

CHAPTER

12

Sound

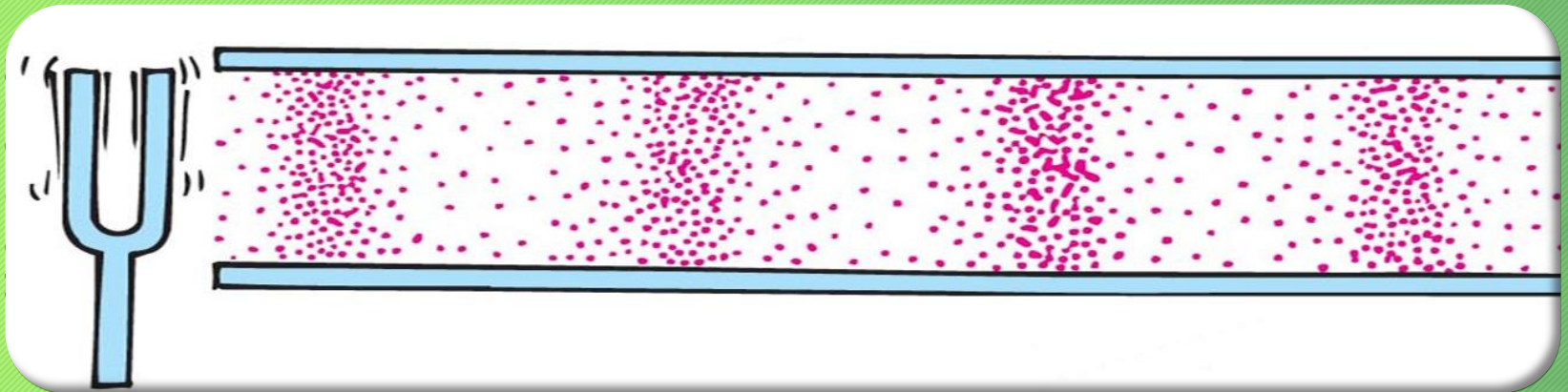
MAIN TOPICS

- Sound Waves
- Reflection
- Refraction
- Interference
- Beats
- Doppler Effect
- Musical Sounds

