WAVES-CLASS-11th

#SHM (simple harmonic motion) & SHW (simple harmonic wave):-

→ waves → oscillation

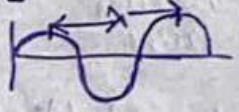
Mechanical wave

- Transverse wave → Eg-Light, →String wave
- Longitudinal wave → Sound wave

→ wave is propagating? mean = it is the propagation of energy in a medium.

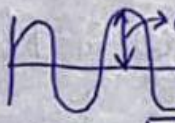
#Wave property:

(a) Wavelength = distance b/w two consecutive point at the same phase of oscillations.



(b) frequency = No° of wave passing in one second. Unit = hertz

(c) Amplitude = maximum displacement of wave from its mean position.



$$V = \frac{\omega}{K}$$

Wave speed :- $V = f\lambda$

#Plane progressive wave:

$y = (x - vt)f$ or $y = f(y + vt)$

general = $y = f(ax \pm bt)$

Harmonic wave → $y = A\sin(ax + bt + c)$

Gaussian wave → $y = Ae^{-(ax+bt+c)}$

Lorentz → $y = \frac{1}{1+(ax+bt+c^2)}$

#Harmonic wave:-

$y = A\sin(kx - \omega t + \phi)$

$k = \frac{2\pi}{\lambda}$ (wave number) A = Amplitude

ϕ = Phase

$\omega = 2\pi f$ (angular frequency)

$y = f(x \pm vt)$

same sign of x and t → -ve x direction

opposite sign of x & t → +ve x direction

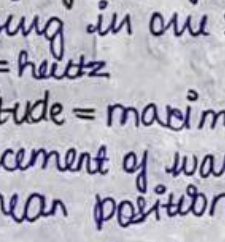
Q. $y = A\sin(Kx + \omega t + \phi)$ wave in -ve x direction

$$\text{Speed} = V = \frac{b}{a}$$

$\left(\frac{|\text{coff of time}|}{|\text{coeff° of } x|}\right)$

Q: $y = -2\sin(2x - 3t)$ dirn = +x $v = \frac{3}{2}$ m/s

#Velocity and acceleration of particle:



$V_{max} = A\omega$

$a_{max} = \omega^2 A$

$V_p = -V_{(\omega)} \cdot \text{Slope}$ (wave)

($V_{Particle}$) at A = 0 (zero)

#Velocity of transverse wave in strings:-

$$V = \sqrt{\frac{T}{\mu}} \qquad \mu = \frac{M}{L}$$

T = Tension

μ = mass per unit length of the wire.

#Velocity of longitudinal wave:

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

B = Bulk modulus

ρ = density

Newton's Assumption - sound travels isothermally.

$$\beta_{iso} = P$$

P = Pressure

$P = 1.01 \times 10^5$

$\rho = 1.3$ of air

(V_{sound}) in air = 279 m/s ↑ This was wrong!

But Laplace correction sound travels in adiabatically.

$$\beta_{adb} = \gamma P$$

γ = gamma

monatomic gas = 1.66

di-atomic gas = 1.4

Poly-atomic gas = 1.33

$$V = \sqrt{\frac{\beta}{\rho}} = \sqrt{\frac{\gamma P}{\rho}}$$

$\gamma = 1.4$ $\rho = 1.3$ $P = 1.01 \times 10^5$

$V_{sound} = 330$ m/s

$$V_{sound} = \frac{\gamma RT}{M_w}$$

M_w = molecular mass

Temperature: $V \propto \sqrt{T}$

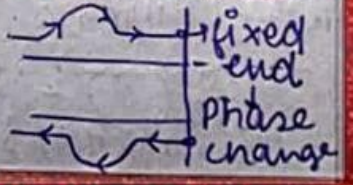
Pressure: T constant then there will be no change in speed of sound.

Relative Humidity :- with increase in humidity speed of sound also increases.

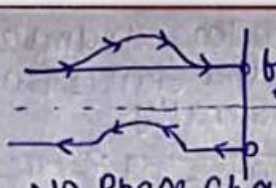
Aptitude = speed doesn't depend on loudness.

Reflection of waves:

1.



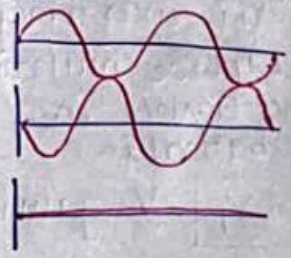
(2°)



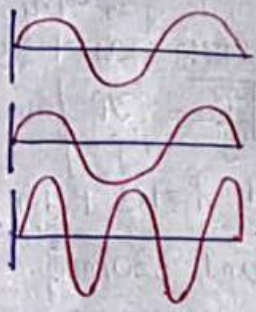
→ NO Phase Change!

