आज PHYSICS में मचाते हैं |

SIR PRATEEK JAIN

. Founder @Physicsaholics
. Top Physics Faculty on Unacademy (IIT JEE & NEET)
. 8+ years of teaching experience in top institutes
  like FIITJEE (Delhi, Indore) , CP (KOTA) etc.
. Produced multiple Top ranks.
. Research work with HC Verma sir at
  IIT Kanpur
. Interviewed by International media.

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JEE MAINS
Previous Years Questions

Geometrical Optics
By Physicsaholics Team

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PYQs on Following Subtopic:

Number of Images when two mirrors are at certain angle.

To get three images of a single object, one should have two plane mirrors at an angle of [2003]

(a) 60°   (b) 90°   (c) 120°   (d) 30°   JEE Main

$$n = \frac{360}{\theta}$$

$\theta = 90 \Rightarrow \frac{360}{90} = 4 \Rightarrow$ no. of Images = 3

$\theta = 120 \Rightarrow \frac{360}{90} = 3 \Rightarrow$ no. of Images = 3   If object is not at

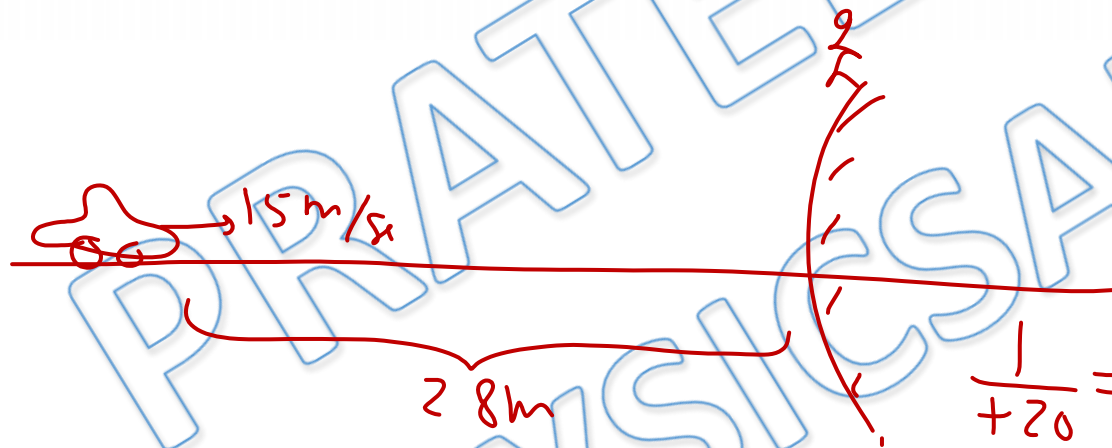Symmetric position

= 2 ,, ,, ,, at Sym ,, ,,

Ans. b

PYQs on Following Subtopic:

Mirror Formula & Velocity of Object & Image

A car is fitted with a convex side-view mirror of focal length 20 cm. A second car 2.8 m behind the first car is overtaking the first car at a relative speed of 15 m/s. The speed of the image of the second car as seen in the mirror of the first one is : **[2011] JEE Main**

(a) $\dfrac{1}{15}$ m/s (b) 10 m/s (c) 15 m/s (d) $\dfrac{1}{10}$ m/s

$$V_I = -\left(\frac{v^2}{u^2}\right) V_0$$

$$= -\left(\frac{280}{15 - (-280)}\right)^2 \times 15$$

$$\frac{1}{+20} = \frac{1}{V} + \frac{1}{-280} \qquad = -\frac{15}{15 \times 15}$$

$$\frac{1}{V} = \frac{1}{280} + \frac{1}{20} \qquad = -\frac{1}{15} \text{ m/sec}$$

$$\frac{1}{V} = \frac{1 + 14}{280} = \frac{15}{280}$$

Ans. a

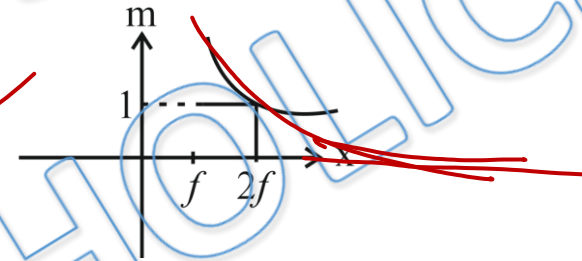Q) An object is gradually moving away from the focal point of a concave mirror along the axis of the mirror. The graphical representation of the magnitude of linear magnification (m) versus distance of the object from the mirror (x) is correctly given by: (Graphs are drawn schematically and are not to scale)
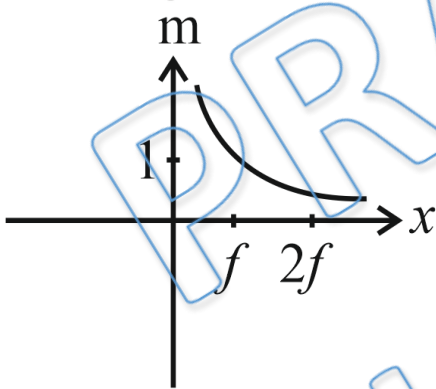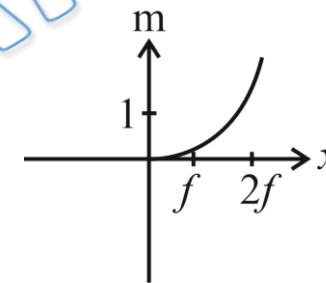
a)
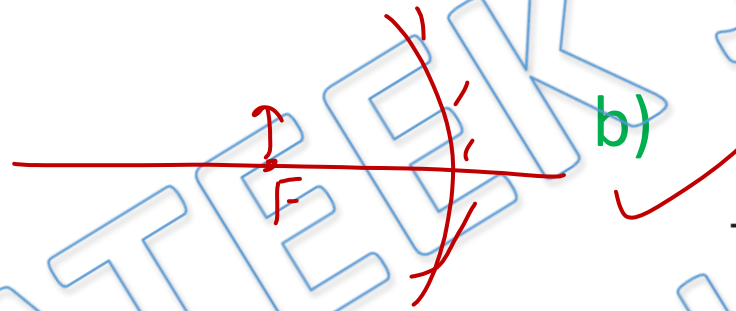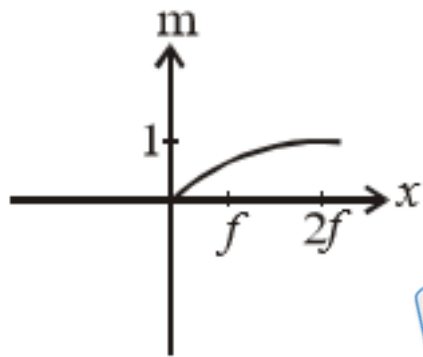
b)

c)

d)

