Nishant Jindal

Case of grazing incidence → [Case of Maximum angle of deviation]

(Path of reversibility)

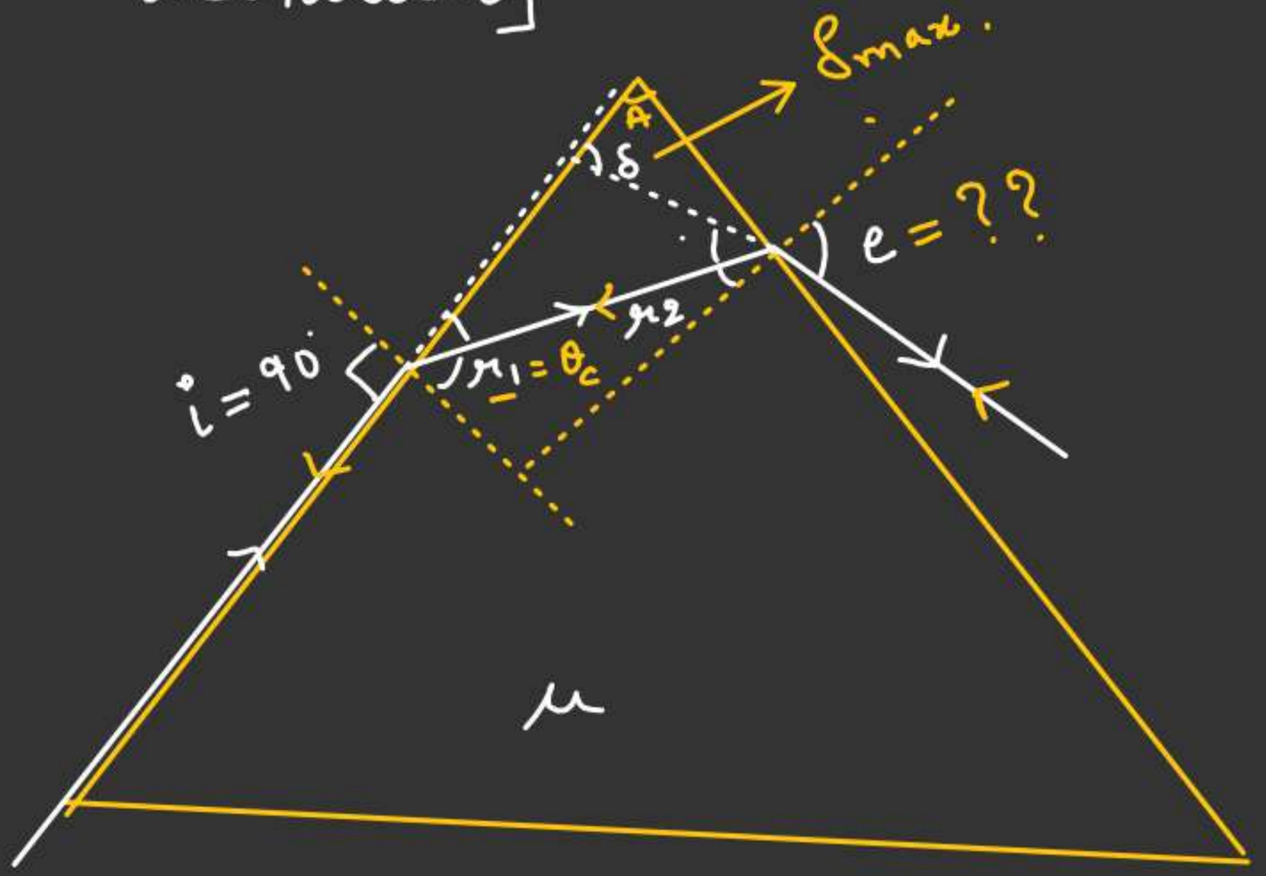
$r_1 = \theta_c$

$\delta = (90 - r_1) + (e - r_2)$

$\delta = 90 + e - (r_1 + r_2)$

$$\boxed{\delta = 90 + e - A}$$

$e = ??$



By Snell's law

$\mu \sin r_2 = 1 \cdot \sin e$

$r_2 = A - r_1$

$r_2 = (A - \theta_c)$

$\mu \sin(A - \theta_c) = \sin e$

Nishant Jindal

Case of grazing incidence → [Case of Maximum angle of deviation]

Snell's law for AC

$$1 \cdot \sin e = \mu \sin r_2$$

$$\left[\begin{array}{l} A = r_1 + r_2 \\ A - r_1 = r_2 \\ A - \theta_c = r_2 \end{array}\right.$$

