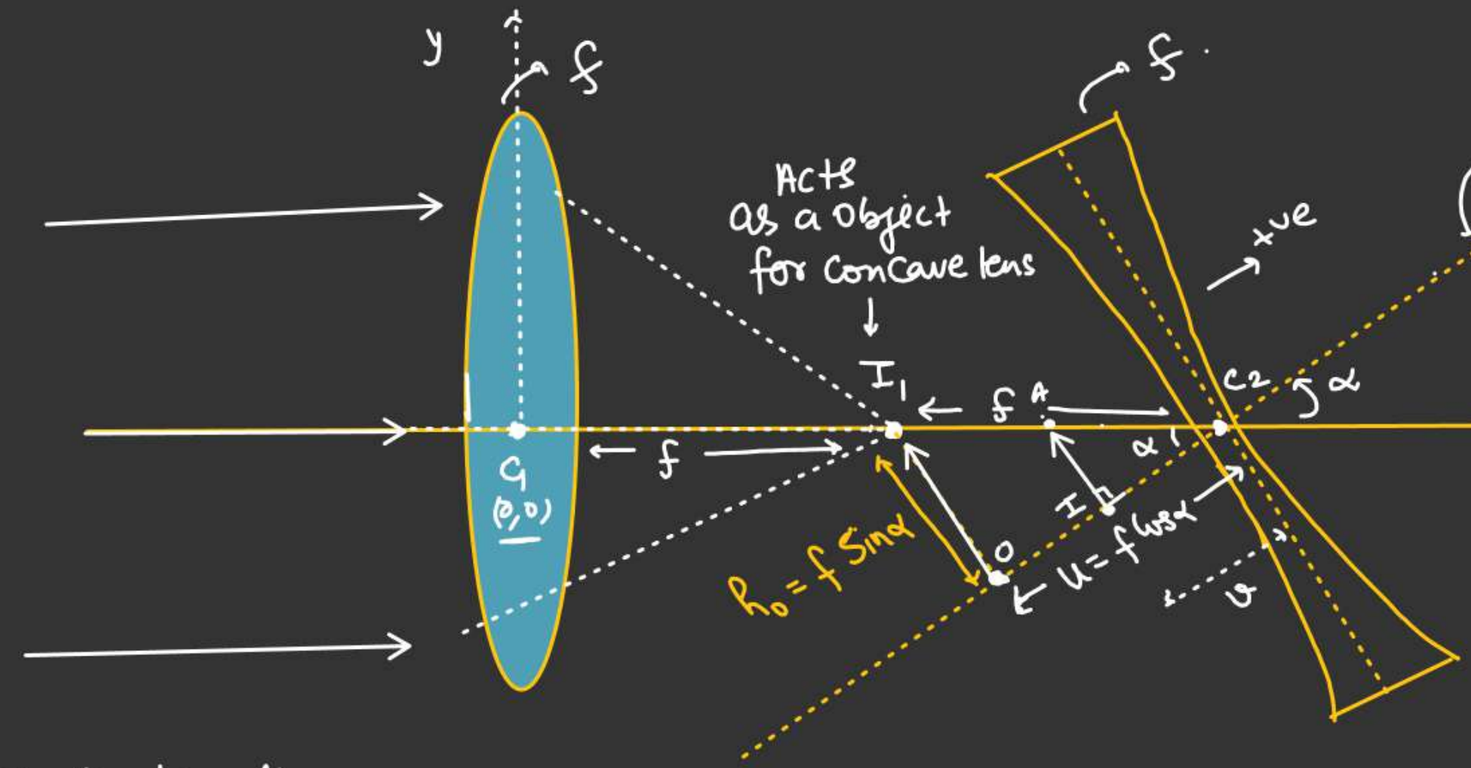
Nishant Jindal

A4



Take origin at C_1

Find final co-ordinate of image after refraction from both the lens.

