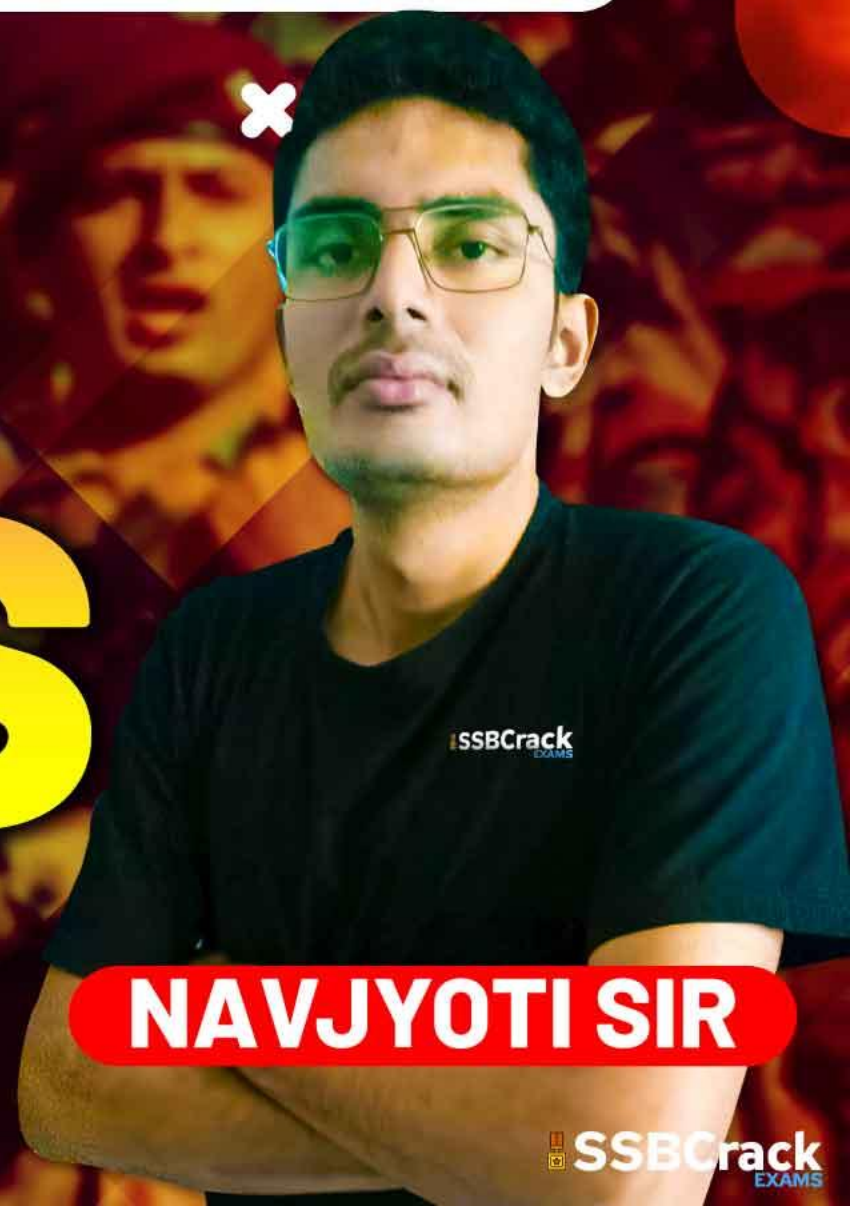
NDA-CDS 1 2025

GS

LIVE

PHYSICS

SOUND



NAVJYOTI SIR

SSBCrack EXAMS

09 Dec 2024 Live Classes Schedule

8:00AM	09 DEC 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	09 DEC 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

NDA 1 2025 LIVE CLASSES

1:00PM	PHYSICS - SOUND	NAVJYOTI SIR
5:30PM	MATHS - DIFFERENTIABILITY & DIFFERENTIATION - CLASS 4	NAVJYOTI SIR

CDS 1 2025 LIVE CLASSES

1:00PM	PHYSICS - SOUND	NAVJYOTI SIR
7:00PM	MATHS - ALGEBRA - CLASS 4	NAVJYOTI SIR

SOUND

WHAT WILL WE STUDY ?

