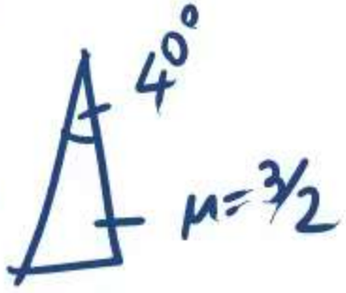
Session 15: Ray Optics – Reflection & Refraction @ curved surfaces

- Recap (Examples)
- Dispersive power of a prism
- Combination of prisms (angular dispersion & mean deviation)
- Examples

- Reflection at curved surfaces

Recap →

Ex. 1 Find δ_{min}

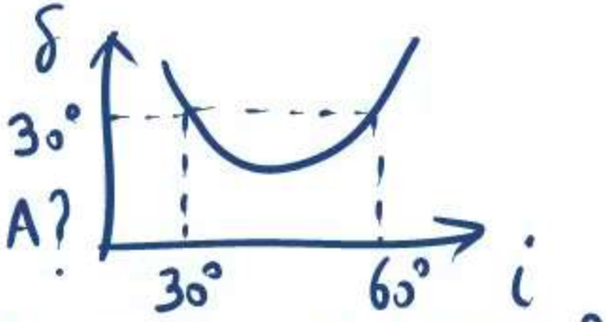


$\delta_{min} = (\mu - 1) A_{small}$

$= (3/2 - 1) \times 4°$

$= 2°$.

Ex 2



Find A?

(A). 45° (B) 30° (C) 60° (D) 15°

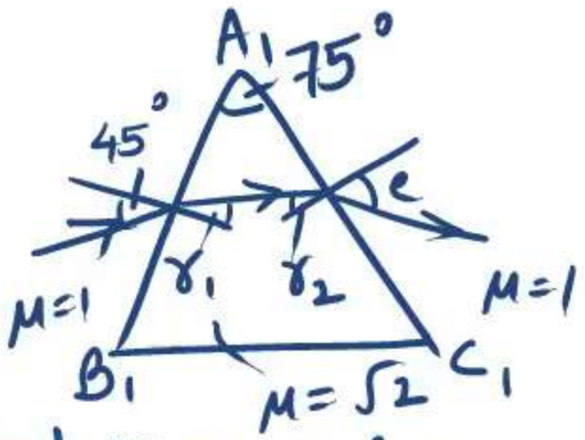
$\delta = i + e - A$

$30° = 30° + 60° - A$

$30° = 60° + 30° - A$

$\Rightarrow \boxed{A = 60°}$

Ex3



Find γ_1, γ_2, e & δ.

$\gamma_1 + \gamma_2 = 75°$.

$1 \times \sin 45° = \mu \sin \gamma_1 \rightarrow @ A_1B_1$

$\frac{1}{\sqrt{2}} = \sqrt{2} \sin \gamma_1$

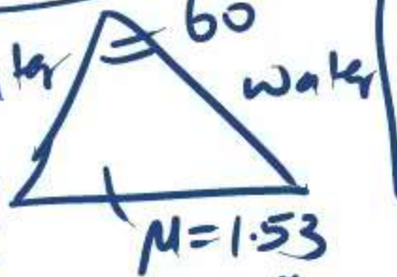
$\sin \gamma_1 = 1/2$

$\gamma_1 = 30° \Rightarrow \gamma_2 = 45°$

$\mu \sin \gamma_2 = 1 \times \sin e$

$\sqrt{2} \sin 45° = \sin e = 1 \Rightarrow \boxed{e = 90°}$

Ex4. Find δ_{min}



$\mu = \frac{\sin\left(\frac{A + \delta_{min}}{2}\right)}{\sin(A/2)}$

$\mu_{rel} = \frac{\mu}{\mu_0} = \frac{1.53}{1.33}$

$\sin\left(\frac{60° + \delta_{min}}{2}\right) = \frac{1.53}{1.33} \sin 30°$ $A = 60°$

$\sin\left(\frac{60° + \delta_{min}}{2}\right) = 0.575$

$\delta_{min} = 35° \times 2 - 60° = \boxed{11°}$

$\delta = i + e - A$

$= 45° + 90° - 75°$

$= \underline{60°}$.

