

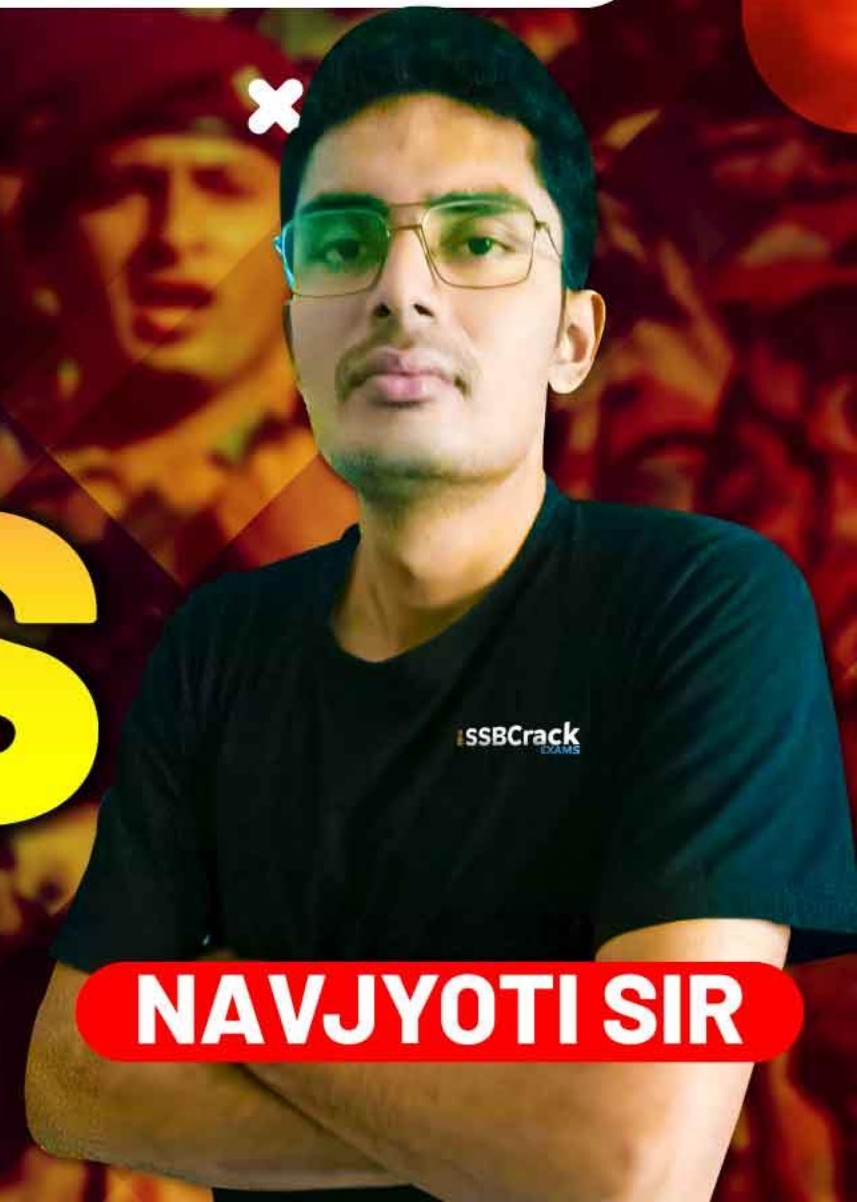
# NDA-CDS 2 2024

# GS

LIVE

# PHYSICS

CLASS 5



NAVJYOTI SIR



## 05 July 2024 Live Classes Schedule

8:00AM	05 JULY 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	05 JULY 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

### SSB INTERVIEW LIVE CLASSES

9:00AM	OVERVIEW OF TAT & WAT	ANURADHA MA'AM
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### NDA 2 2024 LIVE CLASSES

11:30AM	GK - WORLD HISTORY - CLASS 1	RUBY MA'AM
1:00PM	GS - PHYSICS - CLASS 5	NAVJYOTI SIR
2:30PM	GS - CHEMISTRY MCQS - CLASS 10	SHIVANGI MA'AM
4:00PM	MATHS - PROBABILITY - CLASS 1	NAVJYOTI SIR
5:30PM	ENGLISH - PARTS OF SPEECH - CLASS 3	ANURADHA MA'AM

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11:30AM	GK - WORLD HISTORY - CLASS 1	RUBY MA'AM
1:00PM	GS - PHYSICS - CLASS 5	NAVJYOTI SIR
2:30PM	GS - CHEMISTRY MCQS - CLASS 10	SHIVANGI MA'AM
5:30PM	ENGLISH - PARTS OF SPEECH - CLASS 3	ANURADHA MA'AM



# WAVES AND SOUND

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# WHAT WILL WE STUDY ?

- **Waves**
- **Sound Waves**
- **Musical Sound Characteristics**
- **Human Ear**
- **Wave Phenomena**
- **Terms associated with Vibrating Air Column / Strings**
- **Electromagnetic Waves**





# WAVES - Introduction

- A wave is a vibratory disturbance in a medium which carries energy from one point to another point without any actual movement of the medium.

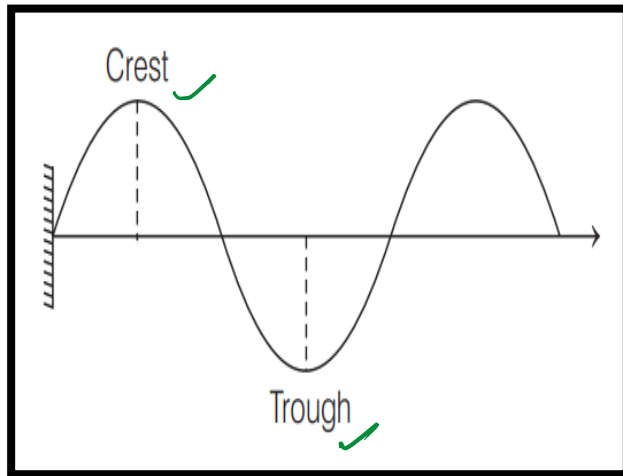


# TYPES OF WAVES

1. ✓ Mechanical Waves : Those waves which require a material medium for their propagation, are called mechanical waves, e.g. sound waves, water waves etc.
2. ✓ Electromagnetic Waves : Those waves which do not require a material medium for their propagation, are called electromagnetic waves, e.g. light waves, radio waves etc.
3. ✓ Matter Waves : These waves are associated with electrons, protons and other fundamental particles.

## ✓ TRANSVERSE

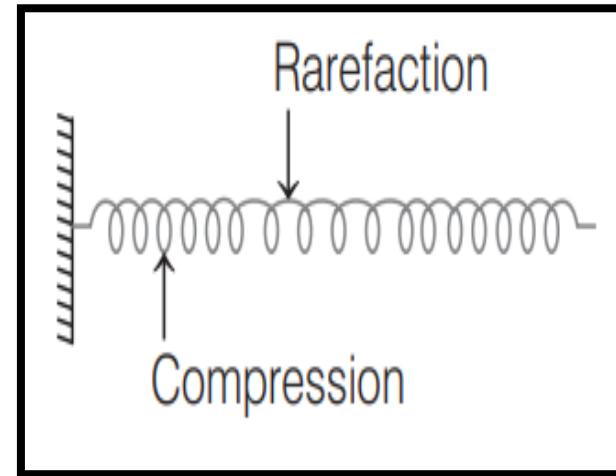
- Particles of the medium vibrate at right angles to the direction of propagation of wave.
- These waves travel in the form of crests and troughs ✓



Eg - water wave

## LONGITUDINAL

- Particles of the medium vibrate in the same direction in which wave is propagating.
- These waves travel in the form of compressions and rarefactions.

