is smooth and glassy. People have used **obsidian** to make sharp tools and weapons. **Rhyolite** is another example of an extrusive igneous rock.

**Pumice** is another type of extrusive rock. As pumice forms, gases bubble through the rock. The holes that are left behind make pumice light and rough. Because it is rough, pumice is often used for grinding or polishing.



**Because of its rough surface, people use pumice to remove dead skin cells.**

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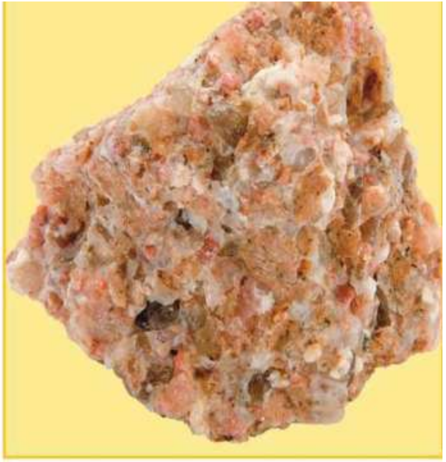
## Sedimentary Rocks

Sedimentary rocks are made of different materials that have been compacted and cemented together. Some sedimentary rocks contain minerals that were once dissolved in water. The minerals formed crystals among the sediments that came together to form the rock.



Some sedimentary rocks are made from smaller rounded stones that have been cemented together. This type of rock is called a ***conglomerate*** (kun•GLAHM•rut) *rock*.

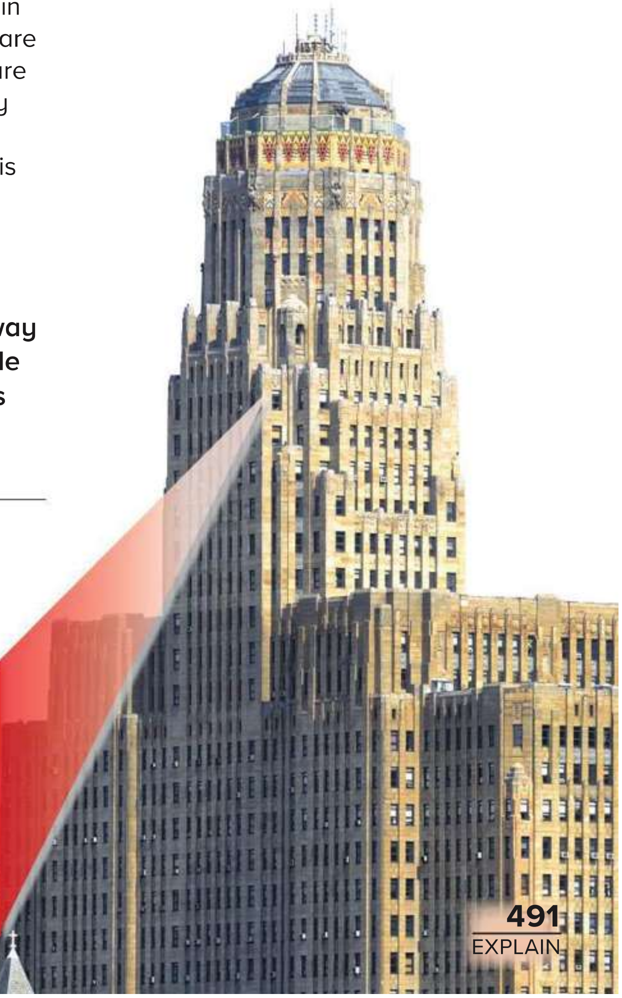
Sedimentary rocks are often used in buildings. **Limestone** and **sandstone** are two types of sedimentary rocks that are used on the outside of buildings. They are also used for making statues and other decorations. Ground limestone is an ingredient in concrete.

### Quick Check

**5. You are driving along a highway cut through walls of rock made of layers. What type of rock is this?**

sedimentary rock

**This building is covered with sandstone and limestone.**



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## What are metamorphic rocks?

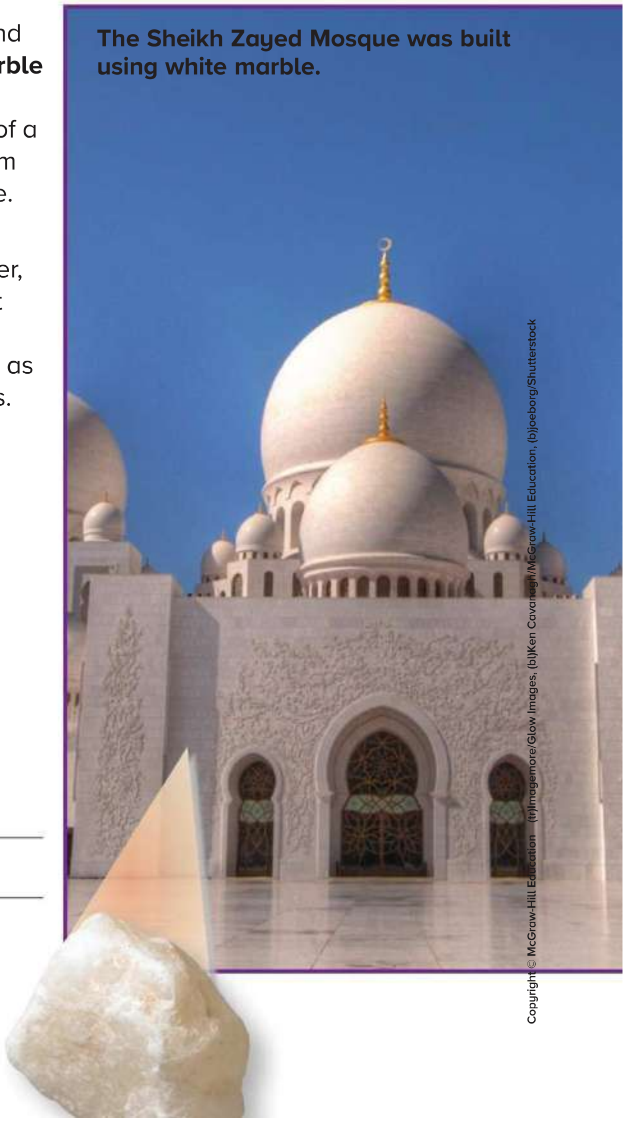
If sedimentary and igneous rocks are put under heat and pressure, the shape or the size of the crystals within them can change. The crystals may also change position to form layers. Heat and pressure may even change one of the minerals in the rock into another mineral. The high pressure also squeezes the particles in the original rock more tightly together.

If you look closely at limestone, you can often see fossil fragments in the rock. As limestone changes into marble under heat and pressure, the fossils are usually crushed. **Marble** is a more compact rock than limestone, with crystals that are locked together like pieces of a jigsaw puzzle. The color in marble comes from the minerals in the original piece of limestone.

**Slate** is a type of metamorphic rock in which the minerals are tightly packed together, making it waterproof. When **slate** is broken, it shows cleavage as it breaks into thin sheets. This makes **slate** useful as a roofing material as well as for stepping stones and outside floors.

Marble is a shiny metamorphic rock that contains minerals that give it brilliant colors. Marble is easy to carve or shape, making it useful for fashioning statues, floors, kitchen counters, and monuments.

**The color in this marble was caused by mineral impurities in the limestone from which it formed.**



**The Sheikh Zayed Mosque was built using white marble.**

***Quick Check***

6. **What happens to the fossils in limestone as the limestone turns into marble?**

As limestone is put under heat and pressure, the fossils are crushed.

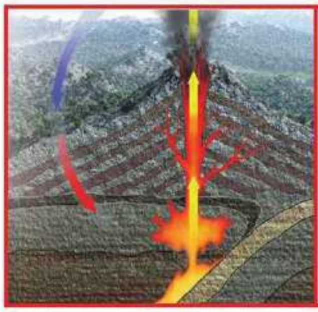
## My Notes

## Visual Summary

Complete the lesson summary in your own words.

**What Are Rocks?** Possible answer: Rocks are solid substances naturally occurring in Earth's crust and contain one or more minerals.

**Classifying Rocks** Possible answer: Rocks can be classified into three groups: igneous, sedimentary, and metamorphic.

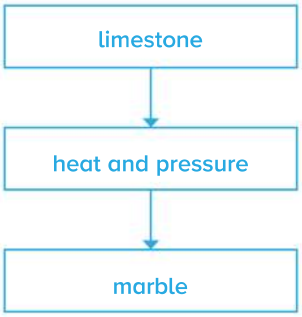


**The Rock Cycle** Possible answer: During the rock cycle, rocks form and change into other types of rocks.

## Think, Talk, and Write

① **Vocabulary** When magma or lava hardens, igneous rock is produced.

② **Sequence** What are the steps by which a sedimentary rock turns into a metamorphic rock?



limestone

heat and pressure

marble

③ **Critical Thinking** What steps of the rock cycle involve heat?

The melting of rock to form igneous rock and the changing of rocks into metamorphic rock involve heat.

④ **Test Prep** From which material does an extrusive rock form?

**A** magma **C** mineral

[✓ B] lava **D** sediment

⑤ **Test Prep** A conglomerate is an example of which type of rock?

**A** intrusive igneous

B extrusive igneous

[✓ C] sedimentary

**D** metamorphic

**Essential Question** What are the properties or rocks and how are they classified?

Answers will vary. Students should note that rocks are classified as igneous, sedimentary, or metamorphic depending on how they form.

# Focus on Skills

## Inquiry Skill: Classify

As you just read, rocks are naturally formed solids made of one or more minerals. Each mineral adds its own properties to a rock. There are billions of different rocks on Earth. Scientists group, or classify, rocks into three groups based on the way they form. In order to determine how they form, scientists observe the properties of the rocks. These properties include color, weight, texture, and whether the rocks float or sink.

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### ▶ Learn It

When you classify, you group objects that share properties. You need to compare and contrast the objects in order to find out what properties they share. Remember, to compare you look at how things are alike, but to contrast you look at how things are different.

Classifying is a useful tool for organizing and analyzing. It can help you understand why things belong in the same group and how some things can belong to several different groups. It is important to keep notes. Your notes can help you figure out how to classify other things.

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## Try It

**Materials** **8 different rocks, water, small bowl**

1. Complete the table below. List the properties that you want to look for in the first column.
2. Examine the first rock carefully.
3. Classify Mark an X in the appropriate box if this rock can be classified by the property listed in the rows.
4. Fill the bowl with water. Place the rock in the bowl to test whether the rock floats.
5. Repeat using the remaining rocks.

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**Classifying Rocks by Properties**

| Answers will vary. | #1 | #2 | #3 | #4 | #5 | #6 | #7 | #8 |
|---|---|---|---|---|---|---|---|---|
| color: dark | | | | | | | | |
| color: light | | | | | | | | |
| several colors | | | | | | | | |
| heavy | | | | | | | | |
| light | | | | | | | | |
| rough | | | | | | | | |
| smooth | | | | | | | | |
| sharp | | | | | | | | |
| has holes | | | | | | | | |
| has layers | | | | | | | | |
| floats | | | | | | | | |
| sinks | | | | | | | | |

## Lesson 3

# Soil

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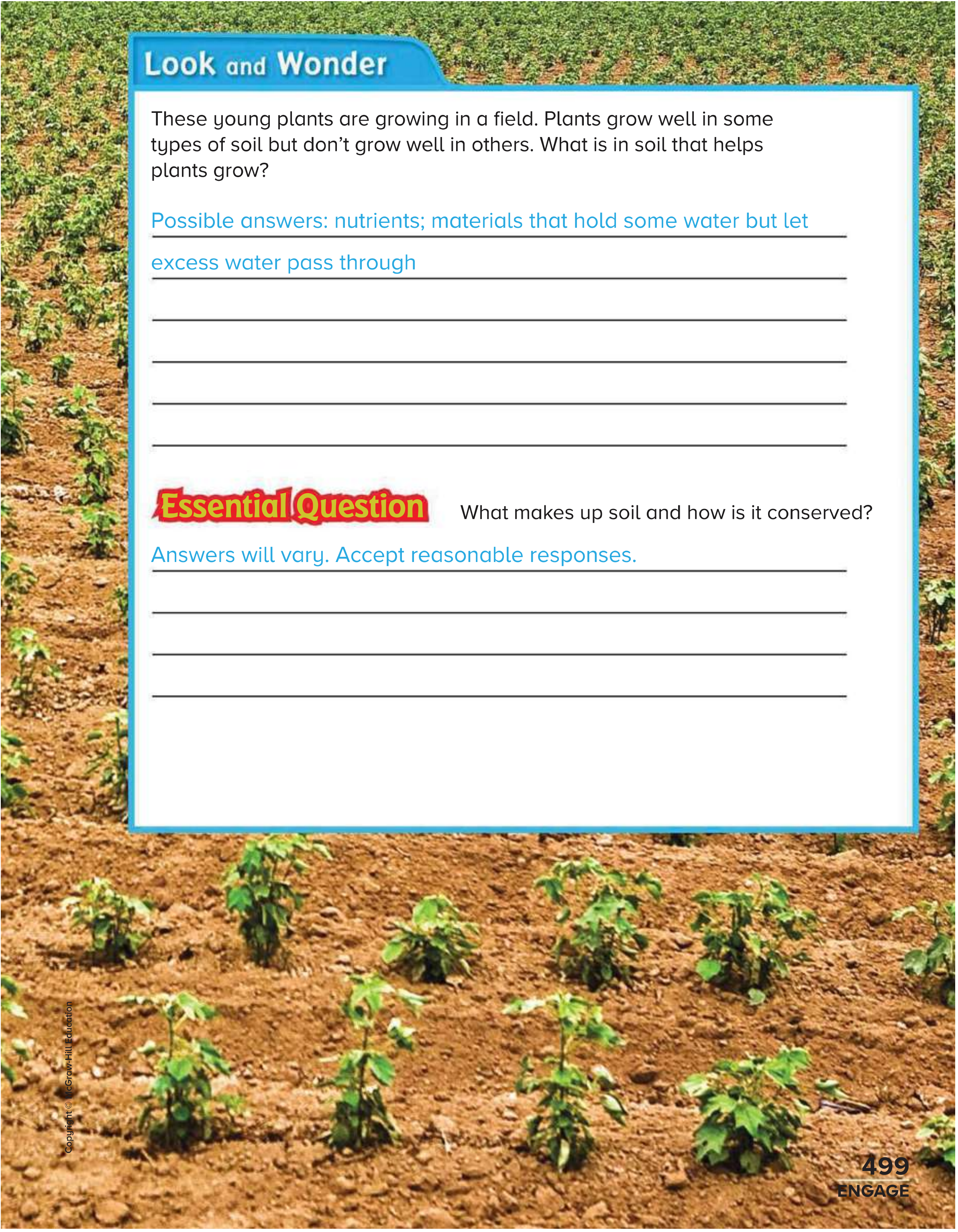
## Look and Wonder

These young plants are growing in a field. Plants grow well in some types of soil but don't grow well in others. What is in soil that helps plants grow?

Possible answers: nutrients; materials that hold some water but let excess water pass through

**Essential Question** What makes up soil and how is it conserved?

Answers will vary. Accept reasonable responses.



## What is in soil?

### Purpose

Examine the contents of a soil sample.

### Procedure

1. **Observe** Use the toothpicks and hand lens to separate the contents of the soil sample.

2. Identify and list the different materials in the soil sample.

   Answers will vary.

**Materials**

- toothpicks
- hand lens
- soil sample

## Draw Conclusions

③ **Classify** Does your soil sample contain nonliving things? What about once-living things?

Answers will vary. Students may find nonliving things, such as sand and rock fragments, and once-living things, such as decayed parts of plants and animals..

④ Based on your observations, what are the contents of soil?

Possible answer: My soil contains sand, rock fragments, insect parts, and dead or decayed plant parts (parts of leaves, twigs, roots, flowers, etc.).

## Explore More

Collect and examine samples of soil from different places in your neighborhood. How do the contents of these samples compare with the one you studied in this activity? Do the additional samples change the conclusion you drew about the contents of soil?

Possible answer: Soil in different places is made from different things. In general, however, soil is made of both once-living and nonliving materials.

## Open Inquiry

What part of soil provides nutrients for growing plants?

Answers will vary. Accept reasonable responses.

# Read and Respond

## What is soil?

Underline the definition of the word *organic*.

If you watched the same rock over many years, you would see that as time passed, the rock weathered. Microscopic organisms would grow among the bits of rock. Some of these organisms would break down the rocks into chemicals that could nourish plants.

As the rock weathers, grasses would grow, followed by bushes and trees. Animals would come to eat the plants, and other animals would feed on the animals that fed on the plants. When the animals and plants die, their bodies add organic nutrients back to the soil. *Organic* means having to do with or coming from living things.

**Soil** is a mixture of bits of rock and bits of onceliving parts of plants and animals. Soil covers most of Earth's landmasses. Without it, plants and animals would not be able to live on land.

Soil covers the ground in rain forests, grasslands, and deserts. The soils in these places look different, but they all started from rocks. As rocks weather, the soil forms in layers. If you dig a hole in the ground, you will see the layers as you dig deeper.

Soil is made of nonliving and once-living things.

(l)Design Pics/Susan Dykstra, (c)Meredith Farmer/Getty Images, (r)Steven P. Lynch

## Soil Horizons

Each layer of soil is called a **soil horizon** (huh•RYE•zuhn). In some places, the layers of soil might look like the ones on this page.

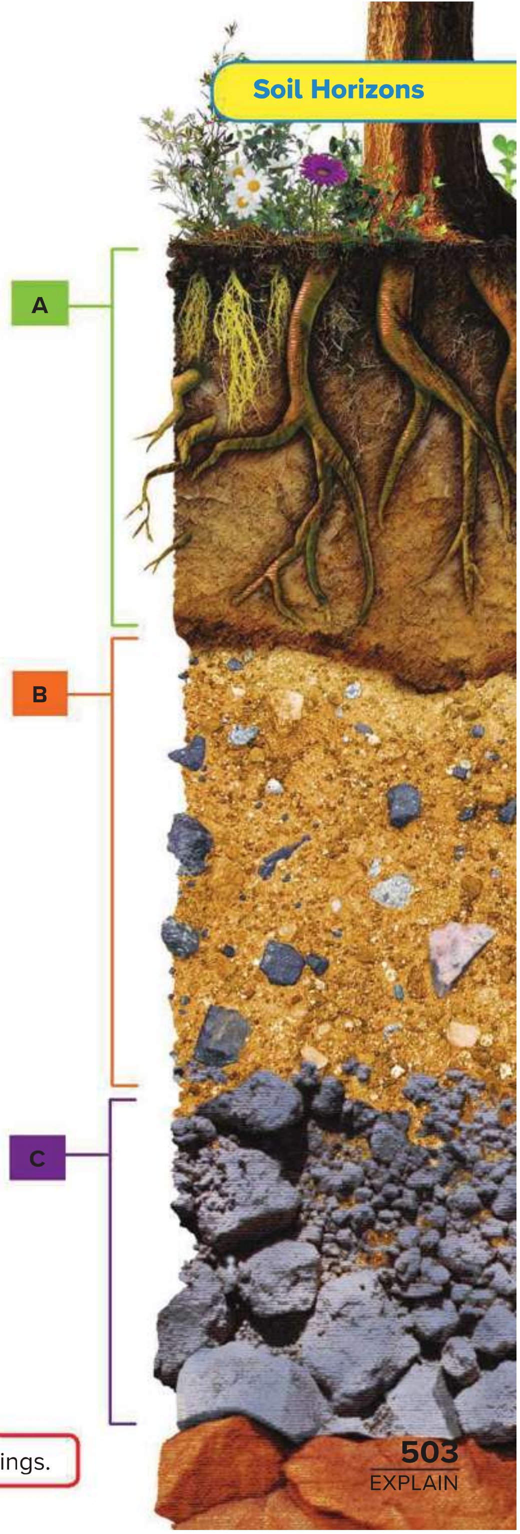
The **A** horizon, which holds the most nutrients, contains humus (HYEW•mus). **Humus** is the part of the soil that is made of decayed organic materials. These materials are the remains of dead plants and animals that are decayed by microscopic organisms. Humus contains nutrients that feed plants. Humus also soaks up and holds water more easily than bits of rock.

The soil in this horizon is called **topsoil**. Most plant roots grow in this soil. The roots absorb nutrients and water from humus.

The **B** horizon is called subsoil. You will find less humus in subsoil and lots of fine particles of rock, such as the particles that make up clay.

Next is the **C** horizon, which is made mostly of larger pieces of weathered rock. These soil horizons rest on solid, unweathered bedrock.

Different areas will have different depths of soil horizons. Some areas may not have one of these soil horizons.



**Soil Horizons**

### Quick Check

1. What are the main steps in the formation of soil?

weathering of rock, breakdown

of rock by microorganisms, plant

growth, decay of plants and animals

**FACT** Soil is made of nonliving and once-living things.

This flowering plant has adapted to the conditions in the Arabian Desert.

## How is soil used?

Soils in different places have different properties. Each type of soil supports different plant and animal life.

The soil in a forest has a thin layer of topsoil with little humus. Frequent heavy rainfall carries minerals deep into the ground. Plants with shallow roots cannot reach these minerals. Crops with shallow roots do not grow well in such soil.

Desert soil is sandy and does not hold much humus. Because desert areas receive little rain, plants have special adaptations to grow there. However, desert soil is rich in minerals. The minerals are not washed away by rain. Animals can sometimes be raised in areas with desert soil. Crops can only be grown if water for the plants is piped to the area.

The Arabian Desert, the second largest on Earth, covers more than 2,300,000 square km and is home to a variety of desert flora, including succulents, shrubs, and flowering plants that have adapted to the desert conditions in the region.

Soil is a resource that can be used up, wasted, or spoiled. Soil can be eroded by flowing water and wind. Plant roots hold soil in place. If plants are removed, more soil may be eroded. This may change the type of plants that can grow in an area or make it difficult for any plants to grow.

The nutrients in soil are naturally removed by plants. The plants use the nutrients to grow and build their body parts. The nutrients are normally replaced when plants die, fall to the ground, and decay. What happens when a farmer completely removes a crop from the land? Then there are no plants left behind to die and decay. The land becomes less able to support the growth of new crops.

**Pollution** (puh•LEW•shun) is the addition of harmful materials to soil, air, or water. Soil can be polluted by chemicals placed in the ground. It can also be polluted by chemicals used to kill insects and weeds. When people dump garbage on the ground, the garbage can also pollute soil.

### Quick Lab

To observe how certain soils hold water, do the Quick Lab in the activity workbook.

### ✓ *Quick Check*

2. What properties of soil are best for farming?

high humus content

high mineral content

ability to hold water

properties of soil best for farming

**Farmers use chemicals to kill insects that eat crops, but these chemicals can pollute the soil that the crops need to grow.**

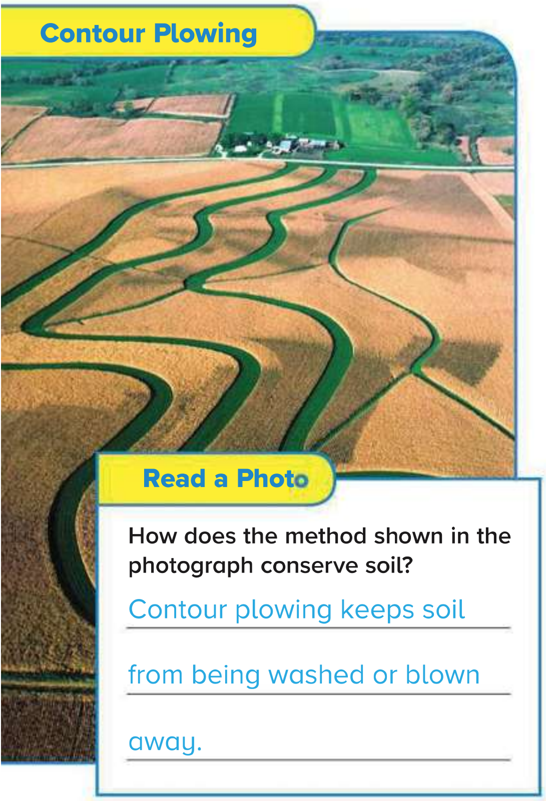
## How is soil conserved?

The preservation or protection of natural resources, including soil, is called **conservation** (kahn•sur•VAY•shun). Listed below are some methods of conserving soil:

**Fertilization** Fertilizers containing one or more nutrients can be added to soil to replace nutrients used up by previous crops.