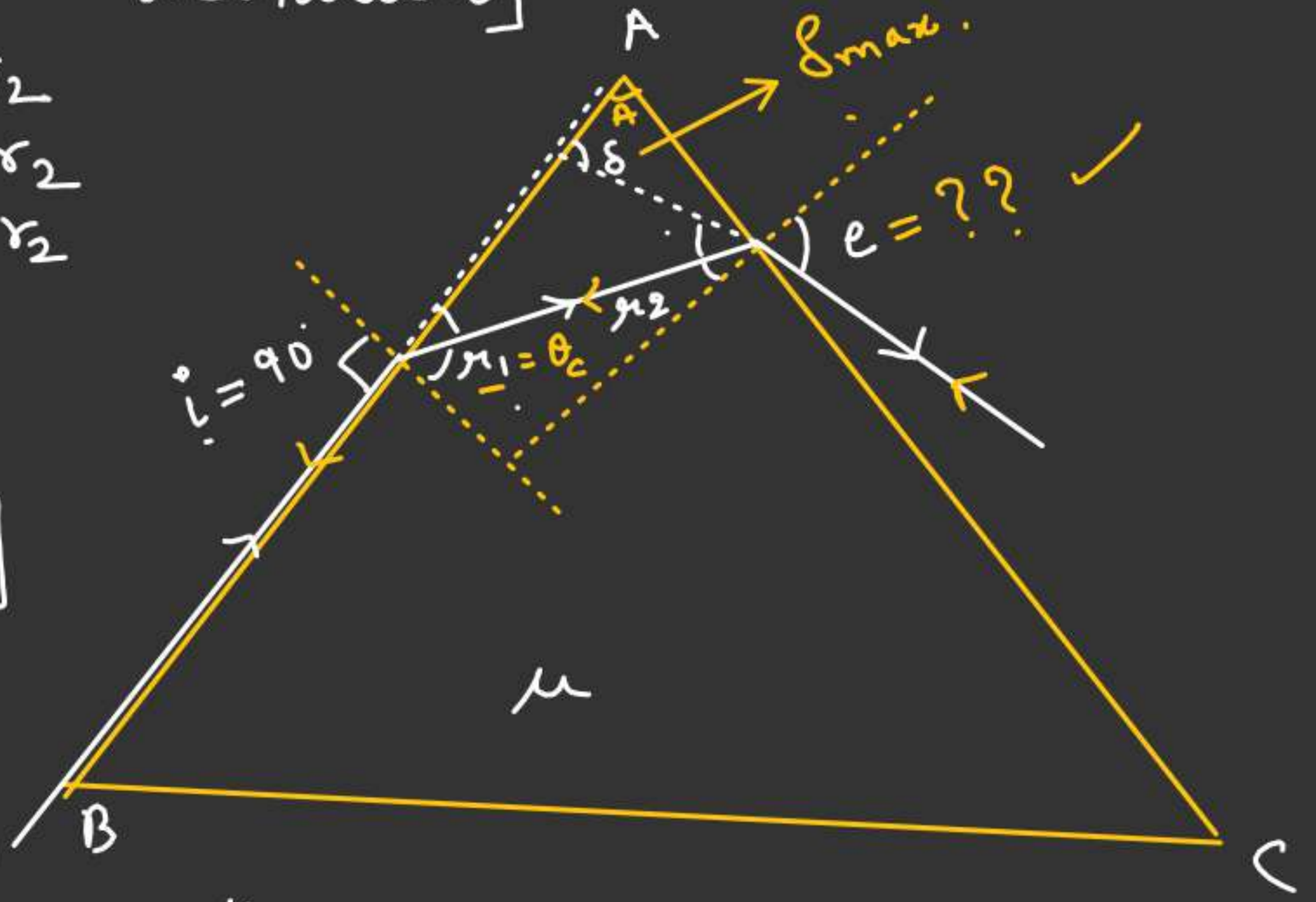
$$\sin e = \mu \sin(A - \theta_c)$$

$$\sin e = \mu \cdot [\sin A \cdot \cos\theta_c - \cos A \cdot \sin\theta_c]$$

$$\sin e = \mu\left[\sin A \sqrt{1 - \sin^2\theta_c} - \cos A \cdot \sin\theta_c\right]$$

$$\sin e = \mu\left[\sin A \sqrt{1 - \frac{1}{\mu^2}} - \cos A \times \frac{1}{\mu}\right]$$

$$e = \sin^{-1}\left[\sin A\left(\sqrt{\mu^2 - 1}\right) - \cos A\right]$$



$$\left(\sin\theta_c = \frac{1}{\mu}\right)$$

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PRISM

Imp: Case of No emergence for any value of angle of incidence.