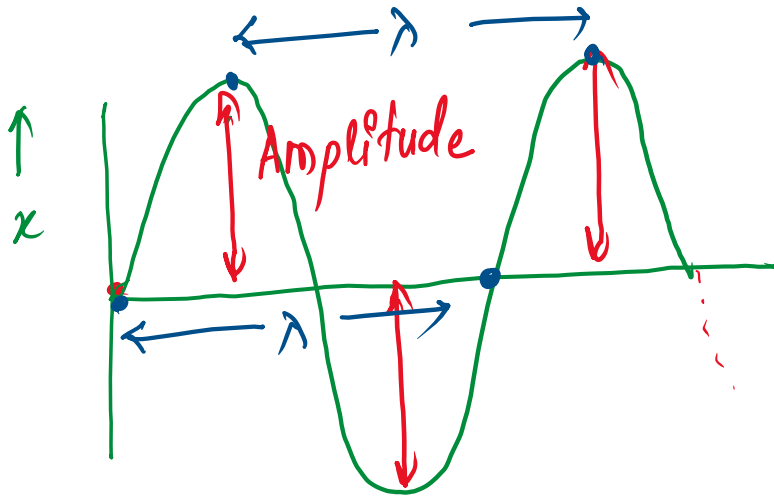


Eg - sound wave

# TERMS RELATED TO WAVE MOTION

1. Amplitude : Magnitude of maximum displacement of the particles from their mean or equilibrium position, as the wave passes through them.  $(A)$  — metre

2. Wavelength : The distance between two crests or two troughs.  $(\lambda)$  — metre





# TERMS RELATED TO WAVE MOTION

3. Time Period (T) : Time taken to complete one vibration is called time period.

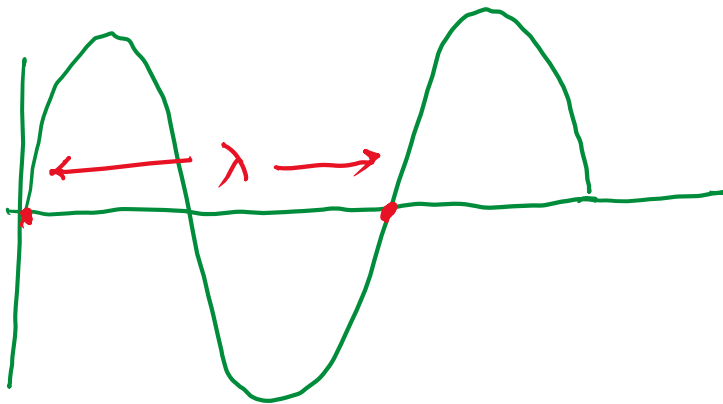
4. Frequency : The number of vibrations completed in one second.

(second)

$$\text{Frequency, } f = \frac{1}{\text{Time period (T)}}$$

sec<sup>-1</sup> or Hertz (Hz)

Angular frequency,  $\omega = \frac{2\pi}{T}$

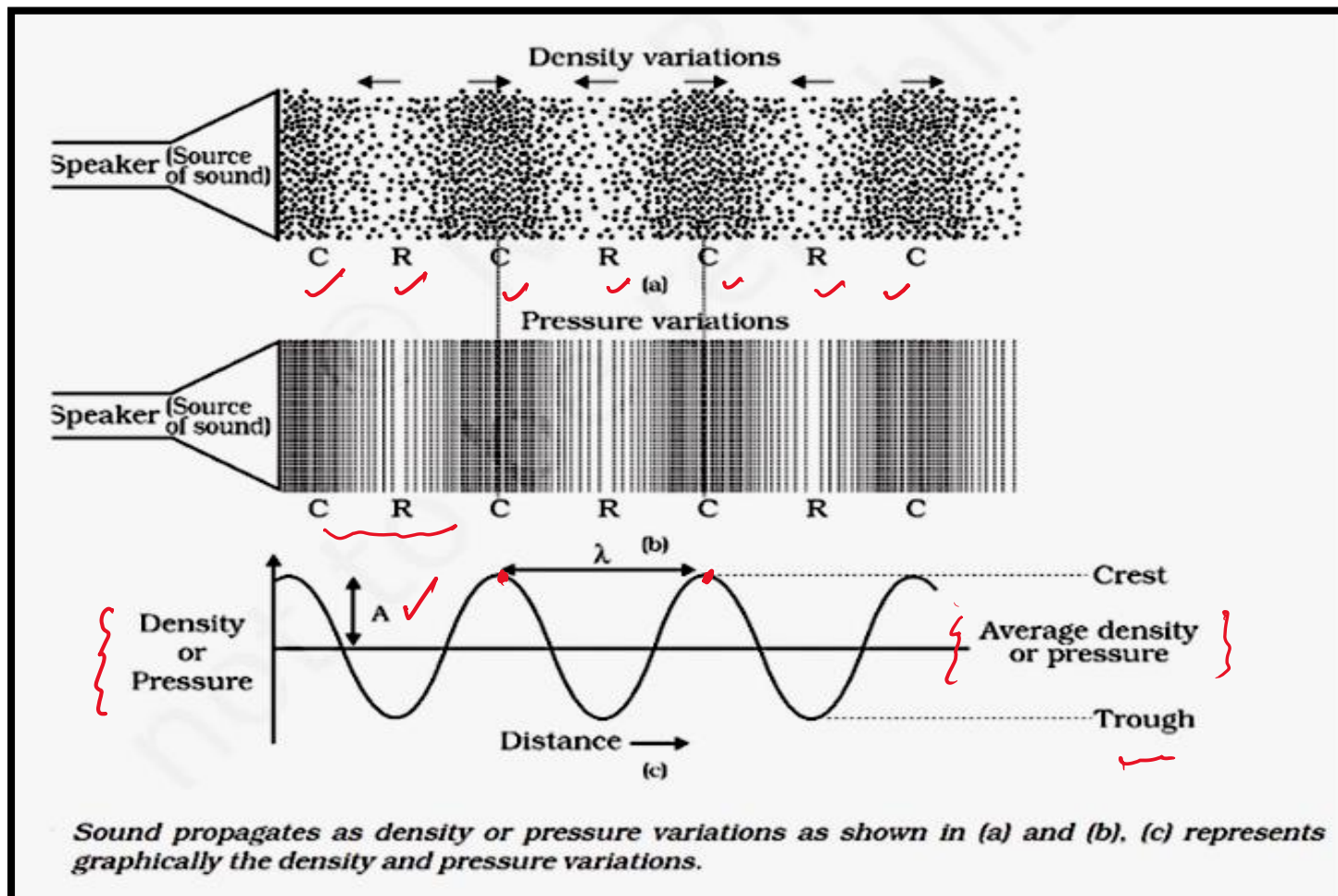


# TERMS RELATED TO WAVE MOTION

5. Velocity of Wave or Wave Velocity : The distance travelled by a wave in one second is called velocity of the wave ( $v$ ).

$$v = f \lambda$$

$$v = \frac{\lambda}{T} = \lambda \left( \frac{1}{T} \right) = \lambda f$$



# 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

# 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

$$v_s > v_l > v_g$$

*(visualize distance between particles)*

# SPEED OF SOUND WAVES

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

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

where ,

- $\gamma$  is a factor , whose value for air is  $7/5$  ,
- $p$  is the pressure of the gas ( modulus of elasticity for medium ) , and
- $\rho$  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	✓ <u>346</u> ✓
	Oxygen	316
	Sulphur dioxide	213

Air → 346 m/s at 25°C



# 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  $0^\circ\text{C}$  and  $t^\circ\text{C}$ , 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.

