

# Waves

## What are waves?

### ..... Before You Read .....

Pre-Assessment

**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.	

3

### Key Concepts

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

Post-Assessment

### ..... Read to Learn .....

## 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.

### 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.

### On going Task

**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.

### Key Concept Check

**1. Identify** What is a wave?

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**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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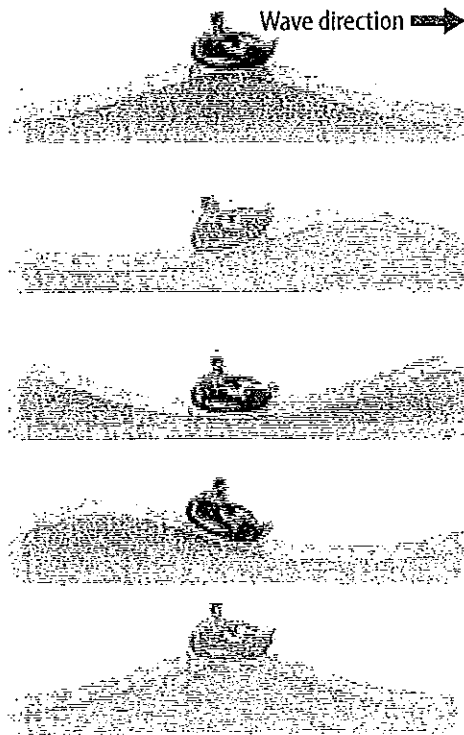
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**Energy Transfer**

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.

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## Mechanical Waves

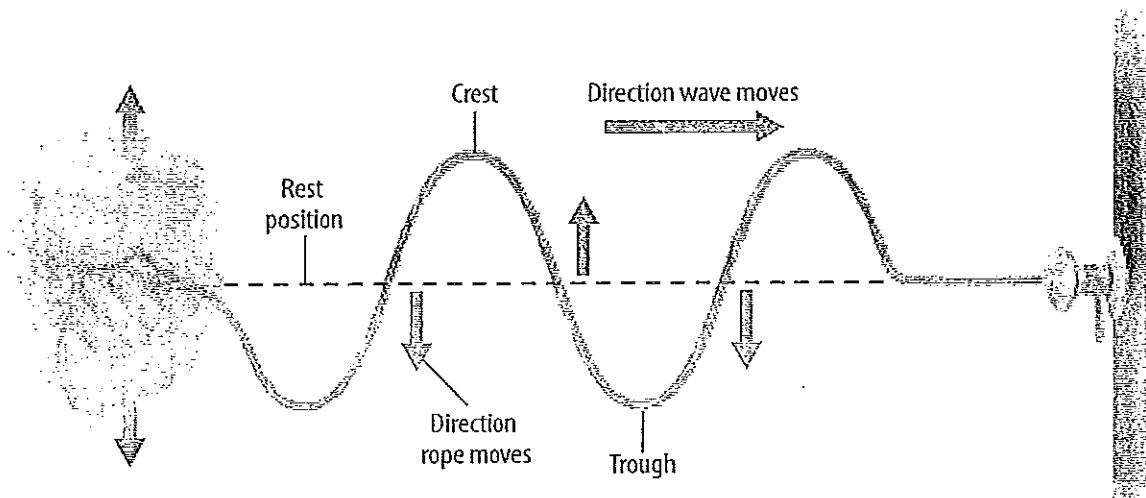
A water wave is an example of a mechanical wave. A wave that can travel only through matter is called a **mechanical wave**. Mechanical waves travel through solids, liquids, and gases. Mechanical waves cannot travel through a vacuum.

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

4b. Identify the media through which ~~mechanical~~ mechanical waves can travel. Cross out any that do not apply.


Solids      liquids

empty space      gases



## 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?

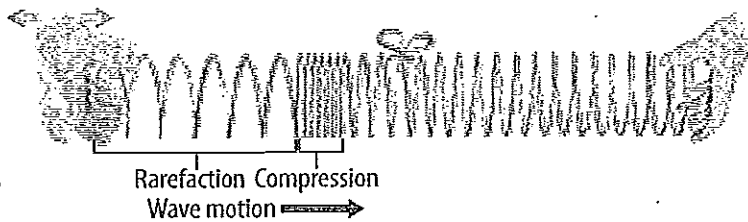
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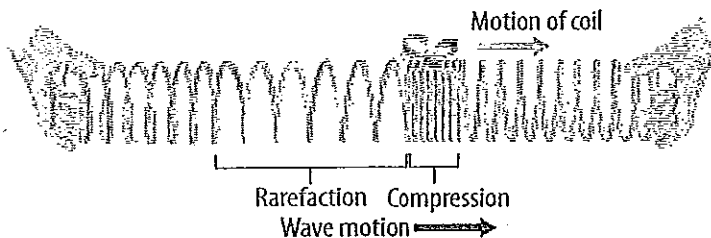
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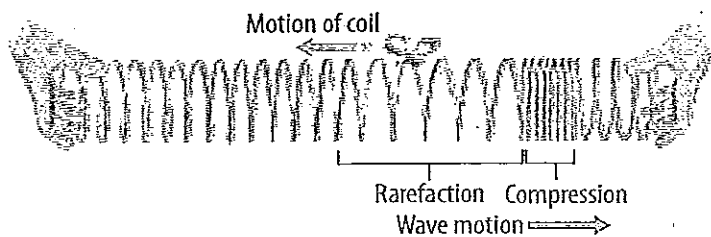
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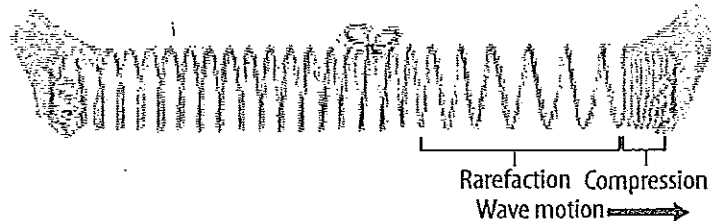
A back-and-forth movement of the hand on the left produces a longitudinal wave that travels to the right.



