Nishant Jindal

Considering Reflection from M_1 first. Find nature, size & location of final image after two successive reflection

Sol^n:- Reflection from Concave Mirror :-

$u = -20\,cm.$

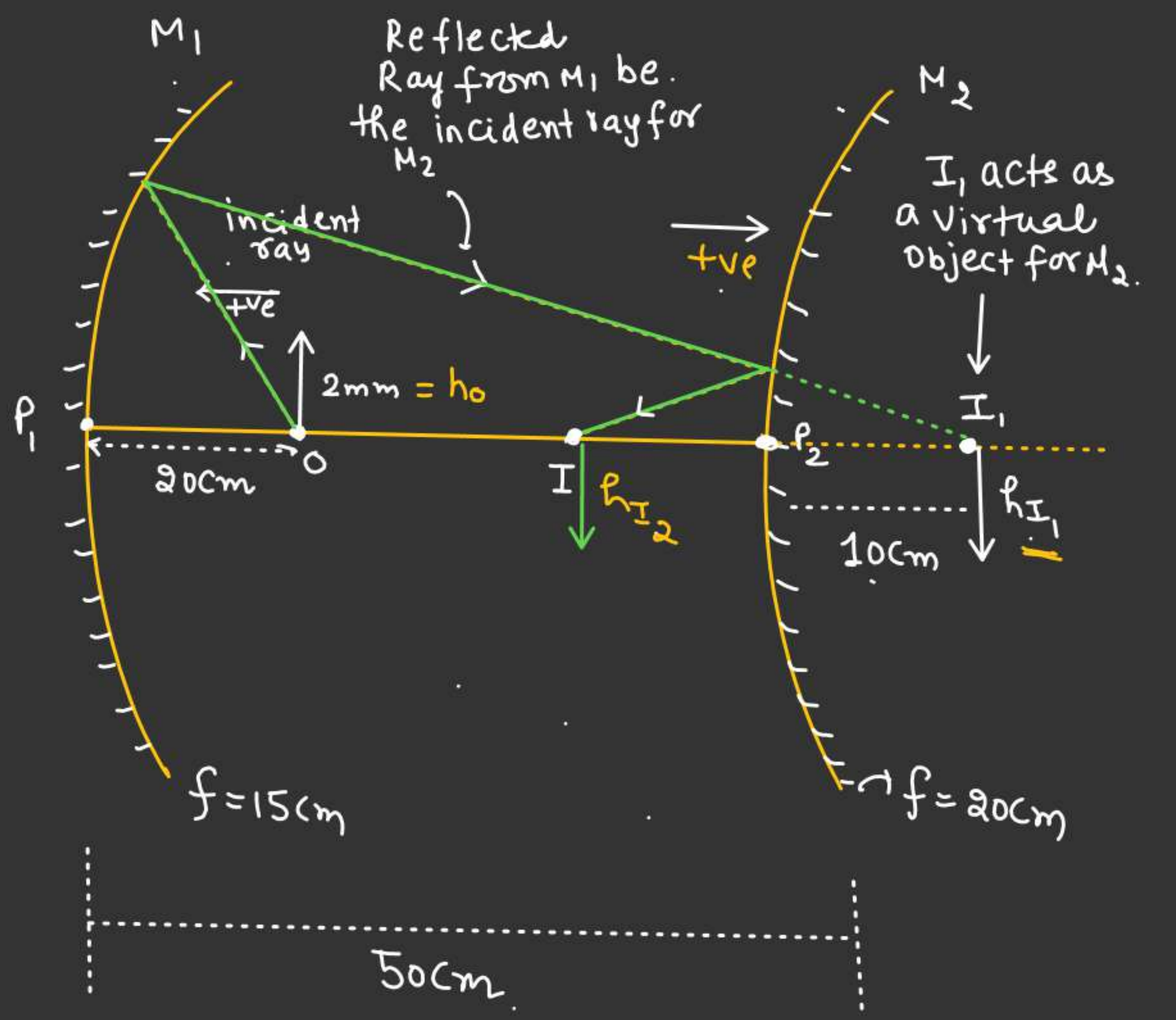
$f = -15\,cm$

v_1 = Image distance after reflection from Concave Mirror.

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

$$\frac{1}{v} = \left(\frac{1}{f} - \frac{1}{u}\right) = \frac{u-f}{uf}$$

$$v = \frac{uf}{u-f} = \frac{(-20)(-15)}{-20-(-15)} = -60\,cm.$$



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Magnification for M_1

$$\frac{h_{I_1}}{h_o} = \frac{-V_1}{u}$$

$$h_{I_1} = \frac{-V_1}{u} \times h_o$$

$$= \frac{-(-60)}{(-20)} \times 2\,mm$$

$$h_{I_1} = \underline{-6\,mm}$$

If m_2 is +ve

$$m_2 = +ve$$

$$\frac{h_{I_2}}{h_{o_1}} = \underline{+ve} \rightarrow$$

h_{I_2} & h_{o_1} of Same Sign ie either both upward or both downward

Reflection from Convex Mirror

$u_2 = \underline{+10\,cm}$, $f = +20\,cm$.