@ A_1C_1

Dispersion thru Prism:

$$\mu(\lambda) = a + \frac{b}{\lambda^2}$$

$$v(\lambda) = \frac{c}{\mu(\lambda)}$$

→ Different components of the while light will travel with different velocities & deviate differently in a dispersive medium like (glass).

→ Sound wave thru won't show dispersion but light wave does.

In order to define dispersion, we define 2 quantities →

① Angular dispersion, $(\theta) = \delta_V - \delta_R$

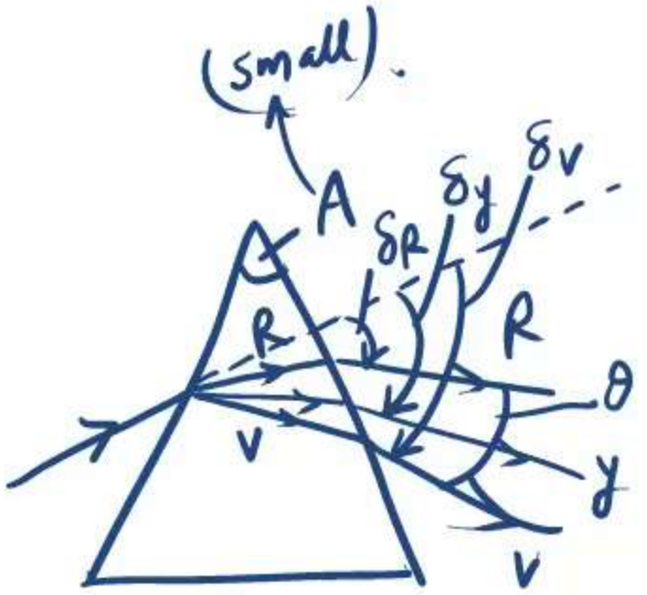
(let's use A small prisms for observing dispersion)

↳ $\delta = (\mu - 1)A$

$$\theta = (\mu_V - 1)A - (\mu_R - 1)A$$

$$\boxed{\theta = (\mu_V - \mu_R)A_{small}}$$

② Mean deviation of beam → $\delta_y = (\mu_y - 1)A_{small}$.



VIBGYOR

Dispersive power (ω) $= \left(\frac{\theta}{\delta}\right) = \frac{(\delta_v - \delta_R)}{\delta_y} =$

$= \frac{(\mu_v - \mu_R)A}{(\mu_y - 1)A}$

$= \boxed{\frac{(\mu_v - \mu_R)}{(\mu_y - 1)}}$

(depends upon properties of medium).

$\mu_y = \left(\frac{\mu_v + \mu_R}{2}\right)$

$\omega = \frac{(\mu_v - \mu_R)}{\left(\left(\frac{\mu_v + \mu_R}{2}\right) - 1\right)}$

4 cases of dispersion :-

1). Prism → $\theta \rightarrow$ dispersion
$\delta \rightarrow$ deviation

2). Glass slab → $\theta \rightarrow 0$
$\delta \rightarrow 0$.