**Crop Rotation** Farmers can plant different crops on the same land in different years. They can choose crops that add the nutrients that have been removed by other crops.

**Contour Plowing**



**Read a Photo**

How does the method shown in the photograph conserve soil?

Contour plowing keeps soil from being washed or blown away.

**Strip Farming** Plant roots help prevent soil from being washed or blown away. For this reason, farmers may plant grasses between rows of other crops.

**Contour Plowing** Rainwater flows swiftly down hills and can carry away rich topsoil. Farmers can slow the speed of water flowing down the hill by contour plowing. Instead of plowing up and down the slope of the hill, farmers plow furrows across the slope.

**Terracing** Terraces are flat shelves that are cut into a hillside. Crops are planted along each terrace. This also slows the speed of water flowing down a slope.

**Wind Breaks** Farmers plant tall trees along the edges of farmland to slow the speed of wind across the ground. Where there are trees, the wind is less likely to blow away topsoil.

**Laws** Governments may pass laws to stop the pollution of soil.

**Individual Efforts** You can avoid polluting soil with trash and help clean up land that has already been polluted.

**Education** You can help inform people of the value of soil and how to conserve it.

***Quick Check***

**3. What might cause mountaintops to have little or no topsoil?**

Topsoil is on the surface of the land. On a mountaintop, rain can easily wash soil down the slope.

## My Notes

## Visual Summary

Complete the lesson summary in your own words.

**What Is Soil?** Possible answer: Soil is a mixture of bits of rock and once-living parts of plants and animals.

**Soil Use** Possible answer: Soil supports plant and animal life and can be polluted.

**Conserving Soil** Possible answer: Soil can be conserved in many different ways including crop rotation and contour plowing.

## Think, Talk, and Write

① **Vocabulary** The part of soil that is made of decayed organic materials is called humus.

② **Summarize** Describe the methods used to protect soil from erosion by water.

strip farming

terracing

contour plowing

→ Soil can be protected from water erosion.

③ **Critical Thinking** Compare and contrast forest soil with desert soil.

Forest and desert soil are both low in humus. Desert soil is high in minerals.

④ **Test Prep** Which is the C horizon of soil made of?

**A** clay
**B** humus
**C** bedrock
[✓ **D**] large rocks

⑤ **Test Prep** Which is strip farming?

**A** adding fertilizer to soil
**B** cutting shelves in hills
[✓ **C**] planting grasses between crop rows
**D** planting trees around crops

**Essential Question** What makes up soil and how is it conserved?

Answers will vary. Students should note that soil is a mixture of once-living things and bits of rock. They should also list methods of soil conservation mentioned in this lesson.

# Be a Scientist

## Materials

- 2 pans

- potting soil

- ruler

- sand

- grass seeds

- 2 measuring cups with water

**Structured Inquiry**

## Which soil is better for plant growth?

### Form a Hypothesis

Different types of soil are made of different materials. Sand is a type of soil made from small pieces of rocks. Potting soil is made from bits of sticks and leaves. How fast will grass seeds grow in potting soil compared to sand? Write your answer in the form "If grass seeds are planted in potting soil and in sand, then…"

Possible answer: If grass seeds are planted in potting soil

and in sand, then the grass seeds in the soil will grow

faster than the grass seeds in the sand.

### Test Your Hypothesis

1. Fill one pan with potting soil until the soil is 3 centimeters deep. Fill the other pan with sand until the sand is 3 centimeters. deep.
2. Evenly scatter grass seeds over each pan.
3. Place the pans in the sunlight.

(t to b, 3, tr, cr)McGraw-Hill Education, (2, 4)Ken Cavanagh/McGraw-Hill Education, (5)Jacques Cornell/McGraw-Hill Education (6) Ken Cavanagh/McGraw-Hill Education

4. Every other day, pour the same amount of water on the seeds in both pans.

5. **Observe** What do the pans look like after three days? After one week?

The pan with potting soil should

show more plant growth after each

period.

## Draw Conclusions

6. Why is it important to make sure the pans get the same amount of light and water?

The amount of light and water must be the same for both samples so

that the only variable, or difference between the two samples, is the

type of soil.

7. **Infer** What differences between the potting soil and the sand may have affected the plant growth?

The plants needed the nutrients in the soil. Sand does not have as

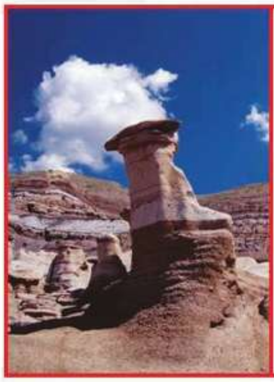
many nutrients available for plant growth.

# CHAPTER 9 Review

## Visual Summary

**Summarize each lesson in your own words.**

Minerals Minerals are identified by observing properties such as color and streak.



Rocks Rocks are produced in different ways and have different properties.

Soil Soil is a natural resource made of a mixture of nonliving material and once-living things.

## Vocabulary

Fill in each blank with the best term from the list.

hardness
igneous rock
luster
mineral
rock cycle

sedimentary rock
soil
soil horizon
streak
top soil

**1.** A mixture of minerals, bits of rock, and pieces of once-living parts of plants and animals is soil.

**2.** A solid, natural material made from nonliving substances in the ground is a(n) mineral.

**3.** As lava or magma cools, a(n) igneous rock is formed.

4. Most plant roots grow in top soil.

**5.** The continuous process in which rocks change from one kind into another is called the rock cycle.

**6.** The way a mineral reflects light is its luster.

7. The color of a mineral's powder is called streak.

**8.** Friedrich Mohs created a scale to measure the hardness of a mineral.

**9.** Each layer of soil is called a(n) soil horizon.

**10.** A rock that forms from sediments is called sedimentary rock.

# CHAPTER 9 Review

## Skills and Concepts

Answer each of the following in complete sentences.

**11.** Fact and Opinion **Some minerals contain crystals.** Is this statement a fact or an opinion? Explain your answer.

The statement is a fact. It can be observed and tested to see if it if true.

**12.** Summarize Write a description of the soil horizons.

The A horizon contains humus and is called topsoil. The B horizon, or subsoil, has lots of fine particles of rock. The C horizon is made mostly of larger pieces of weathered rock. They rest on solid, unweathered bedrock.

**13.** Use Variables You are doing an experiment to determine and compare the hardnesses of talc, fluorite, and calcite by scratching them with your fingernail. Which variable could you change in this experiment? How could changing this variable affect the results?

You could change the pressure with which you scratch the minerals with your fingernail. This change might reveal more about the hardness of the materials.

**14.** Critical Thinking Why do metamorphic rocks not form at depths greater than 20 km below Earth's surface?

It is too hot for metamorphic rocks to form below that depth.

**15.** True or False **Heat and pressure can change the properties of a rock.** Is this statement true or false? Explain.

True. Rocks can melt as they get hotter. The grains can also be changed under great pressure.

**16.** Main Idea and Details How are the three types of rock formed?

Igneous rocks form when molten rock cools. Sedimentary rock forms when sediments are stuck together. Metamorphic rocks form when igneous or sedimentary rocks move deep underground where there is great heat and pressure.

**17.** Explanatory Writing Explain how you can tell that this is an extrusive rock and not an intrusive rock.

It is shiny and glassy, which shows that it cooled and hardened very quickly. Large crystals did not have time to form.

**18.** What are minerals, rocks, and soil?

Possible answer: Minerals are solid materials formed in nature. Rocks are made up of minerals. Soil is a mixture of rocks, minerals, and once-living things.

# Test Preparation

Circle the best answer for each question.

**1.** Which mineral property describes how easily a mineral can be scratched?

- **A** streak
- [✓ B] hardness
- C cleavage
- **D** reaction to acid

**2.** All are changes that happen in the rock cycle EXCEPT __________.

- [✓ **A**] magma → sedimentary rock
- B igneous rock → sediments
- C metamorphic rock → magma
- **D** sediments → sedimentary rock

**3.** A student tested the hardness of four mineral samples by using each sample to scratch the others. Mineral 1 scratched Mineral 2 but would not scratch Mineral 3. Mineral 2 would not scratch any of the others. Mineral 4 scratched Mineral 3. Which list shows the mineral samples in order from softest to hardest?

- **A** 1, 2, 3, 4
- B 1, 3, 4, 2
- [✓ C] 2, 1, 3, 4
- **D** 2, 4, 1, 3

**4.** Which properties are most helpful in identifying minerals?

- **A** weight and shape
- B size and ability to float
- [✓ C] luster and streak
- **D** shape and color

*Use the chart below to answer question 5.*

| Rock Group | Characteristics |
|---|---|
| | forms as melted rock cools and hardens into a solid |
| | forms when rocks are exposed to increases in heat and pressure |
| | forms when pieces of rocks and minerals are cemented together |

5. The chart above lists characteristics of the three main rock groups. Which order correctly fills in the left column (top to bottom)?

- **A** igneous, sedimentary, metamorphic
- B lava, igneous, metamorphic
- C sedimentary, metamorphic, igneous
- [✓ **D**] igneous, metamorphic, sedimentary

**6.** Study the table below.

| Hardness | Mineral |
|---|---|
| 1 | talc |
| 2 | gypsum |
| 3 | calcite |
| 4 | fluorite |
| 5 | apatite |
| 6 | feldspar |
| 7 | quartz |
| 8 | topaz |
| 9 | corundum |
| 10 | diamond |

Copper has a hardness of 3. Which minerals would copper most likely scratch?

**A** topaz and talc
B apatite and diamond
[✓ C] gypsum and talc
**D** feldspar and quartz

**7.** You are trying to find out what kind of mineral you have. You will need a white tile to find out which property?

**A** color
B hardness
C luster
[✓ **D**] streak

**8.** What causes an igneous rock to change into a metamorphic rock?

**A** weathering and erosion
[✓ B] heat and pressure
C compaction and cementation
**D** melting and cooling

**9.** A student placed a liquid on a mineral and the mineral began to fizz and bubble. What property was the student investigating?

**A** cleavage
B hardness
C luster
[✓ **D**] reaction to acid

**10.** Rocks are changed by conditions above and below Earth's surface. Explain how a sedimentary rock can become an igneous rock.

As sedimentary rocks are pushed underneath Earth's crust, heat and pressure melt them into magma. The magma becomes lava if it erupts through a volcano. As the lava cools and hardens, it becomes igneous rock.

# Careers in Science

UD_CAR_002P_288009.jpg

## Cartographer

Do you like making maps and charts? Do you have good math and computer skills? If so, then you might become a cartographer, or mapmaker. Whenever families go on road trips or truckers do their jobs on the highways, they depend on maps or a global positioning system (GPS). Other people who depend on maps or GPS include airplane pilots, ship captains, hikers—most anyone who is going anywhere. Following high school, you'll need a college degree in geography and cartography. After that, it's on to further studies for a fascinating career.

▲ **This cartographer is analyzing a map.**

### Write About It

What are the skills and knowledge required for a cartographer? What does a cartographer do every day? Write a job announcement for a cartographer that you might see in a newspaper, trade magazine, or online employment search site. Be sure to list all the qualifications and duties for this job.

Answers will vary. Accept reasonable responses.

# Science, Technology and Engineering

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## CHAPTER 10

# Technology and Design

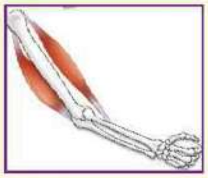
## How do we design technologies to meet our needs?

Answers will vary. Accept reasonable responses.

### Vocabulary

**technology** all of the ways that humans adapt nature to meet their needs

**prosthesis** an artificial extension that replaces a body part



**musculoskeletal system** the system that includes the parts of the muscular system and the skeletal system

**model** a representation of a product or an idea

**design process** a series of steps for developing products and processes that solve problems

**prototype** a full-sized working model that can be tested

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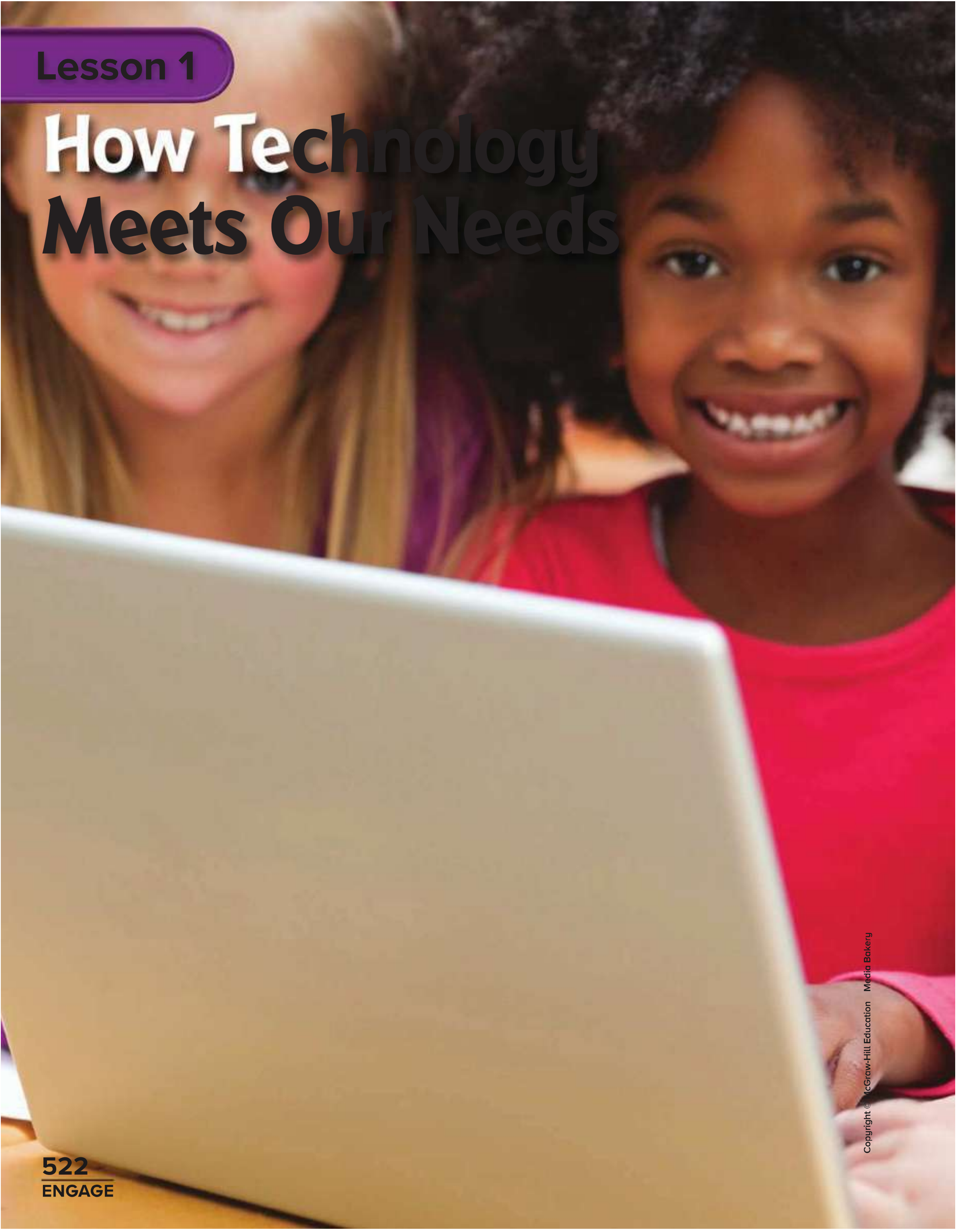
Before reading this chapter, write down what you already know in the first column. In the second column, write down what you want to learn. After you have completed this chapter, write down what you learned in the third column.

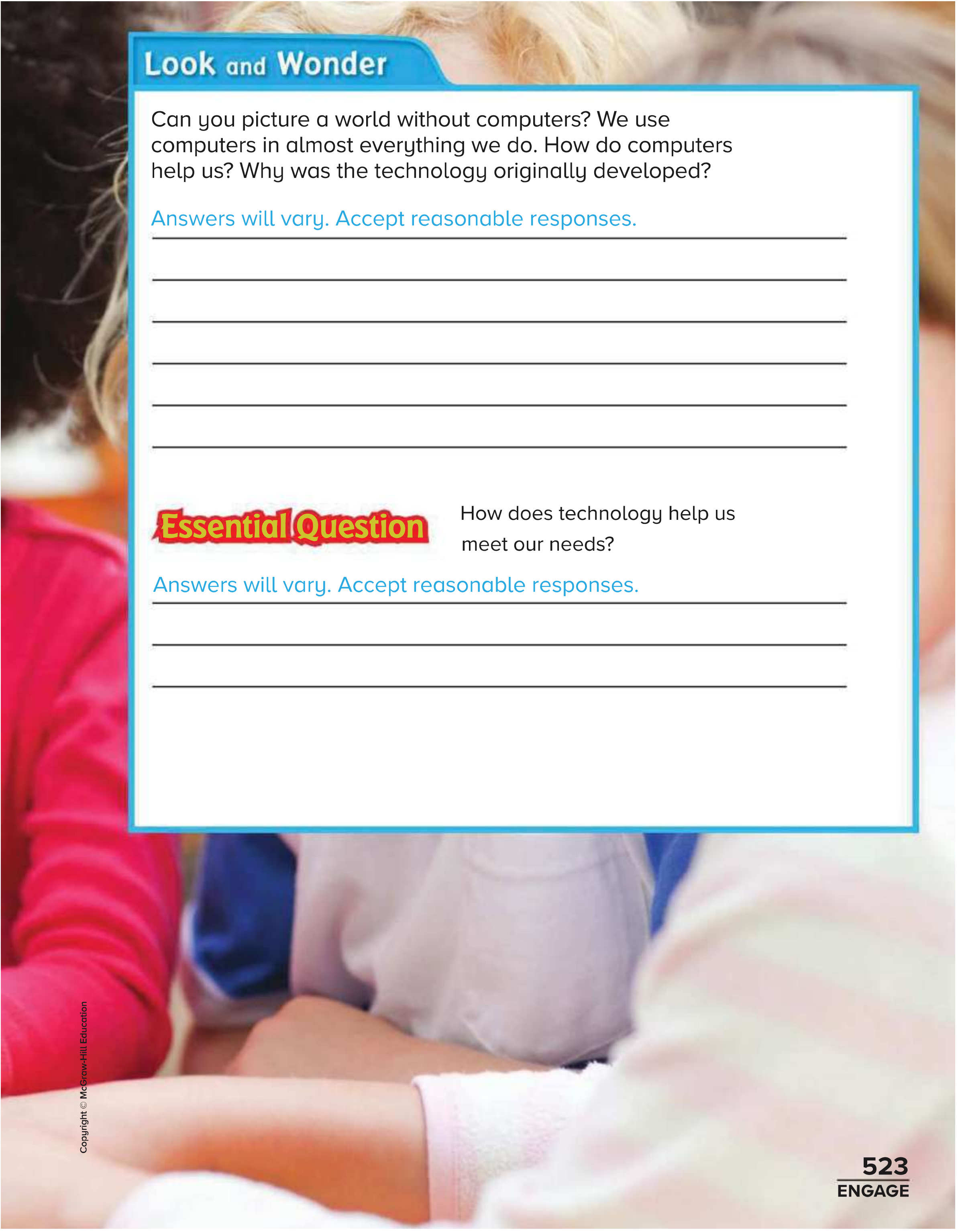
## Technology and Design

| What We **K**now | What We **W**ant to Know | What We **L**earned |
|---|---|---|
| New products are being designed all the time. | How do people create new products? | |
| People try to make products more useful. | How do people test the safety of products? | |
| People try to make products safer. | | |

## Lesson 1

# How Technology Meets Our Needs





## Look and Wonder

Can you picture a world without computers? We use computers in almost everything we do. How do computers help us? Why was the technology originally developed?

Answers will vary. Accept reasonable responses.

**Essential Question** How does technology help us meet our needs?

Answers will vary. Accept reasonable responses.

# How can we get freshwater from salt water?

## Purpose

You will construct a device that allows you to obtain freshwater from salt water.

## Procedure

1. Use the measuring cup to add water to the bowl until it is about 3 centimeters deep. Keep track of how many cups of water are in the bowl.
2. **Measure** Add 29 milliliters of salt for every cup of water that is in the bowl. Stir the solution until the salt dissolves.
3. Place the beaker in the middle of the bowl. The top of the beaker should be below the top edge of the bowl.
4. Cover the bowl with plastic wrap. Place the rock on top of the plastic wrap, directly over the beaker.
5. **Observe** Carefully place your setup in a warm area. Observe the setup each day for 1 week. Record your observations. Where does the freshwater collect?

The freshwater collects in the beaker.

### Materials

- salt
- water
- measuring spoons
- measuring cup
- large bowl
- beaker
- plastic wrap
- tape
- small rock

## Draw Conclusions

⑥ Why might people need to obtain freshwater from salt water?

People might live near an open ocean and not near any source of freshwater for drinking or raising crops.

⑦ **Communicate** How did you use the materials to solve a problem?

Answers will vary.

## Explore More

Is there a way to obtain more freshwater? How could you make your device work better? Test your device and present your results.

Answers will vary.

## Open Inquiry

Do you think you could remove sugar or dirt from water in the same way?

Why or why not? Answers will vary. Accept reasonable responses

# Read and Respond

## What is technology?

Look around you. What do you see? Maybe you see computers, televisions, and cell phones. All of these things are technology. Perhaps you also see desks, books, doors, and windows. These things are also technology. **Technology** is all of the ways humans adapt or change nature to meet their needs. Technology is all of the products and inventions made by people.

Draw a circle around the type of television your grandparents may have had.

Technology is designed to solve human problems. Technology began years ago when humans changed natural materials to make them more useful. Since that time, humans have continued to develop new techniques, make design improvements, and use new materials.

Technology is always changing. Your grandparents may have had a black-and-white television in their home when they were your age. When your parents were growing up, they might have had bo shaped color television. Today you may have a television with a flat screen.

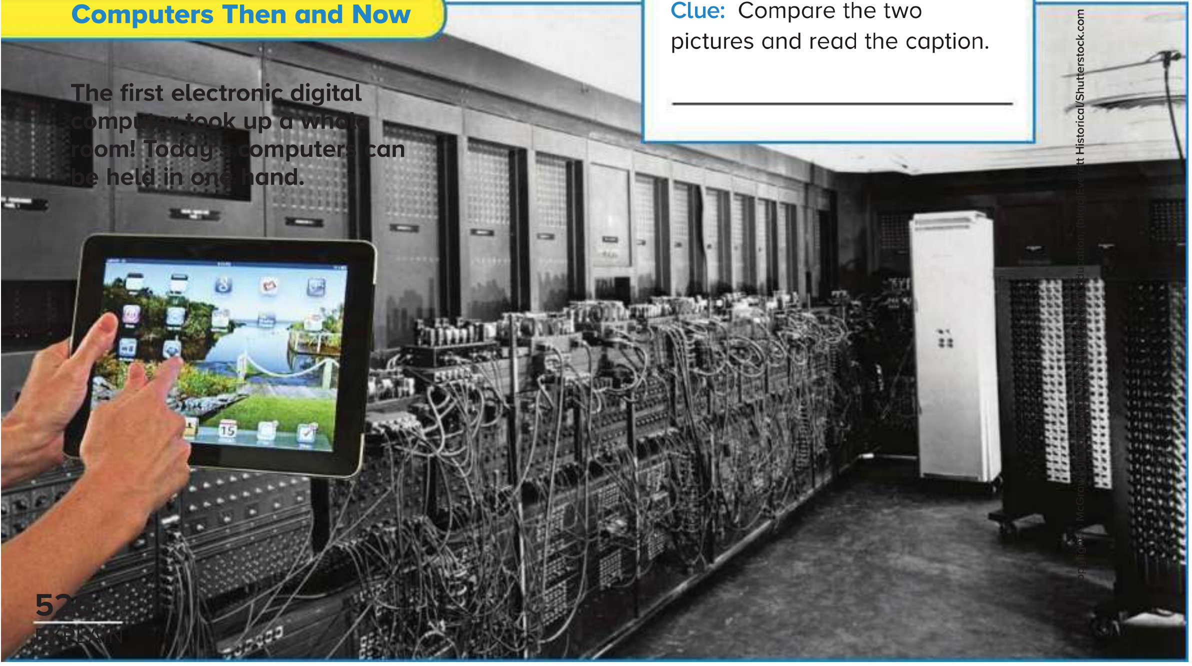
**Read a Photo**

**How have computers changed since they were first invented?**

**Clue:** Compare the two pictures and read the caption.

______________________________

**Computers Then and Now**



**The first electronic digital computer took up a whole room! Today's computers can be held in one hand.**

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**The invention of the microscope allowed cells to be discovered.**

You may have noticed that the words *science* and *technology* are often used together. This is because technology depends on science. Before a solution to a problem can be developed, humans must understand the scientific principles behind the problem. For example, doctors have to understand the causes of diseases before they can treat them.

