Sound

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Sound - (Introduction)

Sound is a form of energy that travels in the form of waves.

Examples : Baby crying, Coughing, Roaring of lion.

There are basically two types of sound -
(i) Audible Sound
(ii) Inaudible Sound

Audible Sound (20Hz to 20KHz)

This sound can be detected by human ears. Its range is (20Hz to 20KHz), It is also called Sonic sound.

Inaudible Sound ($\lambda > 20KHz$)

This sound cannot be detected by human ears Its range is ($\lambda > 20KHz$) more than 20 KHz. It is also called ultrasonic sound.

Sound less than frequency of 20 Hz is also inaudible and cannot detected by human ears. It is also called Infrasonic Sound.

Speed of Sound

Sound is longnitudnal mechnical waves, mechnical wave means it can travel any material but

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not in vaccum.

[Speed of sound in Solid > Liquid > Gas.]

At 0°c (atmosphere) sound speed is 332 m/s, and at room temperature sound speed is 340 m/s. Speed of sound is increase with increase in temperature.

- Factors related to Sound

(i) Intensity : The actual volume of sound produced by source.

(ii) Loudness : The volume of sound as per detected by listner.

(iii) Tone : It is single freq. sound.

(iv) Note : Set of tones form notes. (Tones - सुरक्षित संगीत बनाता है)

(v) Melody : It is a pleasent sound.

(vi) Noise : It is a unpleasent sound.

- Production of Sound

Sound is produced when object vibrates or sound is produced by vibrating objects.

- Vibration :- To and fro motion of body

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The energy required to make an object - vibrate and produce sound is provided by some outside source (like our hand, wind, etc.)

Example: Sound of our voice is produced by vibration of two vocal cords in our throat.

Propagation of Sound Waves

The substance through which sound travels is called a medium. The medium may be solid, liquid or gas.

When an object vibrates, then the air particles around it also start vibrating in exactly the same way. These vibrating air particles exert a force on nearby air particles, so they are also displaced from their rest position and start vibrate.

This process is continued in the medium till sound reaches our ears.

The disturbance produced by sound travels through the medium - Wave is a disturbance which travels through a medium and carries energy, So, Sound travels in wave form known as mechnical waves.

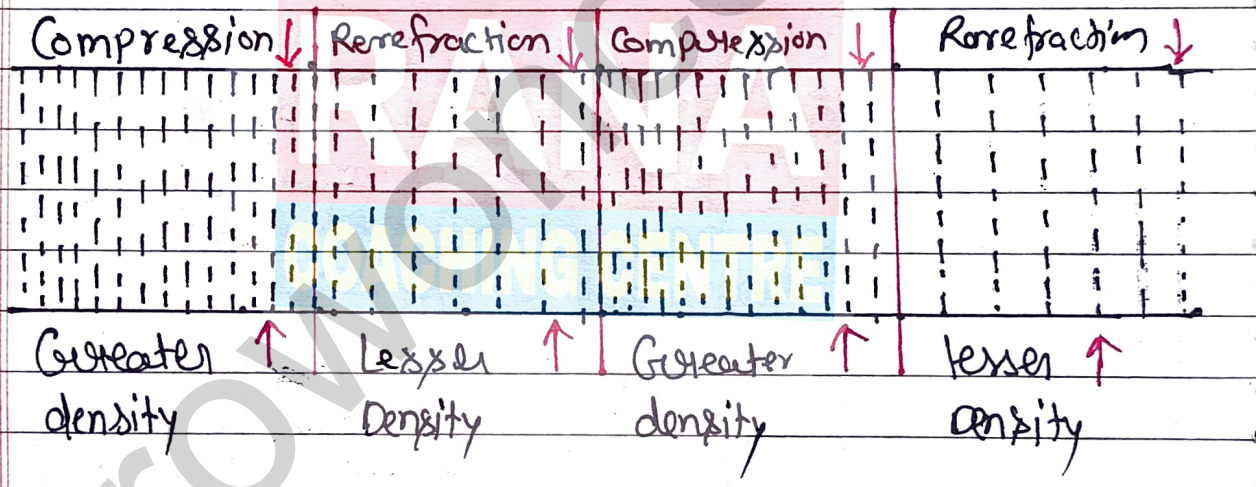
- **Compression (C):** When a body vibrates then it compresses the air surroundings it and form a area of

high density called compression.

