Physicsaholics

DPP – 1 (Geometrical Optics)

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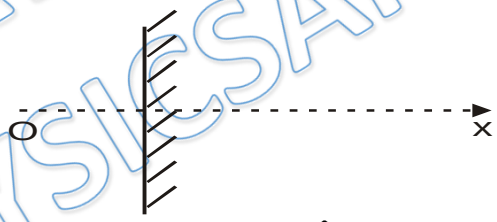
Q 1. A ray of light making an angle 10° with the horizontal is incident on a plane mirror making an angle θ with the horizontal. What should be the value of θ so that the reflected ray goes vertically upwards -
(a) 20° (b) 30° (c) 40° (d) 45°

Q 2. An object moves in front of a fixed plane mirror. The velocity of the image of the object is
(a) Equal in the magnitude and in the direction to that of the object.
(b) Equal in the magnitude and opposite in direction to that of the object.
(c) Equal in the magnitude and the direction will be either same or opposite to that of the object.
(d) Equal in magnitude and makes any angle with that of the object depending on direction of motion of the object.

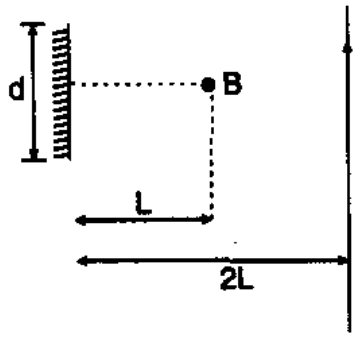
Q 3. Object O is moving with velocity $\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ and mirror (lies in y-z plane) is moving with velocity $2\hat{\imath}$.



(a) Velocity of image w.r.t ground $3\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$
(b) Velocity of image w.r.t mirror $\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$
(c) Velocity of image w.r.t object $2\hat{\imath}$
(d) Velocity of object w.r.t mirror $-\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$

Q 4. A plane mirror is placed at origin parallel of y-axis, facing the positive *x*-axis. An object starts from (2 m, 0, 0) with a velocity of $(2\hat{\imath} + 2\hat{\jmath})$ m\s. The relative velocity of image with respect to object is along:
(a) positive x-axis (b) negative x-axis
(c) positive y-axis (d) negative y-axis

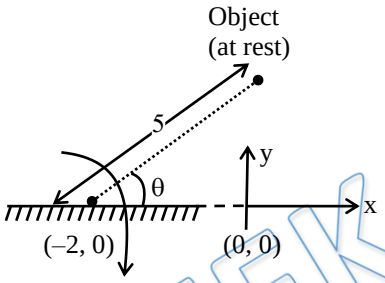
Q 5. A point source of light B, placed at a distance L in front of the centre of a plane minor of width d, hangs vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror at a distance 2L from it as shown. The greatest distance over which he can see the image of the light source in the mirror is



(a) d/2 (b) d (c) 2d (d) 3d

Passage: (Q.6 to Q.8)

The figure shows time varying θ can be given by equations is : $\theta = (2 + 6t^2)$. The mirror is rotating about a horizontal axis in clockwise direction.



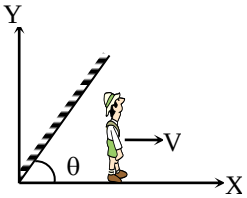
Q 6. Locus of the image is –
(a) $x^2 + y^2 = 5^2$
(b) $(x + 2)^2 + y^2 = 5^2$
(c) $(x - 2)^2 + y^2 = 5^2$
(d) $x^2 + (y - 2)^2 = 5^2$

Q 7. Angular velocity of the image at t = 2 s –
(a) 12 rad/s (b) 24 rad/s (c) 36 rad/s (d) 48 rad/s

Q 8. Acceleration of the image at t = 0
(a)100.2 m/s^2 (b) 120 m/ s^2
(c) 131.4 m/ s^2 (d) 144.4 m/s^2

Q 9. A horizontal fluorescent tube is 80 cm in length. If a square horizontal plane mirror, of each side 20 cm, is placed below the tube at a distance 200 cm from the tube, such that the perpendicular bisector of the length of the tube passes through the mid-point of the mirror and pair of the sides of the mirror are parallel to the length of the tube, find the length of the reflected patch of light on the ceiling, 100 cm above the tube.
(a) 120 cm (b) 170 cm
(c) 150 cm (d) 90 cm

Q 10. A boy is walking under an inclined mirror at a constant velocity V m/s along the x-axis as shown in figure. If the mirror is inclined at an angle θ with the horizontal then what is the velocity of the image ?

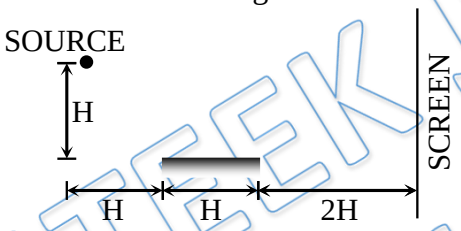


(a) V sin q $\hat{\imath}$ + V cos q $\hat{\jmath}$
(b) V cos q $\hat{\imath}$ + V sin q $\hat{\jmath}$
(c) V sin 2q $\hat{\imath}$ + V cos 2q $\hat{\jmath}$
(d) V cos 2q $\hat{\imath}$ + V sin 2q $\hat{\jmath}$

Q 11. A mirror is inclined at an angle of θ° with the horizontal. If a ray of light is incident at an angle of incidence θ° then the reflected ray makes the following angle with the horizontal-

(a) θ^0 (b) $2\theta^0$
(c) $\theta^0/2$ (d) None of the above

Q 12. A point source has been placed as shown in the figure. What is the length on the screen that will receive reflected light from the mirror?



