chapter 1

Waves

section 1 What are waves?

Before You Read

Describe what comes to mind when you think of waves.

What You'll Learn

- how waves, energy, and matter are related
- the difference between transverse waves and compressional waves

Read to Learn

What is a wave?

Imagine that you are floating on an air mattress in a swimming pool and someone jumps into the pool near you. You and your air mattress bob up and down after the splash. What happened? Energy from the person jumping in made your air mattress move. But the person did not touch your air mattress. The energy from the person jumping in moved through the water in waves. **Waves** are regular disturbances that carry energy without carrying matter. The waves disturbed, or changed the motion of, your air mattress.

What do waves do?

Water waves carry energy. Sound waves also carry energy. Have you ever felt a clap of thunder? If so, you felt the energy in a sound wave. You also move energy when you throw a ball. But, there is a difference between a moving ball and a wave. A ball is made of matter. When you throw a ball, you move matter as well as energy. A wave moves only energy.

A Model for Waves

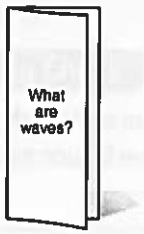
How can a wave move energy without moving matter? Imagine several people standing in a line. Each person passes a ball to the next person. The ball moved, but the people did not. Think of the ball as the energy in a wave and the people as the molecules that move the energy.

Study Coach

Create a Quiz As you read this section, write quiz questions based on what you have learned. After you write the quiz questions, answer them.

FOLDABLES

A Identify Make the following Foldable from a sheet of notebook paper to help you organize information about waves.



Think it Over

1. **Recognize** Write two examples of a mechanical wave.

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Picture This

2. **Draw and Label** In the figure, draw a circle around each crest in the wave. Then, use a different color of pen or pencil to draw a square around each trough.

Mechanical Waves

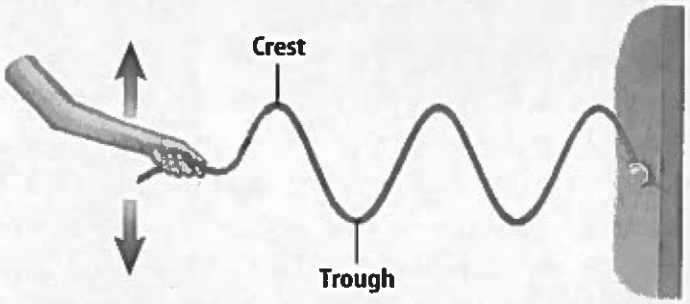
In the model of the wave, the ball (energy) could not be moved if the people (molecules) were not there. The same thing happens when a rock is thrown into a pond. Waves form where the rock hits the water. The molecules in the water bump into each other and pass the energy in the waves. The energy of a water wave cannot be moved or transferred if there are no water molecules.

Waves that use matter to move or transfer energy are **mechanical waves**. Water waves are mechanical waves. The matter that a mechanical wave travels through is called a medium. In a water wave, the medium is water. Solids, liquids, and gases are also mediums. For example, sound waves can travel through air, water, solids, and other gases. Without one of these mediums, there would be no sound waves. There is no air in outer space, so sound waves cannot travel in space.

What are transverse waves?

One kind of mechanical wave is a transverse wave. Transverse means to pass through, across, or over. In a **transverse wave**, the energy of the wave makes the medium move up and down or back and forth at right angles to the direction the wave moves. Think of a long rope stretched out on the ground. If you shake one end of the rope up and down, you make a wave that seems to slide along the rope, like the wave shown in the figure.

Transverse Wave



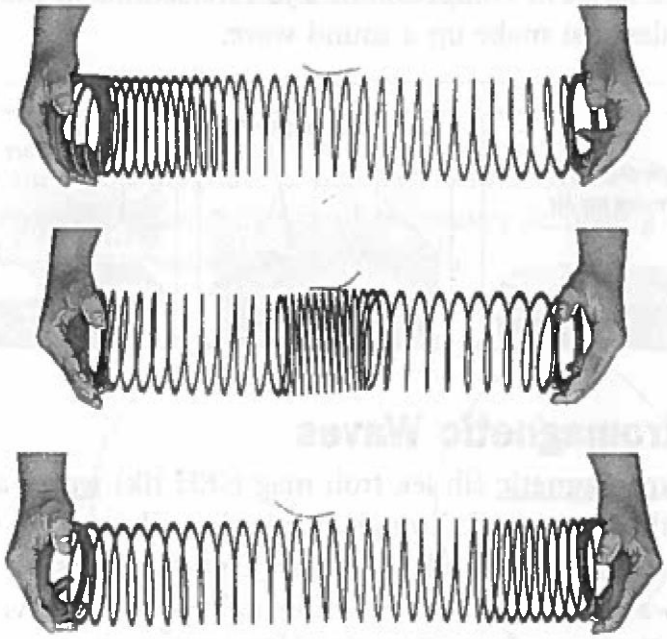
It might seem that the rope is moving away from you, but only the wave is moving away from your hand. The energy of the wave travels through the rope. But the matter in the rope does not move. Look at the figure. You can see that the wave has peaks and valleys that are spaced apart at even and regular distances. The high points of transverse waves are called crests. The low points are called troughs.

What are compressional waves?

Mechanical waves can be either transverse or compressional. Compress means to press or squeeze together. In a **compressional wave**, matter in the medium moves forward and backward along the same direction that the wave travels.

An example of a compressional wave made with a coiled spring is shown in the figure. A string is tied to the spring to show how the wave moves. Some coils on one end are compressed and then let go. As the wave begins, the coils near the end are close together. The other coils are far apart. The wave travels along the spring.

