Physicsaholics

DPP – 3 (Geometrical Optics)

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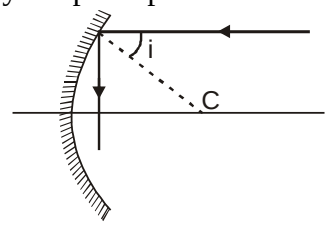
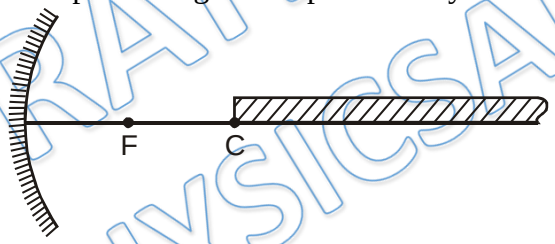
Q 1. Angle of incidence of the incident ray for which reflected ray intersect perpendicularly the principal axis. Incident ray is parallel to principal axis.



(a) 0° (b) 30°
(c) 45° (d) 60°

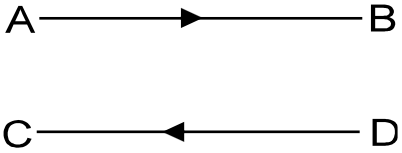
Q 2. An infinitely long rectangular strip is placed on principal axis of a concave mirror as shown in figure. One end of the strip coincides with centre of curvature as shown. The height of rectangular strip is very small in comparison to focal length of the mirror. Then the shape of image of strip formed by concave mirror is



(a)Rectangle (b) Trapezium
(c) Triangle (d) Square

Q 3. A convex mirror cannot form (for real or virtual object):
(a) real, diminished image (b) virtual, diminished image
(c) real, enlarged image (d) virtual, enlarged image

Q 4. AB is an incident beam of light and CD is a reflected beam (the number of reflections for this may be 1 or more than 1) of light. AB & CD are separated by some distance (may be large). It is possible by placing what type of mirror on the right side.



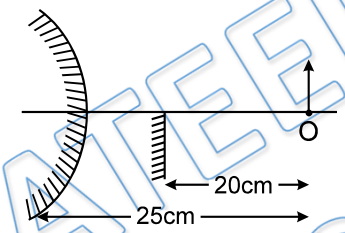
(a) one plane mirror
(b) one concave mirror
(c) one convex mirror

(d) none of these

Q 5. A point object is moving along principal axis of a concave mirror with uniform velocity towards pole. Initially the object is at infinite distance from pole on right side of the mirror as shown. Before the object collides with mirror, the number of times at which the distance between object and its image is 40 cm are.

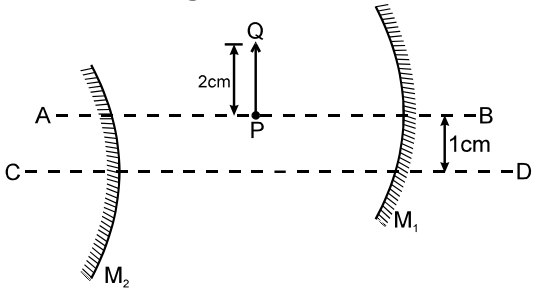
(a) one time
(b) two times
(c) three times
(d) Data insufficient

Q 6. In the figure, an object is placed at distance 25 cm from the surface of a convex mirror, and a plane mirror is set so that the image formed by the two mirrors lie adjacent to each other in the same plane. The plane mirror is placed at 20 cm from the object. What is the radius of curvature of the convex mirror?



(a) 50 cm (b) 36 cm
(c) 75 cm (d) 90 cm

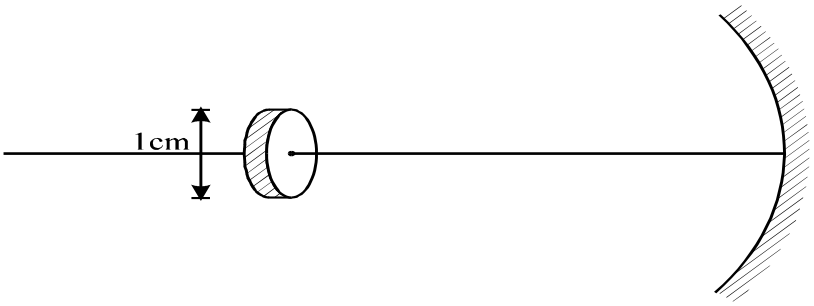
Q 7. In the figure shown M_1 and M_2 are two spherical mirrors of focal length 20 cm each. AB and CD are their principal axes respectively which are separated by 1 cm. PQ is an object of height 2 cm and kept at distance 30 cm from M_1 . The separation between the mirrors is 50 cm. Consider two successive reflections first on M_1 then on M_2 . Find the size of the 2nd image. Also find distances of end points P'' and Q'' of that image from the line AB



Comprehension (Q8 to Q11)

A concave mirror of radius of curvature 20 cm is shown in the figure. A circular disc of diameter 1 cm is placed on the principal axis of mirror with its plane perpendicular to the principal axis at a distance 15 cm from the pole of the mirror. The radius of disc

starts increasing according to the law $r = (0.5 + 0.1\ t)$ cm/sec where t is time is second.



