THE DOCTORS’ INN
THE ENGINEERS’ INN

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Waves

Waves generation??

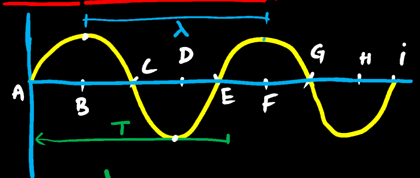
Transfer of energy??

⇒ Mechanical & Electromagnetic

⇒ Progressive & Standing

⇒ Transverse & Longitudinal ⇓ compressional

Periodic Waves:-



$V = \frac{\lambda}{T}$, $V = f\lambda$

$\lambda, 2\lambda, 3\lambda, \dots$ inphase

$\frac{\lambda}{2}, \frac{3\lambda}{2}, 5\frac{\lambda}{2}, \dots$ out of phase

WE HAVE TO OPEN THE DOORS IN THE DARK *** THE DOCTORS INN ***

Sound Wave:-

Longitudinal or Compressional wave

Speed of Sound waves depends upon,

1) Compressibility } of Medium.
2) Inertia

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

E = Elastic Modulus

ρ = density of Medium.

The speed of sound is much higher in solids Than in gases.

Iron = 5130 m/s

Glass = 5500 m/s

Water = 1483 m/s

Air = 332 m/s

⇒ Sound Waves speed in air???

I Newton's Assumption.

at Const: Temp.

$E \approx P$ pressure.

$$V = \sqrt{\frac{P}{\rho}} = 280 \text{ m/s}$$

II Laplace Correction

Temp does not remain const:

$PV^{\gamma} = \text{const}$ $\qquad \gamma = \frac{\text{MSH of gas at const: P}}{\text{MSH of gas at Const: V}}$

$E \approx \gamma P$ $\qquad$ For air $\gamma = 1.4$

Thus $V = \sqrt{\frac{\gamma P}{\rho}} = 333 \text{ ms}^{-1}$

⇒ Effect of Variation of P, ρ, T on the speed of sound in a Gas.

I Effect of Pressure:-

not effected by Pressure, as $\frac{\uparrow P}{\uparrow \rho} = \text{const:}$

II Effect of density:-

at same T and same P

$V = 1/\sqrt{\rho}$ inversely proportional

III Effect of Temp:-

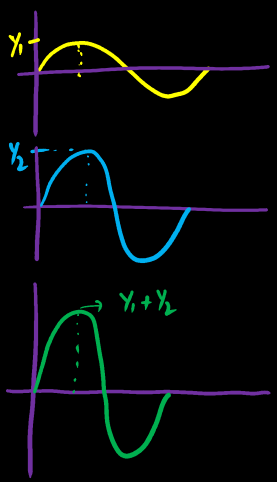
$V = V_0 + 0.61t$

One degree Celsius rise in temperature produce approximately 0.61 ms^{-1} increase in the speed of sound.

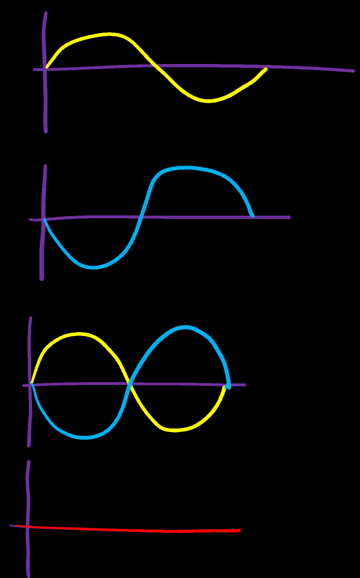
Superposition :-

Addition of two or more waves.

i Waves with same frequency and inphase



i Waves with same frequency and inphase



Superposition

- **Interference:** two waves having same f and travel in same dir direction
- **Beats:** Two waves of slitly diff. f and travelling in same direction.
- **Stationary Waves:** Two wave of equal f Travelling in opp. direction

Interference :-

Superposition of two waves having the same frequency and travelling in the same direction results in a phenomenon called interference.

→ Constructive interference :-

path difference $\Delta S = n\lambda$, $n = 0, \pm1, \pm2, \ldots$

→ Destructive Interference :

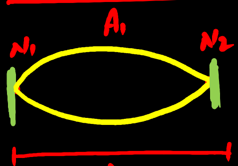
Path difference $\Delta S = (2n+1)\frac{\lambda}{2}$, $n = 0, \pm1, \pm2, \ldots$

⇒ Beats :-

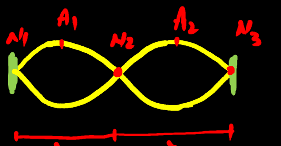
Number of beats per second is equal to the difference between the frequencies.

$$N = f_2 - f_1$$

Standing Waves in Strings:-



$l = \frac{\lambda}{2}$



$\frac{\lambda}{2}$ $\frac{\lambda}{2}$

$l = \lambda_2$

$f = \frac{v}{\lambda}$

$f_1 = \frac{v}{\lambda_1}$

$\therefore \lambda = 2l$

$$\boxed{f_1 = \frac{v}{2l}}$$

$f_n = n f_1$

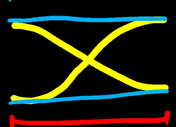
$f_2 = \frac{v}{\lambda_2}$

$f_2 = \frac{v}{l}$

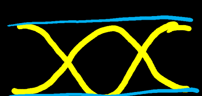
$$\boxed{f_n = \frac{nv}{2l}}$$

Stationary Waves in Organ Pipe:-

open at both ends:-



$l = \frac{\lambda}{2}$



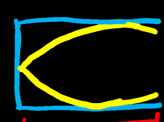
$f_1 = \frac{v}{\lambda_1}$

$f_1 = \frac{v}{2l}$

$f_n = \frac{nv}{2l}$

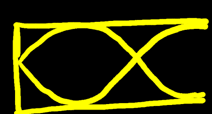
$$\boxed{f_n = n f_1}$$

closed at one end:



$l = \frac{\lambda}{4}$

$f_1 = \frac{v}{4l}$



$f_2 = \frac{3v}{4l}$

$f_n = (2n-1)\frac{v}{4l}$

Doppler's Effect:-

The apparent change in pitch of sound due to the relative motion b/w the source and listener (observer) is known as...