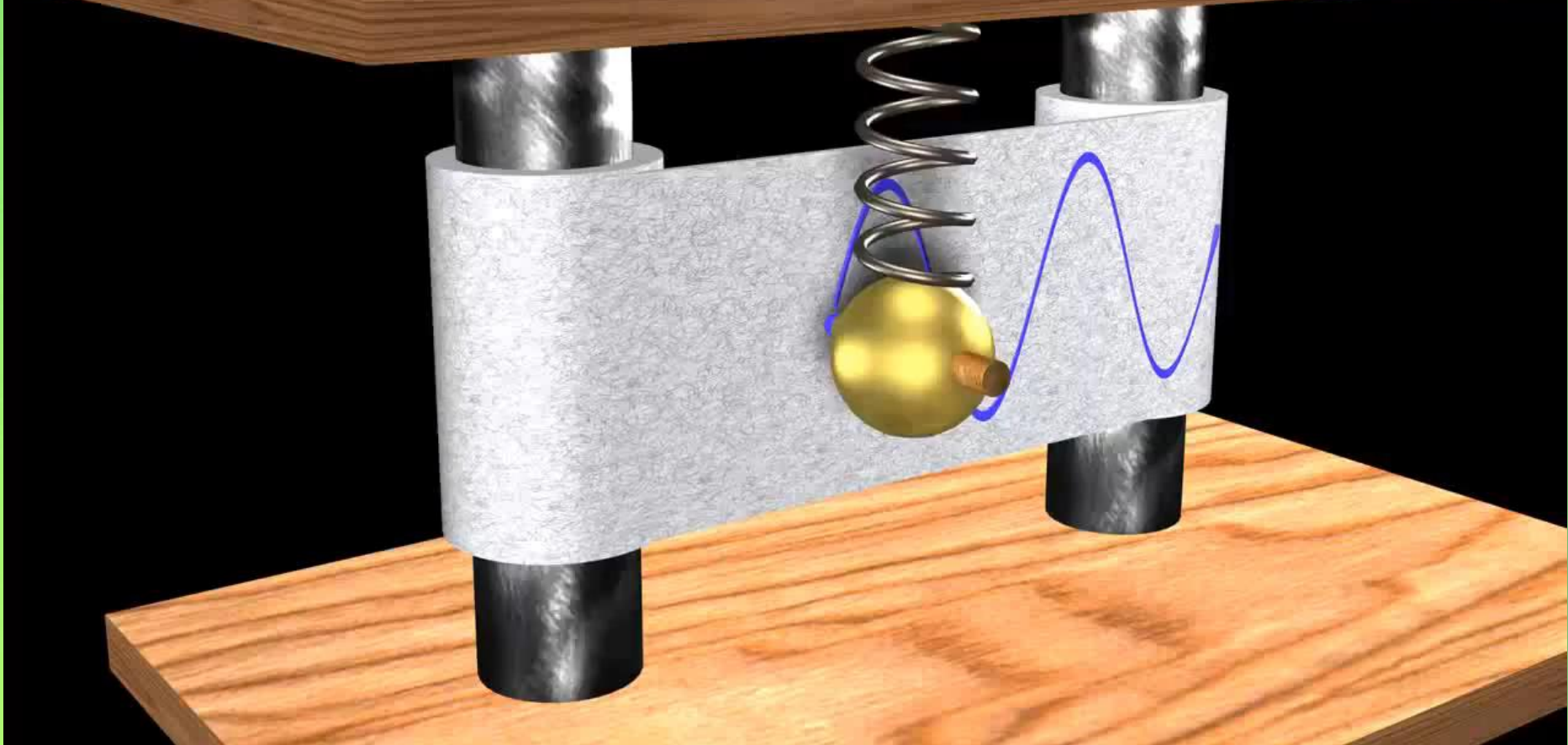
SOUND

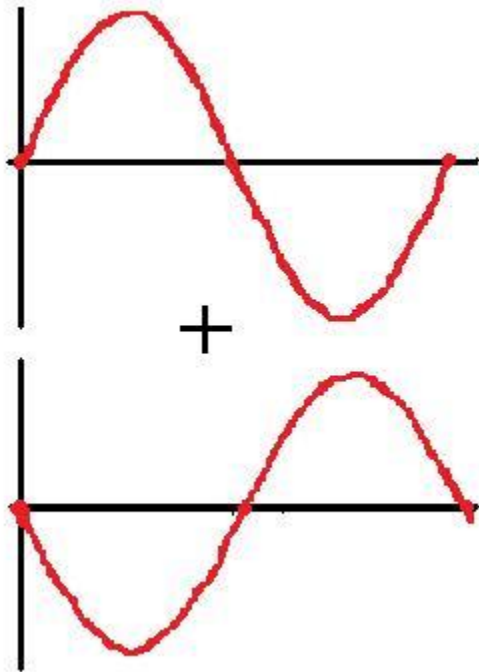
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- Sound travels in longitudinal waves
- Sound waves can only travel in a medium.
- vibrating compressions and rarefactions through air



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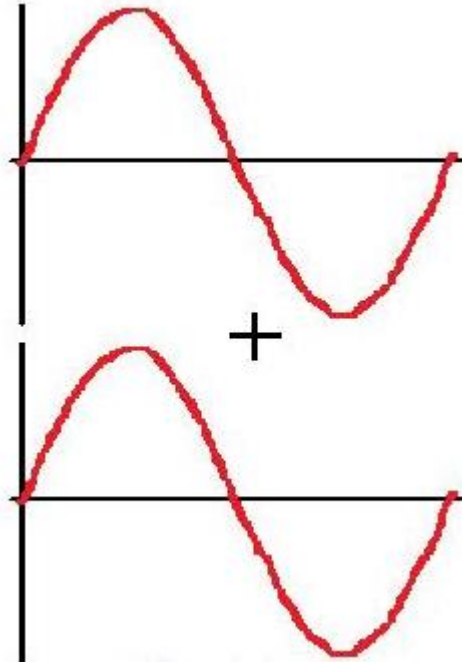