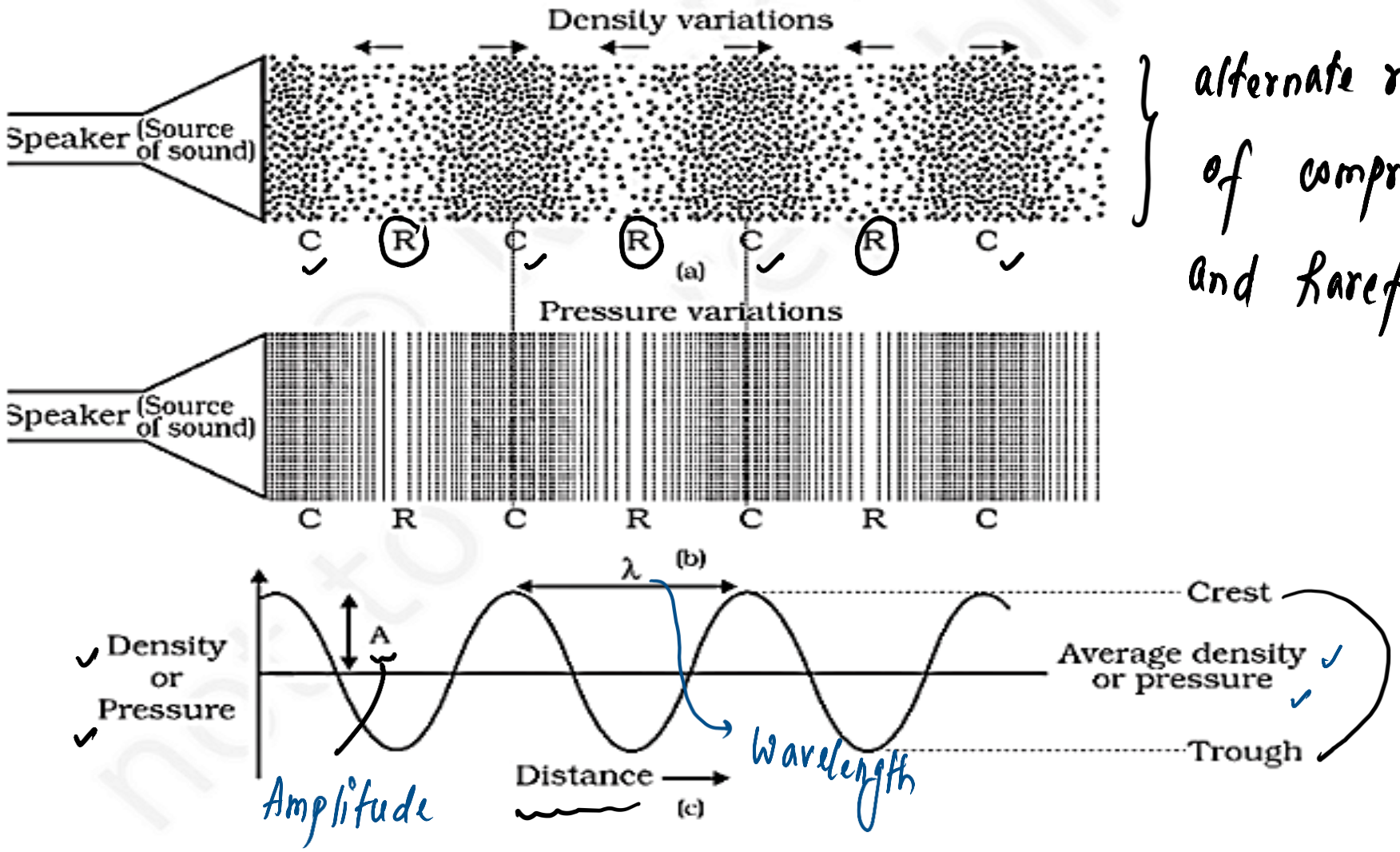
- Sound Waves
- Musical Sound Characteristics
- Human Ear

SOUND WAVES

- Sound is a form of energy which produces a sensation of hearing in our ears.
- Sound waves are longitudinal in nature.
- Sound waves are of three types, depending on frequency ranges :

1. Infrasonic : Less than 20 Hz
2. Audible : 20 – 20,000 Hz , or 20 Hz to 20 KHz
3. Ultrasonic : Above 20,000 Hz or 20 kHz.

SOUND WAVE - LONGITUDINAL WAVE



alternate regions of compressions (C) and rarefactions (R)

To relate with Transverse wave,

Sound propagates as density or pressure variations as shown in (a) and (b). (c) represents graphically the density and pressure variations.

SOUND WAVES – MECHANICAL WAVE

- Sound Wave is a mechanical wave , that is it requires a material medium for travelling.
- Sound waves cannot propagate through vacuum.
- If v_s , v_l and v_g are speed of sound waves in solid, liquid and gases, then

$$v_s > v_l > v_g$$

SPEED OF SOUND WAVES

Velocity of longitudinal (sound) wave in any medium is given by

$$v = \sqrt{\frac{\gamma p}{\rho}}$$

where ,

- γ is a factor , whose value for air is 7/5 ,
- p is the pressure of the gas (modulus of elasticity for medium) , and
- ρ is the density of the medium.