3). Deviation w/o dispersion 4). dispersion w/o deviation.
Combination of prisms

2). Dispersion w/o deviation

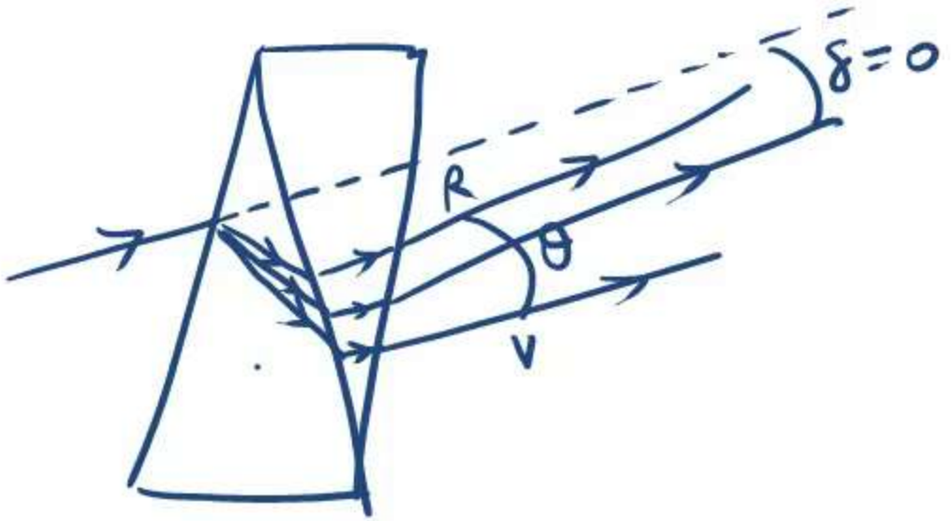
$\delta = 0$

$= \delta_1 + \delta_2$

$= (\mu_y - 1)A + (\mu_y' - 1)A' = 0$

$$\Rightarrow \boxed{A' = -\frac{(\mu_y - 1)}{(\mu_y' - 1)} A}$$

-ve sign implies prisms are opp. to each other.



Ex.1 $A = 5^\circ$, $\mu_R = 1.641$

$\mu_B = 1.659$

Find angle of dispersion?

$\theta = \delta_B - \delta_R$

$= (\mu_B - 1)A - (\mu_R - 1)A$

$= (\mu_B - \mu_R)A$

$= (1.659 - 1.641)\,5^\circ$

$= 0.09^\circ$

Ex.2 $A = 10^\circ$, $\mu_R = 1.51$

$\mu_V = 1.52$

Find dispersive power, ω?

$$\omega = \frac{\theta}{\delta_y} = \frac{\delta_V - \delta_R}{\delta_y}$$

$$= \frac{(\mu_V - \mu_R)A}{(\mu_y - 1)A}$$

$$\mu_y = \frac{1.51 + 1.52}{2} = 1.515$$

$$\omega = \frac{(1.52 - 1.51)}{(1.515 - 1)} = \boxed{0.019}$$

2). Dispersion w/o deviation

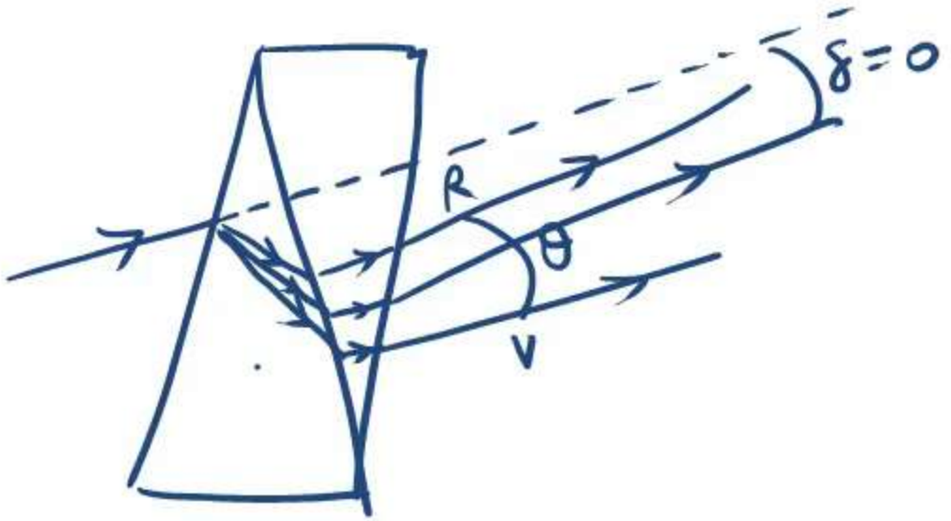
$\delta = 0$

$= \delta_1 + \delta_2$

$= (\mu_y - 1)A + (\mu_y' - 1)A' = 0$

$$\Rightarrow \boxed{A' = -\frac{(\mu_y - 1)}{(\mu_y' - 1)} A}$$

-ve sign implies prisms are opp. to each other.



$$\boxed{A' = -\frac{(\mu_v - \mu_R)}{(\mu_v' - \mu_R')} A}$$

(Deviation w/o dispersion)

$\delta = (\mu_y - 1)A + (\mu_y' - 1)A'$