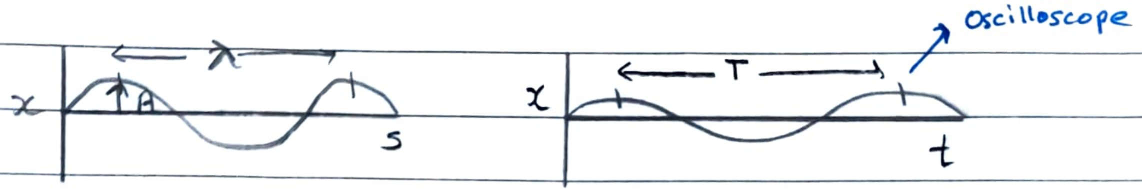
Waves - pg 1

Introduction

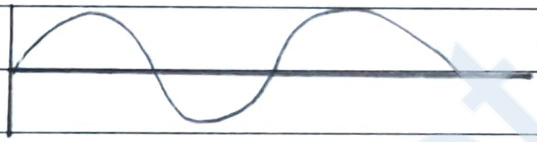
⟹ Progressive Waves



$v = f\lambda$ $\qquad$ $f = \frac{1}{T}$

→ **Transverse wave**

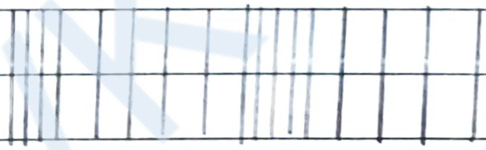
→ particles are oscillating at 90° to the direction of the wave



→ Example: Light (all electromagnetic waves), string

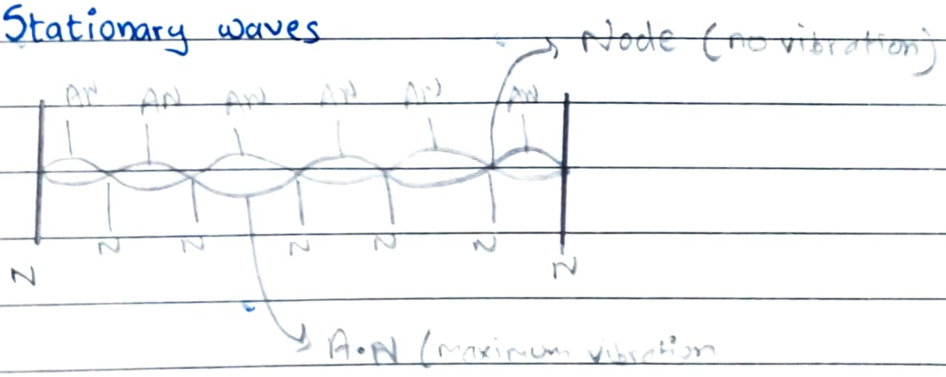
→ **Longitudnal wave**

→ particles are oscillating in the same direction as the energy transfer



→ Example: Sound, ultra sound (high frequency sounds)

⟹ Stationary waves

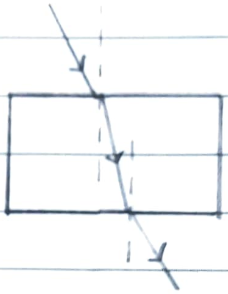


distance between two successive Nodes = $\frac{\lambda}{2}$

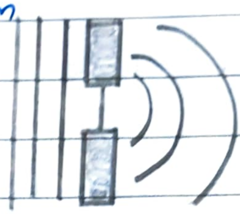
distance between Antinode and Node = $\frac{\lambda}{4}$

