# Signals Across Materials

Trace how a medium changes the speed of sound and light.

**PS.2.c** "Analyze the ways in which different media and their characteristics affect the speed of sound and light waves."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline each medium or condition named in the passage, circle each wave speed, and number two sentences that explain why a wave's speed changes.

### A Signal at the Pool

1 At a swimming pool, a coach taps a metal railing to get a swimmer's attention. Sound begins when the tap makes the metal vibrate. In room-temperature air, sound travels about 340 meters per second. In water, it travels about 1,500 meters per second, and in steel, about 5,000 meters per second. Sound moves by passing vibrations from particle to particle. A material's stiffness and density both matter: stiffness helps it pass along a disturbance, while greater density adds inertia. Sound usually travels faster in stiff solids than in gases, but different solids can have very different speeds.

2 The coach also aims a flashlight through the pool's surface. In air, light travels at nearly 300 million meters per second. In water, its speed drops to about 225 million meters per second. Through ordinary clear glass, it travels at about 200 million meters per second. Unlike sound, light does not require particles to carry it; it crosses empty space at about 300 million meters per second. In transparent materials, interactions with the material cause light to travel more slowly than it does in empty space. As the beam enters water at an angle, its change in speed also changes its direction.

3 Now imagine a sealed, airless gap between two rooms at the pool. A flashlight beam can cross that empty gap, but a shout cannot: sound has no particles there to carry its vibrations. Returning air to the gap lets sound pass again. Temperature can change sound's speed even when the medium stays the same. Sound travels faster through warm air than through cold air because faster-moving air particles transfer the disturbance more quickly. Comparing waves therefore requires more than naming a medium. Its physical state, material properties, and conditions can all affect the outcome.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. How does sound's speed in steel compare with its speed in water? Explain why material properties matter.

2. How would warming the air change the speed of a sound wave? Explain the cause.

3. What happens to a flashlight beam's speed when it enters the pool water from air at an angle? What other change can result?

4. Does light travel faster in water or in ordinary clear glass? Use the passage to explain why its speed can differ between transparent materials.

## 3 YOUR TURN

Your own words

An alarm sends a sound pulse through a wooden door and a light pulse through a clear plastic window. In 3 to 4 sentences, predict how each pulse's speed changes when it leaves the solid and enters air, explain each prediction using a property of the medium, and state which pulse could cross an evacuated gap.

ANSWER KEY

# Signals Across Materials

HIGH SCHOOL · PS.2.c

## PART 1 · READ AND MARK

Underline each medium or condition named in the passage, circle each wave speed, and number two sentences that explain why a wave's speed changes. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | How does sound's speed in steel compare with its speed in water? Explain why material properties matter. | **Sound travels about 5,000 meters per second in steel and 1,500 meters per second in water. A material's stiffness helps it pass along vibrations, while its density adds inertia.** |
| 2 | How would warming the air change the speed of a sound wave? Explain the cause. | **Sound would travel faster because faster-moving particles in warm air transfer the disturbance more quickly.** |
| 3 | What happens to a flashlight beam's speed when it enters the pool water from air at an angle? What other change can result? | **Its speed drops from nearly 300 million to about 225 million meters per second. The change in speed can also change its direction.** |
| 4 | Does light travel faster in water or in ordinary clear glass? Use the passage to explain why its speed can differ between transparent materials. | **Light travels faster in water, about 225 million meters per second compared with about 200 million in glass. Light's interactions with transparent materials affect its speed.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

The sound pulse would usually slow down when it leaves the stiff wooden door and enters air. The light pulse would speed up when it leaves the clear plastic window and enters air, where it interacts less with the material around it. The sound pulse needs particles to carry its vibrations. Only the light pulse could cross an evacuated gap.

Accept qualitative speed comparisons without exact values in the open response. Students should connect sound's speed to material properties and light's speed to its interactions with transparent materials.