Humans also use technology to gain more scientific knowledge. For example, technology like computers, CAT scans, and MRIs allow doctors to learn more about the human body. This allows people to develop new technology to treat diseases. Science and technology go hand in hand.

**Quick Lab**

To learn more about the factors that change the brightness of a lightbulb, do the Quick Lab in the activity workbook.

### Quick Check

1. How is technology involved in scientific advances?

______________________________

______________________________

______________________________

______________________________

2. Why are pencils and paper considered technology?

______________________________

______________________________

______________________________

## How does technology help us?

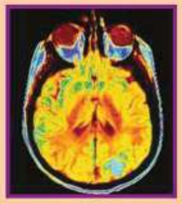
Now that you know what technology is, you might realize that we use technology in almost everything that we do! There are several different fields of technology. The fields that are discussed on this page are changing rapidly.

**Quick Check**

3. Underline the needs that each field of technology discussed on this page meets.

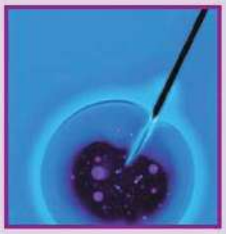
**Fields of Technology**

### Medical Technology



*Biotechnology* is the field of technology that uses knowledge about living things to meet human needs. Medical technology is a type of biotechnology. It focuses on developing devices and methods that improve how we diagnose and treat disease.

### Medical Technology



Genetic engineering is another type of biotechnology. It allows scientists to alter an organism's genetic makeup. Genetic engineering is used in many different fields today. For example, some bacteria can be genetically engineered to clean up oil spills.

### Transportation Technology

Since the invention of the wheel thousands of years ago, humans have continued to develop faster and more effective ways of getting around. The invention of the wheel allowed humans to design chariots. Today jet engines and maglev trains allow us to travel thousands of miles in just hours.

### Communication Technology

Communication technology has progressed from smoke signals to computers, cell phones, and the Internet, with several other technologies in between, allowing people to share information with others. Each new type of technology built on a previous technology.

(tl)National Cancer Institute/Getty Images, (tr)Don Farrall/Getty Images, (bl)U.S. Navy photo by Ronald Dejarnett, (br)Martial Colomb/Photographer's Choice RF/Getty Images

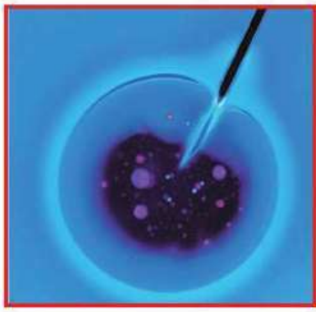
# My Notes

## Visual Summary

Complete the lesson summary in your own words.

**Technology** Technology is how humans adapt nature to meet their needs.

**Science and technology** Science and technology go hand in hand.



**Fields of technology** There are several different fields of technology: medical technology, transportation technology, genetic engineering, and communication technology.

## Think, Talk, and Write

① **Vocabulary** Define technology in your own words.

Possible answer: Technology is how people change nature to solve their problems.

② **Cause and Effect** Give an example of how an advancement in science has affected technology.

| Cause | Effect |
|---|---|
| Possible answer: Doctors learned the causes of some diseases | Possible answer: People were able to develop treatment methods |

③ **Critical Thinking** How is technology different than science?

Possible answer: Science explains how things happen. Technology uses the scientific principles to solve problems.

④ **Test Prep** **Which is an example of technology?**

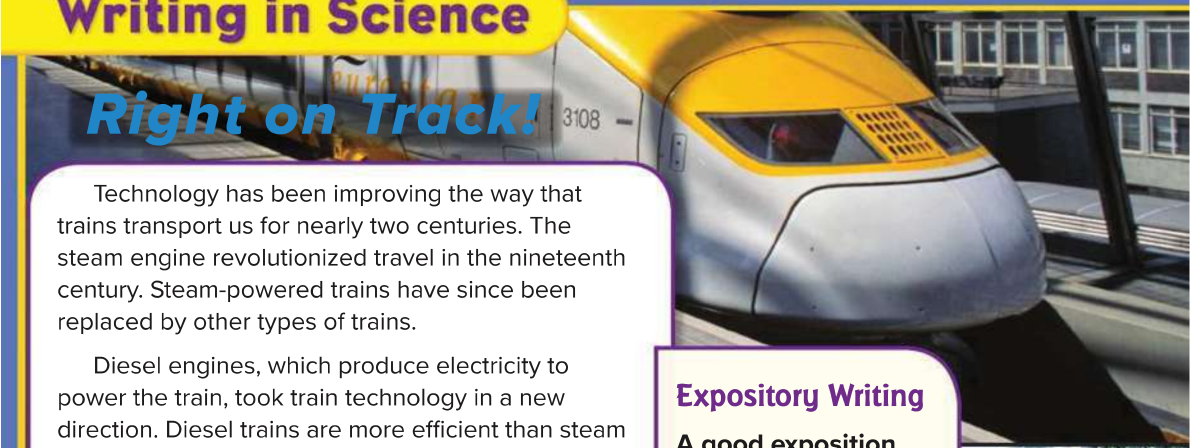
[✓ **A**] lumber
**B** apple
**C** soil
**D** tree

**Essential Question** How does technology help us meet our needs?

Technology uses science to help humans change natural materials to make them more useful.

## Writing in Science

# Right on Track!



Technology has been improving the way that trains transport us for nearly two centuries. The steam engine revolutionized travel in the nineteenth century. Steam-powered trains have since been replaced by other types of trains.

Diesel engines, which produce electricity to power the train, took train technology in a new direction. Diesel trains are more efficient than steam trains, and are still used today.

Electric trains powered by overhead cables or electrified rails represent another advance in technology. These fast, quiet trains are used by millions of commuters in and around large cities. Some are called “bullet trains” due to their unique shape and high speed.

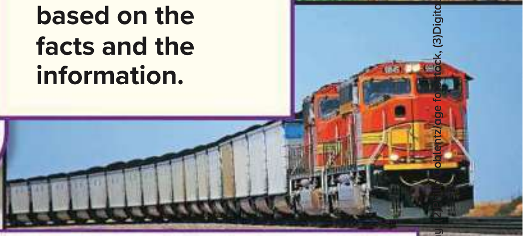
The latest technology is the maglev, or magnetic levitation train. Electromagnets in the train and track produce charges that repel each other, making the vehicle “float” as it moves. Because the train and track don’t touch, maglevs are very fast and efficient.

A drawback of trains is that they are restricted to tracks. However, as technology makes trains faster and quieter, trains are “on track” to become a main transportation method in many cities.

### Expository Writing

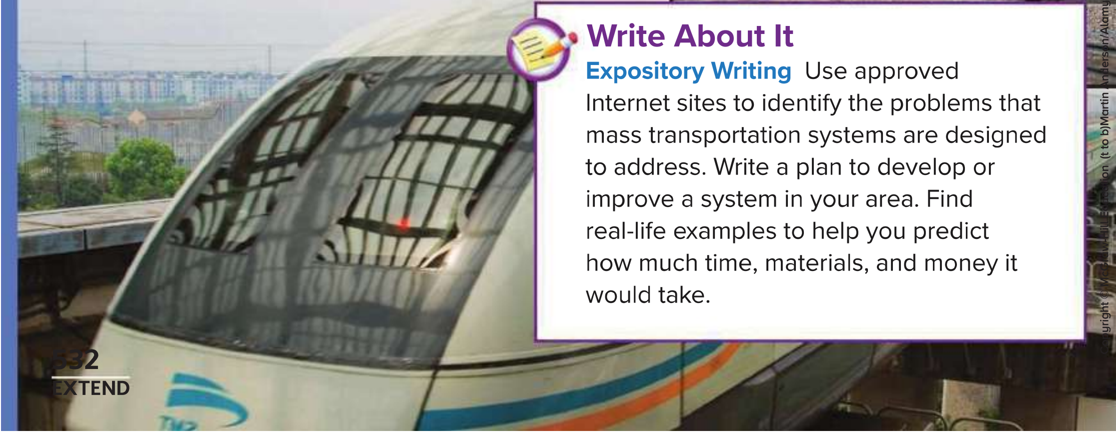
**A good exposition**

- **develops the main idea with facts and supporting details;**
- **summarizes information from a variety of sources;**
- **uses transition words to connect ideas;**
- **draws a conclusion based on the facts and the information.**



### Write About It

**Expository Writing** Use approved Internet sites to identify the problems that mass transportation systems are designed to address. Write a plan to develop or improve a system in your area. Find real-life examples to help you predict how much time, materials, and money it would take.



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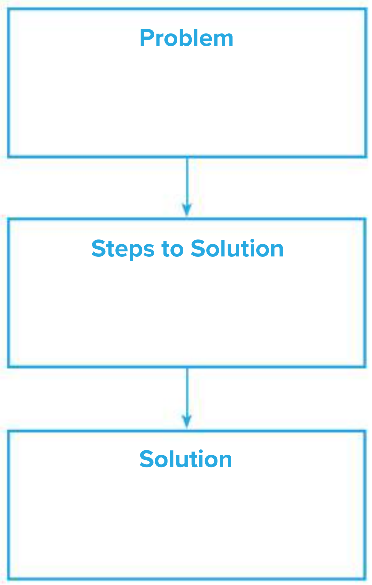
## Getting Ideas

Copy the chart below on a piece of paper. Identify a problem that occurs with a mass transportation system in your area. Write this problem in the top box of the chart. In the center box, write steps you would take to help solve this problem. In the bottom box, write how you think the problem would best be resolved.



## Drafting

Write a sentence to begin your plan. Tell what the problem is and how you would solve it.

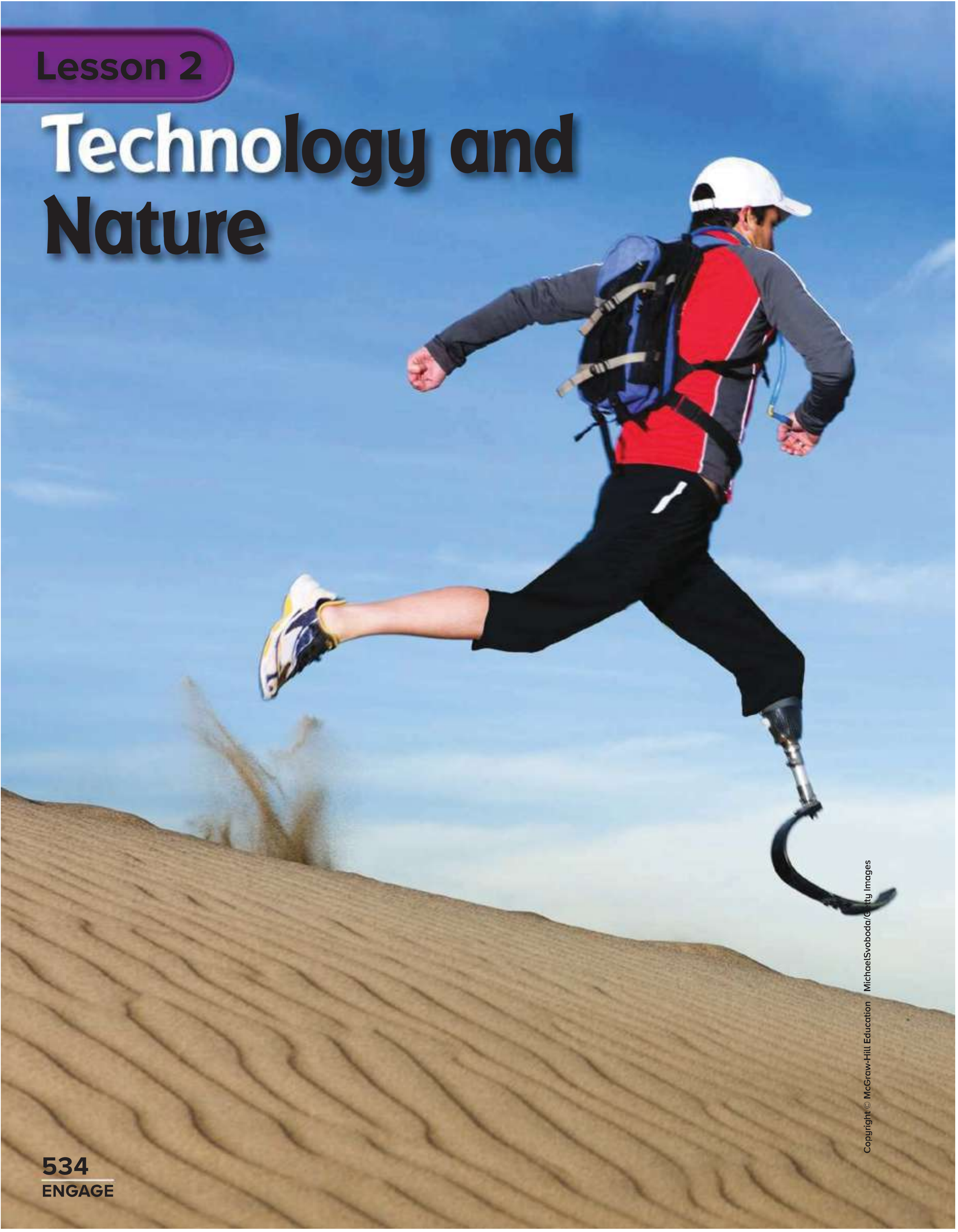
Write your plan on a separate piece of paper. Explain why a model would be useful in designing the solution to your problem. Include any limitations in cost or design features that might affect the outcome.

## Revising and Proofreading

Now revise and proofread your writing.

## Lesson 2

# Technology and Nature



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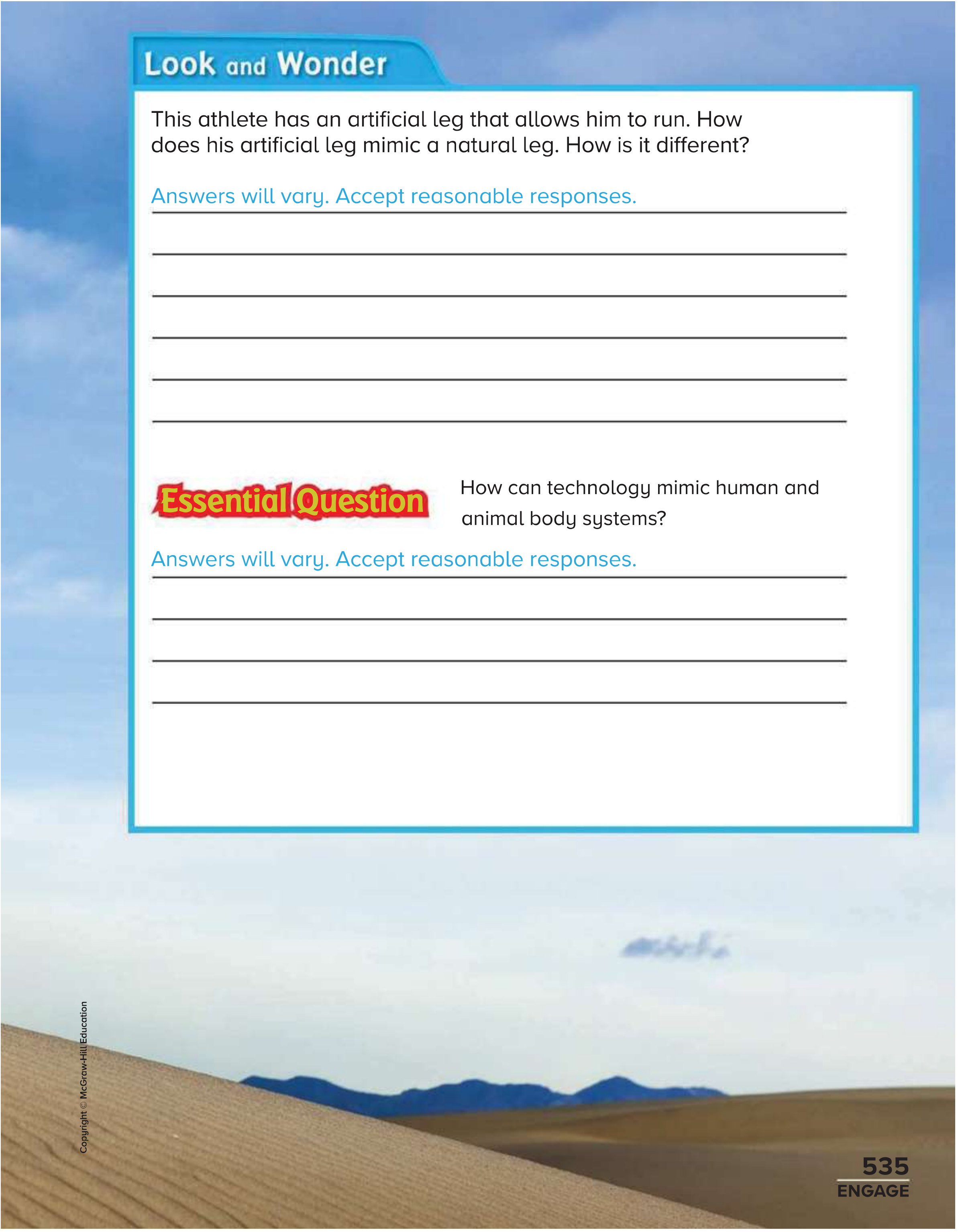

## Look and Wonder

This athlete has an artificial leg that allows him to run. How does his artificial leg mimic a natural leg. How is it different?

Answers will vary. Accept reasonable responses.

**Essential Question** How can technology mimic human and animal body systems?

Answers will vary. Accept reasonable responses.

# How can you build a model that works like a human hand?

## Purpose

Work with classmates to make a model hand that can pick up a piece of paper.

## Procedure

1. **Observe** Move your hand and fingers, watching to see how the bones and muscles work together.
2. Pick up a piece of paper using just two fingers of one hand. Notice which parts of your hand move.
3. Record how the different parts of your hand moved as you picked up the paper.
4. **Make a Model** Using any materials available, construct a model of a human hand that allows you to pick up the paper without touching it with your own hands.

### Materials

- drinking straws
- scissors
- rubber bands
- craft sticks
- chenille stems
- wire hangers
- any other objects you think you can use

Step 4

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## Draw Conclusions

5 **Communicate** Share your model with other groups, and observe their models. Was one model better at picking up a piece of paper than others? Explain.

Answers will vary.

6 **Infer** Why do new technologies often mimic nature?

Answers will vary.

## Explore More

Could you construct a model leg that can kick a football? The model should have enough strength to move a football by kicking it. What materials would you need? Make your model and test it. Share your model with your classmates.

Answers will vary.

# Read and Respond

## How can technology mimic nature?

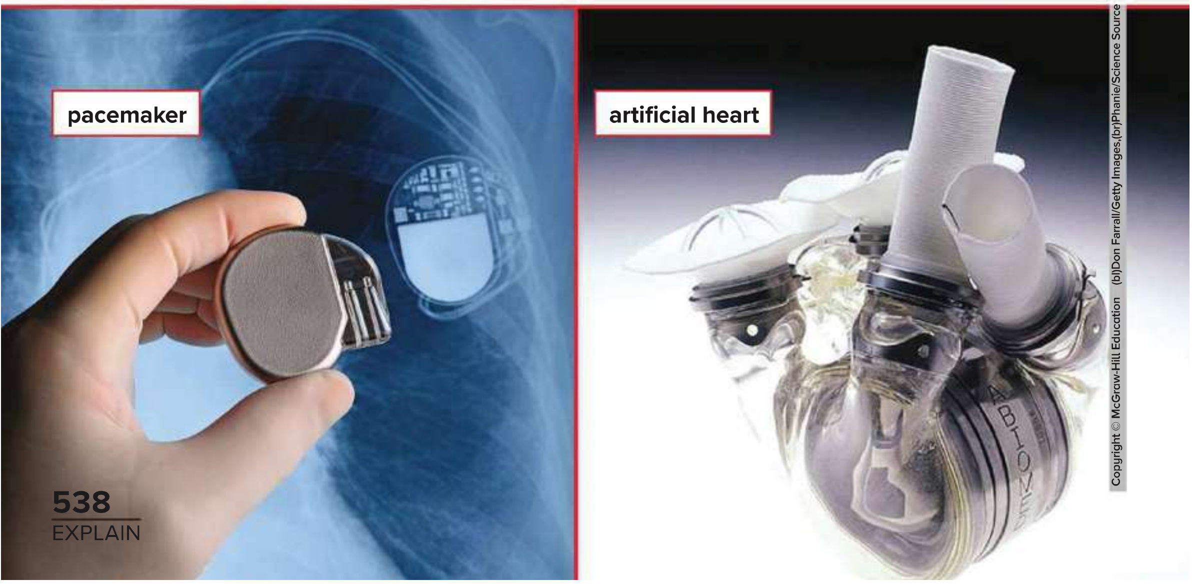
Underline three objects that imitate objects that occur in nature.

When you think of technology, computer chips, robots, televisions, and spacecraft might come to mind. Nature seems to have nothing to do with technology—or does it? In fact, nature plays an essential role in the invention of many new technologies.

Many types of technology are created to mimic, or imitate, objects that occur in nature. Artificial lungs “breathe” air like real lungs. An electronic implant, such as a hearing aid, enhances the ear’s ability to hear. A pacemaker helps a heart maintain its correct rhythm.

Technology does not necessarily have to be complex to be effective. A pair of tweezers or forceps, for example, is very simple. It doesn’t have a motor, wires, or a computer chip in it. Yet when we use tweezers or forceps to grasp a small object, they mimic the motion of two fingers.

**These technologies are designed to mimic nature. A pacemaker regulates a human’s heartbeat. An artificial heart can replace a person’s natural heart.**



(bl)Don Farrall/Getty Images,(br)Phanie/Science Source

**Many airplanes are designed to mimic the position and shape of bird wings in flight.**

## Bionics

Our bodies are amazing structures, with many parts that constantly interact. If a part is damaged or diseased, it can affect our entire body. Medical engineers work to develop systems that can replace body parts that are injured or missing. This field is known as *bionics*.

Some people receive donor organs from other people when they are in need of a new heart or lung. However, donor organs are not always available. Artificial organs, including hearts, lungs, kidneys, and even eyes, are now a possibility, thanks to bionics.

## Transportation

Technology that mimics nature can be found in transportation as well. Scientists noticed that birds adjust their wings to change the way air flows over them as they fly. Many airplanes' wings are built to mimic birds' wings. The shape of the wing causes air to move faster over the top of the wing than the bottom. As the air moves it lifts them into flight.

### ✓ *Quick Check*

1. **Why do scientists create technologies that mimic objects in nature?**

Most natural objects and systems

help individual organisms survive.

So scientists think the design must

work well and they try to copy it.

Copyright © McGraw-Hill Education (t)Rob Wilson/Shutterstock.com, (b)Don Hammond/Design Pics

**Quick Lab**

To learn how to mimic human actions with physical tools, do the Quick Lab in the activity workbook.

## What is a prosthesis?

Throughout much of history, wooden peg legs and metal hookshaped hands were used to replace human limbs when they were lost. These are early examples of prosthetics. A **prosthesis** (prahs•THEE•sis) is an artificial extension that replaces a body part. Human body parts may need to be replaced due to accidents, diseases, or birth defects.

As technology improved, hinges were added and the materials used to make prostheses changed. The basic structure and purpose, though, remain the same. Today, each prosthesis is different. Each is customized for the person and for its intended use. Modern prostheses move, function, and often even look like real body parts.

Prostheses replace the function of the skeletal and muscular system of the missing limb and often allow patients to live normal lives. A *skeletal system* includes all of the bones and cartilage in a human's or an animal's body. It supports, protects, and gives shape to the body. The power to produce movement is provided by the muscular system. The *muscular system* includes the muscles that move bones and other body parts. Together, the parts of the muscular and skeletal systems make up the **musculoskeletal system**.

