11th Session - optics - Refraction @ plane surface

ABLES® KOTA

→ Recap (TIR)

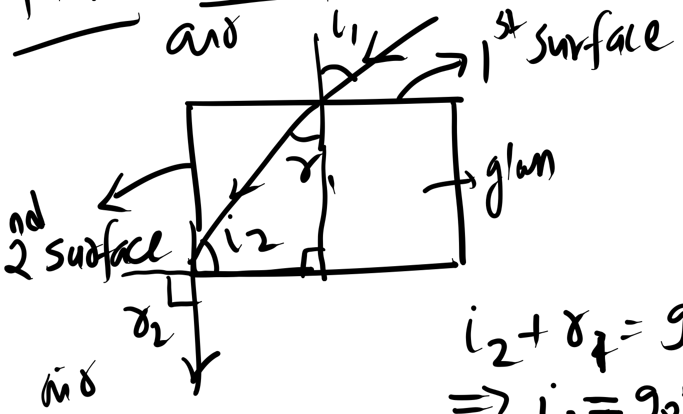
→ Dispersion
  ↳ refraction

→ why prism

→ slab v/s prism

→ δ → deviation in prism.

TIR Recap



$i_2 + r_1 = 90°$

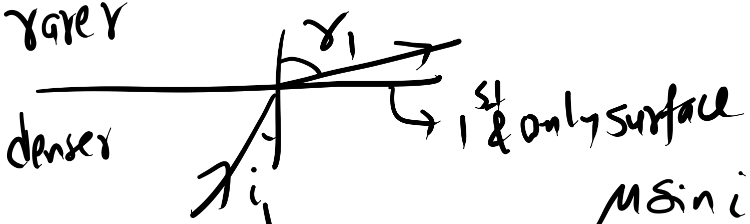
$\Rightarrow i_2 = 90° - r_1$

$i_1 \uparrow \quad r_1 \uparrow \quad i_2 \downarrow \quad r_2 \downarrow$

$i_1 \downarrow \quad r_1 \downarrow \quad i_2 \uparrow \quad r_2 \uparrow$

Max^m value of i_1 → TIR happens (2nd surface)

Min^n value of μ → —— " ——



$\mu \sin i_1 = \sin r_1$

$i_1 \uparrow \quad r_1 \uparrow$

Min^m value of $i = \theta_c$ → TIR will happen

Max^m value of μ for a given i → —"—

ABLES KOTA

Dispersion → Refraction of a non monochromatic source

↳ Splitting of light (wave) into its component (waves/colours)

↳ Both glass slab & prism disperse white light but prism only can make the dispersion visible.

$$v_{Sound} = \sqrt{\frac{\gamma RT}{M}}$$

$$v_{String\ wave} = \sqrt{T/\mu}$$

$$v_{EM} = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = \frac{1}{\sqrt{\mu \epsilon}}$$

$\mu = \mu_0 \mu_r$

$\epsilon = \epsilon_0 \epsilon_r$

Dispersive media

↳ (speed of wave depends not only on physical properties of medium but also on the freq./wavelength of the wave)

Non Dispersive media

↳ speed of wave depends only on physical properties of medium.

In dispersive media → Speed of wave depends upon freq or λ.

$$\mu(\lambda) = a + b/\lambda^2$$ Couchy's relationship.

$$v(\lambda) = c/\mu(\lambda)$$

λ → wavelength in vaccum

$$\lambda_{med} = \frac{\lambda}{\mu(\lambda)} \Rightarrow \left(\mu(\lambda) = \frac{\lambda}{\lambda_{med}}\right)$$

a & b are constants → for a particular medium

→ Empirical relationship.

→ valid only for visible light wave.