- **Rarefraction(R):** When vibrating body vibrates back a area of low pressure is formed called rarefraction(R).

When body vibrates back and forth, a series of compression and rarefraction is formed in air resulting in sound wave.

Propagation of sound wave is propagation of density change.



- **Sound Needs a Medium to Travel**

Sound waves are mechnical waves, it needs material - medium for propagation like Solid, liquid and air. It can-not travel in vaccum.

Sound propagation faster order:

Solid > Liquid > Gas > Vaccum

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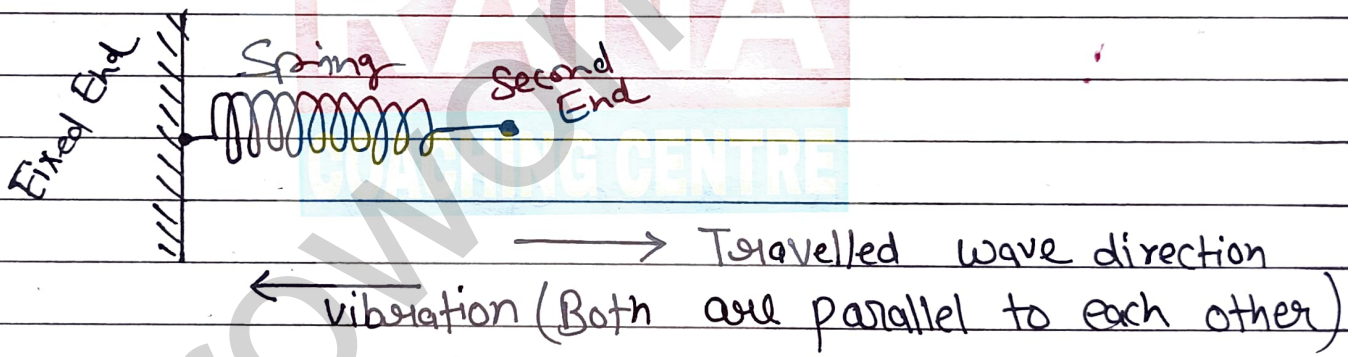
Sound Waves as longitudinal Waves

A wave in which the particles of the medium vibrate back and forth in the same direction in which the wave is moving, is called – longitudinal waves.

The direction of vibrations of the particles is parallel to the direction of wave.

Examples : (Spring wave and Sound wave)

(i) Spring का एक सिरा दीवार से बाँध, दूसरा सिरा खींचें कर छोड़ कर देखा तो left-right Spring moves कर रहा होगा- longitudinal की Example है



(ii) Sound Wave - Speaker से निकली - आस पास के air particles पर pressure बनाकर आगे बढ़ती जायेगी।

Characteristics of Sound

The characteristics of sound waves are : wavelength, frequency, amplitude, time period and velocity.

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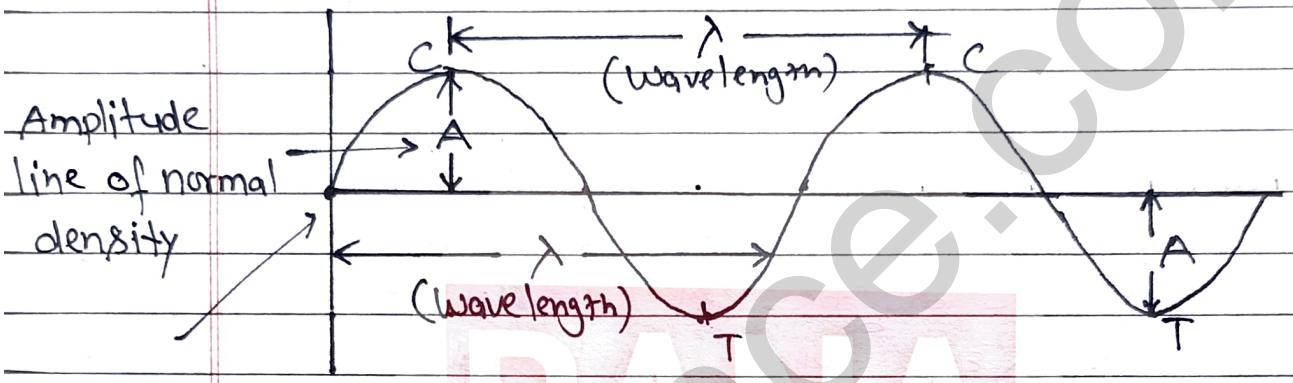
(i) Wavelength (λ)