For TIR takes place always

$(r_2)_{min} > \theta_c$ — ①

$A = r_1 + r_2$

$(r_2)_{min} = A - (r_1)_{max}$

For $(r_1)_{max}$, $i \to i_{max} = 90°$

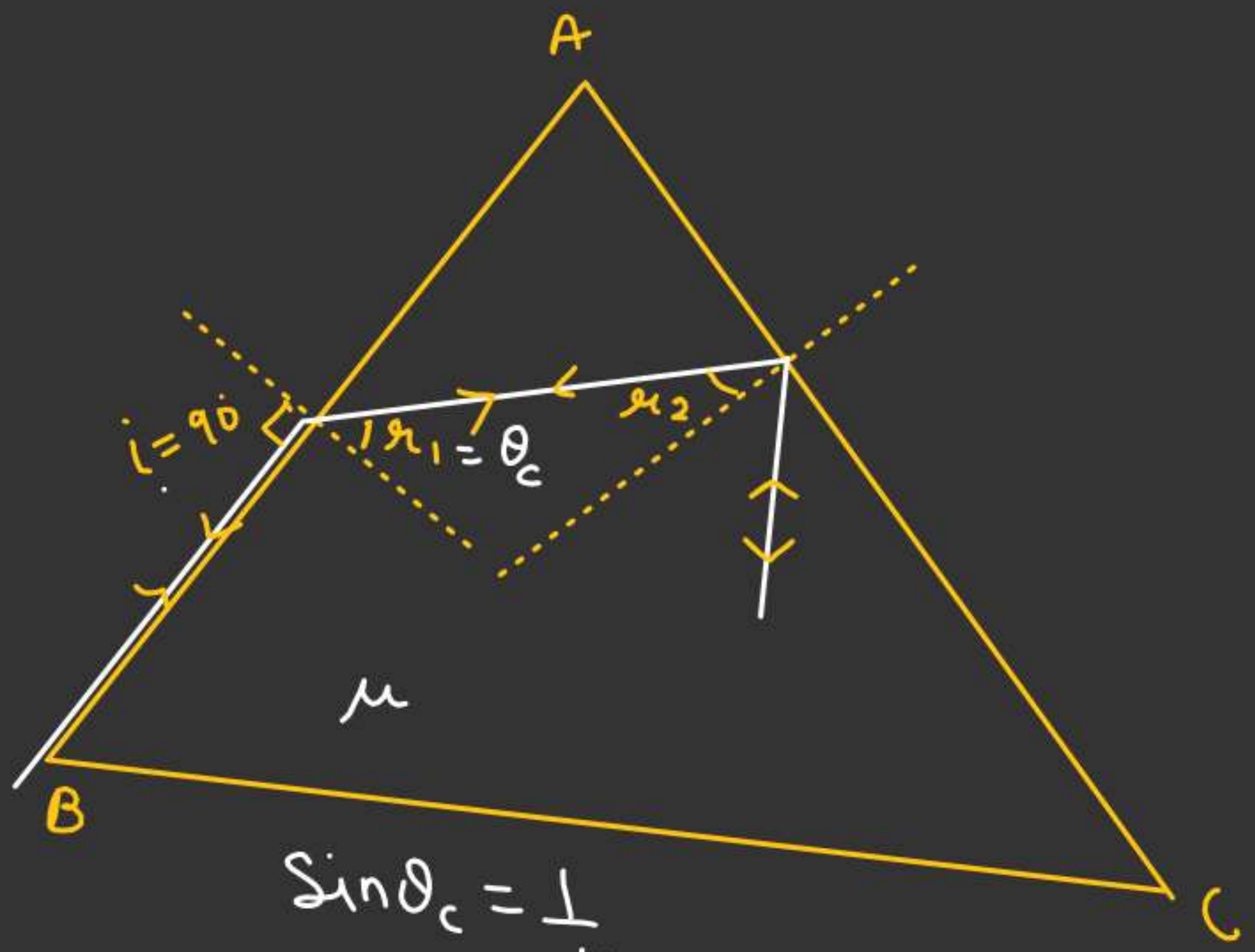
$(r_1)_{max} = \theta_c$

$(r_2)_{min} = A - \theta_c$ — ②

From ① & ②

$A - \theta_c > \theta_c$

$\boxed{A > 2\theta_c}$ ✓



$\frac{A}{2} > \theta_c$

$\sin(A/2) > \sin\theta_c$

$\sin(A/2) > \frac{1}{\mu}$

$\sin\theta_c = \frac{1}{\mu}$

$\boxed{\mu > \text{cosec}(A/2)}$

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PRISM