Compressional Wave



The coils and string move only as the wave passes them. Then, they go back to where they were. Compressional waves carry only energy forward along the spring. The spring is the medium the wave moves through, but the spring does not move along with the wave.

Sound Waves Sound waves are compressional waves. How do you make sound waves when you talk or sing? Hold your fingers against your throat while you hum. You can feel your vocal cords vibrating, or moving back and forth very quickly. You can also feel vibrations when you touch a stereo speaker while it is playing. All waves are made by something that is vibrating. ☑

Picture This

3. **Describe** Look at the figures. Describe the coils of the spring when the wave passes through them. Are they close together or far apart?

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Reading Check

4. **Identify** What kind of waves are sound waves?

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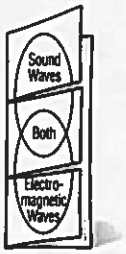
FOLDABLES

B Compare and Contrast
Make the following Foldable to compare and contrast the characteristics of sound waves and electromagnetic waves.



Picture This

5. **Identify** Look at the figure. What do the dots above the drum represent?

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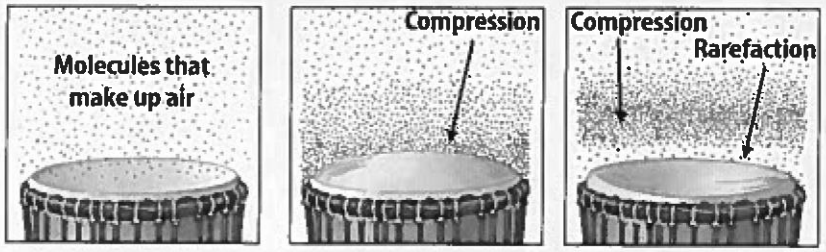
Making Sound Waves

A vibrating object causes the air molecules around it to vibrate. Look at the figure. When the drum is hit, the drumhead vibrates up and down. When the drumhead moves up, the air molecules next to it are pushed closer, or compressed, together. The group of compressed molecules is called a compression. The compression moves away from the drumhead.

When the drumhead moves down, the air molecules near it have more room and can spread apart. This group of molecules is a rarefaction. Rarefaction means something that has become less dense. The rarefaction also moves away from the drumhead. As the drumhead vibrates up and down, it makes a series of compressions and rarefactions in the air molecules that make up a sound wave.



Electromagnetic Waves

Electromagnetic (ih lek troh mag NEH tik) waves are waves that can travel through space where there is no matter. There are different kinds of electromagnetic waves, such as radio waves, infrared waves, visible light waves, ultraviolet waves, X rays, and gamma rays. These waves can travel in matter or in space. For example, radio waves from TV and radio stations travel through air. They can be reflected from a satellite in space. Then, they travel through air and the walls of your house to your TV or radio.

How does the Sun emit light and heat?

The Sun emits electromagnetic waves that travel through space and reach Earth. The energy carried by electromagnetic waves is called radiant energy. Almost 92 percent of the radiant energy that reaches Earth from the Sun is carried by infrared and visible light waves. Infrared waves make you feel warm. Visible light waves make it possible for you to see. Some of the Sun's radiant energy is carried by ultraviolet waves. These are the waves that can cause sunburn. ☑

Reading Check

6. **Classify** What is radiant energy?

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After You Read

Mini Glossary

compressional wave: a type of mechanical wave in which matter in the medium moves forward and backward along the same direction that the wave travels

electromagnetic waves: waves that can travel through space where there is no matter

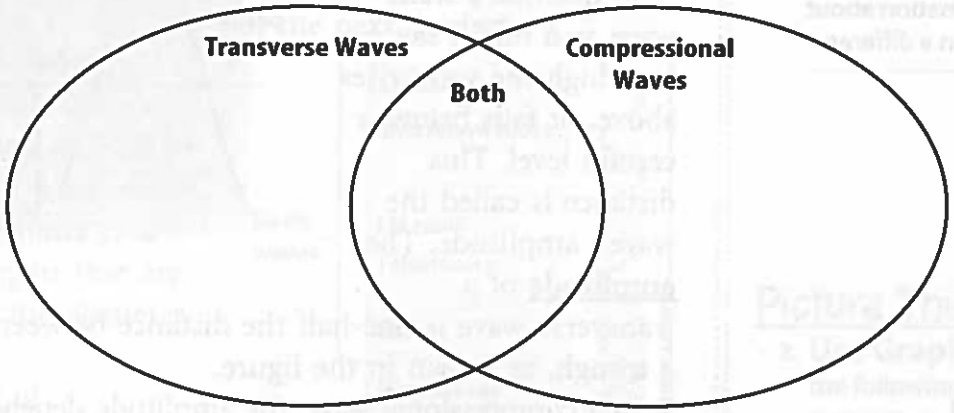
mechanical waves: waves that use matter to move energy

transverse wave: a type of mechanical wave in which the energy of the wave makes the medium move up and down or back and forth at right angles to the direction the wave travels

waves: regular disturbances that carry energy without carrying matter

1. Read the key terms and definitions in the Mini Glossary above. Write a sentence using the term *mechanical wave* on the lines below.

2. Use the Venn diagram to compare and contrast transverse and compressional waves. Arrange the characteristics of the waves according to whether they are true for transverse waves, compressional waves, or both.



3. How did the examples of the rope and the spring toy help you understand the difference between transverse and compressional waves?

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End of Section