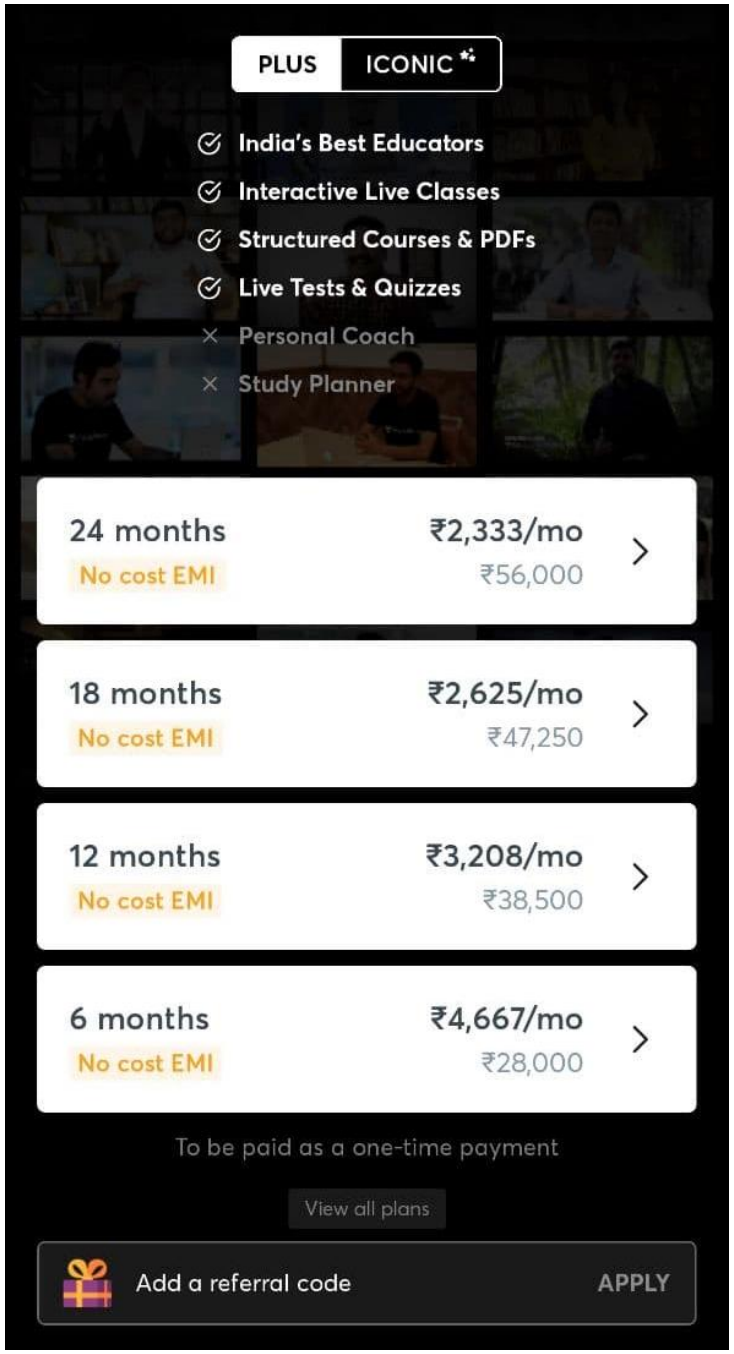
(a) 2 H (b) 3H (c) H (d) None

Q 13. A plane mirror is moving with velocity $4\hat{\imath} + 5\hat{\jmath} + 8\hat{k}$. A point object in front of the mirror moves with a velocity $3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$. Here $\hat{k}$ is along the normal to the plane mirror and facing towards the object. The velocity of the image is –

(a) $-3\hat{\imath} - 4\hat{\jmath} + 5\hat{k}$ (b) $3\hat{\imath} + 4\hat{\jmath} + 11\hat{k}$
(c) $-3\hat{\imath} - 4\hat{\jmath} + 11\hat{k}$ (d) $7\hat{\imath} + 9\hat{\jmath} + 11\hat{k}$

Answer Key

Q.1 c	**Q.2 d**	**Q.3 a,b,c,d**	**Q.4 b**	**Q.5 d**
Q.6 b	**Q.7 d**	**Q.8 b**	**Q.9 b**	**Q.10 d**
Q.11 d	**Q.12 a**	**Q.13 b**		



