Waves

What are waves?

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. Waves carry matter as they travel from one place to another.	
	2. Sound waves can travel where there is no matter.	

Key Concepts

- What is a wave?
- How do different types of waves make particles of matter move?
- Can waves travel through empty space?

Read to Learn

Mark the Text

Underline Main Ideas As you read, underline the main ideas under each heading. After you finish reading, review the main ideas that you have underlined.

What are waves?

Imagine a warm summer day. You are floating on a raft in the middle of a calm pool. Suddenly, a friend does a cannonball dive into the pool. You probably know what happens next—you are no longer resting peacefully on your raft. Your friend's dive causes you to start bobbing up and down on the water. However, after you stop moving up and down, you haven't moved forward or backward in the pool. Why did your friend's dive make you move up and down? Your friend's jump into the water creates waves.

Throwing a stone into a calm pool of water makes waves on the water's surface. When the stone hits the water, the waves spread out over the surface of the water. But what is a wave? *A* **wave** *is a disturbance that transfers energy from one place to another without transferring matter.*

Key Concept Check

1. Identify What is a wave?

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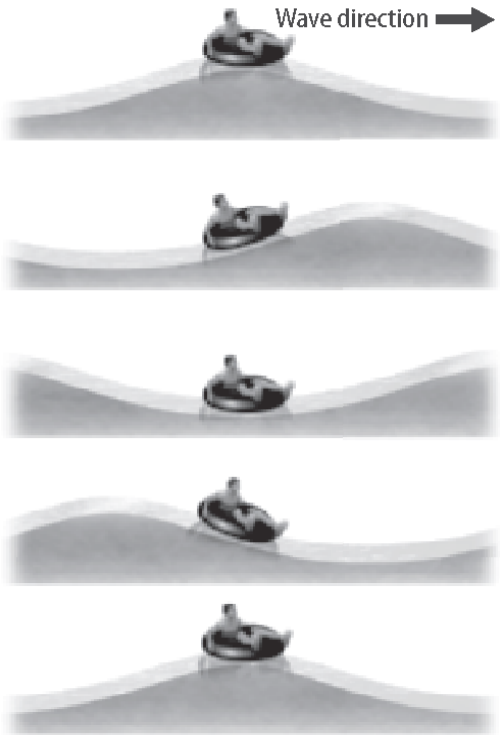
A Source of Energy

Waves transfer energy away from the source, or starting place, of the energy. The contact of raindrops or a stone on the surface of the water is the source of energy for the water waves. Light waves also spread out in all directions from a candle flame. The burning wick is the energy source for the light waves.

Energy Transfer

When a stone hits the surface of the water, the stone's energy transfers, or is given, to the water. The energy transferred to the water produces waves. The waves then transfer energy in all directions.

If you are on a raft in the ocean, the raft will be lifted up and down by the waves, as shown in the figure below. The waves will not carry the raft in the direction the waves are moving. The waves will move the raft only up and down. They will not move any ocean water in the direction the waves are moving, either. The water will only go up and down.



How Waves Transfer Energy

How do waves transfer energy without transferring matter? Like all materials, water is made of tiny particles. When an object hits water, the impact of the object hitting the water transfers energy to the water, pushing and pulling on the water particles. The neighboring water particles then transfer energy outward. This energy then travels through the water, from particle to particle, as a wave.