The wave makes the coil with the yarn move to the right as the compression of the wave reaches that coil.



The wave makes the coil with the yarn move to the left as the rarefaction of the wave reaches that coil.



The coil with the ribbon returns to its original position after the wave passes.

### 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.

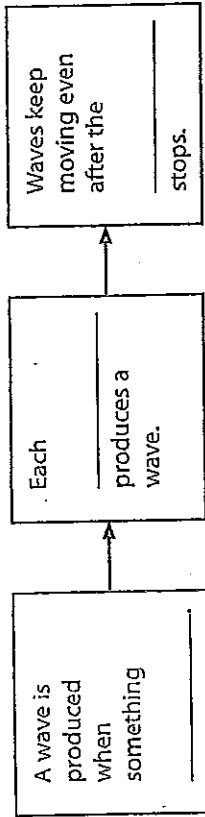
Before a wave moves through the spring, the coils of the spring are all the same distance apart. This is the rest position of the spring. This changes when a wave moves through the spring. The wave produces regions in the spring where the coils are closer together than they are in the rest position and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

10 Organize information about types of mechanical waves. Complete the table with the number of each phrase in the list below. Numbers can be used more than once.

1. travels only through matter
2. travels through gas medium
3. travels through liquid medium
4. travels through solid medium
5. caused by vibration
6. a longitudinal wave
7. a transverse wave
8. a combination of longitudinal and transverse waves

	Water Waves	Seismic Waves
Sound Waves		

9 Organize information about how mechanical waves are produced. Fill in the sequence chart below.



9+10

#11+12

## 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

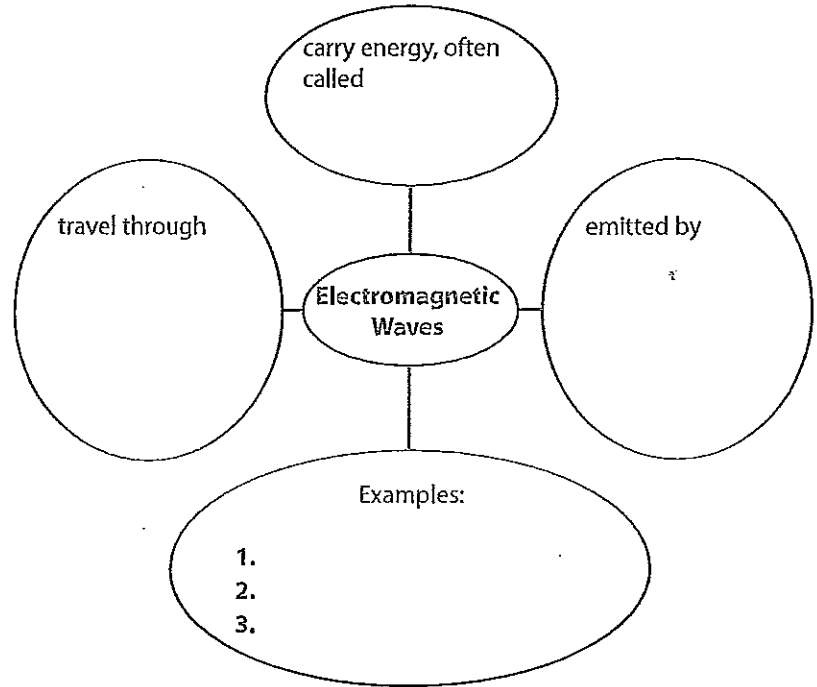
Like all waves, electromagnetic waves carry energy. Scientists often call this radiant energy. Infrared and visible light waves carry about 92 percent of the radiant energy that reaches Earth from the Sun. Ultraviolet waves carry about 7 percent of the Sun's energy.

Lesson 1 | What are waves? (continued)

Main Idea Details

Electromagnetic Waves

11 Organize information about electromagnetic waves by completing the concept map.



**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?

14

12 Assess information about electromagnetic waves. Read the statements below. If a statement is true, write true on the line. If it is false, rewrite the underlined part of the statement so that it is true.

An electromagnetic wave can travel only through empty space.

Electromagnetic waves called ultraviolet waves are given off by your body.

Like other waves, electromagnetic waves carry energy.

13 Analyze It You are with a friend in the schoolyard. You rest your ear against a metal leg of the swings while your friend gently taps on the leg. You hear the tapping. Describe the wave produced by tapping. Is it a longitudinal wave or a transverse wave? Through what type of medium does it pass?

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