Q 8. The image formed by the mirror will be in the shape of a :
(a) circular disc
(b) elliptical disc with major axis horizontal
(c) elliptical disc with major axis vertical
(d) distorted disc

Q 9. In the above question, the area of image of the disc at $t = 1$ second is :
(a) $1.2\ \pi\ cm^2$ (b) $1.44\ \pi\ cm^2$
(c) $1.52\ \pi\ cm^2$ (d) none of these

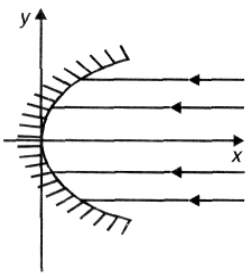
Q 10. What will be the rate at which the radius of image will be changing?
(a) 0.2 cm/sec increasing (b) 0.2 cm/sec decreasing
(c) 0.4 cm/sec increasing (d) 0.4 cm/sec decreasing

Q 11. The minimum distance of the real image of a real object, formed by a concave mirror of focal length 'f' from the mirror is:
(a) 0 (b) f (c) 2 f (d) 4 f

Q 12. When an object is at distance x_1 and x_2 from the poles of a concave mirror, images of same magnification are formed. The focal length of the mirror is
(a) $\frac{x_1 + x_2}{2}$ (b) $\frac{x_1 - x_2}{2}$
(c) $|\ x_1 - x_2\ |$ (d) $|\ x_1 + x_2\ |$

Q 13. An object is placed in front of a concave mirror of focal length *f*. A virtual image is formed with a magnification of 2. To obtain a real image of same magnification, the object has to move by a distance:
(a) f (b) $\frac{f}{2}$ (c) $\frac{3f}{2}$ (d) $\frac{2f}{3}$

Q 14. A mirror of parabolical shape is shown. The equation of mirror surface is $y^2 = 8x$, rays parallel to principal axis are focussed at



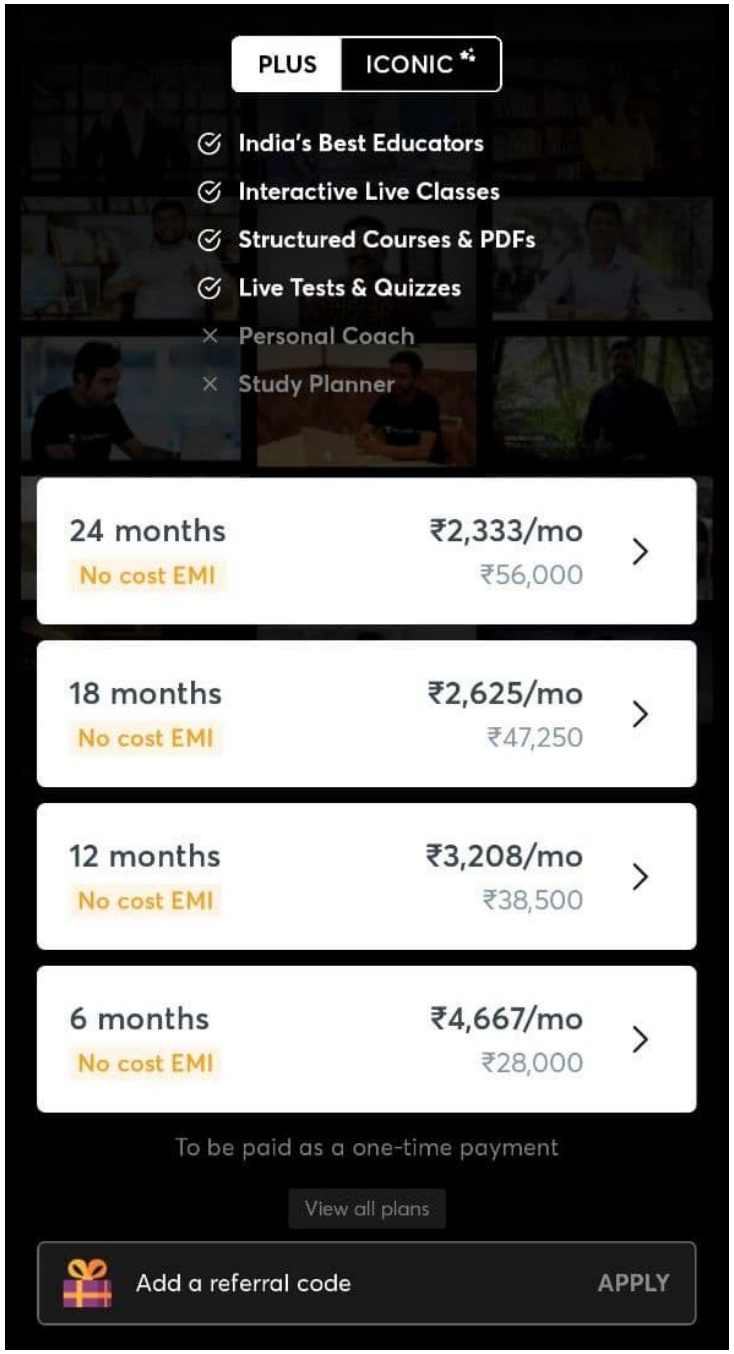
(a) (2,0) (b) (0,2) (c) (4,0) (d) (6,0)