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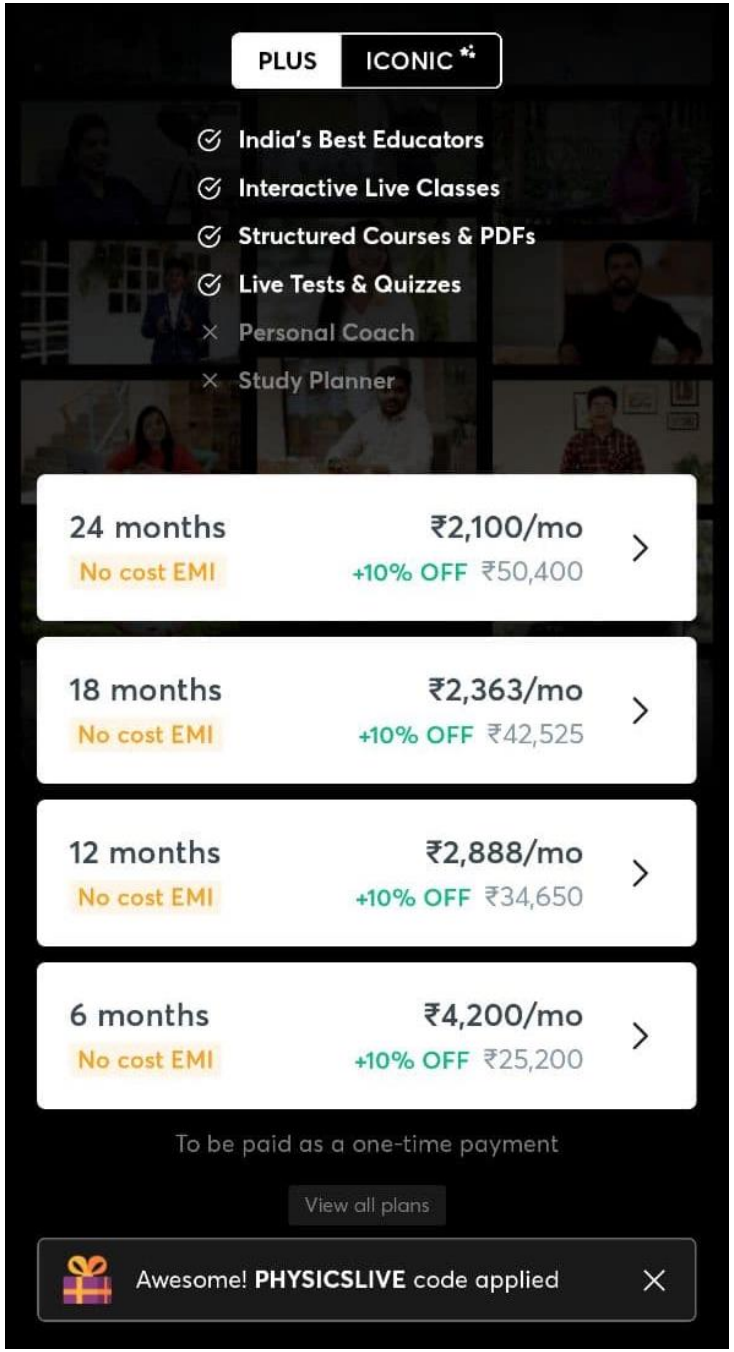
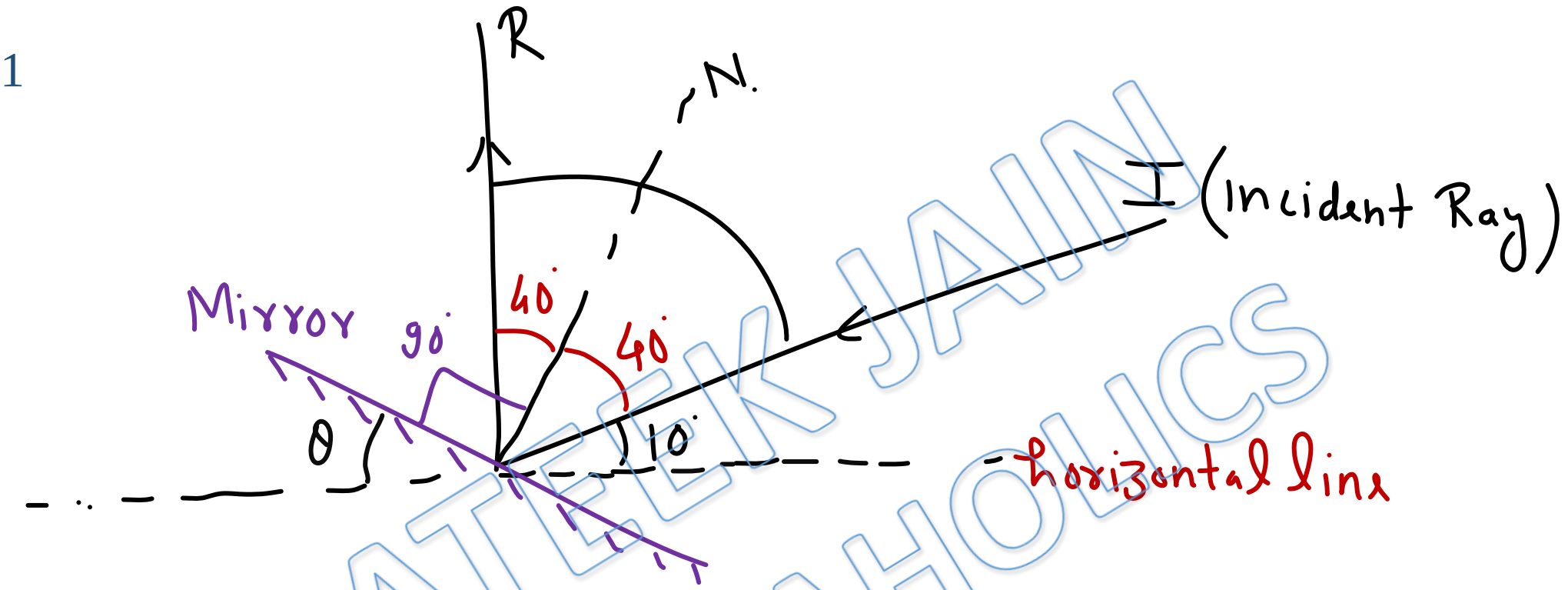


Written Solution

DPP- 1 Geometrical Optics: Plane Mirror, Real, Virtual , Rotation of Mirror, Velocity of Image

