CHAPTER 4
LESSON 1

Sound

Producing and Detecting Sound

Key Concepts

- How is sound produced?
- How does sound move from one place to another?
- Why does sound travel at different speeds through various materials?
- What are the functions of the different parts of the human ear?

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	1. Sound waves travel fastest in empty space.	
	2. Hearing loss is mainly caused by brief, loud sounds, such as a firecracker.	

Study Coach

Identify the Main Ideas As you read, write one sentence to summarize the main idea in each paragraph. Write the main ideas on a sheet of paper or in your notebook to study later.

Read to Learn

What is sound?

Everywhere you look, people seem to have something on their ears! Some talk on cell phones, some listen to music, and others wear ear protection to prevent damage to their hearing. All of these devices have something to do with sound. Sound is produced by **sound waves**—*longitudinal waves that can only travel through matter.* A **longitudinal wave** *is a wave that makes the particles in the material that carries the wave move back and forth along the direction the wave travels.*

Sources of Sound

Every sound, from the buzzing of a bee to a loud siren, results from a vibration. *A* **vibration** *is a rapid, back-and-forth motion that can occur in solids, liquids, or gases.* The energy carried by a sound wave is caused by vibration. For example, as you pull on a guitar string, you transfer energy to the string. When you let go, the string snaps back and vibrates. As the string vibrates, it collides with nearby air particles and transfers energy to these particles. The air particles collide with other air particles and pass on energy.

The string vibrates in a back-and-forth motion. This motion causes a disturbance in the air that carries energy outward from the source of the sound. This disturbance is a sound wave.

Key Concept Check

1. Determine How is sound produced?

How Sound Waves Travel

Vibrating objects cause sound waves that occur only in matter. So, sound waves must travel through a solid, a liquid, or a gas. *A material in which a wave travels is a* **medium.**

You usually hear sound through the medium of air. But sound waves also can travel through other media, such as water, wood, and metal. Sound waves cannot travel through empty space, because empty space has no medium to carry the energy.

From a Sound Source to Your Ear Sound waves move away from a sound source, such as the speaker below, as compressions and rarefactions. If you touch a speaker, you can feel it vibrate as it produces sound waves.

Air particles fill a room. Each time the speaker cone moves forward, it pushes air particles ahead of it in the room. This push forces the particles closer together, increasing air pressure in that area. *A region of a longitudinal wave where the particles in the medium are closest together is a* **compression.** The image on the left in the figure below illustrates a compression.

With each vibration, the speaker cone moves forward and then back. When the speaker cone moves back, it leaves behind a low-pressure region with fewer air particles. The image on the right in the figure illustrates this low-pressure region, called a rarefaction. *A* **rarefaction** (rayr uh FAK shun) *is a region of a longitudinal wave where the particles are farthest apart.*

SCIENCE USE V. COMMON USE

media

Science Use plural form of *medium;* forms of matter through which sound travels

Common Use a type of mass communication, such as radio

Visual Check

2. Identify As a speaker is producing sound, when does a rarefaction occur?

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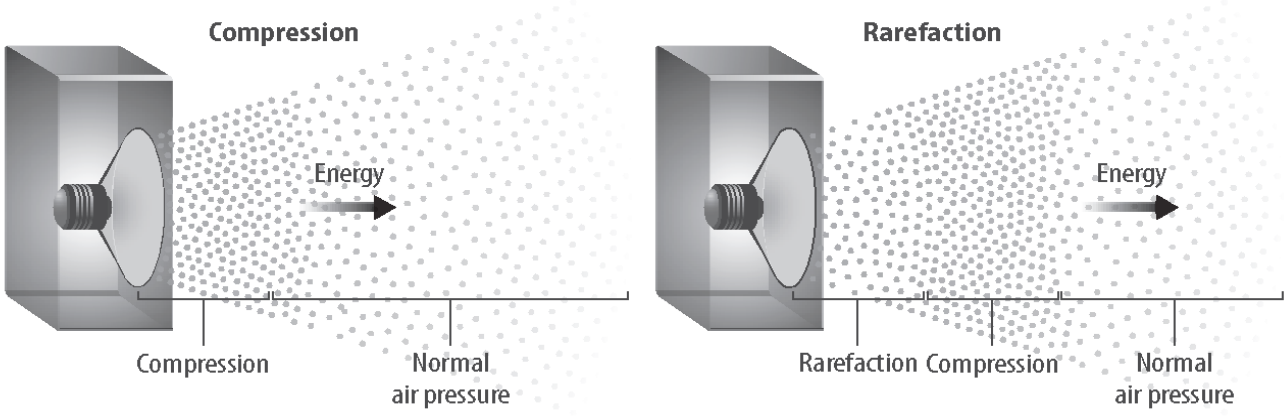
_____

How Sound Waves Move



When the speaker cone moves out, it forces particles in the air closer together. This produces a high pressure area, or compression.