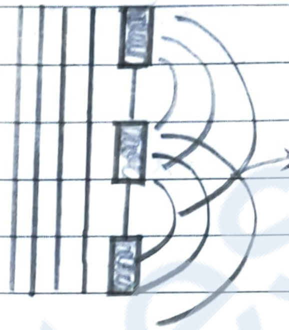
⇒ Waves interaction

→ Refraction



→ Diffraction





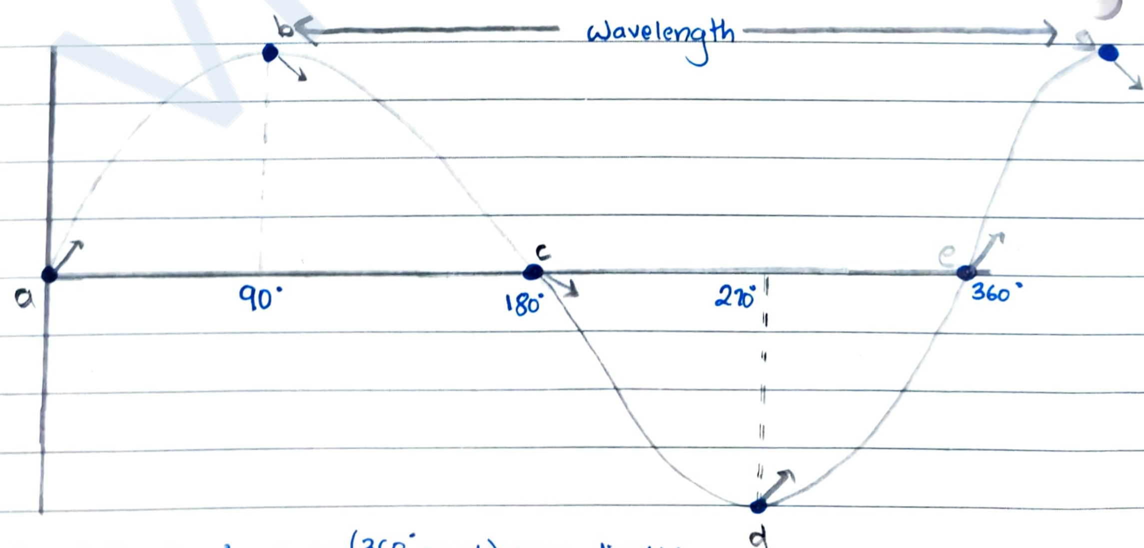
⇒ Waves

→ Mechanical

- → dependent on particles
- → Examples: Sound, seismic
  : String, water
- → particles are vibrating along their equilibrium position

→ Electromagnetic

- → it goes through a whole spectrum
- → it does not rely on particles
- → Ex. radio, ligh, gamma
- → Electric field and magnetic field is oscillating



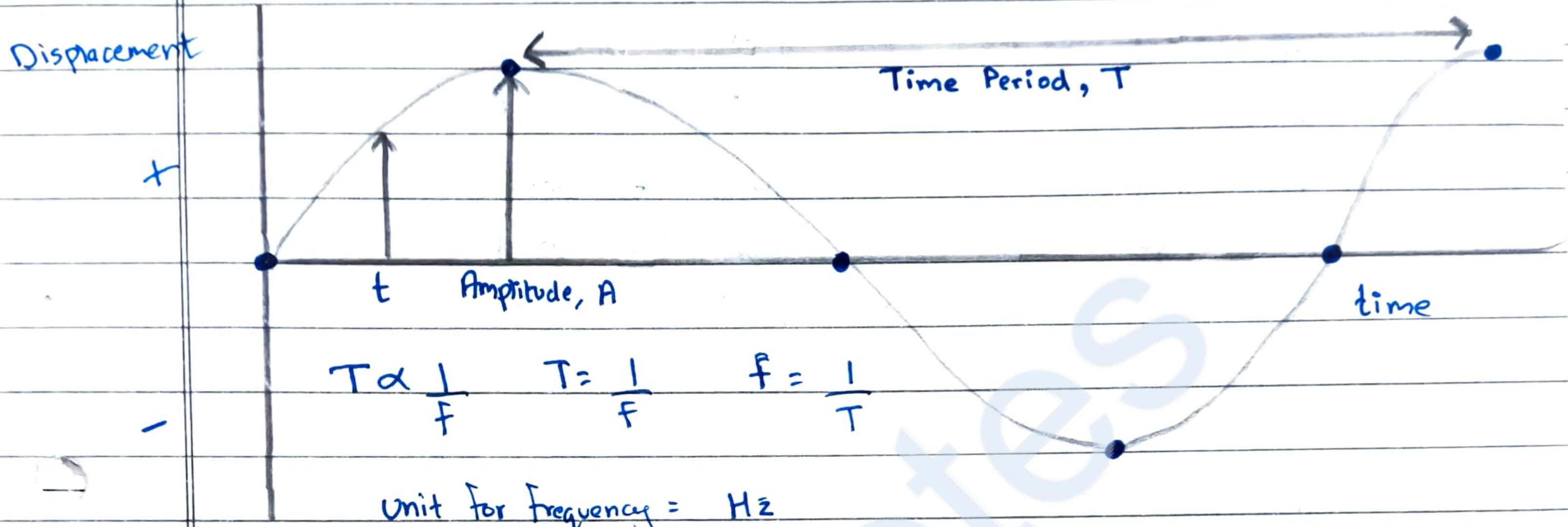
a and e are in phase (360° apart) same direction