Ans. b

PYQs on Following Subtopic:
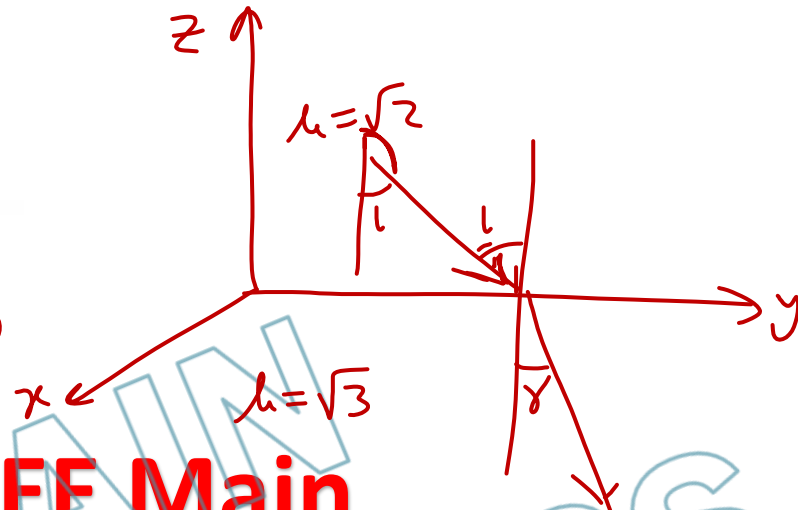
Law of Refraction
in Vector Form

Let the x-y plane be the boundary between two transparent media. Medium 1 in $z \geq 0$ has a refractive index of $\sqrt{2}$ and medium 2 with $z < 0$ has a refractive index of $\sqrt{3}$. A ray of light in medium 1 given by the vector $\vec{A} = 6\sqrt{3}\hat{i} + 8\sqrt{3}\hat{j} - 10\hat{k}$ is incident on the plane of separation. The angle of refraction in medium 2 is:

[2011] **JEE Main**

(a) 45°   (b) 60°   (c) 75°   (d) 30°

$$\sqrt{2} \times \frac{\sqrt{3}}{2} = \sqrt{3} \sin\gamma$$

$$\frac{\sqrt{3}}{\sqrt{2}}$$

$$\gamma = 45°$$

$$\cos\gamma = \frac{-10}{\sqrt{36 \times 3 + 64 \times 3 + 100}}$$

$$= \frac{-10}{\sqrt{108 + 192 + 100}} = \frac{-10}{\sqrt{400}}$$

$$= \frac{-10}{20} = -\frac{1}{2}$$

$$\cos i = +\frac{1}{2}$$

$$i = 60$$

Ans. a

PYQs on Following Subtopic:

Concept of Apparent Depth

Q) A vessel of depth 2h is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquids are immiscible. The apparent depth of the inner surface of the bottom of vessel will be:
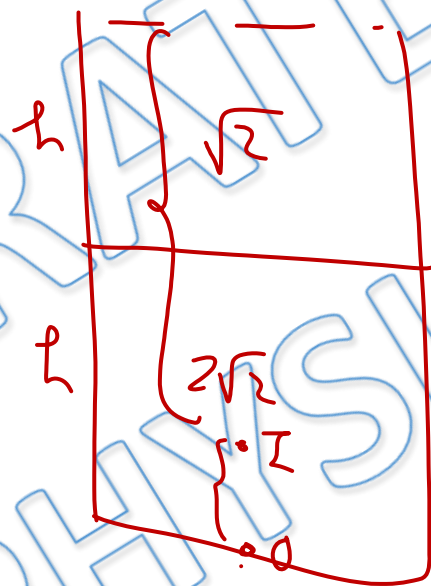
a) $\dfrac{h}{2(\sqrt{2}+1)}$

b) $\dfrac{3h}{2\sqrt{2}}$

c) $\dfrac{h}{(\sqrt{2})}$

d) $\dfrac{h}{3\sqrt{2}}$

$$\text{App Shift} = h\left(1 - \frac{1}{2\sqrt{2}}\right) + h\left(1 - \frac{1}{\sqrt{2}}\right)$$

$$= 2h - \frac{3h}{2\sqrt{2}}$$

$$\text{App depth} = 2h - \text{app Shift}$$

$$= \frac{3h}{2\sqrt{2}}.$$

Ans. b

PYQs on Following Subtopic:

Snell's Window

A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\dfrac{4}{3}$ and the fish is 12 cm below the surface, the radius of this circle in cm is

[2005] **JEE Main**

(a) $\dfrac{36}{\sqrt{7}}$

(b) $36\sqrt{7}$

(c) $4\sqrt{5}$

(d) $36\sqrt{5}$

$\sin i_c = \dfrac{3}{5}$
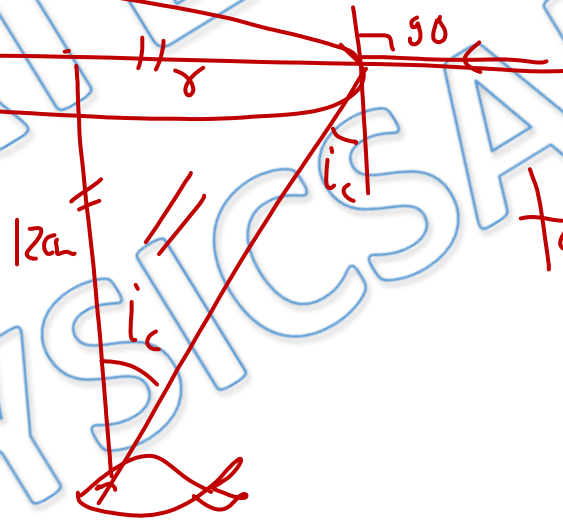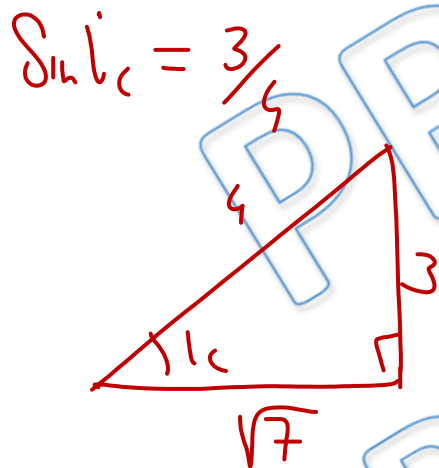
$\tan i_c = \dfrac{3}{\sqrt{7}} = \dfrac{r}{12}$