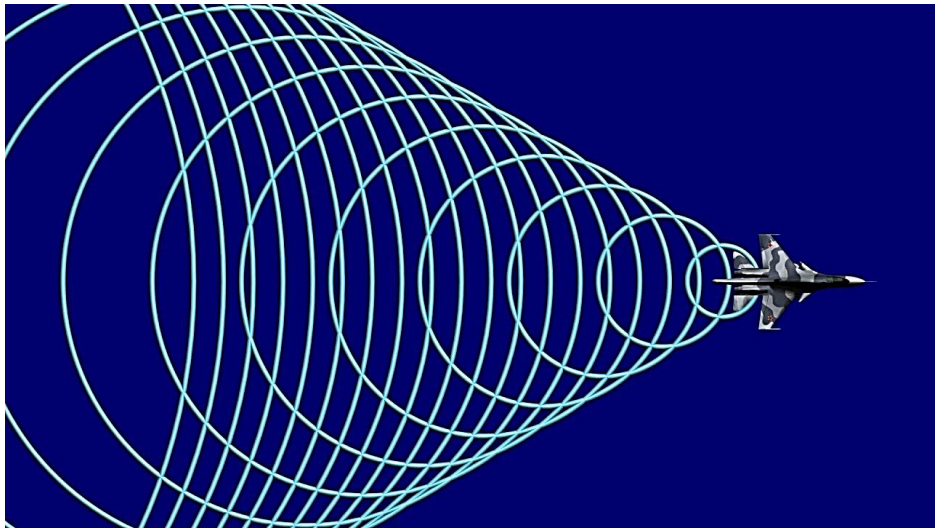
SPEED OF SOUND WAVES

At 25°C

State	Substance	Speed in m/s
Solids	Aluminium	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
	Glass (Flint)	3980
Liquids	Water (Sea)	1531
	Water (distilled)	1498
	Ethanol	1207
	Methanol	1103
Gases	Hydrogen	1284
	Helium	965
	Air	346
	Oxygen	316
	Sulphur dioxide	213

SHOCK WAVES

- A body moving with supersonic speed in air leaves behind it, a conical region of disturbance, which spreads continuously. Such a disturbance is called shock wave.
- These waves carry huge energy and may even make cracks in window panes or even damage a building. Earthquakes have shock waves.



FACTORS AFFECTING SPEED OF SOUND IN GASES

1. **Temperature :** Velocity of sound in a gas is directly proportional to the square root of its absolute temperature.

$$v \propto \sqrt{T}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$$

If v_0 and v_t are velocities of sound in air at 0°C and t°C, then

$$v_t = v_0 + 0.61\, t$$

2. **Density :** The velocity of sound in a gas is inversely proportional to the square root of density of the gas.

$$v \propto \frac{1}{\sqrt{\rho}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}}$$

FACTORS AFFECTING SPEED OF SOUND IN GASES

3. Pressure: There is no effect of pressure on velocity of longitudinal wave.

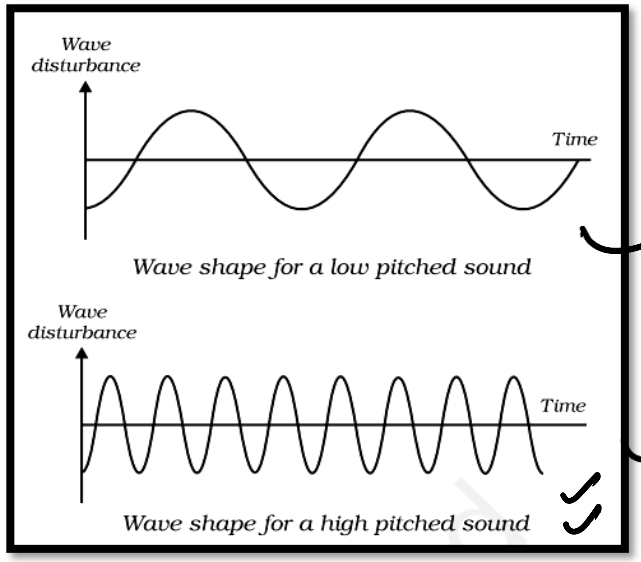
4. Humidity: The velocity of sound increases with increase in humidity in air. Thus, speed of sound in moist air is slightly greater than in dry air.

5. Frequency : Speed of sound in air is independent of its frequency. Sound waves with different frequency travels with the same speed in air but their wavelengths in air are different.

