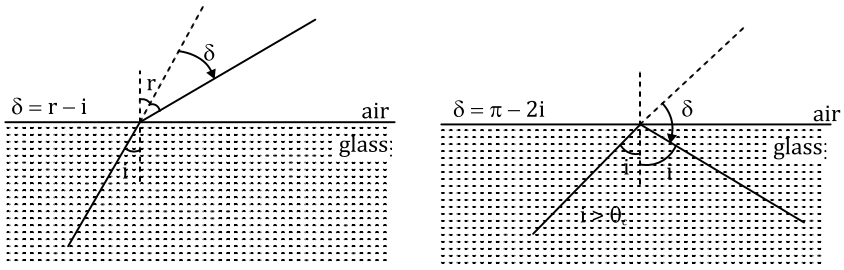
DPP 04

1. For deviation angle to be 90° light must reflect internally as for glass critical angle is less than 45° so for all refracted ray's deviation angle will be smaller.



$\delta = \pi - 2i = 90°$

$\Rightarrow i = \dfrac{\pi - \frac{\pi}{2}}{2} = \dfrac{\pi}{4}$

$\Rightarrow i = 45°$

2. Consider Point A on which by Snell's law, we have

$\mu_1 \sin\ \theta_1 = \mu_2 \sin\ \theta_2$ ... (1)

and angle of incidence on top face is

$\theta_2 = 90° - \theta_c$

For total internal reflection at top face we use

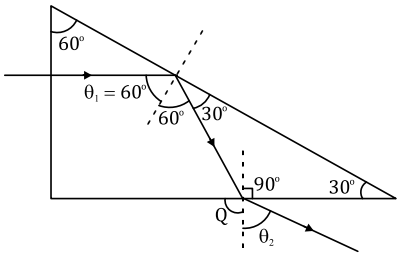
$\theta_2 > \theta_c$

$\Rightarrow \cos\theta_2 = \sin\ \theta_c = \frac{\mu_1}{\mu_2}$ ... (2)

Elimination of θ_2 between (1) and (2), we get

$\sin\ \theta_1 = \sqrt{\left(\dfrac{\mu_2}{\mu_1}\right)^2 - 1}$

3. Using Snell's law at point Q, we have



$\mu_1 \sin\ \theta_1 = \mu_2 \sin\ \theta_2$

$\Rightarrow \dfrac{5}{3} \cdot \sin\ 30° = \dfrac{4}{3} \cdot \sin\ \theta_2$

$\Rightarrow \theta_2 = \sin^{-1}\left(\dfrac{5}{8}\right)$

For total internal reflection at P, we use

$$\frac{5}{3}\sin 60^\circ = \mu_2 \cdot 1$$

$$\Rightarrow \mu_2 = \frac{5}{2\sqrt{3}}$$

4. From the figure given in question, $\theta = 2C = 98^\circ$.

5. $${}_\alpha\mu_g = \frac{1}{\sin\theta} \Rightarrow \mu = \frac{1}{\sin\theta}$$

Now from Snell's law, $\mu = \frac{\sin i}{\sin r} = \frac{\sin\theta}{\sin r} \Rightarrow \sin r = \frac{\sin\theta}{\mu}$

From equations (i) and (ii)

$$\sin r = \frac{1}{\mu^2} \Rightarrow r = \sin^{-1}\left(\frac{1}{\mu^2}\right)$$

6. When total internal reflection just takes place from lateral surface $i = C$ i.e., $60^\circ = C$

$$\sin 60^\circ = \sin C = \frac{1}{\mu} \Rightarrow \mu = \frac{2}{\sqrt{3}}$$

Time taken by light to traverse some distance in a medium

$$t = \frac{\mu x}{c} = \frac{\frac{2}{\sqrt{3}} \times 10^3}{3 \times 10^8} = 3.85\mu\text{sec.}$$

7. For TIR at AC

$\theta > C$

$$\Rightarrow \sin\theta \geq \sin C \Rightarrow \sin\theta \geq \frac{1}{{}_w\mu_g}$$

$$\Rightarrow \sin\theta \geq \frac{\mu_w}{\mu_g} \Rightarrow \sin\theta \geq \frac{8}{9}$$