

Sound: Mediums

Let's Review Sound Waves

- A Sound wave is a mechanical wave because it has to travel through a medium.
- A Sound wave is also a Compressional wave because matter in the medium moves forward and backward along the same direction that the wave travels.



Sound Waves and Mediums

A medium is the substance through which a wave can travel

Examples of Mediums:

- Air
- Water
- Particles
- Strings
- Solids
- Liquids
- Gases

Sound Waves and Mediums

- Sound waves travel through different materials at different speeds.
- The speed of sound is usually fastest in solids, where molecules are closest together, and slowest in gases, where molecules are farthest apart.
- In a vacuum (such as space), there are no particles to vibrate. So, no sound can be made

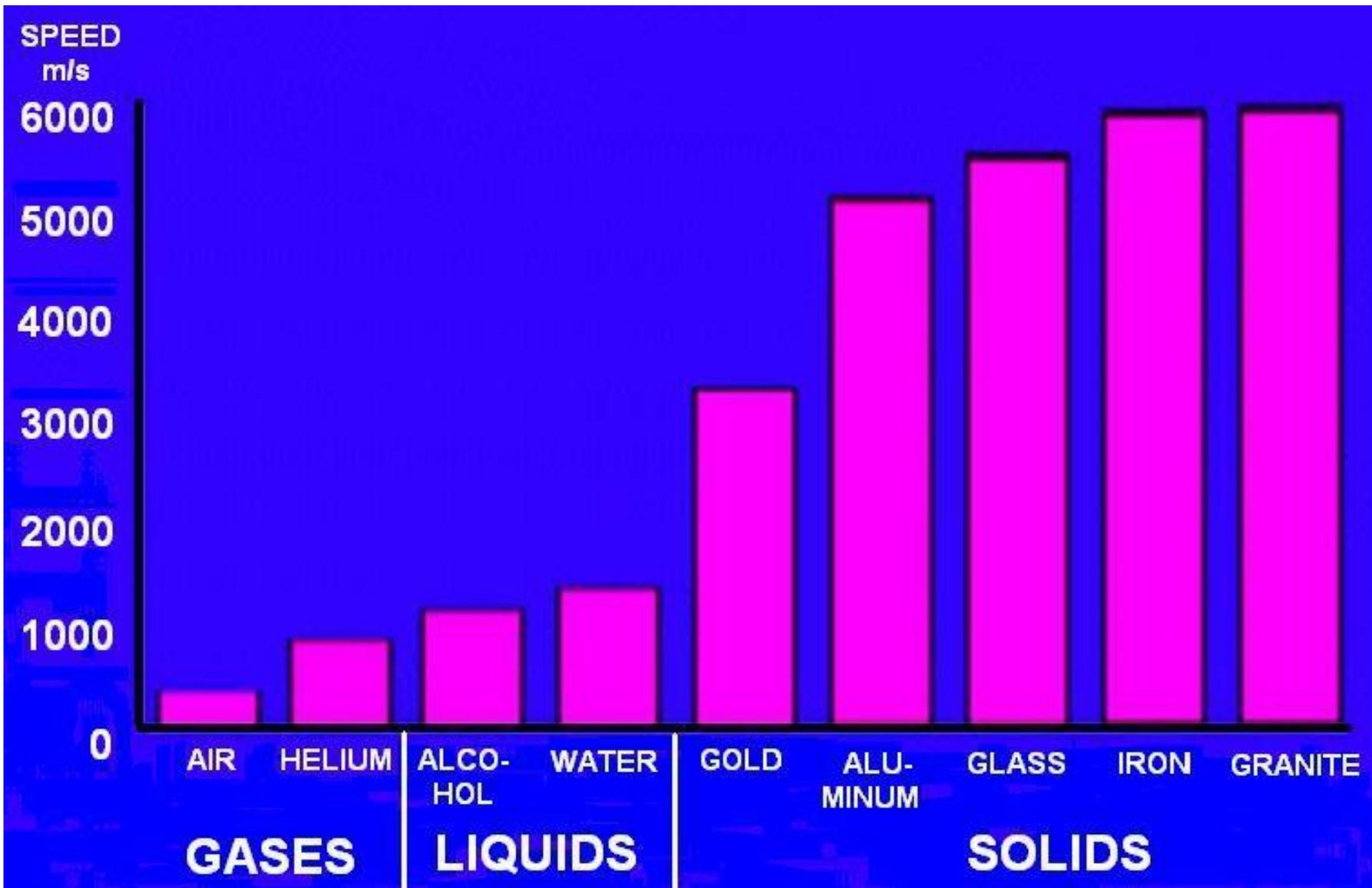
Speed of Sound Through Different Materials

