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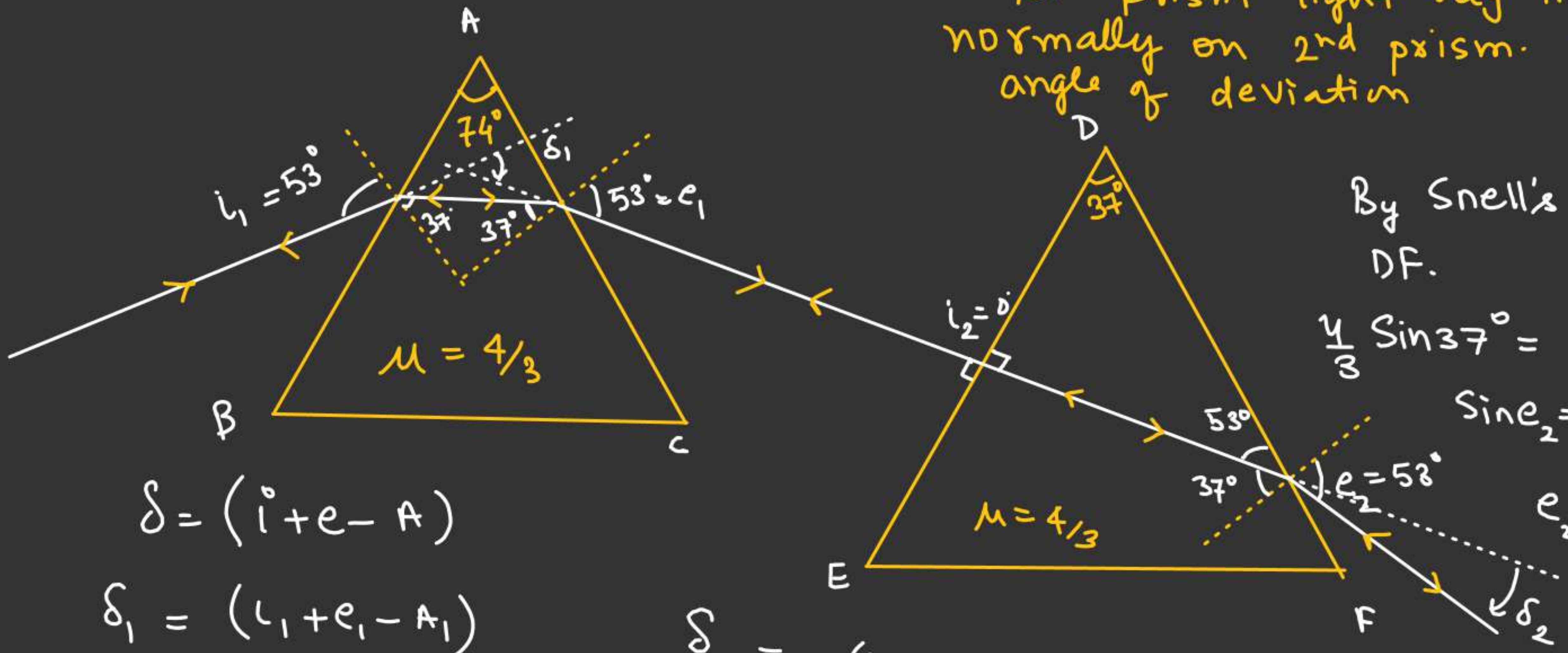
PRISM

After refraction from 1st prism light ray incident normally on 2nd prism. Find net angle of deviation



By Snell's law at DF.

$$\frac{4}{3}\sin 37^\circ = 1\cdot \sin e_2$$

$$\sin e_2 = \frac{4}{3}\times\frac{3}{5} = \frac{4}{5}$$

$$e_2 = 53^\circ$$

$$\delta = (i + e - A)$$

$$\delta_1 = (i_1 + e_1 - A_1)$$
$$= (53^\circ \times 2 - 74^\circ)$$
$$= (106^\circ - 74^\circ)$$
$$= 32^\circ$$

