Physicsaholics

DPP – 4 (Geometrical Optics)

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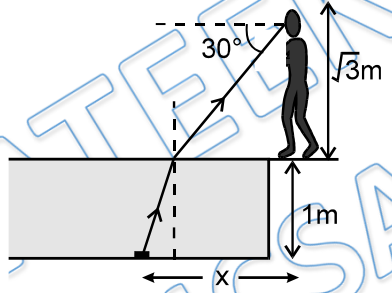
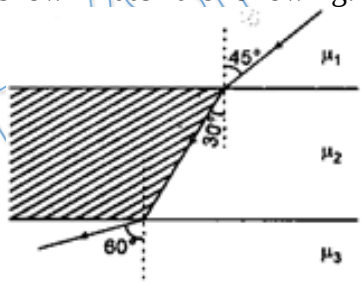
Q 1. The refractive index of air with respect to glass is 2/3. The refractive index of diamond with respect to air is 12/5. Then the refractive index of glass with respect to diamond will be

(a) 5/8 (b) 8/9 (c) 5/18 (d) 18/5

Q 2. A man is standing at the edge of a 1m deep swimming pool, completely filled with a liquid of refractive index. $\sqrt{3/2}$. The eyes of the man are $\sqrt{3}$ m above the ground. A coin located at the bottom of the pool appears to be at an angle of depression of 30^0 with reference to the eye of man. Then horizontal distance (represented by x in the figure) of the coin from the eye of the man is _____ mm.



Q 3. For the figure shown match the following:



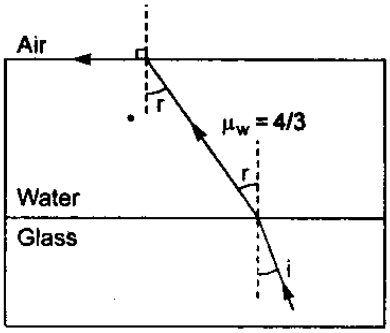
(a)	μ_1/μ_3	(p)	$\sqrt{2}$
(b)	μ_2/μ_1	(q)	$\sqrt{1.5}$
(c)	μ_2/μ_3	(r)	$\sqrt{3}$

Q 4. A light of wavelength 6000 Å in air enters a medium of refractive index 1.5. Inside the medium, its frequency is ν and its wavelength is λ.

(a) $\nu = 5 \times 10^{14}$ Hz (b) $\nu = 7.5 \times 10^{14}$ Hz

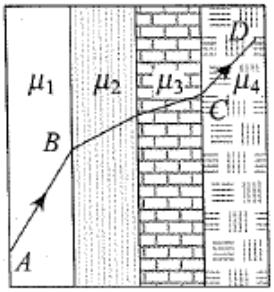
(c) $\lambda = 4000$ Å (d) $\lambda = 9000$Å

Q 5. A ray of light is incident at the glass-water interface at an angle i, it emerges finally parallel to the surface of water, then the value of μ_g would be:



(a) (4/3) sin i (b) 1/sin i (c) 4/3 (d) i

Q 6. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have.

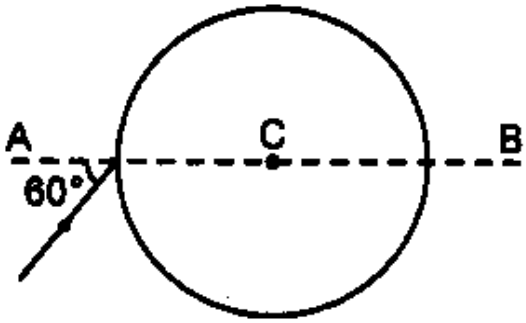


(a) $\mu_1 = \mu_2$ (b) $\mu_2 = \mu_3$ (c) $\mu_3 = \mu_4$ (d) $\mu_4 = \mu_1$

Q 7. The x-z plane separates two media A and B of refractive indices $\mu_1 = 1.5$ and $\mu_2 = 2$. A ray of light travels from A to B. Its directions in the two media are given by unit vectors $\vec{a}_1 = a\hat{\imath} + b\hat{\jmath}$ and $u_2 = c\hat{\imath} + d\hat{\jmath}$. Then:

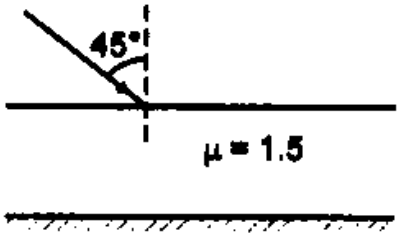
(a) $\frac{a}{c} = \frac{4}{3}$ (b) $\frac{a}{c} = \frac{3}{4}$ (c) $\frac{b}{d} = \frac{4}{3}$ (d) $\frac{b}{d} = \frac{3}{4}$

Q 8. A ray of light falls on a transparent sphere with center at C as shown in figure. The ray emerges from the sphere parallel to line AB. The refractive index of the sphere is



(a) $\sqrt{2}$ (b) $\sqrt{3}$ (c) $\frac{3}{2}$ (d) $\frac{1}{2}$

Q 9. One side of a glass slab is silvered as shown. Any of light is incident on the other side at angle of incidence i = 45°. Refractive Index of glass is given as 1.5. The deviation of the ray of light from its initial path when it comes out of the slab is:

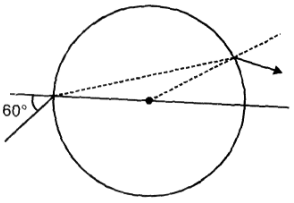


(a) 90° (b) 180° (c) 120° (d) 45°

Q 10. A ray incident at a*n* angle of incidence 60° enters a glass sphere of refractive index μ = $\sqrt{3}$ This ray is reflected and refracted at the farther surface of the sphere. The angle between reflected and refracted rays at this surface is:

(a) 90° (b) 60° (c) 70° (d) 40°

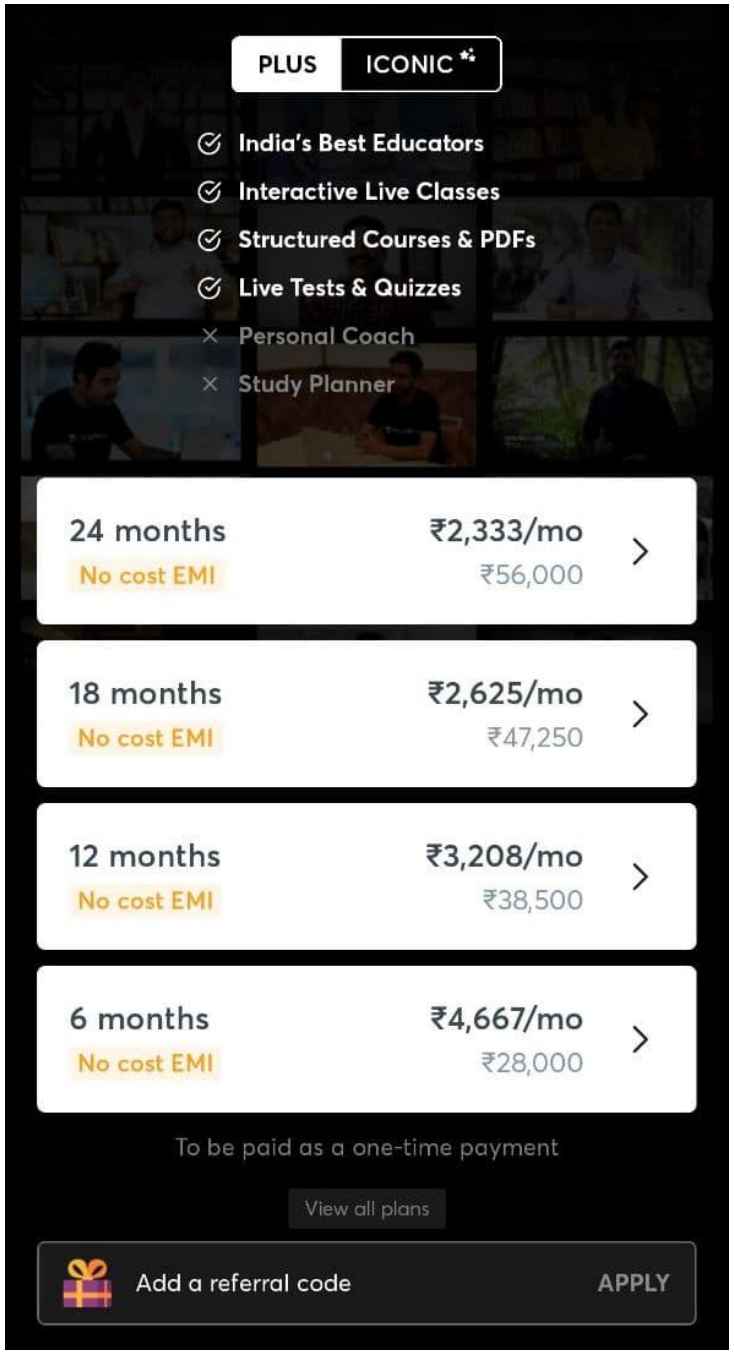
Q 11. A ray is incident at an angle 60° on a sphere which is made of material having refractive index $\sqrt{3}$ find angle by which final ray is deviated



(a) 30° (b)15° (c) 45° (d)60°

Answer Key

Q.1 a	**Q.2 4000**	**Q.3 a(q), b(p), c(r)**	**Q.4 a, c**	**Q.5 b**
Q.6 d	**Q.7 a**	**Q.8 b**	**Q.9 a**	**Q.10 a**
Q.11 d				