b and g are in phase (360° apart) same direction

a and c are in antiphase (180° apart) opp direction

b and d are in antiphase (180° apart) opp direction

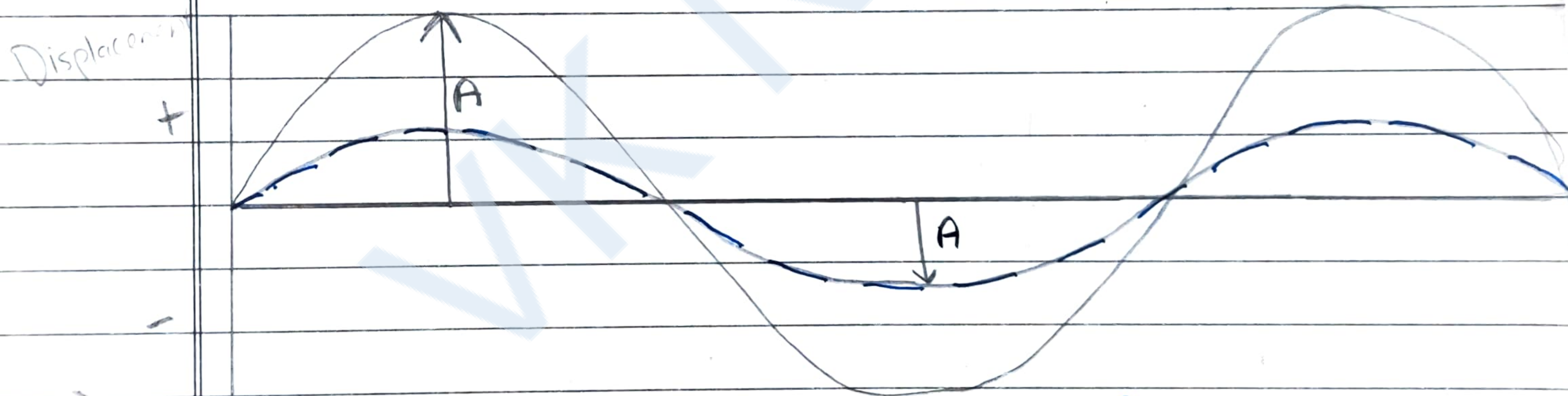
Waves - pg 2



$T \propto \frac{1}{f}$ $T = \frac{1}{f}$ $f = \frac{1}{T}$

Unit for frequency = Hz

⇒ Wave amplitude and intensity



$$\text{Intensity} = \frac{\text{Power}}{\text{Area}}$$

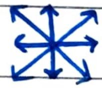
$A^2 \propto I$

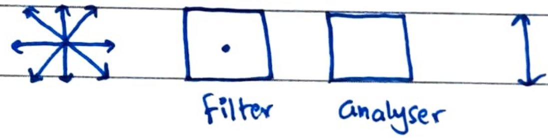
a wave of double amplitude carries four times more energy