Q 15. A point object lies at the center of curvature of a concave mirror. The mirror starts moving with velocity $\vec{v}$, then the instantaneous velocity of the image is:
(a) $\vec{v}$ (b) $2\vec{v}$ (c) $-\vec{v}$ (d) $-2\vec{v}$

Answer Key

Q.1 c	**Q.2 c**	**Q.3 a**	**Q.4 b**	**Q.5 c**
Q.6 c		**Q.8 a**	**Q.9 b**	**Q.10 a**
Q.11 b	**Q.12 a**	**Q.13 a**	**Q.14 a**	**Q.15 b**

Q.7 Size of final image is = 8 cm, distance of P'' from AB = 1 cm, distance of Q'' from AB = 7 cm



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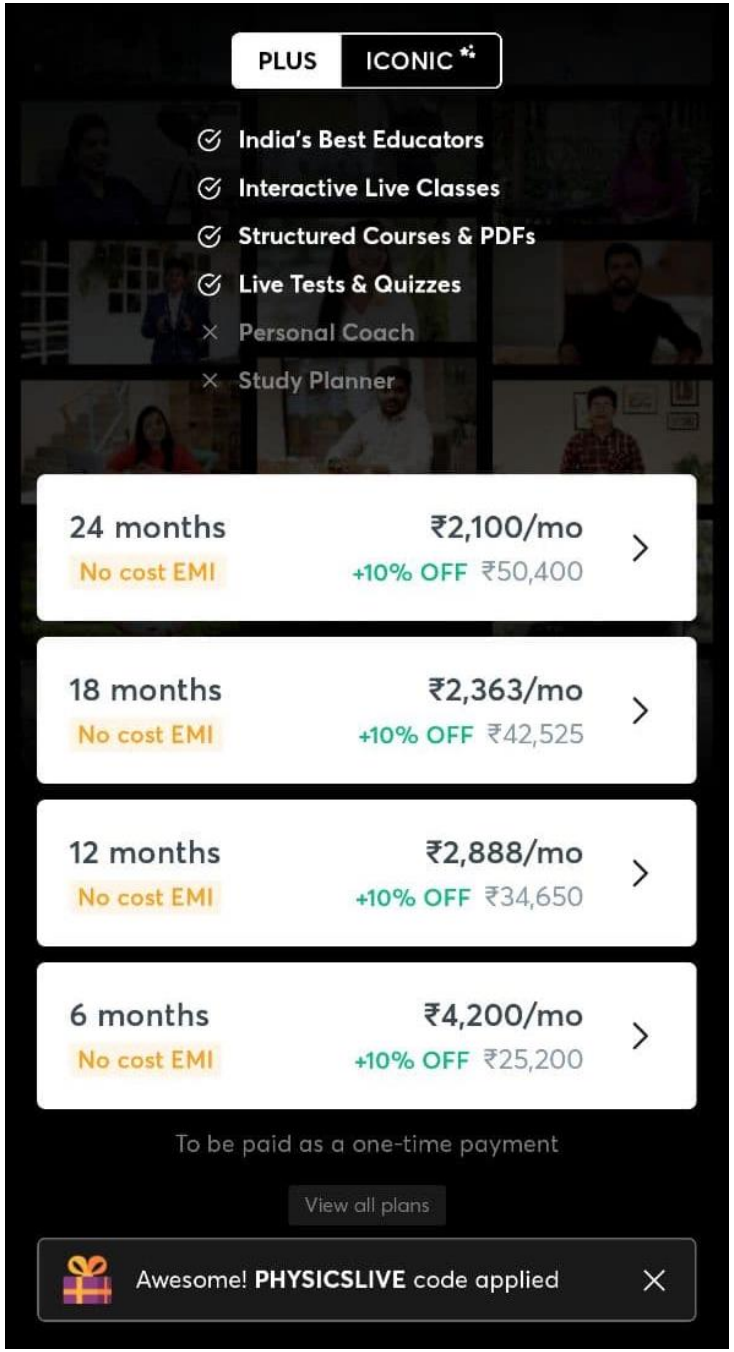
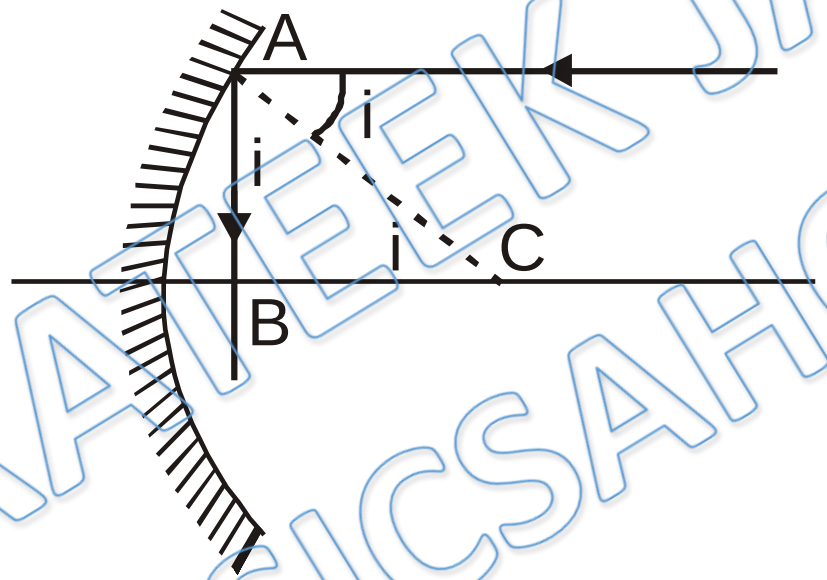