$r = \dfrac{36}{\sqrt{7}}$

Ans. a

Q) There is a small source of light at some depth below the surface of water (refractive index $\frac{4}{3}$) in in a tank of large cross sectional surface area. Neglecting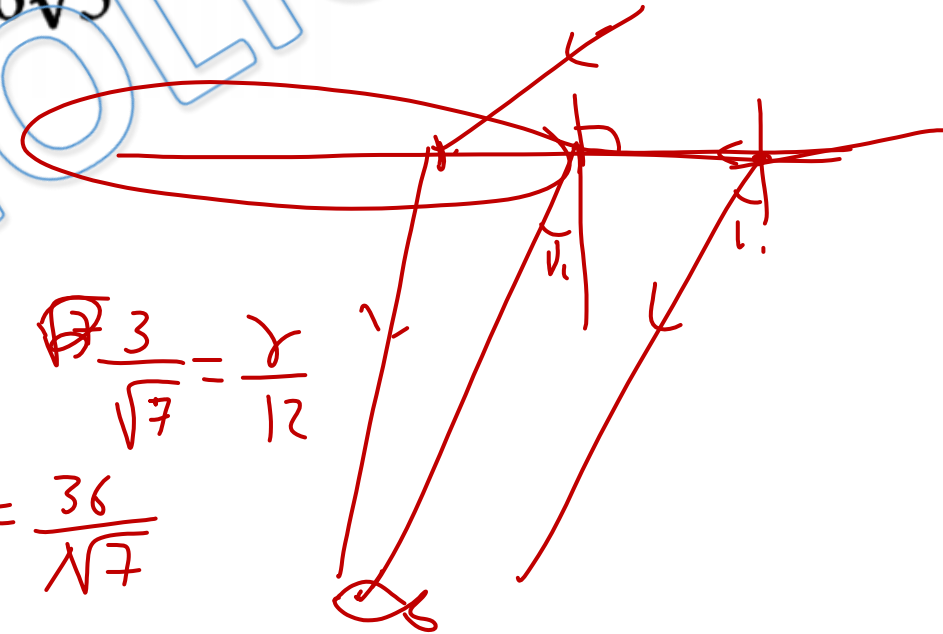 any reflection from the bottom and absorption by water, percentage of light that emerges out of surface is (nearly): [Use the fact that surface area of a spherical cap of height h and radius of curvature r is 2πrh]:

a) 17%   b) 21%   c) 34%   d) 50%

$\sin i_c = 3/5$

$\tan i_c = \frac{3}{\sqrt{7}}$

$\frac{2\pi r \times h}{4\pi r \times r} \times 100$

$= \frac{h}{2r} \times 100$

$= \frac{r(1-\frac{\sqrt{7}}{4})}{2r} \times 100$

$= \frac{4-2.6}{8} \times 100$
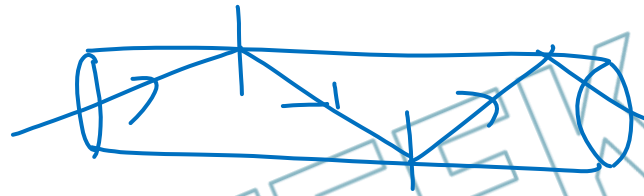
$= \frac{140}{8}$

Ans. a

PYQs on Following Subtopic:

Optical Fiber

Which of the following is used in optical fibres?
(a) total internal reflection   [2002] JEE Main
(b) scattering
(c) diffraction
(d) refraction.
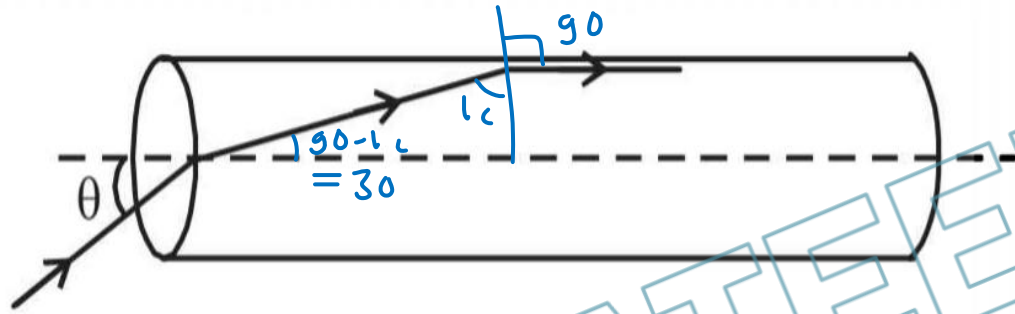
Ans. a

A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid-point of one end of the rod as shown in the figure.

$1 \times \sin\theta = \frac{2}{\sqrt{3}} \times \sin 30$

$l_c = \sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$

$= 60°$

The incident angle θ for which the light ray grazes along the wall of the rod is :

[2009] **JEE Main**

(a) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(b) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(c) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

(d) $\sin^{-1}\left(\frac{1}{2}\right)$

Ans. c

PYQs on Following Subtopic:

Lens Maker Formula

A thin convex lens made from crown glass $\left(\mu = \dfrac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\dfrac{4}{3}$ and $\dfrac{5}{3}$, it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is: **[JEE Main 2014]**

(a) $f_1 = f_2 < f$

(b) $f_1 > f$ and f_2 becomes negative

(c) $f_2 > f$ and f_1 becomes negative

(d) f_1 and f_2 both become negative

Handwritten working:

$$\frac{1}{f} = \frac{1}{2}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$f = \frac{2}{\frac{1}{R_1} - \frac{1}{R_2}}$$

$$\frac{1}{f_1} = \left(\frac{3/2}{4/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$f_1 = \frac{8}{\frac{1}{R_1} - \frac{1}{R_2}}$$

$$\frac{1}{f_2} = \left(\frac{3/2}{5/3} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$f_2 = -\frac{1}{10}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$f_2 = \frac{-10}{\frac{1}{R_1} - \frac{1}{R_2}}$$

