

Chapter 17

Use with Section 3

ENRICHMENT

● Wave Behavior

Refraction and Reflection of Sound Waves

Refraction occurs when a wave bends because its speed changes. This usually happens when a wave travels from one medium to another, such as from air to water. Temperature and wind, however, also affect wave speed, so they too can cause refraction.

Have you ever yelled to a friend across a playground, only your friend didn't hear you? This happens because of the temperature of the air. During the day, the sun warms the ground. The ground then warms the air closest to it. Sound waves travel faster in warm air than in the cool air. As sound waves move from cooler air through warmer air, the waves refract upward, and the sound may not reach its destination. No matter how loud you yell, much of the sound will still tend to refract up. It won't reach your friend's ears.

There are special conditions called temperature inversions in which air temperature increases

with altitude. This occurs at two typical times, at night and on days when there are many dense clouds. In a temperature inversion, sound waves are refracted downward. Have you ever wondered why sound "travels so well" at night? It's not because it's quieter at night. It's because when the sound reaches the warmer air, the higher temperature changes the wave speed. That bends the sound waves back toward the ground, where the listeners are standing.

Differences in temperature are also found in the ocean. Generally, ocean temperatures decrease as the water gets deeper, the warmer water is found nearer the surface. When sounds originate in the water, the sound waves tend to refract down, toward the cooler water. Scientists think this downward refraction is one reason why sounds from marine animals such as whales can be heard over hundreds of miles.

Making the Connection

Air and water temperatures are not the only things that affect sound waves. So do wind and humidity. Research how these two factors can affect sound and prepare a poster to share your results.

1. How does the behavior of sound waves in the ocean help marine animals, such as dolphins and whales, to communicate?

2. What atmospheric conditions can cause sound wave refractions similar to those observed in the ocean?