$v_2 = ??$

$$\frac{1}{v_2} + \frac{1}{u_2} = \frac{1}{f}$$

$$V_2 = \left(\frac{u_2 f}{u_2 - f}\right) = \frac{(+10)(+20)}{(+10) - (20)}$$

$$= \underline{-20\,cm}$$

Magnification for M_2

$$m_2 = \left(\frac{-V_2}{u_2}\right) \quad (h_{o_2} = h_{I_1})$$

$$\leftarrow m_2 = \frac{-(-20)}{+10} = (+2)$$

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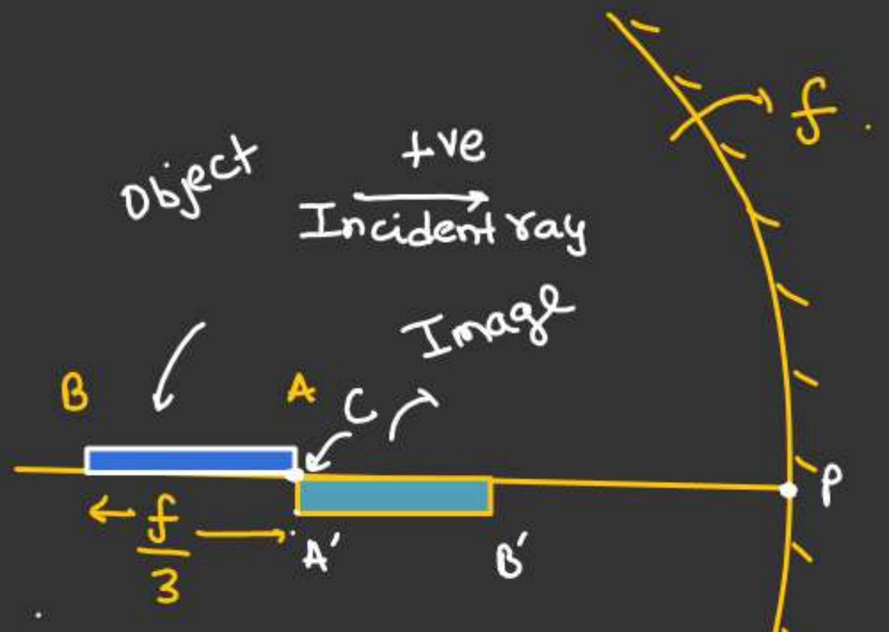
Object is placed along the principal axis such that image of the object concide $\boxed{\text{one end}}$ of the object. Find Magnification.

Sol^n :- Case-1 :- If A at the Center of Curvature



$u_A = 2f$

$u_B = (2f + f/3) = 7f/3$

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

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

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

$$v_A = \frac{u_A f}{u_A - f} = \frac{(-2f)(-f)}{-2f+f}$$

$$v_A = -(2f)$$

No Need to Calculate

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

$$v_B = \frac{\left(-\frac{7f}{3}\right)(-f)}{-\frac{7f}{3} - (-f)}$$

$$v_B = \frac{+\,7f^2/3}{-\frac{4f}{3}} = \left(-\frac{7f}{4}\right)$$

Length of image

$$= |2f| - \left|\frac{7f}{4}\right| = f/4$$

$$m_l = \frac{\text{length of image}}{\text{length of object}}$$

$$m_l = \frac{f/4}{f/3} = \left(\frac{3}{4}\right)$$

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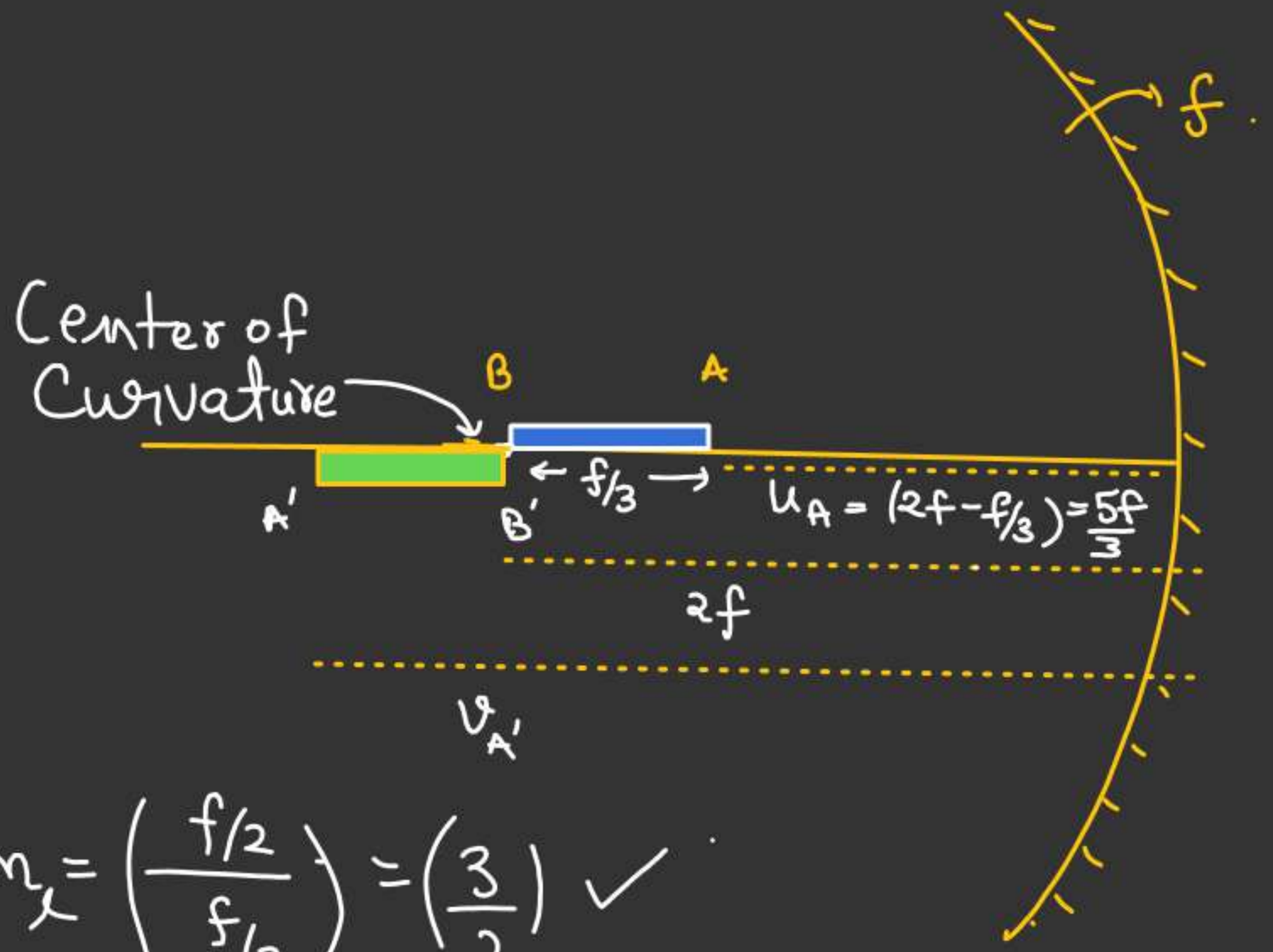
2nd Case :- B at Center of Curvature.