When the speaker cone moves back, it leaves behind an area with fewer particles. This is a low pressure area called a rarefaction.

Visual Check

3. Describe What happens to particles of matter as sound waves travel?

Key Concept Check

4. Explain How do sound waves travel?

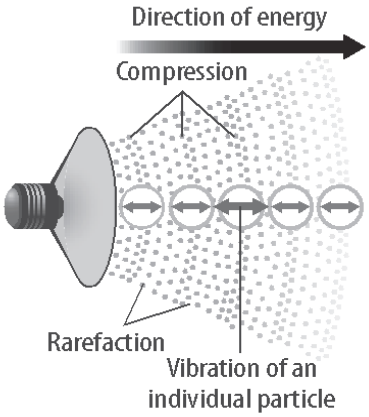
Interpreting Tables

5. Predict Based on the data in the table, do you think sound will move faster in cool pond water or in warm bath water?

Key Concept Check

6. Explain Why does sound travel at different speeds through various materials?

Direction of Sound Energy



Energy in Sound Waves Imagine someone at the back of a line bumping into the next person. That person bumps the next person and then returns to his or her original place. The energy of the bump continues down the line. In the same way, particles of a medium vibrate back and forth as a sound wave carries energy away from a source. The figure at right shows this process.

Speed of Sound

Sound waves travel faster in water than in air. The table compares the speed of sound in different media.

The Speed of Sound

Material	Speed (m/s)
Air (0°C)	331
Air (20°C)	343
Water (20°C)	1,481
Water (0°C)	1,500
Seawater (25°C)	1,533
Ice (0°C)	3,500
Iron	5,130
Glass	5,640

Material Two factors that affect the speed of sound waves are the density and the stiffness of the material, or medium. Density is how closely the particles are packed. Gas particles are far apart and do not collide as often as do the particles of a liquid or a solid. Therefore, sound energy transfers more slowly in a gas than in a liquid or a solid. In a stiff or rigid solid, where particles are packed close together, the particles collide and transfer energy quickly. Sound waves travel faster in seawater than in freshwater. Seawater contains dissolved salts and has a higher density than freshwater.

Temperature The temperature of a medium also affects the speed of sound. As the temperature of a gas increases, the particles move faster and collide more often. This increase in collisions transfers more energy in less time. Notice that sound waves travel faster in air at 20°C than in air at 0°C.

In liquids and solids, temperature has the opposite effect. Why do sound waves travel faster in water at 0°C than at 20°C? As water cools, the molecules move closer together, colliding more often. Sound waves travel even faster when the water freezes into ice because ice is rigid.

Detecting Sound

The fennec fox is a small fox with large ears. How do you think having large ears helps a fennec fox? Sound waves fill the air, and the large outer ear helps funnel sound waves to the inner ear, where sound is detected. Ears also tell the direction a sound comes from. With its large ears, the fennec fox can hear predators approach from greater distances. The fox's ears can even detect prey moving underground.

The Human Ear

Have you ever cupped your hand around the back of your ear so you could hear better? Why does that work? The human ear has three main parts. The outer ear collects sound waves. By cupping your hand around your ear, you extend the outer ear and collect more waves. The middle ear amplifies sound. The inner ear sends signals about sound to the brain. As shown in the figure below, each part of the ear has a special shape with different parts that help it perform its function.