**Modern prostheses allow people with missing limbs to have much of the function of a normal limb.**

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Just like real limbs, prosthetic limbs have a skeletal system. The *pylon* is the skeleton of the prosthetic limb. It is the internal frame of the prosthesis and provides support.

For many years, prosthetic limbs looked real, but they didn't work like real limbs. They lacked muscles, or a power source. Today, power for prostheses can be created in a variety of different ways. Some prostheses are powered by cables that are connected to other parts of the body. The cable serves as the muscle that moves the prosthetic. Other prosthetics are powered by motors.

Some prosthetic devices have computer chips and sensors. The most advanced prosthetic devices use electrical signals from the brain to move the prosthetic device. The patient thinks about moving

### ✓ *Quick Check*

2. Why are modern prostheses different from older designs?

Possible answer: Modern prostheses are customized for the person and allow more normal movement.

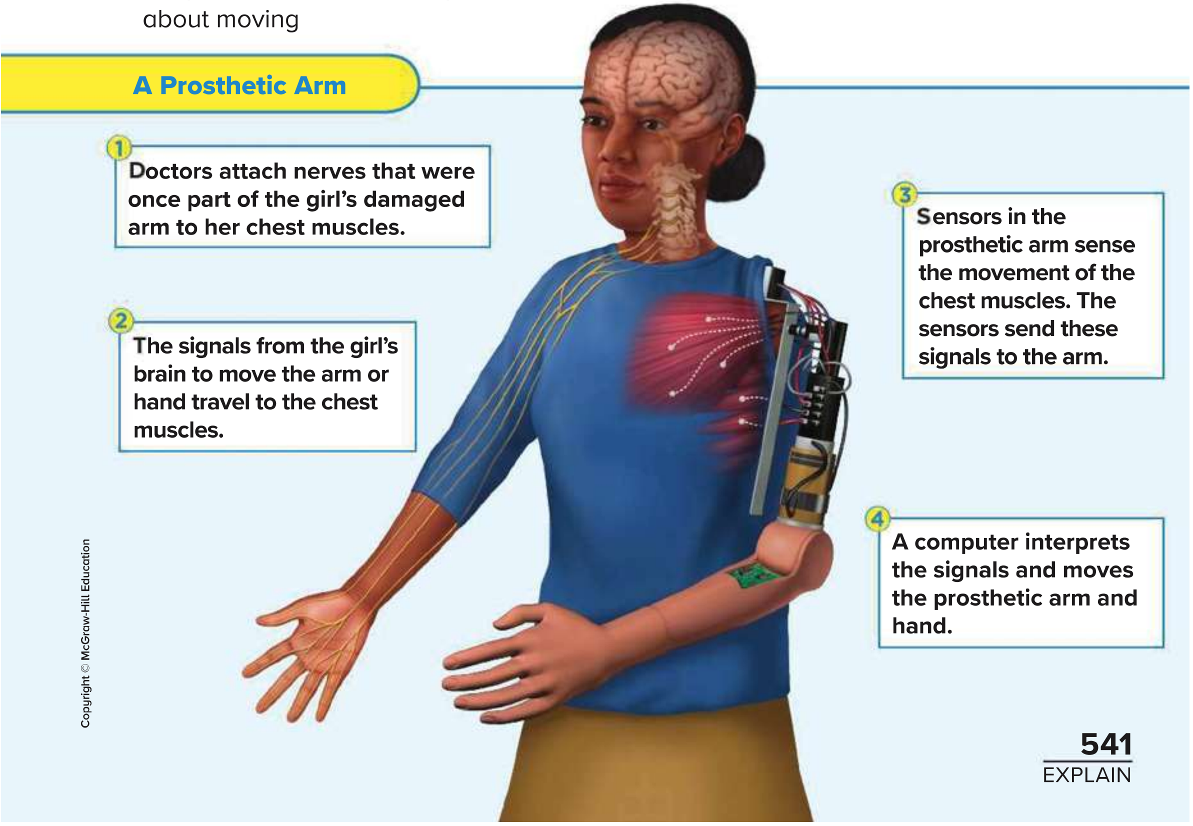
### Read a Diagram

**How is the prosthetic arm controlled?**

by the girl's brain

**Clue:** Read the captions in order.

### A Prosthetic Arm



① **Doctors attach nerves that were once part of the girl's damaged arm to her chest muscles.**

② **The signals from the girl's brain to move the arm or hand travel to the chest muscles.**

③ **Sensors in the prosthetic arm sense the movement of the chest muscles. The sensors send these signals to the arm.**

④ **A computer interprets the signals and moves the prosthetic arm and hand.**


The robotic arm is able to make precise movements during surgery.

## How can technology meet other needs?

Some technologies mimic the human body to perform jobs that are too dangerous or difficult for humans to perform themselves. **Robotics** is the field of science and technology that uses robots. Robots are programmable machines that perform tasks. Robots can have structures that mimic the musculoskeletal system. For example, some robots resemble a human arm. Some robots even mimic animals. Robots are usually controlled by instructions coming from a computer. The computer is operated by a human.

The first industrial robot was invented in 1954. It was an electronic arm that lifted heavy objects. The robots in those days could only perform simple tasks, like welding.

Today, robots can perform several different tasks. For example, doctors might use robots to perform surgery. With robots, doctors can perform surgery from far away.

Robots can sometimes perform motions that the human hand or arm cannot. The movements can also be more precise. Robots are also used in industry. They can put things together, lift heavy objects, and handle hazardous materials.

Robots are often sent to dangerous or inaccessible areas like the surface of Mars. The Mars rovers and other space probes, such as the *Voyagers,* have traveled far into space.

### ✓ *Quick Check*

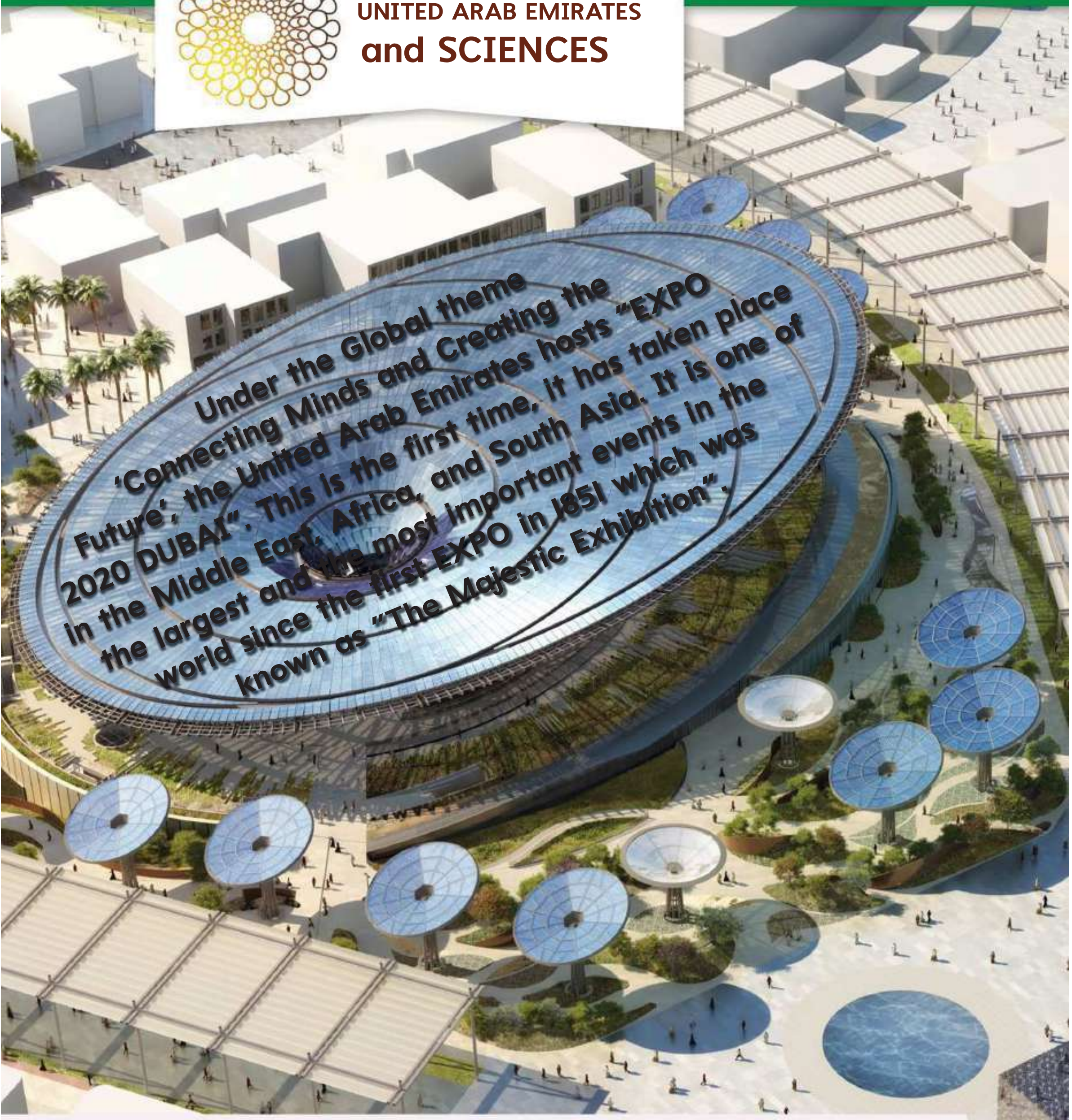
**3. What needs do robots meet?**

They perform dangerous or difficult tasks that humans cannot.

**4. *Critical Thinking* How are most robots controlled?**

Robots are usually controlled by instructions from a computer.

# EXPO 2020 DUBAI
## UNITED ARAB EMIRATES
## and SCIENCES



Under the Global theme 'Connecting Minds and Creating the Future', the United Arab Emirates hosts "EXPO 2020 DUBAI". This is the first time, it has taken place in the Middle East, Africa, and South Asia. It is one of the largest and the most important events in the world since the first EXPO in 1851 which was known as "The Majestic Exhibition".

**Visit** the website of "Expo 2020 Dubai" to know what can be done with food waste to benefit both humanity and nature.

It's time to explore sustainability efforts!

Complete the lesson summary in your own words.

**Technology and Nature** Possible answer: Many types of technology mimic the human body to meet a need.

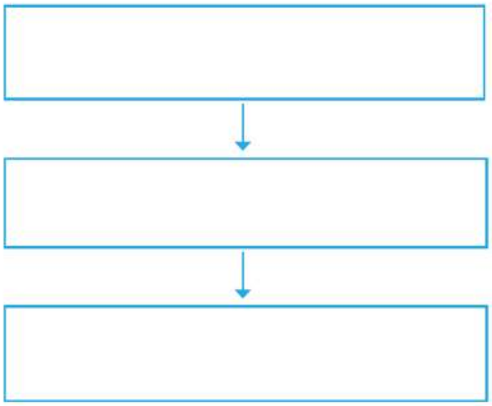
**Prosthetic Limbs** Possible answer: Prosthetic limbs mimic the muscular and skeletal systems of the human body.

**Robots** Possible answer: Robots perform dangerous or difficult tasks that humans cannot.

## Think, Talk, and Write

① **Vocabulary** Define *robotics* in your own words.

② **Problem and Solution** How could you improve the function of a prosthetic limb so it has a better grip?



③ **Critical Thinking** Modern prostheses often allow patients to live normal lives, but not all people who need prosthetic limbs have them. Why?

④ **Test Prep** A device that replaces the function of the musculoskeletal system of a missing limb is a

**A** pylon.    **C** prosthesis
B bionic.    **D** robot.

**Essential Question** How can technology mimic human and animal body systems?

# Living with Prostheses

Today, lost teeth can be replaced with implants. Damaged bones or joints can be replaced with metal or plastic substitutes. If someone loses an arm or a leg in an accident or to disease, it can be replaced with an artificial limb that bends and works a lot like a natural one.

Hugh Herr knows about artificial limbs, or prostheses. At the age of 17, the young mountain climber was stranded for almost 4 days in freezing temperatures. Hugh suffered from frostbite, a condition where skin and other tissues become damaged due to extreme cold. His frostbite was so severe that doctors had to amputate his lower legs. That was in 1982. Today, Hugh is a college professor and an inventor of several prosthetic technologies.

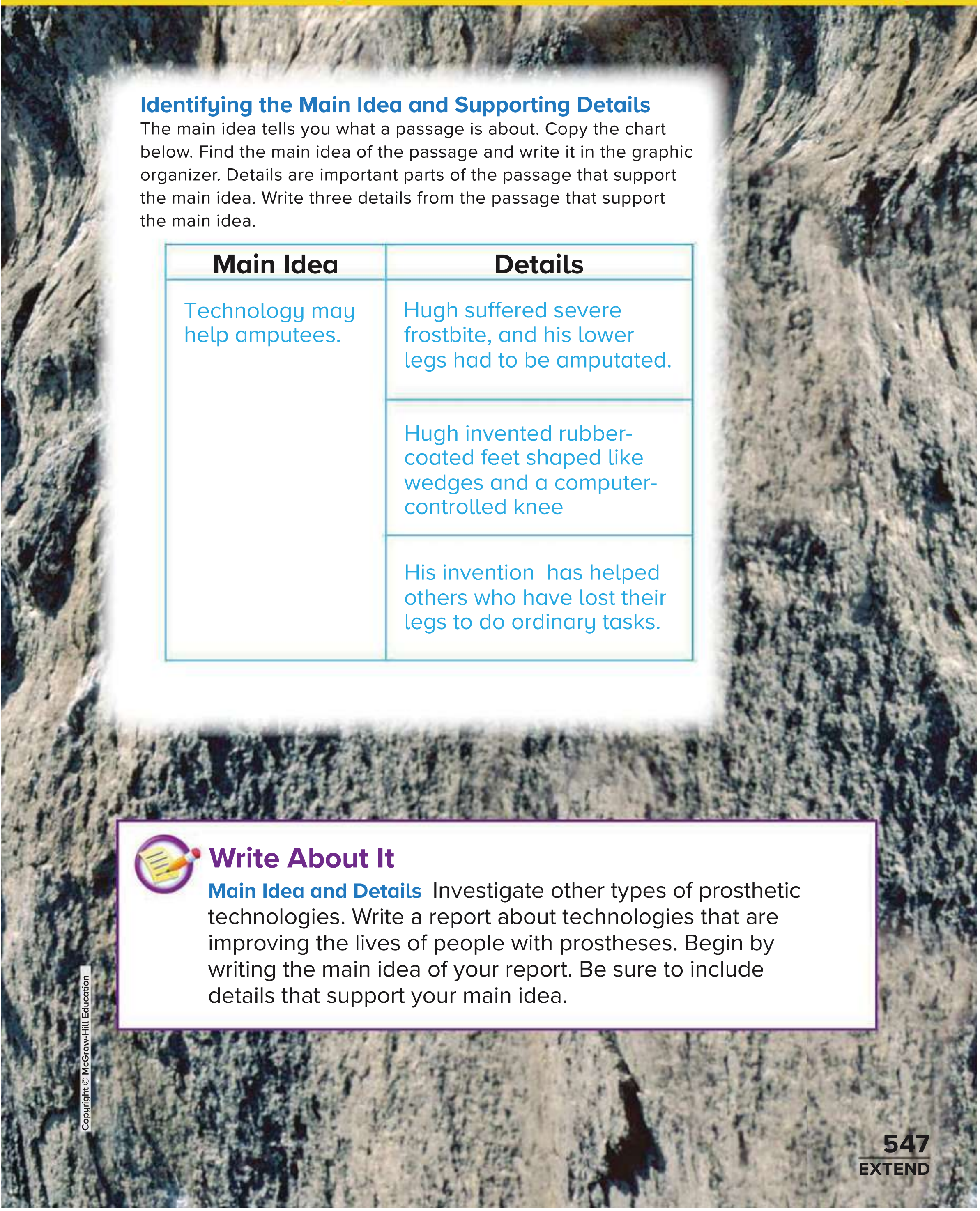
To be able to continue climbing mountains, Hugh invented rubber-coated feet made of light but strong metal. The feet are shaped like wedges, so they can slip right into cracks in the rocks. Hugh also developed a computer-controlled knee. A computer chip inside the prosthesis adjusts to give the right amount of support.

Because of Hugh's inventions, many people who have lost limbs are able to carry out everyday functions, such as climbing stairs. However, Hugh is not finished. He is developing other technologies, including a prosthesis that will pick up signals from a person's nerves and brain, just as a real leg does.

### Main Idea and Details

- Look for the central point of a selection to find the main idea.
- Details are important parts of the selection that support the main idea.

Beth Wold/Aurora Photos



## Identifying the Main Idea and Supporting Details

The main idea tells you what a passage is about. Copy the chart below. Find the main idea of the passage and write it in the graphic organizer. Details are important parts of the passage that support the main idea. Write three details from the passage that support the main idea.

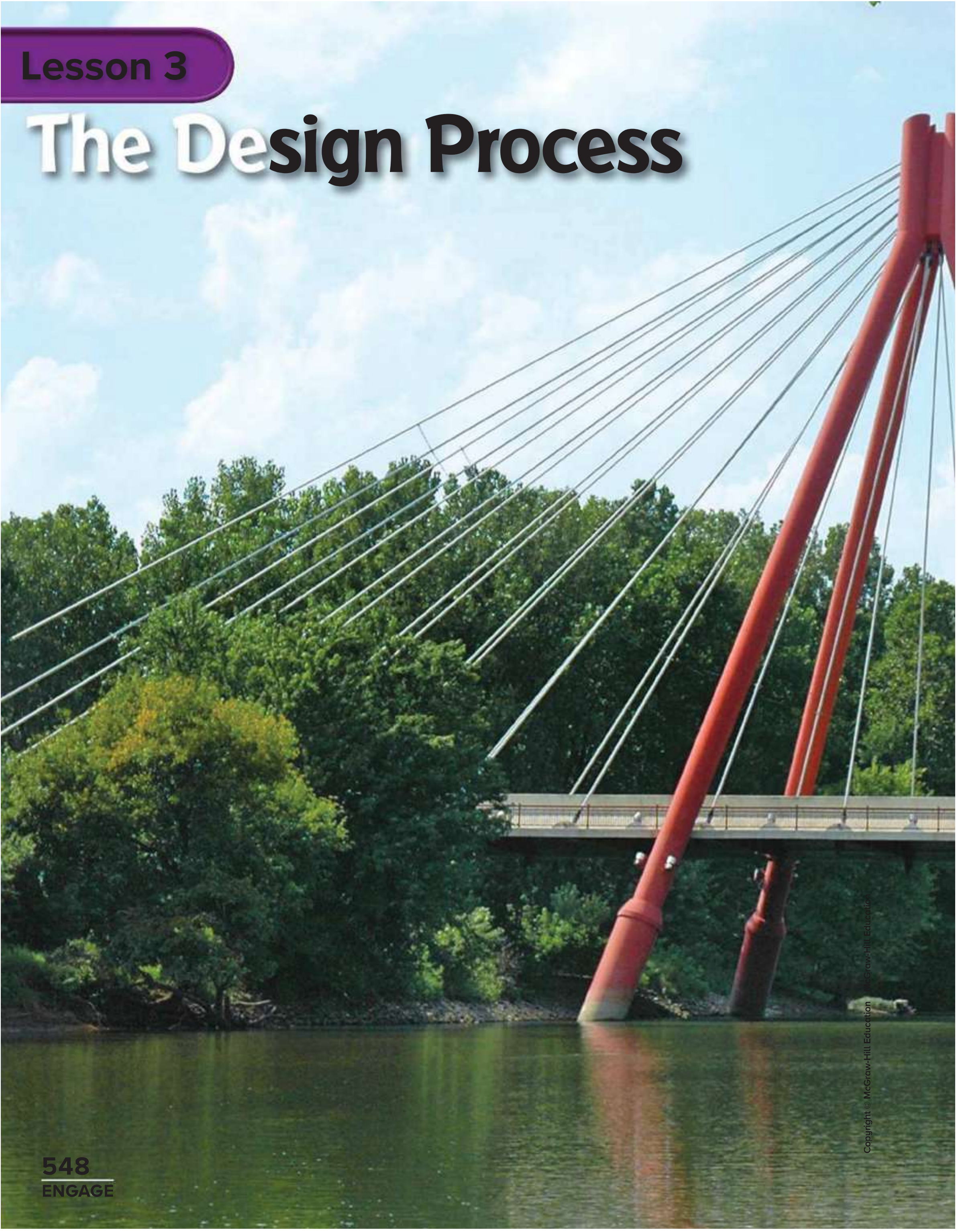
| Main Idea | Details |
|---|---|
| Technology may help amputees. | Hugh suffered severe frostbite, and his lower legs had to be amputated. |
| | Hugh invented rubber-coated feet shaped like wedges and a computer-controlled knee |
| | His invention  has helped others who have lost their legs to do ordinary tasks. |

## Write About It

**Main Idea and Details** Investigate other types of prosthetic technologies. Write a report about technologies that are improving the lives of people with prostheses. Begin by writing the main idea of your report. Be sure to include details that support your main idea.

Lesson 3

# The Design Process



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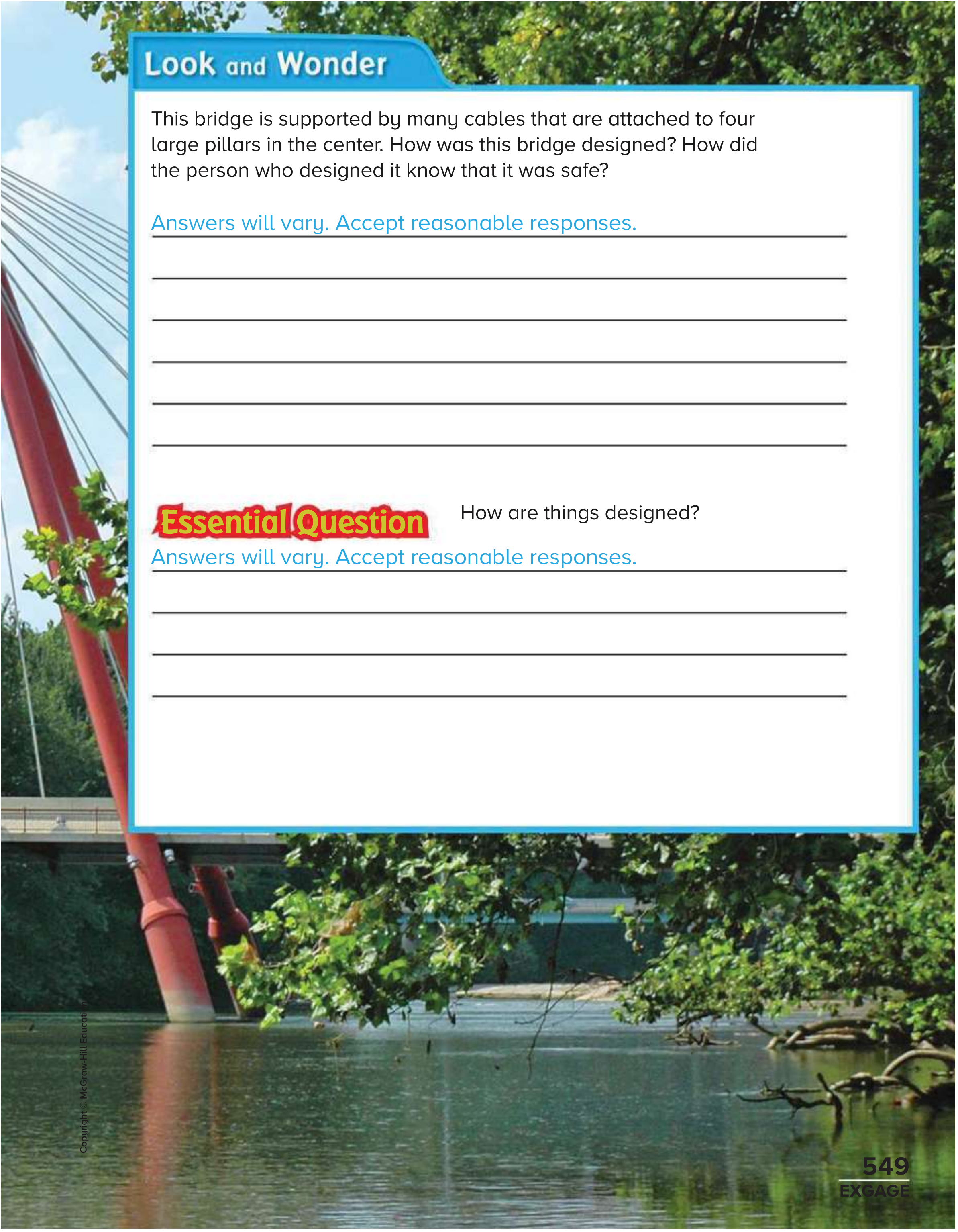


## Look and Wonder

This bridge is supported by many cables that are attached to four large pillars in the center. How was this bridge designed? How did the person who designed it know that it was safe?

