

10.4: Speed of Sound



Figure 12.2.1

Has this ever happened to you? You see a flash of lightning on the horizon, but several seconds pass before you hear the rumble of thunder. The reason? The speed of light is much faster than the speed of sound.

What Is the Speed of Sound?

The **speed of sound** is the distance that sound waves travel in a given amount of time. You'll often see the speed of sound given as 343 meters per second (m/s). But that's just the speed of sound under a certain set of conditions, specifically, through dry air at 20°C (or 68°F). The speed of sound may be very different through other matter or at other temperatures.

Speed of Sound in Different Media

Sound waves are mechanical waves, and mechanical waves can only travel through matter. The matter through which the waves travel is called the medium (plural, media). The Table below gives the speed of sound in several different media. Generally, sound waves travel most quickly through solids, followed by liquids, and then by gases. Particles of matter are closest together in solids and farthest apart in gases. When particles are closer together, they can more quickly pass the energy of vibrations to nearby particles.

| Medium (20 °C) | Speed of Sound Waves (m/s) |
|----------------|----------------------------|
| Dry Air | 343 |
| Water | 1437 |
| Wood | 3850 |
| Glass | 4540 |
| Aluminum | 6320 |

Q: The table gives the speed of sound in dry air. Do you think that sound travels more or less quickly through air that contains water vapor? (Hint: Compare the speed of sound in water and air in the table.)

A: Sound travels at a higher speed through water than air, so it travels more quickly through air that contains water vapor than it does through dry air.

Temperature and Speed of Sound

The speed of sound also depends on the temperature of the medium. For a given medium, sound has a slower speed at lower temperatures. You can compare the speed of sound in dry air at different temperatures in the following Table below. At a lower temperature, particles of the medium are moving more slowly, so it takes them longer to transfer the energy of the sound waves.

| Temperature of Air | Speed of Sound Waves (m/s) |
|--------------------|----------------------------|
| 0 °C | 331 |
| 20 °C | 343 |
| 100 °C | 386 |

Q: What do you think the speed of sound might be in dry air at a temperature of -20 °C?

A: For each 1 degree Celsius that temperature decreases, the speed of sound decreases by 0.6 m/s. So sound travels through dry, -20 °C air at a speed of 319 m/s.

Can you calculate the speed of sound in air and the wave speed on the string in the Violin simulation below? Use the Wavelength vs Frequency graph on the top left to analyze the waves produced by the violin. The product of the wavelength and frequency can be used to determine the speed of sound in air and wave speed on the violin string:

Summary

- The speed of sound is the distance that sound waves travel in a given amount of time. The speed of sound in dry air at 20 °C is 343 meters per second.
- Generally, sound waves travel most quickly through solids, followed by liquids, and then by gases.
- For a given medium, sound waves travel more slowly at lower temperatures.

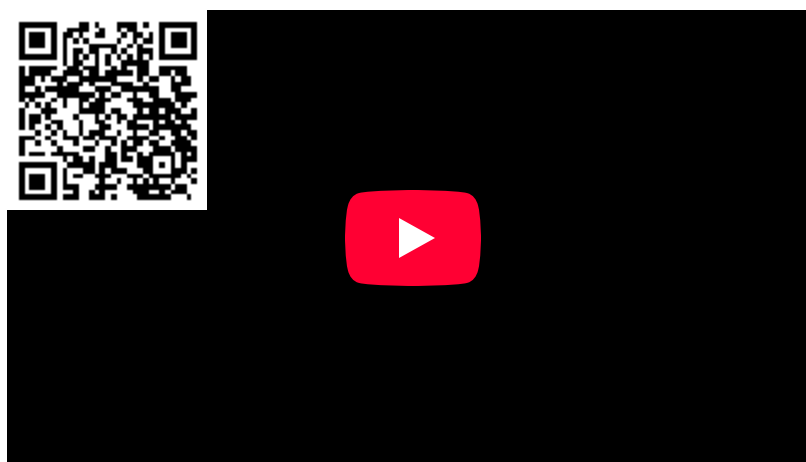
Review

1. What is the speed of sound in dry air at 20 °C?
2. Describe variation in the speed of sound through various media.
3. Explain how temperature affects the speed of sound.

Additional Resources

Real World Application: Tracking the Storm

Videos:





Study Guide: Waves Study Guide

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