

# Sound: Mediums

Essential Question:

How are sound waves  
affected by medium?

# 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

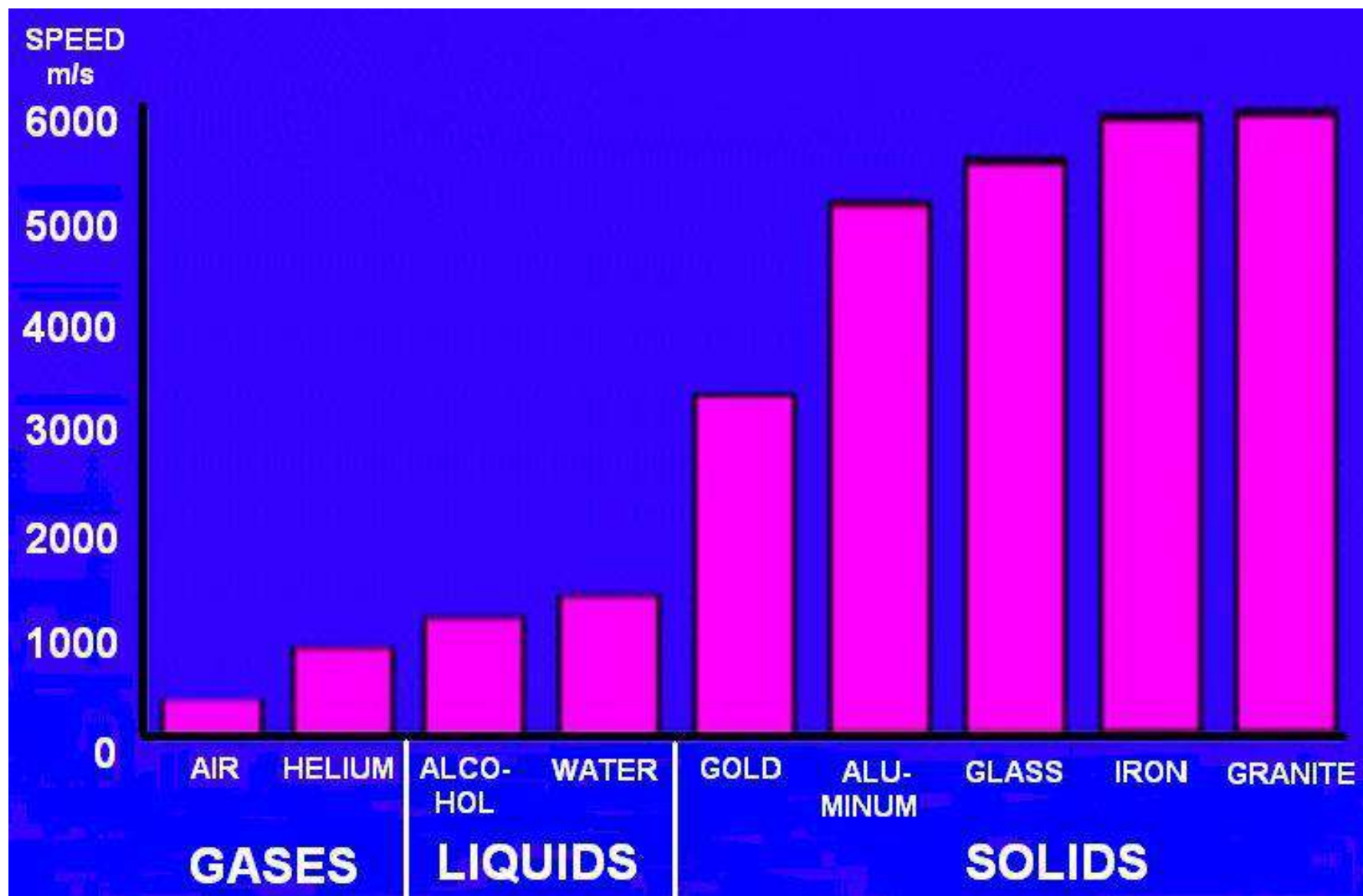
## Speed of Sound Through Different Materials

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?