$$V_{A'} = \frac{u_A \cdot f}{u_A - f}$$

$$= \frac{\left(-\frac{5f}{3}\right)\cdot(-f)}{-\frac{5f}{3} - (-f)}$$

$$= \frac{-\frac{5f^2}{3}}{\left(-\frac{2f}{3}\right)} = \left(\frac{5f}{2}\right) \checkmark$$



Length of image $= |V_{A'}| - |V_{B'}|$

$$\left(\frac{5f}{2} - 2f\right)$$

$$= \left(\frac{f}{2}\right)$$

$$m_l = \left(\frac{f/2}{f/3}\right) = \left(\frac{3}{2}\right) \checkmark$$

Nishant Jindal

** # At what distance from Object a plane Mirror be placed So that final image after reflection from plane Mirror concide with object.

By Mirror formula

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

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

$$v_1=\frac{(-30)(-20)}{-30-(-20)}$$

$$v_1=\underline{-60\,cm}$$

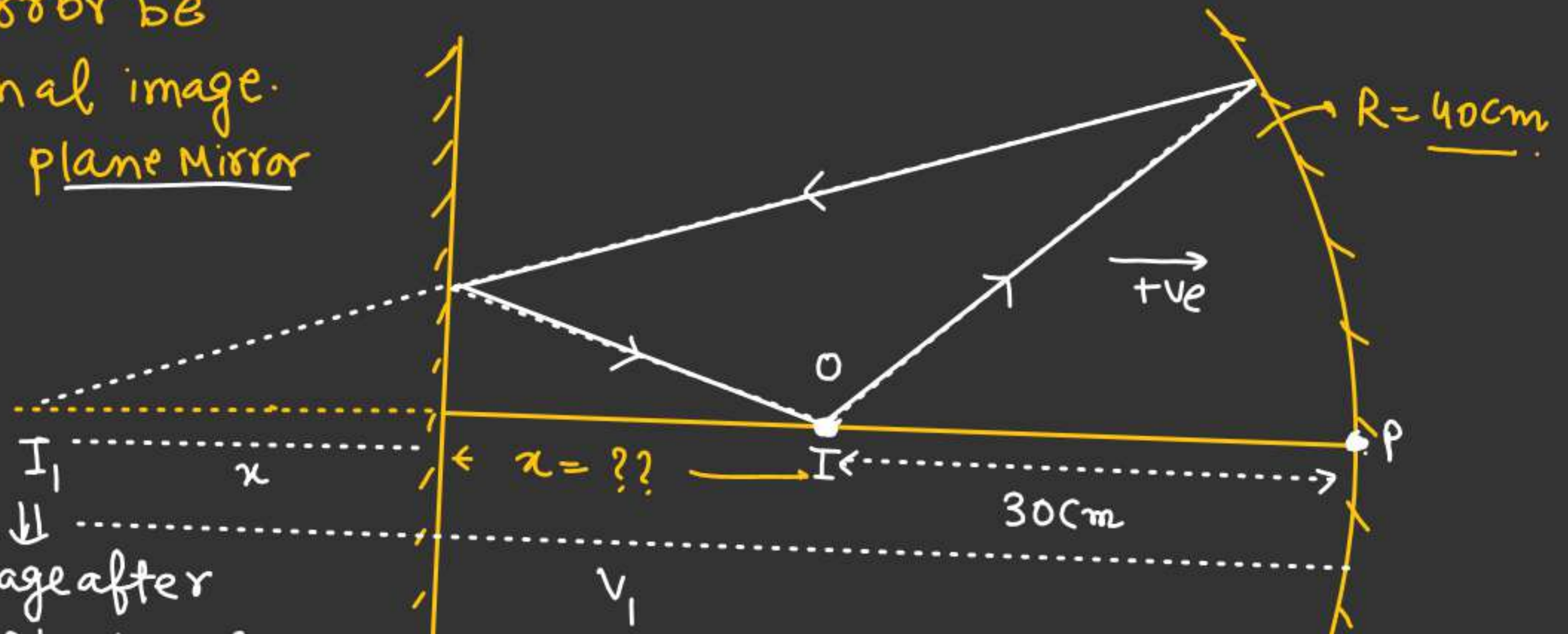


Image after reflection from Concave Mirror. Which will acts as a Virtual object for plane Mirror

