

WAVE MOTION**I. Formulae in this chapter: -**

1. The velocity of sound wave $v = n\lambda$ where n is frequency and λ is wavelength.

2. Equation of plane progressive wave

$$y = A \sin(\omega t \pm \phi)$$

$$(i) y = A \sin \frac{2\pi}{\lambda} (vt \pm x)$$

$$(ii) y = A \sin \frac{2\pi}{\lambda} \left(\frac{t}{T} \pm \frac{x}{\lambda} \right)$$

y - displacement x - position at time t

A - amplitude v - velocity of wave

λ - wavelength T - time period

3. Maximum Particle velocity $v = A\omega$

A - amplitude, ω - angular velocity

ϕ - phase difference $\phi = kx$

4. Propagation constant $K = \frac{2\pi}{\lambda}$

5. $v = \frac{\lambda}{T}$ (T - time period)

6. Velocity of transverse wave in stretched

string $v = \sqrt{\frac{T}{m}}$, T - tension in string

m - mass per unit length or linear density

7. Frequency of string in one loop =

$$\text{fundamental frequency } n = \frac{1}{2l} \sqrt{\frac{T}{m}}$$

l - length of string

8. For p loops frequency $n_1 = \frac{p}{2l} \sqrt{\frac{T}{m}}$

$n_2 = p \times n$

9. Over tone = harmonic + 1

10. $n \propto \sqrt{T}$ if l, m are constants $\frac{n_1}{n_2} = \sqrt{\frac{T_1}{T_2}}$

11. $n \propto \frac{1}{\sqrt{m}}$ if T, l are constants $\frac{n_1}{n_2} = \sqrt{\frac{m_2}{m_1}}$

12. $n_1 l_1 = n_2 l_2$ if T, m are constants.

13. Beat frequency = difference in frequencies
= $n_1 - n_2$

II. Doppler effect: -

1. General formula for apparent frequency :

$$n' = \left(\frac{V \pm W \pm V_o}{V \pm W \pm V_s} \right) n$$

Here n - Original frequency of sound

V - Velocity of sound in air

W - Velocity of wind

V_o - Velocity of the observer

V_s - Velocity of source of sound

2. Sign convention

(i) Source moving towards observer = $(-V_s)$

(ii) Source moving away = $(+V_s)$

(iii) Observer moving towards source = $(+V_o)$

(iv) Observer moving away = $(-V_o)$

(v) If air moves in direction of sound $(V+W)$

(vi) If air moves in opposite direction $(V-W)$

3. Source moving towards stationary observer

$$(V_o = 0), n' = \left(\frac{V}{V - V_s} \right) n$$

4. Source moving away from stationary observer

$$(V_o = 0), n' = \left(\frac{V}{V + V_s} \right) n$$

5. Observer moving towards stationary source

$$(V_s = 0), n' = \left(\frac{V + V_o}{V} \right) n$$

6. Observer moving away from stationary

$$\text{source } (V_s = 0), n' = \left(\frac{V - V_o}{V} \right) n$$

7. Source and observer moving towards each other V_s, V_o

$$n' = \left(\frac{V + V_o}{V - V_s} \right) n$$

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