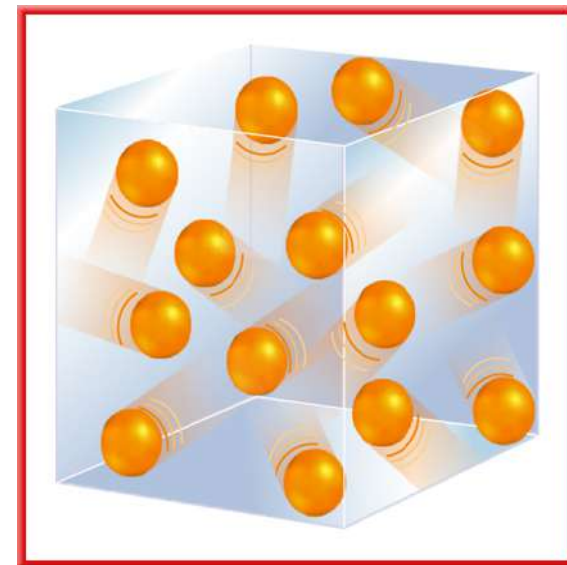
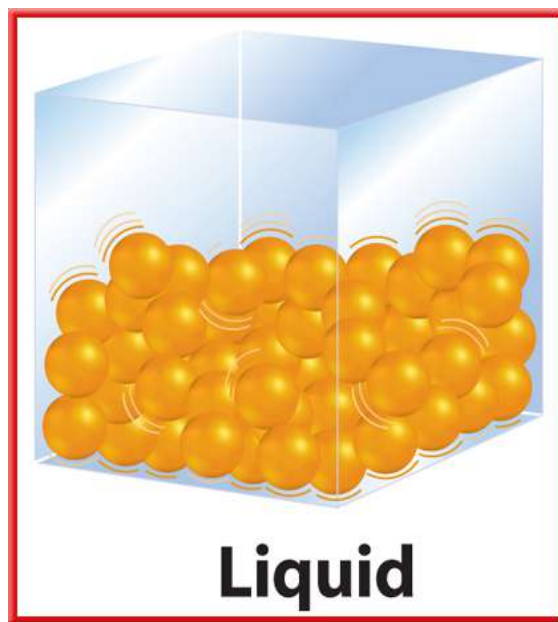
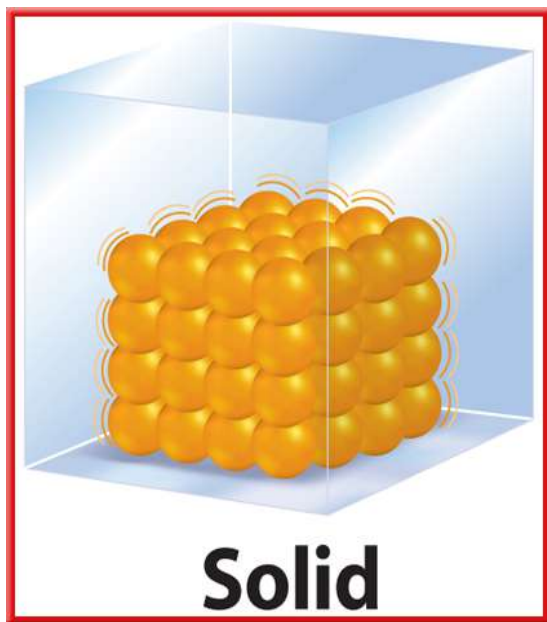
Why? **Yes, because sound travels faster and with less loss of energy through the ground than through the air.**

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.



Watch the animation links below to review the relationship between temperature and the movement of molecules

[http://www.middleschoolchemistry.com/multimedia/chapter1/lesson2#heating\\_and\\_cooling](http://www.middleschoolchemistry.com/multimedia/chapter1/lesson2#heating_and_cooling)

<http://nortonbooks.com/college/biology/animations/ch04a01.htm>

<http://chemconnections.org/Java/molecules/index.html>

# 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

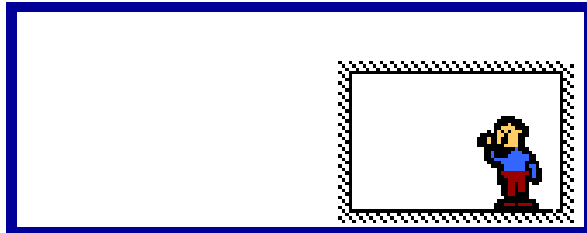
Compare sound in a gymnasium and an auditorium (where musical performances occur).

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.