By Lens formula for Concave lens.

$$\frac{1}{V} - \frac{1}{(-f\cos\alpha)} = \left(\frac{1}{-f}\right)$$

$$\frac{1}{V} = -\left[\frac{1}{f} + \frac{1}{f\cos\alpha}\right]$$

$$\frac{1}{V} = -\left[\frac{1+\cos\alpha}{f\cos\alpha}\right]$$

$$V = \left(\frac{-f\cos\alpha}{1+\cos\alpha}\right)$$

X- Cordinate.

AC_2 ⇓

$d = 2f$

$$= (2f - f\sec\alpha)$$

$$= 2f - \frac{f}{1+\cos\alpha} = \frac{2f + 2f\cos\alpha - f}{1+\cos\alpha} = \left(\frac{f + 2f\cos\alpha}{1+\cos\alpha}\right)$$ Ans ✓

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$$m = \left(\frac{v}{u}\right)$$

$$\frac{h_I}{h_O} = \left(\frac{v}{u}\right)$$

$$h_I = \frac{v}{u} \times h_O$$

$$= \frac{-\left(\frac{f\cos\alpha}{1+\cos\alpha}\right)}{(-f\cos\alpha)} \times (f\sin\alpha)$$

$$h_I = \left(\frac{f\sin\alpha}{1+\cos\alpha}\right)$$

$\Downarrow$

Height of image

Co-ordinate of image $= (x, 0)$

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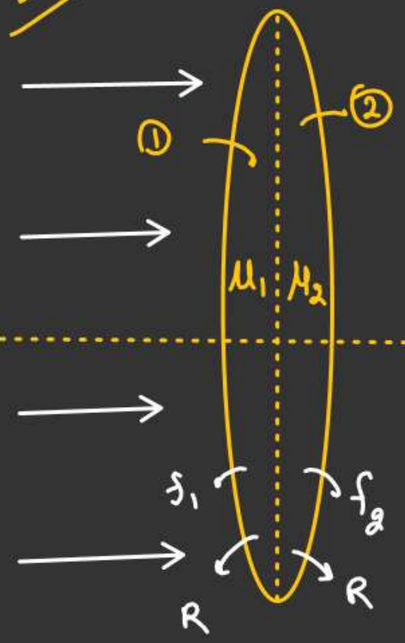
Q4.

Case-1



$\mu_1 = 1.4$ ✓

$\mu_2 = 1.5$ ✓

$R = 20\,cm$

$\frac{1}{F} = \left(\frac{1}{f_1} + \frac{1}{f_2}\right)$

$F = \frac{200}{9}\,cm$

Find co-ordinate of final image. Take origin on G in both the Case.

Case-2

Case-2

$\frac{1}{f_1} = (\mu_1 - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right) = \frac{(\mu_1 - 1)}{R}$

$\frac{1}{f_1} = \frac{4}{10 \times 20} = \frac{1}{50}$ ✓ $\Rightarrow f_1 = 50\,cm$.

$\frac{1}{f_2} = (\mu_2 - 1)\left(\frac{1}{\infty} - \frac{1}{(-R)}\right) = \left(\frac{\mu_2 - 1}{R}\right)$

$\frac{1}{f_2} = \frac{1}{40}$.

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Case-2

A. Refraction for L_2

$$\frac{1}{v} - \frac{1}{-50} = \frac{1}{+40}$$

$$\frac{1}{v} = \frac{1}{40} + \frac{1}{50}$$

$$\frac{1}{v} = \frac{50+40}{2000} = \frac{90}{2000} = \frac{9}{200}$$

$$v = \frac{200}{9} \text{ cm.}$$

By Magnification for Concave lens.

$$\frac{h_I}{h_O} = \left(\frac{V}{u}\right)$$

$$h_I = \frac{V}{u} \times h_O$$

$$= \frac{200/9}{50} \times 4.5 \text{ mm}$$

$$= \frac{4}{9} \times 4.5 \text{ mm}$$

$$= 2 \text{ mm}$$

Co-ordinate of image $= \left(\frac{200}{9} \text{ cm}, -2.5 \text{ mm}\right)$ ✓

Q.6 A rod of length $2\ \text{cm}$ makes an angle $2\pi/3\,\text{rad}$ with the principal axis of a thin convex lens. The lens has a focal length of $10\ \text{cm}$ and is placed at a distance of $\frac{40}{3}\ \text{cm}$ from the object as shown in the figure. The height of the image is $\frac{30\sqrt{3}}{13}\ \text{cm}$ and the angle made by it with respect to the principal axis is $\alpha\,\text{rad}$.