Material	Speed (m/s)
Air	343
Water	1,483
Steel	5,940
Glass	5,640

Which material does sound travel the fastest?

Which material does sound travel the slowest?

What causes sound to travel fastest in these types of substances?



Distributed Summarizing

With a partner, answer the following questions:

In some western movies, a character would be shown putting an ear to the hard ground to find out if someone was coming. Does this work?
Why?

You are the commander of a space station and your chief of security tells you that sensors have just detected an explosion. How long will it be before you hear the sound of the explosion?

Distributed Summarizing

In some western movies, a character would be shown putting an ear to the hard ground to find out if someone was coming. Does this work?

Why? **Yes, because sound travels faster and with less loss of energy through the ground than through the air.**

You are the commander of a space station and your chief of security tells you that sensors have just detected an explosion. How long will it be before you hear the sound of the explosion? **You won't hear it. Sound waves will not travel in the vacuum of space.**

Sound: Speed and Temperature

- The temperature of the material affects the speed of the sound.
- Molecules move faster in warmer substances. As a substance heats up, its molecules move faster, so they collide more frequently
- Sound travels faster in warmer temperatures. The more frequent the collisions are, the faster the speed of sound is in the material.

Sound: Changes in Mediums

- Like any wave, a sound wave doesn't just stop when it reaches the end of the medium or when it encounters an obstacle in its path.
- Rather, a sound wave will undergo certain behaviors when it encounters the end of the medium or an obstacle.
- Possible behaviors include absorption, reflection, diffraction, and refraction.

Sound: Changes in Mediums

Absorption and Reflection

- **Reflection** occurs when a wave strikes an object or surface and bounces off.
- An echo is reflected sound.
- Your echo bounces off the walls, floor, ceiling, furniture, and people.
- A hard, smooth surface (cardboard) reflects sound better than an uneven, soft surface (pillow). This is because the soft surface **absorbs** most of the sound.

Sound Reflection and Absorption

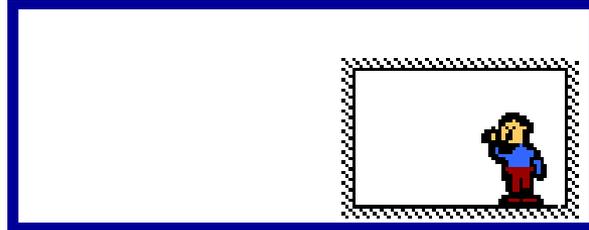
Compare sound in a gymnasium and an auditorium (where musical performances occur).

Sound waves easily **reflect** off the smooth, hard walls of a gymnasium. For this reason, you hear an echo.

In well-designed auditoriums, echoes are reduced by soft materials that **absorb** sound waves.