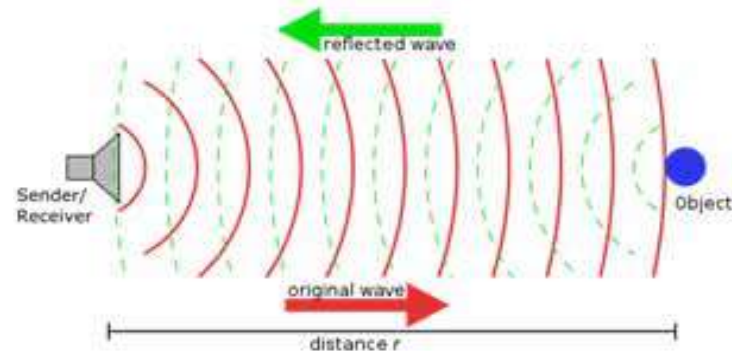
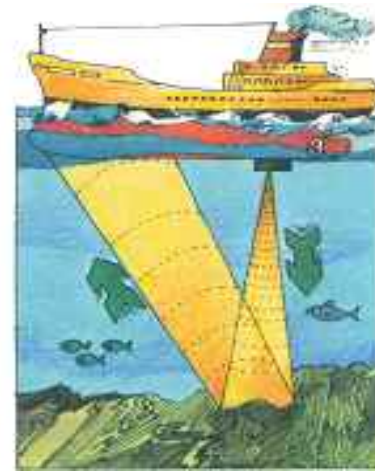
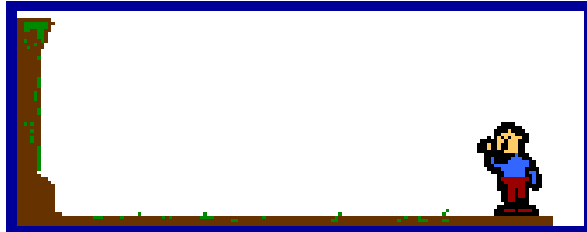
# Reflection of Sound

## Reflection off a Nearby Wall



Time (s): 0.00

## Reflection off a Distant Cliff



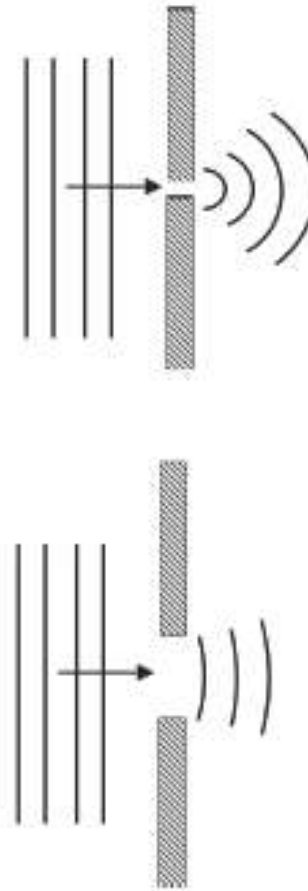
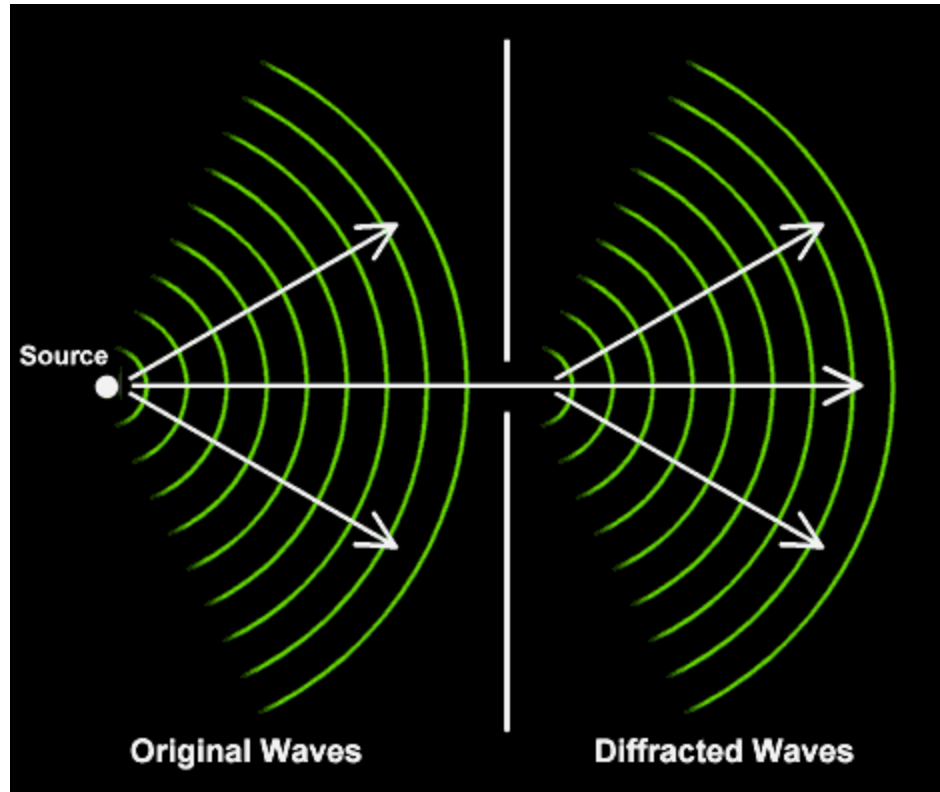
<http://www.ndt-ed.org/EducationResources/HighSchool/Sound/reflection.htm>