Electromagnetic waves are transverses waves, $c = 3 \times 10^8 \, ms^{-1}$

⇒ Polarisation

→ it works only in transverse waves (∿)

 unpolarised light  polarised light



if analyser is rotated by 90° no light will be passed through analyser.

$$A = A_0 \cos\theta$$

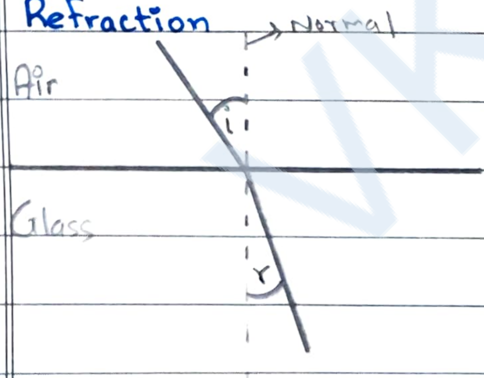
- A → Ampli that comes through the analyser
- A_0 → og ampli

$$I = I_0 \cos^2\theta$$

- I → Intensity that comes through analyser
- I_0 → og intensity

→ Malus's law

⇒ Refraction



n = refractive index (variable for transfers from different mediums)

$$n = \frac{\sin(i)}{\sin(r)}$$

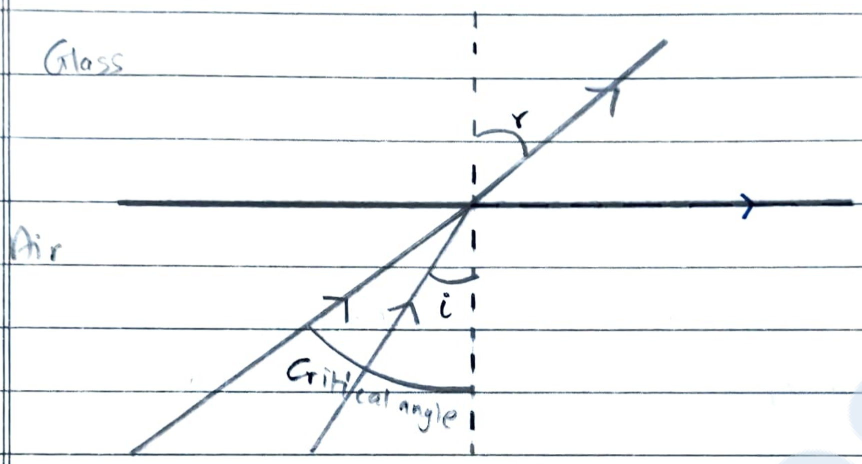
$$n = \frac{\text{Speed of light in (Air)}}{\text{Speed of light in (Glass)}}$$

⇒ Total internal reflection

→ works only when wave is travelling from denser to rarer medium.

↓

$\angle r > \angle i$

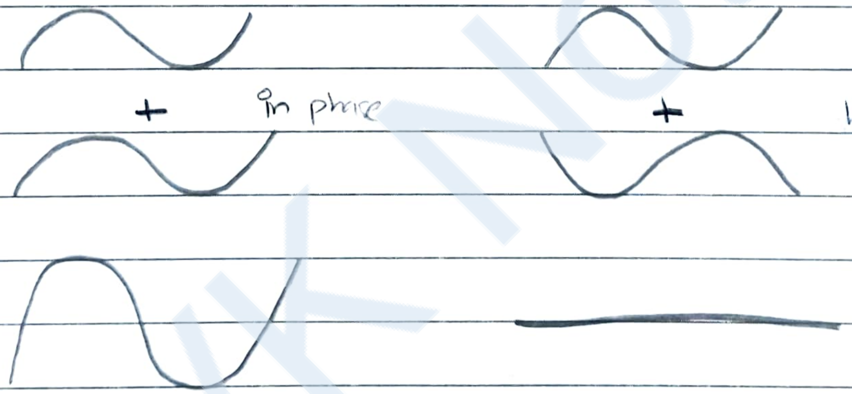


$\sin C = \frac{n_{air}}{n_{glass}}$

☆ critical angle is when $\angle r = 90^\circ$

☆ if $\angle i > c$ then TIR.