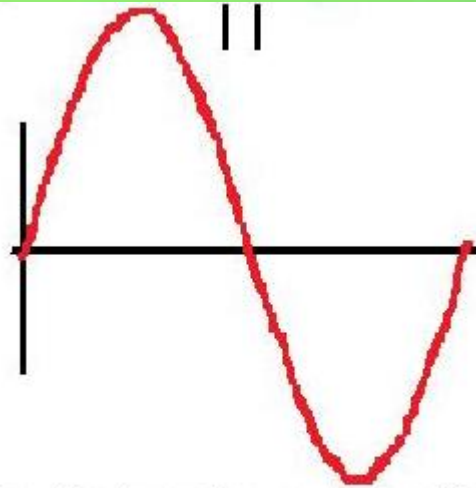
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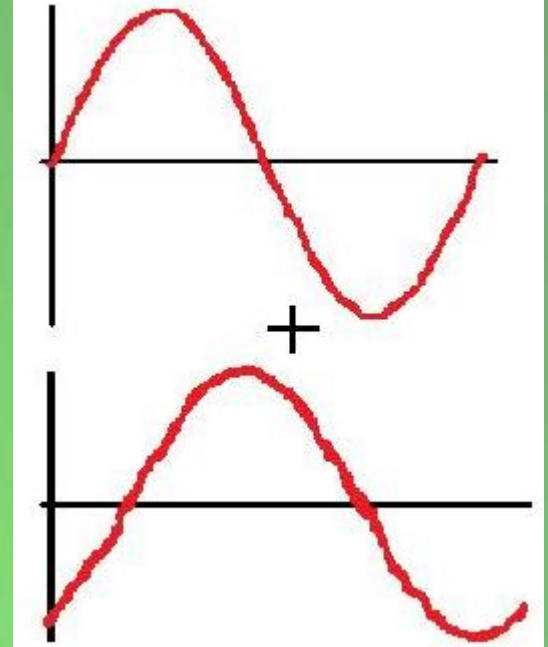
The two waves collide and cancel each other.



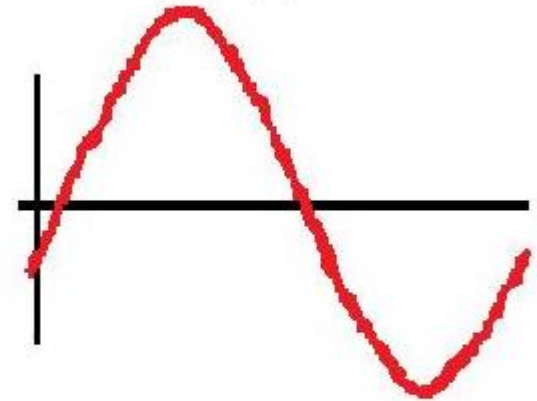
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Here the two sine waves are "in phase" with one another and the resultant has a larger amplitude.



||



This is a third example of superposition.

SOUND

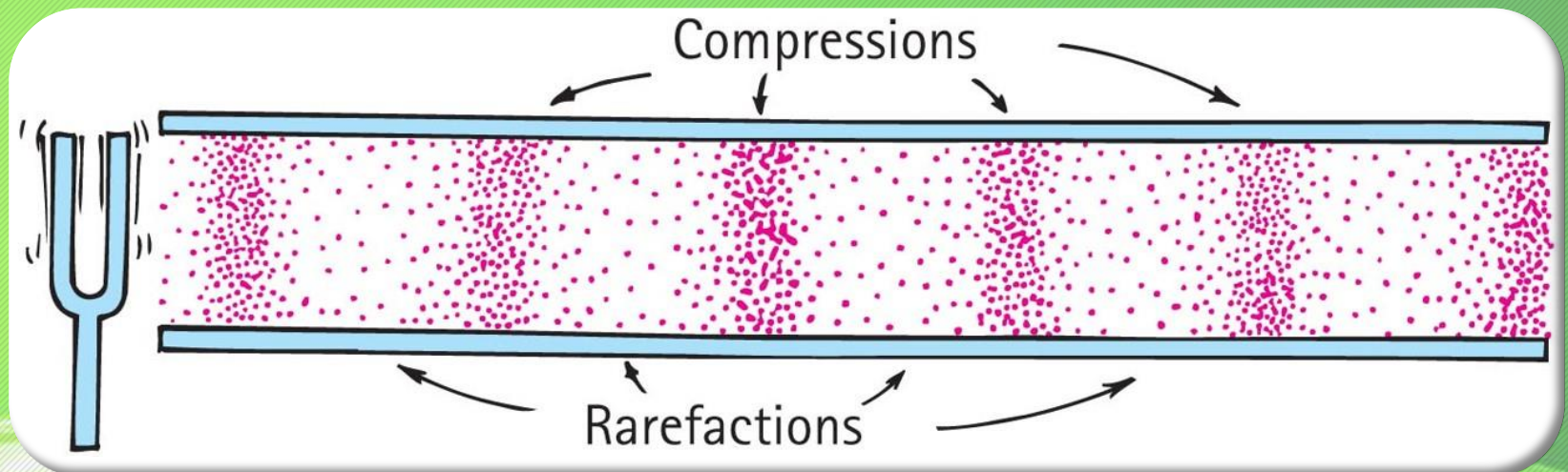
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Compression:

Area where molecules are closer than the normal

Rarefaction:

Area where molecules are farther than the normal

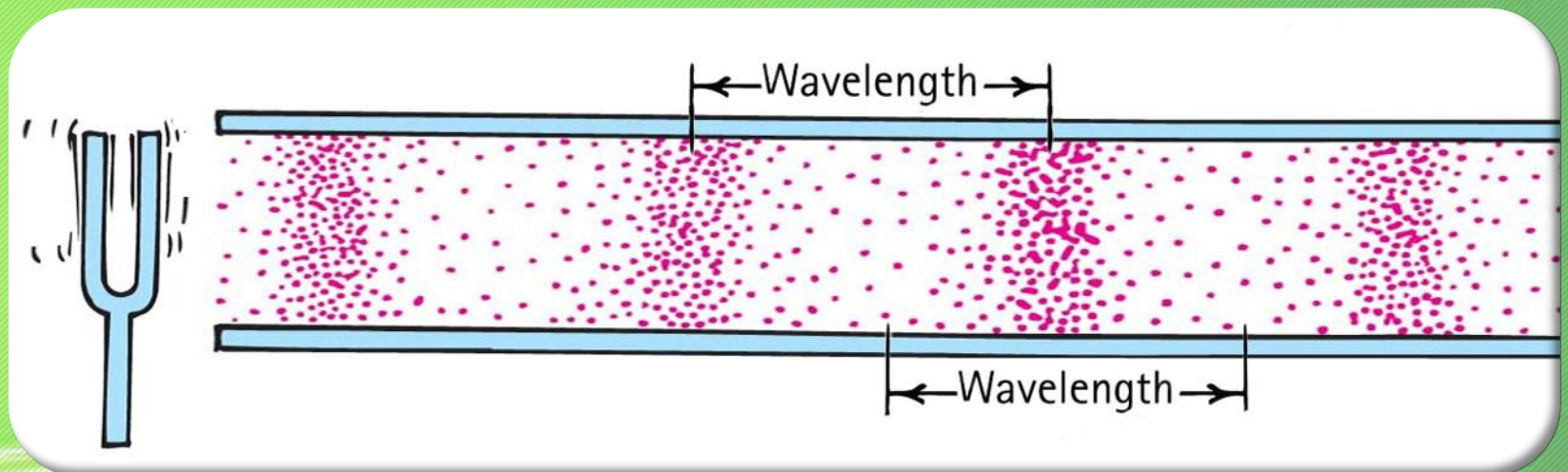


Sound

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Wavelength:

Distance from one compression to the next compression, or from one rarefaction to the next rarefaction.



SPEED AND FREQUENCY

Speed of Sound:

- Speed of sound in the air is 340 m/s at 20°C
- For each increase of 1°C above 0°C, speed of sound increases by 0.6 m/s.

Example:

- Speed of sound in the air at 0°C is 328 m/s
- Speed of sound in the air at 50°C is 358 m/s

SPEED IN DIFFERENT MEDIA

Order of increasing speeds of sound:

- in air (≈ 340 m/s)
- in warm air (>340 m/s)
- in water (\approx four times speed in air)
- in steel (≈ 15 times speed in air)

LOUDNESS

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The amplitude determines the loudness of the sound.

- If the amplitude is large, then the sound is loud.
- If the amplitude is small then the sound is soft.

unit:

The unit of the loudness is decibels

AUDIBLE SOUND

Audible Frequency:

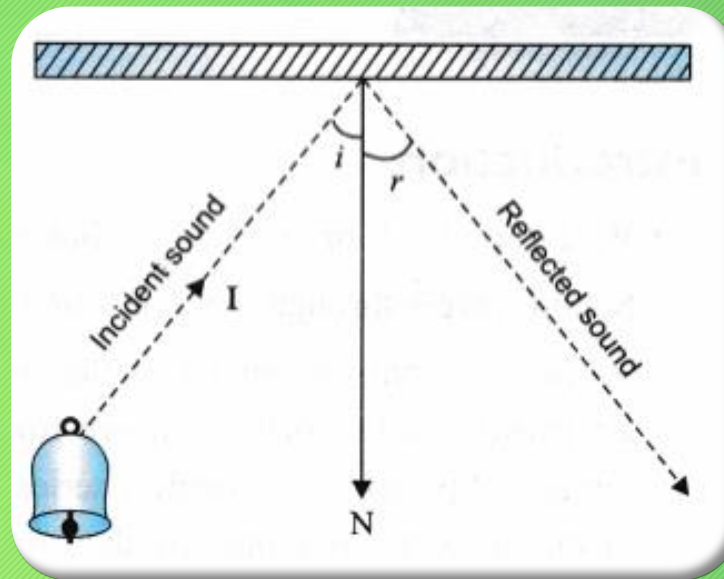
Human ear can hear the sound having frequency between 20-20000 Hz.

Audible Loudness:

- Human ear can hear from 1 to 120 dB.
- Sounds louder than 120 dB are painful and dangerous.
- Normal speech is at the level of 20-30 dB.

REFLECTION

Process in which sound encountering a surface is returned



- Angle of Incidence = Angle of Reflection

ECHO AND REVERBERATIONS

Echo:

A single reflection is often called an echo

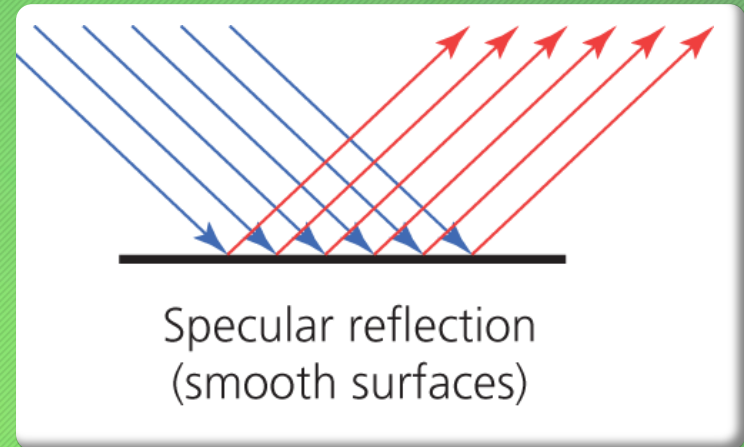
Reverberations:

When multiple reflections occur, the process is called reverberations

TYPES OF REFLECTION

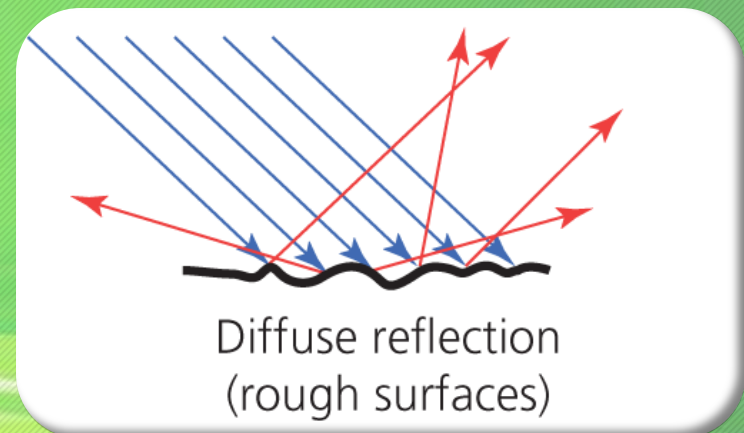
Specular Reflection:

When sound is incident on a smooth surface, it is reflected in single directions



Diffuse Reflection:

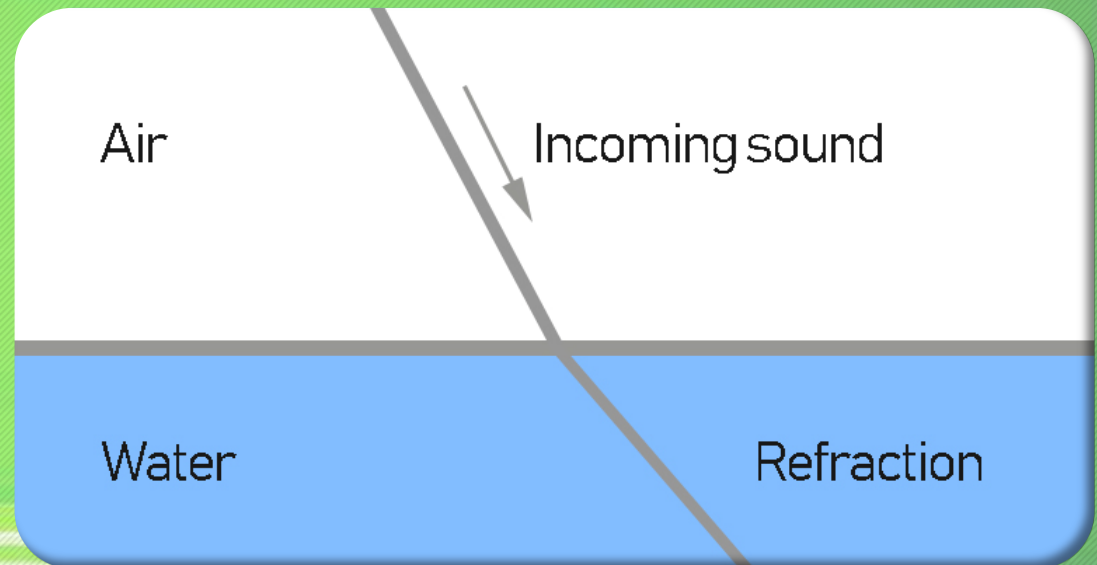
When sound is incident on a rough surface, it is reflected in many directions



REFRACTION

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The bending of a wave due to a change in the medium and/or speed of the wave

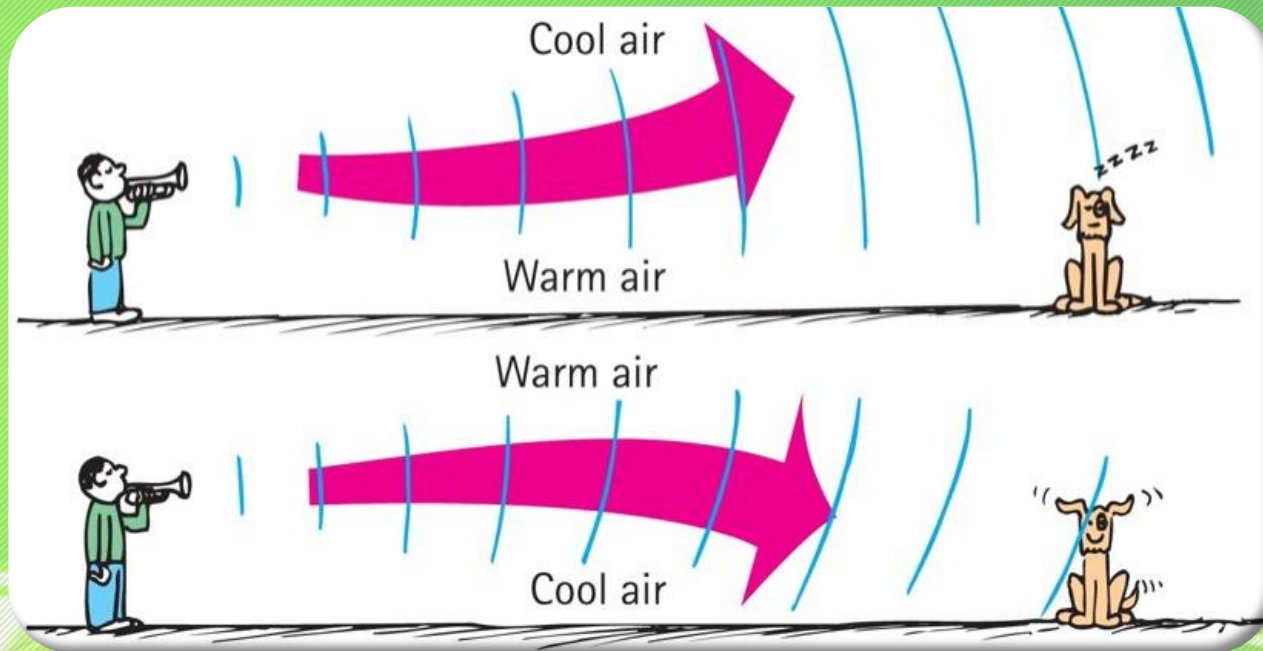


REFRACTION

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Sound waves refract when parts of the wave fronts

- Travel at different speeds.
- Are affected by uneven winds
- When air near the ground is warmer than air above



INTERFERENCE

At certain distance, stereo speakers produce constructive interference, and we hear loud sound.