# 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

Note: Refraction is most commonly associated with electromagnetic waves; however, sound waves can refract.

The following slide is not required and should be used simply as an example.

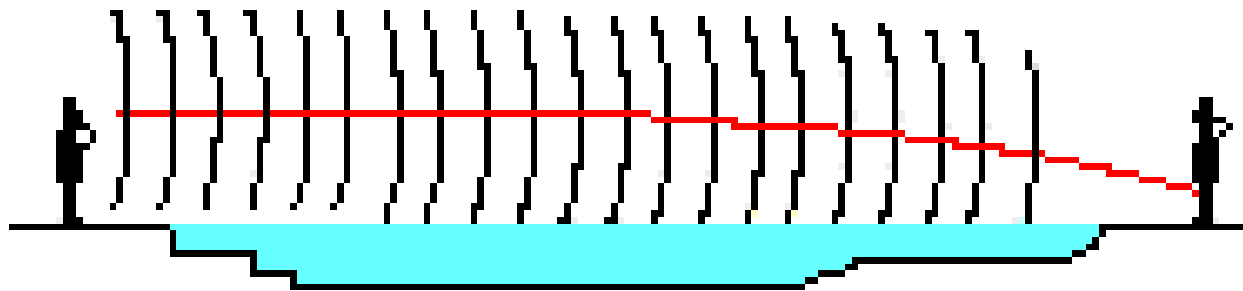
# Sound: Changes in Mediums

## 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

<http://www.physicsclassroom.com/class/sound/u11l3d.cfm>

# Distributed Summarizing

With a partner, answer the following question:

**Discuss everyday examples of the reflection and diffraction of sound.**

# TOTD 12/08

1. What is a medium? Give 3 examples
2. Why does a sound wave travel faster in warmer air than colder air?
3. What is Reflection of a wave? Give an example.
4. What is Refraction of a wave? Give an example.
5. What is Diffraction of a wave? Give an example.

# Wave Interactions Activities

Missed 2 or more? Do this assignment

Directions: Focus on sound waves when completing this assignment.

**\*Examples and drawings should be for sound.**

1. Divide a Power Point slide into 4 equal parts.
2. Label each part with one of the following vocabulary words: reflection, Diffraction, refraction, and Wave Interference (Constructive and Destructive).
3. In your own words define the vocabulary word in each section, give an example, and include picture to illustrate that vocabulary word.

Missed 1 or less? Do this assignment.

Directions: Focus on light waves when completing this assignment. **\*Examples and drawings should be for light.**

1. Divide a Power Point slide into 4 equal parts.
2. Label each part with one of the following vocabulary words: reflection, Diffraction, refraction, and Wave Interference (Constructive and Destructive).
3. In your own words define the vocabulary word in each section, give an example, and include picture to illustrate that vocabulary word.

# Helpful Sites

- [http://missionscience.nasa.gov/ems/03\\_behaviors.html](http://missionscience.nasa.gov/ems/03_behaviors.html)
- [www.physicsclassroom.com](http://www.physicsclassroom.com)
- [http://www.ducksters.com/science/physics/wave\\_behavior.php](http://www.ducksters.com/science/physics/wave_behavior.php)
- <http://www.explainthatstuff.com/light.html>
- <http://www.olympusmicro.com/primer/lightandcolor/particleorwave.html>
- <http://www.pbslearningmedia.org/resource/npe11.sci.phys.energy.lightbehaviors/light-wave-behaviors/>