By Physicsaholics Team

Solution: 1



Angle between I & R = 90° − 10° = 80°

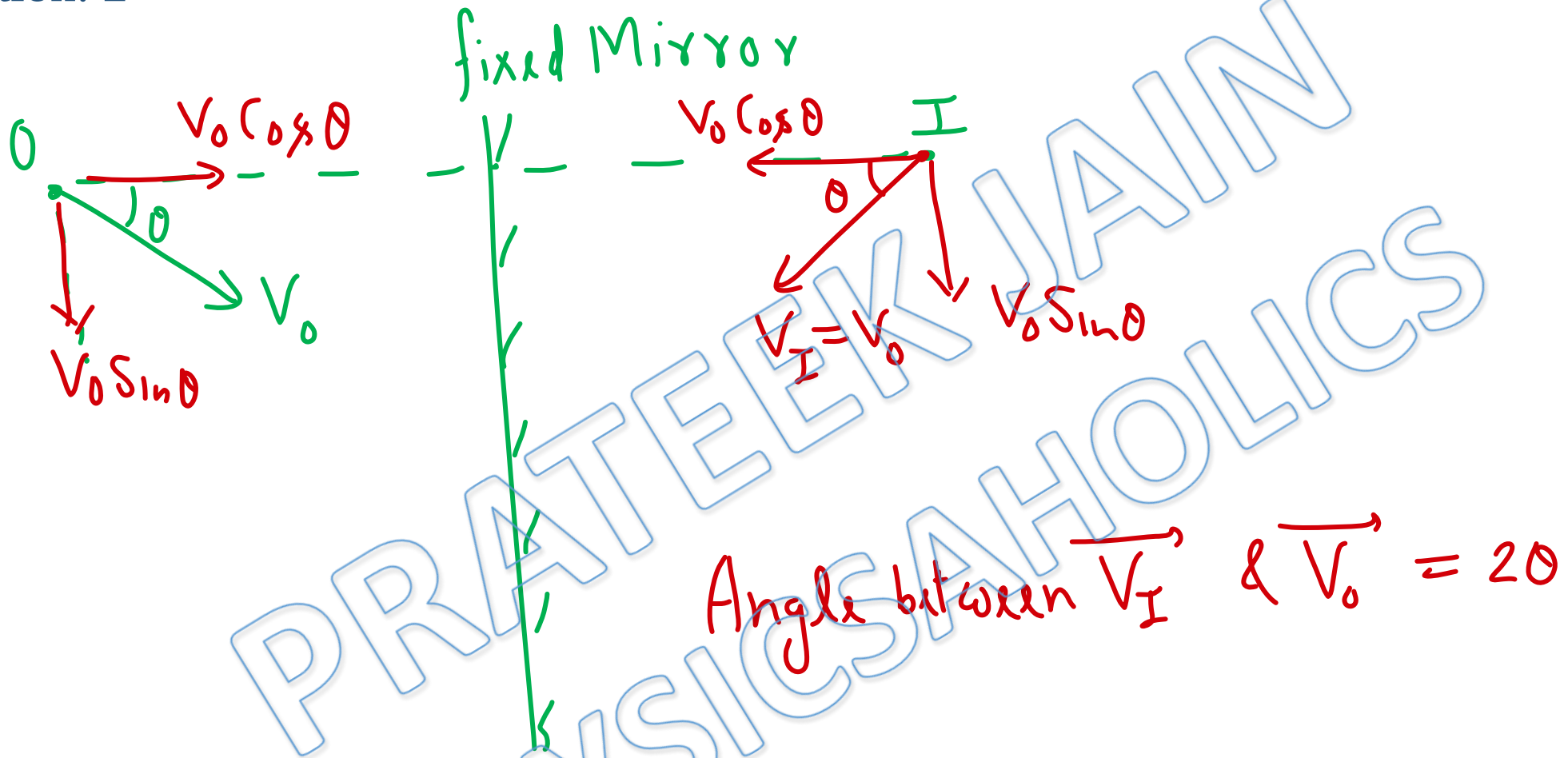
" " " " & N = $\frac{80°}{2}$ = 40°

Angle b/w Mirror & Reflected Ray = 50°

$\Rightarrow \theta = 90° - 50° = 40°$

Ans(c)

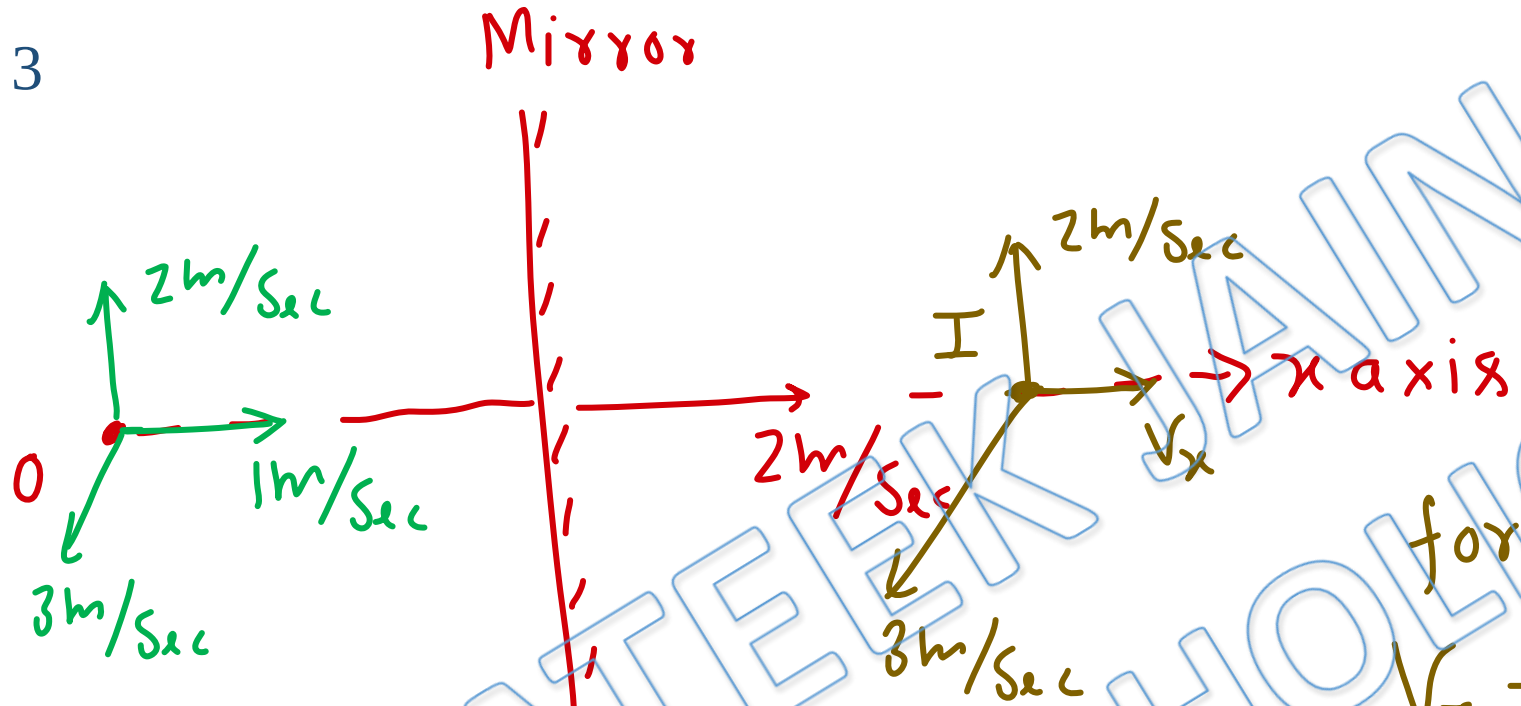
Solution: 2



Angle between $\overrightarrow{V_I}$ & $\overrightarrow{V_0}$ = 2θ

Ans (d)

