Chapter # 08 (Waves) pakcity.org

Important Short Questions

1. Differentiate between mechanical waves and electromagnetic waves.

Ans:

Mechanical Waves	Electromagnetic Waves
• Waves which require any medium for their propagation are called mechanical waves. • For example, Water waves, Sound waves.	• Waves which do not require any medium for their propagation are called electromagnetic waves. • For example, Radio waves, Television waves.

2. Differentiate between longitudinal waves and transverse waves.

Ans:

Longitudinal waves	Transverse waves
• The waves in which the particles of the medium move back and forth along the direction of propagation of wave is called the longitudinal waves. • For example, Sound waves, Waves produced in slinky.	• The waves in which the vibratory motion of particles of the medium is perpendicular to the direction of waves is called transverse waves • For example, Water waves, string waves and waves produced in slinky.

3. Why did Newton's fail to calculate the velocity of sound accurately?

Ans: Newton's failed to calculate the speed of sound accurately.

Reason:

Newtons assumed that it is **isothermal process**. The temperature of the air during a compression or refraction remains constant but the temperature of air does not remain constant. As it is an **adiabatic process.**

4. What are the effects of pressure and density on speed of sound?

Ans: Effect of Pressure:

There is no effect of pressure on speed of sound.

Reason:

As we know that,

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

Since density is directly proportional to the pressure. When pressure of gas is increases, density of gas also increases, so the speed of sound remains same.

Effect of density:

At constant pressure and temperature having same value of γ, the speed of sound is inversely proportional to the square root of their densities.

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

$$v = \sqrt{\gamma P} \times \frac{1}{\sqrt{\rho}}$$

$$v = \text{constant } \frac{1}{\sqrt{\rho}}$$

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

Example:

The speed of sound in hydrogen is **four times** to its speed of sound in oxygen because density of oxygen is **sixteen times** as that of hydrogen.

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5. Why sound travel faster in hydrogen than in oxygen?

Ans: Sound travel faster in hydrogen than in oxygen.

Reason:

The speed of sound in hydrogen is **four times** to its speed of sound in oxygen because density of oxygen is **sixteen times** as that of hydrogen.

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6. What is effect of temperature on the speed of sound?

Ans: Effect of temperature:

The speed of sound increases by increasing the temperature of gas. When a gas is heated at constant pressure then density is increased.

Reason:

As we know that,

$$V_t = V_o + 0.61t$$

This equation shows that with one-degree Celsius rise in temperature, the speed of sound is increased by 0.61 ms^{-1}.

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7. State the principle of super position. What are its different cases?

Ans: Principle of Super Position:

If a particle of medium is simultaneously acted upon by a number of waves then the resultant displacement of the particle is the algebraic sum of their individual displacements, this is called superposition principle.

$$y = y_1 + y_2 + y_3 + \dots\dots\dots\dots + y_n$$

Different cases:

- Two waves having **same frequency** and travelling in the **same direction** produce the phenomenon of interference.
- Two waves of **slightly different frequencies** and travelling in the **same direction** produces beats.
- Two waves of **same frequency** travelling in **opposite direction** produce stationary waves.

8. Define interference. What is constructive and destructive interference?

Ans: Interference:

When two identical waves meet each other in a medium then at some points they reinforce each other effect and at some points they cancel the effect of each other. This phenomenon is called interference.

(i) Constructive interference:

When two identical waves meet each other in a medium then at some points they reinforce each other effects and resultant amplitude becomes maximum. This phenomenon is called interference.

Condition for constructive interference:

Whenever path difference is an integral multiple of wavelength, displacements of two waves are added up. This effect is called constructive interference.

$\Delta S = n\lambda$ Where n = 0, ±1, ±2, ±3, ±4 , ……..

(ii) Destructive interference:

When two identical waves meet each other in a medium then at some points they cancel each other effects and resultant amplitude becomes minimum. This phenomenon is called interference.

Condition for destructive interference:

Whenever path difference is an integral multiple of $\frac{\lambda}{2}$, displacements of two waves cancel each other effects. This effect is called constructive interference.

$\Delta S = (2n+1)\frac{\lambda}{2} n\lambda$ Where n = 0, ±1, ±2, ±3, ±4 , ……..

$$\Delta S = \left(n+\frac{1}{2}\right)\lambda$$

9. What is path difference? What should be the path difference for construction and destructive interference?

Ans: Path Difference:

The distance between the starting point of two waves.