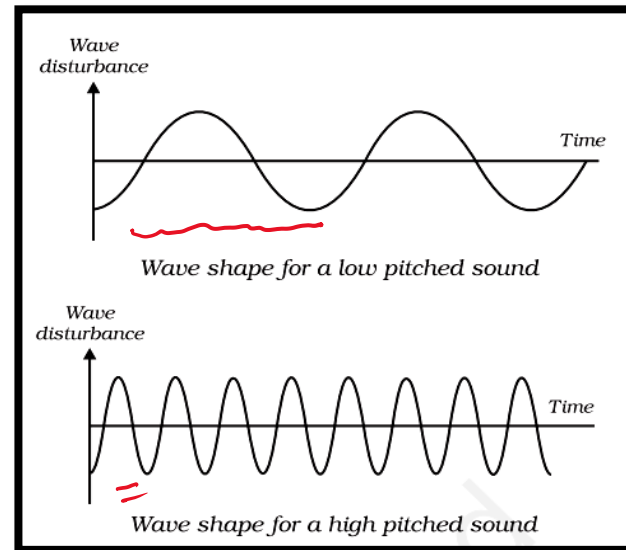
Thus, speed of sound in moist air is slightly greater than in dry air.

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.

$$\text{speed} = \lambda \times f = \underline{\text{constant}}$$

# 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.

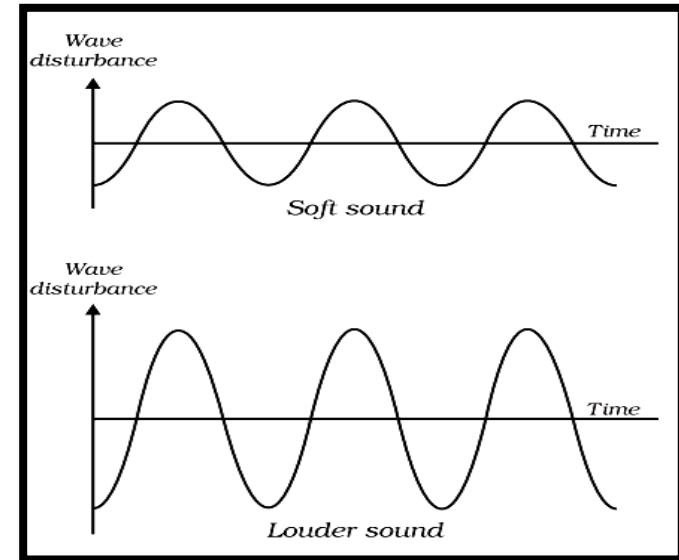


- **Intensity** : Intensity of sound is energy transmitted per second per unit area by sound waves.
- Its SI unit is watt/metre<sup>2</sup>.

# 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.
- Its Unit is Decibel (Db).

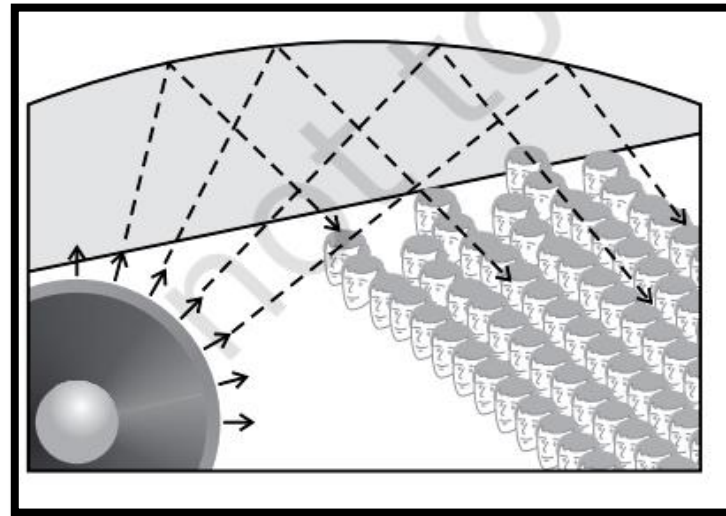
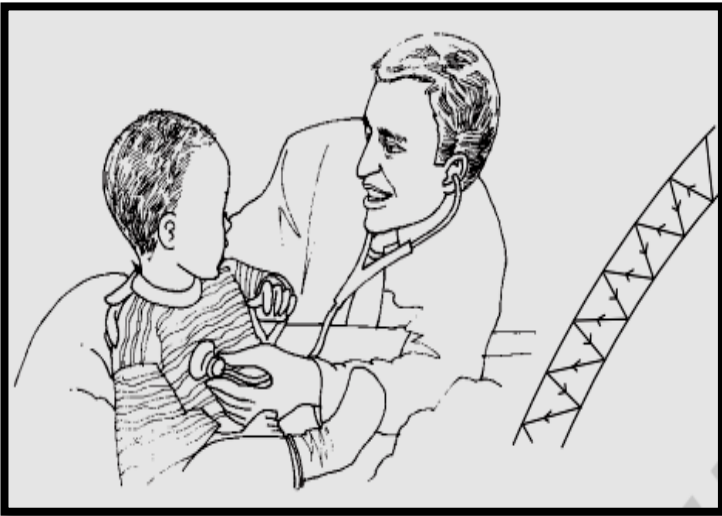
$$\text{Loudness} \propto (A)^2$$



- 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.

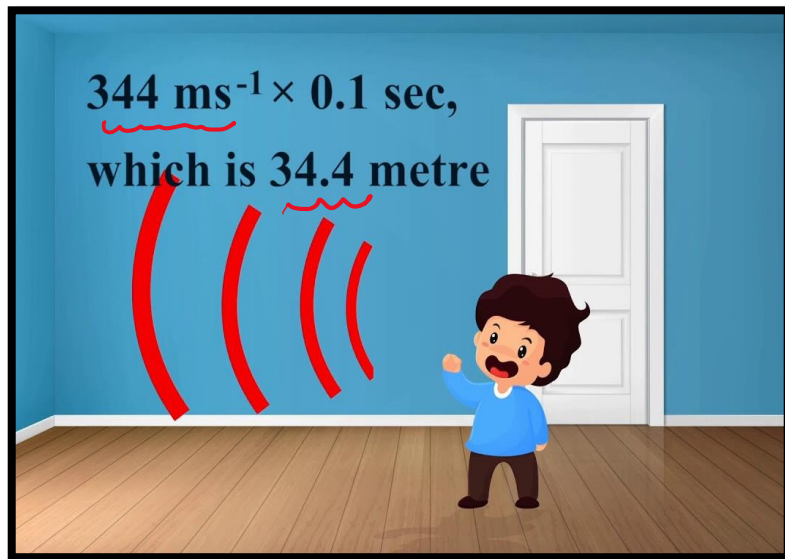
# Reflection of Sound

- 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.
- 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.