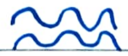
⇒ Superpositions

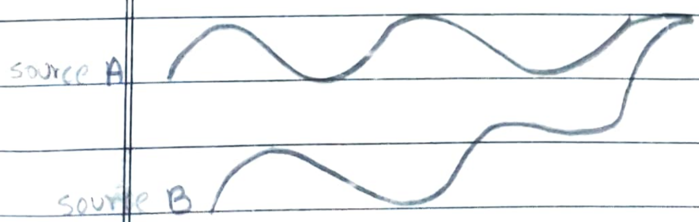


Constructive Interference

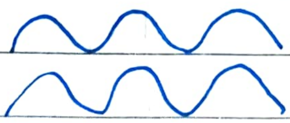
Destructive Interference

⇒ Path Difference

coherent source is when two wave emitting sources are emitting waves with same wave length 



if path difference is a multiple of λ

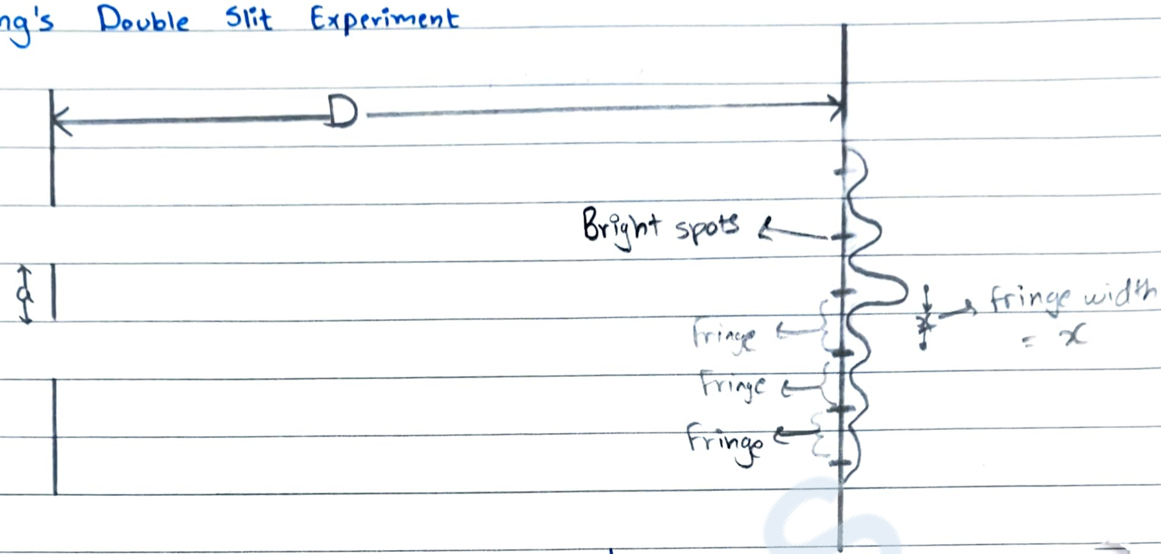


constructive Interference

if path difference is not a multiple of λ

destructive Interference

⇒ Young's Double Slit Experiment