Written Solution

DPP 3 - Spherical mirrors

By Physicsaholics Team

Solution: 1



In ΔABC

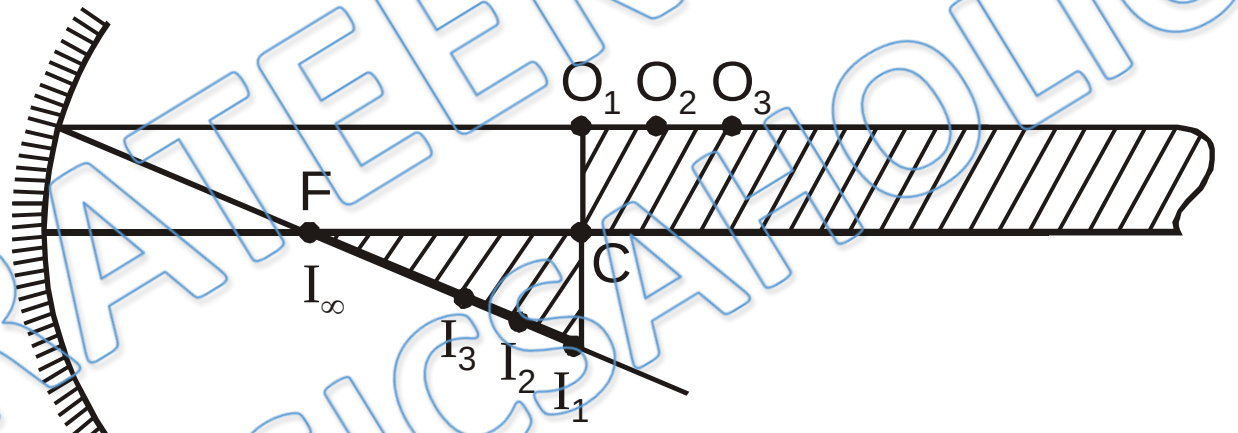
$i + i + 90° = 180^0$

$\therefore \quad i = 45°$

Ans. c

Solution: 2

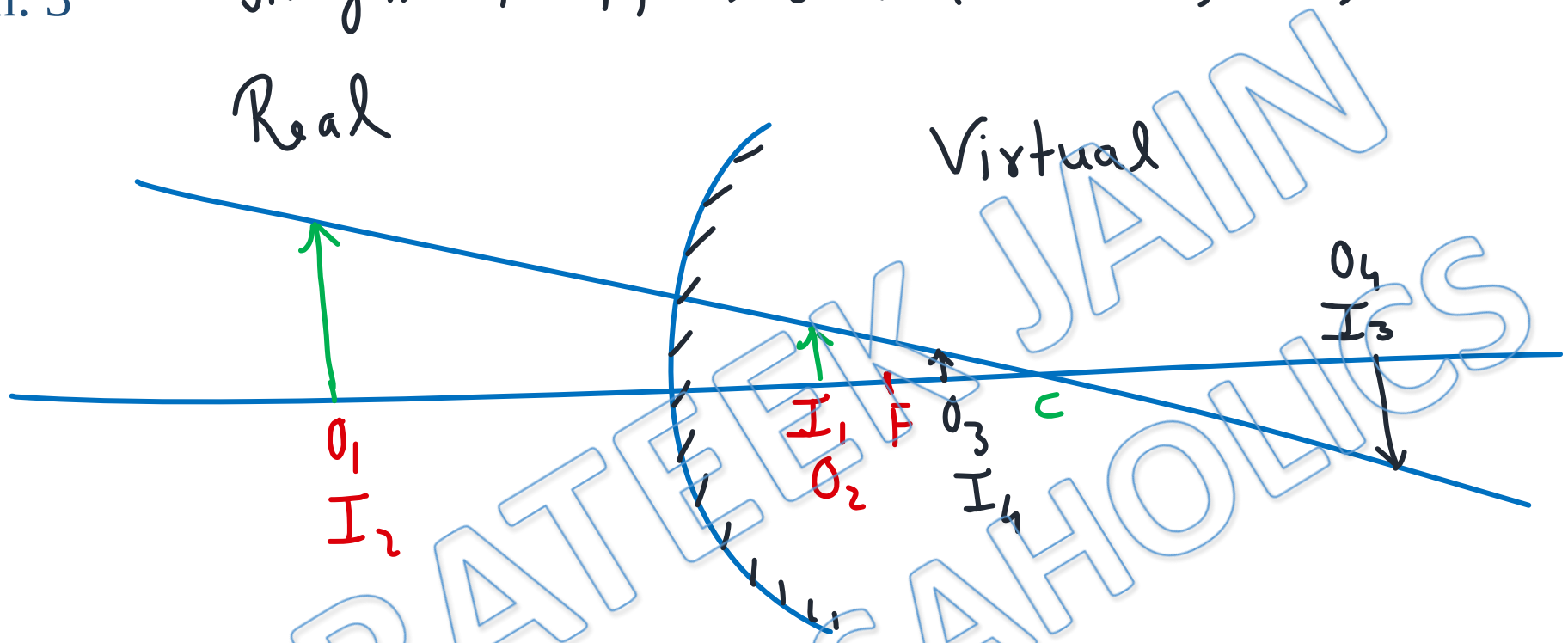
Draw an incident ray along the top side of rectangular strip, which happens to be parallel to the principal axis. After reflection this ray passes through focus. Hence image of all points (for e.g. O_1, O_2, O_3, ...) on top side of the strip lie on this reflected ray (at I_1, I_2, I_3, ...) in between focus and centre of curvature. Thus the image of this strip is a triangle as shown in figure