Ans. b

Q) A thin lens made of glass (refractive index = 1.5) of focal length f = 16 cm is immersed in a liquid of refractive index 1.42. If its focal length in liquid is f_1, then the ratio f_1/f is closest to the integer:

a) 1 b) 5 c) 9 d) 17

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$
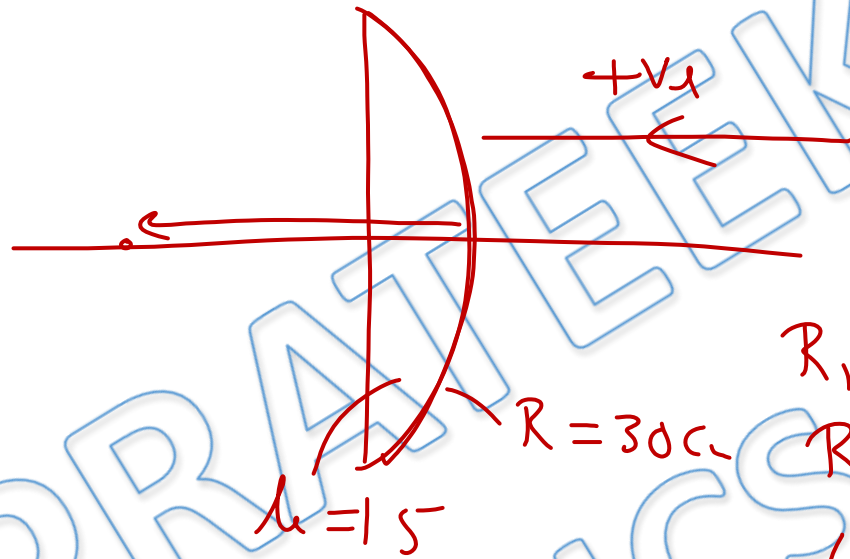
$$\frac{1}{f_1} = \left(\frac{1.5}{1.42} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{f_1}{f} = \frac{(1.5-1)1.42}{1.5-1.42} = \frac{1.42 \cdot 71}{2 \times 1.08} =$$

Ans. c

Q) A point object in air is in front of the curved surface of a plano-convex lens. The radius of curvature of the curved surface is 30 cm and the refractive index of the lens material is 1.5, then the focal length of the lens (in cm) is_____.

$+ve$

$R = 30\,cm$

$R_1 = +30\,cm$

$R_2 = \infty$

$\mu = 1.5$

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{30} - \frac{1}{\infty}\right)$$
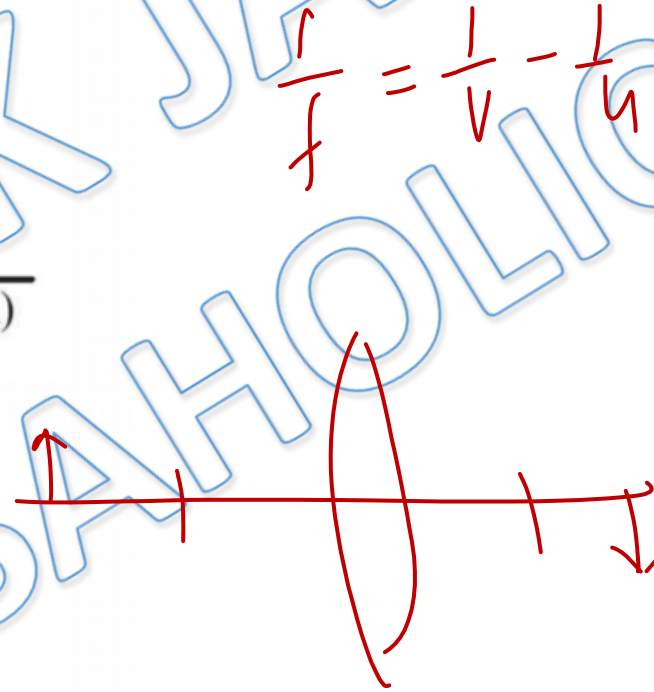
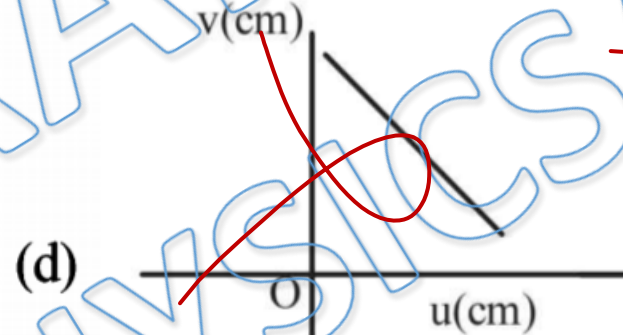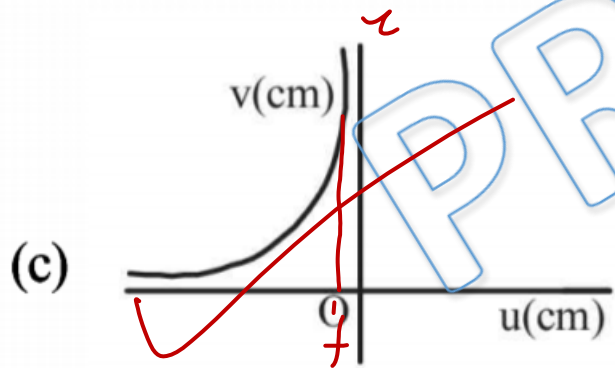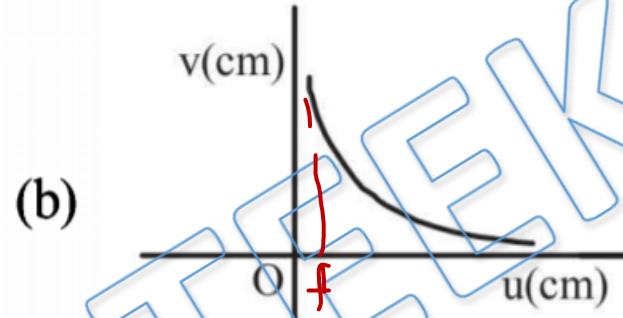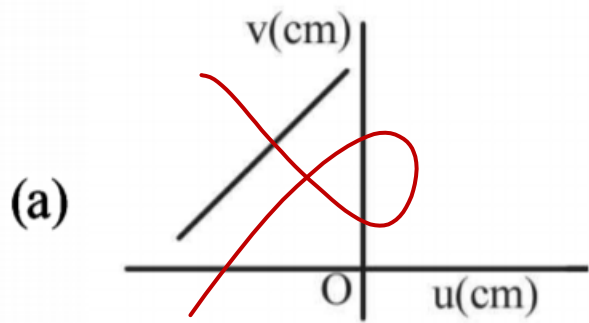$$\frac{1}{f} = \frac{1}{60}$$