Solution: 3



for Motion along x axis

$V_I = 2V_M - V_O$

$= 2\times 2 - 1 = 3$

$\Rightarrow \vec{V_I} = 3\hat{i} + 2\hat{j} + 3\hat{k}$

$\vec{V}_{I,M} = \vec{V}_I - \vec{V}_M = (3\hat{i} + 2\hat{j} + 3\hat{k}) - 2\hat{i} = \hat{i} + 2\hat{j} + 3\hat{k}$

$\vec{V}_{I,O} = \vec{V}_I - \vec{V}_O = (3\hat{i} + 2\hat{j} + 3\hat{k}) - (\hat{i} + 2\hat{j} + 3\hat{k}) = 2\hat{i}$

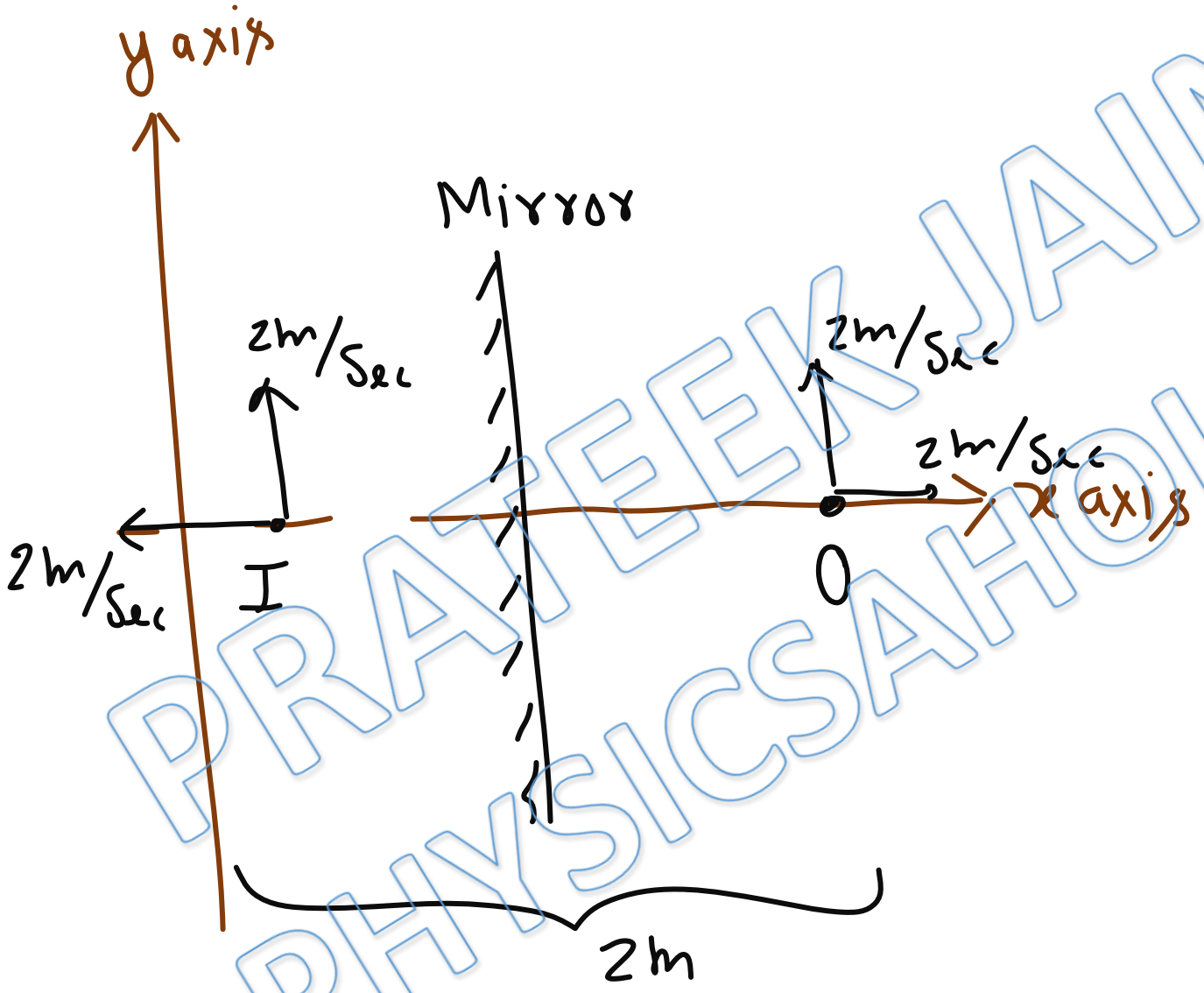
$$\vec{V}_{0,M} = \vec{V}_0 - \vec{V}_M$$

$$= (\hat{i} + 2\hat{j} + 3\hat{k}) - (2\hat{i})$$

$$= -\hat{i} + 2\hat{j} + 3\hat{k}$$

Ans (a, b, c, d)