6. Direction of Wind : If wind is blowing, then the speed of sound changes. The speed of sound is increased, if wind is blowing in the direction of propagation of sound wave.

Characteristics of Musical Sound

- **Pitch** : How the brain interprets the frequency of an emitted sound is called its pitch. A shrill and sharp sound has higher pitch and a grave and dull sound has lower pitch.



lower frequency — low pitch

high frequency — high pitch.

- **Intensity** : Intensity of sound is energy transmitted per second per unit area by sound waves.
  - Its SI unit is watt/metre^2.

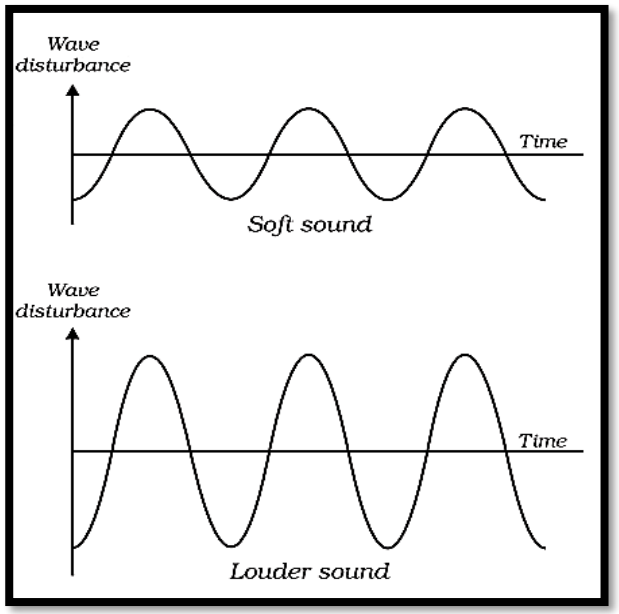
$\frac{E}{t \times A}$ Power — watt

watt/m^2

Characteristics of Musical Sound

- Loudness : Loudness is a measure of the response of the ear to the sound. Even when two sounds are of equal intensity, we may hear one as louder than the other simply because our ear detects it better.
- Loudness of a sound is determined by its amplitude. (A)
- Its Unit is Decibel (Db). #

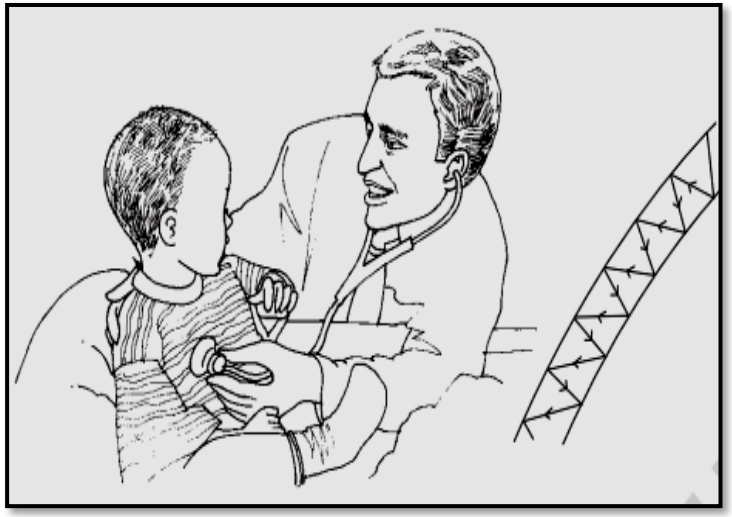
Loudness $\propto A^2$

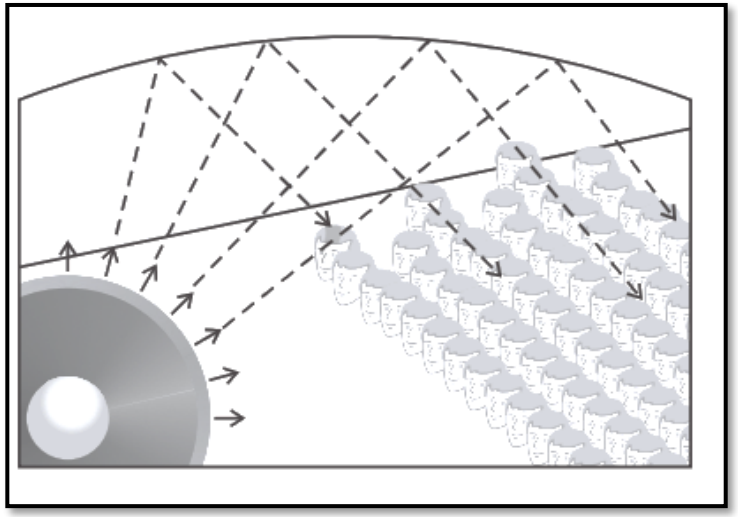


- Quality or Timbre : The quality or timber of sound is that characteristic which enables us to distinguish one sound from another having the same pitch and loudness. It depends on harmonics and their relative order and intensity.