$$f=\frac{R}{2}=20\,cm$$

$$2x+30=60$$

$$x=\frac{30}{2}=\underline{15\,cm}$$

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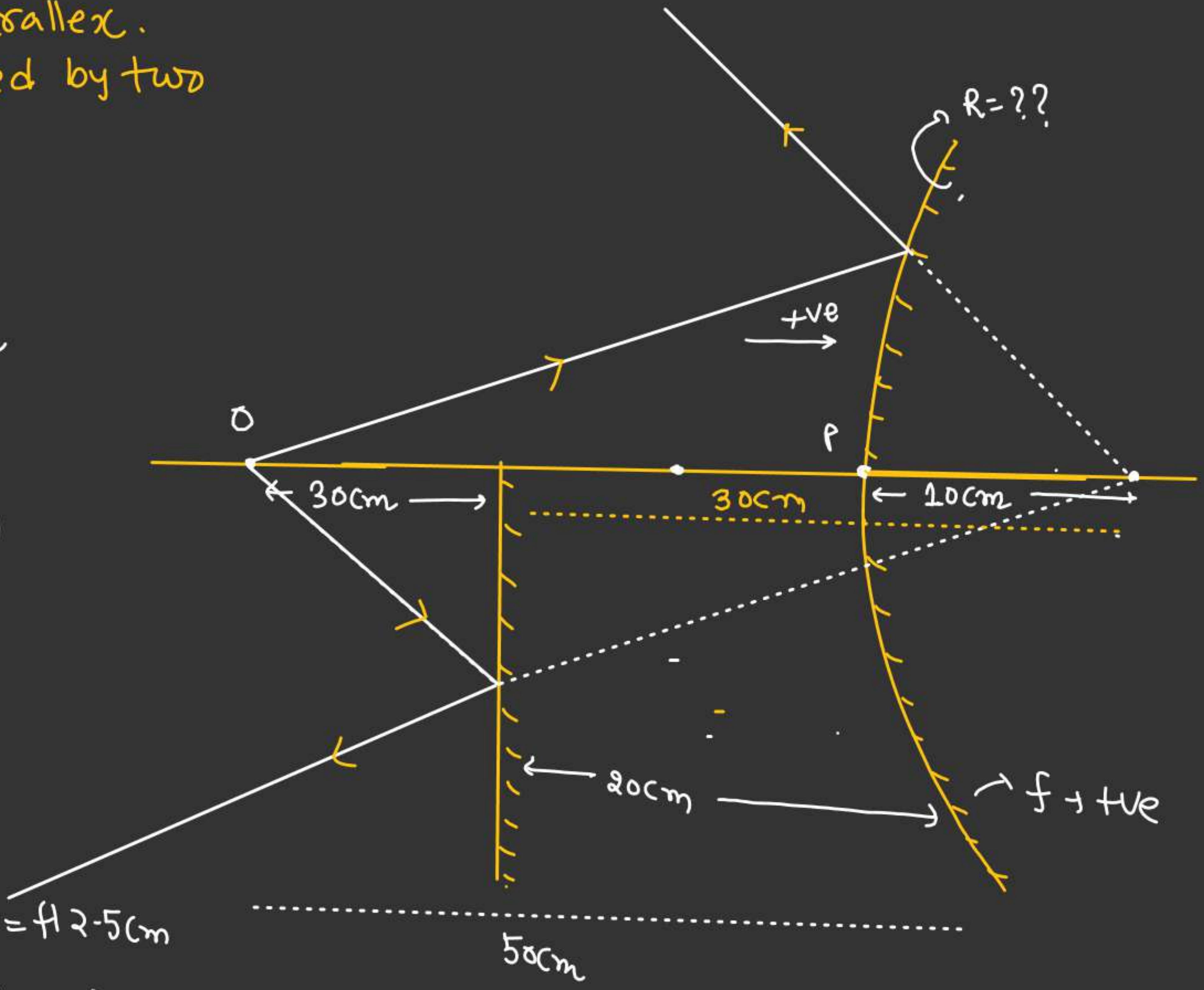
Find R so that no parallex b/w the image formed by two mirrors.

No Parallex means image due to plane mirror concide with image due to convex Mirror.