Condition for grazing emergence

$i = ??$

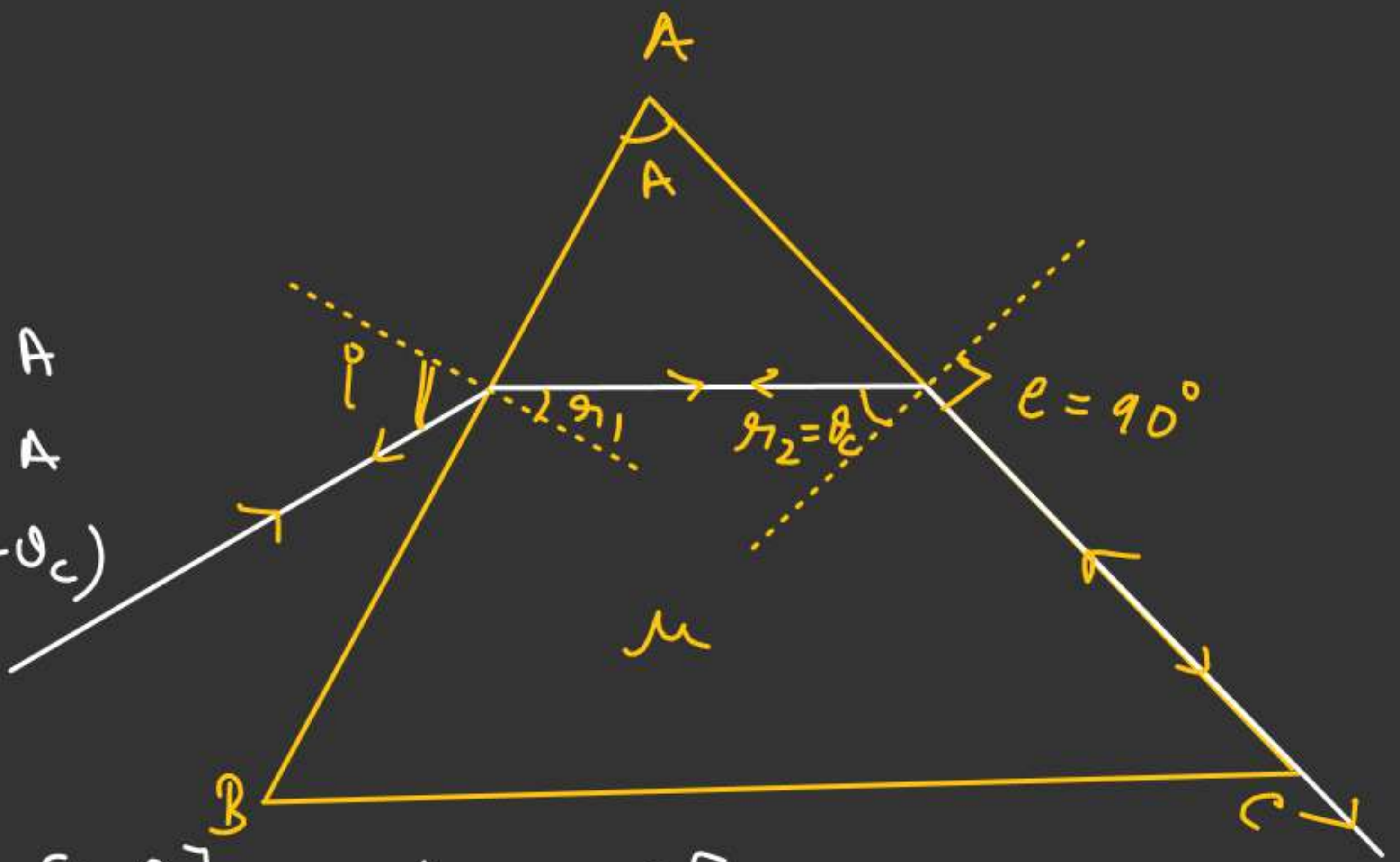
$\mu \sin r_2 = 1 \cdot \sin 90$ (AC)

$\sin \theta_c = \left(\frac{1}{\mu}\right)$

$r_1 + r_2 = A$

$r_1 + \theta_c = A$

$r_1 = (A - \theta_c)$



for AB

$1 \cdot \sin i° = \mu \sin r_1$

$\sin i° = \mu \sin(A - \theta_c)$

$\sin i° = \mu[\sin A \cdot \cos\theta_c - \cos A \cdot \sin\theta_c]$

$\sin i° = \mu\left[\sin A \sqrt{1 - \sin^2\theta_c} - \cos A \cdot \sin\theta_c\right]$

$\sin i° = \mu\left[\sin A \sqrt{1 - \frac{1}{\mu^2}} - \frac{\cos A}{\mu}\right]$