Reflection of Sound

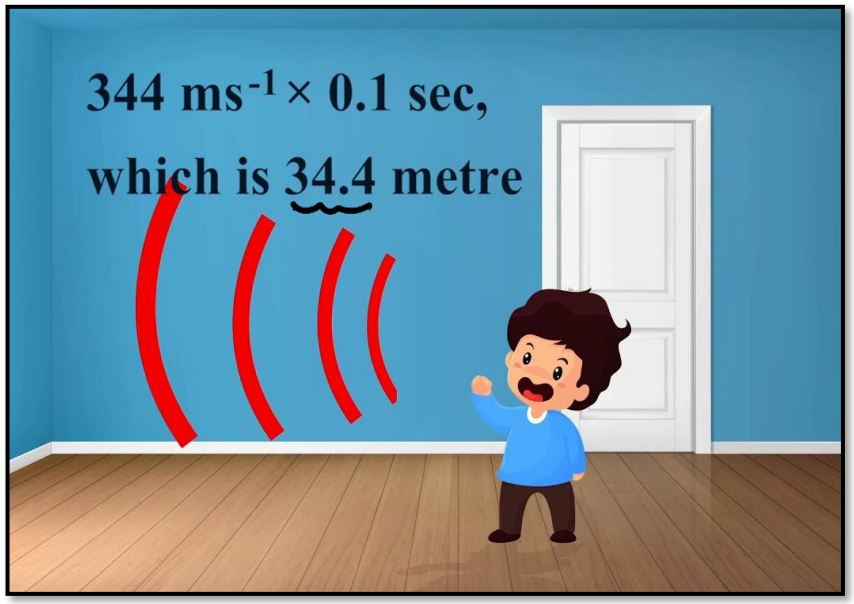
- Sound bounces off a solid or a liquid like a rubber ball bounces off a wall. Like light, sound gets reflected at the surface of a solid or liquid and follows the same laws of reflection.
- An obstacle of large size which may be polished or rough is needed for the reflection of sound waves.





ECHO

- The repetition of sound caused by the reflection of sound waves at a distant surface, e.g. a cliff, a row of building etc.
- Sound persists in ear for 0.1 s.



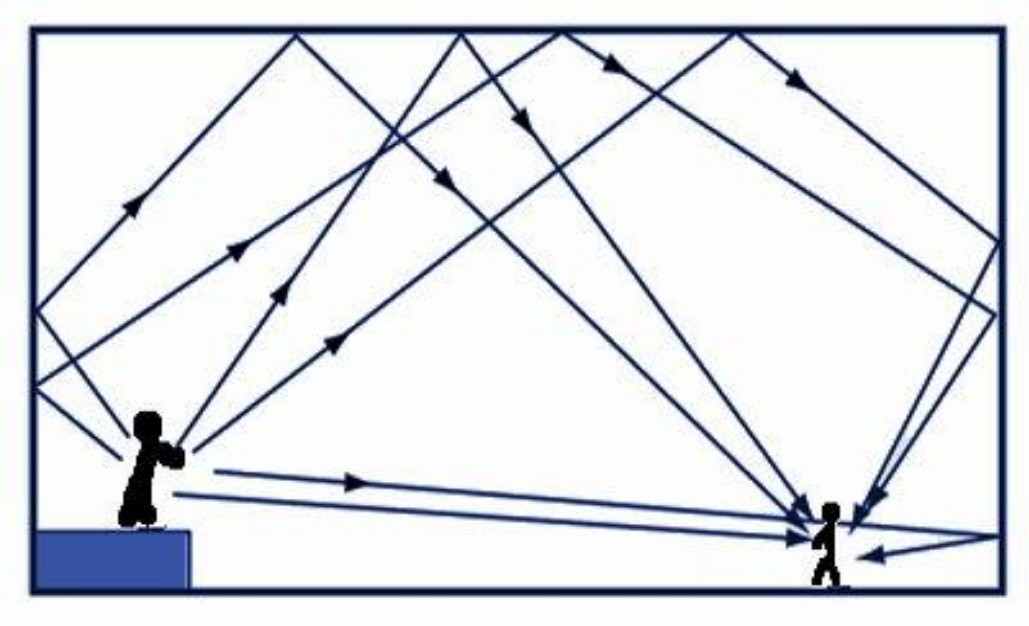
Distance to object $= \frac{34.4}{2} = 17.2$ m

(min. distance)

- If first echo be heard after t_1 second, second echo after t_2 second, then third echo will be heard after ($t_1 + t_2$) s.