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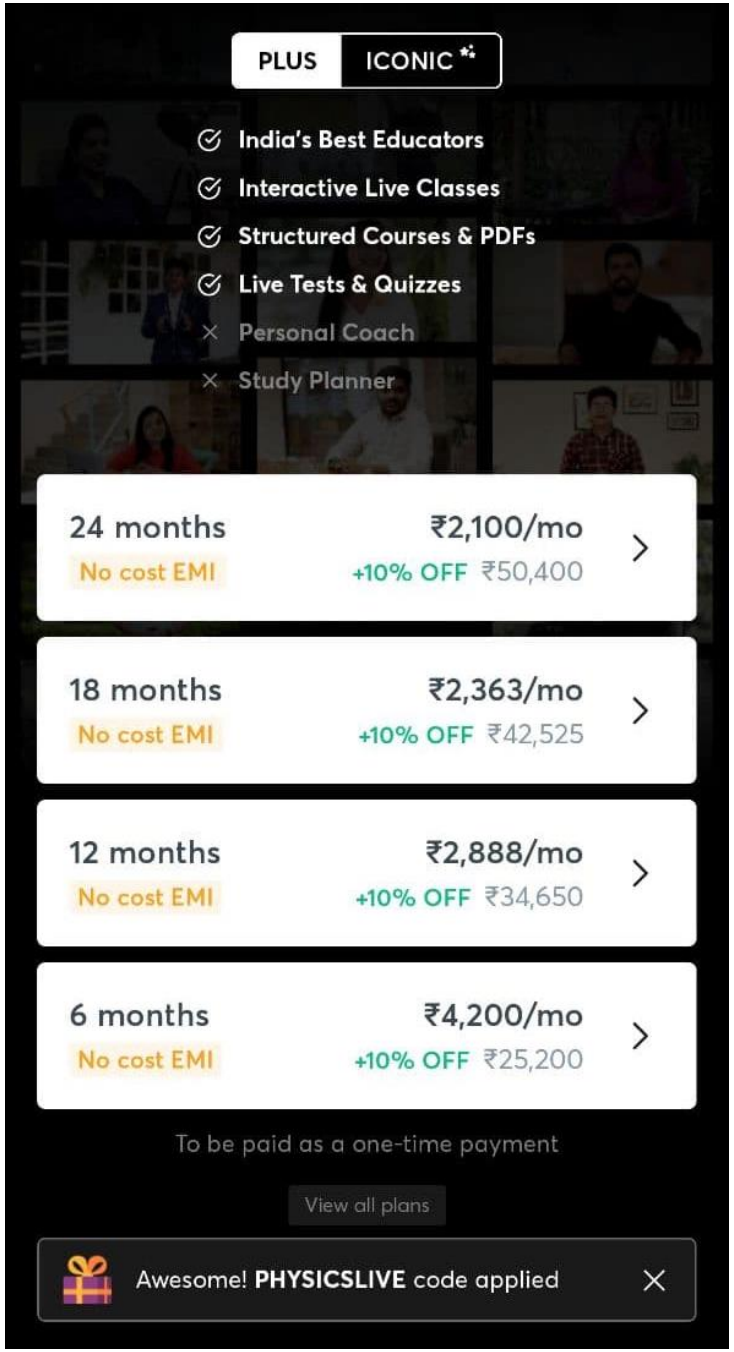


Written Solution

DPP 4 – Snell's Law

By Physicsaholics Team

Solution: 1

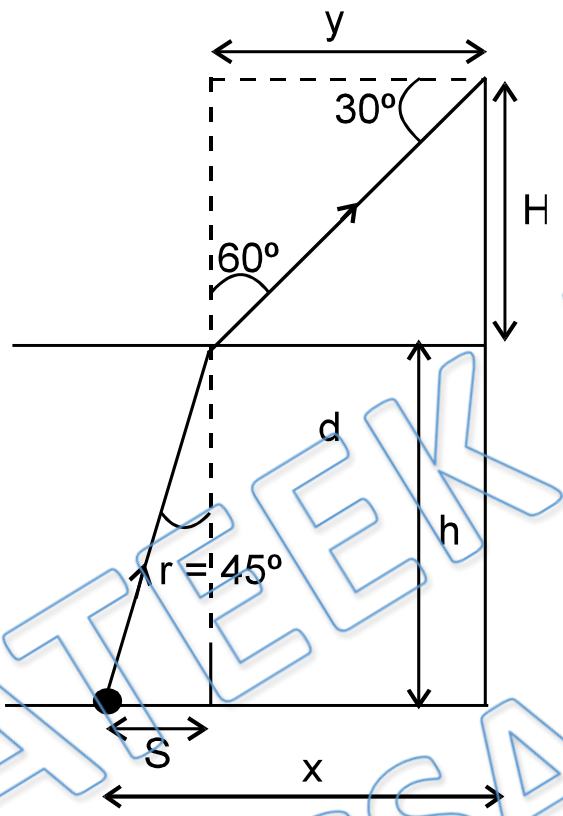
$$_g\mu_a = \frac{\mu_a}{\mu_g} = \frac{2}{3} \Rightarrow \mu_g = 3/2$$

$$_a\mu_D = 12/5 = \frac{\mu_D}{\mu_a} \Rightarrow \mu_D = 12/5$$

$$_D\mu_g = \frac{\mu_g}{\mu_D} = \frac{3/2}{12/5} = \frac{3\times 5}{2\times 12} = \frac{5}{8}$$

Ans (a)