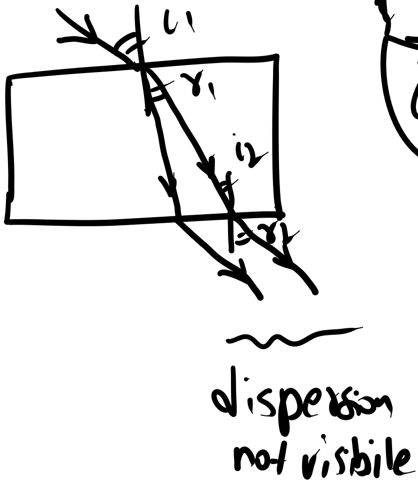
$\frac{d\mu}{d\lambda} < 0$ (normal dispersion)

as $\lambda \uparrow$ $\mu(\lambda) \downarrow$

$\frac{d\mu}{d\lambda} > 0$ (anomalous dispersion)

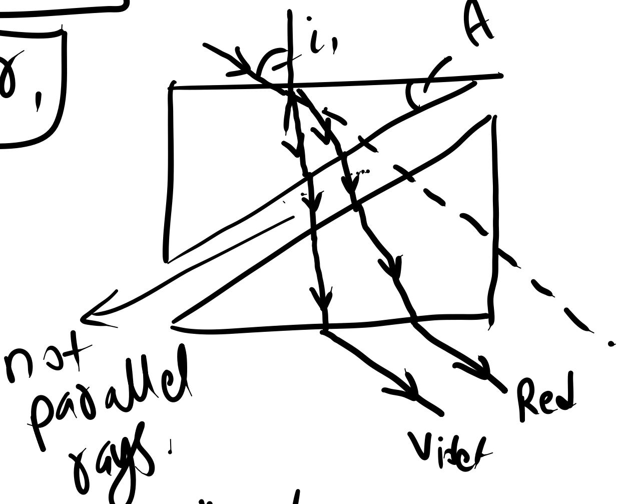
as $\lambda \uparrow$ $\mu(\lambda) \uparrow$

Difference b/w glass slab & prism w.r.t. dispersion



$r_1 = i_2$

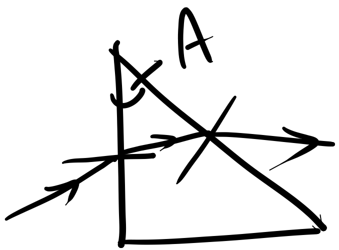
$i_2 = r_1$

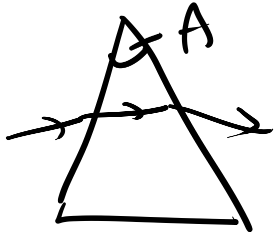


→ Using a prism instead of glass slab, the dispersion of light becomes visible.

→ for prism, $i_2 \neq r_1 \Rightarrow$ dispersion is visible.
emergent ray is diverging
& not parallel to incident ray.

Prism → A homogeneous & transparent medium enclosed by two plane surfaces.





→ **Angle of prism**

↳ Angle b/w incident & final emergent surfaces

Terminologies w.r.t. prism → XY surface → incident surface

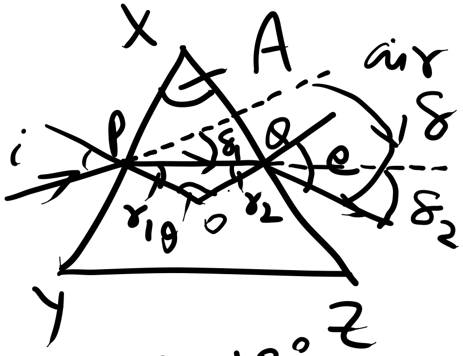
XZ — " — → emergent — " —

i → angle of incidence

e → — " — emergence

δ → total deviation

δ_1, δ_2 } → deviation components.



$r_1 + r_2 + \theta = 180^\circ$

□ XPOQ → $A + \theta = 180^\circ$

$r_1 + r_2 + \cancel{180^\circ} - A = \cancel{180^\circ}$

$\boxed{r_1 + r_2 = A}$

(deviation w.r.t. i)

$\delta_1 = i_1 - r_1$

$\delta_2 = e - r_2$

$\delta = \delta_1 + \delta_2$

$= (i_1 - r_1) + (e - r_2) \equiv i_1 + e - (r_1 + r_2)$

$\equiv (i_1 + e - A)$

Deviation angle (δ) in prism

$$\boxed{\delta = i_1 + e - A}$$

$1 \times \sin i_1 = \mu \sin r_1$ @ XY surface

$\mu \sin r_2 = 1 \times \sin e$ @ XZ surface.

$r_1 + r_2 = A$

$r_1 = A - r_2$

$\delta = f(i_1, A)$