Answers will vary. Accept reasonable responses.

**Essential Question** How are things designed?

Answers will vary. Accept reasonable responses.

## How can you design a bridge?

### Purpose

When you design something, you create a plan then build the object. Usually a design will have to meet certain needs. In this activity, you will design the strongest bridge that will cross a 30 cm gap.

**Materials**

- a variety of objects
- plastic cup
- several coins

### Procedure

1. Research different bridge designs before beginning. Choose one type to construct. Sketch the design you chose. Label the design and list the materials you will use to construct the bridge.

2. Construct your bridge.

3. Test your design by placing the plastic cup on the bridge. Add coins to the cup one by one. Keep track of how many coins are in the cup. Record how many coins your bridge held before collapsing.

Answers will vary.

## Draw Conclusions

4 **Interpret Data** Share your results with your classmates. Which design worked best?

Answers will vary, but students will most likely find some elements that all the successful bridges have in common.

5 How could you improve your design to support more weight?

Answers will vary, but students should explain why their proposals would improve their bridges.

6 **Infer** you were building a real bridge, why would it be important to build a model?

Possible answer: Creating a model would help builders lower the cost of making the bridge and increase the safety of the finished product.

## Explore More

How would you change your design if you had different requirements? Design a bridge that must cross a 50-cm gap, but only has to support the weight of a toy car. Test your design.

Answers will vary.

# Read and Respond

## How do we design things?

Do you ever wonder who makes all the technology around you? Just about everything you see started as an idea in someone's mind. People come up with ideas all the time. Some ideas are not practical. However, others help solve a problem or meet a need.

Taking an idea and making it into a solution takes a lot of work. Designers can help. A *designer* is someone who takes an idea and creates a detailed plan to make it a reality.

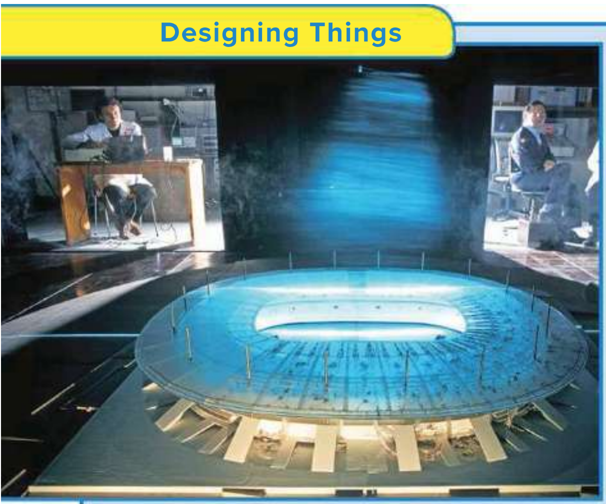
Underline the word that describes someone that takes an idea and creates a detailed plan to make it a reality.

When a design depends on precise measurements, it might involve an engineer. **Engineering** is a profession that involves designing and constructing technological solutions. Just like designers, engineers take ideas and turn them into products. Engineers use their knowledge of mathematics and science to determine how to make something. They might decide what materials should be used, if the product works well, or if it is safe to use. Engineers are more involved than designers in the construction of a product.

**Engineers build all types of technologies.**

**Anyone can develop new technologies, even students like you.**

## Designing Things



The model in the photo on the left is being used to test the effects of wind on the roof of the stadium. The wind is measured using a blue laser.

### Read a Diagram

**Why might designers perform tests on a model of a building?**

**Clue:** Think about the final product.

Possible answer: to make sure

the building is safe

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Most engineers have a certain area of expertise. For example, structural engineers make sure buildings are resistant to earthquakes. Aerospace engineers build and test rockets and spacecraft. Many engineers work closely with designers and other scientists.

## Making Models

Designs often require the construction of a model. A **model** is a representation of the product. Models make it easier to see and understand how an object works.

Models can be made of many different materials. Computers can also make three-dimensional models. Models do not need to be the same size as the actual products. Dams and skyscrapers can be represented as much smaller models. Tiny particles can be represented as much larger models.

### ✓ *Quick Check*

1. **Why might an engineer build a model?**

to perform tests before the

product is actually made

## What is the design process?

Anyone with an imagination can design things. The **design process** is a series of steps for developing products and processes that solve problems. Designers and engineers might follow the design process differently. However, they all have a goal to find a solution to a problem.

### Identify a Need or Problem

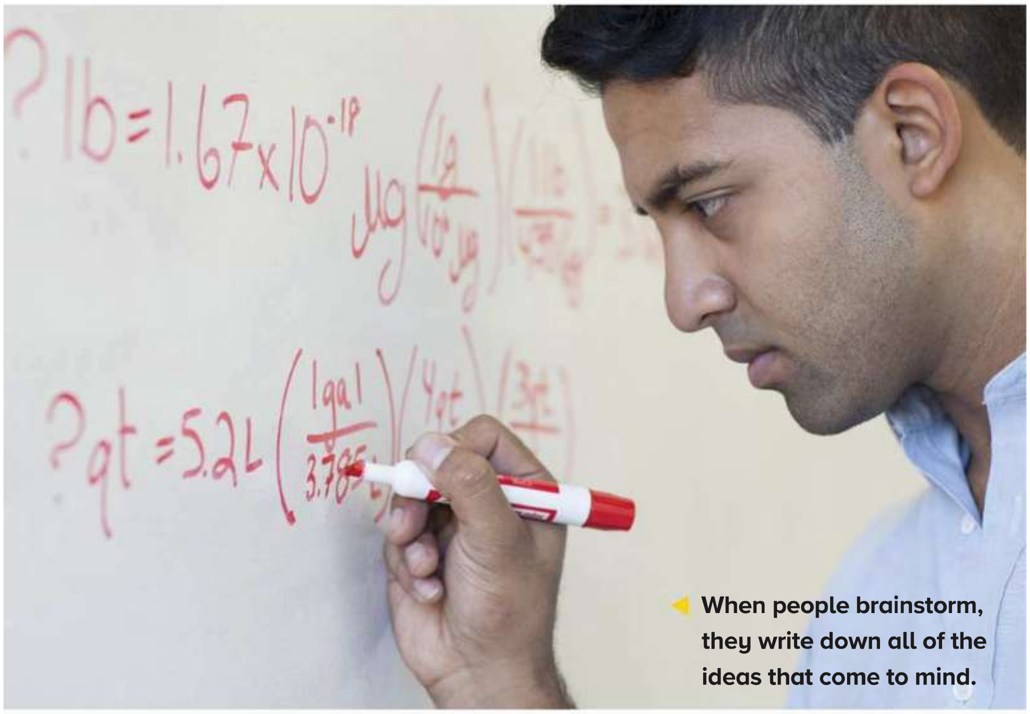
The design process starts when someone identifies a need or problem. How do you identify a problem or know what people need? One way is to observe trends, or patterns. Another way might be to conduct surveys.

Before proceeding with the design, you will need to conduct research. Someone may have already solved the same problem. Sometimes a problem can be solved by making improvements on an existing product.

### Brainstorm Potential Solutions

When you brainstorm, you think of possible ideas for solutions. Write down all your ideas. Some ideas might seem silly. However, silly ideas sometimes trigger other ideas that will work. Most problems have more than one possible solution. Some work better than others.

Be sure to document your work throughout the design process. This means you record what you do and what you learn. Others might need to repeat your procedures to verify your results.



**When people brainstorm, they write down all of the ideas that come to mind.**

## Brainstorm Potential Solutions

After generating possible solutions, you have to pick the best idea to try. In order to select the most appropriate solution, you need to ask questions. What materials will you need? Will the product cost too much to make? What safety risks might there be?

Questions like these help you identify *constraints*, or limitations, and criteria. Criteria are requirements a design must meet. For example, people might want a small, lightweight vacuum that can be easily carried up stairs. A vacuum that is too large does not meet these criteria.

## Select Appropriate Materials

It is important to consider the type of material that will be needed. Some materials might be too expensive.

A solution might work well, but if it is expensive, people might not buy it. Other materials could be dangerous to use.

Look at the three solutions for the design of a vacuum cleaner below. The designer picks the second solution. Why? The first idea would make a lighter vacuum, but heat buildup could melt the plastic. The third idea might be possible someday, but would cost too much to make now.

### ✓ Quick Check

2. **Why is brainstorming important?**

   Brainstorming helps people generate multiple, often different, ideas for a solution to a problem.

3. **Why should criteria and constraints be determined at the beginning of the design process?**

   Possible answer: Designers and engineers do not want to waste time working on a design that cannot be used.

**Solution #1**

Replace materials in vacuum with lighter weight plastic.

**Solution #2**

Make a vacuum that has lightweight, battery-operated, breakaway parts with a telescoping handle.

**Solution #3**

Make a computerized robotic vacuum that climbs stairs and changes tasks by voice command.

## How can you create a solution through a prototype?

After choosing a solution, make a detailed drawing, or **schematic**, of the design. A schematic shows what each part is, where it goes, and what it does. Recall that you can also build a model of the object.

After creating your model or schematic, it is time to make a prototype. A *prototype* is a full-sized working model that can be tested. The prototype can be used to test such things as reliability and safety.

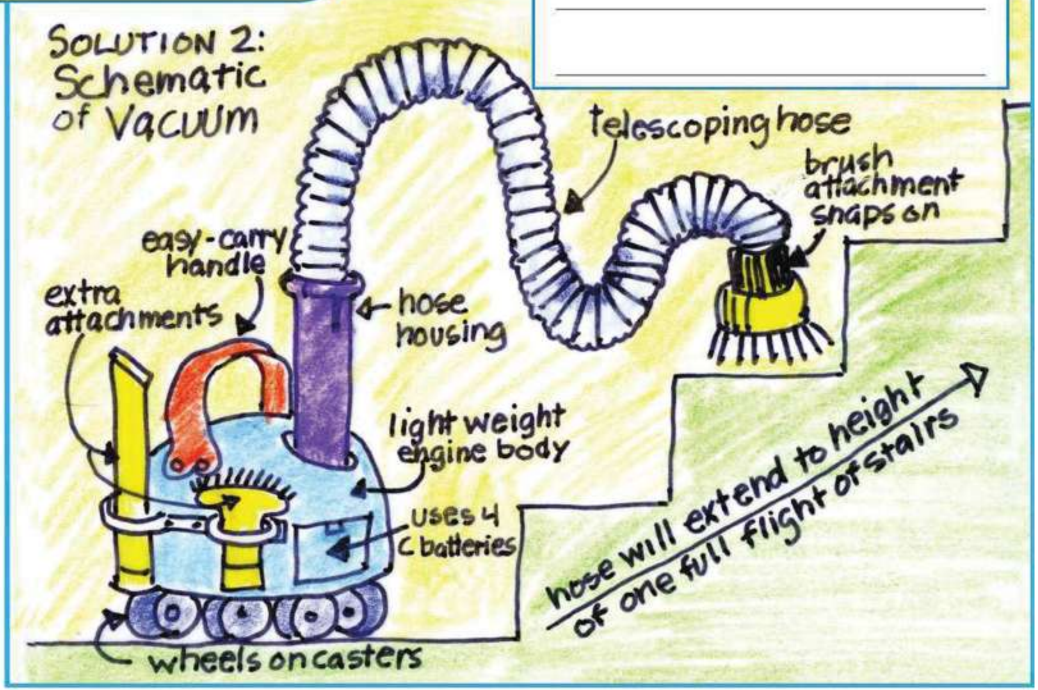
## Test and Evaluate How Well the Solution Meets the Goal

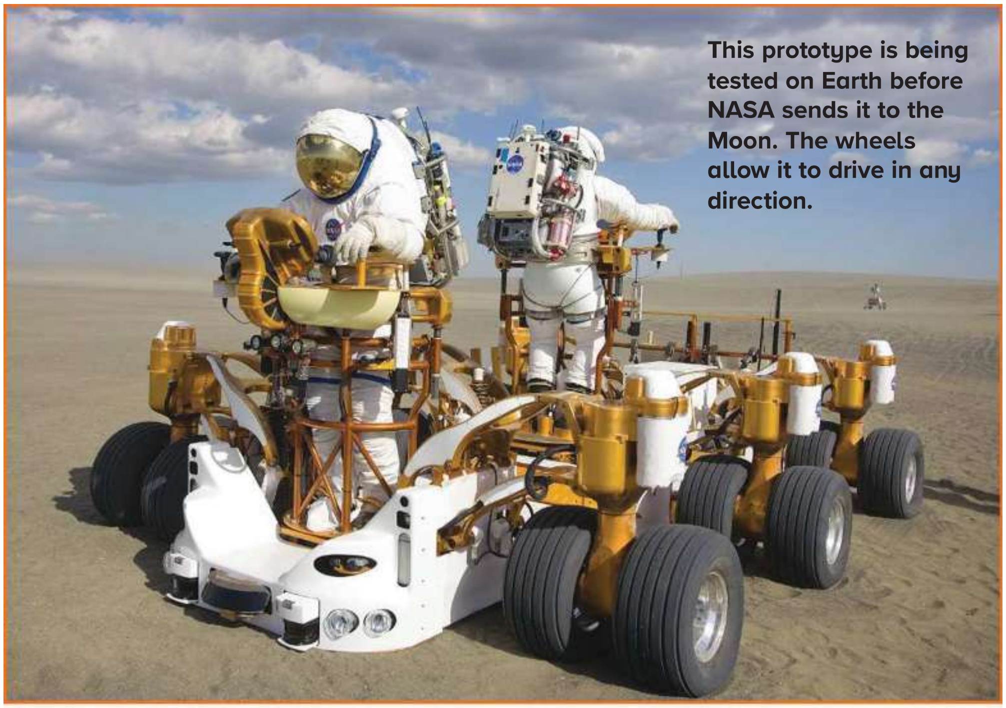
Once the prototype is constructed, you should test it to see if it solves the problem or meets the need. Often, the best way to test the prototype is to actually use it. For example, if you made a vacuum cleaner, you need to try to vacuum with it. You might also want other people to test the design and then listen to their feedback.

**Read a Diagram**

**What makes this vacuum good for cleaning stairs?**

**Creating Schematics**





This prototype is being tested on Earth before NASA sends it to the Moon. The wheels allow it to drive in any direction.

## Evaluate Using Measurement

Make sure to take careful measurements as you test your prototype. You should record your test results and ask more questions to evaluate the design. Does it work? Did it meet all the criteria and constraints? Is the product safe to use? You should then repeat your tests. This will allow you to verify your results.

## Present Evidence

After testing and collecting data about your product, it might be necessary to present your findings to your team and others. Graphs, data tables, and charts can help you communicate your test results. You will most likely have to go back and look at your design and modify it.

### *Quick Check*

4. Why do engineers build and test prototypes?

_______________________________________________

5. Why are schematics used to build prototypes?

_______________________________________________

_______________________________________________

NASA/Sean Smith

## How are designs improved?

Look at the results of your prototype tests and the feedback you received. This will allow you to evaluate how well your design solved the problem or met the need.

Most designers and engineers improve or refine their designs many times until they are completely satisfied that the product really works. After they make revisions, they test their designs again. This allows them to see if the revisions improved the product.

Sometimes you might need to make minor adjustments to your product. Sometimes problems in designs cannot be easily fixed. In that case, the designer or engineer will have to rethink the design. It might require a completely different solution.

If a new solution must be chosen, the steps in the design process should be repeated. Use the knowledge you gained from your previous design tests to create a new and better solution. Communicate how to improve the solution with any team members.

### Communicate the Solution

Once you are completely satisfied with the design, you need to communicate to others how you solved the problem or met the need. If you've made a product, you might want to name it. You might also want to advertise and sell it.

### ✓ *Quick Check*

6. Why is communication an important part of the design process?

Without communication, others

would not know the problem had

been solved or the need had

been met.

**This NASA rover prototype will undergo many tests before it is sent to the Moon to collect soil and rock samples.**

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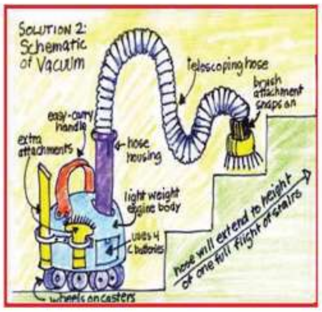
## My Notes

## Visual Summary

Complete the lesson summary in your own words.

**Engineers** Possible answer: Engineers design and construct products that will solve a problem or meet a need.



**Prototype** Possible answer: Once a designer or an engineer comes up with a possible solution to a problem, he or she needs to build a prototype.

**Improvement of Designs** Possible answer: A solution to a problem often needs to be modified after it has been tested.

(t) Christian Lagerek/Shutterstock.com, (3)NASA/Sean Smith

## Think, Talk, and Write

① **Vocabulary** Describe what goes on during a brainstorming session.

Possible answer: During a brainstorming session, people think of possible ideas for a solution to a problem.

② **Summarize** Why is it important that designers and engineers follow the design process when creating a product that will solve a problem?

| Main Idea | Details |
|---|---|
| The design process is a series of steps for developing products and processes that solve problems. | Following the design process ensures that the design will be tested and the results will be verified. |
| | Following the design process ensures that problems will be addressed and needs will be met. |

③ **Critical Thinking** What are some constraints that might affect the construction of a particular prototype?

**Possible answers: The materials used in the prototype are too expensive; the types of materials used might cause safety hazards; the prototype is too big to be effective.**

④ **Test Prep** An engineer developed a prototype. What step will she MOST LIKELY perform next?

**A** Identify the problem to be solved.
[✓ **C**] Test the prototype.
B Brainstorm possible solutions.
**D** Draw a schematic.

**Essential Question** How are nutrients cycled through ecosystems?

Things are designed by identifying a need or a problem, generating possible solutions, selecting a possible solution, testing and evaluating the prototype or design, and presenting the evidence to determine if the design will work.

# Focus on Skills

## Apply It

④ Compare your tower design with a partner's. Are the towers similar? How are they different? Analyze each other's tower and suggest improvements. Note your partner's suggestions in your table. Can you modify your tower so it will hold more weight?

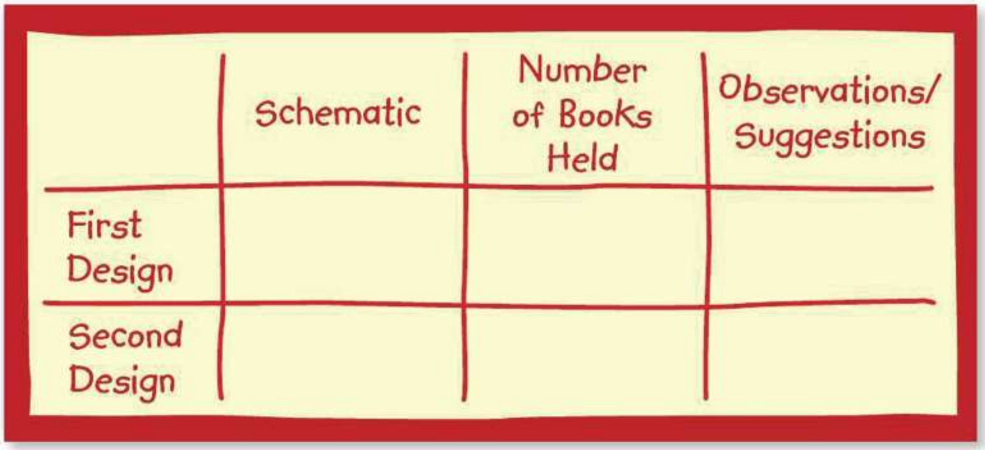
Answers will vary.

⑤ Change the design of your tower based on your partner's suggestions. In what other ways might you make your tower stronger? Draw the new tower in your table. Repeat the test above, and record your results. Did the new tower hold more weight?

Answers will vary.

⑥ Share your design with the rest of the class. Did the other students' towers hold more weight? Did your design have anything in common with the other students' designs?

Answers will vary.



| | Schematic | Number of Books Held | Observations/ Suggestions |
|---|---|---|---|
| First Design | | | |
| Second Design | | | |

# CHAPTER 10 Review

## Visual Summary

Summarize each lesson in your own words

**Lesson 1** ______________________________

______________________________

______________________________

______________________________

**Lesson 2** ______________________________

______________________________

______________________________

______________________________

**Lesson 3** ______________________________

______________________________

______________________________

## Vocabulary

**Use the list of words to complete each sentence.**

brainstorm
criteria
design process
engineering
mimic
model
prosthesis
prototype
schematic
technology

**1.** You brainstorm to generate ideas.

**2.** A(n) model is a representation of an object or event.

3. The profession that involves designing and constructing technological solutions is called engineering.

4. The design process is a series of steps that scientists and engineers follow when creating solutions to problems.

5. Standards that a product must meet are called criteria.

6. A working model is called a(n) prototype.

7. People use to adapt nature to meet their needs technology.

8. A detailed drawing is called a(n) schematic.

9. A(n) prosthesis is an artificial extension that replaces a human body part.

10. When you imitate something you it mimic.

# CHAPTER 10 Review

## Skills and Concepts

**11.** **Critical Thinking** Give an example of a robotic technology that could lead to an advance in scientific knowledge.

Possible answer: Space probes and ROVs could make discoveries about distant planets or deep-sea life

**12.** **Explanatory Writing** Explain why water is not technology, but a water filter is technology.

Water is natural and has not been changed by humans in any way. A water filter has been designed and made by humans to meet our needs.

**13.** **Critical Thinking** What might happen if an artificial heart is manufactured before the prototype is tested?

Possible answer: The prototype might not meet all of the design criteria. In the case of an artificial heart, that might mean that it cannot pump blood correctly.

**14.** **Experiment** You have developed a prototype for a new prosthetic hand. Identify three design criteria that you will test.

Possible answer: I will test its range of motion, how realistic its appearance is, and its strength.

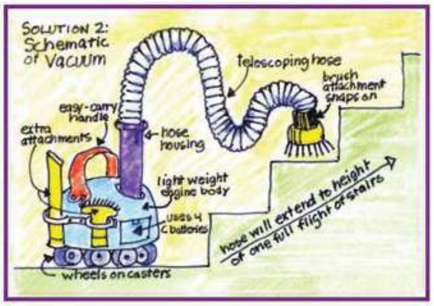
**15.** **Compare and Contrast** How are prostheses and robotics similar? How are they different?

Both prostheses and robots mimic body parts to meet a need. Prostheses replace human body parts and robots are machines that perform tasks.

**16.** **Make a Model** Describe how you would make a model of a prosthetic leg that can bend at the knee. Identify the materials that you would use.

Possible answer: Students might suggest using two pieces of wood or metal attached at the knee by a hinge. The two parts may be connected by a cable that controls the movement.

**17.** **Communicate** What is the diagram below? What is its purpose?



The diagram is a schematic. It is a drawing that shows and labels the parts of a proposed design, where they go, what they do, and what they will be made of.

**18.** A robotic arm in an automobile factory welds car parts together. What need does the robot MOST LIKELY meet?

**A** It performs a dangerous job.
B It designs the cars.
C It serves as a prototype.
**D** It is controlled by a computer.

The Big Idea

**19.** How do we design technologies to meet our needs?

# Test Preparation

Circle the best answer for each question.

1. A design criterion for a computeroperated prosthetic arm prototype is the amount of time it takes to move the arm after a command is given.

| Prosthetic Arm Design | Response Time (seconds) |
|---|---|
| Design 1 | 1.2 |
| Design 2 | 5.4 |
| Design 3 | 2.6 |
| Design 4 | 3.6 |

The table above shows the results of four different designs. Which design had the best response time?

[✓ A] Design 1
B Design 2
C Design 3
D Design 4

2. What need does a robot that performs surgery most likely meet?

A It mimics a human arm.
B It is able make precise movements that the human hand cannot.
C It makes scientific discoveries.
D It performs a dangerous job that a human cannot do.