Ans. (60)

PYQs on Following Subtopic:

Lens Formula

A student measures the focal length of a convex lens by putting an object pin at a distance 'u' from the lens and measuring the distance 'v' of the image pin. The graph between 'u' and 'v' plotted by the student should look like

[2008] **JEE Main**

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

(a)

v(cm)

O   u(cm)

(b)

v(cm)

O   f   u(cm)

(c)

v(cm)

O   u(cm)
f

(d)

v(cm)

O   u(cm)

Ans. c

In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45° with the x-axis meets the experimental curve at P. The coordinates of P will be : [2009]

(a) $\left(\dfrac{f}{2}, \dfrac{f}{2}\right)$
(b) (f, f)
(c) $(4f, 4f)$
(d) $(2f, 2f)$
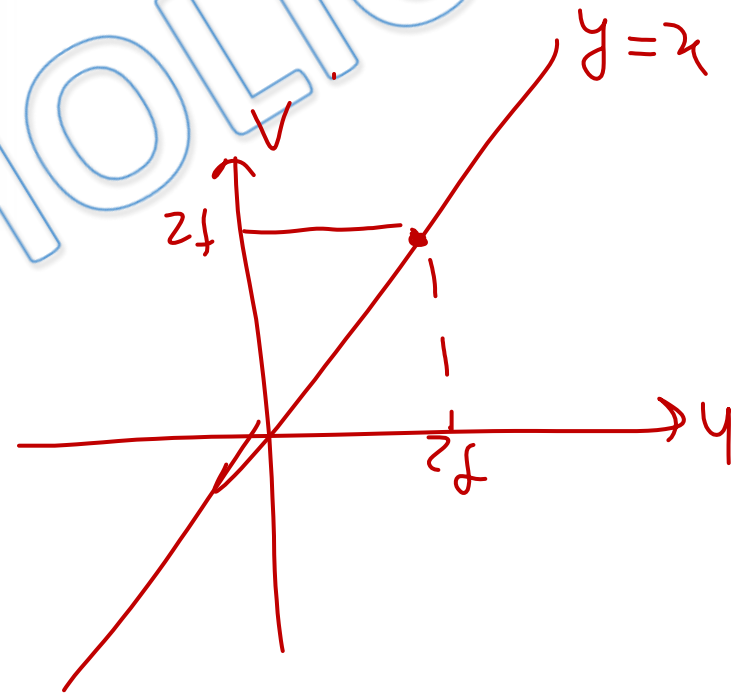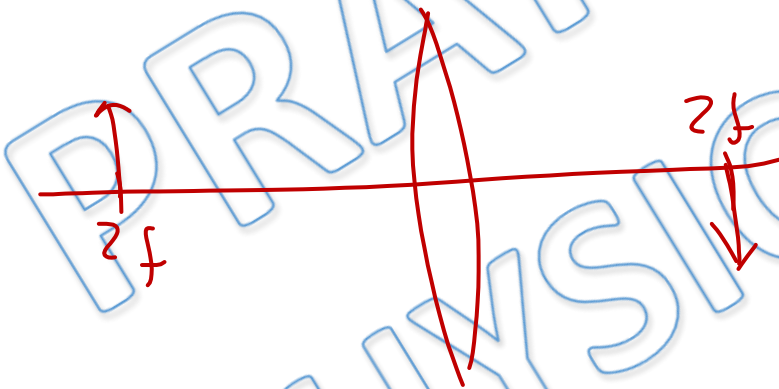
Ans. d

An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object shifted to be in sharp focus of film? **[2012]**
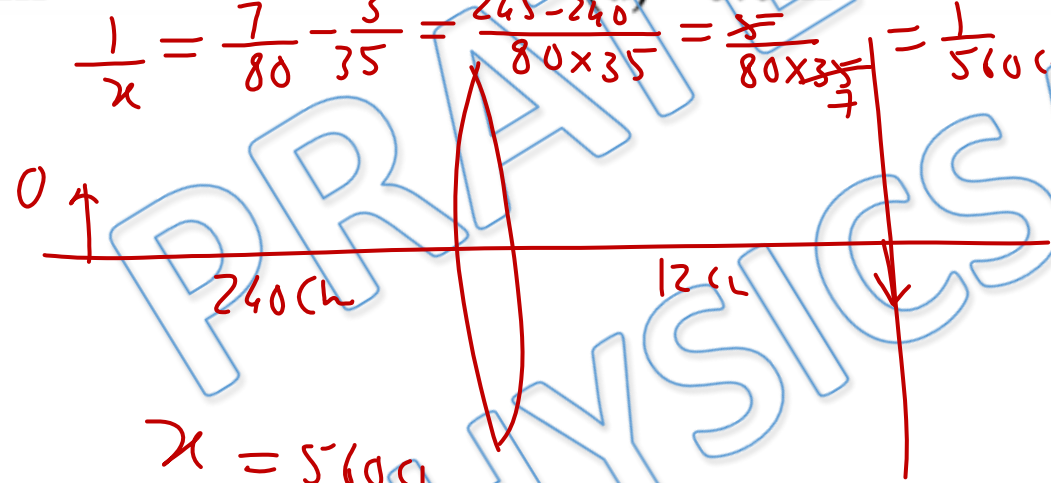
(a) 7.2 m

