14 WAVES

1 OMQ+1 VSAQ + 1 SAQ [1M+2M + 4M = 7M]

CONCEPTS & DEFINITIONS

1. A **wave** represents a disturbance that moves in a medium or space.
2. Vibrations of particles produce **Mechanical waves** and they require a medium to propagate.
3. The changes in electric field in space produce **Electromagnetic waves** and they do not require any medium to propagate.
4. Waves in which the particles of the medium vibrate in perpendicular to the direction of wave propagation are called **transverse waves.**
5. Waves in which the particles of the medium vibrate along the direction of wave propagation are called **longitudinal waves.**
6. $y = A \sin (kx - \omega t + \phi)$ represents a progressive wave along +ve x-direction.
7. $y = A\sin (kx + \omega t + \phi)$ represents a progressive wave along –ve x-direction.
8. Amplitude $A = y_{max}$
9. Angular wave number $k = \frac{2\pi}{\lambda}$ where λ is wavelength.
10. Angular frequency $\omega = 2\pi\nu$
11. Phase gives the position and direction of motion of the particle in wave motion.
12. Distance between two successive points of same phase is called **wavelength (λ).**
13. Phase difference between two points separated by one wavelength is 2π radians.
14. Phase difference between two points $\Delta\phi$ separated by distance Δx is given by $\Delta\phi = \frac{2\pi}{\lambda}(\Delta x)$
15. The number of waves per second or number of oscillations per second is called **frequency (ν).**
16. The time taken by a particle in wave motion to complete one oscillation is called **period (T).**
17. Relation between frequency & period $\nu = \frac{1}{T}$
18. Speed of a progressive wave $V = \nu\lambda$ (or) $V = \frac{\lambda}{T}$ (or) $V = \frac{\omega}{k}$
19. Speed of transverse wave in a stretched string $V = \sqrt{\frac{T}{\mu}}$ where T = tension and μ = linear density.

20. Mass per unit length is linear density. Linear density of a string $\mu = \frac{M}{L} = \frac{m}{l}$ or $\mu = A\rho = \pi r^2 \rho$ where A is area of cross section of the given wire, r is its radius and ρ is density.

21. Speed of longitudinal wave in a liquid $V = \sqrt{\frac{B}{\rho}}$ where B = Bulk modulus of given liquid and ρ = density of liquid

22. Speed of longitudinal wave in a solid $V = \sqrt{\frac{Y}{\rho}}$ where Y = Young's modulus of given solid ρ = density of solid

23. According to Laplace speed of longitudinal wave in a gas $V = \sqrt{\frac{\gamma P}{\rho}}$ where P = pressure, ρ = density and γ = ratio between specific heats(specific ratio)

24. Principle of superposition $\vec{y} = \vec{y}_1 + \vec{y}_2 + \vec{y}_3 + ...$

25. A wave reflects at closed end with a phase difference of π radians (180º).

26. A wave reflects at open end with same phase. (i.e., 2π radians or 360º).

27. The resultant wave formed due to super position of two progressive waves travelling in opposite directions is called standing or **stationary wave**.

28. Amplitude at node $A_N = A_1 - A_2$

29. Amplitude at antinode $A_{AN} = A_1 + A_2$

30. Always nodes are formed at closed ends (rigid boundaries).

31. Always antinodes are formed at open ends (free boundaries).

32. Distance between two successive nodes or antinodes is $\frac{\lambda}{2}$.

33. Distance between a node and its adjacent antinode is $\frac{\lambda}{4}$.

34. When a **stretched string** is vibrating in fundamental mode, length of the string $l = \frac{\lambda}{2}$

fundamental frequency(first harmonic) $\nu_1 = \frac{V}{2l}$ or $\nu_1 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

x^{th} harmonic frequency $\nu_x = x\nu_1 = \frac{x}{2l}\sqrt{\frac{T}{\mu}}$ where, x = 1, 2, 3.....

35. When an **open pipe** is in fundamental mode of vibration, length of the open pipe $l = \frac{\lambda}{2}$

fundamental frequency $\nu_1 = \frac{V}{2l}$

x^{th} harmonic frequency $\nu_x = x\nu_1$ where, x = 1, 2, 3.....

36. When a **closed pipe** is in fundamental mode of vibration, length of the closed pipe $l = \frac{\lambda}{4}$

fundamental frequency $\nu_1 = \frac{V}{4l}$

x^{th} harmonic frequency $\nu_x = (2x-1)\nu_1$ where, x = 1, 2, 3.....

37. The phenomenon in which waxing and waning of sound at regular intervals is heard is called **beats**.

Number of beats/second is called beat frequency.

$\nu_{beat} = \nu_1 \sim \nu_2$

The time interval between two successive beats is called beat period.Beat period $T = \frac{1}{\nu_1 \sim \nu_2}$

38. If a tuning fork is loaded with wax, its frequency decreases.

39. If a tuning fork is filed, its frequency increases.