It is the distance between two successive crest or trough.

It is denoted by the Greek letter lamda (λ). Its SI Unit is metre(m)



(ii) Velocity (v)

The distance travelled by a wave in one second is called velocity of the wave.

Its SI unit is metre per second (ms^{-1}).

$$\text{Velocity} = \frac{\text{Distance travelled}}{\text{Time taken}} \quad m/s$$

$$V = \lambda / T \quad ms^{-1}$$

λ is the wavelength of the waves travelled in one time period T

$$V = \lambda v \quad (1/T = v)$$

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So, Velocity = Wavelength × Frequency

This is the wave equation.

(iii) Amplitude (A)

It is the distance between mean position and any of the extreame position of wave.

It is denoted by 'A'. Its SI unit is metre(m).

(iv) Frequency (n)

It is the number of waves passing through any given point of medium in one second

It is denoted by V(nu). Its SI unit is hertz(Hz)

(v) Time Period (T)

It is the time required by one wave to pass through any given point of medium.

OR Time taken to complete one vibration is called time period.

It is denoted by T. Its SI unit is second (s).

(vi) Loudness

The loudness depends on the amplitude of the sound wave.

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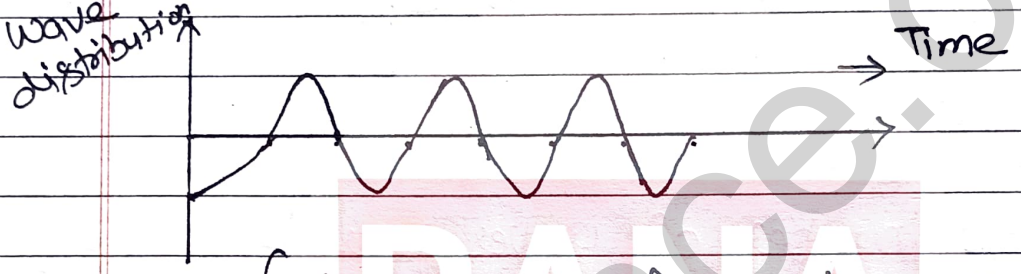
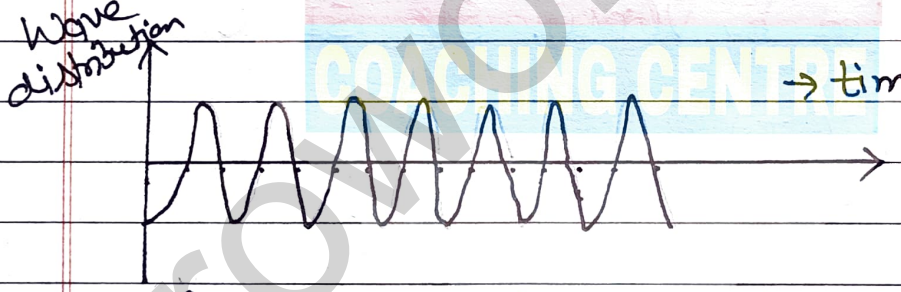
Loudness is the measure of the sound energy reaching the ear per sec.

Greater the amplitude of sound wave, greater is the energy, louder the sound. Short is the amplitude, less is the energy Soft is the sound.

Loudness is measured in decibel 'dB'.