3. A patient has an irregular heartbeat. Which technology might she benefit from?

A a prosthesis
B a bionic lung
[✓ C] a pacemaker
D a robotic muscle

4. An engineer is designing a new lower-leg prosthesis. Which material would be best to represent the skeletal system?

[✓ A] a light but strong metal material
B a flexible plastic material
C a comfortable, soft rubber material
D a strong, heavy wood material

5. The tool shown below is used to pick up small objects.

Which human body part was the tool most likely designed to mimic?

A hands
B feet
C arms
[✓ D] fingers

**6.** A robotic arm is designed to lift heavy objects in a factory. When the prototype was tested, the arm broke as a result of the weight. What should the engineers do next?

**A** They should start the design process over.

[✓ B] They should rebuild the prototype with a stronger material.

C They should rebuild the prototype with the same material and test it again.

D They should only use the prototype to lift light objects.

**7.** Students have each created their own designs for cargo boats. Which would work best to test their designs?

**A** Put the boats in water to see which float and which sink.

[✓ B] Put the boats in water and add weights to see which can hold the most weight before sinking.

C Weigh and measure each boat and then place them in water to see which sink and which float.

**D** Have students vote on the best design.

**8.** A new artificial heart design is needed for patients whose bodies reject the traditional artificial heart. You have brainstormed and documented several ideas. What are your next steps?

Build at least one prototype.

Thoroughly test its functionality

before testing it on patients.

**9.** Complete the graphic organizer below with the parts of a prosthetic limb that represent the human body systems listed.

| **Body System** | **Part of Prosthetic Limb** |
|---|---|
| Muscular | cables and motors |
| Skeletal | hinges and pylons |

**10.** You created a prototype of a prosthetic hand that allows more natural movement. The prototype was tested on several patients. Tests show that the hand moves naturally, but it does not look like a real hand. What should you do?

Possible answer: Research and

test a variety of materials that

could be used to mimic the skin

and nails of a human hand.

## Prosthetist

Are you interested in both medicine and engineering? A prosthetist (PRAHS•thuh•tist) must have skill in both of these fields. He or she works with patients to build and custom-fit prosthetic limbs. In order to make a prosthetic limb, the prosthetist must take precise measurements so the limb will fit correctly. After the prosthesis is made, the prosthetist monitors the patient's use of the limb and continues to make adjustments. The prosthetist continues working with patients throughout their lives to ensure that their prostheses work as much like the real thing as possible. To be a prosthetist, you need to be good at math, physics, and biology.

**A prosthetist makes sure prosthetic limbs fit and work correctly.**

### Write About It

Describe how a prosthetist can use design and technology to solve problems.

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

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# Reference

## Science Handbook

# Measurements

## Units of Measurement

| Table of Measurements | |
|---|---|
| **International System of Units (SI)** | |
| **Temperature**<br>Water freezes at 0°C (degrees Celsius) and boils at 100°C. |  |
| **Length and Distance**<br>1,000 meters (m) = 1 kilometer (km)<br>100 centimeters (cm) = 1 meter (m)<br>10 millimeters (mm) = 1 centimeter (cm) |  |
| **Volume**<br>1,000 milliliters (mL) = 1 liter (L)<br>1 cubic centimeter ($cm^3$) = 1 milliliter (mL) |  |
| **Mass**<br>1,000 grams (g) = 1 kilogram (kg) |  |
| **Weight**<br>1 kilogram (kg) weighs 9.81 newtons (N). |  |

## Making Measurements

### Temperature

You use a thermometer to measure temperature. A thermometer can be made of a thin tube with liquid inside that is usually red in color. When the liquid inside the tube gets warmer, it expands and moves up the tube. When the liquid gets cooler, it contracts and moves down the tube.

① Look at the thermometer shown here. It has two scales—a Fahrenheit scale and a Celsius scale.

② What is the temperature on the thermometer? At what temperature does water freeze on each scale?

### Time

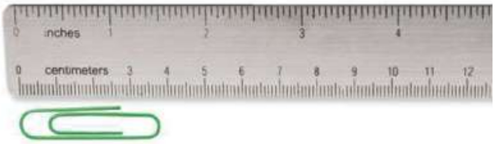
You use timing devices to measure the amount of time it takes for something to occur. Two timing devices are a stopwatch and a clock with a second hand. A clock with a second hand is accurate to 1 second. A stopwatch is accurate to parts of a second.

### Length

① Look at the ruler below. Each centimeter is divided into 10 millimeters. Estimate the length of the paper clip.

② The length of the paper clip is about 3 centimeters plus 8 millimeters. You can write this length as 3.8 centimeters.

Try estimating the length of some objects found in your classroom. Then measure the length of the objects with a ruler. Compare your estimates with accurate measurements.



# Measurements

## Measuring Mass, Weight, and Volume

### Mass

Mass is the amount of matter that makes up an object. You can use a balance to measure mass. To find the mass of an object, you balance or compare it with masses you know.

1. Place the balance on a level surface. Check that the two pans are empty, clean, and balanced with each other. The pointer should point to the middle mark. If it does not, move the slider to the right or left until the pans are balanced.
2. Gently place the object you want to measure in the left pan. The left pan will then lower.
3. Now add masses to the right pan until both pans are balanced again. Add the masses in the right pan to get the total mass. This total is the mass of the object in grams.

### Weight

You can use a spring scale to measure weight. Weight is the amount of gravity pulling down on the mass of an object. Therefore, weight is a force. Weight is measured in newtons (N).

1. To find the weight of your object, hold the spring scale by the top. Determine the weight of the empty plastic cup. Add the object to the cup.
2. Subtract the first measurement from the second, and the difference is the weight of the rock.

### Volume

1. You can use a beaker or a graduated cylinder to find the volume of a liquid.
2. You can also find the volume of a solid, such as a rock. Add water to a beaker or a graduated cylinder. Gently slide the object down into the beaker. To find the volume of the rock, subtract the starting volume of the liquid from the new volume. The difference is equal to the volume of the rock.

(tr, bl)McGraw-Hill Education, (c, br)Ken Karp/McGraw-Hill Education

## Collecting Data

### Microscopes

① Look at the photograph to learn the different parts of your microscope.

② Always carry a microscope with both hands. Hold the arm of the microscope with one hand, and put your other hand under the base. Place the microscope on a flat surface.

③ Move the mirror so that it reflects light from the room up toward the stage. Never point the mirror directly at the Sun or a bright light. ⚠ **Be careful.** Bright light can cause permanent eye damage.

④ Place a small piece of newspaper on a slide. Put the slide under the stage clips. Be sure that the area you are going to examine is over the hole in the stage.

⑤ Look through the eyepiece. Turn the focusing knob slowly until the newspaper comes into focus.

⑥ Draw what you see through the microscope.

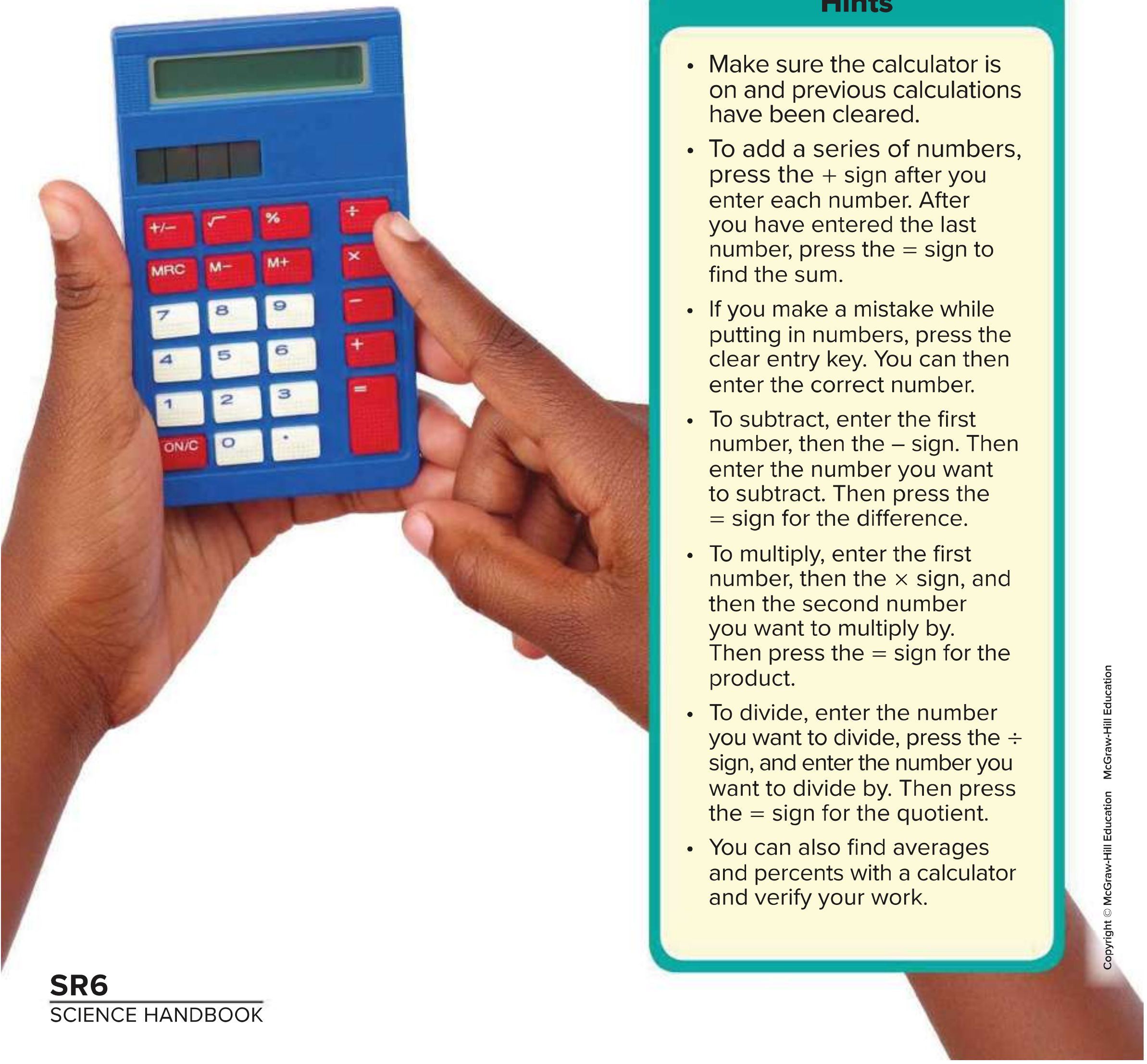
⑦ Look at other objects through the microscope. Try a piece of leaf, a human hair, or a pencil mark.

### Other Lenses

You use a hand lens to magnify an object, or make the object look larger. With a hand lens, you can see more detail than you can without the lens. Look at a few grains of salt with a hand lens and draw what you see. Binoculars are a tool that makes distant objects appear closer. In nature, scientists use binoculars to look at animals without disturbing them. These animals may be dangerous to approach or frightened at the approach of people. Cameras can act like binoculars, or they can be used to see things up close. Cameras have the advantage of making a record of your observations. Cameras can make a record on film or as data on a computer chip.

## Use Calculators

Sometimes after you make measurements, you have to analyze your data to see what they mean. This might involve doing calculations with your data. A handheld calculator helps you do calculations quickly and accurately, and it can also be used to verify your calculations.



### Hints

- Make sure the calculator is on and previous calculations have been cleared.
- To add a series of numbers, press the + sign after you enter each number. After you have entered the last number, press the = sign to find the sum.
- If you make a mistake while putting in numbers, press the clear entry key. You can then enter the correct number.
- To subtract, enter the first number, then the – sign. Then enter the number you want to subtract. Then press the = sign for the difference.
- To multiply, enter the first number, then the × sign, and then the second number you want to multiply by. Then press the = sign for the product.
- To divide, enter the number you want to divide, press the ÷ sign, and enter the number you want to divide by. Then press the = sign for the quotient.
- You can also find averages and percents with a calculator and verify your work.

## Use Computers

A computer has many uses. You can write a paper on a computer. You can use programs to organize data and show your data in a graph or a table. The Internet connects your computer to many other computers and databases around the world. You can send the paper you wrote to a friend in another state or another country. You can collect all kinds of information from sources near and far. Best of all, you can use a computer to explore, discover, and learn. You can also get information from computer disks that can hold large amounts of information. You can fit the information found in an entire encyclopedia set on one disk.

One class used computers to work on a science project. They were able to collect data from students in another area who were working on a similar project and share their data with them. They were also able to use the Internet to write to local scientists and request information. The students collected and stored their data, moved paragraphs around, changed words, and made graphs. Then they were able to print their report to share their discoveries with others.

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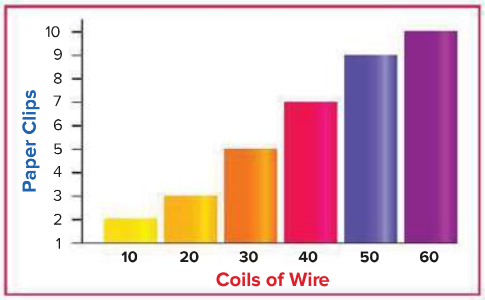
# Organizing Data

## Use Graphs

When you do an experiment in science, you collect information, or data. To find out what your data mean, you can organize them into graphs. Several different kinds of graphs can be made. You can choose the type of graph that best organizes your data and makes it easier for you and others to understand the data presented.

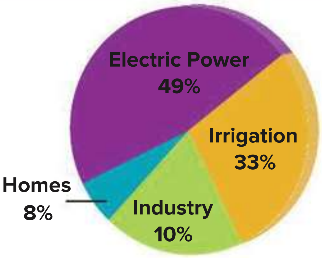
### Bar Graphs

A bar graph uses bars to show information. For example, what if you performed an experiment to test the strength of a nail electromagnet and the number of coils of wire wrapped around it? This graph shows that increasing the number of coils increases the strength of the electromagnet.



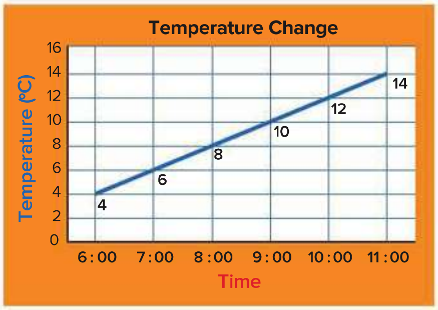
### Circle Graphs

A circle graph is used to show how a complete set of data is divided into parts. This circle graph shows how water is used in the United States. In a circle graph, all the data must add up to 100.



### Line Graphs

A line graph shows information by connecting dots plotted on a graph. A line graph is often used to show changes that occur over time. For example, this line graph shows the relationship between temperature and time for a particular morning.



## Use Tables and Maps

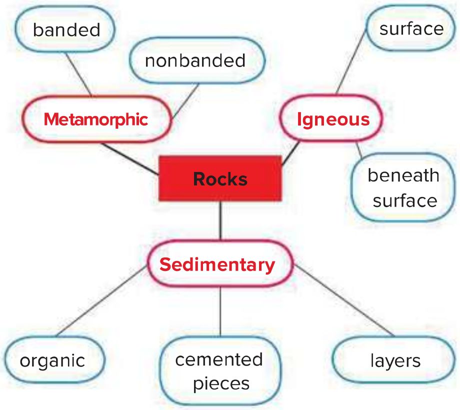
### Tables

Tables help you organize data during experiments. Most tables have vertical columns and horizontal rows. The columns and rows have headings that tell you what kind of data go in each part of the table. The table here shows a record of the conductivity of several different kinds of substances.

| Material | Thermal Conductivity |
|---|---|
| Aluminum | 109.0 |
| Copper | 385.0 |
| Wood | 0.1 |
| Packing foam | 0.01 |

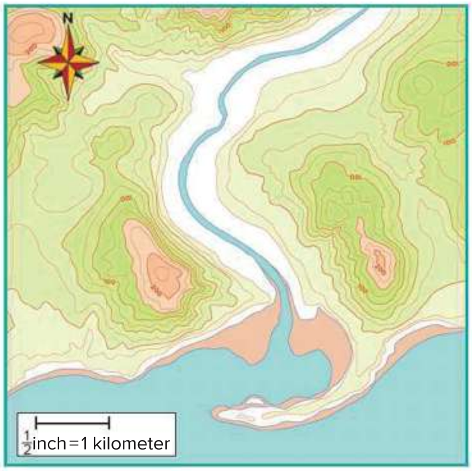
### Idea Maps

This kind of map shows how ideas or concepts are connected to each other. Idea maps help you organize information about a topic. The idea map shown here connects different ideas about rocks.



### Maps

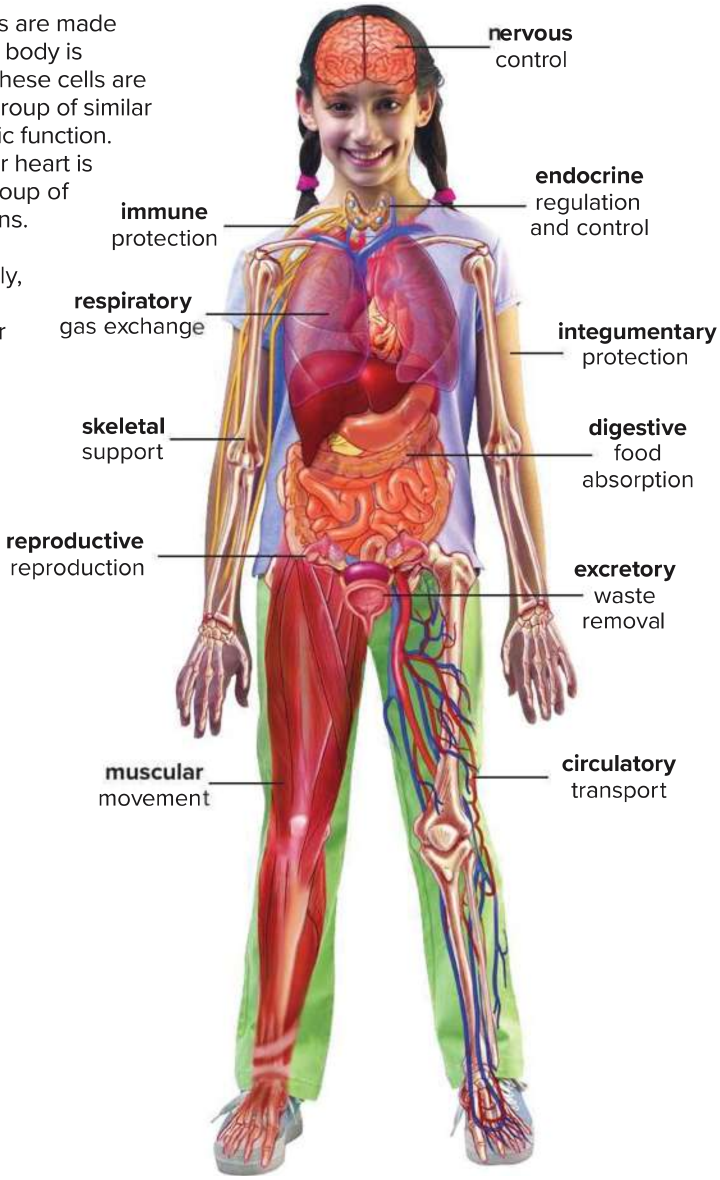
A map is a drawing that shows an area from above. Maps help you learn about a location. You are probably most familiar with road maps, which are often used to plan routes to travel from one place to another. Other kinds of maps show terrain. Hills and valleys, for example, can be shown on some types of maps. A good map has a legend that shows the scale it was made to and a compass point that at least shows the direction of north.



# Human Body Systems

## Organization of the Human Body

Like all organisms, humans are made of cells. In fact, the human body is made of trillions of cells. These cells are organized into tissues, a group of similar cells that perform a specific function. The cardiac muscle in your heart is an example of tissue. A group of tissues, in turn, form organs. Your heart and lungs are examples of organs. Finally, organs work together as part of organ systems. For example, your heart and blood vessels are part of the circulatory system. The organ systems in the human body function together to keep the body healthy.



## The Skeletal and Muscular Systems

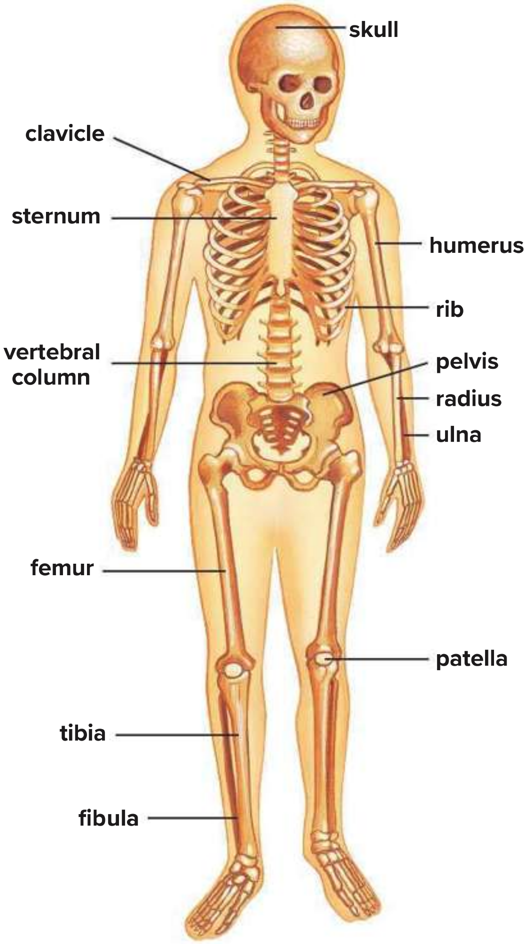
The body has a supporting frame called a skeleton, which is made of bones. The skeleton gives the body its shape, protects organs in the body, and works with muscles to move the body.

Each of the 206 bones of the skeleton is the size and the shape best fitted to do its job. For example, long and strong leg bones support the body's weight.

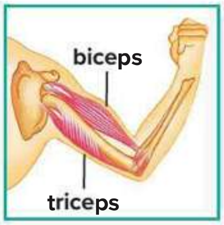
Three types of muscles make up the body—skeletal muscle, cardiac muscle, and smooth muscle. Cardiac muscles are found only in the heart. These muscles contract to pump blood throughout the body.

Smooth muscles make up internal organs, such as the intestines, as well as blood vessels.

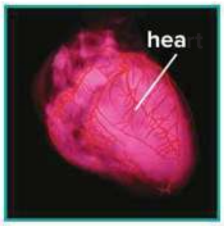
The muscles that are attached to and move bones are called skeletal muscles. Skeletal muscles pull bones to move them. Most muscles work in pairs to move bones.



smooth muscle



skeletal muscles



cardiac muscle

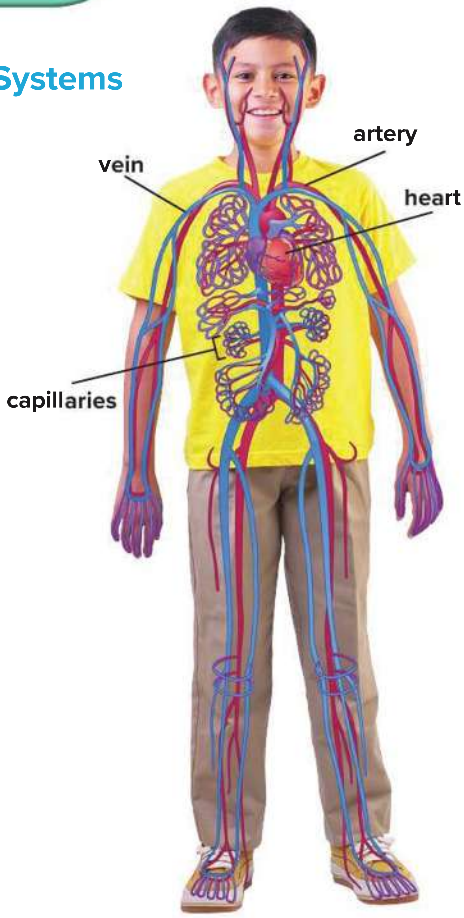
David Bassett/Photo Researchers, Inc.