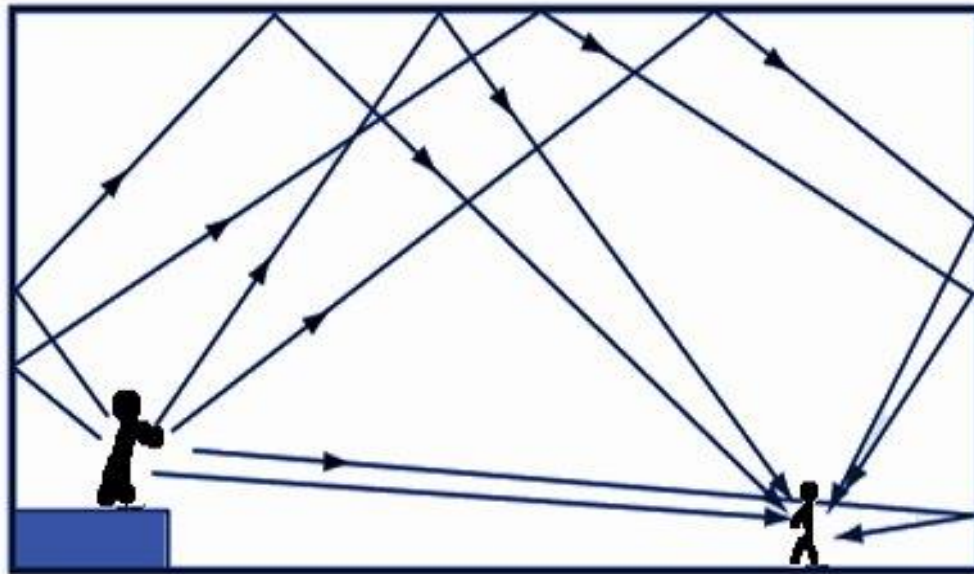
$$\text{min. dist. for echo} = \frac{34.4}{2} = \underline{17.2 \text{ m}}$$

(for 344 ms<sup>-1</sup> — speed of sound wave)



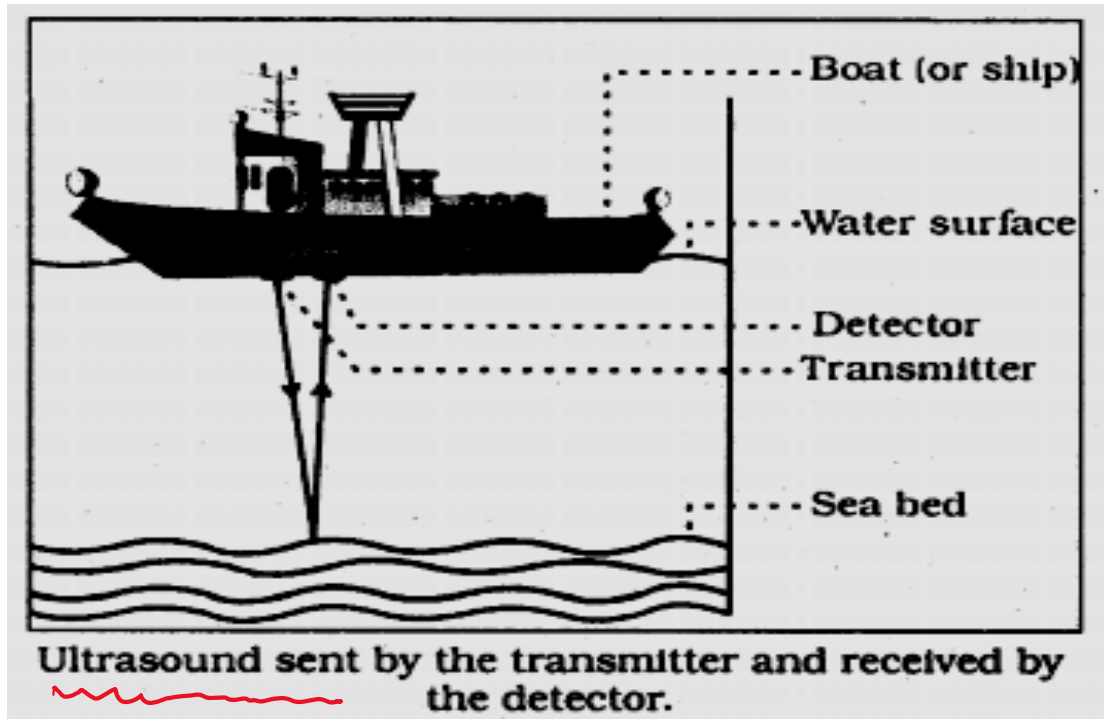
# REVERBERATION

- 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.