Reflection from Convex Mirror

$$V = \frac{uf}{u-f} = \frac{(-50)(f)}{-50-f}$$

$$(+10) = \frac{50f}{50+f}$$

$$500 + 10f = 50f$$

$$500 = 40f \qquad f = \frac{50}{4} = 12.5\,cm$$

$$R = 2f = \underline{25\,cm}$$ ✓

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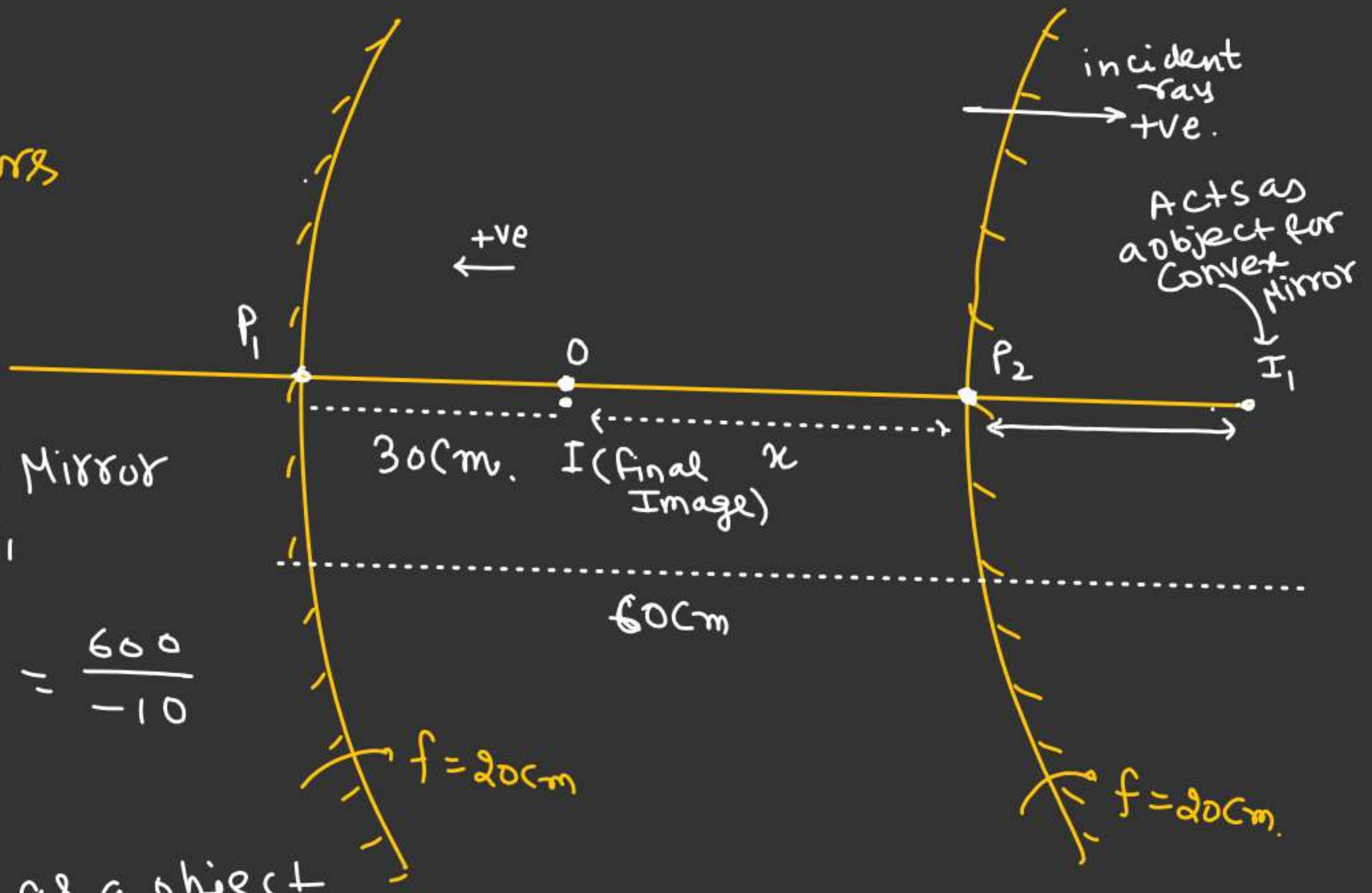
Q: Consider image formed by maximum two reflection.

Find the distance b/w the Mirrors so that final image concide with object.

1st reflection from Concave Mirror.



Sol^n:- Reflection from Concave Mirror

let, Image distance be V_1

$$V_1 = \frac{uf}{u-f} = \frac{(-30)(-20)}{-30-(-20)} = \frac{600}{-10}$$

$$\underline{V_1 = -60Cm}.$$

Image from Concave Mirror acts as a object for Convex Mirror.

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Reflection from Convex Mirror

$$u = 60 - (30 + x)$$
$$= (30 - x)$$
$$v = x.$$

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

Sign taken

$$-x = \frac{(30-x)(+20)}{(30-x)-20}$$

$$-x = \frac{600-20x}{10-x}$$

$$-10x + x^2 = 600 - 20x$$

$$x^2 + 10x - 600 = 0.$$

$$x^2 + 30x - 20x - 600 = 0.$$

$$x(x+30) - 20(x+30) = 0.$$

$$x = 20, \quad x = -30$$

$$x = 20$$

Distance b/w the Mirrors = 50cm.

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length of Chord AB $= \left(\frac{\sqrt{5}+1}{2}\right)R$

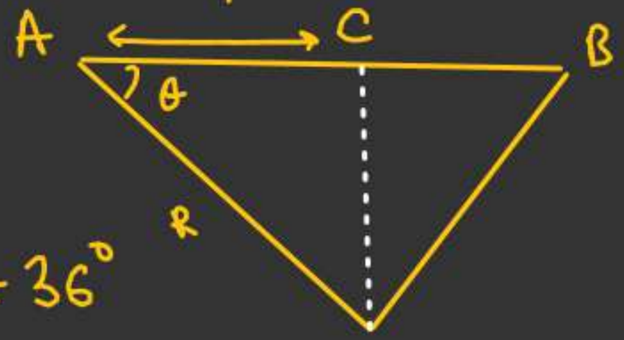
$\cos 36^\circ = \left(\frac{\sqrt{5}+1}{4}\right)$ given.

Find No of reflection taken by incident ray when it again reaches to A.