Reading Check

2. Identify What do waves transfer from place to place?

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Visual Check

3. Describe what happens to the raft, shown in the figure, when the wave transfers energy to it.

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Think it Over

4. Explain What happens to water when an object hits it?

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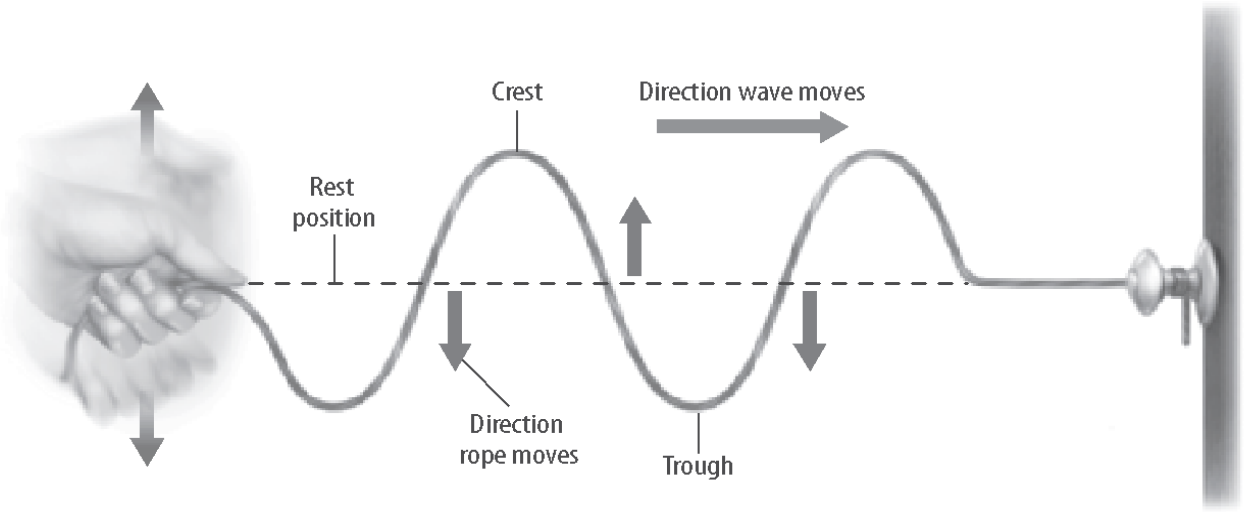
Mechanical Waves

A water wave is an example of a mechanical wave. *A wave that can travel only through matter is called a* **mechanical wave.** Mechanical waves travel through solids, liquids, and gases. Mechanical waves cannot travel through a vacuum.

A material in which a wave travels is called a **medium.** Mechanical waves can be either transverse waves or longitudinal waves.



Transverse Waves

You can make a wave on a rope by shaking one end of the rope up and down, as shown in the figure above. A wave traveling through a rope is a transverse wave. *A* **transverse wave** *is a wave in which the disturbance is perpendicular to the direction the wave travels.*

In the figure above, the dotted line shows where the rope was before it was shaken. This is the rest position. When you shake the rope, the particles in the rope move up and down, and the wave moves forward or away from the source of energy. The rope moves in a direction that is perpendicular, or at right angles, to the direction the wave moves. All transverse waves move like this.

The highest points on a transverse wave are **crests.** *The lowest points on a transverse wave are* **troughs.** As a transverse wave moves through a rope, it makes crests and troughs in the rope.