Ans. c

Solution: 3

Images of O_1, O_2, O_3 & O_4 are I_1, I_2, I_3 & I_4 respectively.



Real Image Cannot be diminished.

Ans (a)

OR

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

for real image $v = -v_s$, let $v = -v_0$ (↑ magnitude)

$$\Rightarrow \frac{1}{u} = \frac{1}{f} + \frac{1}{v_0} = \frac{v_0 + f}{f v_0}$$

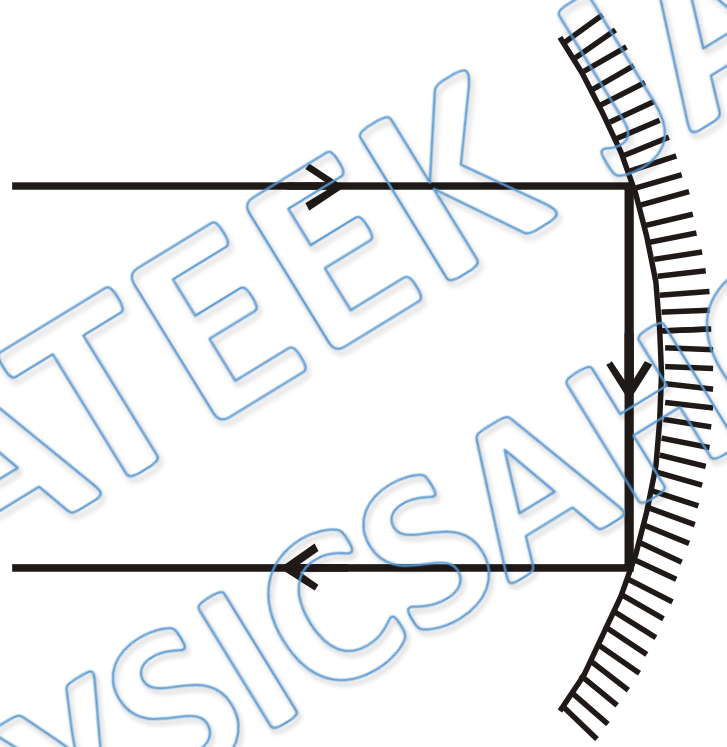
$$\Rightarrow u = v_0\left(\frac{f}{f+v_0}\right) < v_0$$ & u is +ve.

$$m = -\frac{v}{u} = \frac{v_0}{u} > 1$$

$\Rightarrow$ Image is magnified.

Solution: 4

The only possibility is by reflection from concave mirror as shown.



Ans. b

Solution: 5

As the object moves from infinity to centre of curvature, the distance between object and image reduces from infinity to zero.

As the object moves from centre of curvature to focus, the distance between object and image increases from zero to infinity.

As the object moves from focus to pole, the distance between object and its image reduces from infinity to zero. Hence the distance between object and its image shall be 40 cm three times.

Ans. c

Solution: 6

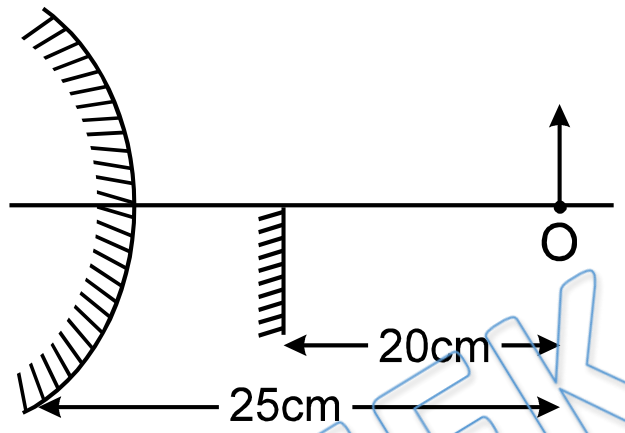


Image due to plane mirror will form at a distance of 20 cm left of the mirror.

Since image formed by two mirrrors lie adjacent to each other.

For convex mirror, image position is 15 cm towards left.

$u = -25$ cm

$v = +15$ cm

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

$f = 37.5$ cm

$R = 2f = 75$ cm.