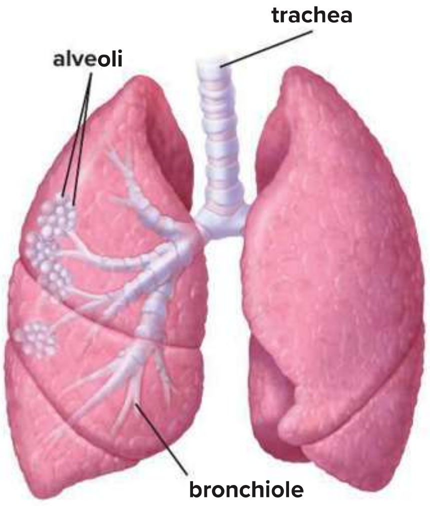
# Human Body Systems

## The Circulatory and Respiratory Systems

The circulatory system consists of the heart, the blood vessels, and the blood. Circulation is the flow of blood through the body. Blood is a liquid that contains red blood cells, white blood cells, and platelets. Red blood cells carry oxygen and nutrients to cells. They also carry $CO_2$ and cellular wastes away from the cells. White blood cells work to fight germs that enter the body. Platelets are cell fragments that help make the blood clot.

The heart is a muscular organ about the size of a fist. Arteries carry blood away from the heart. Some arteries carry blood to the lungs, where red blood cells pick up oxygen. Other arteries carry oxygen-rich blood from the lungs to all other parts of the body. Veins carry blood from other parts of the body back to the heart. Blood in most veins carries the wastes released by cells and has little oxygen. Blood flows from arteries to veins through narrow vessels called capillaries.



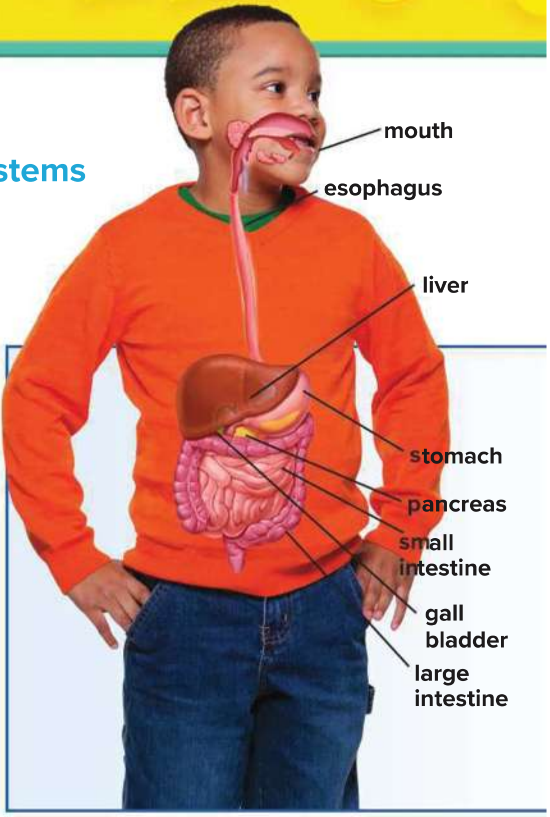


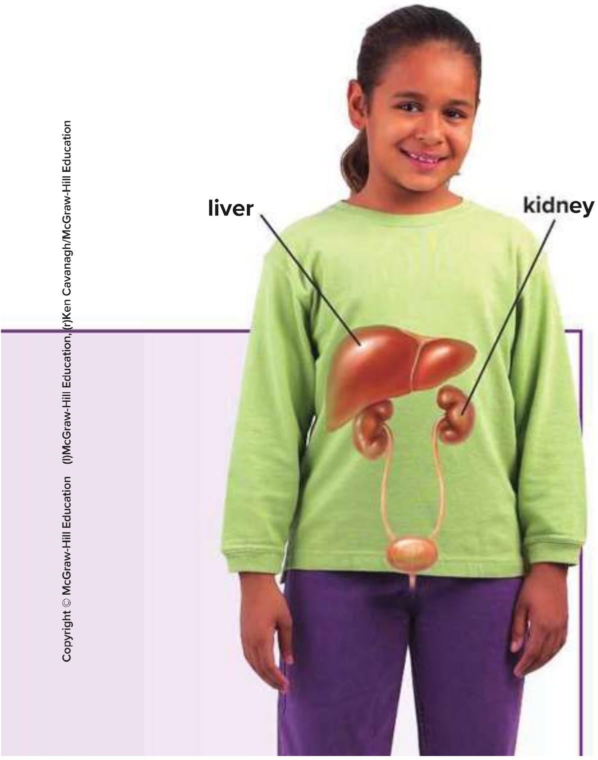
The process of getting and using oxygen in the body is called respiration. When a person inhales, air is pulled into the nose or the mouth. The air travels down into the trachea. In the chest the trachea divides into two bronchial tubes. One bronchial tube branches into smaller tubes called bronchioles. At the end of each bronchiole are tiny air sacs called alveoli. The alveoli exchange carbon dioxide for oxygen.

## The Digestive and Excretory Systems

Digestion is the process of breaking down food into simple substances the body can use. Digestion begins when a person chews food. Chewing breaks the food into smaller pieces and moistens it with saliva. Food passes through the esophagus and into the stomach. The stomach mixes digestive juices with food before passing it on to the small intestine.

Digested food is absorbed in the small intestine. The walls of the small intestine are lined with villi, which are fingerlike projections. Digested food is absorbed through the surface of the villi. From the villi the blood transports nutrients to every part of the body. Water is absorbed from undigested food in the large intestine.





Excretion is the process of removing waste products from the body. The liver filters nitrogen wastes from the blood and converts them into urea. Urea is then carried by the blood to the kidneys for excretion. Each kidney contains more than a million nephrons. Nephrons are structures in the kidneys that filter blood.

The skin takes part in excretion when a person sweats. Glands in the inner layer of skin produce sweat. Sweat is mostly water. It also contains a tiny amount of urea and mineral salts.

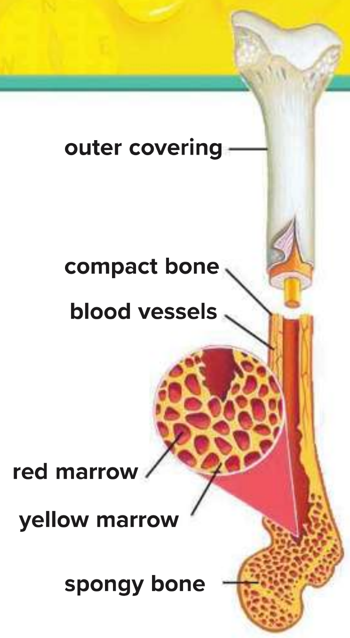
# Human Body Systems

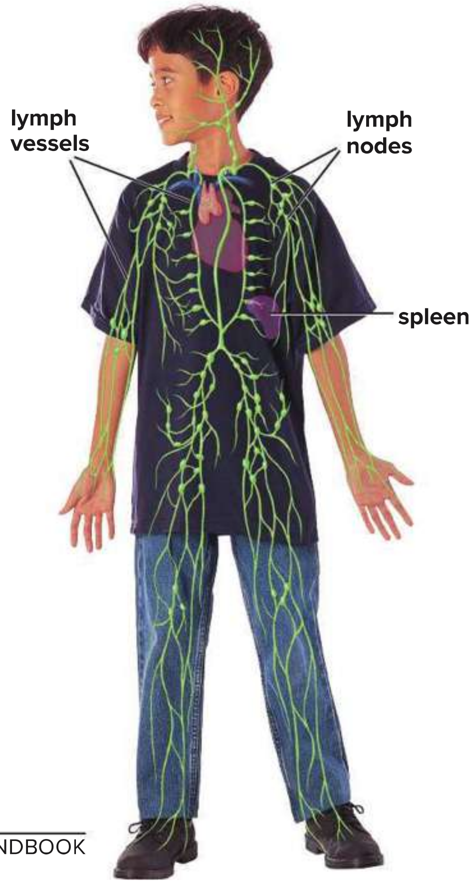
## The Immune System

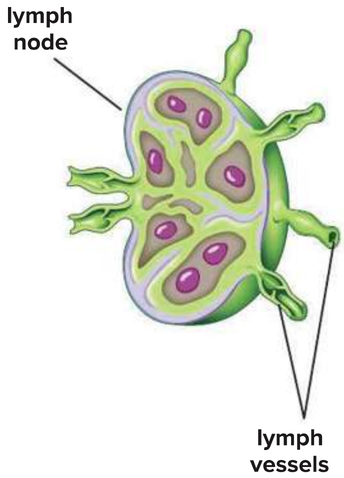
The immune system helps the body fight disease. A soft tissue known as red marrow fills the spaces in some bones. Red marrow makes new red blood cells, germ-fighting white blood cells, and platelets that stop a cut from bleeding.

White blood cells are found in the blood vessels and in the lymph vessels. Lymph vessels are similar to blood vessels. Instead of blood, they carry lymph. Lymph is a straw-colored fluid that surrounds body cells.

Lymph nodes filter out harmful materials in lymph. Like red marrow, they also produce white blood cells to fight infections. Swollen lymph nodes in the neck are a clue that the body is fighting germs.



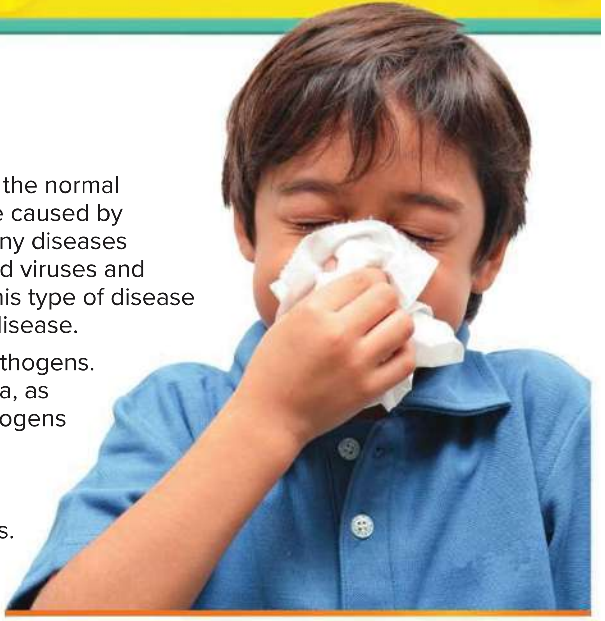




## Communicable Diseases

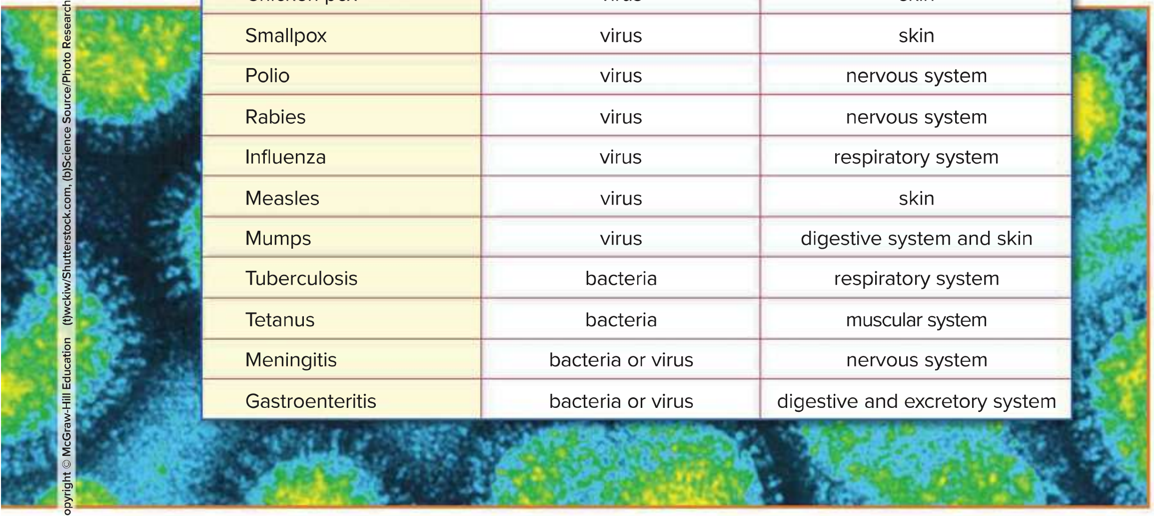
A disease is anything that interferes with the normal functions of the body. Some diseases are caused by harmful materials in the environment. Many diseases are caused by microscopic organisms and viruses and can be passed from person to person. This type of disease is called a communicable, or infectious, disease.

Disease-causing agents are called pathogens. Pathogens include many types of bacteria, as well as viruses. Diseases caused by pathogens are also called communicable diseases because they can be passed from one person to another. Pathogens must enter the body before they can cause an illness. Once these invaders enter the body, the immune system works hard to fight them off.



### Human Infectious Diseases

| Disease | Caused by | Organ System Affected |
|---|---|---|
| Common cold | virus | respiratory system |
| Chicken pox | virus | skin |
| Smallpox | virus | skin |
| Polio | virus | nervous system |
| Rabies | virus | nervous system |
| Influenza | virus | respiratory system |
| Measles | virus | skin |
| Mumps | virus | digestive system and skin |
| Tuberculosis | bacteria | respiratory system |
| Tetanus | bacteria | muscular system |
| Meningitis | bacteria or virus | nervous system |
| Gastroenteritis | bacteria or virus | digestive and excretory system |



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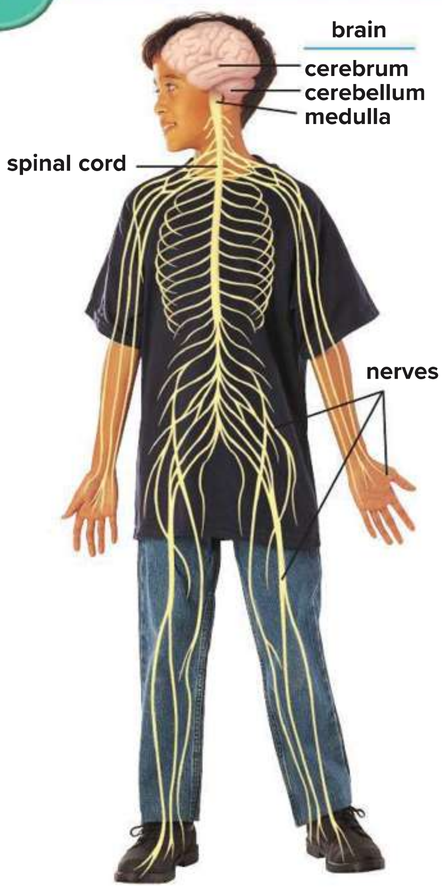
# Human Body Systems

## The Nervous System



The nervous system has two parts. The brain and the spinal cord make up the central nervous system. All other nerves make up the outer, or peripheral, part of the nervous system.

The largest part of the human brain is the cerebrum. A deep groove separates the right half, or hemisphere, of the cerebrum from the left half. The right and left hemispheres of the cerebrum contain control centers for the senses. The cerebrum is the part of the brain where thought occurs.

The cerebellum lies below the cerebrum. It coordinates the skeletal muscles so they work together smoothly. It also helps to keep balanced.

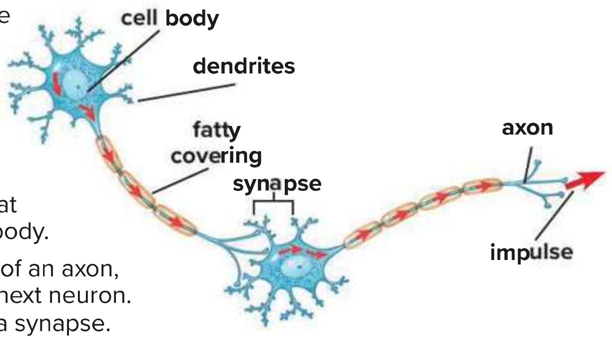
The brain stem connects to the spinal cord. The lowest part of the brain stem is the medulla. It controls heartbeat, breathing, blood pressure, and the muscles in the digestive system.

The spinal cord is a thick band of nerves that carries messages to and from the brain. Nerves branch off from your spinal cord to all parts of your body. The spinal cord also controls reflexes. A reflex is a quick reaction that occurs without waiting for a message to and from the brain. For example, if you touch something hot, you pull your hand away without thinking about it.

### Parts of a Neuron

The nerves in the nervous system are made of nerve cells called neurons. Each neuron has three main parts—a cell body, dendrites, and an axon. Dendrites are branching nerve fibers that carry impulses, or electrical signals, toward the cell body. An axon is a nerve fiber that carries impulses away from the cell body.

When an impulse reaches the tip of an axon, it must cross a tiny gap to reach the next neuron. This gap between neurons is called a synapse.



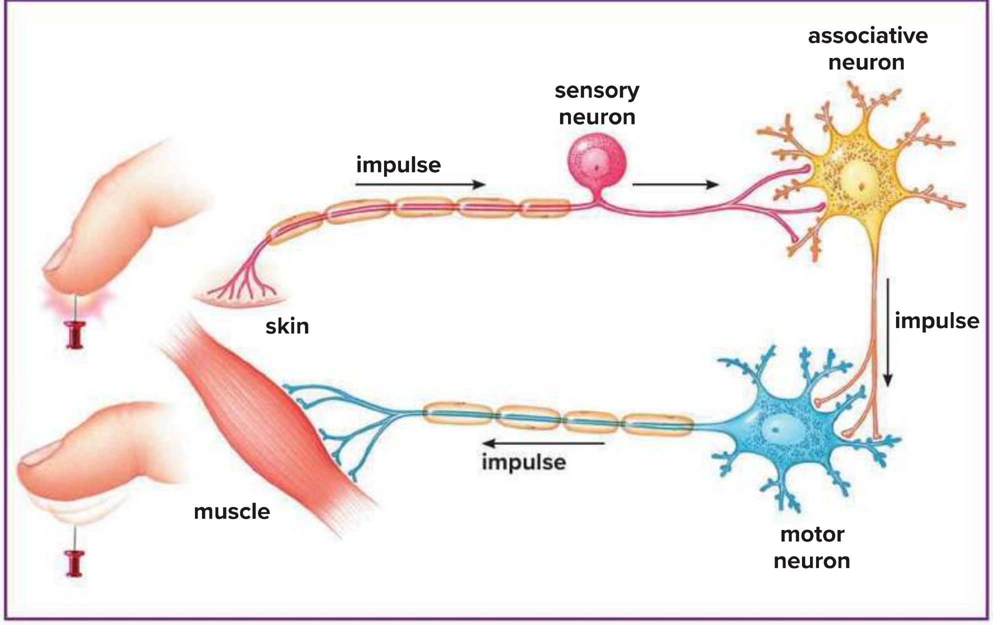
## Stimulus and Response

The nervous system, the skeletal system, and the muscular system work together to help you adjust to your surroundings. Anything in the environment that requires your body to adjust is called a stimulus (plural: stimuli). A reaction to a stimulus is called a response.

As you learned, nerve cells are called neurons. There are three kinds of neurons: sensory, associative, and motor. Each kind does a different job to help your body respond to stimuli. Sensory neurons receive stimuli from your body and the environment. Associative neurons connect the sensory neurons to the motor neurons. Motor neurons carry signals from the central nervous system to the organs and glands.

In addition to responding to external stimuli, your body also responds to internal changes. Your body regulates its internal environment to maintain a stable condition for survival. This is called a steady-state condition.

**Nerve Response**



## The Senses

### Sense of Sight

Light reflected from an object enters your eye and falls on the retina. Receptor cells change the light into electrical signals, or impulses. These impulses travel along the optic nerve to the vision center of the brain.

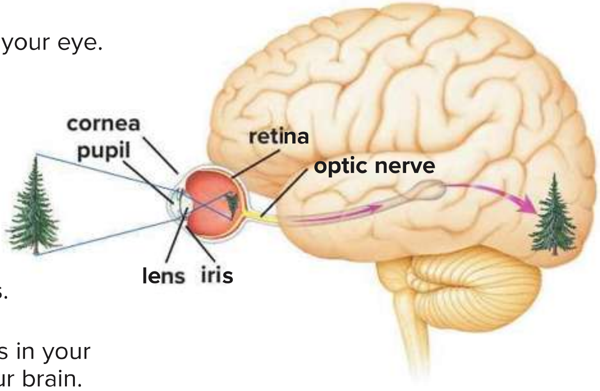
① Light reflects off the tree and into your eye.

② The light passes through your cornea and the pupil in your iris.

③ The lens bends the light so that it hits your retina.

④ Receptor cells on your retina change the light into electrical signals.

⑤ The impulses travel along neurons in your optic nerve to the vision center of your brain.



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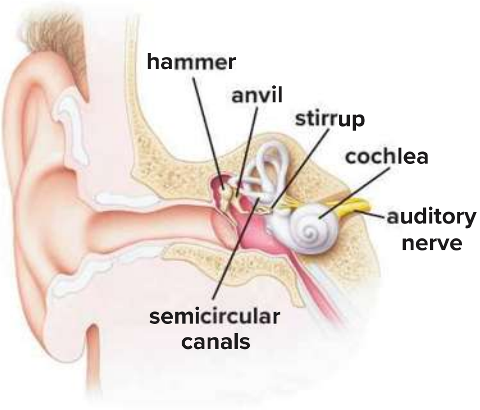
### Sense of Hearing

Sound waves enter your ear and cause the eardrum to vibrate. Receptor cells in your ear change the sound waves into impulses that travel along the auditory nerve to the hearing center of the brain.



① Your outer ear collects sound waves.

② They travel down your ear canal.

③ The eardrum vibrates.

④ Three tiny ear bones vibrate.

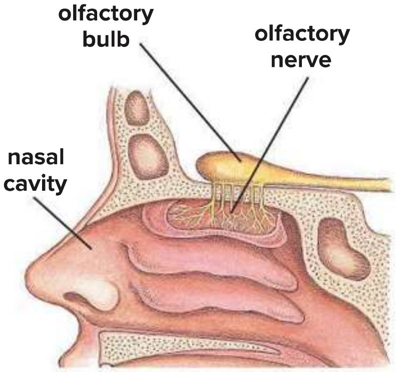
⑤ The cochlea vibrates.

⑥ Receptor cells inside your cochlea change.

⑦ The impulses travel along your auditory nerve to the brain's hearing center.

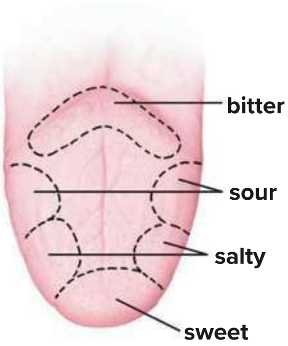
### Sense of Smell

The sense of smell is the ability to detect chemicals in the air. When you breathe, chemicals dissolve in mucus in the upper part of your nose, or nasal cavity. When the chemicals come in contact with receptor cells, the cells send impulses along the olfactory nerve to the smelling center of the brain.



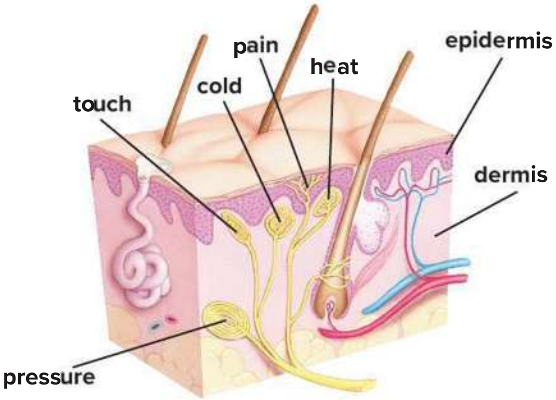
### Sense of Taste

When you eat, chemicals in the food dissolve in saliva. Saliva carries the chemicals to taste buds on the tongue. Inside each taste bud are receptors that can sense the four main tastes—sweet, sour, salty, and bitter. The receptors send impulses along a nerve to the taste center of the brain. The brain identifies the taste of the food, which is usually a combination of the four main taste categories.



### Sense of Touch

Receptor cells in the skin help a person tell hot from cold and wet from dry. These can also tell the light touch of a feather or the pressure of stepping on a stone. Each receptor cell sends impulses along sensory nerves to the spinal cord. The spinal cord then sends the impulses to the touch center of the brain.



## The Endocrine System

Hormones are chemicals that control body functions. An organ that produces hormones is called an endocrine gland.

The endocrine glands are scattered around the body. Each gland makes one or more hormones. Each hormone seeks a target organ or organ system, the place in the body where the hormone acts. Changing levels of different hormones communicate important messages to target organs and organ systems.