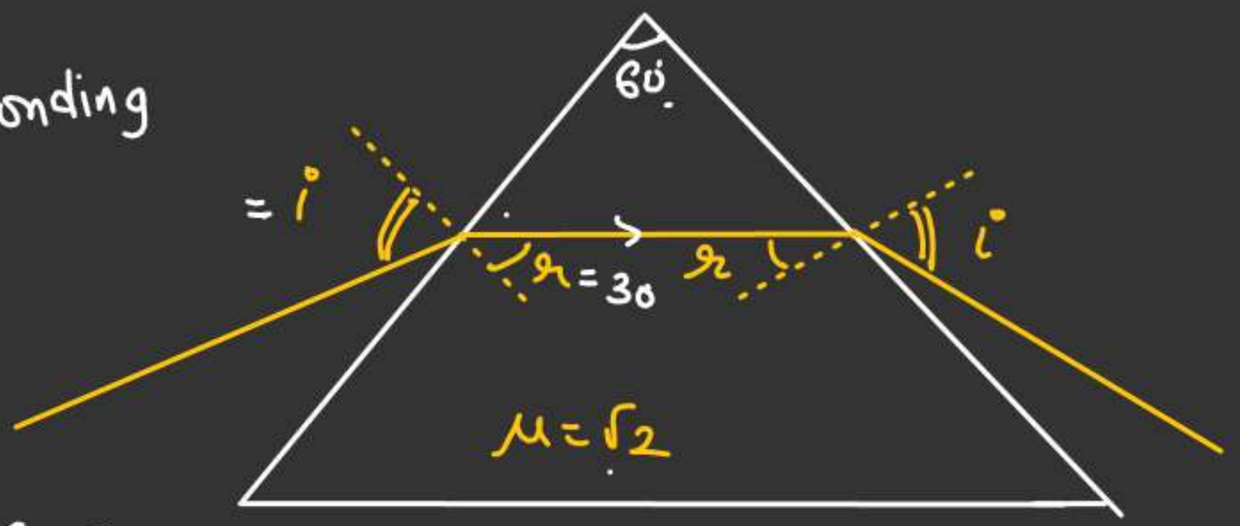
$i = \sin^{-1}\left[\sin A \sqrt{\mu^2 - 1} - \cos A\right]$ ✓

PRISM

\# A ray of light undergoes a deviation of 30° when incident on an equilateral prism of refractive index $\sqrt{2}$ $\rightarrow$

What is the angle subtended by refracted ray inside the prism from base of the prism.

$i = e$
$r_1 = r_2$



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

$\sqrt{2} \rightarrow \mu$ Corresponding to δ_{min}

$$\mu = \frac{\sin\left(\frac{60^\circ+30^\circ}{2}\right)}{\sin 30^\circ}$$

$$\mu = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{1}{\sqrt{2}} \times 2 = \sqrt{2}$$