The value of α is $\frac{\pi}{n}\,\text{rad}$, where n is_____ **(2020)**

Ans. 6

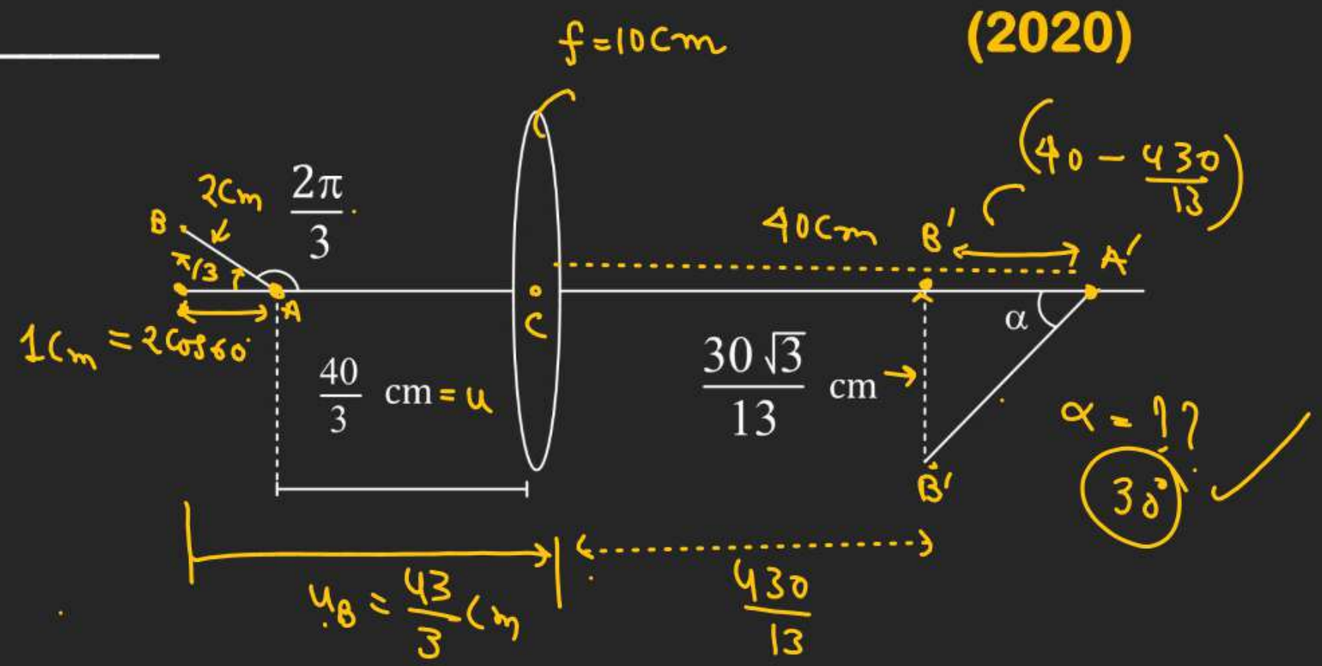
$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