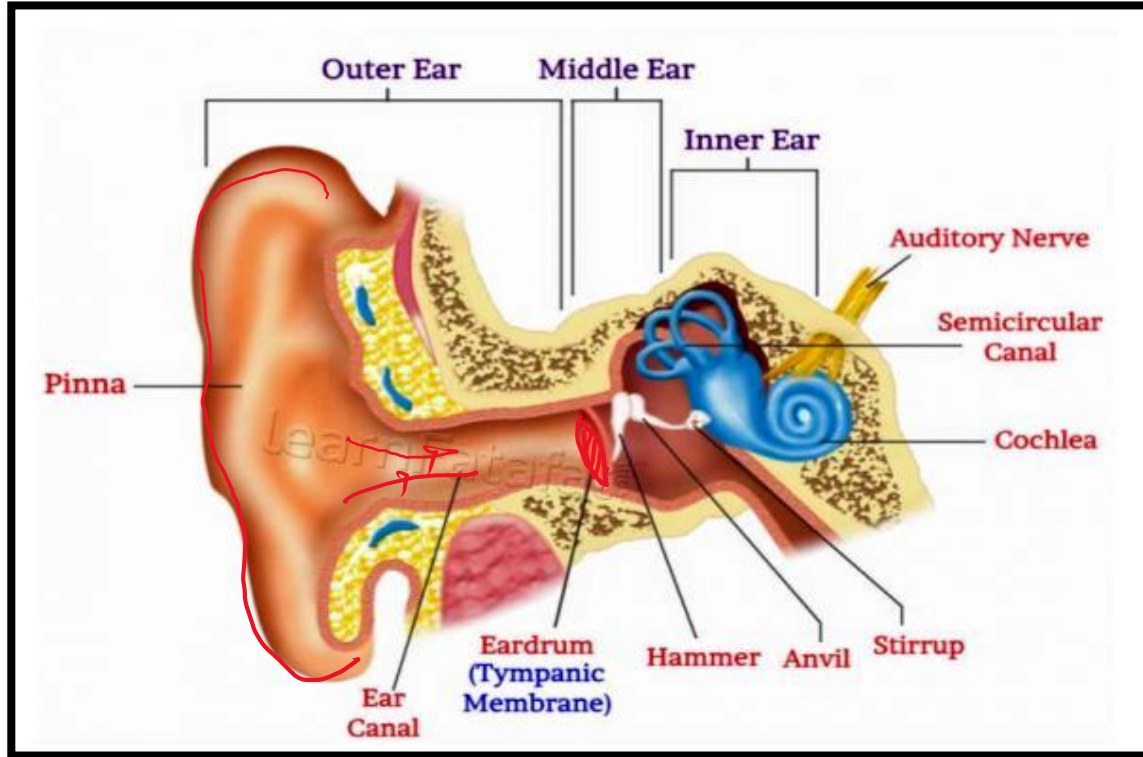
# SONAR

## Sound Navigation and Ranging



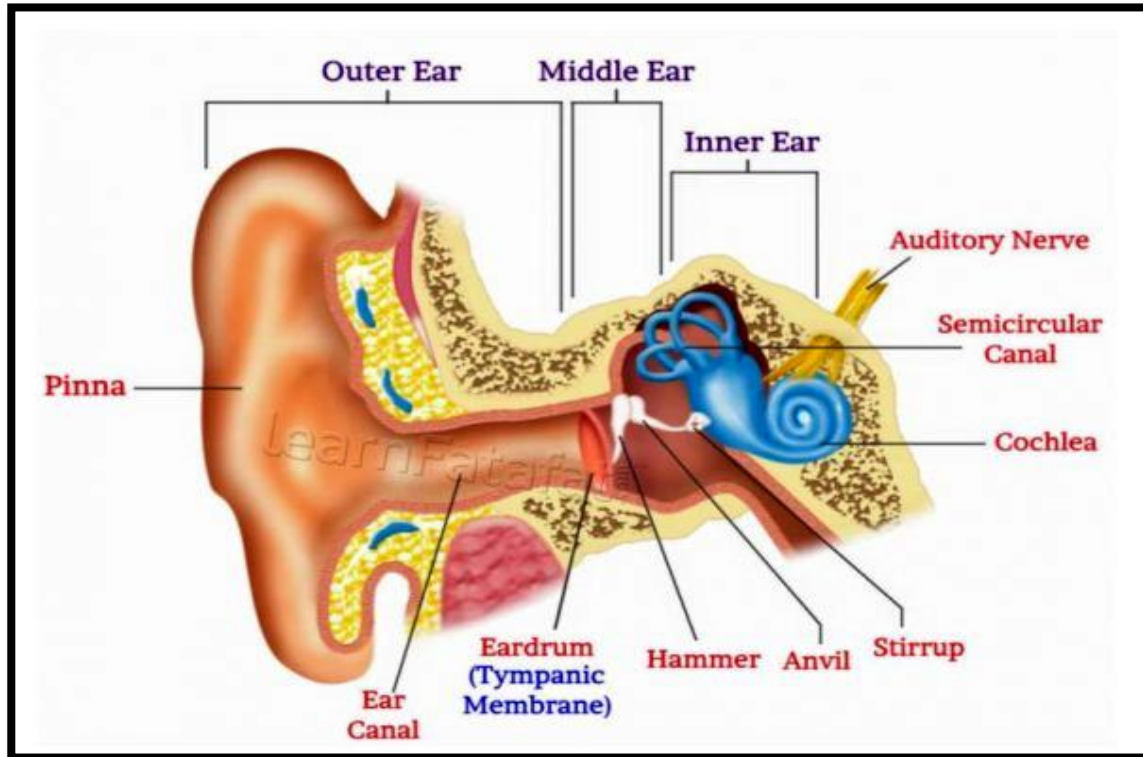
$$2 \times d = v \times t$$

# HUMAN EAR



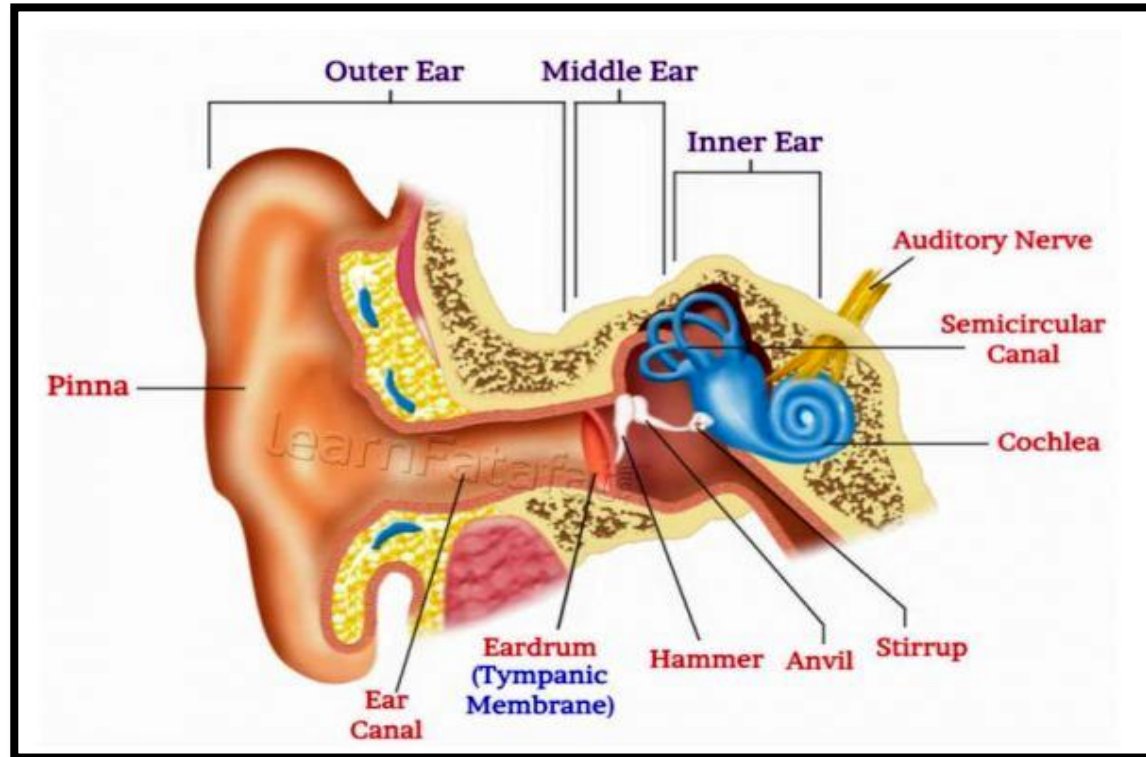
- Outer Ear : The function of the outer ear is to collect sound waves and guide them to the tympanic membrane. *(eardrum)*.  
(Pinna | Auditory or Ear Canal | Eardrum )