$$\delta_2 = (i_2 + e_2 - A_2)$$
$$= 0 + (53^\circ - 37^\circ)$$
$$= 16^\circ$$

$$\delta_{net} = \delta_1 + \delta_2$$
$$= 48^\circ$$

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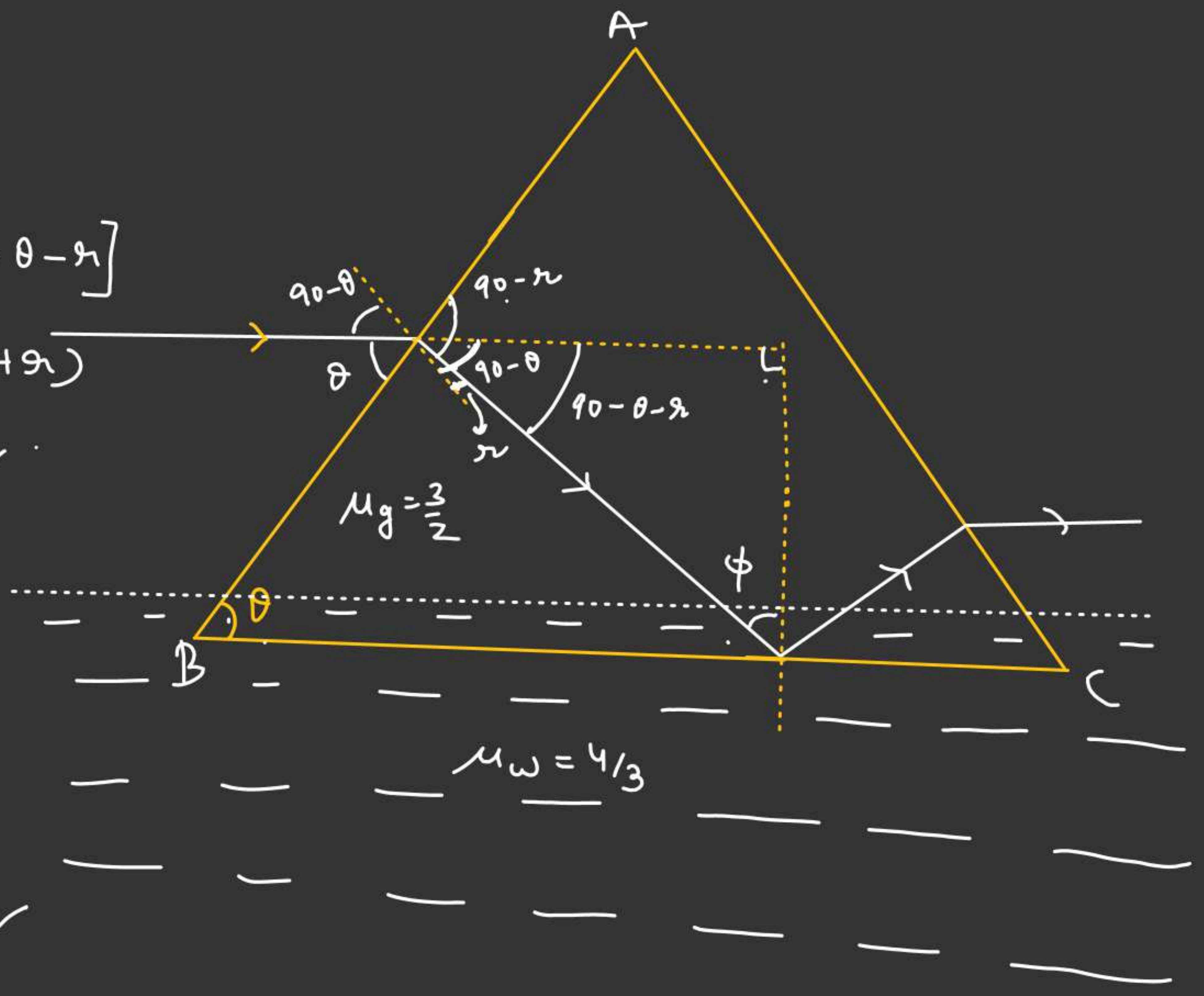
FOR TIR

$(\theta + r) > \theta_c$

$$\phi = 180 - [90 + 90 - \theta - r]$$

$$\phi = \cancel{180} - \cancel{180} + (\theta + r)$$

$$\phi = (\theta + r) \checkmark$$



By Snells law at AB.