Solution: 4



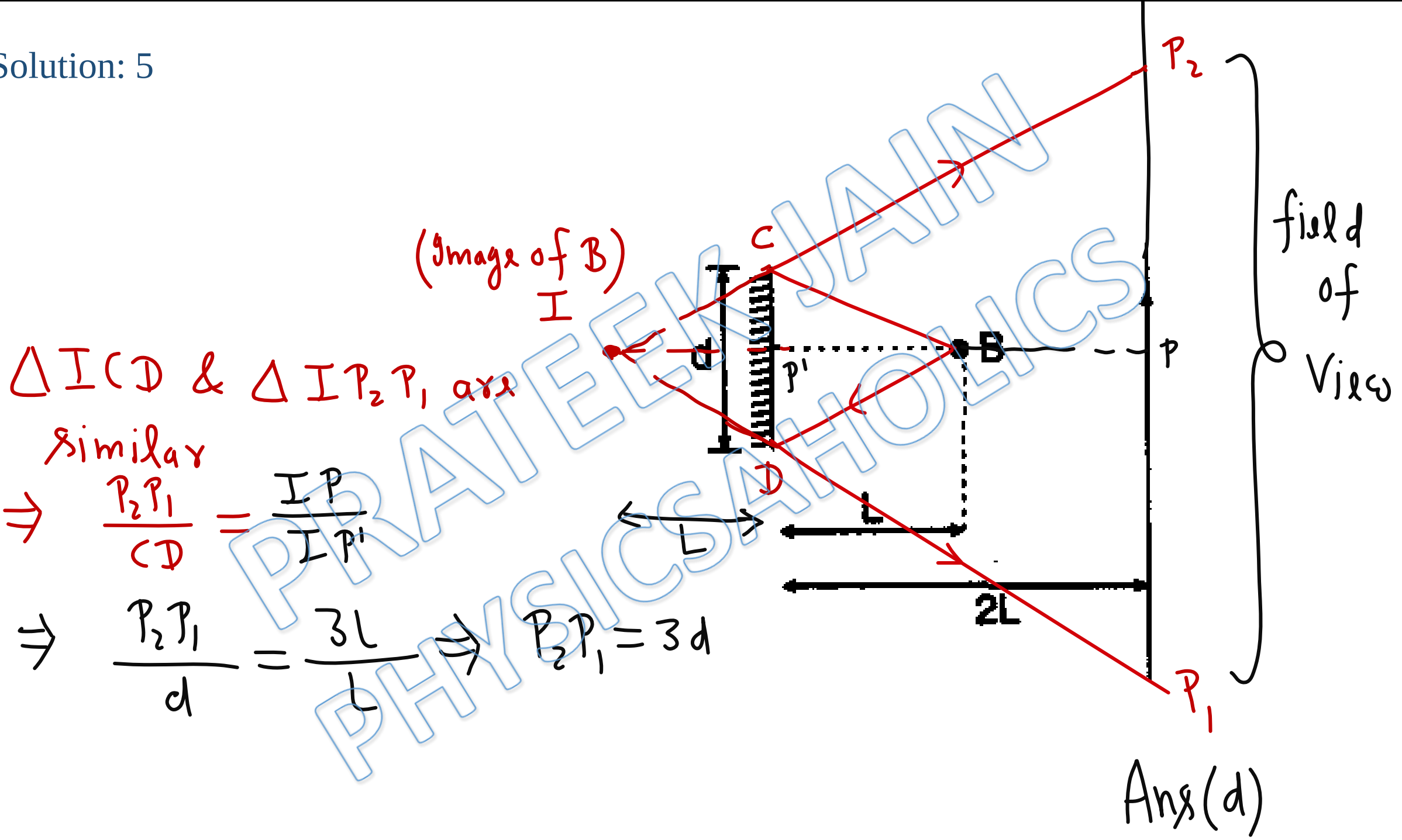
$\overrightarrow{V_O} = 2\hat{i} + 2\hat{j}$

$\overrightarrow{V_I} = -2\hat{i} + 2\hat{j}$

$\overrightarrow{V_{I,O}} = -4\hat{i}$

Ans(b)

Solution: 5



Solution: 6

Whatever be the value of θ,

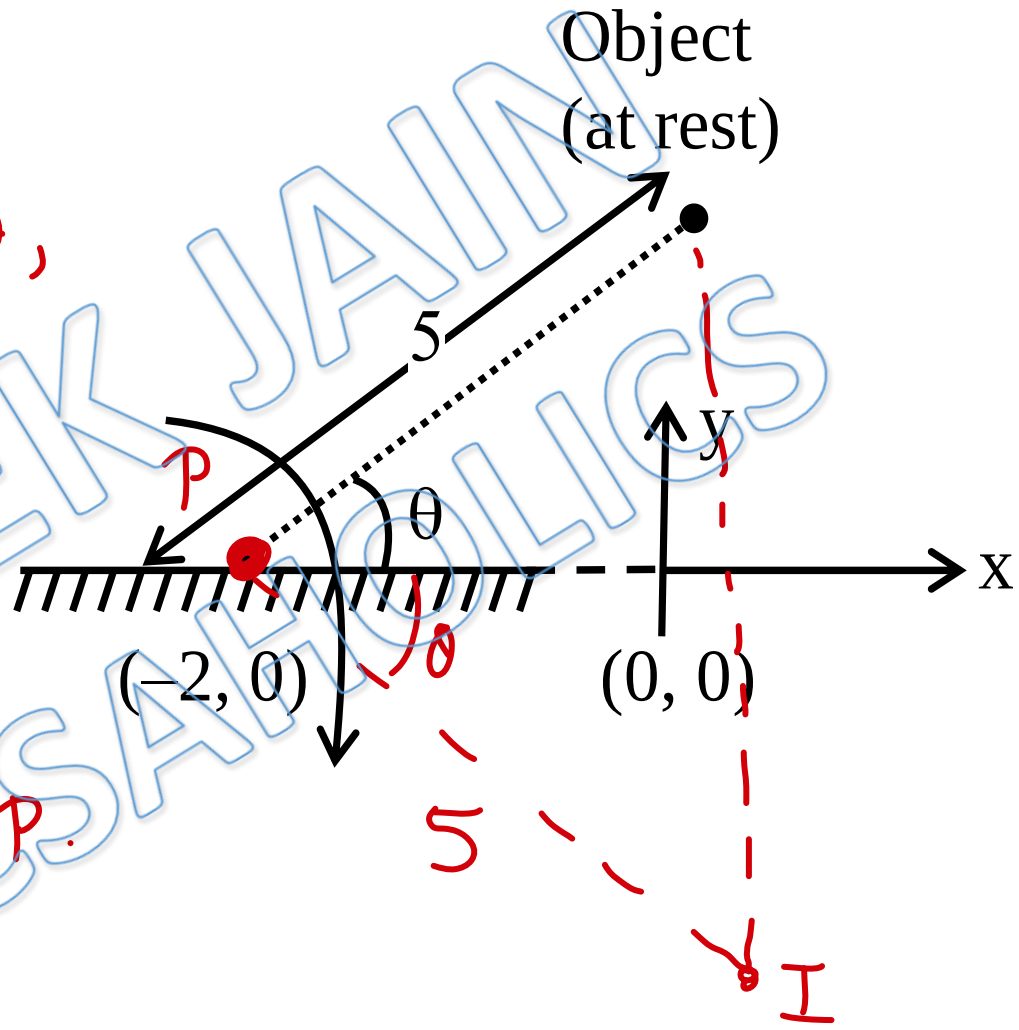
distance of I from P

$= 5\,m$

$\Rightarrow$ Locus of I is circle

of radius 5 & Centre at P.

