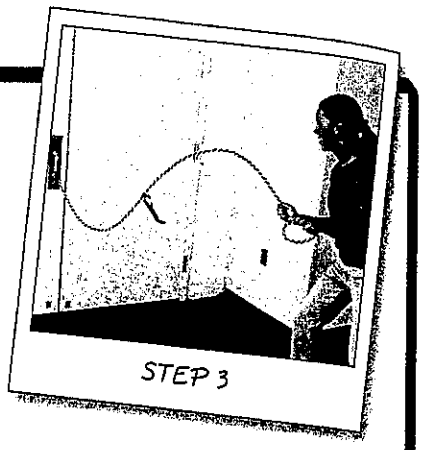
17-2 How do waves travel through matter?

INVESTIGATE

Observing Waves in a Rope

HANDS-ON ACTIVITY



1. Tie a colored ribbon to the middle of a 3-m length of rope.
2. Tie one end of the rope to a doorknob. Hold the other end of the rope and stand opposite the door.
3. Quickly move your end of the rope up and down. Observe the ribbon's motion.
4. Increase the speed at which you move the end of the rope up and down. Observe the resulting waves.

THINK ABOUT IT: a. What happened to the ribbon when you moved the rope? **b.** What happened when you increased the speed of your movements? **c.** What happened to the wavelength?

Objective

Classify waves as transverse or longitudinal.

Key Terms

transverse (trans-VUHRS) **wave:** wave in which the particles of the medium move up and down at right angles to the direction of the wave motion

crest: high point of a transverse wave

trough (TRAWF)**:** low point of a transverse wave

longitudinal (lahn-juh-TOOD-uhn-uhl) **wave:** wave in which the particles of the medium move back and forth in the direction of the wave motion

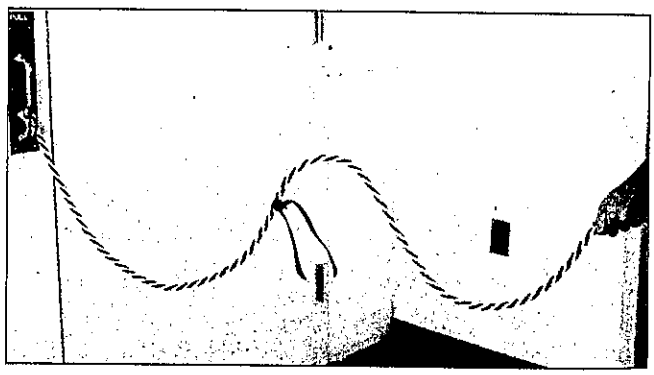
compression (kuhm-PRESH-uhn)**:** part of a medium where the particles are close together

rarefaction (rer-uh-FAK-shuhn)**:** part of a medium where the particles are far apart

Transverse Waves There are two types of mechanical waves, transverse and longitudinal. The difference between the two kinds of waves is the way the particles of the medium move. In a **transverse wave,** the particles of the medium move at right angles, or perpendicular, to the direction of the wave motion. Water waves are transverse waves.

There are two parts to a transverse wave. The **crest** is the high point of a transverse wave. The **trough** is the low point of the wave.

You can demonstrate a transverse wave by tying one end of a rope to a doorknob and jerking the other end with a sharp up-and-down motion as shown in Figure 17-6.

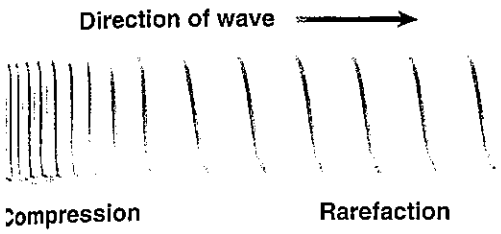


▲ **Figure 17-6** A model of a transverse wave

1 **LIST:** What are the two parts of a transverse wave?

Longitudinal Waves The sound of thunder moves in a series of longitudinal waves. A **longitudinal wave** is a wave in which particles of the medium move back and forth, parallel to the direction of the wave motion. The air is the medium that carries the energy of the thunder clap.

A longitudinal wave has two parts. A clap of thunder pushes the particles of air close together. This part of the wave is called a **compression.** The compressed particles move forward in the direction of the wave motion. As the particles move forward, they leave behind part of the wave where the particles are far apart. This part of the wave is called a **rarefaction.** The rarefaction also moves forward.



▲ **Figure 17-7** A model of a longitudinal wave

DEFINE: What are rarefactions?

CHECKING CONCEPTS

1. All waves carry _____.
2. The difference between waves depends on how the _____ of the medium move.
3. The particles of the medium move up and down in a _____ wave.
4. The particles of the medium move back and forth in a _____ wave.
5. The parts of a transverse wave are the crest and the _____.

THINKING CRITICALLY

6. **INFER:** Are ocean waves transverse waves or longitudinal waves? How do you know?
7. **CLASSIFY:** Clap your hands together. What kind of wave did you make?
8. **INFER:** Have you ever seen fans do "the wave" at a baseball or football game? What kind of wave did they make?

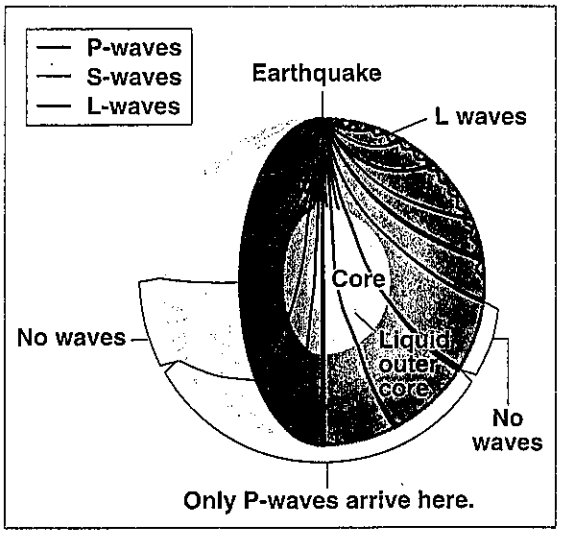
Integrating Earth Science

TOPICS: earthquakes, seismic waves

EARTHQUAKE WAVES

In October 1989, a large earthquake struck San Francisco and Oakland, California. The earthquake registered 7.1 on the Richter scale. The Richter scale is a measure of how much energy an earthquake releases. The California earthquake of 1989 was very powerful.

The energy of an earthquake produces waves that travel through the Earth. All earthquakes produce three main types of waves. These waves are called primary waves (P-waves), secondary waves (S-waves), and long waves (L-waves). L-waves are also called surface waves. They cause the surface of the Earth to rise and fall. L-waves cause the greatest damage during an earthquake.



▲ **Figure 17-8** A diagram of three kinds of seismic waves

Scientists record earthquake waves on an instrument called a seismograph. P-waves, S-waves, and L-waves travel at different speeds. Scientists calculate the difference in arrival times of the three waves. They use this information to locate the area of Earth's surface directly above the earthquake's origin.

Thinking Critically Which waves cause the most damage? Explain your answer.