$\Downarrow$

$1 \cdot \sin i = \sqrt{2} \cdot \sin 30^\circ$

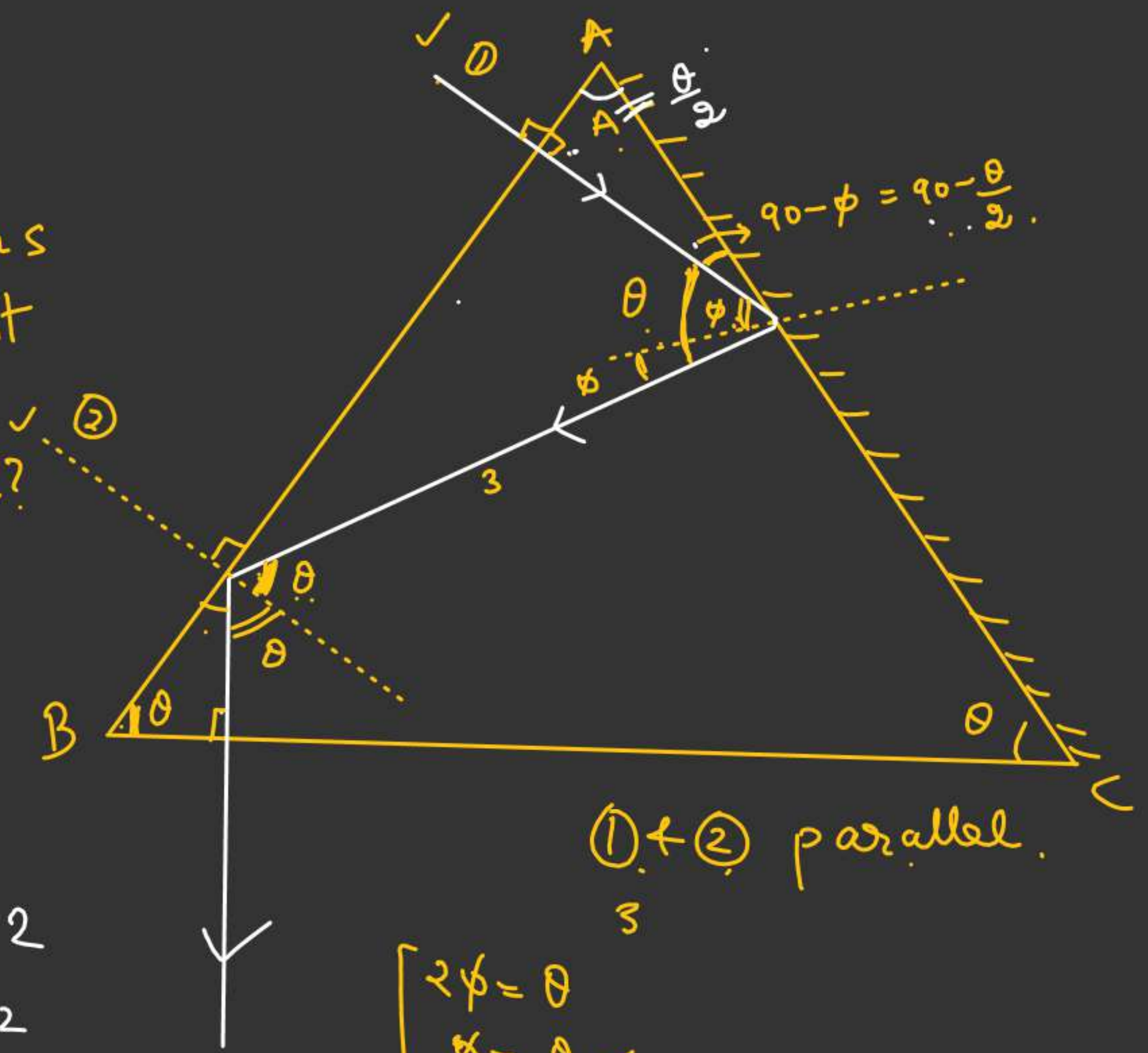
$\sin i = \frac{1}{\sqrt{2}}$

$i = 45^\circ$

Nishant Jindal

PRISM

Q. An Isosceles prism having one side silvered. A ray of light incident Normally on face AB after that it suffers two reflection & finally incident normally on face BC then find $\theta = ??$, & Angle of prism $= ??$



$A + 2\theta = 180^\circ$

$A = (180 - 2\theta)$ $\left(A = \frac{\theta}{2}\right)$

$\frac{\theta}{2} + 2\theta = 180^\circ$

$\frac{5\theta}{2} = 180^\circ$

$5\theta = 180^\circ \times 2$

$\theta = \frac{180 \times 2}{5}$

$\theta = 72^\circ$ $A = \theta/2 = 36^\circ$

① & ② parallel.

$2\phi = \theta$

$\phi = \frac{\theta}{2}$

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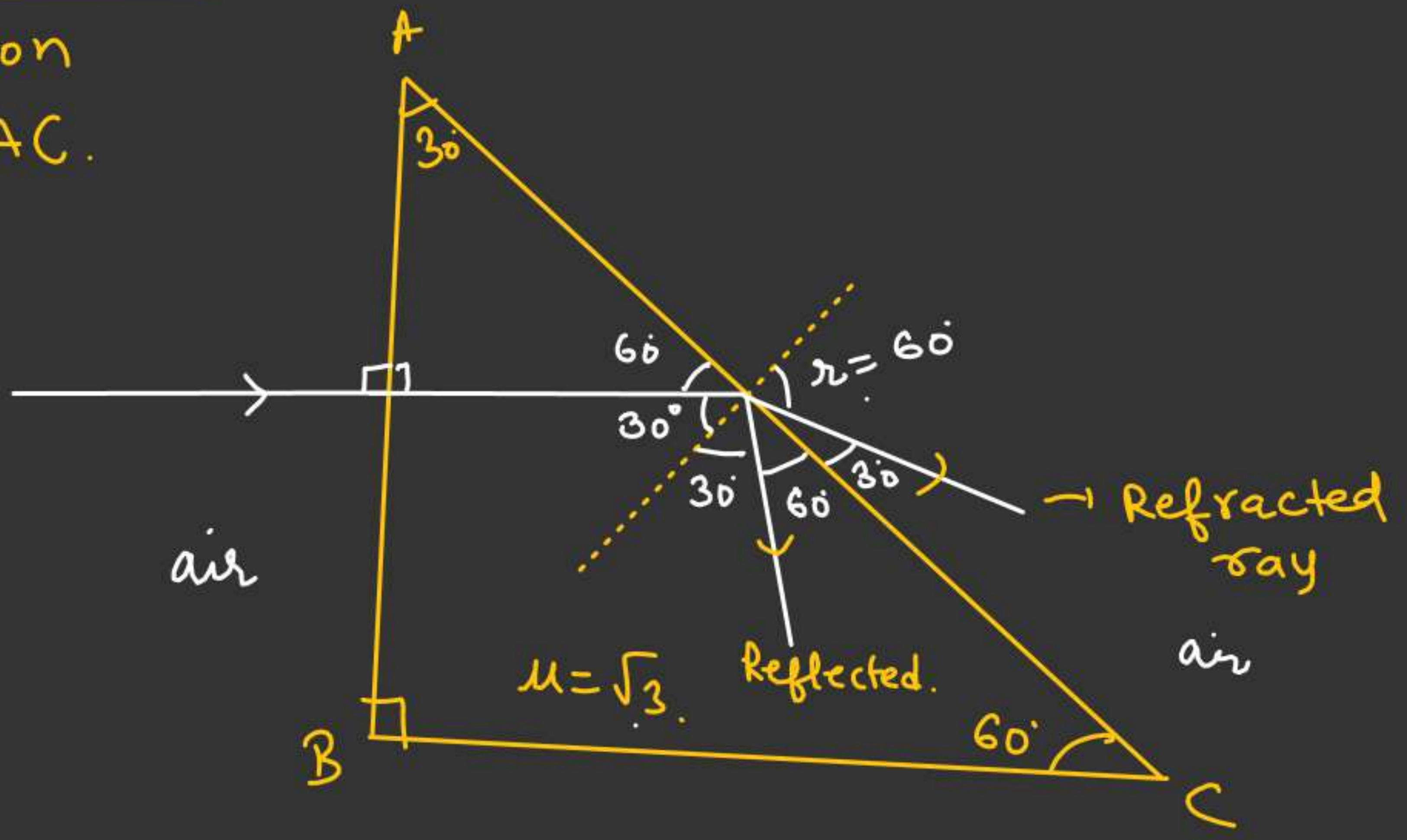
PRISM

