SOUND

① Relation Between v, n & λ

$$\boxed{v = n\lambda} \qquad n = \frac{1}{T}$$

② Speed of Transverse waves:

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

- $T \rightarrow$ Tension in the string
- $m \rightarrow$ linear mass density
- $m = M/L$

③ Velocity of longitudinal wave:

i) $v = \sqrt{\frac{Y}{\rho}}$ (In solid)

$Y \rightarrow$ Young's modulus.

ii) $v = \sqrt{\frac{\beta}{\rho}}$ (In liquid)

$\beta \rightarrow$ Bulk modulus

iii) $v = \sqrt{\frac{\gamma P}{\rho}}$ (In gases)

④ Laplace's formula:

a) $v = \sqrt{\frac{\gamma P}{\rho}}$ $\qquad \gamma = \frac{C_p}{C_v}$

ii) $v = \sqrt{\frac{\gamma RT}{M}}$

Factors Affecting speed of sound.

i. Density: $v \propto \frac{1}{\sqrt{\rho}}$ i.e $\boxed{\frac{v_1}{v_2} = \sqrt{\frac{\rho_2}{\rho_1}}}$

ii. Temperature: $v \propto \sqrt{T}$

$$\boxed{\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{273 + t_1}{273 + t_2}}}$$

iii. Humidity:

$\rho_m \rightarrow$ density of moist air

$\rho_d \rightarrow$ density of dry air

$v_m \rightarrow$ speed of sound in moist air

$v_d \rightarrow$ speed of sound in dry air.

$v \propto \sqrt{\frac{P\gamma}{\rho}}$ i.e $v \propto \frac{1}{\sqrt{\rho}}$

$$\boxed{\frac{v_m}{v_d} = \sqrt{\frac{\rho_d}{\rho_m}}}$$

$\Rightarrow$ Humidity $\uparrow \Rightarrow \rho \downarrow \Rightarrow v \uparrow$

iv. Pressure: Jab Tak temperature change nahi hoga Tab tak pressure ka koi effect nahi hai.

Velocity of sound in $t^{\circ}C$:

$$V_t = V_0 \sqrt{\left(1 + \frac{t}{273}\right)}$$

If we move away from a (practically) point source, the intensity of its sound varies inversely with square of the distance i.e $I \propto \frac{1}{r^2}$

Loudness:

$\rightarrow I \propto A^2$

for perfectly healthy human ear, the least audible intensity is

$$I_0 = 10^{-12} W/m^2$$

Loudness of sound of Intensity I, measured in the unit bel

$$L_{bel} = \log_{10}\left(\frac{I}{I_0}\right)$$

1 decimetre or 1 dm = 0.1m

Similarly,

1 decibel or 1db = 0.1 bel

$\therefore$ 1 bel = 10 db

$$\therefore L_{db} = 10 L_{bel} = 10 \log_{10}\left(\frac{I}{I_0}\right)$$