Visual Check

5. Identify In which direction is the wave in the figure moving?

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Key Concept Check

6. Describe How do particles move in a transverse wave?

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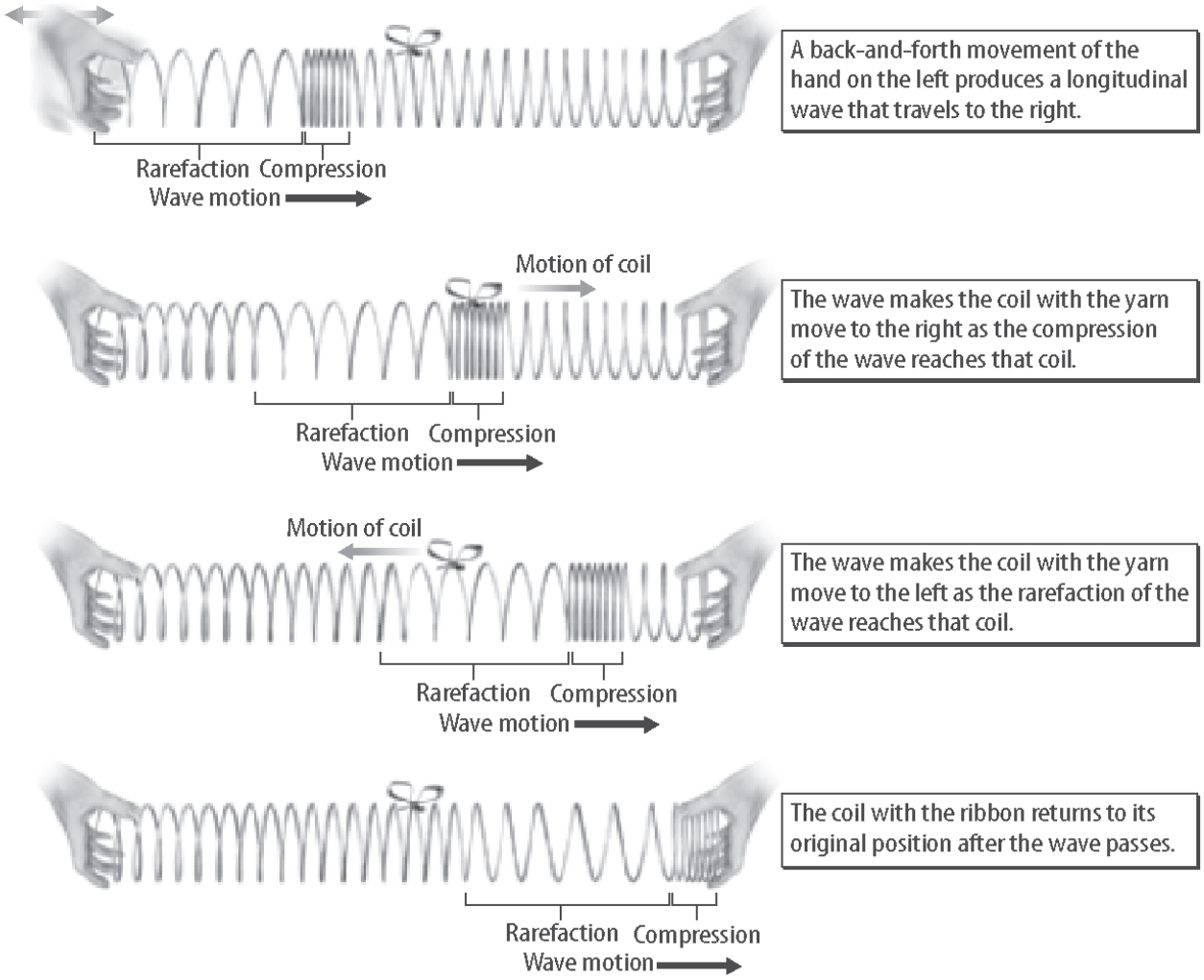

Visual Check

7. Identify What is the medium through which the longitudinal wave is moving in this figure?

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Key Concept Check

8. Explain How do particles move in a longitudinal wave?

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Longitudinal Waves

Another kind of mechanical wave is a longitudinal (lahn juh TEWD nul) wave. *A* **longitudinal wave** *makes the particles in a medium move parallel to the direction that the wave travels.* The figure above shows a longitudinal wave moving along a spring. As the wave passes, the coils of the spring move closer together, then move farther apart, and back again. This is parallel to the direction that the wave itself moves.

Before a wave moves through the spring, the coils of the spring are all the same distance apart. This is the rest position of the spring. This changes when a wave moves through the spring. The wave produces regions in the spring where the coils are closer together than they are in the rest position and regions where they are farther apart. *The regions of a longitudinal wave where the particles in the medium are closest together are* **compressions.** *The regions of a longitudinal wave where the particles of the medium are farthest apart are* **rarefactions.**

Vibrations and Mechanical Waves

When you hit a drum with a drumstick, the surface of the drum moves up and down, or vibrates. Vibrating objects are the sources of energy that produce mechanical waves.

One Wave per Vibration Imagine that you are making a transverse wave through a rope. Each time you move your hand up and down, a single vibration occurs. One vibration produces a transverse wave with one crest and one trough.

Vibrations Stop—Waves Go What happens when you stop moving your hand? No new waves are produced. The waves that are already moving through the rope will keep moving along the rope.

Types of Mechanical Waves

All mechanical waves travel only in matter. Sound waves, water waves, and waves made by earthquakes are mechanical waves. Sound waves are longitudinal waves that travel in solids, liquids, and gases. Water waves are a combination of transverse waves and longitudinal waves. Earthquake waves are also called seismic (SIZE mihk) waves. There are both longitudinal and transverse seismic waves.

Electromagnetic Waves

Light from the Sun is a wave, but it is not a mechanical wave. A mechanical wave cannot travel through the space between the Sun and Earth. Light is an electromagnetic wave. *An* **electromagnetic wave** *is a wave that can travel through empty space and through matter.*

Types of Electromagnetic Waves

There are other kinds of electromagnetic waves besides light waves. Radio waves, microwaves, infrared waves, and ultraviolet waves are electromagnetic waves. Each has a different wavelength.