- If both waves start from the same point, then the path difference is equal to zero.
- If one wave starts to move at one point and other wave start to move from another point. Then the distance between these points is called path difference.

(i) Condition for constructive interference:

Whenever path difference is an integral multiple of wavelength, displacements of two waves are added up. This effect is called constructive interference.

$\Delta S = n\lambda$ Where n = 0, ±1, ±2, ±3, ±4 , ……..

(ii) Condition for constructive interference:

Whenever path difference is an integral multiple of wavelength, displacements of two waves cancel each other effects. This effect is called constructive interference.

$\Delta S = (2n+1)\frac{\lambda}{2} n\lambda$ Where n = 0, ±1, ±2, ±3, ±4 , ……..

$$\Delta S = \left(n + \frac{1}{2}\right)\lambda$$

10. What are beats? Write its formula and uses.

Ans: Beats:

When two waves of slightly different frequencies, travelling in the same direction overlap each other then there is a periodic variation of sound between maximum and minimum loudness called beats.

Beats frequency:

Number of beats per second is equal to the difference between frequencies of turning forks.

$$f_A - f_B = \pm n$$

Uses of beats:

Beats are used:

- Tune a string instrument such as piano or violin by beating a note against a note of known frequency.
- Find unknown frequency of vibrating body.
- Produce variety in music.

11. What is effect on phase of a wave when it is reflected from
(i) rare medium (ii) denser medium

Ans: Denser Medium:

If a transverse wave travelling in a rare medium is incident on a denser medium, it is reflected such that it undergoes a phase change of 180^0 (Path difference of $\lambda/2$).

Rare Medium:

If a transverse wave travelling in a denser medium is incident on a rare medium, it is reflected without any change in phase (no path difference).

12. What are stationary waves? How are they produced?

Ans: Stationary Wave:

The resultant wave produced by the superposition of two identical waves travelling in opposite direction is called stationary wave.

Production of Stationary Waves:

Two waves of **same frequency** travelling in **opposite direction** produce stationary waves.

13. On what factors does the fundamental frequency in a stretched string depends?

Ans: As we know that,

$$f = \frac{1}{2l}\sqrt{\frac{F}{m}}$$

Fundamental frequency in a stretched string depends upon:

- Length of string. (l)
- Tension in the string. (F)
- Mass of string per unit length. (m)

14. Which is richer in harmonics? An open organ pipe or a closed organ pipe?

Ans: Open organ pipe is richer in harmonics than a closed organ pipe.

Mathematically,

For organ pipe that is open at both ends:

$$f_n = \frac{nv}{2l}, \qquad n = 1, 2, 3, \ldots.$$

For a closed organ pipe,

$$f_n = \frac{nv}{4l}, \qquad n = 1, 3, 5, \ldots.$$

Open organ pipes due to open ends produce sounds of high frequencies (rich harmonic).

15. Define Doppler's effect. Give its example.

Ans: Doppler's Effect:

The apparent change in the frequency (Pitch) of waves due to the relative motion between the source and observer is called Doppler's effect.

Example:

- The pitch of whistle of an engine coming **towards** the platform appears to become **higher** to an observer standing on the platform.
- The pitch of whistle of an engine coming **away** the platform appears to become **slow** to an observer standing on the platform.

16. Define Doppler shift. Write down its formula.

Ans: Doppler's Shift:

The apparent change (increase or decrease) in wavelength of sound eave in one second is called Doppler's shift.

$$\Delta\lambda = \frac{u_s}{f}$$

17. What do you mean by red shift and blue shift?

Ans: Red Shift:

The frequency of light emitted by star **decreases (wavelength increases)** if it is moving **away** the Earth. Thus spectrum is shifted towards the **longer wavelength** i.e, towards the red end of the spectrum, which is called **red shift**.

Blue Shift:

The frequency of light emitted by star **increases (wavelength decreases)** if it is moving **towards** the Earth. Thus spectrum is shifted towards the **shorter wavelength** i.e, towards the blue end of the spectrum, which is called **blue shift**.

18. Write the applications of Doppler's effect.

Ans: Applications of Doppler's Effect:

Doppler's effect is used in:

- Radar System.
- Speed of Satellite.
- SONAR (Sound and Navigation and Ranging)
- Speed of Star.
- Speed of Car.

Exercise Short Questions

1. What features do longitudinal waves have common with transverse waves?

Ans: Common Features:

- Both types of waves **transport energy**.
- Both types of waves can produce **interference, diffraction, refraction** and **reflection**.
- For determination of **speed of wave**, $v = f\lambda$ is applicable for both waves.