(b) 2.4 m

(c) 3.2 m

(d) 5.6 m

$$\frac{1}{f} = \frac{1}{12} + \frac{1}{240} = \frac{1 \times 3}{35} + \frac{1}{x}$$

$$\frac{1}{x} + \frac{3}{35} = \frac{20+1}{240}$$

$$\frac{1}{x} = \frac{7}{80} - \frac{3}{35} = \frac{245-240}{80 \times 35} = \frac{5}{80 \times 35} = \frac{1}{560}$$

$$x = 560 \text{ cm}$$

$$= 5.6 \text{ m}$$

abb Shift $= t\left(1 - \frac{1}{\mu}\right) = \frac{1}{3}$ cm
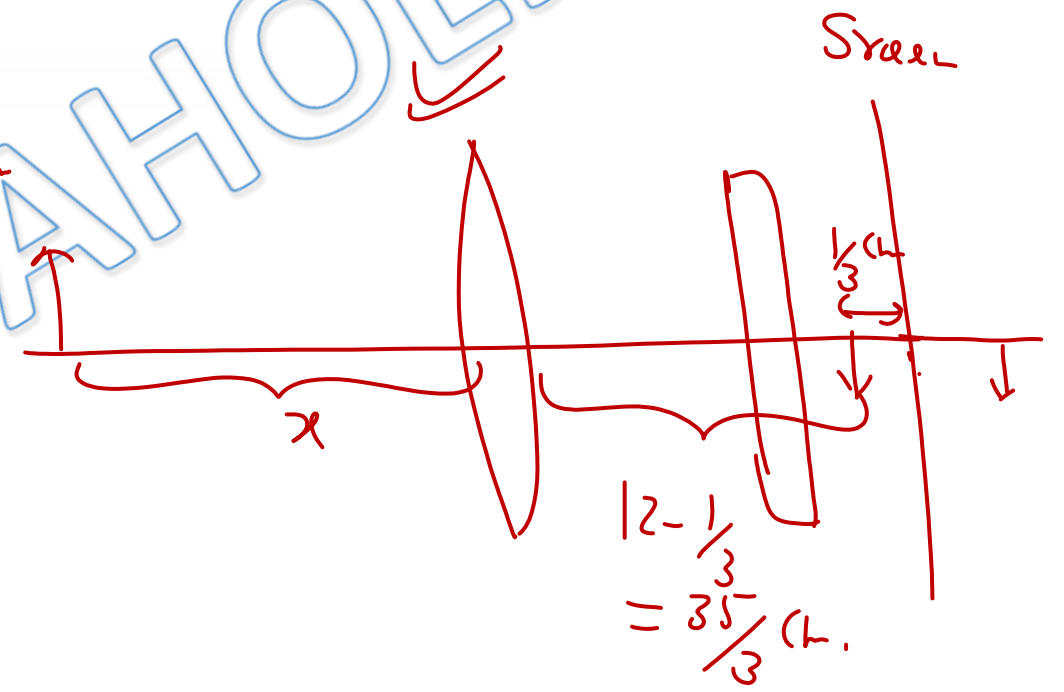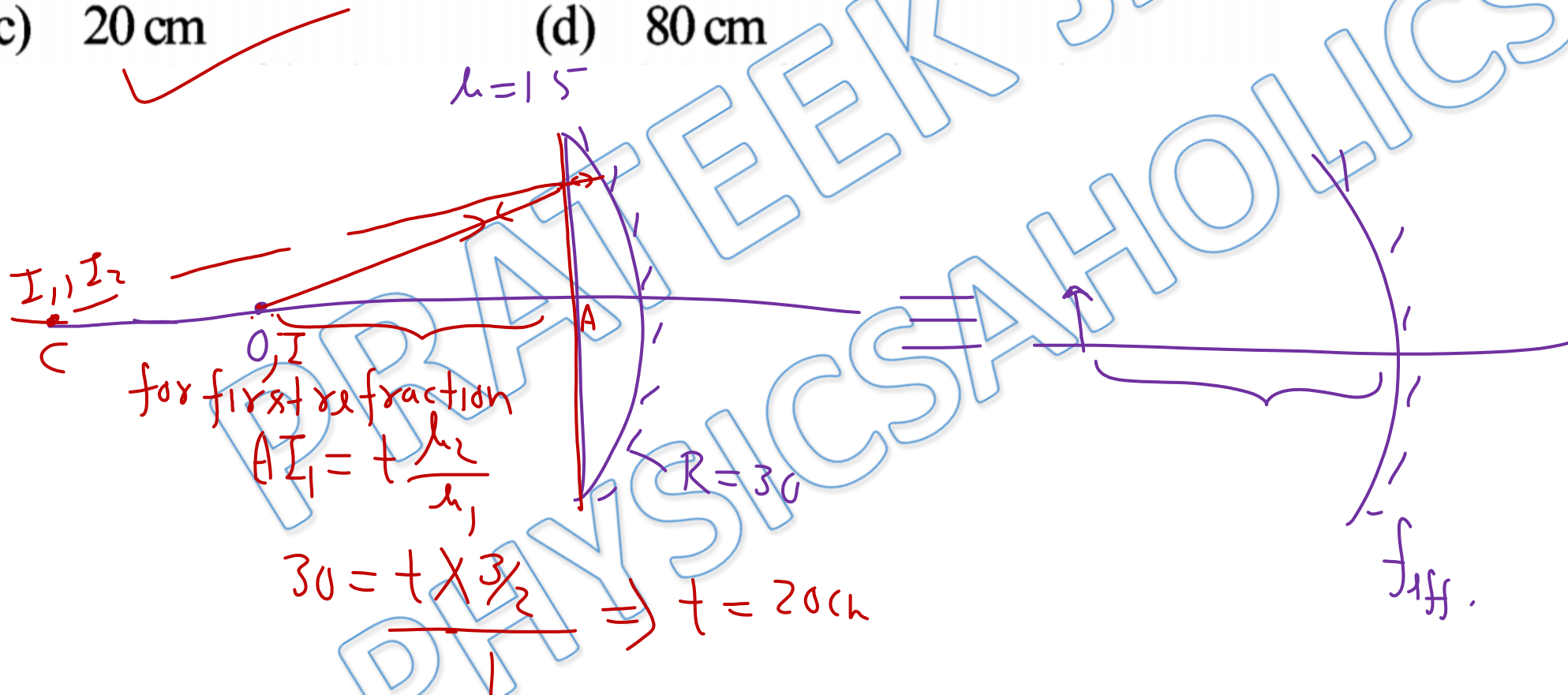
$12 - \frac{1}{3} = \frac{35}{3}$ cm.