#Superposition of waves:
Opposite phase wave ⊖⊖
same phase wa ⊕⊕

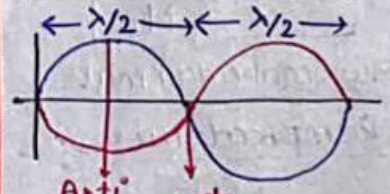
CASE I



CASE II



*STANDING WAVE ANALY:

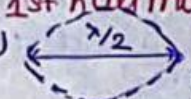


2 Node = at dist° of $\frac{\lambda}{2}$

2 Antinode = at dist of $\frac{\lambda}{2}$

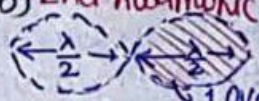
1 Node & 1 Antinode = at ,, ,, $\frac{\lambda}{4}$

1st Harmonic

(a) 

$L = \frac{\lambda}{2}$ $f = \frac{v}{\lambda}$

$\lambda = 2L$ $f = \frac{v}{2L}$

(b) 2nd harmonic 

$L = 2(\frac{\lambda}{2})$

$\lambda = 2L/2$ $\frac{2v}{2L}$

(c) 3rd harmonic 

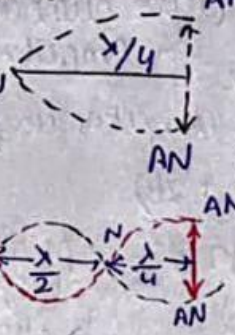
$L = 3(\frac{\lambda}{2})$

$\lambda = 2L/3$

$f = \frac{3v}{2L}$

Overtone = Extra loops
Harmonic = No° of by which the f is multiplied

Only one end is fixed :-



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

$\lambda = 4L$

$f \frac{2V}{4L}$

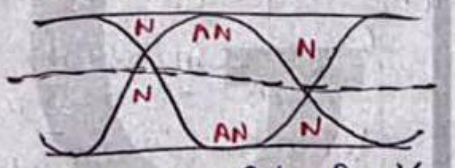
$\frac{3}{4}\lambda = L$

$\lambda = \frac{4L}{3}$

only odd harmonic $f = 3\frac{V}{4L}, \frac{5V}{4L}$

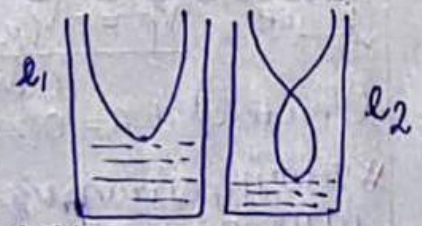
#standing wave in closed organ pipe and string free at one end have same formula

OPEN ORGAN PIPE :-



$L = \frac{\lambda}{2}$ $\lambda = 2L$ $f = \frac{V}{2L}$

RESONANCE TUBE EXP :-
Speed of sound nikalta hai



→ Both ends fixed

$V_s = 2f(l_2 - l_1)$

#DOPPLER'S EFFECT :-
→ source velocity = 0



→ Source moving.



$\lambda_{app} = \lambda\left(\frac{V \pm V_s}{V}\right)$

towards observer (-) large source is moving towards observer

away from observer (+) large source is moving away from observer.

observer k move karne se λ_{app} change nhi hota hai!

$f_{app} = f\frac{(V \pm V_o)}{(V \pm V_s)}$

V_o = observer
V_s = source

$V_o \rightarrow$ S $f\left(\frac{V + V_o}{V}\right)$

$V_s \leftarrow$ S Rest $f\left(\frac{V \pm V_o}{V - V_s}\right)$

$V_o \leftarrow$ $V_s \leftarrow$ S $f_a = f\left(\frac{V - V_o}{V \pm V_s}\right)$

$V_o \rightarrow$ $V_s \rightarrow$ S $f_a = f\left(\frac{V + V_o}{V - V_s}\right)$

#BEAT FREQUENCY :-

$f_{beat} = |f_2 - f_1|$

ψ wave loading f↓

ψ → filling f↑

#POWER :

$P = 2\pi^2 f^2 A^2 \mu V$

$I = P/S = 2\pi^2 f^2 A^2 \rho V$