Wave :-

- Transverse wave eqn. :-

$$\boxed{y = A \sin(\omega t - Kx + \phi)}$$

$$\boxed{\frac{\omega}{K} = f\lambda = V}$$

wave ~~Angular~~ Speed

$$\boxed{\text{Angular Wave No.} = K = \frac{2\pi}{\lambda}}$$

$$\boxed{V_p = \omega\sqrt{A^2 - y^2}}$$

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda}\Delta x}$$

$\Delta\phi \rightarrow$ Phase difference

$\Delta x \rightarrow$ path diff.

$$\boxed{a_p = -\omega^2 y}$$

General Eqn. of Wave

$$\boxed{\left(\frac{\partial^2 y}{\partial t^2}\right)_x = v^2\left(\frac{\partial^2 y}{\partial x^2}\right)_t}$$

Note:- 1.) Phase diff. b/w two such points whose speeds always remains equal?

$\boxed{\Delta x = \frac{\lambda}{2}}$, $\boxed{\Delta\phi = \pi}$

2.) Phase diff. b/w two such points whose velocity always remains equal?

ESTIMATE $\boxed{\Delta x = \lambda}$ $\boxed{\Delta\phi = 2\pi}$

Wave Speed

- **Wave on a String :-**

$$\boxed{v = \sqrt{\frac{T}{\mu}}}$$

$T \rightarrow$ Tension

$\mu \rightarrow$ Linear mass density (Mass per unit length)

If s be cross-section area of rod :-

$$\boxed{v = \sqrt{\frac{T}{\rho s}}}$$

Also,

$$\boxed{v = \sqrt{\frac{Y}{\rho}}}$$

Y → Young's Modulus

- **Sound Waves :**

$$\boxed{v = \sqrt{\frac{B}{\rho}}}$$

$B \rightarrow$ Bulk Modulus

$\rho \rightarrow$ density

Laplace's Correction → (Process Adiabatic)

$$\boxed{v = \sqrt{\frac{\gamma P}{\rho}}} \qquad \boxed{v = \sqrt{\frac{\gamma R T_{(\text{K})}}{M}}}$$

Effect of pressure on speed of sound

v is fixed

Effect of Temp. on speed of sound

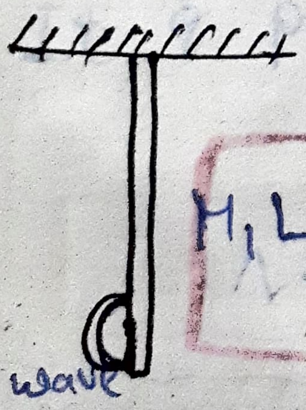
$$\boxed{\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}}$$

Effect of Humidity :-

$$\boxed{M_{dry\ air} > M_{humid\ air}}$$

∴ On increasing humidity

$\boxed{\text{velocity} \uparrow}$



H, L, Time taken by wave to reach the top

$$\boxed{T = 2\sqrt{\frac{l}{g}}}$$

$$P_{avg.} = \frac{1}{2}\mu A^2\omega^2 v$$

Intensity :- $I = \frac{1}{2}\rho A^2\omega^2 v$

Loudness of Sound Wave

$$\beta = 10\log_{10}\frac{I}{I_0}$$

$I_0 = 10^{-12}$

$I = \frac{P}{A}$

Interference

$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$$\tan\delta = \frac{A_2\sin\phi}{A_1 + A_2\cos\phi}$$

Intensity

$$I \propto A^2$$

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

Constructive Interference

$$\phi = 2n\pi \quad \Delta x = n\lambda$$

$$A_{max} = A_1 + A_2 \quad I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$$

Destructive Interference

$$\phi = (2n-1)\pi \;, \quad \Delta x = (2n-1)\frac{\lambda}{2}$$

$$A_{min} = |A_1 - A_2| \quad I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$$

$$\frac{I_{max}}{I_{min}} = \frac{(\sqrt{I_1} + \sqrt{I_2})^2}{(\sqrt{I_1} - \sqrt{I_2})^2}$$

Reflecting Waves

$$I_i = I_r + I_t$$

$$\frac{I_i}{I_r} = \frac{A_i^2}{A_r^2}$$

$$A_r = \left(\frac{V_2 - V_1}{V_1 + V_2}\right) A_i$$

$$A_t = \frac{2V_2 A_i}{V_1 + V_2}$$

ESTIMATE

Standing waves

$$\boxed{y = 2A \sin \omega t \cos kx}$$

Nodes :- Amplitude = 0

$$\boxed{x = (2n-1)\frac{\lambda}{4}} \quad \left\{\frac{\lambda}{4}, \frac{3\lambda}{4} \text{ --- }\right\}$$

Antinodes :- Maxi. Amplitude

$$\boxed{x = \frac{n\lambda}{2}} \quad 0, \frac{\lambda}{2}, \lambda$$

Total Energy in Standing Wave

$$\boxed{T.E. = \frac{1}{2}\lambda \mu A^2 \omega^2}$$

Amp. of the wave which forms standing waves

Application

1) In open organ pipe :-

fundamental frequency (f_0)

↓

Minimum frequency

$$\boxed{f_0 = \frac{v}{\lambda} = \frac{v}{2L}}$$

1st Overtones :-

$$\boxed{\text{No. of loops} = n+1}$$

$$\boxed{f_{n\text{th overtone}} = (n+1)\text{th harmonic} = (n+1) f_0}$$

2) In closed organ pipe

$$\boxed{f_0 = \frac{v}{4L}}$$

$$\boxed{f_{n\text{th overtone}} = (2n+1) f_0 = \frac{(2n+1)v}{4L}}$$

Sonometer Wire

$$\boxed{f_{n\text{th overtone}} = \frac{(n+1)}{2L}\sqrt{\frac{Mg}{\mu}}}$$

ESTIMATE

End Correction

(i) In open pipe:

$$\boxed{L_{eff} = L + 2e}$$

(ii) In closed pipe:

$$\boxed{L_{eff} = L + e}$$

Resonance Tube Column

$$\boxed{e = \frac{L_2 - 3L_1}{2}}$$

$$\boxed{v = 2f(L_2 - L_1)}$$

$$\boxed{v = 2f(L_{n+1} - L_n)}$$

Beats:

$$\boxed{\text{Beat period} = \frac{1}{|f_1 - f_2|}}$$

Beat Frequency

Beat frequency $= |f_1 - f_2|$

Tuning Fork

Tuning Fork $\xrightarrow[\text{Putting weight}]{\text{Waxing}}$ [Frequency decrease]

Tuning Fork $\xrightarrow[\text{Filing}]{\text{Wanning}}$ [Frequency Increase]

Doppler Effect

$$f' = f_0\left[\frac{V - V_{o/w}}{V - V_{s/w}}\right]$$

vel. of observer w.r.t wind,

freq. heard

Original frequ.

Speed of sound

Velocity of source w.r.t wind

Direction of from source to Observer is taken positive