Solution: 2



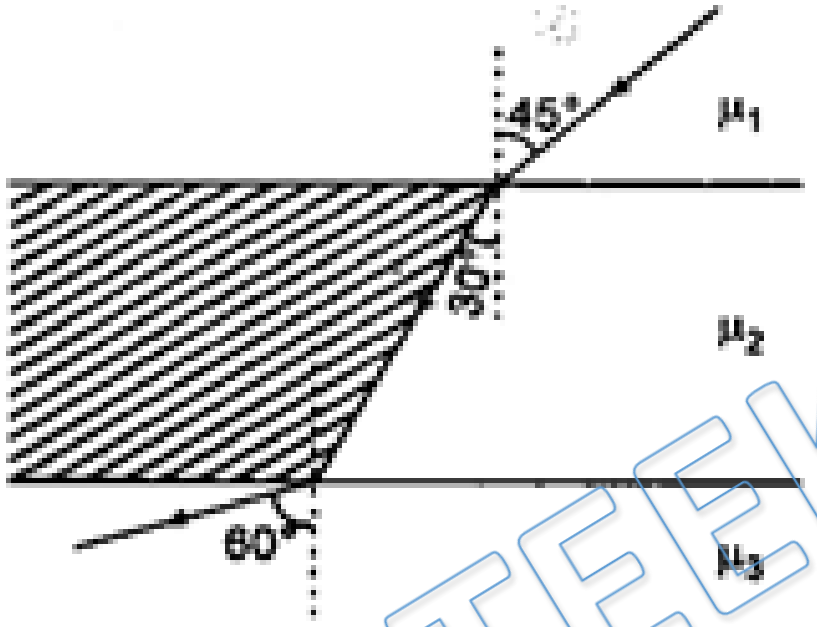
sin 60º = √(3/2) sinr r = 45º

S = h = 1 m

y = H tan60^0 = 3m

x= S + y = 4m = 4000 mm

Solution: 3



Using Snell's Law

$$\mu_1 \sin 45^\circ = \mu_2 \sin 30^\circ = \mu_3 \sin 60^\circ$$

$$\Rightarrow \frac{\mu_1}{\sqrt{2}} = \frac{\mu_2}{2} = \frac{\mu_3\sqrt{3}}{2}$$

$$\frac{\mu_1}{\mu_3} = \sqrt{\frac{3}{2}}$$

$$\frac{\mu_2}{\mu_1} = \sqrt{2}$$

$$\frac{\mu_2}{\mu_3} = \sqrt{3}$$

Solution: 4

$$\lambda_{air} = 6000\,A^{\circ} = 6\times10^{-7}\ m$$

$$\nu = \frac{c}{\lambda_{air}} = \frac{3\times10^{8}}{6\times10^{-7}} = 5\times10^{15}\ s^{-1}$$

$$= 5\times10^{15}\ Hz$$

$$\mu = \frac{\lambda_{air}}{\lambda_{med}} = 1.5$$

$$\Rightarrow \lambda_{med} = \frac{6000\,A^{\circ}}{1.5} = 4000\,A^{\circ}$$

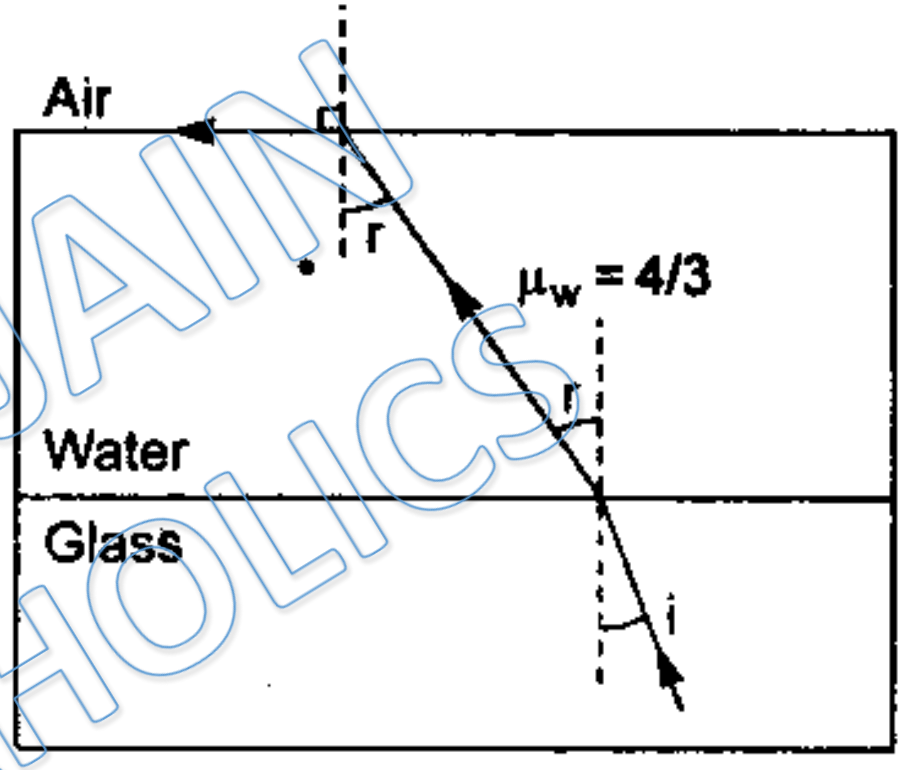
Ans (a, c)