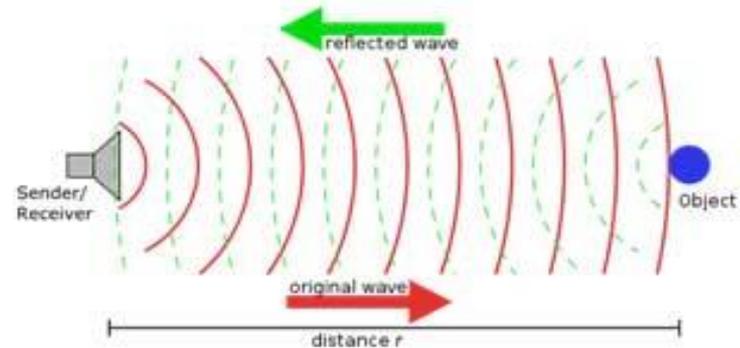
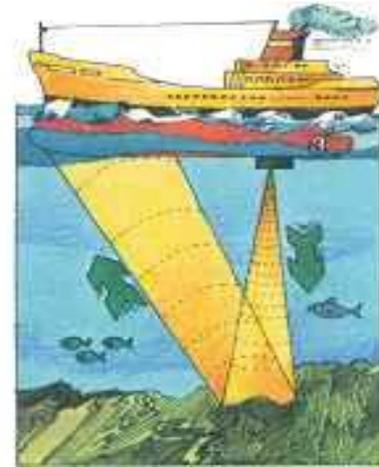
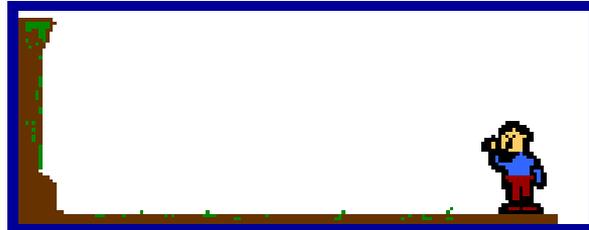
Reflection of Sound

Reflection off a Nearby Wall



Time (s): 0.00

Reflection off a Distant Cliff

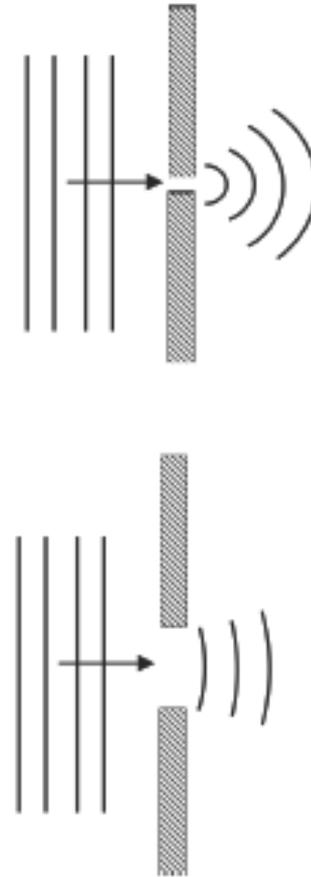
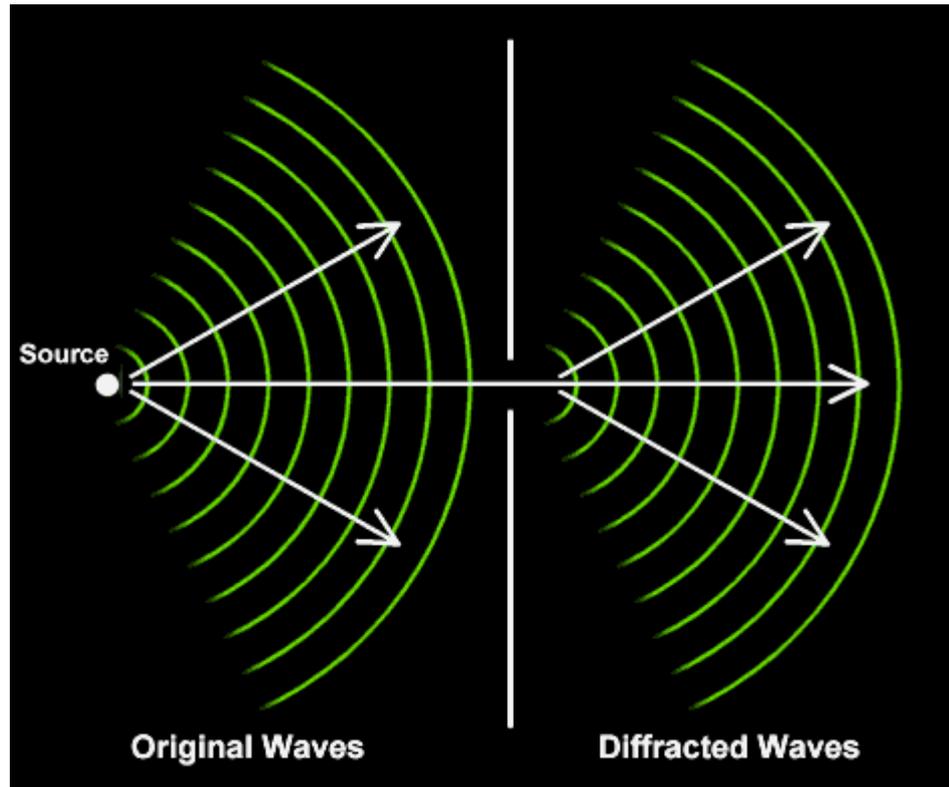