Soln :-

$\cos\theta = \left(\frac{\sqrt{5}+1}{4\cancel{R}}\right)\cancel{R}$

$\cos\theta = \left(\frac{\sqrt{5}+1}{4}\right) \Rightarrow \theta = 36^\circ$



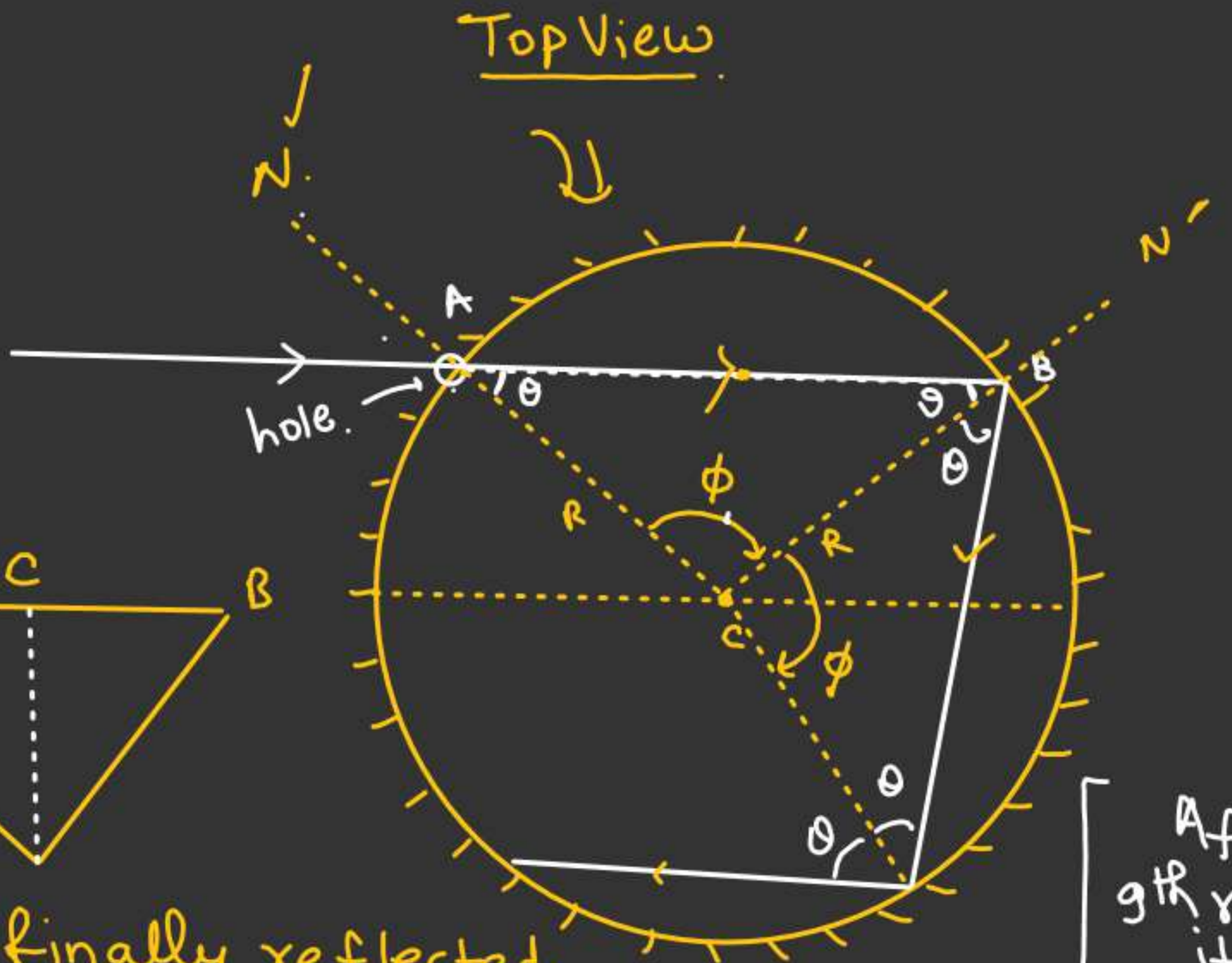
$\phi + 2\theta = 180$

$\phi = 180 - 2\theta$

$= 180 - 2\times 36^\circ$

$= 180 - 72$

$= 108^\circ$



After 9th reflection it will reaches at A

let, finally reflected ray reaches at A after n reflection

$n\phi = (2\pi)m$ ✓

$n = 10.$

$m = 3$ ✓

$\frac{n}{m} = \frac{360}{108} = \frac{90}{27} = \frac{30}{9} = \frac{10}{3}.$

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Q.

Aperture diameter.

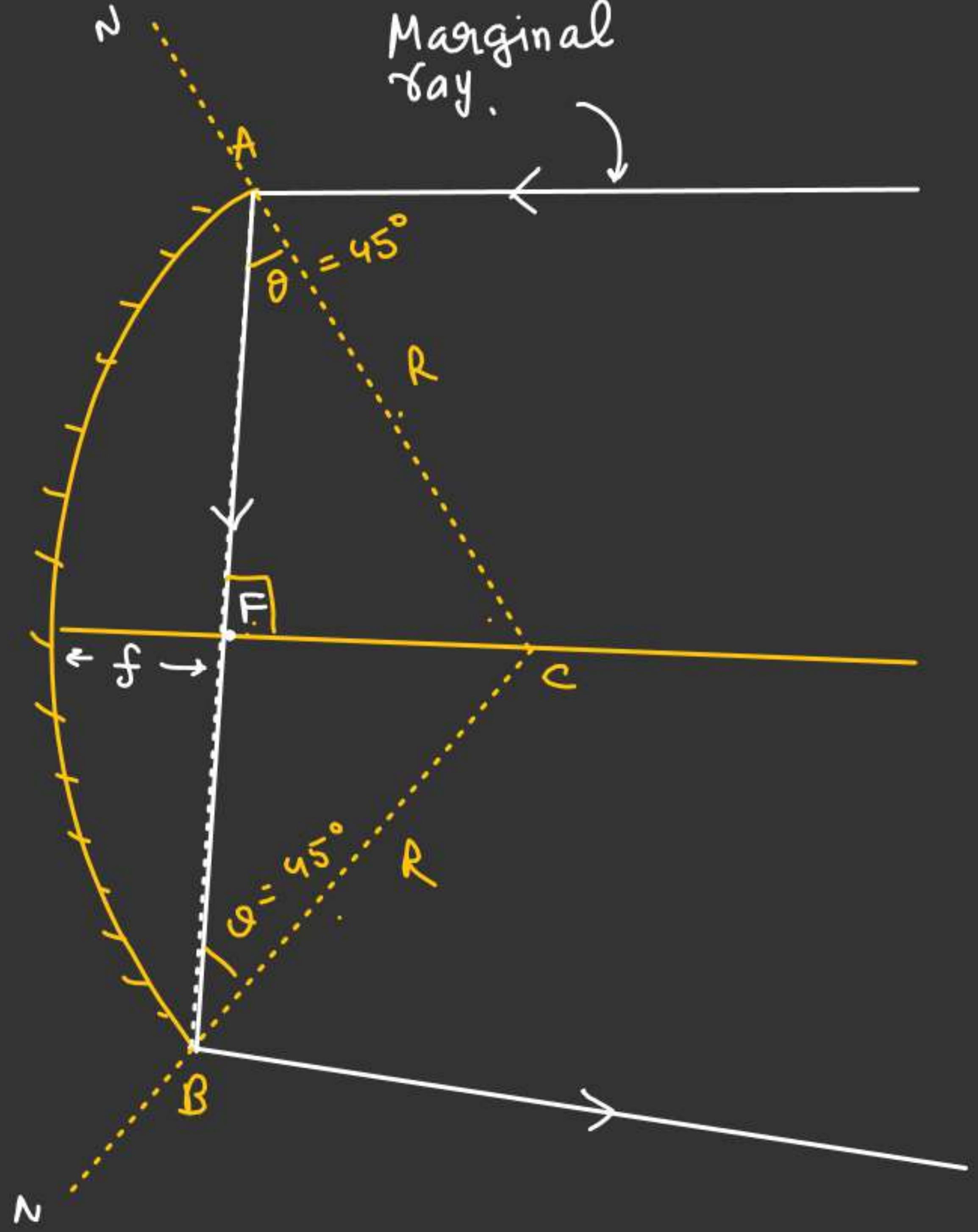
$\underline{AB} = \underline{\eta R}$ when $\eta < 2$.