2. The five possible waveforms obtained, When the output form from a microphone is fed into the Y-input of cathode ray of oscilloscope, with the times base on, are shown in fig. These waveforms obtained under the same adjustment of the cathode ray of oscilloscope controls. Indicate the waveform.

(a) Which trace represents the loudest note?
(b) Which trace represents the highest frequency?

Ans: Loudest Note:

In fig (d), the **amplitude** is **maximum**, so **loudness** is **maximum** for this case.

Maximum frequency:

In fig (b), the **number of waves** is **maximum**, so **frequency** is **maximum** in this case.

3. is it possible for two identical waves travelling in the same direction along a string to give rise to a stationary wave?

Ans: No, it is not possible.

Reason:

Stationary waves are produced only when **two identical waves** travelling in **opposite direction** along the same string superpose.

4. A wave is produced along the stretched string but some of its particles permanently show zero displacement. What type of wave is it?

Ans: These waves are stationary waves.

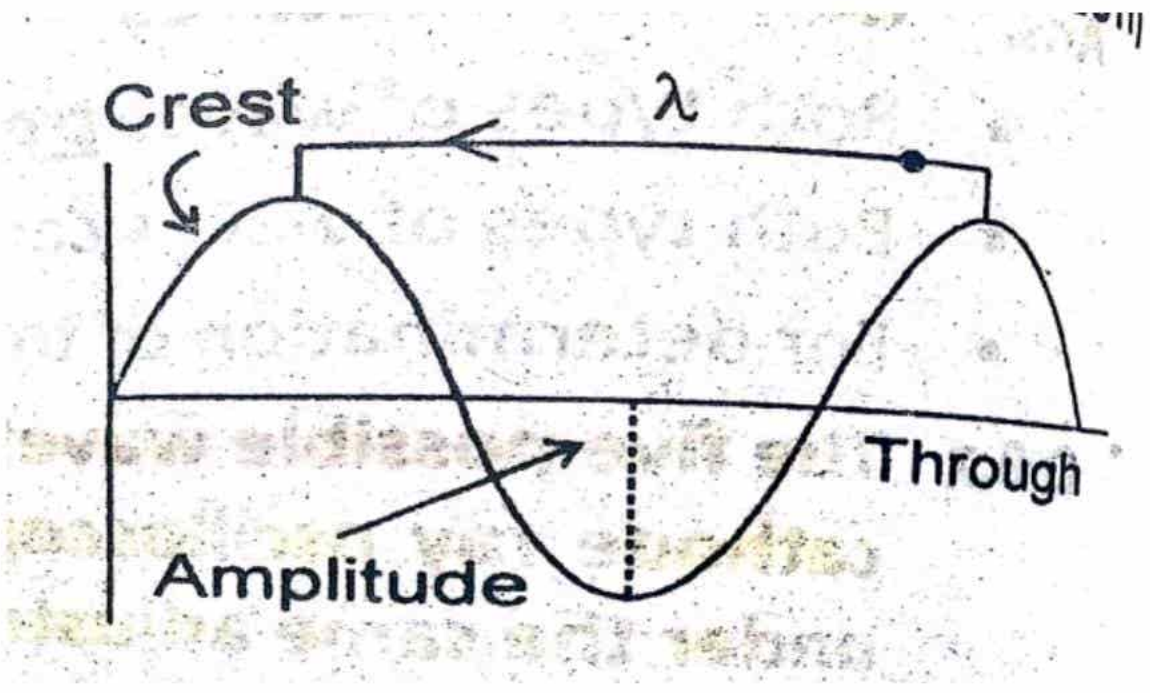
Reason:

Only in stationary waves some points show permanently **zero displacement** called **Nodes** and some points show, **maximum displacement** called **antinode**.

5. Explain the terms, crest, node and antinode.

Ans: Crest:

"The portion of the transverse wave **above** the mean position is called crest."