The endocrine glands help maintain a constant, healthy condition in your body. These glands can turn the production of hormones on or off whenever your body produces too little or too much of a particular hormone.

# Glossary/القاموس

Use this glossary to understand the meanings of the science words used in this book. Page numbers tell you where to find the words in the book.

يمكنك استخدام مسرد المصطلحات هذا في فهم معاني الكلمات العلمية المستخدمة في هذا الكتاب. وتبين أرقام الصفحات أين يمكنك العثور على تلك الكلمات في الكتاب.

## A

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|---|---|
| **adaptations** special characteristics that help organisms survive in their environments | **تكيّف** بعض السمات الخاصة التي تساعد الكائنات الحية على البقاء حية في بيئتها |
| **alternative energy source** a source of energy other than the burning of a fossil fuel | **مصدر طاقة** بديل أي مصدر للطاقة بخلاف احتراق الوقود الأحفوري |
| **atmosphere** the layers of gases that surround Earth | **غلاف جوي** طبقات الغازات التي تحيط بالأرض |

## B

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|---|---|
| **balanced diet** meals and snacks that provide the proper amounts of foods from each food group daily | **نظام غذائي متوازن** الوجبات الرئيسية والوجبات الخفيفة التي توفر المقدار اليومي الصحيح من الأطعمة من كل مجموعة من الاغذية |
| **brainstorm** the process of thinking of possible solutions for a problem | **عصف ذهني** عملية التفكير بحلول محتملة لإحدى المشكلات |

## C

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|---|---|
| **carbohydrates** a group of nutrients made from carbon, hydrogen, and oxygen; commonly called starches and sugars | **كربوهيدرات** مجموعة من المواد المغذية التي تتكون من الكربون والهيدروجين والأكسجين. ويطلق عليها عادة النشويات والسكريات |
| **carrying capacity** the maximum population size that an ecosystem can support | **طاقة استيعابية** الحد الأقصى لحجم الجماعة الأحيائية التي يستطيع النظام البيئي دعمها |
| **cellular respiration** a process in the cells of living organisms that breaks down sugars to make energy | **تنفس خلوي** عملية تتم داخل خلايا الكائنات الحية تعمل على تفتيت السكريات لتصنع الطاقة |
| **chloroplasts** the parts of a plant cell where photosynthesis occurs | **بلاستيدات خضراء** أجزاء في خلية النبات حيث يحدث البناء الضوئي |
| **cleavage** the number of planes along which the mineral breaks | **اسطح التشقق** عدد الأسطح التي ينكسر عبرها المعدن |
| **commensalism** a relationship between two kinds of organisms that benefits one without harming the other | **تعايش أو إفادة** علاقة بين نوعين من الكائنات الحية يستفيد أحدهما من الآخر دون أن يضره |
| **community** all the living things in an ecosystem | **مجتمع أحيائي** جميع الكائنات الحية في النظام البيئي |
| **conservation** saving, protecting, or using natural resources wisely | **حفظ** حفظ أو حماية أو استخدام الموارد الطبيعية استخدامًا حكيمًا |

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| **consistency** the ability to repeat a task with little variation | **اتساق** القدرة على تكرار مهمة باختلاف طفيف |
| **continental drift** the concept that a single supercontinent broke apart into separate continents which drifted to their current positions on Earth | **نظرية الانجراف القاري** مبدأ يفيد أن قارة عظمى واحدة انشطرت إلى قارات منفصلة انجرفت إلى مواقعها الحالية على الأرض |
| **controlled experiment** a scientific investigation that involves changing one factor and observing its effects on another factor while keeping all other factors constant | **تجربة مضبوطة** تحقيق علمي يقوم على استخدام عامل واحد وملاحظة تأثيره على عامل آخر مع الحفاظ على ثبات جميع العوامل الأخرى |
| **criteria** requirements to accomplish a goal | **معيار** متطلبات تحقيق هدف ما |
| **crust** the rocky surface that makes up the top of the lithosphere, including the continents and the ocean floor | **القشرة الأرضية** أرضية السطح الصخري الذي يكوّن الطبقة العلوية من المحيط اليابس للأرض والذي يشمل القارات وقاع المحيط |

| | |
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| **crystal** solid whose shape forms a fixed pattern | **مادة متبلورة** مادة صلبة تكوّن بنية نمطية محددة |

## D

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| **data** different types of information that can be collected to answer a scientific question | **بيانات** أنواع مختلفة من المعلومات التي يمكن جمعها للإجابة على إحدى المسائل العلمية |
| **deciduous forest** a forest ecosystem with four distinct seasons and deciduous trees | **غابة أشجار متساقطة أو نفضية** غابة ذات نظام بيئي يتميز بفصول أربعة وأشجار متساقطة |
| **deforestation** when people cut down forests, causing living things to lose their habitats | **إزالة الغابات** قطع الناس أشجار الغابات، وبهذا تفقد الكائنات الحية موطنها البيئي |
| **dependent variable** the variable that is being measured by the experiment | **متغير تابع** المتغير الذي تقيسه التجربة |

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| **deposition** the process of dropping off pieces of eroded rock | **ترسيب** عملية انزال وتراكم أجزاء الصخور المتآكلة |
| **description** a summary of observations | **وصف** ملخص الملاحظات |
| **design process** a series of steps for developing products and processes that solve problems | **عملية التصميم** مجموعة متسلسلة من الخطوات لتصميم المنتجات والعمليات التي تحل المشكلات |

## E

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|---|---|
| **earthquake** a sudden shaking of Earth's crust | **زلزال** اهتزاز مفاجئ للقشرة الأرضية |
| **ecosystem** all the living and nonliving things in an environment, including their interactions with each other | **نظام بيئي** جميع الكائنات الحية وغير الحية الموجودة بإحدى البيئات. والتي تتضمن تفاعلاتهم مع بعضهم البعض |
| **endangered species** a species that is in danger of becoming extinct | **أنواع مهددة بالانقراض** الأنواع المهددة بأن تصبح منقرضة |
|  |  |
| **endurance** the ability to perform an activity without becoming tired | **تحَمُّل** القدرة على أداء نشاط دون الشعور بالإجهاد |
| **energy pyramid** a diagram that shows the amount of energy available at each level of an ecosystem | **هرم الطاقة** مخطط يوضح مقدار الطاقة المتوفرة في كل مستوى من مستويات النظام البيئي |
| **engineering** a field of study focused on designing and constructing technological solutions to problems | **هندسة** أحد مجالات الدراسة التي تركز على تصميم وإنشاء الحلول التكنولوجية للمشكلات |
| **erosion** the process of carrying away soil or pieces of rocks | **تعرية** عملية انجراف التربة أو قطع الصخور |
| **explanation** an interpretation of observations | **تفسير** تفسير الملاحظات |

Stephen Frink Collection/Alamy

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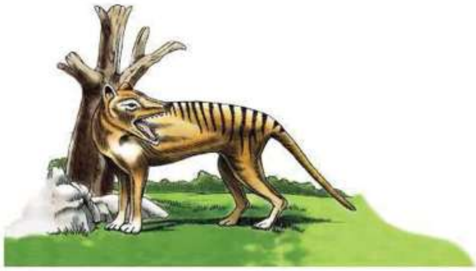
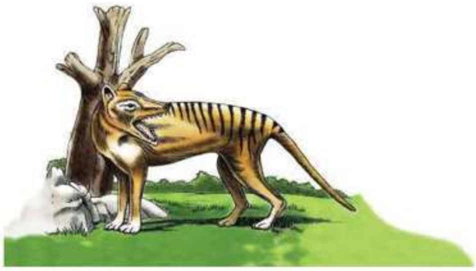
| **extinct species** a species that has died out completely) | **أنواع منقرضة** الأنواع التي ماتت واختفت تمامًا |





## F

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| **Flood plain** land near a river that is likely to be under water during a flood | **سهل فيضي** الأرض بجانب النهر التي يحتمل أن تغمرها مياه الفيضان |
| **food chain** the path that energy and nutrients follow in an ecosystem | **سلسلة غذائية** مسار تأخذه الطاقة والمواد المغذية في نظام بيئي معين |
| **food web** the overlapping food chains in an ecosystem | **شبكة غذائية** السلسلة الغذائية المتداخلة في نظام بيئي معين |
| **fossil fuel** a material formed from the decay of ancient organisms and is used as a source of energy | **وقود أحفوري** مادة تتكون من تحلل الكائنات الحية القديمة وتُستخدم كمصدر للطاقة |
| **fracture** a mineral property that breaks along rough or uneven surfaces | **مُكسِر** إحدى خواص المعادن التي تقسم الأسطح الخشنة أو غير المستوية |

## G

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|---|---|
| **glacier** a large sheet of ice and snow that moves slowly over land | **نهر جليدي** صفيحة ضخمة من الجليد والثلج تتحرك ببطء على الأرض |
| **graduated cylinder** a tall, narrow, clear container used to measure liquid volume | **أسطوانة مدرجة** وعاء طويل وضيق وشفاف يُستخدم لقياس حجم السوائل |

## H

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|---|---|
| **habitat** the place where a plant or an animal lives and grows | **موطن بيئي** المكان الذي يعيش به وينمو أحد الحيوانات أو النباتات |
| **hardness** how easily a mineral is scratched or how easily it scratches something else | **صلادة** مدى سهولة تعرض المعدن للخدش أو مدى سهولة خدشه لمادة أخرى |
| **humus** decayed plant or animal material in soil | **دبال** المادة الموجودة بالتربة والناتجة عن تحلل النباتات والحيوانات |

| | |
|---|---|
| **hydrosphere** Earth's water, whether found on continents or in oceans, including the freshwater in ice, lakes, rivers, and underground | **غلاف مائي** الماء الموجود على الأرض. سواء أوجد في القارات أم المحيطات ويشمل الماء العذب الموجود بالجليد والبحيرات والأنهار والمياه الجوفية |
| **hygiene** the practice of keeping your body clean | **حفظ الصحة العامة** ممارسات الحفاظ على نظافة جسدك |
| **hypothesis** a prediction or an answer to a question that can be tested | **فرضية** تنبؤ أو إجابة على مسألة يمكن اختبارها |

## I

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|---|---|
| **igneous rock** a rock formed when magma or lava cools and hardens | **الصخر الناري** صخرة تتكون عندما تبرد أو تتصلب الصهارة أو الحمم البركانية |
|  |  صخر الجرانيت |
| **independent variable** the variable that changes in an experiment | **المتغير المستقل** المتغير الذي يتم تبديله في التجربة |
| **inference** a conclusion formed from available information or evidence | **الاستدلال** الاستنتاج الذي يتم استنباطه من المعلومات أو الأدلة المتاحة |
| **inner core** a solid layer of iron and nickel inside Earth | **اللب الداخلي** طبقة صلبة من الحديد والنيكل داخل الأرض |
| **island arc** a string of volcanic islands made from melted rock rising up from under the sea floor | **قوس جزيري** سلسلة من الجزر البركانية تتكون من صخور منصهرة ترتفع من أسفل سطح البحر |

## L

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|---|---|
| **landform** a physical feature on Earth's surface | **تضاريس** سمة فيزيائية لسطح الأرض |
| **lava** hot, melted rock that reaches Earth's surface | **حمم بركانية** صخور ساخنة منصهرة تصل إلى سطح الأرض |
| **limiting factor** anything that controls the growth or survival of a population | **عامل محدد** أي عامل يتحكم في نمو أو بقاء الجماعة الأحيائية على قيد الحياة |
| **luster** the way a mineral reflects light | **بريق** الطريقة التي يعكس بها المعدن الضوء |

sciencephotos/Alamy

# M

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|---|---|
| **magma** hot fluid rock in Earth's mantle, the layer below Earth's surface | **صهارة** صخر ساخن مائع بطبقة وشاح الأرض. وهي الطبقة التي تقع تحت القشرة الأرضية |
| **mantle** a nearly melted layer of hot rock below Earth's crust | **طبقة الوشاح** طبقة شبه منصهرة من الصخور الساخنة تحت القشرة الأرضية |
| **mean** a set of data is the sum of the numbers in a data set divided by the number of entries in the data set | **المتوسط الحسابي** مجموعة من البيانات عبارة عن مجموع الأرقام في مجموعة البيانات مقسومةً على عدد الإدخالات في مجموعة البيانات |
| **meander** a bend or S-shaped curve in a river | **منعطف المجرى** انعطاف أو منحنى على شكل حرف S في مسار النهر |
| **measurement** a precise expression of a physical property | **قياس** تعبير دقيق عن خاصية فيزيائية |
| **median** the middle number in a set of data when the data are arranged in numerical order | **وسيط** الرقم الأوسط في مجموعة بيانات عند ترتيب البيانات ترتيبًا عدديًا |
| **metamorphic rock** a rock that forms from another kind of rock under heat and pressure | **صخر متحول** صخر يتحول من نوع آخر من الصخور نتيجة الحرارة والضغط |

صخر الرخام

| | |
|---|---|
| **metric balance** an object used to measure mass | **ميزان متري** أداة تستخدم لقياس الكتلة |
| **mimic** to copy or imitate | **محاكاة** تقليد |
| **mineral** a solid, natural material made from nonliving substances in Earth's crust; some minerals are also nutrients that help living organisms grow and function | **معدن** مادة طبيعية صلبة تتكون من مواد غير عضوية في القشرة الأرضية؛ تكون بعض المعادن أيضًا مواد مغذية تساعد الكائنات الحية على النمو والحياة |
| **model** a representation of an object, event, or concept that describes how it works; often used as a tool for understanding the natural world or defining the construction of a product | **نموذج** تمثيل لجسم أو حدث أو مفهوم يصف كيف يعمل؛ يُستخدم النموذج عادةً كأداة لفهم عالم الطبيعة أو تعريف مكونات المنتج |
| **musculoskeletal system** all of the bones, cartilage, and muscles that work together to make a body move | **جهاز عضلي هيكلي** جميع العظام والغضاريف والعضلات التي تعمل معًا لتساعد الجسم على الحركة |
| **mutualism** a relationship between two kinds of organisms that benefits both | **تبادل المنفعة** علاقة بين نوعين من الكائنات الحية يستفيد منها الطرفان |

Ken Cavanagh/McGraw-Hill Education

## N

| | |
|---|---|
| **natural resources** materials people take from Earth to meet their needs | **موارد طبيعية** المواد التي يأخذها البشر من الأرض لتلبية احتياجاتهم |
| **niche** the role of an organism in an ecosystem | **الوضع الوظيفي** الدور الوظيفي الذي يقوم به الكائن الحي في النظام البيئي |
| **nonrenewable resource** natural resources that can be used more quickly then they made by Earth's natural processes, or are elements that cannot be made ; | **موارد غير متجددة** الموارد الطبيعية التي يتم استهلاكها بوقت أسرع من الوقت الذي تستغرقه عمليات الأرض الطبيعية في إنتاجها أو العناصر التي لا يمكن صناعتها ؛ |
| **nutrients** substances in foods that your body needs for growth, repair, and energy | **مواد مغذية** المواد الموجودة بالطعام والتي يحتاجها الجسم للنمو وترميم الخلايا والحصول على الطاقة |

## O

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|---|---|
| **observation** using one or more of your senses to identify or learn about something | **ملاحظة** استخدام إحدى الحواس أو أكثر لتحديد أو تعلم شيء ما |
| **outer core** a liquid layer of iron and nickel below Earth's mantle | **اللب الخارجي** طبقة سائلة من الحديد والنيكل أسفل طبقة وشاح الأرض |

## P

| | |
|---|---|
| **parasitism** a relationship in which one organism lives in or on another organism and benefits from that relationship while the host organism is harmed by it | **تطفل** علاقة بين اثنين من الكائنات الحية حيث يعيش أحدهما بداخل الآخر أو معتمدًا عليه فيستفيد الكائن المتطفل بينما يُضرّ الكائن الآخر |
| **photosynthesis** a plant's process of making food using sunlight, water, and air | **بناء ضوئي** العملية التي يقوم بها النبات ليصنع الغذاء من أشعة الشمس والماء والهواء |
| **physical fitness** when your heart, lungs, muscles, and body are healthy and working at their best | **لياقة بدنية** عندما يكون قلبك ورئتيك وعضلاتك وجسمك بصحة جيدة ويعملون بأقصى كفاءتهم |
| **plastic** a synthetic substance made from petroleum or natural gas that is easily shaped or molded | **بلاستيك(لدائن)** مادة صناعية تُصنع من البترول أو الغاز الطبيعي ويسهل تشكيلها أو قولبتها |
| **plate tectonics** a model in which Earth's surface is broken into large plates (some bigger than continents) that move slowly over the liquid magma below the surface | **تكتونية الألواح** نموذج لسطح الأرض حيث انقسم إلى صفائح كبيرة (بعضها أكبر من القارات) تتحرك ببطء على الصهارة السائلة تحت سطح الأرض |
| **pollution** the addition of harmful substances to the environment | **تلوث** إضافة مواد ضارة إلى البيئة |
| **population** all the members of one species in an area | **جماعة أحيائية** جميع الأفراد الذين ينتمون إلى نوع واحد في منطقة ما |

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| **precision** a description of how close repeated measurements are to each other | **دقة** وصف لمدى تقارب القياسات المتكررة ببعضها البعض |
| **predator** an animal that hunts other animals for food | **مفترس** حيوان يقوم باصطياد الحيوانات الأخرى للحصول على الغذاء |
| **prey** a living thing that is hunted for food | **فريسة** الكائنات الحية التي يتم اصطيادها للحصول على الغذاء |
| **primary succession** the beginning of a community where few, if any, living things exist | **تتابع أولي** بداية مجتمع أحيائي حيث يوجد أعداد قليلة من الكائنات الحية. إن وجدت. |
| **prosthesis** an artificial extension that replaces a body part | **أطراف صناعية** طرف صناعي يحل محل أحد أجزاء الجسم |
| **proteins** nutrients in food that are needed for growth and repair of body tissues | **بروتينات** مواد مغذية توجد بالطعام وتعتبر ضرورية للنمو وترميم أنسجة الجسم |

## Q

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| **qualitative data** descriptive data that cannot be measured | **بيانات نوعية** بيانات وصفية لا يمكن قياسها |
| **quantitative data** data that can be measured | **بيانات كمية** بيانات يمكن قياسها |

## R

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| **range** a set of data is the difference between the highest and lowest values | **المدى(المجال)** مجموعة من البيانات تمثل الاختلاف بين أعلى وأقل قيمة |
| **relief map** a map that shows the elevation of an area using colors or shading | **خريطة التضاريس** خريطة تبين المستويات المرتفعة في منطقة ما باستخدام الألوان أو التظليل |
| **resource** a substance needed by an organism for growth and other life processes | **موارد** المواد التي يحتاجها الكائن الحي للنمو وللعمليات الحيوية الأخرى |
| **robotics** field of science and technology that makes and uses programmable machines that perform specific tasks | **علم الانسان الآلي(الروبوت)** مجال من مجالات العلم والتكنولوجيا يهتم بتصنيع واستخدام الماكينات المبرمجة التي تؤدي مهام محددة |
| **rock** a solid object made naturally in Earth's crust that contains one or more minerals | **صخر** جسم صلب يتكون طبيعيًا في القشرة الأرضية ويحتوي على معدن أو أكثر |
| **rock cycle** a never-ending process in which rocks change from one kind into another | **دورة الصخور** عملية لا نهائية تتحول فيها الصخور من نوع إلى آخر |

## S

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| **schematic** a detailed drawing showing the parts and functions of an object or system | **مخـــطـــط تمثيلي** رسم مفصل يوضح أجزاء ووظائف جسم أو نظام |
| **science** a way of learning about the natural world | **عِلم** منهاج للتعلم بشأن العالم الطبيعي |
| **scientific law** a rule that describes a pattern in nature | **قانون علمي** قاعدة تصف أحد الأنماط في الطبيعة |

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| **scientific method** a series of steps that scientists use when conducting an investigation | **طريقة علمية** سلسلة من الخطوات يتبعها العلماء عند إجراء تحقيق |
| **scientific theory** an attempt to explain a pattern observed repeatedly in the natural world | **نظرية علمية** محاولة لتفسير نمط معين بتكرار ملاحظته في الطبيعة |
| **secondary succession** the beginning of a new community where an earlier community already existed | **تتابع ثانوي** بداية مجتمع أحيائي جديد بينما لا يزال المجتمع الأحيائي السابق موجود بالفعل |
| **sediment** the particles of soil or rock that may be eroded and deposited | **رواسب** جزيئات التربة أو الصخر التي تتآكل وتترسب |
| **sedimentary rock** a rock made of compacted and cemented materials | **صخر رسوبي** صخر مُكون من حبيبات متجمعة ومتلاحمة |
| **shelter** a part of animals environment that offers protection | **مأوى** جزء من بيئة الحيوانات توفر لهم الحماية |
| **soil** a mixture of bits of rock and once-living plants and animals | **تربة** خليط من حبيبات الصخور وبقايا النباتات والحيوانات الميتة |
| **soil horizon** any of the layers of soil from the surface to the bedrock | **افق التربة** أيٌّ من طبقات التربة بدءًا من السطح وحتى صخر القاعدة |
| **spring scale** an object that uses springs and gravity to measure weight | **ميزان زنبركي** أداة تستخدم الزنبركات والجاذبية لقياس الوزن |
| **stomata** tiny pores on the underside of plant leaves that allow air to enter leaves and water to evaporate out of leaves | **ثغور** ثقوب دقيقة في أسفل أوراق النباتات تسمح للهواء بدخول الأوراق وتُخرج بخار الماء من الأوراق |
| **streak** the color of a mineral's powder | **مخدش المعدن** لون مسحوق المعدن |
| **succession** the process of one ecosystem changing into a new and different ecosystem | **تتابع** عملية تغير أحد النظم البيئية ليصبح نظامًا جديدًا ومختلفًا |
| **symbiosis** a relationship between two kinds of organisms over time | **تكافل أو تبادل منفعة** علاقة تنشأ بين نوعين من الكائنات الحية بمرور الوقت |
| **synthetic** made by humans; not found in nature | **اصطناعي** من صنع الإنسان أي لا يوجد في الطبيعة |

## T

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| **taiga** a cool forest of coniferous evergreen trees | **غابة صنوبر** غابة باردة من أشجار الصنوبر الخضراء |
| **technology** the scientific ways that humans adapt or change nature to meet their needs | **تكنولوجيا** الطرق العلمية التي يستخدمها الإنسان لتعديل أو تغيير الطبيعة بحيث تلبي احتياجاته |
| **temperate rainforest** an ecosystem with a lot of rain, fog, and a cool climate | **غابات مطيرة معتدلة الحرارة** نظام بيئي يتميز بكثرة الأمطار والضباب والمناخ الرائع |

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| **textile** any type of fabric, especially one made by weaving or knitting fibers together | **نسيج** أي نوع من الأقمشة، لا سيما الأقمشة المغزولة أو المخيطة |
| **threatened species** a species that is in danger of becoming endangered | **أنواع مهددة** الأنواع المهددة بأن تصبح مهددة بالانقراض |
| **topographical map** a map that shows the elevation of an area of Earth's surface using contour lines | **خريطة طوبوغرافية** خريطة تبين المناطق المرتفعة على سطح الأرض باستخدام خطوط الكنتور |
| **topsoil** the dark, top layer of soil, rich in humus and minerals, in which organisms live and most plants grow | **التربة الفوقية** طبقة التربة العليا الداكنة الغنية بالدبال والمعادن. وتعيش على تلك الطبقة الكائنات الحية وتنمو عليها معظم النباتات |
| **tropical rainforest** a forest ecosystem characterized by a rainy, hot, and humid climate | **غابة مطيرة إستوائية** غابة يتميز نظامها البيئي بمناخ مطير وحار ورطب |
| **tsunami** a huge wave caused by an earthquake under the ocean | **تسونامي** موجة هائلة ناتجة عن زلزال أسفل المحيط |

## V

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| **vitamins** nutrients that help your body grow, function, and use other nutrients | **فيتامينات** المواد المغذية التي تساعد جسمك على النمو وأداء وظائفه والاستفادة من المواد المغذية الأخرى |
| **volcano** an opening in Earth's crust through which lava may flow | **بركان** فتحة بالقشرة الأرضية تتدفق من خلالها الحمم |

## W

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| **weathering** the process through which rocks or other materials are broken down into smaller pieces | **تجوية** العملية التي تتفتت بها الصخور أو المواد الأخرى إلى أجزاء أصغر |