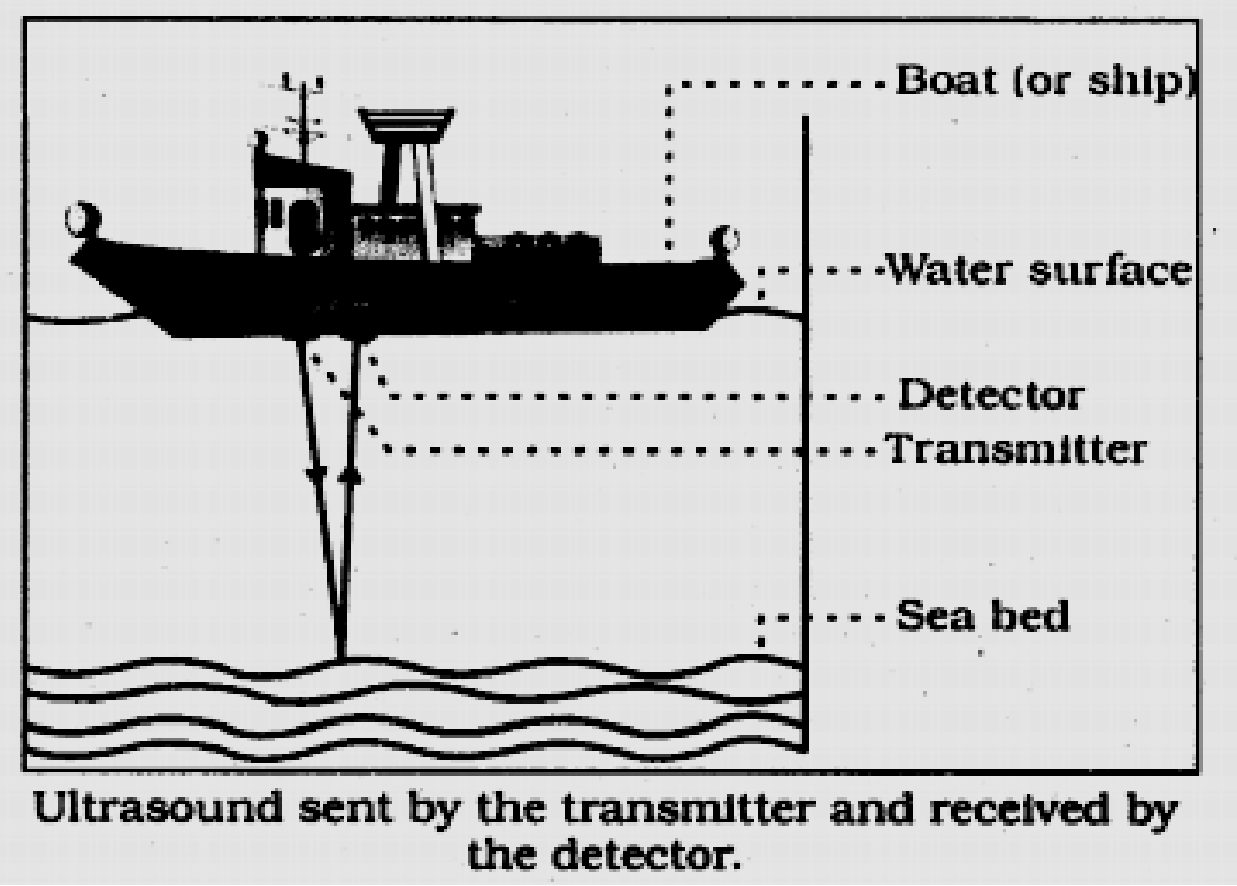
REVERBERATION

- The repeated reflection that results in the persistence of sound.
- Excessive Reverberation is highly undesirable. To reduce it , the roof and walls of the auditorium are generally covered with sound-absorbent materials like compressed fibreboard, rough plaster or draperies. The seat materials are also selected on the basis of their sound absorbing properties.