R = Radius of Curvature.

Find $\eta_{min} = ??$

a) When Marginal rays Suffer only two reflections.

b) When Marginal rays Suffer 3-reflections.



In Δ AFC.

$$\cos 45° = \frac{AF}{AC}$$

$$AF = \frac{AC}{\sqrt{2}} = R/\sqrt{2}$$

$$AB = 2AF = \sqrt{2}R$$

$$\boxed{\eta = \sqrt{2}}$$ ✓

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Q8

Aperture diameter.

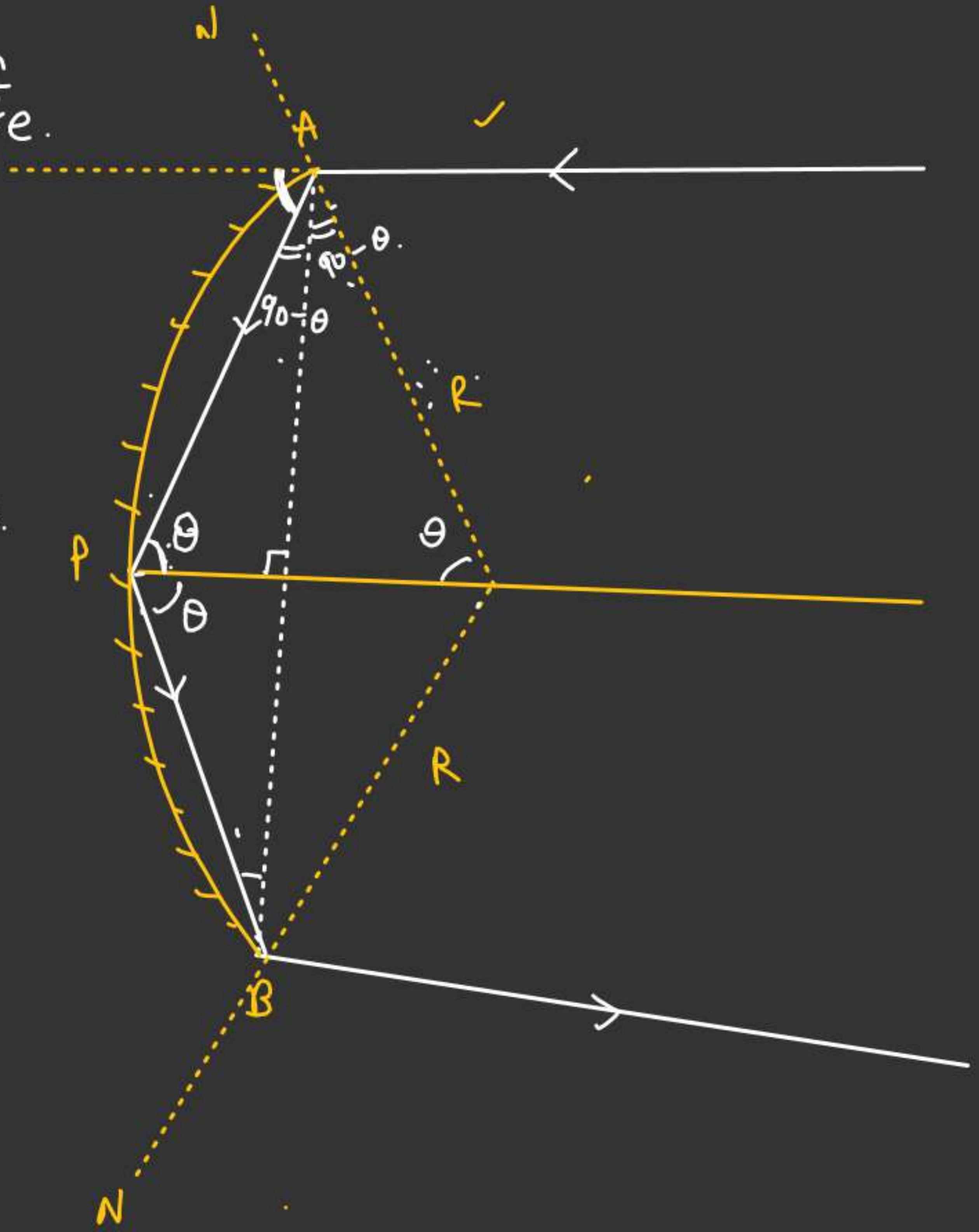
$AB = \eta R$ when $\eta < 2$.