if $x = \lambda$ → constructive interference

then $\boxed{\lambda = a\sin\theta}$

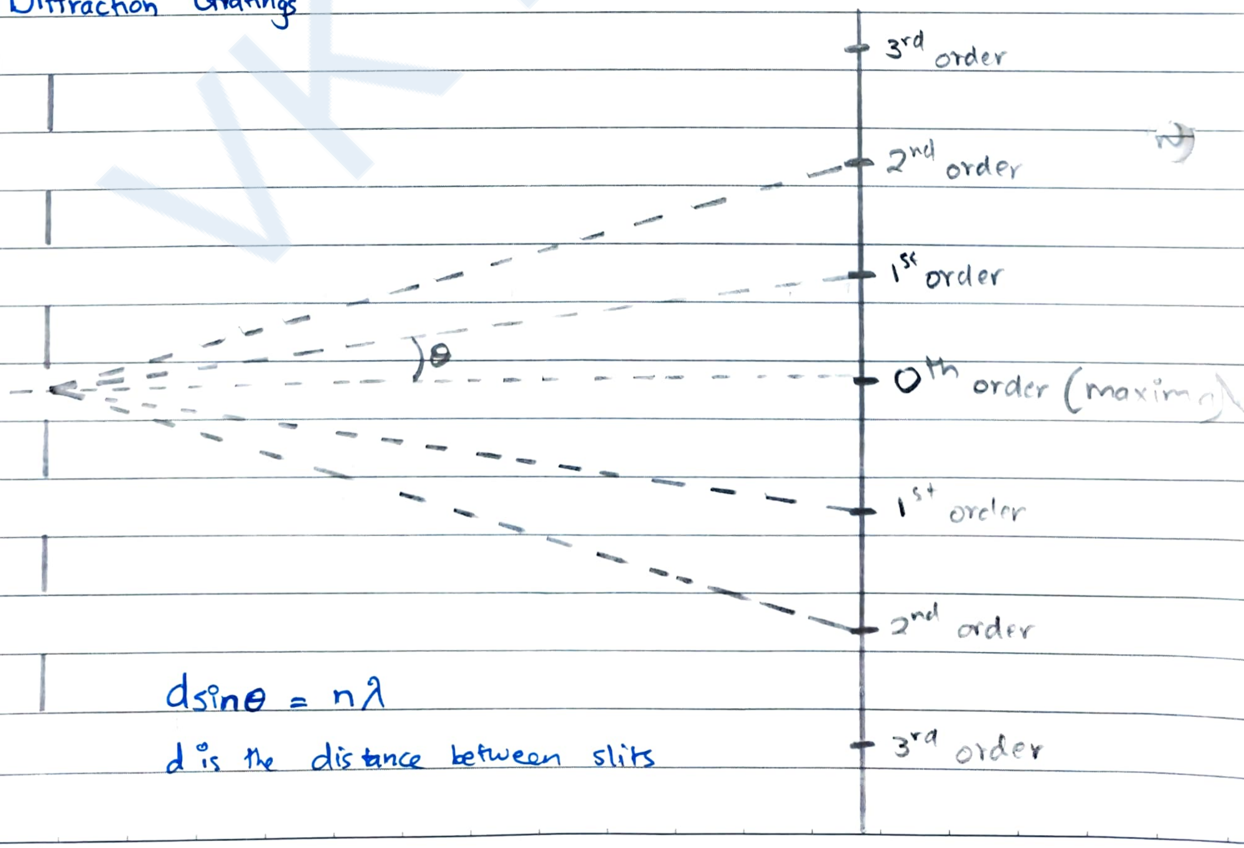
Normally

$$\boxed{\lambda = \frac{xa}{D}}$$

if $x = \frac{\lambda}{2}$ → destructive interference

then $\boxed{\frac{\lambda}{2} = a\sin\theta}$

⇒ Diffraction Gratings

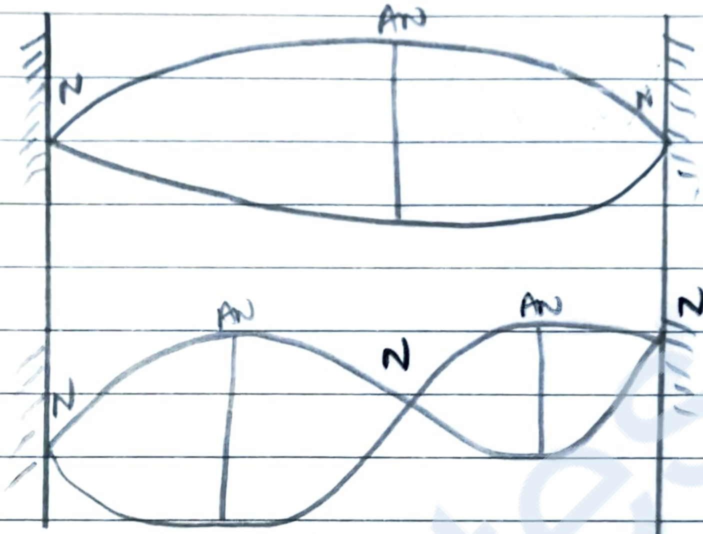


$d\sin\theta = n\lambda$

d is the distance between slits

⇒ Stationary Waves

→ Energy is stored



Fundamental or First Harmonic

$\lambda = 2L$

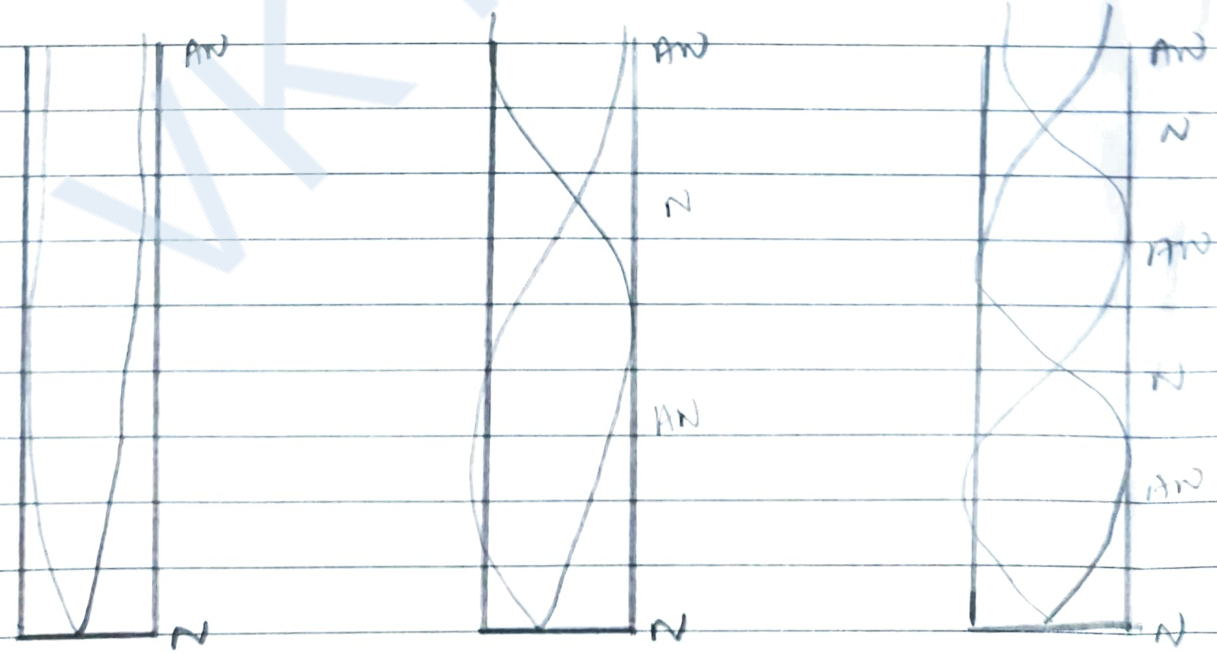
Second Harmonic

$\lambda = L$

distance between two Nodes = $\frac{\lambda}{2}$

$f = n\left(\frac{c}{2L}\right)$ where c = speed

⇒ Stationary waves in an open tube



Fundamental or first Harmonic

Second Harmonic

Third Harmonic

⇒ Doppler's effect

Source moving towards

wavelength → Decreases

frequency → Increases

$$f' = f_s \left(\frac{v_s}{v_s - v} \right)$$

$$f' > f_s$$

Source moving away

wavelength → Increases

frequency → Decreases

$$f' = f_s \left(\frac{v_s}{v_s + v} \right)$$

$$f' < f_s$$