Solution: 5

$$\mu_g \sin i = \mu_w \sin r = \mu_{air} \sin 90^\circ$$

$$\Rightarrow \quad \mu_g \sin i = 1$$

$$\Rightarrow \quad \mu_g = \frac{1}{\sin i}$$

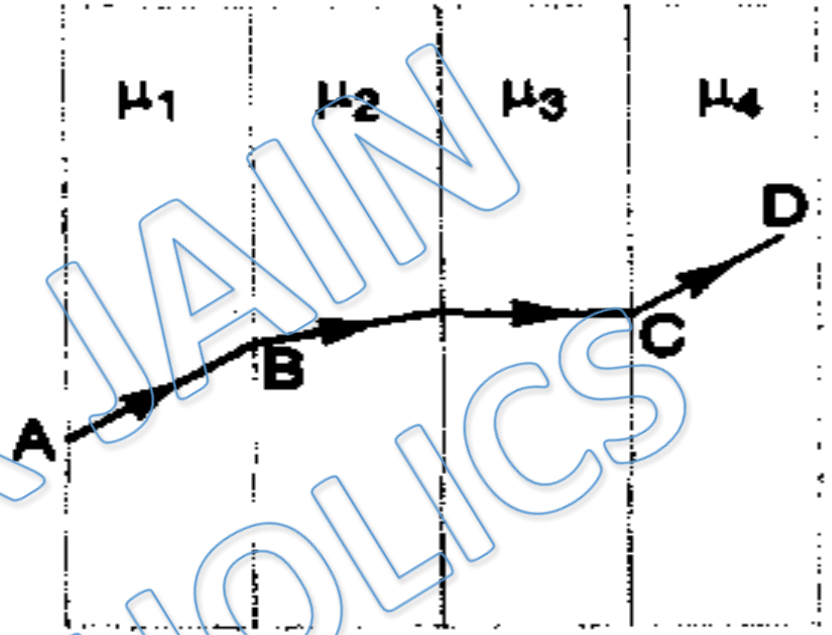


Ans(b)

Solution: 6

In multiple refraction by parallel surfaces

$$\mu \sin\theta = \text{Constant}$$



Since AB is parallel to CD,

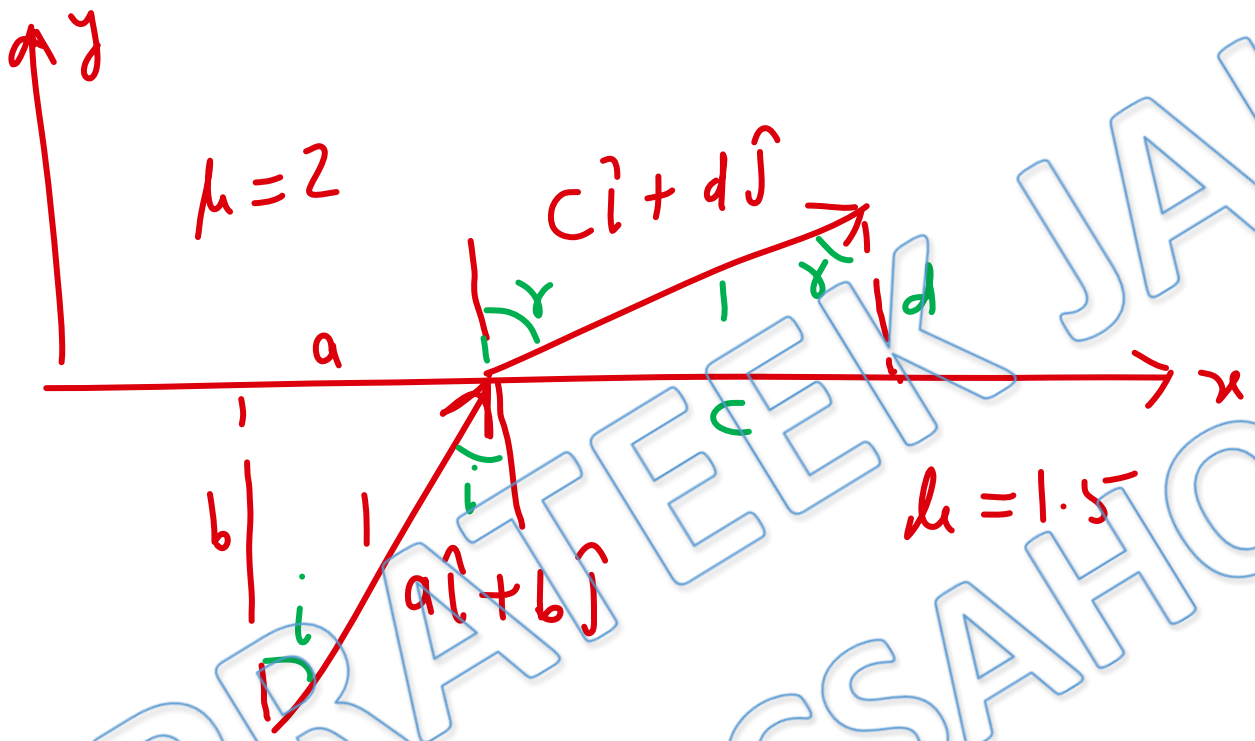
θ is same in both.