$$1 \cdot \sin(90-\theta) = \frac{3}{2}\sin r$$

$$\cos\theta = \frac{3}{2}\sin r$$

$$\sin r = \left(\frac{2}{3}\cos\theta\right) \checkmark$$

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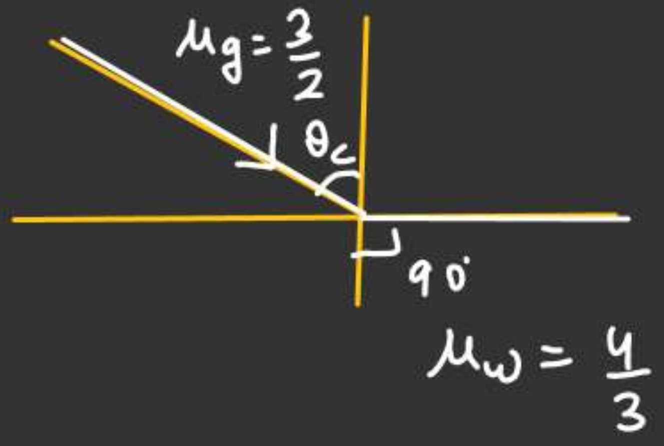
$(\theta + r) > \theta_c$ (For TIR) $\left[\sin r = \frac{2}{3}\cos\theta\right]$



$\sin(\theta + r) > \sin\theta_c$

$\sin\theta \cdot \cos r + \cos\theta \cdot \sin r > 8/9$

$\sin\theta\sqrt{1-\sin^2 r} + \cos\theta \cdot \sin r > 8/9$

$\sin\theta\sqrt{1 - \frac{4}{9}\cos^2\theta} + \cos\theta \times \frac{2}{3}\cos\theta > \frac{8}{9}$

$\sin\theta\sqrt{9 - 4\cos^2\theta} + 2\cos^2\theta > \frac{8}{3}$

$\left(\sqrt{1-\cos^2\theta}\right)\sqrt{9-4\cos^2\theta} + 2\cos^2\theta > \frac{8}{3}$

put $\cos^2\theta = x$.

$\sqrt{1-x}\sqrt{9-4x} > \left(\frac{8}{3} - 2x\right)$

$\frac{3}{2}\sin\theta_c = \frac{4}{3}\sin 90°$

$\sin\theta_c = \left(\frac{8}{9}\right)$

$(1-x)(9-4x) > \left(\frac{8}{3} - 2x\right)^2$

$9(1-x)(9-4x) > (8-6x)^2$

$x < 17/21$

$\cos^2\theta < 17/21$

$\theta < \cos^{-1}\sqrt{17/21}$ Ans.

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DISPERSION :- (JEE MAINS ONLY)

↳ Phenomena of Splitting of light into its Constitutient Colour. is Called Dispersion.