Sound interference in stereo speakers out of phase sending a monoaural signal (one speaker sending compressions of sound and other sending rarefactions)

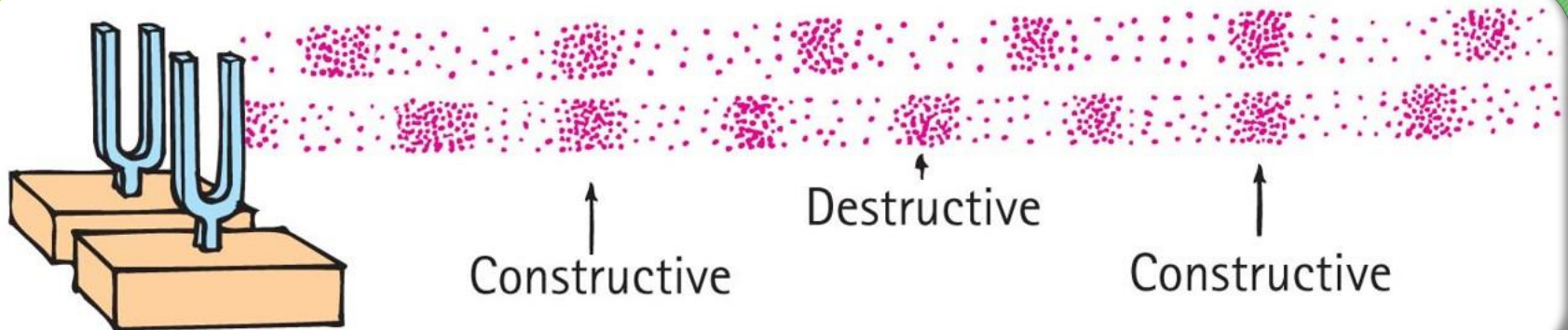


As speakers are brought closer to each other, sound is diminished

BEATS

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- periodic variations in the loudness of sound due to interference
- occur with any kind of wave
- provide a comparison of frequencies



DOPPLER EFFECT

The change in frequency as measured by an observer due to the motion of the

- source or
- Listener

When the distance between source and listener is decreasing, frequency increases and vice versa



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DOPPLER EFFECT

Example of Doppler Effect:

- Frequency of waves received by an observer increases as a sound source approaches.
- Wave frequency decreases as the source recedes.



ANSWER CHECK

When a fire engine approaches you, the

- A. speed of its sound increases.
- B. frequency of sound increases.
- C. wavelength of its sound increases.
- D. All increase.

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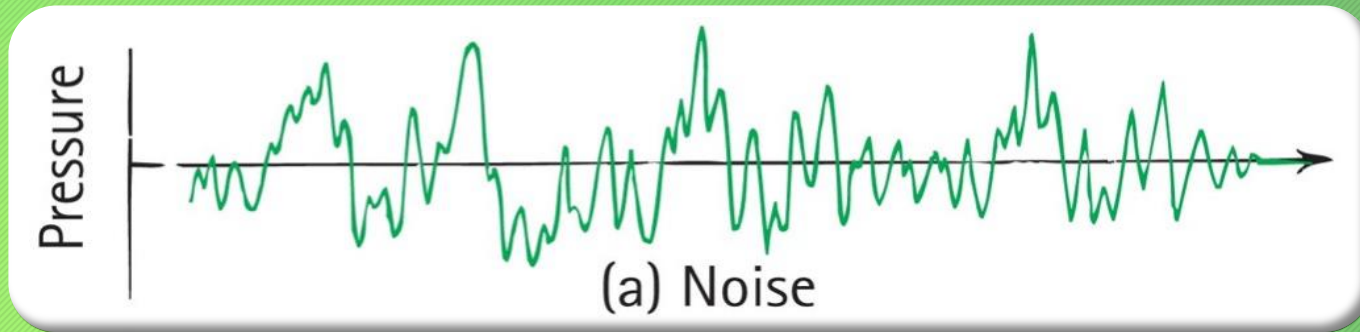
Explanation:

Be sure you distinguish between sound, speed, and sound frequency.

MUSICAL SOUND

Graphical representations of noise and music.

(a) Noise has no clear repeatable pattern.



(b) Music has a frequency (repeatable wave), wavelength, and speed.

