# Waves on the Move

Model how waves move through rock, rope, and air

**PHS.6** "Students will explore the characteristics of waves. Use models to analyze and describe examples of mechanical waves' properties (e.g., wavelength, frequency, speed, amplitude, rarefaction, and compression)..."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline each description of how particles move, circle each statement about energy transfer, and number the two rope-wave calculations. Use your marks to compare motion in the different materials.

### Signals at a Coastal Station

1. At a coastal monitoring station, a small earthquake sets off two sensors. The first records a P wave: rock particles shift back and forth parallel to the direction the disturbance travels. Packed regions alternate with spread-out regions, called compressions and rarefactions. Later, an S wave arrives. In this wave, rock particles move across the travel direction, much like a rope shaken up and down. Both waves carry energy away from the earthquake, but the rock does not ride along to the station. A P wave usually travels faster than an S wave through solid rock.

2. The station crew uses a rope to model the sideways motion of an S wave. One person shakes one end four times each second. Crests pass a mark at a frequency of 4 hertz, and the distance from one crest to the next, the wavelength, is 0.5 meter. Multiplying frequency by wavelength gives a speed of 2 meters per second. If the rope's tension stays the same, shaking at 8 hertz makes the wavelength about 0.25 meter. Making the hand's motion larger increases the wave's amplitude and the energy it transfers, without making the rope travel down its length.

3. A warning speaker then sends sound across the room. Its cone moves outward, squeezing nearby air into a compression, and moves inward, leaving a rarefaction. Each air particle vibrates back and forth near its starting place while these regions move toward a listener. Sound is a longitudinal wave because particle motion follows the wave's direction, as in a P wave. The rope wave is transverse because its motion crosses that direction, as in an S wave. These models show a shared pattern: a traveling disturbance transfers energy, even though the material carrying it does not travel with the wave.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. A sensor records rock particles moving parallel to a wave's direction of travel. Which earthquake wave fits this record? Explain using the model in the passage.

2. Calculate the speed of the rope wave from its frequency and wavelength. Show the calculation and units.

3. On the same rope at the same tension, the shaking frequency rises to 8 hertz. What wavelength should the model show? Explain why it changes.

4. In the sound model, what travels toward the listener, and what do individual air particles do?

## 3 YOUR TURN

Your own words

Sketch two snapshots of a wave traveling right on the same rope at the same tension, first with a small amplitude and then with a larger amplitude. In each panel, label the wavelength, amplitude, particle motion, and energy direction; beneath the panels, write two sentences comparing energy transfer and wave speed.

# Waves on the Move



## PART 1 · READ AND MARK

Underline each description of how particles move, circle each statement about energy transfer, and number the two rope-wave calculations. Use your marks to compare motion in the different materials. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | A sensor records rock particles moving parallel to a wave's direction of travel. Which earthquake wave fits this record? Explain using the model in the passage. | **A P wave. Its rock particles move back and forth parallel to the wave's direction of travel.** |
| 2 | Calculate the speed of the rope wave from its frequency and wavelength. Show the calculation and units. | **Speed = 4 hertz × 0.5 meter = 2 meters per second.** |
| 3 | On the same rope at the same tension, the shaking frequency rises to 8 hertz. What wavelength should the model show? Explain why it changes. | **About 0.25 meter. With the wave speed about the same, doubling the frequency halves the wavelength.** |
| 4 | In the sound model, what travels toward the listener, and what do individual air particles do? | **Compressions and rarefactions travel toward the listener and transfer energy. Individual air particles vibrate back and forth near their starting places.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: Two crests 2 cm apart, amplitude 0.5 cm, particle-motion arrows pointing up and down, and an energy arrow pointing right. Panel 2: Two crests 2 cm apart, amplitude 1 cm, particle-motion arrows pointing up and down, and an energy arrow pointing right. Sentences: The larger wave transfers more energy because its amplitude is greater. Both waves travel at about the same speed because the rope and its tension are unchanged.

Accept sketches with any consistent wavelength and a clearly larger amplitude in the second panel. Particle motion should cross the direction of energy travel, and the comparison should keep wave speed about the same.