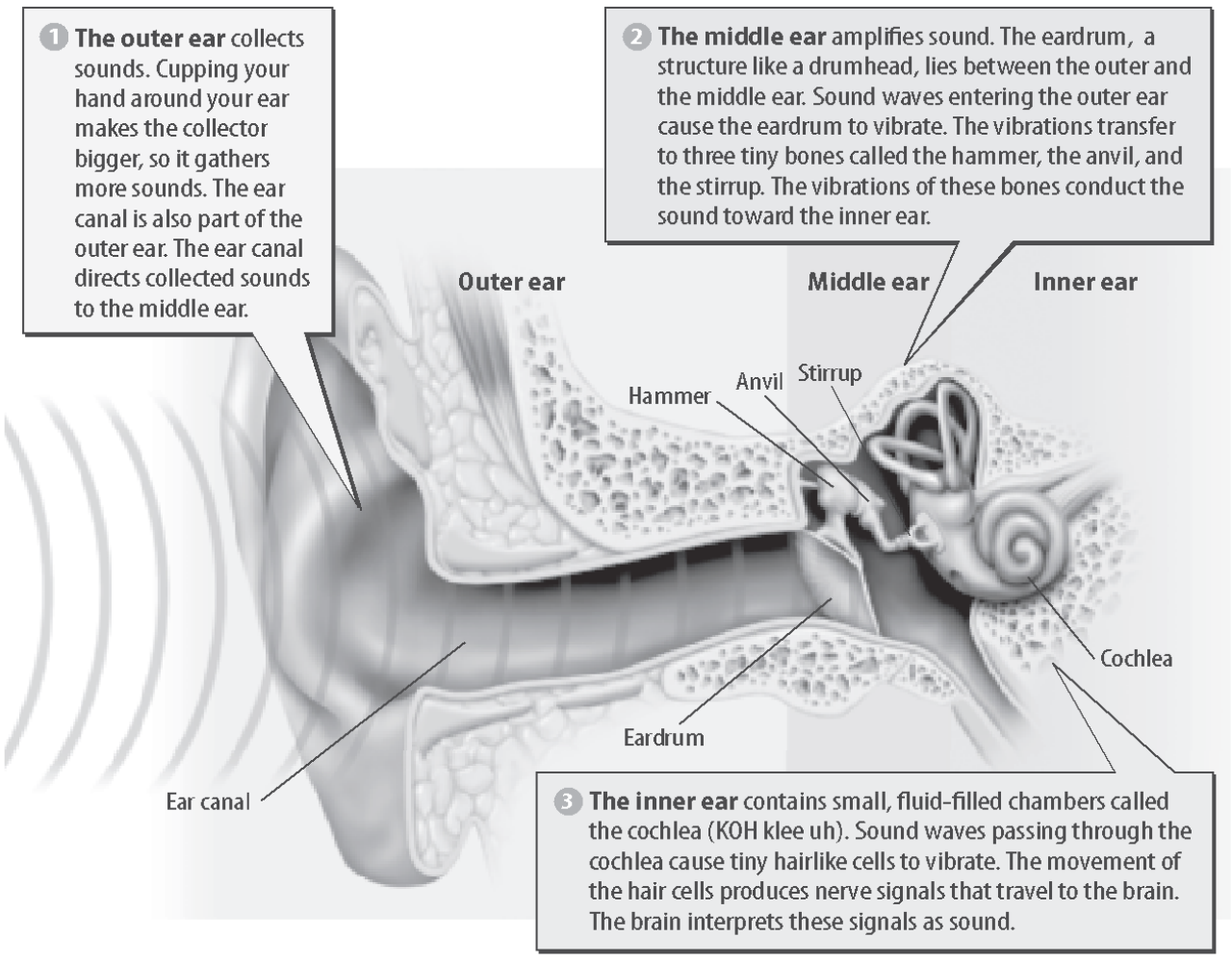
Key Concept Check

7. Identify What are the functions of the different parts of the human ear?

Visual Check

8. Analyze How does the eardrum help you hear?

Functions of Human Ear Parts



FOLDABLES®

Make a vertical three-tab book to organize your notes about sound.

Reading Check

9. Analyze Why can a very loud sound cause the eardrum to tear?

_____

_____

_____

Reading Check

10. Name some things that might happen to your ear to cause hearing loss.

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Hearing Loss

The harder you pound on a drum, the farther the drumhead travels as it vibrates. What would a drum sound like if the drumhead had a big tear in it? Like a drumhead, the eardrum can be damaged. The eardrum vibrates as pressure changes in the ear. The louder the sound is, the farther the eardrum moves in and out as it vibrates.

A very loud sound can make the eardrum vibrate so hard that it tears. Damage to the eardrum can cause hearing loss. Also, the tear can allow bacteria into the ear, causing infection. The tear may heal, but thick, uneven scar tissue can make the eardrum less sensitive to sounds.

Listening to loud music over a long period of time also can damage the ears. Locate the cochlea in the figure on the previous page. Infection or loud sounds can damage tiny hair cells in the cochlea. Cells that are damaged or die do not grow back. As a result, hearing becomes less sensitive. Many people who work around loud machines, construction, or traffic wear ear protection to prevent damage. Wearing a headset while listening to loud music, however, traps the pressure changes in the ear. This can lead to permanent hearing loss.

After You Read

Mini Glossary

compression: a region of a longitudinal wave where the particles in the medium are closest together

longitudinal wave: a wave that makes the particles in the material that carries the wave move back and forth along the direction that the wave travels

medium: a material in which a wave travels

rarefaction (rayr uh FAK shun): a region of a longitudinal wave where the particles are farthest apart

sound wave: longitudinal wave that travels only through matter

vibration: a rapid back-and-forth motion that can occur in solids, liquids, or gases

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that identifies the media through which sound can travel.

2. In the table below, describe the function of each main area of the ear. Then identify the parts within each area.

Outer Ear	Middle Ear	Inner Ear
function:	function:	function:
parts:	parts:	parts:

3. How did summarizing the main ideas help you learn about sound? In the space below, summarize one main idea that you learned from your notes.

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

Connect ED

Log on to ConnectED.mcgraw-hill.com and access your textbook to find this lesson's resources.

END OF LESSON