Sound: Changes in Mediums

Diffraction

- Diffraction is the bending of waves around a barrier.
- Diffraction of sound waves is commonly observed; we notice sound diffracting around corners or through door openings, allowing us to hear others who are speaking to us from adjacent rooms.
- Owls are able to communicate across long distances due to the fact that their long-wavelength hoots are able to diffract around forest trees and carry farther than the short-wavelength tweets of songbirds.
- Low-pitched (long wavelength) sounds always carry further than high-pitched (short wavelength) sounds

Diffraction of Sound



Sound: Changes in Mediums

Refraction

- Refraction is the bending of a wave as it moves from one medium into another
- The speed and wavelength of a wave changes during refraction.

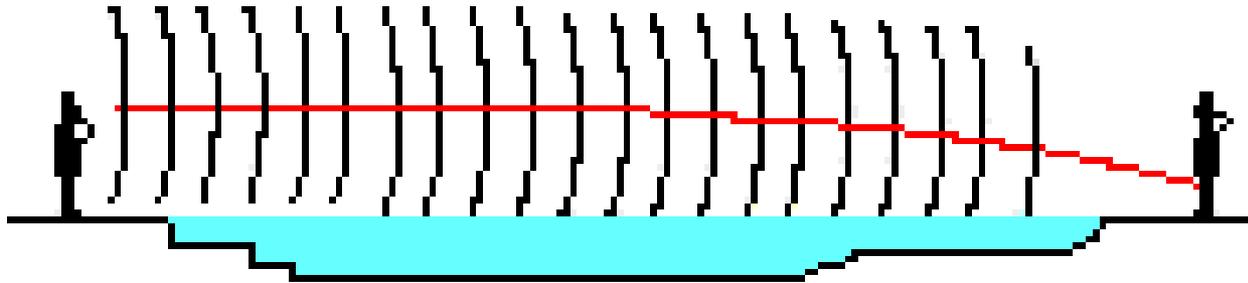
Sound: Changes in Mediums

Refraction

For example, sound waves are known to refract when traveling over water. Even though the sound wave is not exactly changing media, it is traveling through a medium with varying properties; thus, the wave will encounter refraction and change its direction.

Since water has a moderating affect upon the temperature of air, the air directly above the water tends to be cooler than the air far above the water. Sound waves travel slower in cooler air than they do in warmer air. For this reason, the portion of the wave directly above the water is slowed down, while the portion of the wave far above the water speeds ahead. So, the direction of the wave changes, refracting downwards towards the water.

Sound: Changes in Mediums Refraction



Refraction of Sound Waves