CAUCHY EQUATION

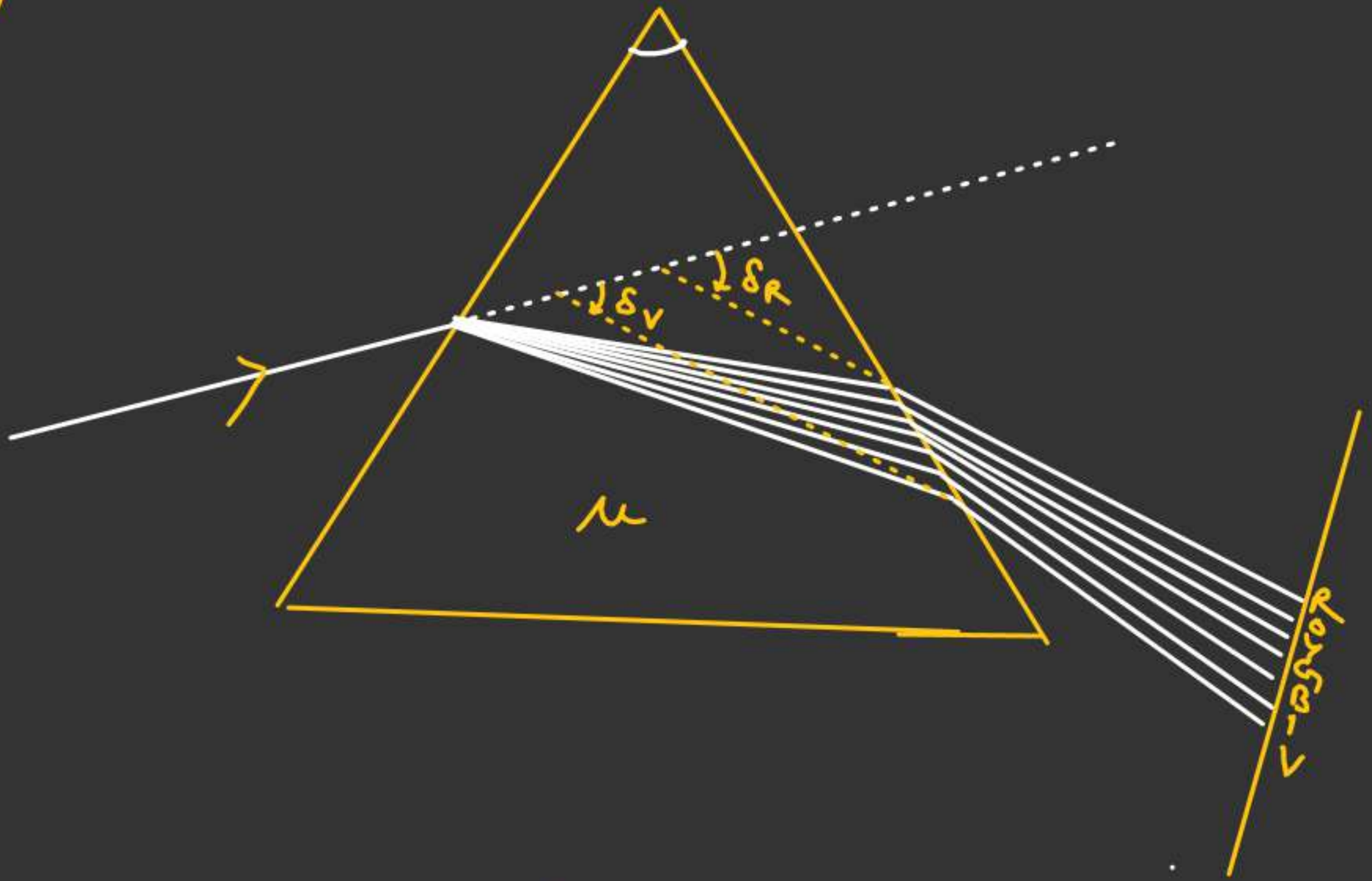
$$\mu = \left(A + \frac{B}{\lambda^2}\right)$$

$$\left(\mu \propto \frac{1}{\lambda}\right)$$

$$\delta = (\mu - 1)A$$

$$\delta \propto \mu \propto \frac{1}{\lambda}$$

$$\begin{bmatrix} \mu_R > \mu_V \\ \delta_R < \delta_V \end{bmatrix}$$



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Angular Dispersion $\Rightarrow$ (Difference in the deviation of violet & Red Colour)

$$\delta = (\delta_V - \delta_R)$$

$$\delta_V = (\mu_V - 1)A$$

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

$$\delta = (\delta_V - \delta_R)$$

$$\boxed{\delta = (\mu_V - \mu_R)A}$$ **

Dispersive power = $\left(\dfrac{\text{Angular dispersion}}{\text{Mean deviation}}\right)$

Mean deviation :- deviation due to yellow colour light.

$$\delta_Y = (\mu_Y - 1)A$$

$$\mu_Y = \left(\frac{\mu_V + \mu_R}{2}\right)$$

$$\boxed{\omega = \frac{(\mu_V - \mu_R)A}{\delta_Y} = \left[\frac{\mu_V - \mu_R}{(\mu_Y - 1)}\right]}$$