$\Rightarrow (x+2)^2 + y^2 = 5^2$



Ans (b)

Solution: 7

$\theta = 2 + 6t^2 \Rightarrow \frac{d\theta}{dt} = 12t$

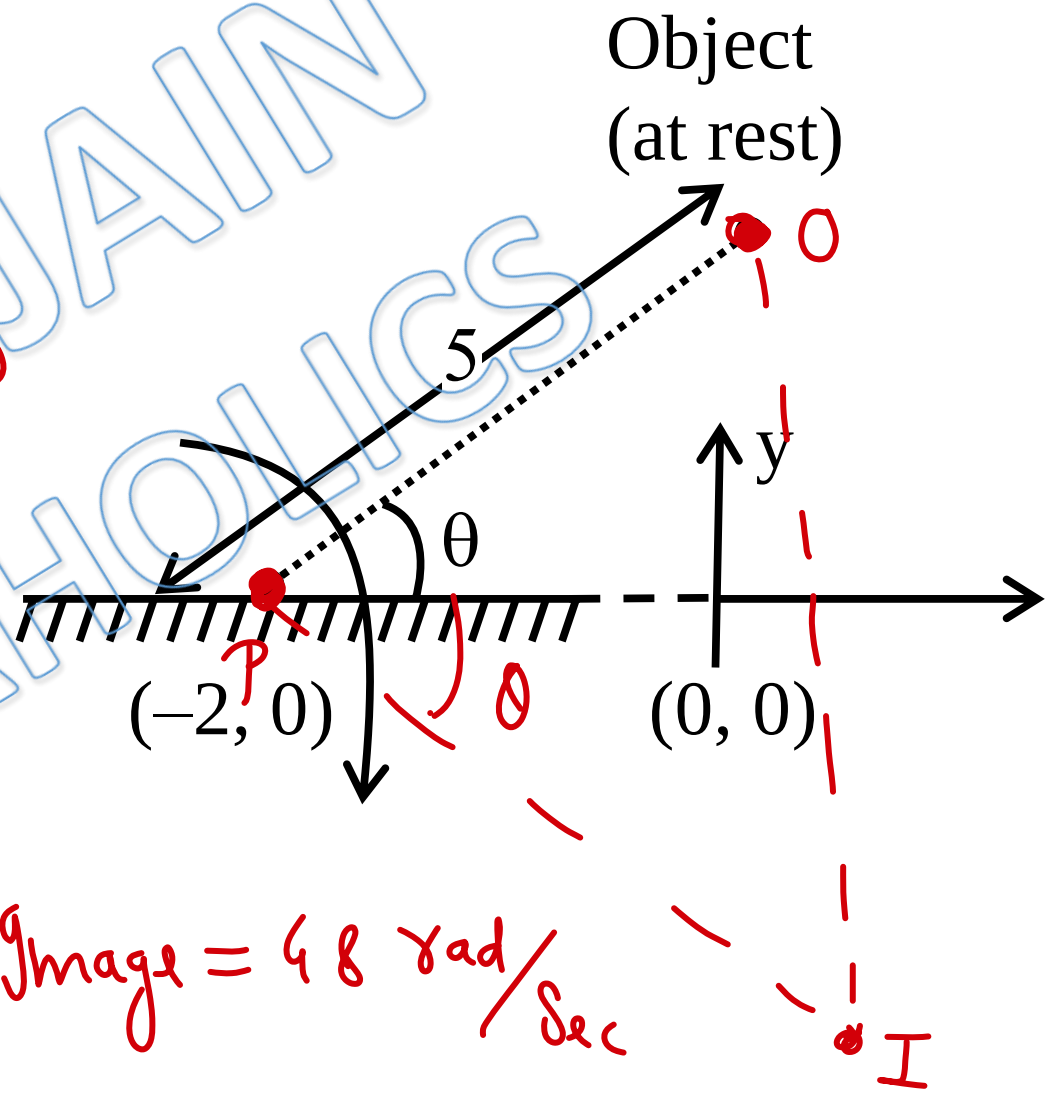
Angle b/w PI & fixed line PO

$= 2\theta$

$\Rightarrow$ Angular velocity of Image

$= \frac{d}{dt}(2\theta) = 2\frac{d\theta}{dt} = 24t$

at $t = 2$, angular velocity of Image $= 48$ rad/sec



Ans (d)