$\Rightarrow \mu$ is " " "

$\Rightarrow \mu_1 = \mu_4$

Ans(d)

Solution: 7



$1.5 \sin i = 2 \sin r \Rightarrow 1.5 \times \frac{a}{1} = 2 \times \frac{c}{1}$

$\Rightarrow \frac{a}{c} = \frac{2}{1.5} = 4/3$

Ans (a)

Solution: 8

$$\delta = \delta_1 + \delta_2$$

$$60^\circ = (60-\gamma) + (60-\gamma)$$

$$2\gamma = 60^\circ$$

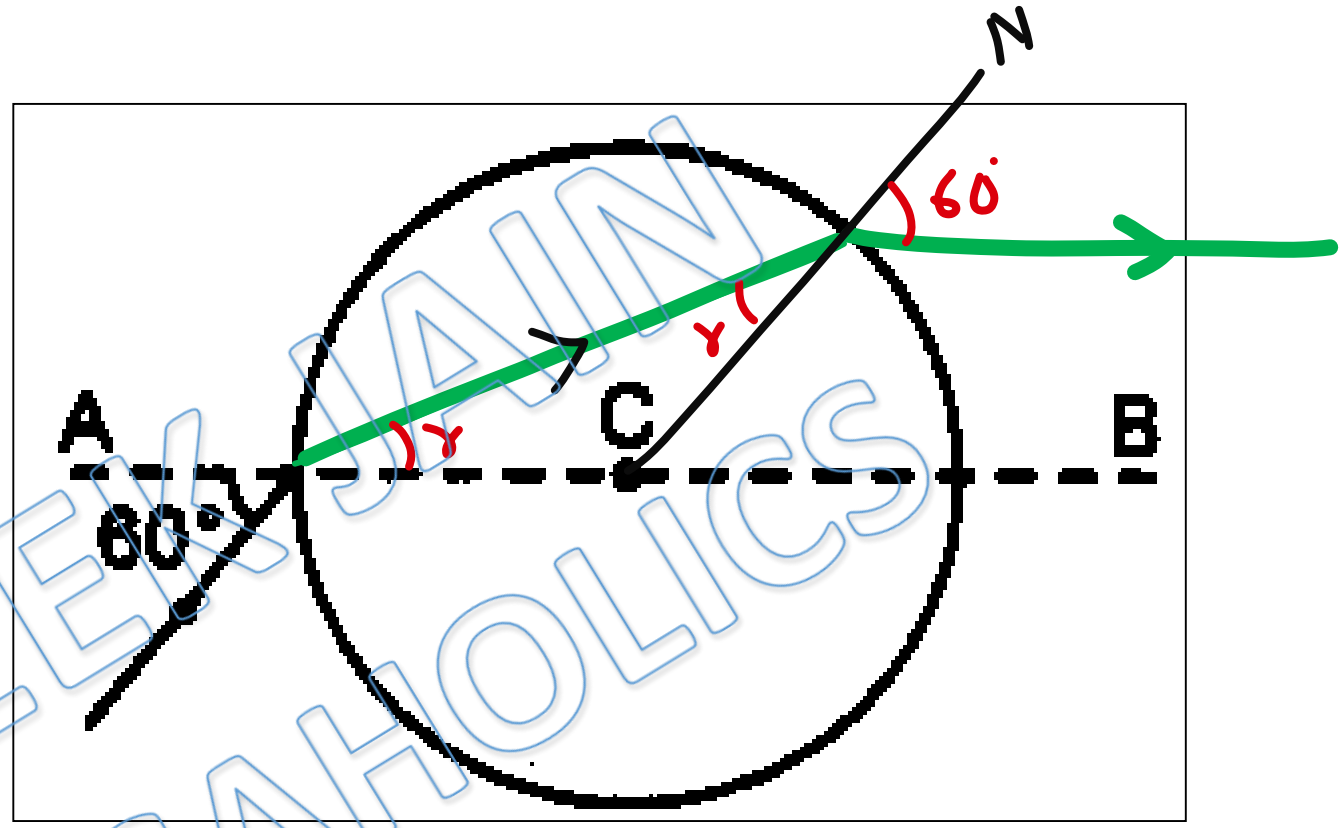
$$\gamma = 30^\circ$$

Using snell's law

$$1 \sin 60^\circ = \mu \sin 30^\circ$$

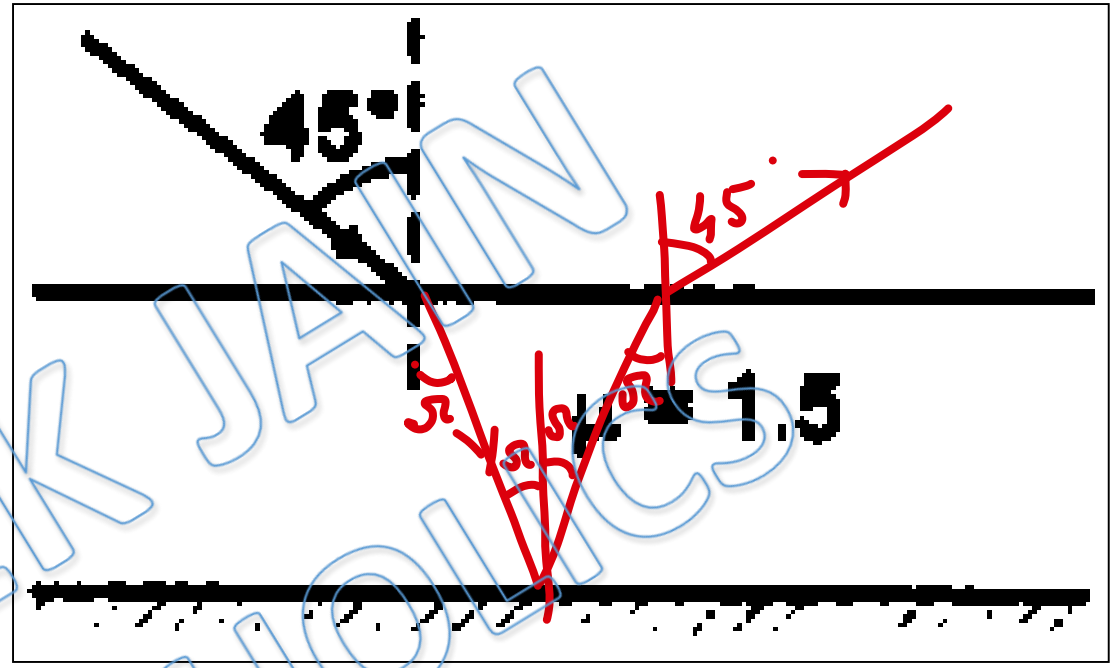
$$\frac{\sqrt{3}}{2} = \mu \times \frac{1}{2}$$

$$\Rightarrow \mu = \sqrt{3}$$



Ans (b)

Solution: 9



Total deviation
= angle between initial
& final ray = 90°

Ans(a)