# HUMAN EAR



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

# HUMAN EAR



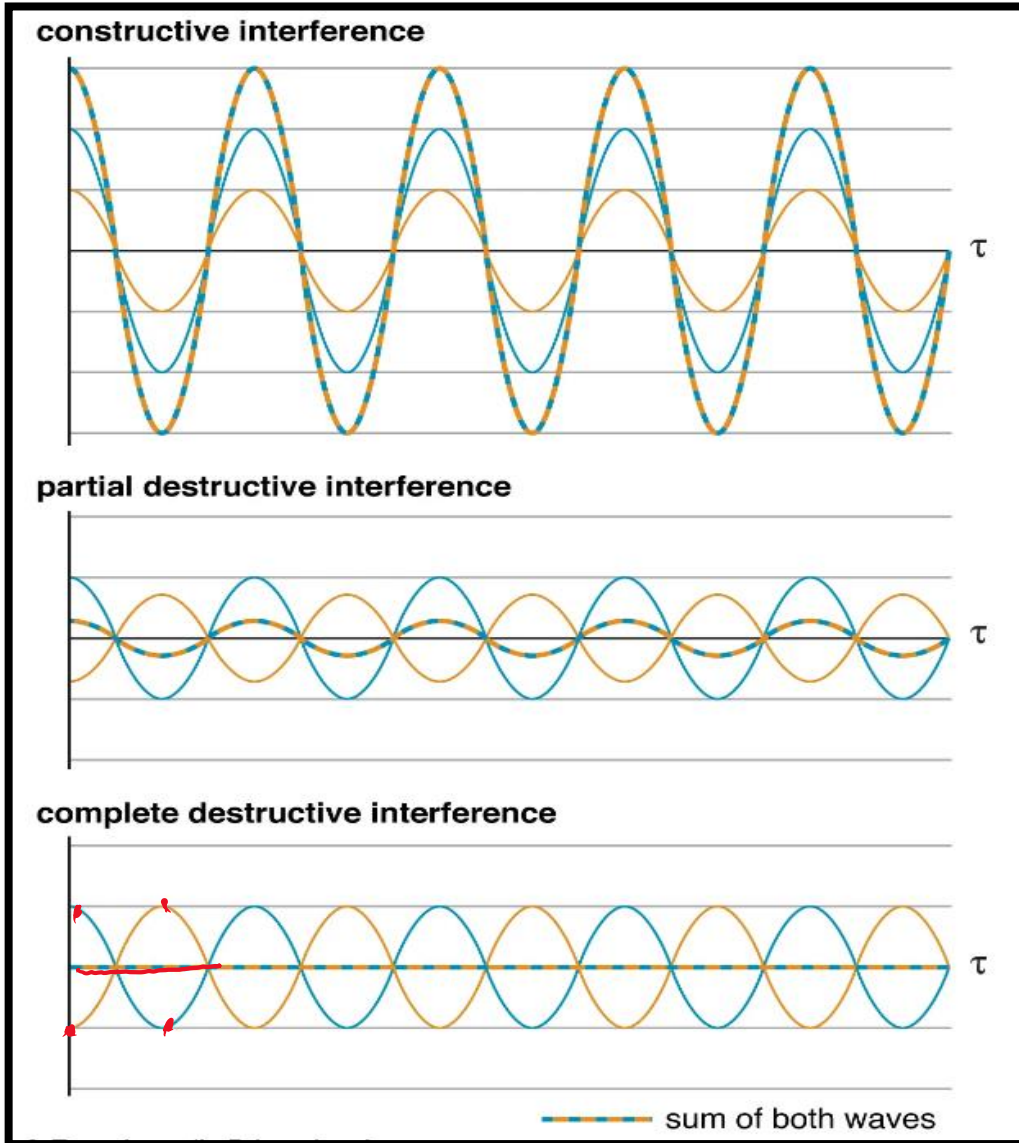
- **Inner Ear** : Converting the amplified vibrations in sound to electrical signals. These signals are then sent to brain.  
(Cochlea)

# SOME WAVE PHENOMENA

1. Reflection : A wave encounters an obstacle and bounces back.
2. Refraction : A wave bends when it enters a medium through which it has a different speed.
3. Diffraction : Waves bend when they pass around small obstacles and spread out when they pass through small openings
4. Interference : In Interference, when two waves meet, they can interfere constructively, creating a wave with larger amplitude than the original waves, or destructively, creating a wave with a smaller (or even zero) amplitude.
5. Polarisation : Making light ( its Electric Field Vectors) , vibrate in a single direction.  
(ONLY POSSIBLE IN TRANSVERSE WAVES)



# SOME WAVE PHENOMENA



(in phase) — new wave of higher amplitude,

# TERMS RELATED TO VIBRATING AIR COLUMNS / STRINGS

1. Fundamental Note : It is the sound of lowest frequency produced in fundamental note of vibration of a system.
2. Overtone : Tones having frequencies greater than the fundamental note are called overtones.
3. Harmonics : When the frequencies of overtone are integral multiples of the fundamental, then they are known as harmonics. Thus, the note of lowest frequency  $n$  is called fundamental note or first harmonics. The note of frequency  $2n$  is called second harmonic or first overtone.

# BEATS

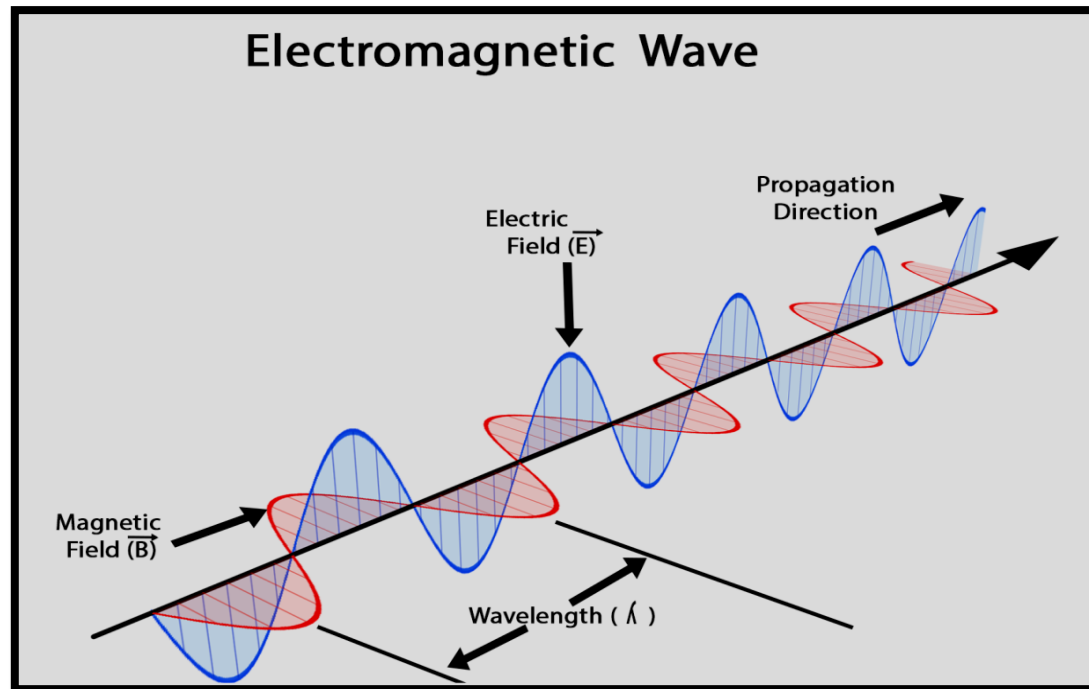
- Phenomenon based on Interference of waves.
- Beats arise when two waves having slightly different frequencies,  $\nu_1$  and  $\nu_2$  and comparable amplitudes, are superposed. The beat frequency is