Ans. c

Solution: 7

for reflection by M_1

$u = -30\,cm$, $O = +2\,cm$

$f = -20\,cm$

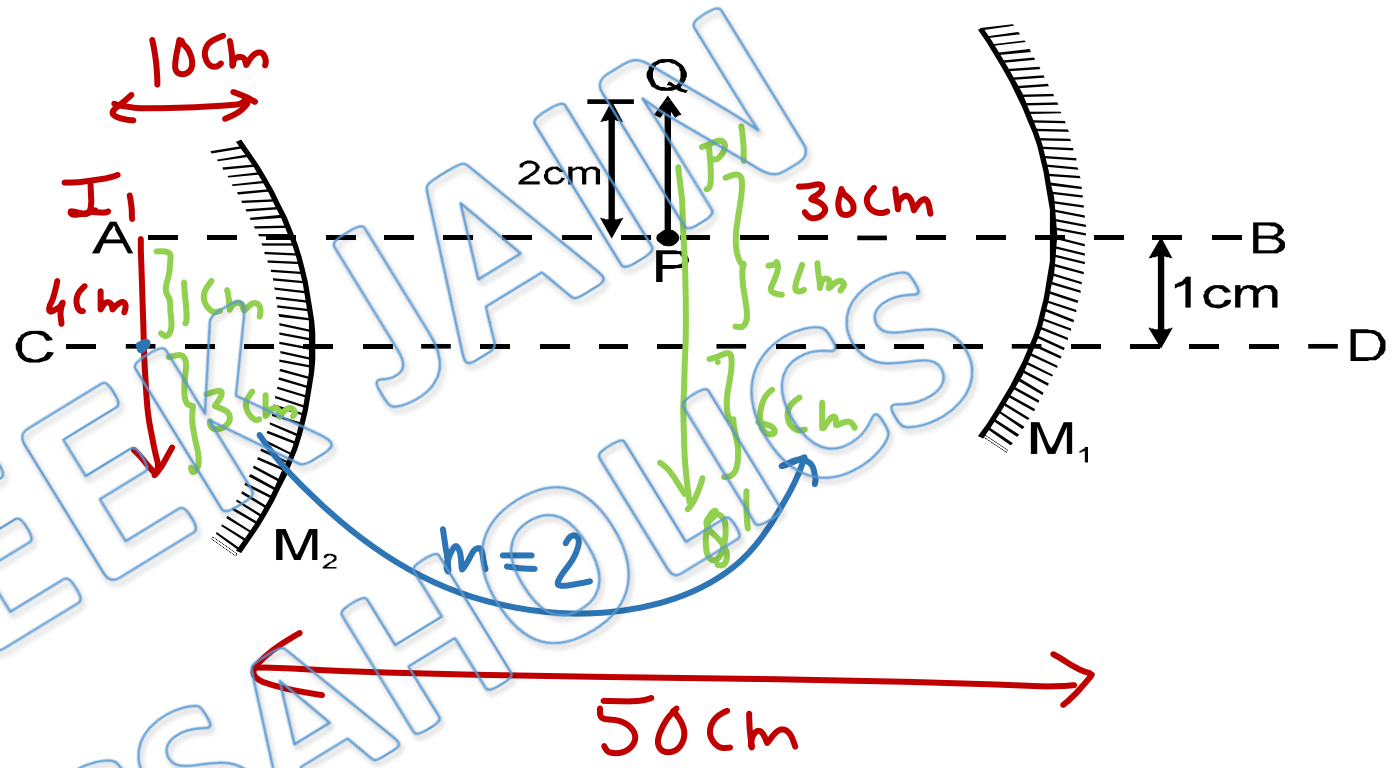
$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\Rightarrow \frac{1}{-20} = \frac{1}{v_1} + \frac{1}{-30}$$

$$\Rightarrow \frac{1}{v_1} = \frac{1}{30} - \frac{1}{20} = \frac{-1}{60}$$

$$\Rightarrow v_1 = -60\,cm$$

$$m = \frac{I_1}{+2} = \frac{-60}{-30} \Rightarrow I_1 = -4\,cm$$



for reflection by M_2

$u = +10\,cm$, $f = +20\,cm$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{20} - \frac{1}{10} = -\frac{1}{20} \Rightarrow v = -20\,cm$$

$$m = \frac{I_2}{-4} = -\left(\frac{-20}{+10}\right) \Rightarrow I_2 = -8\,cm \quad \& \quad m = 2$$

Solution: 8

All dimensions of the disc are perpendicular to the principal axis. Hence all dimensions are equally magnified, resulting in an image in the shape of a circular disc.

Ans. a

Solution: 9

At t = 1 sec.

r = 0.5 t + 0.1 t = 0.6 cm

m = = = – 2

$\Rightarrow$ Radius of image = 2r = 1.2 cm

Area of image = π(1.2)2 = 1.44 π cm^2.