SONAR

Sound Navigation and Ranging

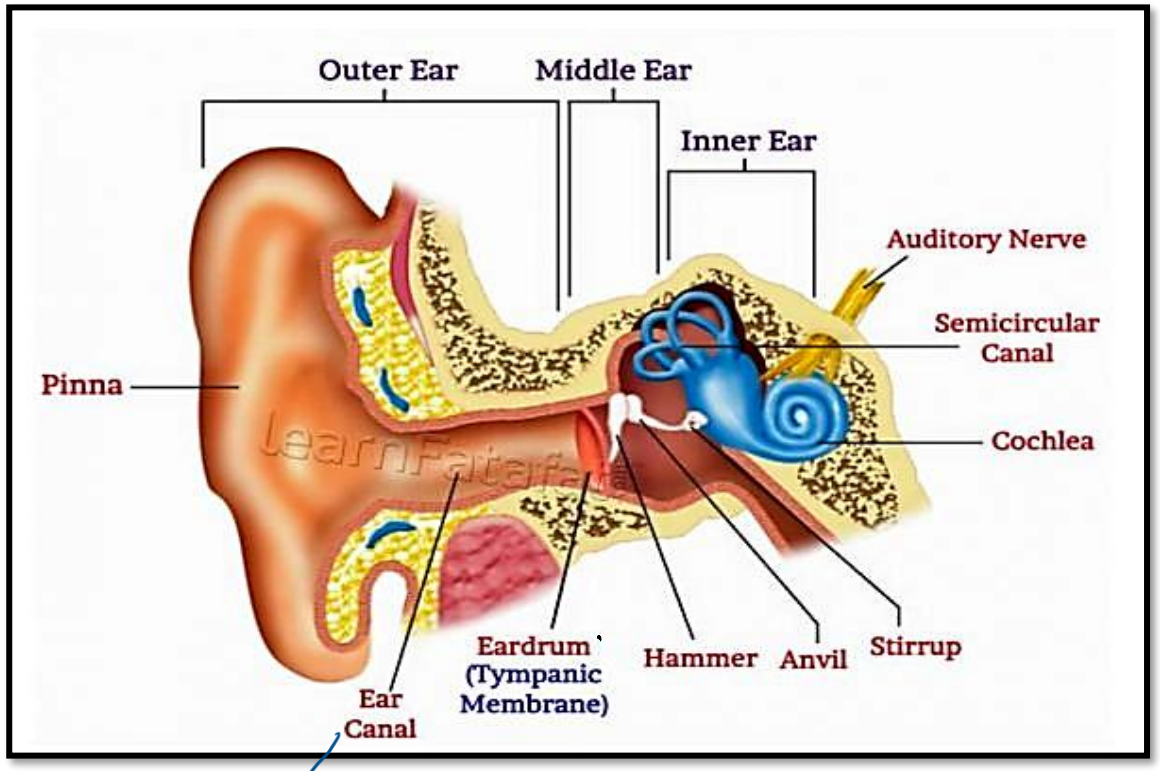


Ultrasound sent by the transmitter and received by the detector.

