DPP 03

Solution

1. Incidence angle, $\angle i = 60°$

$\mu = \sqrt{3}$

Lateral shift, $t = 4\sqrt{3}cm$

Let the thickness of slab is d.

$\therefore$ Lateral shift, $t = \frac{d}{\cos r}\sin(i - r)$ ... (i)

$\mu = \frac{\sin i}{\sin r} \Rightarrow \sqrt{3} = \frac{\sin 60°}{\sin r}$;

$\sin r = \frac{1}{2} \Rightarrow r = 30°$

From equation (i), we get

$4\sqrt{3} = \frac{d}{\cos 30°}\sin(60° - 30°)$;

$4\sqrt{3} = \frac{d \times 2}{\sqrt{3}} \times \frac{1}{2}; d = 12cm$

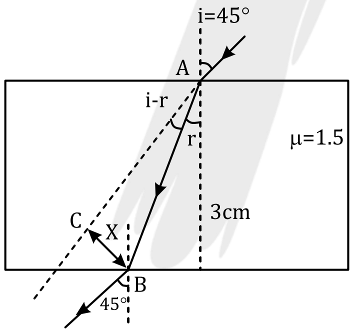
2. The snell's law at the interfaces

$n \sin\theta = n_1 \sin\theta_2 = n_2 \sin\theta_3 = \ldots\ldots n_m \sin 90°$

$\therefore 1.6 \sin 30° = (n - m\Delta n)\sin 90°$

$1.6 \times \frac{1}{2} = 1.6 - m \times 0.1 \Rightarrow 0.8 = 1.6 - m \times 0.1$ or $m = 8$

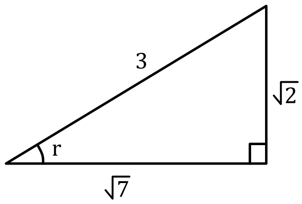
3.



Emergent ray is parallel to incident Ray, angle of emergence = 45°

$\mu = \frac{\sin 45}{\sin r} = 1.5$

$\sin r = \frac{1}{\sqrt{2} \times 1.5} = \frac{\sqrt{2}}{3}$



$$AB = \frac{3}{\cos r} \times = AB\sin(i - r) = \frac{3\left[\frac{1}{\sqrt{2}} \times \frac{\sqrt{7}}{3} - \frac{1}{\sqrt{2}} \times \frac{\sqrt{2}}{3}\right]}{\frac{\sqrt{7}}{3}} = 3\left[\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{7}}\right] cm$$

4. Apparent depth

$$= \frac{t}{\mu} = \frac{40}{4} \times 3 = 30\ cm$$

5. Apparent shift $= 25\left(1 - \frac{2}{3}\right) + 15\left(1 - \frac{2}{5}\right) = \frac{52}{3} cm.$ toward A

Apparent depth $= \left(25 + 15 - \frac{52}{3}\right) = \frac{68}{3} cm$

6. Apparent shift

$$= 1.4\left(1 - \frac{1}{1.4}\right) + 2\left(1 - \frac{1}{1}\right) + 1.3\left(1 - \frac{1}{1.3}\right) + 2\left(1 - \frac{1}{1}\right) + 1.2\left(1 - \frac{1}{1.2}\right) + 2\left(1 - \frac{1}{1}\right)$$

So image is formed 0.9 cm above P.

7. $\mu_A \rightarrow t_1;$ $t_2 - t_1 = 5 \times 10^{-10} s$ $\Rightarrow \mu_B \rightarrow t_2;$ $\frac{\mu_A}{\mu_B} = \frac{1}{2}$

Let the thickness is s.

As, $s = v_A . t_1, s = v_B . t_2, v_A t_1 = v_B t_2$

$$\frac{v_A}{v_B} = \frac{t_2}{t_1} \qquad \dots (i)$$

$$v_A = \frac{c}{\mu_A}, v_B = \frac{c}{\mu_B}$$

$$\frac{v_A}{v_B} = \frac{\mu_B}{\mu_A} = \frac{2}{1} \quad (put\ in\ (i))$$

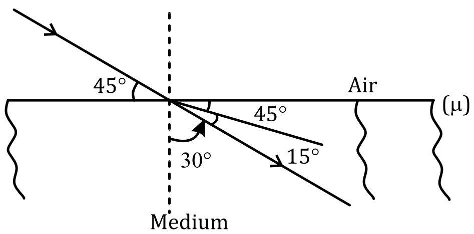
So, $\frac{t_2}{t_1} = 2; t_2 = 2t_1$

So, $t_2 - t_1 = 5 \times 10^{-10}, 2t_1 - t_1 = 5 \times 10^{-10}$

$t_1 = 5 \times 10^{-10} s$

So, $s = v_A \times t_1 = 5 \times 10^{-10} v_A$

sss8. From, snell's law



$1 \times sin(90° - 45°) = \mu \times sin(30°) \Rightarrow \sin 45° = \mu \times sin\, 3\, 0°$

$\frac{1}{\sqrt{2}} = \mu \times \frac{1}{2}; \Rightarrow \mu = \sqrt{2} = 1.414$

9. Given, refractive index, $\mu = \sqrt{2n}$ Angle of incidence, i = 2r

As, $\mu = \frac{sin\, i}{sin\, r}$

$\Rightarrow \sqrt{2n} = \frac{sin\, 2\, r}{sin\, r} = \frac{2\, sin\, r\, cos\, r}{sin\, r} = 2\, cos\, r$

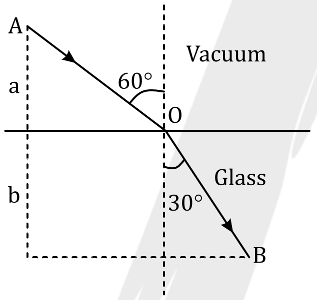
Or $cos\, r = \frac{\sqrt{2n}}{2} = \sqrt{\frac{n}{2}}$ $or\ r = cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$

Since, angle of incidence i = 2r.

Hence, $i = 2\, cos^{-1}\left(\sqrt{\frac{n}{2}}\right)$

10. (c)

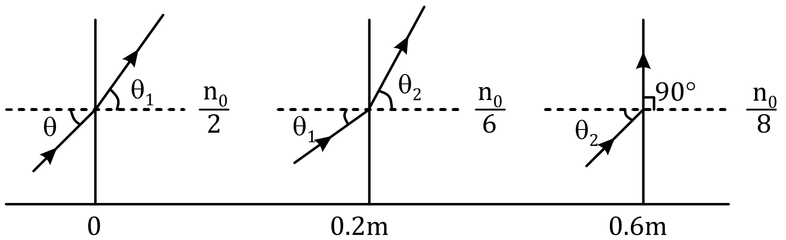
11.



From snell's law, $\frac{sin\, i}{sin\, r} = \mu \Rightarrow \frac{\sin 60°}{\sin 30°} = \mu \Rightarrow \mu = \sqrt{3}$

Required optical path length $= AO + \mu(OB) = \frac{a}{\sin 30°} + \frac{b}{\cos 30°} \times \sqrt{3} = 2a + 2b$

12. As the beam just misses entering the region IV, the angle of refraction in the region IV must be 90°.



By snell's law

$$n_0 \, sin\,\theta = \frac{n_0}{2} sin\,\theta_1 = \frac{n_0}{6} sin\,\theta_2 = \frac{n_0}{8} \sin 90^\circ \Rightarrow sin\,\theta = \frac{1}{8} \; or \; \theta = sin^{-1}\frac{1}{8}$$