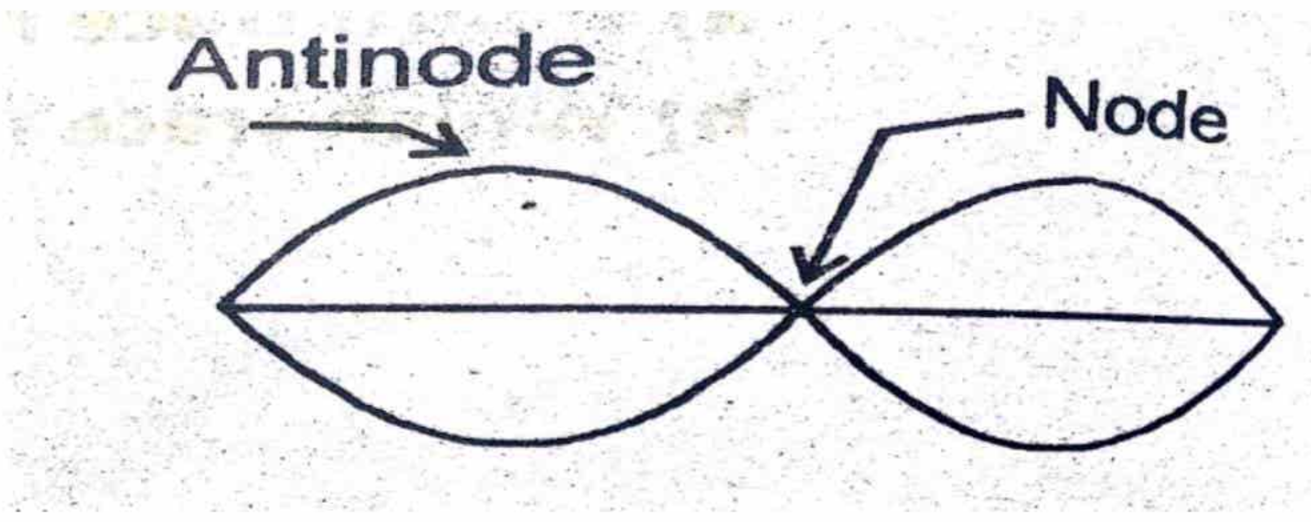


Trough:

"The portion of the transverse wave **below** the mean position is called trough."

Node:

"The points on the stationary wave which show **zero displacement** permanently are called nodes."



Antinode:

"The points on the stationary wave which show **maximum displacement** permanently are called antinodes."

6. Why does sound travel faster in solids than in gases?

Ans: Sound travels faster in solids than in gases.

Reason:

Speed of sound in given as

$$v = \sqrt{\frac{E}{\rho}}$$

Where E is modulus of elasticity ands density of medium. Although the density of solid is greater than ρ density of gases but modulus of elasticity for solids is much greater than for gases. So

$$\sqrt{\frac{E_{solid}}{\rho_{Solid}}} > \sqrt{\frac{E_{gas}}{\rho_{gas}}}$$

Hence, sound travel faster in solids than in gases.

7. How are beats useful in tuning musical instrument?

Ans: Tuning of Musical Instrument:

In order to tune a musical instrument, sound the instrument against the note of known frequency. If the two frequencies do not match, beats will be produced. Adjust the frequency of the unturned instrument by **tightening or loosening** the string. When **no beats** are heard, the instrument is said to be tuned.

8. When two notes of frequencies f_1 and f_2 are sounded together, beats are formed. If $f_1 > f_2$, what will be the frequency of beats?

(i) $f_1 + f_2$ **ii)** $\frac{1}{2}(f_1 + f_2)$

(iii) $f_1 - f_2$ **iv)** $\frac{1}{2}(f_1 - f_2)$

Ans: Since beat frequency is equal to the difference of individual interfering frequencies.

Beat frequency = $f_1 - f_2$

9. As a result of a distant explosion, an observer senses a ground tremor and then hears the explosion. Explain the time difference.

Ans: The observer senses the ground tremor first and then hears the explosion.

Reason:

The speed of sound is give as

$$v = \sqrt{\frac{E}{\rho}}$$

Since the **speed** of sound in **solids (earth)** is **much greater** than the speed of sound in **gases (air)** due to **much greater** value of **elastic modulus**. That is why the observer senses the ground tremor and then hears the sound of explosion.

10. Explain why sound travels faster in warm air than in cold air.

Ans: Sound always travel faster in warm air then in cold air.

Reason:

The speed of sound is given as

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

Since, gases expand on heating. So, the **density** of warm air **decreases**. Hence, according to above equation, the speed of sound will be greater in warm air than in cold air.

11. How should a sound move with respect to an observer so that frequency of its sound does not change?

Ans: If the **relative velocity** between the source and observer is **zero**, there will be no change in frequency of sound.

Examples:

(a) When the observer is at origin and source moves along the circumference of the circle then their distance remains the same and the frequency of sound does not change.

(b) **Source** and **observer** are moving in **same direction** with **same velocity**.