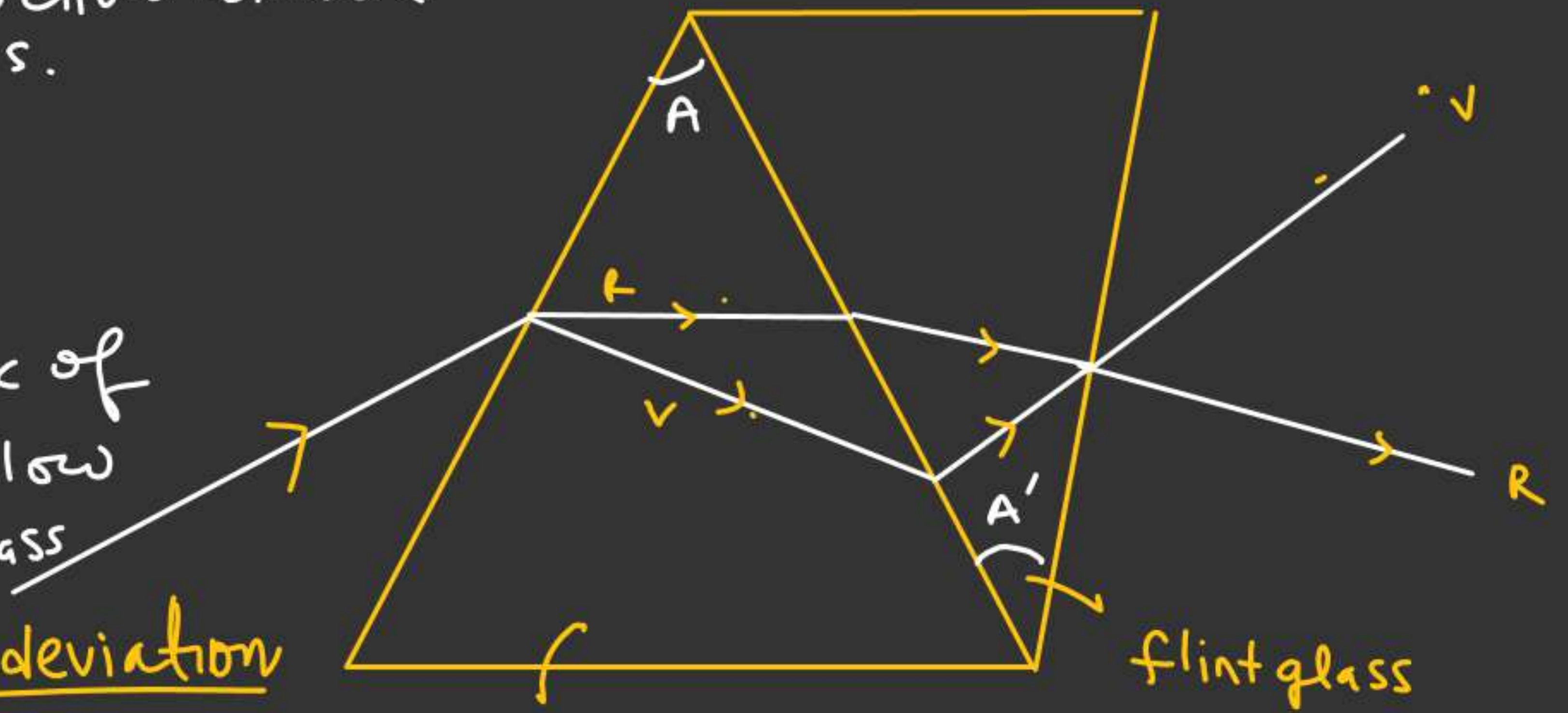
DISPERSION WITHOUT DEVIATION ($\delta_{net} = 0$)

$\mu_R, \mu_V, \& \mu \rightarrow$ Refractive index of Violet, Red & yellow colour of crown glass.

A = Angle of Prism of Crown glass.

$\mu'_R, \mu'_V \& \mu' \rightarrow$ Refractive index of Violet, red & yellow Colour of flint glass

A' = Angle of Prism of flint glass



$$\delta_{net} = \underbrace{\delta}_{\text{Crown}} + \underbrace{\delta'}_{\text{flint}}$$

$$= (\mu-1)A + (\mu'-1)A'$$

Net deviation

$\delta_{net} = 0$

$$(\mu-1)A + (\mu'-1)A' = 0.$$

$$A' = -\frac{(\mu-1)}{(\mu'-1)}A \quad \text{—(1)}$$

Net Angular dispersion $= (\mu_V - \mu_R)A + (\mu'_V - \mu'_R)A'$ $\quad A' = -\left(\frac{\mu-1}{\mu'-1}\right)A$

$$= (\mu_V - \mu_R)A - (\mu'_V - \mu'_R)\frac{(\mu-1)}{(\mu'-1)}A.$$

$$= (\mu-1)A\left[\underbrace{\left(\frac{\mu_V-\mu_R}{\mu-1}\right)}_{\omega} - \underbrace{\left(\frac{\mu'_V-\mu'_R}{\mu'-1}\right)}_{\omega'}\right]$$

$$= \boxed{(\mu-1)A\left[\omega - \omega'\right]}$$

$(\omega' > \omega)$

$(-ve)$

$\Rightarrow$

ω = dispersive power of Crown glass

ω' = dispersive power of flint glass.