Ans. b

Solution: 10

$\gamma = .5 + .1t$

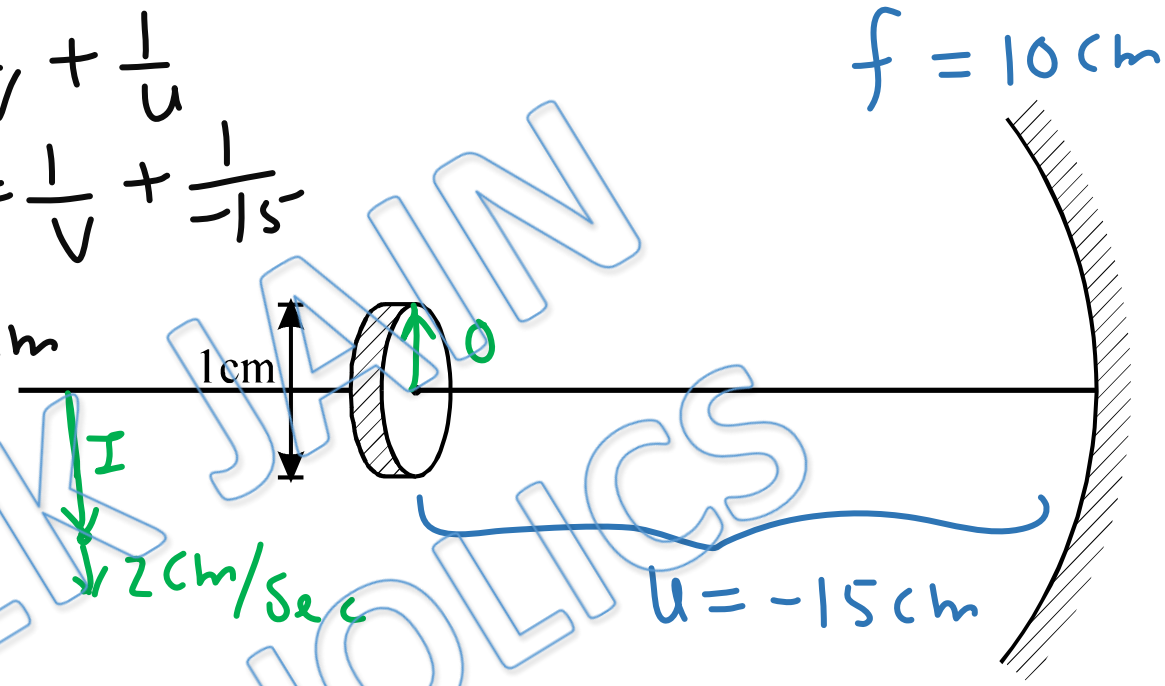
$\frac{d\gamma}{dt} = .1$

$V_I = \frac{dI}{dt}$

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

$\Rightarrow \frac{1}{-10} = \frac{1}{V} + \frac{1}{-15}$

$\Rightarrow V = -30\,cm$



$m = \frac{I}{O} = -\frac{V}{u} \Rightarrow Iu + VO = 0$

$\Rightarrow I\frac{du}{dt} + u\frac{dI}{dt} + V\frac{dO}{dt} + O\frac{dV}{dt} = 0$

$\Rightarrow 0 + (-15)\frac{dI}{dt} + (-30)(.1) + 0 = 0$

$\frac{dI}{dt} = -2\,cm/Sec$

radius of image is increasing with rate 2 cm/sec.

Ans(a)

Solution: 11

Minimum Distance of real Image of real object from Concave mirror is f.

when object is at ∞.

Ans(a)

Solution: 12

In one case magnification is m & in other case it is $-m$.

In first case

$$v = -mu = mx_1$$

In second case

$$v = +mu = -mx_2$$

Since $v = \dfrac{uf}{u-f}$

$$mx_1 = \frac{-x_1 f}{-x_1 - f} \Rightarrow mx_1 = \frac{x_1 f}{x_1 + f}$$

& $$-mx_2 = \frac{-x_2 f}{-x_2 - f} \Rightarrow -mx_2 = \frac{x_2 f}{x_2 + f}$$

$$\Rightarrow \quad -\frac{x_1}{x_2} = \frac{x_1}{x_1+f} \times \frac{x_2+f}{x_2}$$

$$\Rightarrow \quad -x_1 - f = x_2 + f$$

$$\Rightarrow \quad 2f = -(x_1+x_2)$$

$$f = \frac{-(x_1+x_2)}{2}$$

Ans (a)

Solution: 13

$$m = 2 = -\frac{v}{u} \Rightarrow v = -2u$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{-f} = \frac{1}{-2u} + \frac{1}{u} \Rightarrow u = -f/2$$

for real image of same magnification

$$m = -2 = -\frac{v}{u} \Rightarrow v = 2u$$

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{-f} = \frac{1}{2u} + \frac{1}{u} \Rightarrow u = \frac{-3f}{2}$$

Distance between objects = f

Ans (a)