Solution: 10

by using snell's law

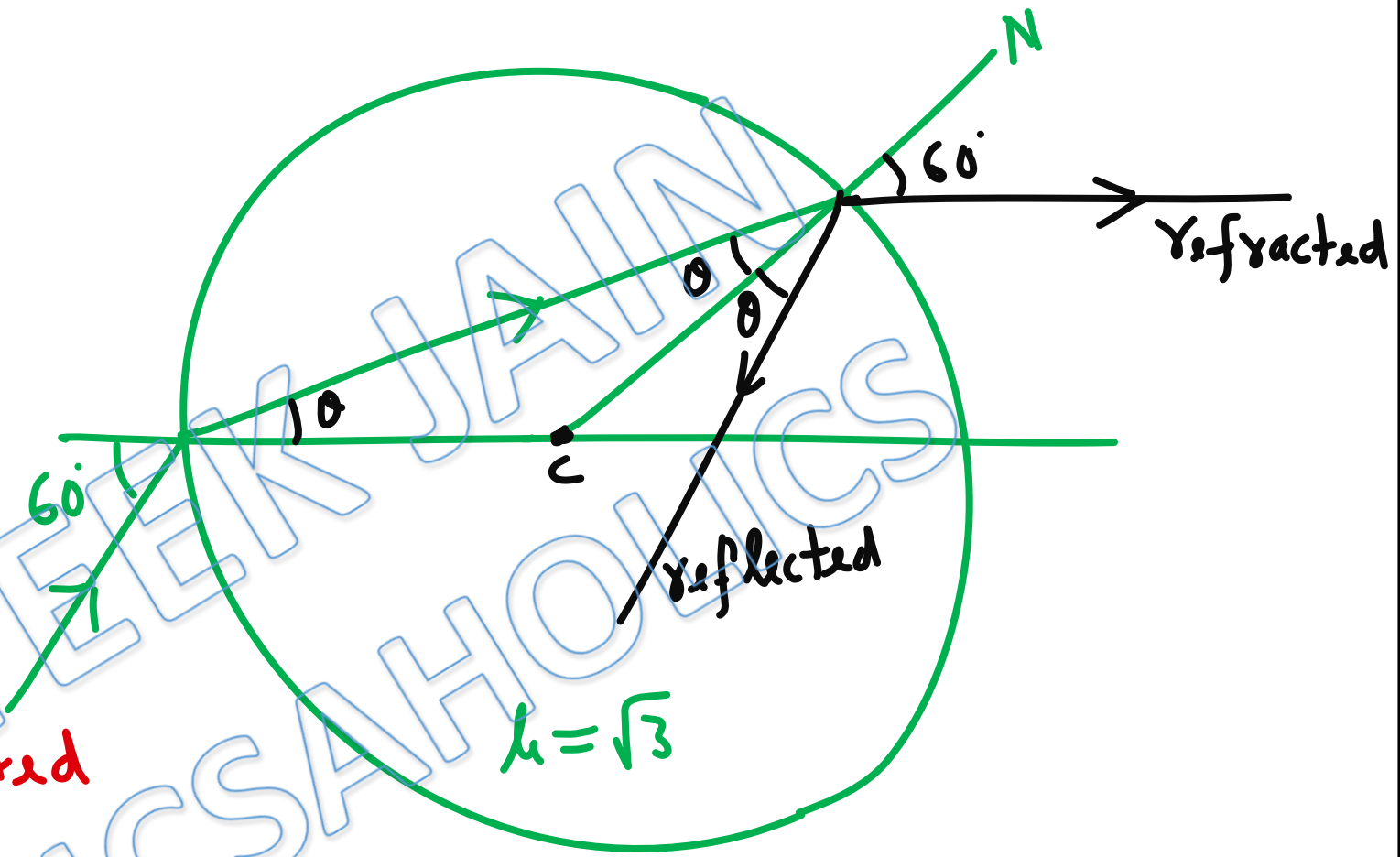
$1 \sin 60^\circ = \sqrt{3} \sin\theta$

$\Rightarrow \sin\theta = 1/2$

$\Rightarrow \theta = 30^\circ$

$\Rightarrow$ Angle between refracted and reflected ray $= 180^\circ - 60^\circ - \theta$

$= 90^\circ$



Ans(a)

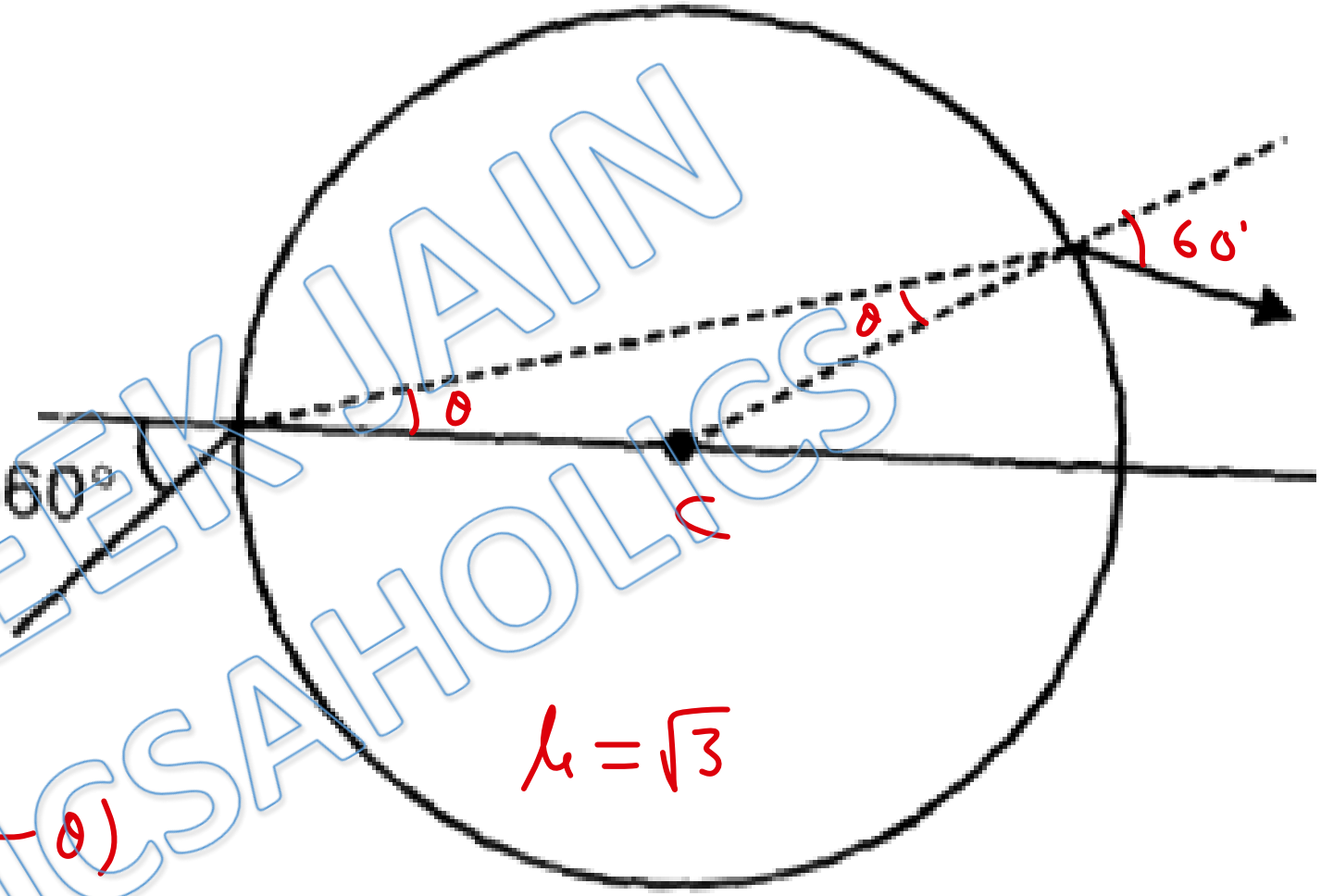
Solution: 11

by Using Snell's Law

$$1 \sin 60^\circ = \sqrt{3} \sin\theta$$

$$\Rightarrow \sin\theta = 1/2$$

$$\Rightarrow \theta = 30^\circ$$



now $\delta = \delta_1 + \delta_2$

$= (60^\circ - \theta) + (60^\circ - \theta)$

$= 120^\circ - 60^\circ$

$= 60^\circ$

Ans(d)

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