light ray suffer reflection as well as reflection from AC. then find angle b/w reflected ray & refracted ray



$\sqrt{3}\sin 30^\circ = 1 \cdot \sin r$

$\frac{\sqrt{3}}{2} = \sin r$

$r = 60^\circ$

Angle b/w Reflected & Refracted ray = $\underline{90^\circ}$ ✓

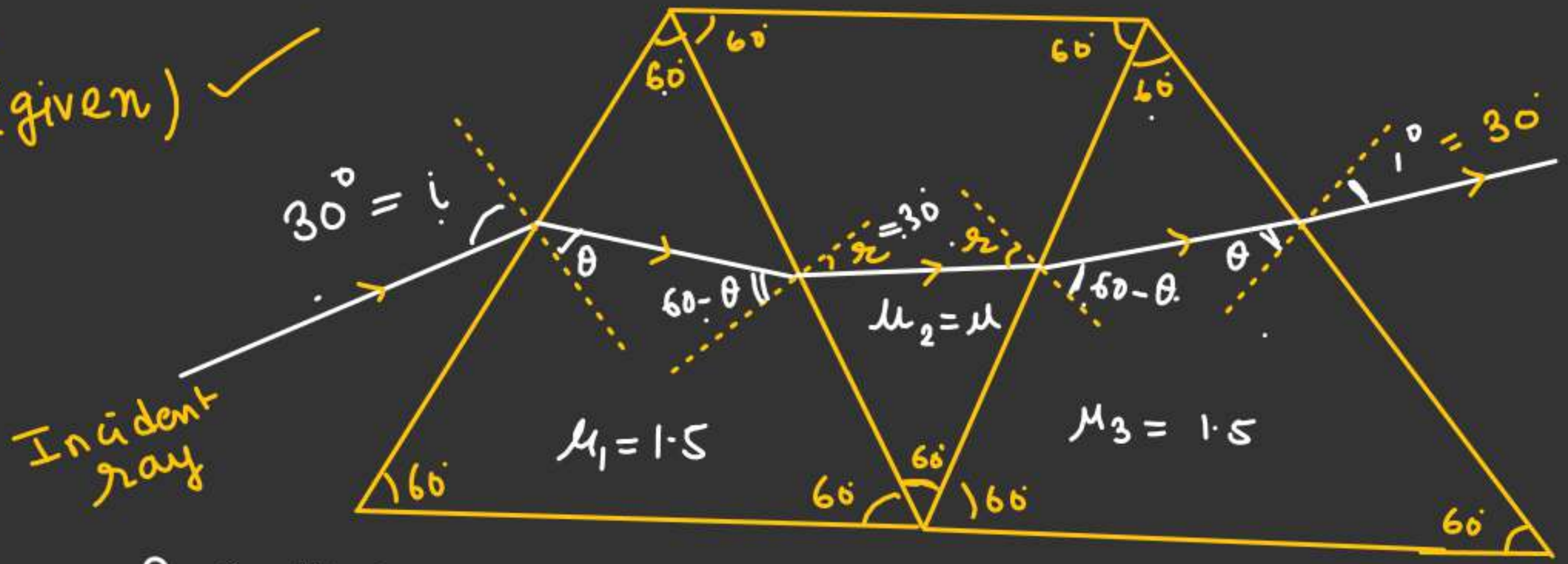
PRISM

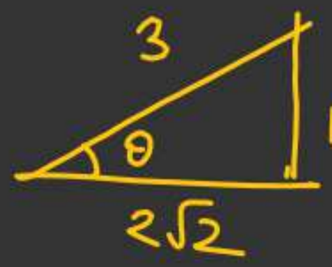
Final refracted ray become parallel to incident ray. then find $\mu = ??$

$\sqrt{6} = 2.4$ (given)

$\mu = ??$

$i = 30^\circ$ (given)





$2r = 60^\circ$

$r = 30^\circ$

By Snell's law.