For A

$v=\frac{uf}{u+f}$

$v_A=\frac{(-\frac{40}{3})\times(+10)}{-\frac{40}{3}+10}$

$V_A=+40\text{cm}$



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For v_B

$$v_B = \left(\frac{u_B \cdot f}{u_B + f}\right)$$

$$v_B = \frac{-\left(\frac{43}{3}\right) \times (10)}{\left(-\frac{43}{3} + 10\right)}$$

$$v_B = \left(\frac{\pm 430}{13}\right)$$

Q.8 An object and a concave mirror of focal length $f = 10\ cm$ both move along the principal axis of the mirror with constant speeds. The object moves with speed $V_0 = 15\ cm\ s^{-1}$ towards the mirror with respect to a laboratory frame. The distance between the object and the mirror at a given moment is denoted by u. When $u = 30\ cm$, the speed of the mirror V_m is such that the image is instantaneously at rest with respect to the laboratory frame, and the object forms a real image. The magnitude of V_m is cms^{-1}. **(2022)**

Ans. 3

$m = \left(\frac{f}{f-u}\right)$

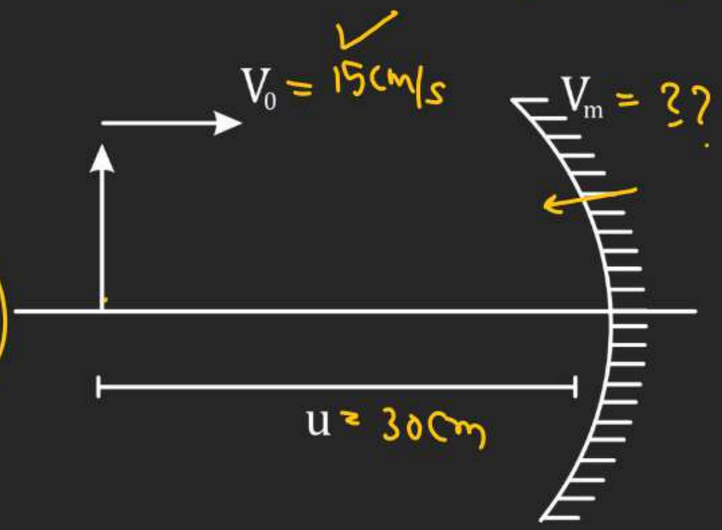
$f = -10\ cm$

$u = -30\ cm$

$\vec{V}_{I/m} = -m^2 \vec{V}_{O/M}$

$\vec{V}_I - \vec{V}_m = -\left(\frac{f}{f-u}\right)^2 (\vec{V}_O - \vec{V}_M)$

$V_m = ??$



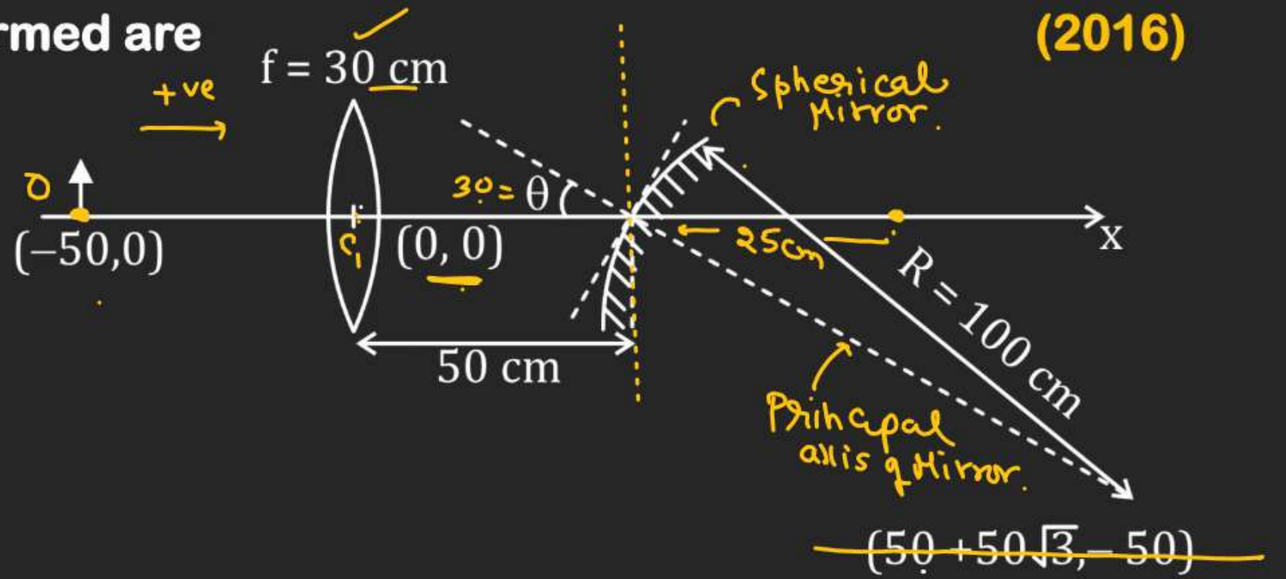
Q.9 A small object is placed $50\ \text{cm}$ to the left of a thin convex lens of focal length $30\ \text{cm}$. A convex spherical mirror of radius of curvature $100\ \text{cm}$ is placed to the right of the lens at a distance of $50\ \text{cm}$. The mirror is tilted such that the axis of the mirror is at an angle $\theta = 30^\circ$ to the axis of the lens, as shown in the figure. If the origin of the coordinate system is taken to be at the centre of lens, the coordinates (in cm) of the point (x, y) at which the image is formed are **(2016)**