(Wave shape for a low pitched Sound)



(Wave Shape for a high pitched Sound)

(vii) Pitch

The pitch of Sound depends on the frequency of Sound (vibration).

$$\text{Pitch} \propto \text{Frequency}$$

High pitch Sound has large number of compressions and rarefactions passing a

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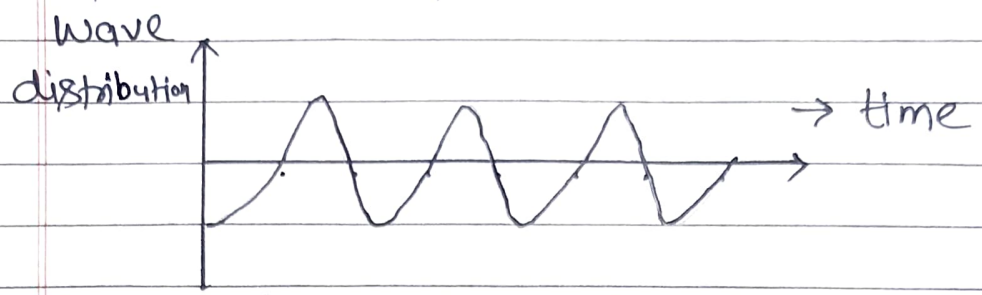
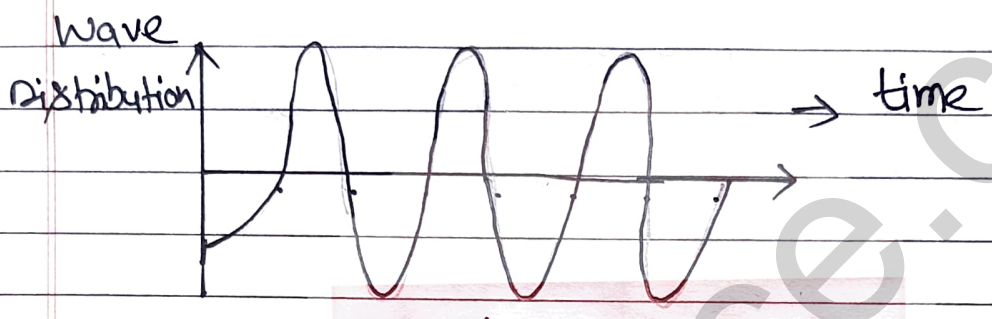
fixed point per unit time.



Soft Sound



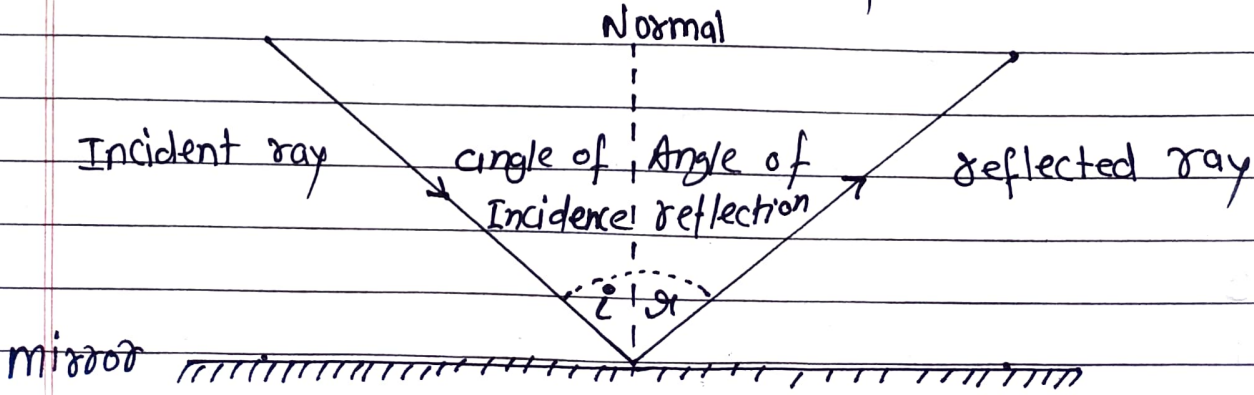
Louder Sound

"Soft Sound has small amplitude and louder sound has large amplitude"

Reflection of Sound

Laws of reflection of light is equivalent to law of reflection of sound.

(i) The incident sound wave, the reflected sound wave, and the normal at the point of incidence, all lies same plane.