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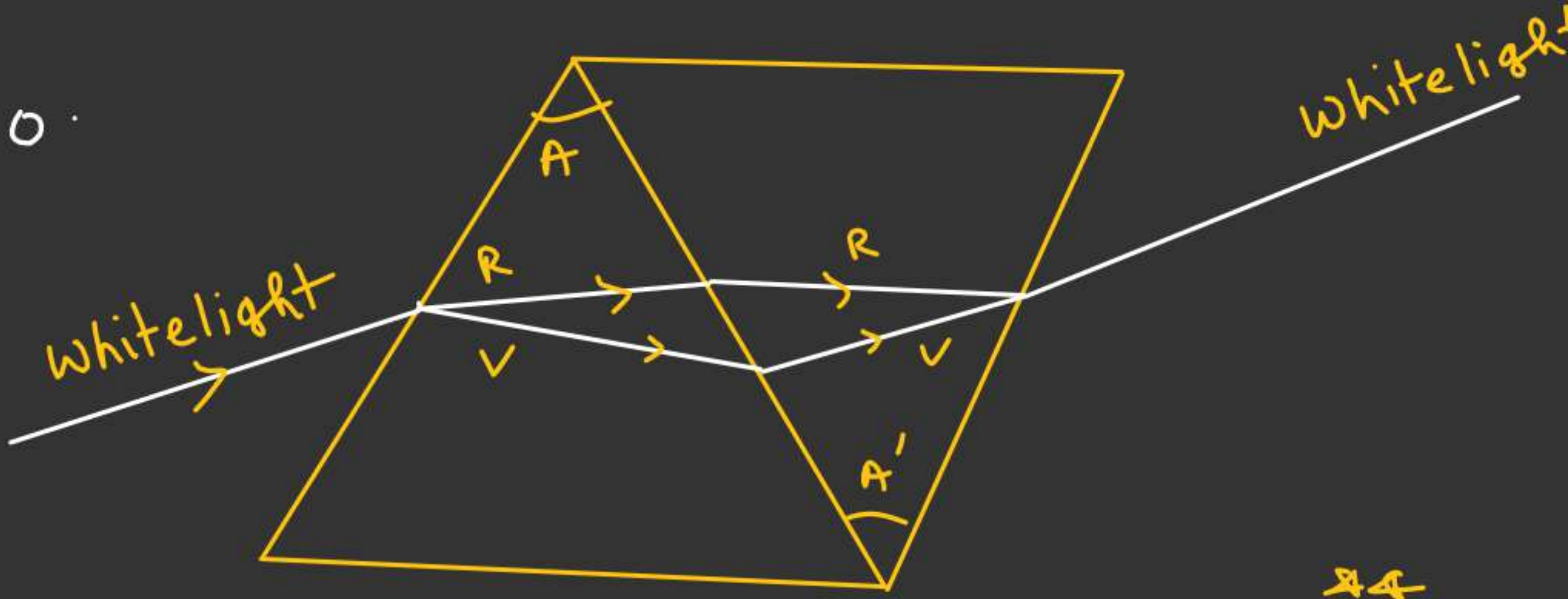
Deviation without dispersion

Net Dispersion zero.

$$(\mu_V - \mu_R)A + (\mu_V' - \mu_R')A' = 0$$

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



$$\delta_{net} = \delta + \delta'$$

$$= (\mu - 1)A + (\mu' - 1)A'$$

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

$$= (\mu - 1)A\left[1 - \underbrace{\left(\frac{\mu_V' - 1}{\mu_V' - \mu_R'}\right)}_{\frac{1}{\omega'}} \times \underbrace{\left(\frac{\mu_V - \mu_R}{\mu - 1}\right)}_{\omega}\right]$$

$$\boxed{\delta_{net} = (\mu - 1)A\left[1 - \frac{\omega}{\omega'}\right]}$$

$\boxed{\omega' > \omega} \Rightarrow$ Dispersive power of flint glass is more than crown glass