(A) $(25, 25\sqrt{3})$

(B) $(0, 0)$

(C) $(125/3, 25/\sqrt{3})$

(D) $(50 - 25\sqrt{3}, 25)$



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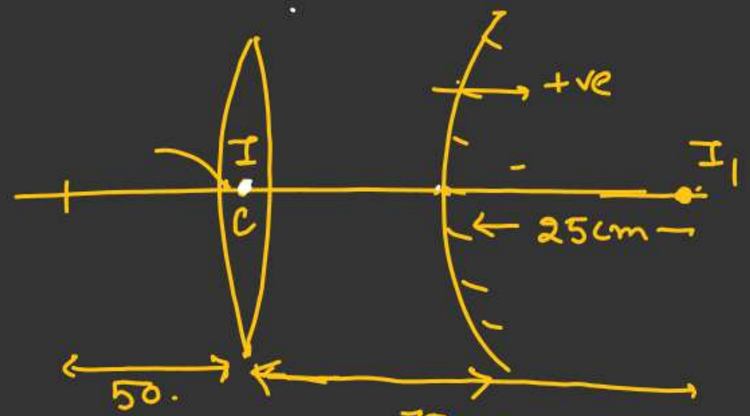
Refraction for lens.

$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f}$$

$$v_1 = \frac{uf}{u+f}$$

$$v_1 = \frac{(-50)(+30)}{-50+30}$$

$$v_1 = \frac{-1500}{-20} = +75\text{cm}$$



Reflection from Mirror

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

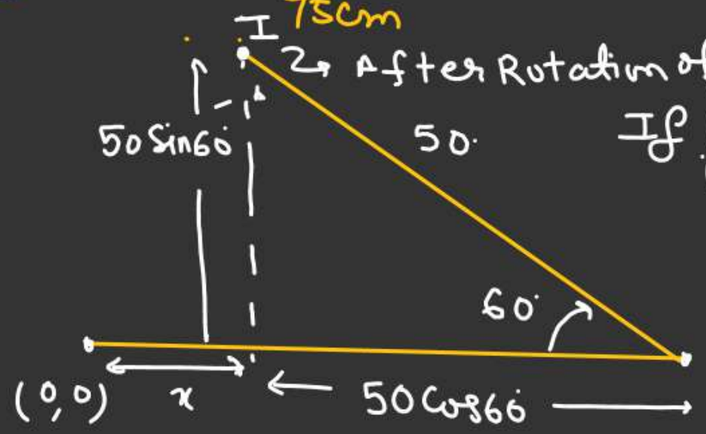
$v = v_2$

$u \to +25\text{cm}$

$f = +R/2 = 50\text{cm}$

$$v = \left(\frac{uf}{u-f}\right)$$

$$v_2 = \left(\frac{25 \times 50}{25-50}\right) = -50\text{cm}$$



After Rotation of Mirror.