$$\nu_{\text{beat}} = \nu_1 - \nu_2$$

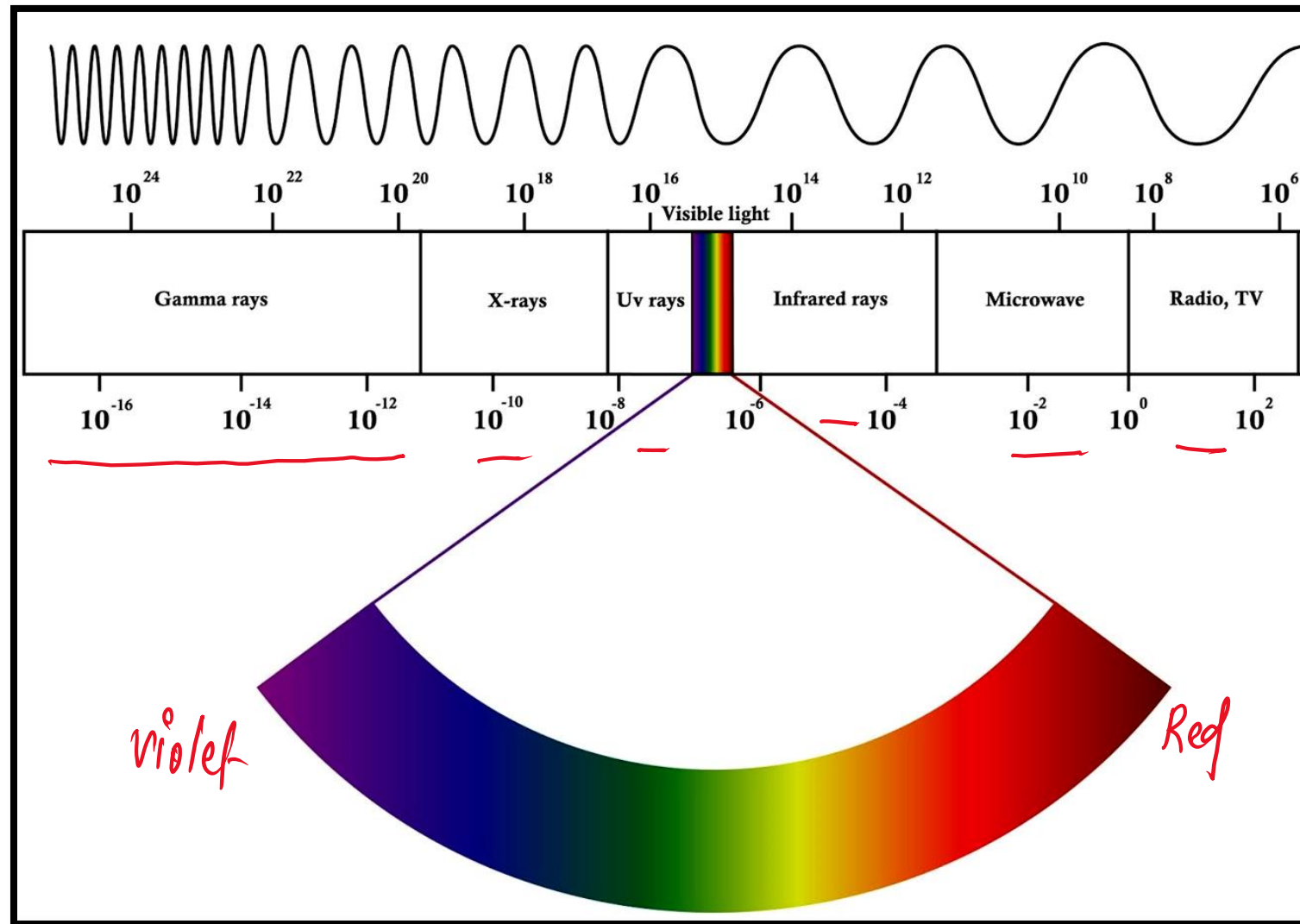
- The difference of frequencies should not be more than 10.
- Artists use this phenomenon while tuning their instruments with each other. They go on tuning until their sensitive ears do not detect any beats.

# ELECTROMAGNETIC WAVES

1. They are transverse waves and do not require a material medium for propagation.
2. They travel at the speed of light which is  $3 \times 10^8$  m/s, that is the speed of light.
3. They consist of two waves oscillating perpendicular to each other, and also perpendicular to the direction of propagation of light.



# ELECTROMAGNETIC SPECTRUM



G X U V I M R

→ increasing  $\lambda$

← increasing freq.

# SUMMARY

- **Waves and Terms Associated**
- **Sound Waves – Types and Nature**
- **Velocity of Sound and Factors affecting it**
- **Reflection of Sound**
- **Characteristics of Musical Sound**
- **Human Ear and parts**
- **Wave Phenomena**
- **Terms Related to Vibrating Air Column / Strings**
- **Electromagnetic Spectrum**



**1. Sound propagates at the maximum speed in**

- A. Solids
- B. Liquids
- C. Gases
- D. All

**1. Sound propagates at the maximum speed in**

**A. Solids**

B. Liquids

C. Gases

D. All



**2. The time taken to complete \_\_\_\_\_ number of oscillations is called Time period.**

- A. One
- B. Two
- C. Ten
- D. Hundred

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- B. Two
- C. Ten
- D. Hundred

3. Which one of the following frequency ranges is sensitive to human ears ?

(a) 0–200 Hz

(b) 20–20,000 Hz

(c) 200–20,000 Hz only

(d) 2,000–20,000 Hz only

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**Answer: B**

4. Compared to audible sound waves, ultrasound waves have
- (a) higher speed.
  - (b) higher frequency.
  - (c) longer wavelength.
  - (d) both higher speed and frequency.

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**Answer: B**

5. Which one of the following *cannot* be the unit of frequency of a sound wave ?

- ✓ (a) dB
- (b)  $s^{-1}$  ✓
- (c) Hz ✓
- (d)  $\text{min}^{-1}$  ✓

5. Which one of the following *cannot* be the unit of frequency of a sound wave ?

- (a) dB
- (b)  $s^{-1}$
- (c) Hz
- (d)  $\text{min}^{-1}$

Answer: A

$$\text{frequency} = \frac{1}{\text{Time period}}$$

$$\begin{array}{c} s^{-1} \quad / \quad \text{min}^{-1} \quad / \\ \downarrow \\ \text{(Hz)} \end{array}$$

(dB)  
Loudness  
—————→



6.

The sound created in a big hall persists because of the repeated reflections. The phenomenon is called

- (a) Reverberation.
- (b) Dispersion.
- (c) Refraction.
- (d) Diffraction.

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- (c) Refraction.
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**Answer: A**

7. Which of the following are the characteristics of electromagnetic waves ?

1. They are elastic waves.
2. They can also move in vacuum.
3. They have electric and magnetic components which are mutually perpendicular.
4. They move with a speed equal to 3 lakh meters per second.

Select the correct answer using the code given below :

- (a) 1, 2, 3 and 4
- (b) 1, 2 and 4 only
- (c) 2 and 3 only
- (d) 3 and 4 only

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- (c) 2 and 3 only
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**Answer: A**

8. The flash of lightning is seen before the thunderstorm is heard. It verifies that
- (a) sound travels much faster than light
  - (b) light travels much faster than sound
  - (c) light and sound both travel with same speed
  - (d) intensity of flash of lightning is very high during thunderstorm

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  - (b) light travels much faster than sound
  - (c) light and sound both travel with same speed
  - (d) intensity of flash of lightning is very high during thunderstorm

Answer : B

9. The part of the human ear that converts the pressure variations associated with audible sound waves to electrical signals is

(a) auditory nerve

(b) cochlea

(c) eardrum

(d) eustachian tube

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(c) eardrum

(d) eustachian tube

**Answer: B**



**10.** Which among the following is true for propagation of sound waves ?

- (a) Sound can travel in vacuum and it is a transverse wave in air.
- (b) Sound cannot travel in vacuum and it is a longitudinal wave in air.
- (c) Sound can travel in vacuum and it is a longitudinal wave in air.
- (d) Sound cannot travel in vacuum and it is a transverse wave in air.

- 10.** Which among the following is true for propagation of sound waves ?
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  - (b) Sound cannot travel in vacuum and it is a longitudinal wave in air.
  - (c) Sound can travel in vacuum and it is a longitudinal wave in air.
  - (d) Sound cannot travel in vacuum and it is a transverse wave in air.

**Answer: B**

- 11.** 'Beats' is a phenomenon that occurs when frequencies of two harmonic waves are
- (a) equal.
  - (b) far apart.
  - (c) multiples of each other.
  - (d) nearly same.

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- (a) equal.
  - (b) far apart.
  - (c) multiples of each other.
  - (d) nearly same.