Ans. d

PYQs on Following Subtopic:

Silvering of Lens

A plano convex lens of refractive index 1.5 and radius of curvature 30 cm. Is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object be placed in order to have a real image of size of the object [2004] **JEE Main**

(a)   60 cm (b)   30 cm
(c)   20 cm (d)   80 cm

$\mu = 1.5$

I_1, I_2

O, I

for first refraction

$A I_1 = t \dfrac{\mu_2}{\mu_1}$

$30 = t \times \dfrac{3/2}{1}$ $\Rightarrow t = 20\,cm$

$R = 30$

$f_{eff}.$

Ans. c

PYQs on Following Subtopic:

Power of Lens

7. A thin glass (refractive index 1.5) lens has optical power of $-5\,D$ in air. Its optical power in a liquid medium with refractive index 1.6 will be **[2005] JEE Main** *(Wrong)*

(a) $-1D$ (b) $1D$ (c) $-25D$ (d) $25D$

$$P = \frac{1}{f} = (15-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$-\overset{10}{5} = 5\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{R_1} - \frac{1}{R_2} = -10$$

$$P^1 = \left(\frac{15}{16} - 1\right)(-10)$$

$$= \frac{-1}{16} \times 10$$

$$= \frac{10}{16} = +\frac{5}{8}D$$

Ans.b

$$\frac{5}{8}D$$

3. Two lenses of power $-15\,D$ and $+5\,D$ are in contact with each other. The focal length of the combination is

(a) $+10\,\text{cm}$ (b) $-20\,\text{cm}$

(c) $-10\,\text{cm}$ (d) $+20\,\text{cm}$

$$P = P_1 + P_2$$

$$= -15 + 5$$

$$= -10$$

$$f = \frac{1}{P} = \frac{-1}{10}\,\text{m}$$

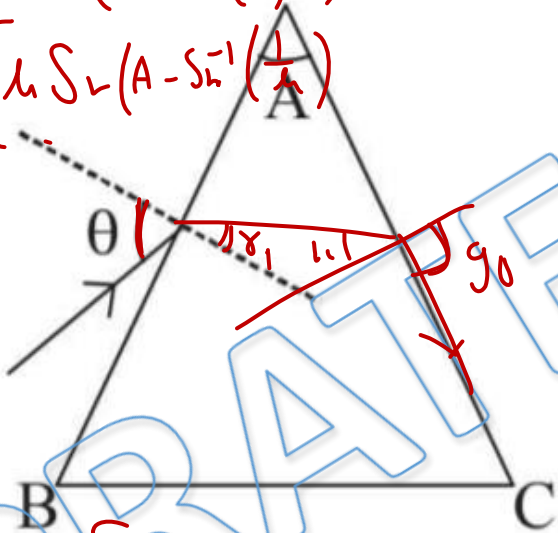$$= \frac{-100}{10}\,\text{cm}$$

Ans. c

PYQs on Following Subtopic:

Prism

Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided : [JEE Main 2015]

$$\sin\theta = \mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right) \; ; \; r_1 = A - \sin^{-1}\left(\frac{1}{\mu}\right)$$

$$\theta = \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$$

JEE Main
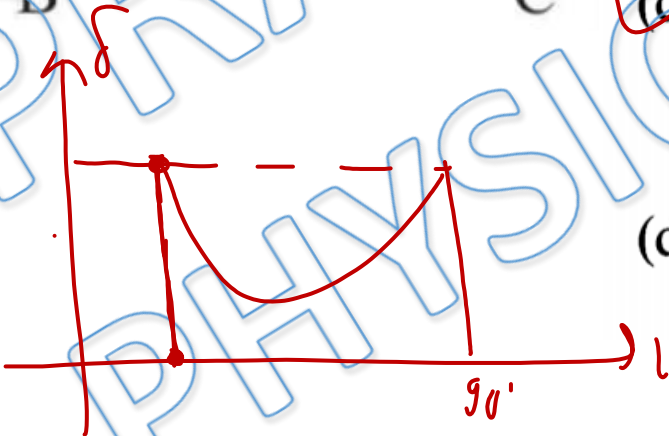
(a) $\theta > \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(b) $\theta < \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(c) $\theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

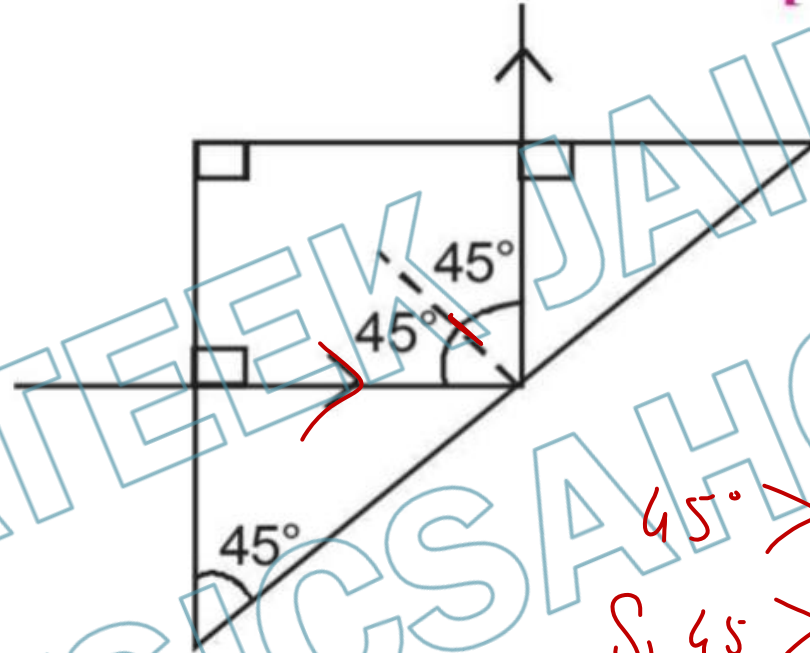(d) $\theta < \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

Ans. c

A light ray is incident perpendicularly to one face of a 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45°, we conclude that the refractive index n