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[Angle of Incidence (i) = Angle of reflection (r)]

(i) Echo - Reflection of Sound

The repetition of sound caused by the reflection of sound waves is called echo.

We can hear echo when there is a time gap of 0.1 second in original sound and echo.

Formula for Echo :

$$S = \frac{2D}{T}$$

D = Distance b/w source and reflecting surface
T = Time interval
S = Speed

Echoes heard more than once due to - successive or multiple reflections.
Applications : Loud speakers, Ceiling of concert Hall.

(ii) Reverberation

The persistence of sound in a big hall due to repeated reflection of sound from the walls, ceiling and floor of the hall is called reverberation.

- Methods to reduce reverberation in Hall :
(i) Heavy curtains are put on doors and

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windows.

(ii) Carpets are put on the floor.

Applications of Reflection of Sound

(i) Megaphones, loudspeakers etc:- are designed to send sound in a particular direction without spreading all around.

All these instruments have funnel tube which reflects sound waves repeatly toward the audience. In this amplitude of sound waves adds up to increase loudness of sound.

(ii) Stethascope: It is a medical instrument used for listening the sounds produced by human heart. The heartbeats reaches the doctor's ears by the multiple reflection of the sound waves in the rubber tube of stethascope.

(iii) Sound Board: In big halls sound is absorbed by walls, ceiling, seats etc. So a curved board (Sound Board) is placed behind the speakers, so that his speech can be heard easily by audiences.

(iv) The ceiling of concert halls are made curved, so that sound after reflection from ceiling, reaches all the parts of the hall.

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Range of Hearing

(i) Range of hearing in human is 20Hz to 20KHz. Elephants and whales produces infrasonic sound (infrasonic sound < 20Hz).

(ii) The sounds of frequencies higher than 20KHz are known as ultrasonic sounds. Dogs, bats and rats can hear ultrasonic sound and Bats & rats can produce ultrasonic sounds.

- **Hearing Aid :** It is battery operated electronic device used by persons who are hard of hearing.

Applications of Ultrasound

The sounds having frequency greater than 20 KHz are called ultrasound.

(i) It is used to detect cracks in metal blocks in industries without damaging them.

(ii) It is used in industries to clean "hard to reach" parts of objects such as spiral tubes, odd shaped machines etc.

(iii) It is used to investigate the internal organs of human body.

(iv) It is used to moniter the development

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of fetus inside the mother's uterus.

(v) It is used to break kidney stones into fine grains.

SONAR

The word 'SONAR' stands for 'Sound Navigation and Ranging'.

SONAR is a device which is used to find distance, direction and speed of underwater objects.

SONAR consists of a transmitter and a detector and installed at the bottom of a ship.

SONAR Applications : It is used to find the depth of sea, to locate the underwater hills, valleys, submarines, icebergs and sunken ships etc.

Structure of Human Ear

The ear is the organ of the human body that enables us to hear different sounds.

The ear can be divided into three main parts:

(i) Outer Ear
(ii) Middle Ear
(iii) Inner Ear

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(I) Outer Ear

(i) This is the outermost visible part of the human ear.

(ii) The outer ear gathered sound waves and forward them toward the ear canal.

(iii) At the end of the ear canal lies the eardrum. Sound waves travel through the ear canal and strike the eardrum.

(II) Middle Ear

(i) The eardrum is made up of a membrane, which starts vibrating with the frequency of the sound wave that falls on it and, it converts the sound waves into vibrations that then travel to the inner ear.

(ii) The eardrum is a thin layer rubber like sheet present in the middle ear.

(iii) When the sound waves reaches the eardrum, the eardrum vibrates and these vibrations propagate to the inner ear.

(III) Inner Ear (Cochlea)

(i) Inner ear (cochlea) receives the vibrations sent by the eardrum.

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(ii) The inner ear contains a liquid-like substance through which the vibrations can travel.

(iii) The inner ear has some tiny hairs that turn the vibrations into signals. The brain receives the signals through the hearing nerve

(iv) When the brain receives the signal, it interpretes the sound instantaneasly. However, the whole process is so quick that we cannot notice it.

Outer ear

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