**Answer: D**

**12.**

A sound wave has a frequency of 1 kHz and wavelength 50 cm. How long will it take to travel 1 km?

(a) 5 s

(b) 4 s

(c) 3 s

(d) 2 s

12.

A sound wave has a frequency of 1 kHz and wavelength 50 cm. How long will it take to travel 1 km?

(a) 5 s

(b) 4 s

(c) 3 s

(d) 2 s

Answer: D

- 13.** SONAR is a device that is used to measure the distance of underwater objects by a ship. Which of the following types of waves does it use for this purpose?
- (a) Infrasonic waves
  - (b) Sound waves in audible range for human beings
  - (c) Ultrasonic waves
  - (d) All of the above

- 13.** SONAR is a device that is used to measure the distance of underwater objects by a ship. Which of the following types of waves does it use for this purpose?
- (a) Infrasonic waves
  - (b) Sound waves in audible range for human beings
  - (c) Ultrasonic waves
  - (d) All of the above

**Answer: C**



14.

Which one of the following statements about the speed of sound waves is **not** correct?

- (a) The speed of sound waves in steel is higher than that in water.
- (b) The speed of sound waves in air decreases with increase in temperature.
- (c) The speed of sound waves in air increases with increase in temperature.
- (d) The speed of sound waves in water is higher than that in air.

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Which one of the following statements about the speed of sound waves is *not* correct?

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- (c) The speed of sound waves in air increases with increase in temperature.
- (d) The speed of sound waves in water is higher than that in air.

Answer: B

**15.** Which one of the following types of radiations has the smallest wavelength ?

- (a) Microwaves
- (b) Infra-red
- (c) Visible light
- (d) X-rays

15. Which one of the following types of radiations has the smallest wavelength ?
- (a) Microwaves
  - (b) Infra-red
  - (c) Visible light
  - (d) X-rays

**Answer: D**

16. The sound above \_\_\_\_\_ is physically painful.

- A. 10 dB
- B. 20 dB
- C. 60 dB
- D. 80 dB

16. The sound above \_\_\_\_\_ is physically painful.

A. 10 dB

B. 20 dB

C. 60 dB

**D. 80 dB**

17. Which one of the following optical phenomena supports that the light is a transverse wave?
- (a) Refraction
  - (b) Diffraction
  - (c) Interference
  - (d) Polarization

17. Which one of the following optical phenomena supports that the light is a transverse wave?
- (a) Refraction
  - (b) Diffraction
  - (c) Interference
  - (d) Polarization

**Answer: D**



**18. In electromagnetic waves , angle between electric and magnetic field vectors is**

- A.  $180^\circ$
- B.  $0^\circ$
- C.  $90^\circ$
- D. None of these

**18. In electromagnetic waves , angle between electric and magnetic field vectors is**

- A.  $180^\circ$
- B.  $0^\circ$
- C.  $90^\circ$**
- D. None of these

**19.**

Which one of the following statements is true for sound waves propagating in air?

- (a) Sound is an electromagnetic wave and transverse in nature
- (b) Sound is a mechanical wave and longitudinal in nature
- (c) Sound is a mechanical wave and transverse in nature
- (d) Sound is an electromagnetic wave and longitudinal in nature

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Which one of the following statements is true for sound waves propagating in air?

- (a) Sound is an electromagnetic wave and transverse in nature
- (b) Sound is a mechanical wave and longitudinal in nature
- (c) Sound is a mechanical wave and transverse in nature
- (d) Sound is an electromagnetic wave and longitudinal in nature

Answer: B

## NDA & CDS 2 2024 PHYSICS - LIVE CLASS - 5

**20.** Which of the following statements about electromagnetic waves, sound waves and water waves is/are correct ?

1. They exhibit reflection
2. They carry energy
3. They exert pressure
4. They can travel in vacuum

Select the correct answer using the code given below :

- 
- (a) 1, 2 and 3
- (b) 2 and 4
- (c) 1 and 3 only
- (d) 1 only

## NDA & CDS 2 2024 PHYSICS - LIVE CLASS - 5

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Select the correct answer using the code given below :

- 
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**Answer : A**

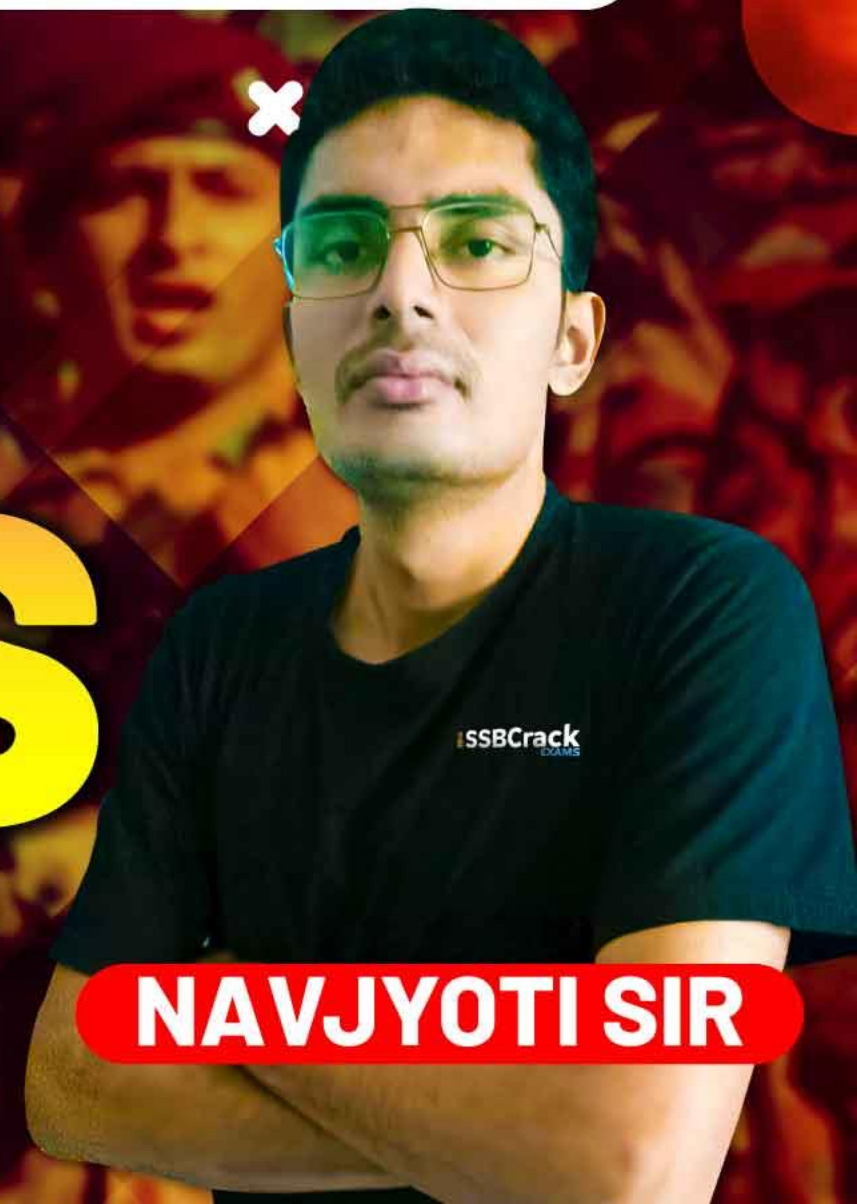
# NDA-CDS 2 2024

# GS

LIVE

# PHYSICS

CLASS 6



NAVJYOTI SIR