If Mirror is Rotated by $30^\circ(\theta)$ image will rotate by 2θ

$$x = 50 - 50\cos 60$$

$$x = 25\text{cm}$$

$$y = 50\sin 60 = 50\frac{\sqrt{3}}{2} = 25\sqrt{3}$$

$(25, 25\sqrt{3})$

H.W

Q.1 The focal length of a thin biconvex lens is $20\ \text{cm}$. When an object is moved from a distance of $25\ \text{cm}$ in front of it to $50\ \text{cm}$, the magnification of its image changes from m_{25} to m_{50}. The ratio $\frac{m_{25}}{m_{50}}$ is (2010)

Ans. 6

H.W

Q.2 Image of an object approaching a convex mirror of radius of curvature $20\ \mathrm{m}$ along its optical axis is observed to move from $\frac{25}{3}\ \mathrm{m}$ to $\frac{50}{7}\ \mathrm{m}$ in 30 seconds. What is the speed of the object in km per hour? (2010)

Ans. 3

H.W

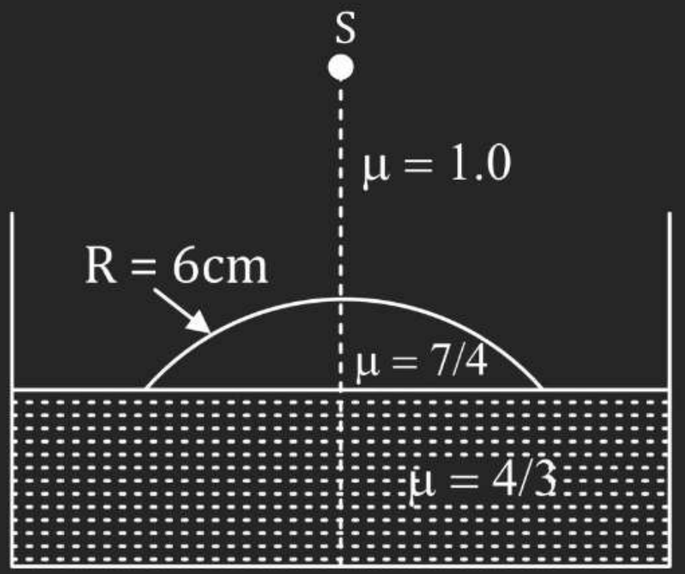
Q.3 A large glass slab $(\mu = 5/3)$ of thickness $8\ \text{cm}$ is placed over a point source of light on a plane surface. It is seen that light emerges out of the top surface of the slab from a circular area of radius $\text{R}\ \text{cm}$. What is the value of R ?

Ans. 6 (2010)

HW

Q.4 Water (with refractive index $= \frac{4}{3}$) in a tank is $18\ \text{cm}$ deep. Oil of refractive index $\frac{7}{4}$ lies on water making a convex surface of radius of curvature $R = 6\ \text{cm}$ as shown. Consider oil to act as a thin lens. An object S is placed $24\ \text{cm}$ above water surface. The location of its image is at $x\ \text{cm}$ above the bottom of the tank. Then x is **(2011)**

Ans. 2



H-W

Q.5 Consider a concave mirror and a convex lens (refractive index $= 1.5$) of focal length $10\ \text{cm}$ each, separated by a distance of $50\ \text{cm}$ in air (refractive index $= 1$) as shown in the figure. An object is placed at a distance of $15\ \text{cm}$ from the mirror. Its erect image formed by this combination has magnification M_1. When the set-up is kept in a medium of refractive index $7/6$, the magnification becomes M_2. The magnitude $\left|\frac{M_2}{M_1}\right|$ is **(2015)**

Ans.7