Solution: 14

$$y^2 = 8x$$

Radius of curvature $R = \dfrac{\left[1 + \left(\frac{dx}{dy}\right)^2\right]^{3/2}}{\frac{d^2x}{dy^2}}$

$$x = y^2/8$$

$$\frac{dx}{dy} = y/4 \Rightarrow \frac{d^2x}{dy^2} = \frac{1}{4}$$

$$\Rightarrow R = \frac{\left[1 + y^2/16\right]^{3/2}}{1/4} = 4$$

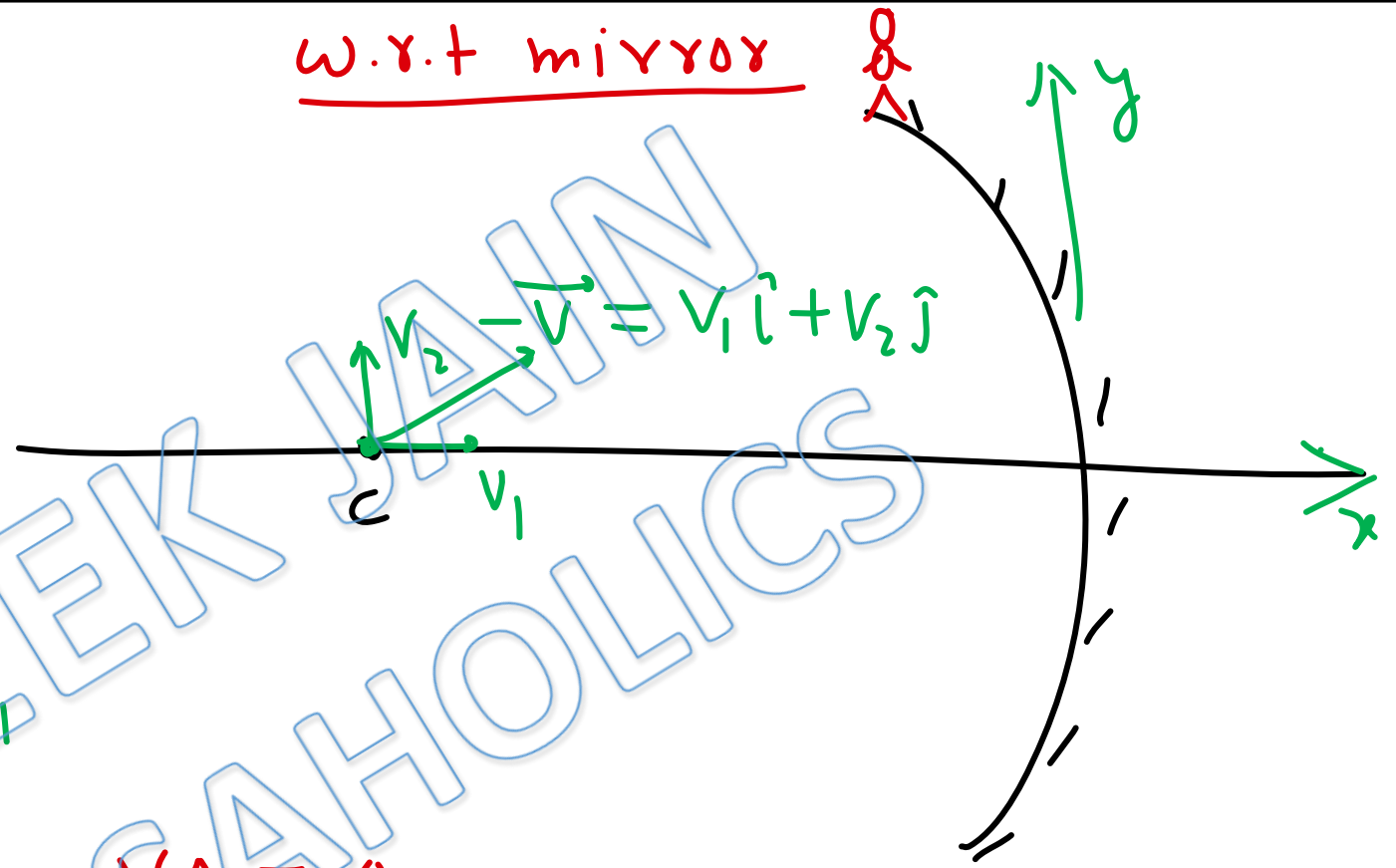
(Since y is zero at pole.)

$$\Rightarrow f = R/2 = 2$$

Ans (a)

. Solution: 15

w.r.t mirror



Let velocity of image with respect to mirror is $\vec{V_I} = V_x\hat{i} + V_y\hat{j}$

$$V_x = -\left(\frac{v^2}{u^2}\right)\frac{du}{dt}$$

$$= -\left(\frac{R^2}{R^2}\right)V_1 = -V_1$$

$$m = \frac{I}{O} = -\frac{v}{u} \Rightarrow Iu + vO = 0$$

$$\Rightarrow I\frac{du}{dt} + u\frac{dI}{dt} + v\frac{dO}{dt} + O\frac{dv}{dt} = 0$$

$$\Rightarrow 0 + (-R)V_y + (-R)V_2 + 0 = 0$$

$$V_y = -V_2$$

$$\Rightarrow \quad \vec{V_I} = -V_1\hat{i} - V_2\hat{j} = +\vec{V}$$

Velocity of Image w.r.t. ground

$$\vec{V}_{I,g} = \vec{V}_{I,M} + \vec{V}_{M,g}$$

$$= \vec{V} + \vec{V} = 2\vec{V}$$

Ans(b)

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