$$\frac{3}{2}\sin(60-\theta) = \mu \cdot \sin 30^\circ$$

$$3\sin(60-\theta) = \mu$$

$$3\left[\sin 60^\circ \cdot \cos\theta - \cos 60^\circ \cdot \sin\theta\right] = \mu$$

$$\left[\frac{\sqrt{3}}{2}\cos\theta - \frac{1}{2}\sin\theta\right] = \frac{\mu}{3}$$

$$\left[\sqrt{3}\cos\theta - \sin\theta\right] = \frac{2}{3}\mu \quad - (1)$$

Snell's Law

$$1 \cdot \sin 30^\circ = \frac{3}{2}\sin\theta.$$

$$\frac{1}{2} = \frac{3}{2}\sin\theta$$

$$\sin\theta = \frac{1}{3}$$

$$\left(\sqrt{3} \times \frac{2\sqrt{2}}{3} - \frac{1}{3}\right) = \frac{2}{3}\mu$$

$$\mu = \left(\sqrt{6} - \frac{1}{2}\right)$$

$$\mu = \left(\frac{2\sqrt{6}-1}{2}\right)$$

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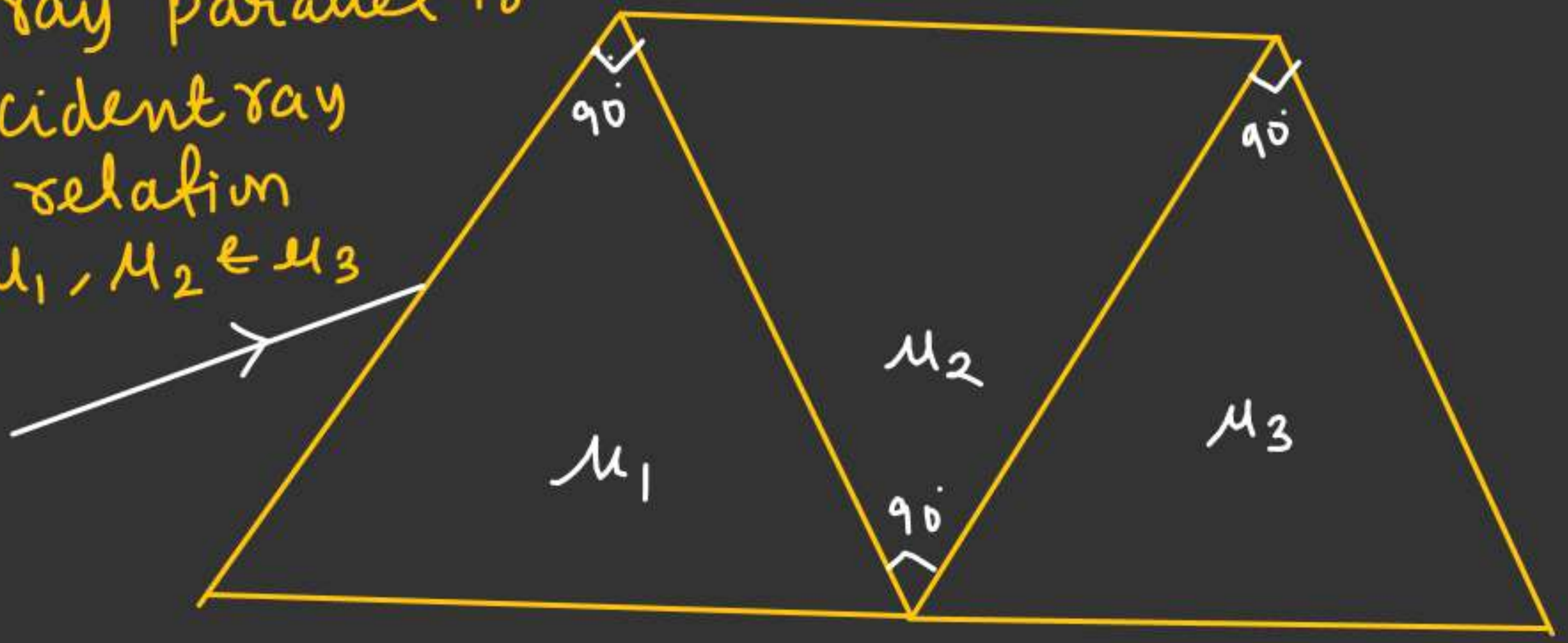
PRISM

H.W

Finally refracted ray parallel to incident ray

Find relation b/w μ_1, μ_2 & μ_3



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PRISM

\# Find net deviation.

Reflected ray passes through the prsim.

$\delta_{net} = \delta_1 \circlearrowright - \delta_2 \circlearrowleft$

$\delta_1 = 180 - 120$

$= 60 \circlearrowright \rightarrow +ve.$

$\delta_2 = (\mu - 1) A$

$= (2-1) 6^\circ$

$= -6^\circ \circlearrowleft$

$\delta_{net} = (60 - 6)$

$= +54^\circ \circlearrowright$