2 x distance = speed of ultrasound wave x time taken

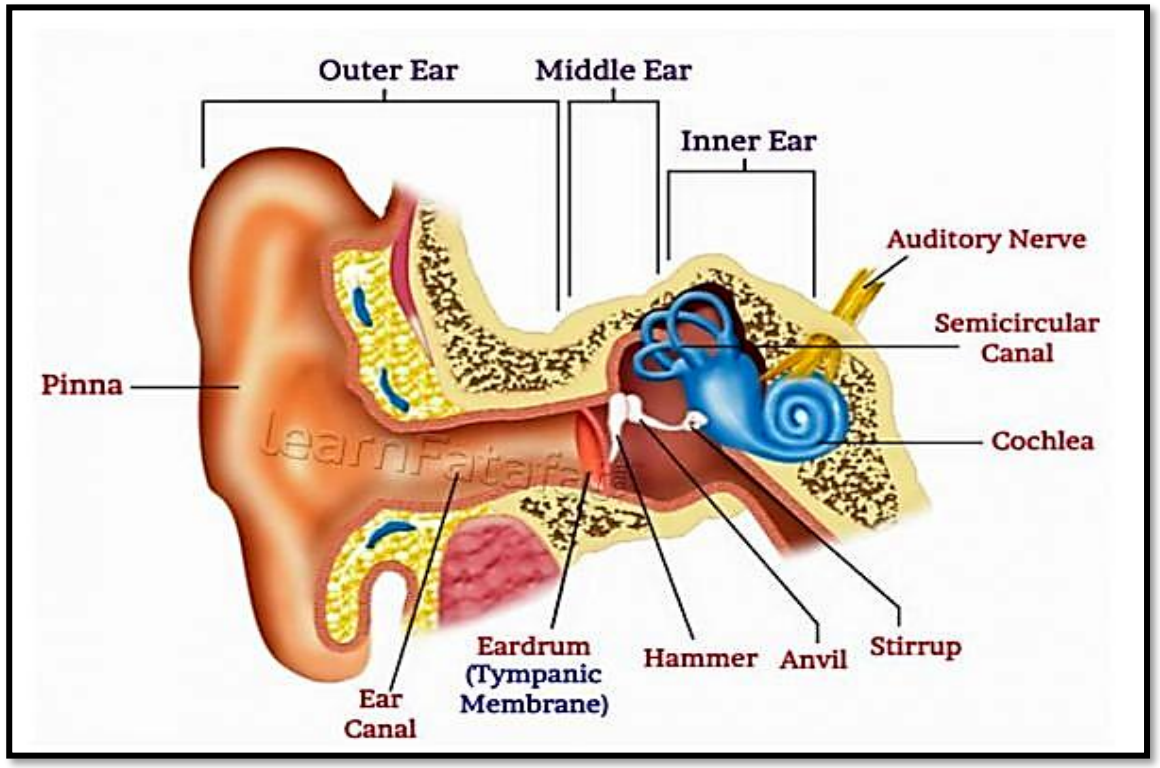
$$d = \frac{v \times t}{2}$$

HUMAN EAR



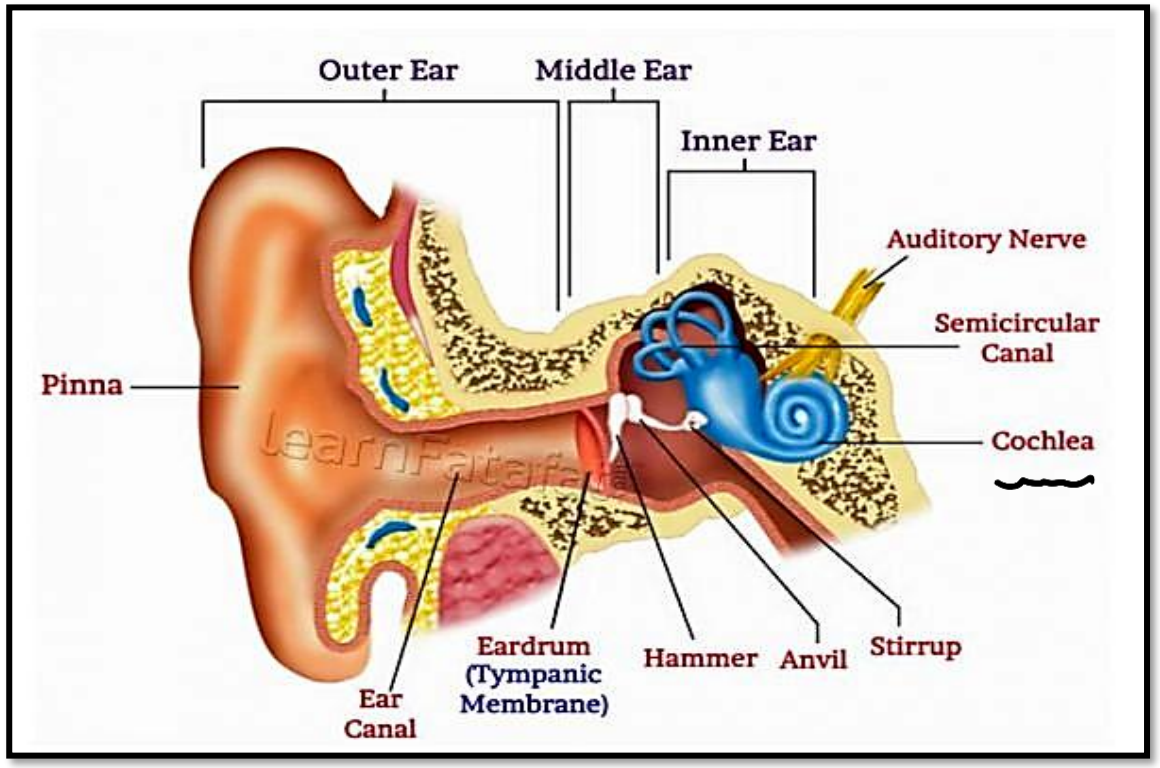
- **Outer Ear** : The function of the outer ear is to collect sound waves and guide them to the tympanic membrane.
(Pinna | Auditory or Ear Canal | Eardrum)

HUMAN EAR



- **Middle Ear : To amplify or increase the amplitude of received sound (vibrations).**
  (3 Tiniest Bones – Hammer , Anvil and Stirrup)

HUMAN EAR



- Inner Ear : Converting the amplified vibrations in sound to electrical signals. These signals are then sent to brain.
  (Cochlea)

SUMMARY

- Sound Waves – Types and Nature
- Velocity of Sound and Factors affecting it
- Reflection of Sound
- Characteristics of Musical Sound
- Human Ear and parts

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MCQ | WAVES & SOUND

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