Electromagnetic Waves and Objects

Every object gives off electromagnetic waves. The type of electromagnetic waves that an object gives off depends mostly on the temperature of the object. Objects near human body temperatures give off mostly infrared waves.

Electromagnetic Waves from the Sun

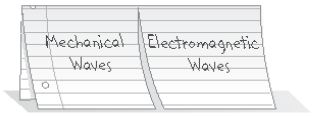
Like all waves, electromagnetic waves carry energy. Scientists often call this radiant energy. Infrared and visible light waves carry about 92 percent of the radiant energy that reaches Earth from the Sun. Ultraviolet waves carry about 7 percent of the Sun's energy.

Reading Check

9. Identify What produces mechanical waves?

FOLDABLES

Make a two-tab book to organize information about mechanical and electromagnetic waves.



Key Concept Check

10. Identify a type of wave that can travel through a vacuum.

After You Read

Mini Glossary

compression (kum PRE shun): the region of a longitudinal wave where the particles in the medium are closest together

crest: the highest point on a transverse wave

electromagnetic (ih lek troh mag NEH tik) wave: a wave that can travel through empty space and through matter

longitudinal (lahn juh TEWD nul) wave: a wave that makes the particles of a medium move parallel to the direction that the wave travels

mechanical (mih KA nih kul) wave: a wave that can travel only through matter

medium: a material in which a wave travels

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

transverse (tranz VURS) wave: a wave in which the disturbance is perpendicular to the direction the wave travels

trough (TRAWF): the lowest point on a transverse wave

wave: a disturbance that transfers energy from one place to another without transferring matter

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes some of the differences between transverse waves and longitudinal waves.

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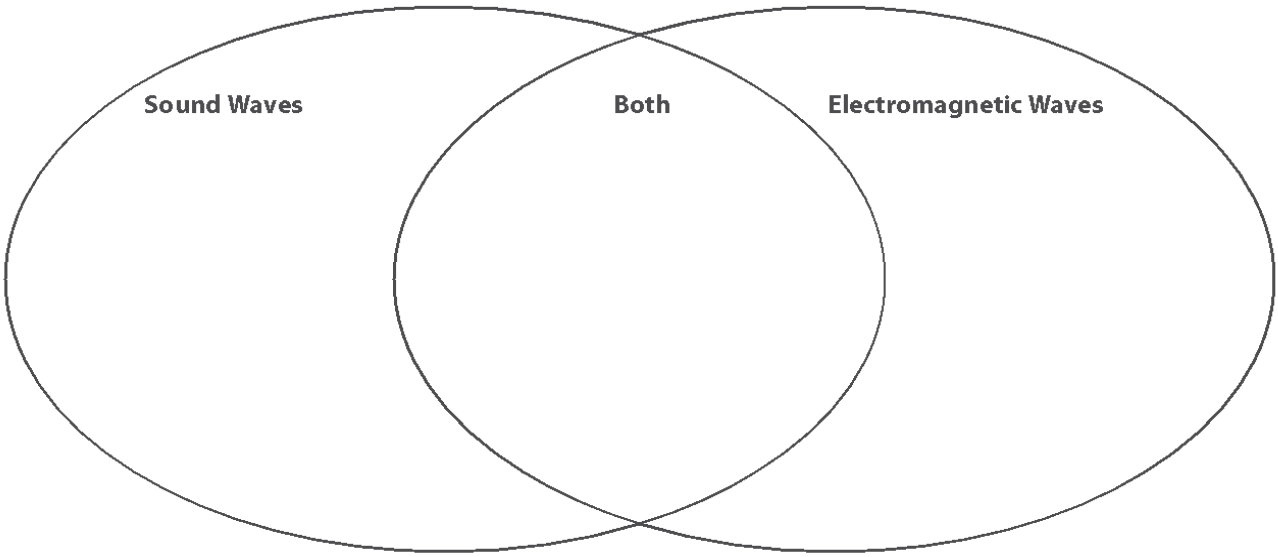
2. Use a Venn diagram to compare and contrast sound waves and electromagnetic waves.



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