(a) $n > \dfrac{1}{\sqrt{2}}$

(b) $n > \sqrt{2}$

(c) $n < \dfrac{1}{\sqrt{2}}$

(d) $n < \sqrt{2}$

$45° > i_c$

$\sin 45 > \sin i_c$

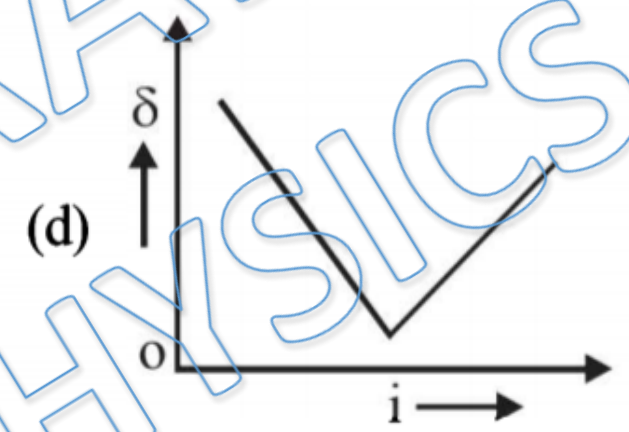$\dfrac{1}{\sqrt{2}} > \dfrac{1}{\mu}$
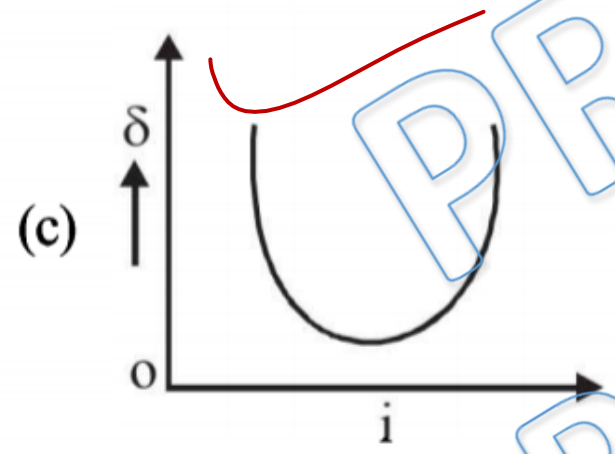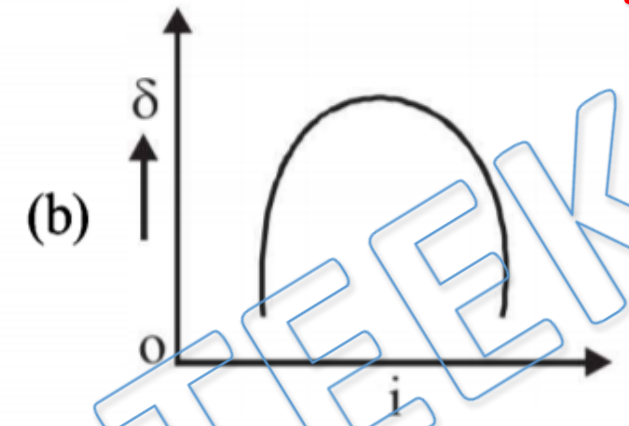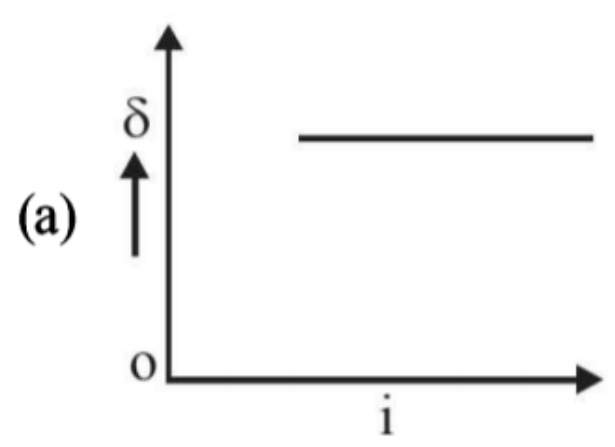
$\mu > \sqrt{2}$

Ans. b

PYQs on Following Subtopic:

Minimum Deviation

The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by

(a)

(b)

(c)

(d)
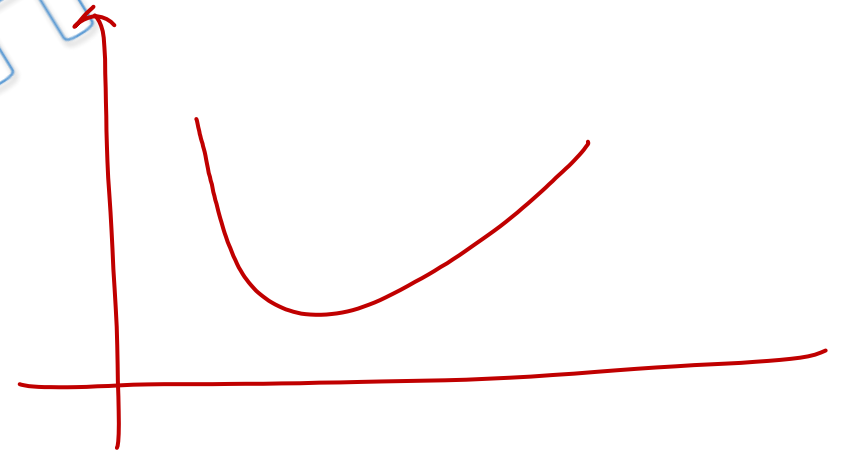
Ans. c

In an experiment for determination of refractive index of glass of a prism by $i - \delta$, plot it was found that a ray incident at angle 35°, suffers a deviation of 40° and that it emerges at angle 79°. In that case which of the following is closest to the maximum possible value of the refractive index?

(a) 1.7

(b) 1.8

(c) 1.5

(d) 1.6

$i = 35°$, $e = 79$

$\delta = 40°$

$A = i + e - \delta$

$= 114 - 40$

$= 74°$

JEE Main

$\delta_{min} < 40$

$\mu < \frac{\sin 57}{\sin 37}$

$\frac{\sin\left(\frac{A + \delta_{min}}{2}\right)}{\sin A/2} < \frac{\sin\left(\frac{A + 40}{2}\right)}{\sin A/2}$

$\mu < \frac{\sin 57}{\sin 37} < \frac{\sin 60}{\sin 37} = \frac{\sqrt{3} \times 5}{2 \times 3} = \frac{1.73 \times 5}{6} = \frac{8.65}{6} = 1.44$

Ans. c

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