R = Radius of Curvature.

Find $\eta_{min} = ??$

a) When Marginal rays suffer only two reflections.

b) When Marginal rays suffer 3-reflections.



$\theta = 30^\circ$

$AB = 2R \sin 60^\circ$

$AB = \sqrt{3} R$

$\eta = \sqrt{3}$

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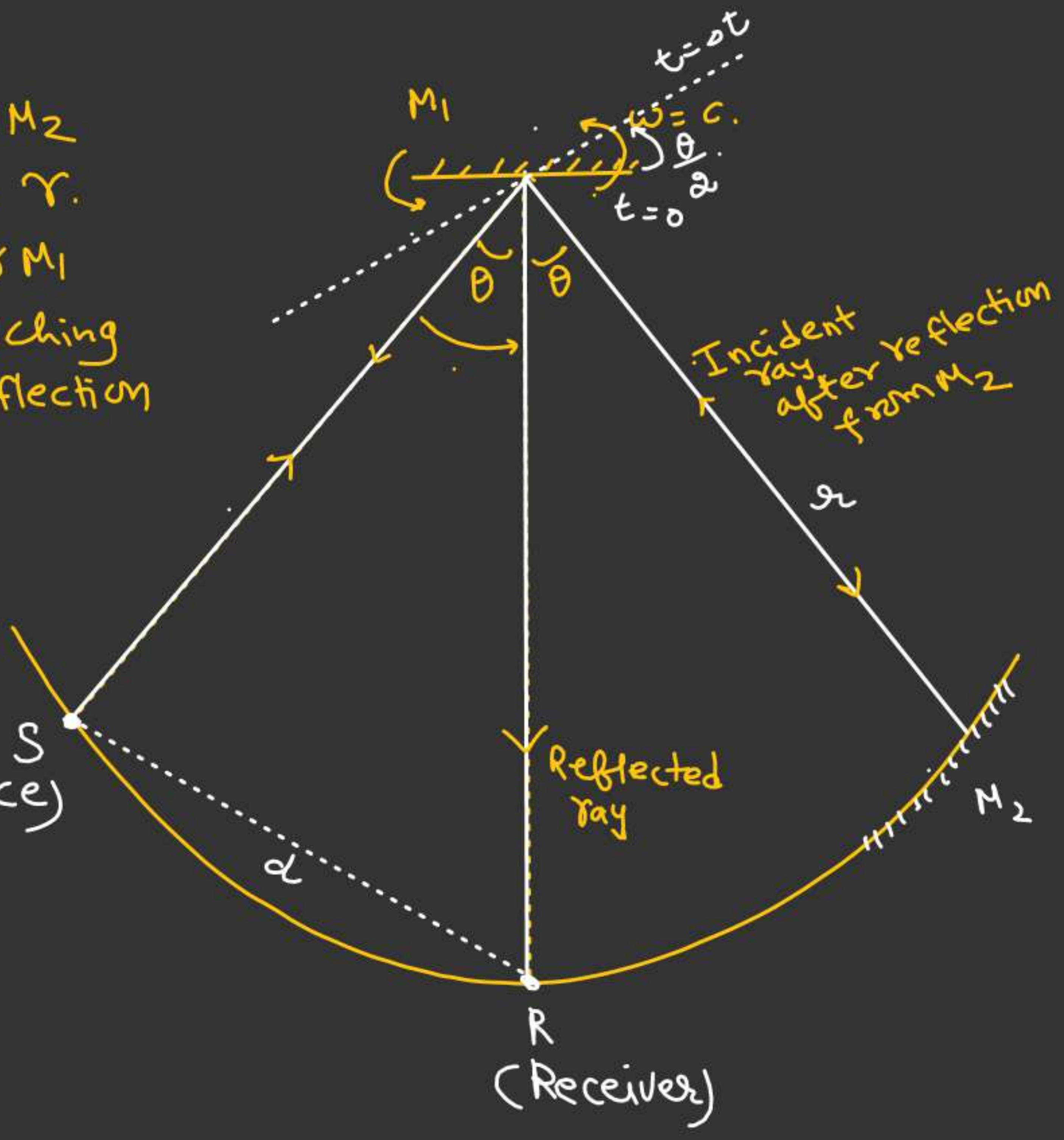
M_1 rotating with constant ω.
Source S, Receiver R and Mirror M_2 on an arc of a circle of radius r.
At the center of arc a small mirror M_1
Find ω so that final reflected reaching to receiver after 3- successive reflection 1st from M_1, then from M_2 and then again from M_1



When M_1 at Rest.

$$d = r\theta$$

$$\theta = \left(\frac{d}{r}\right)$$

$$\Delta\theta = \frac{\theta}{2} = \frac{d}{2r}$$

$$\omega = \left(\frac{\Delta\theta}{\Delta t}\right)$$

$$\Delta t = \left(\frac{2r}{c}\right)$$

$$\omega = \frac{d}{2r \times \left(\frac{2r}{c}\right)} = \left(\frac{cd}{4r^2}\right) ✓$$