Solution: 8

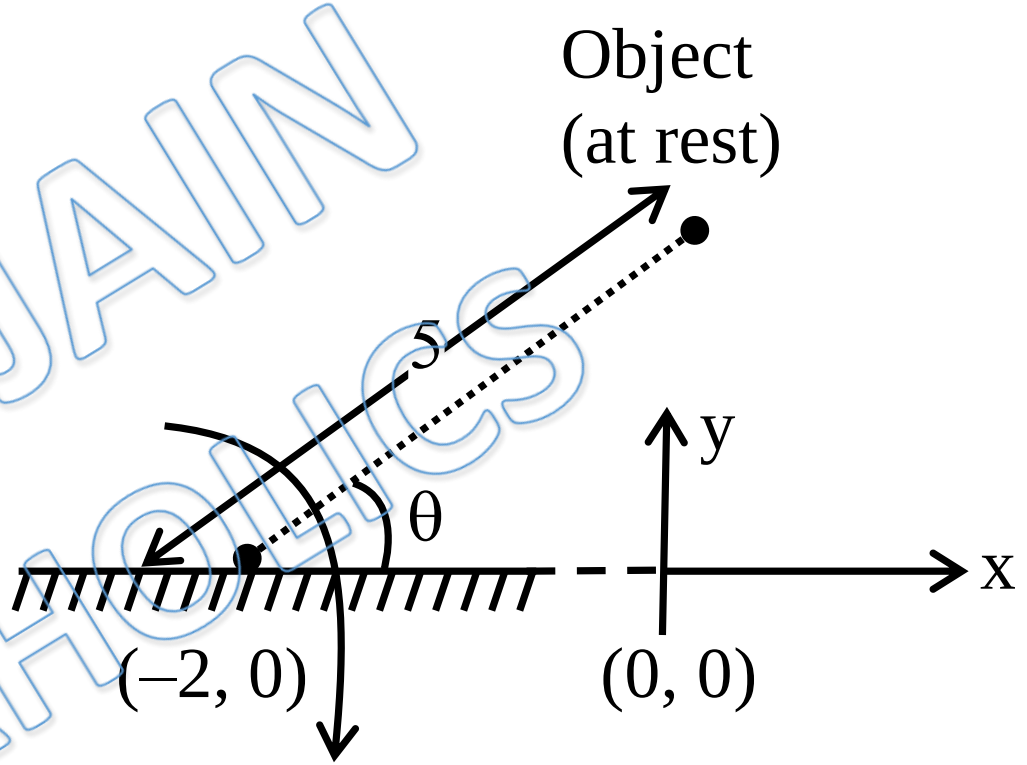
Angular velocity of image $= 24t$

$\Rightarrow$ angular acceleration $=$ " $= 24$

$\Rightarrow$ $a_T = \alpha R = 24 \times 5 = 120\ m/sec^2$

$a_c = \omega^2 R = (24t)^2 R = 0$

$\Rightarrow$ $a = a_T = 120\ m/sec^2$



Ans (b)

Solution: 9 $l \rightarrow$ total length of Path

$$l_1 + l_2 = 200 \quad --(1)$$

ABC & DEC are similar triangles $\rightarrow$

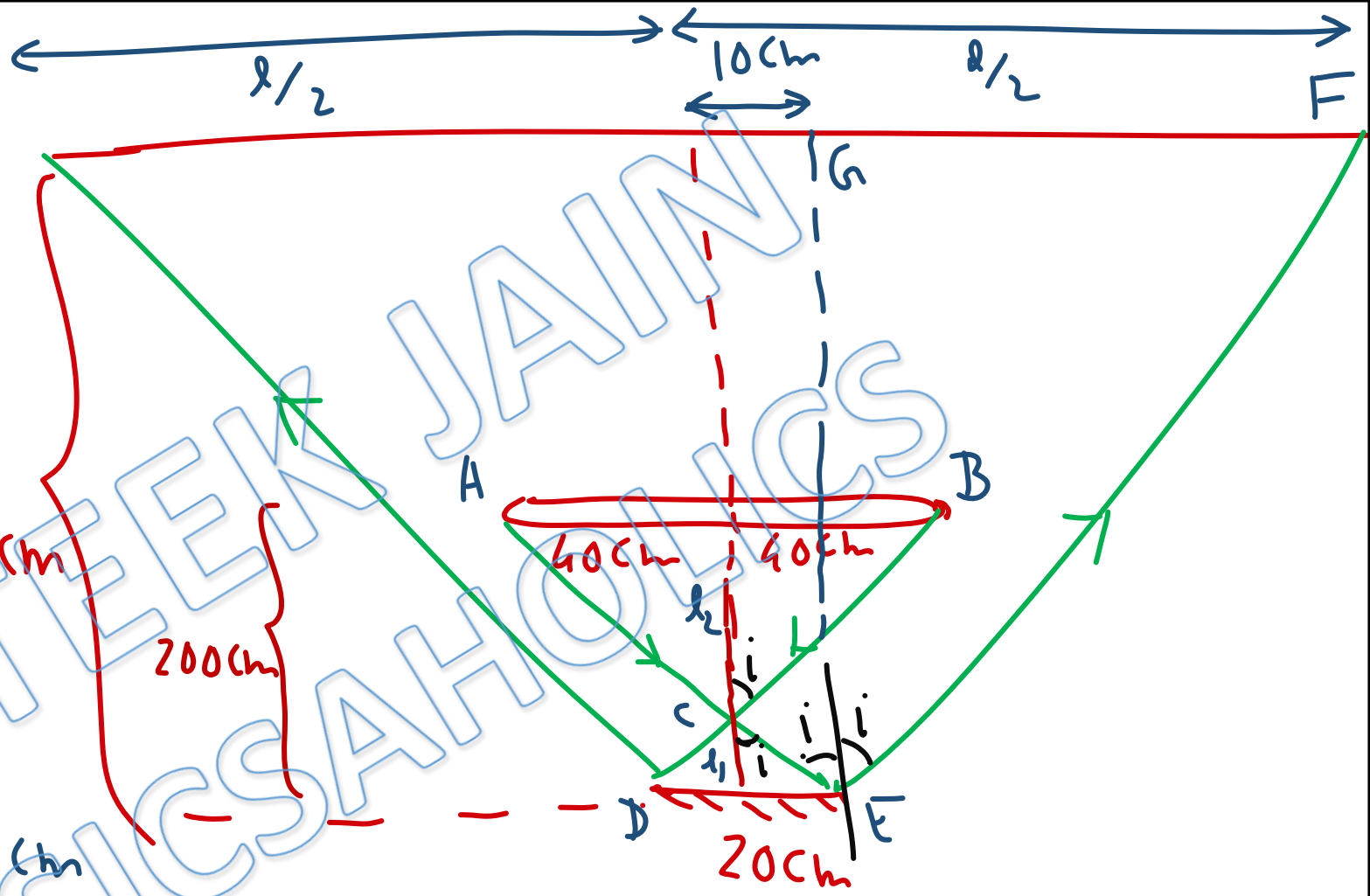
$$\frac{l_1}{l_2} = \frac{20}{80} = \frac{1}{4}$$

$$\Rightarrow l_2 = 4 l_1$$

$$\Rightarrow 5 l_1 = 200 \Rightarrow l_1 = 40\,cm$$

$$\Rightarrow l_2 = 160\,cm$$

$$\Rightarrow \tan i = \frac{40}{l_2} = \frac{40}{160} = \frac{1}{4}$$



AB $\rightarrow$ tube

DE $\rightarrow$ Mirror

In triangle EFG

$$\tan i = \frac{\ell/2 - 10}{300} = \frac{1}{4}$$

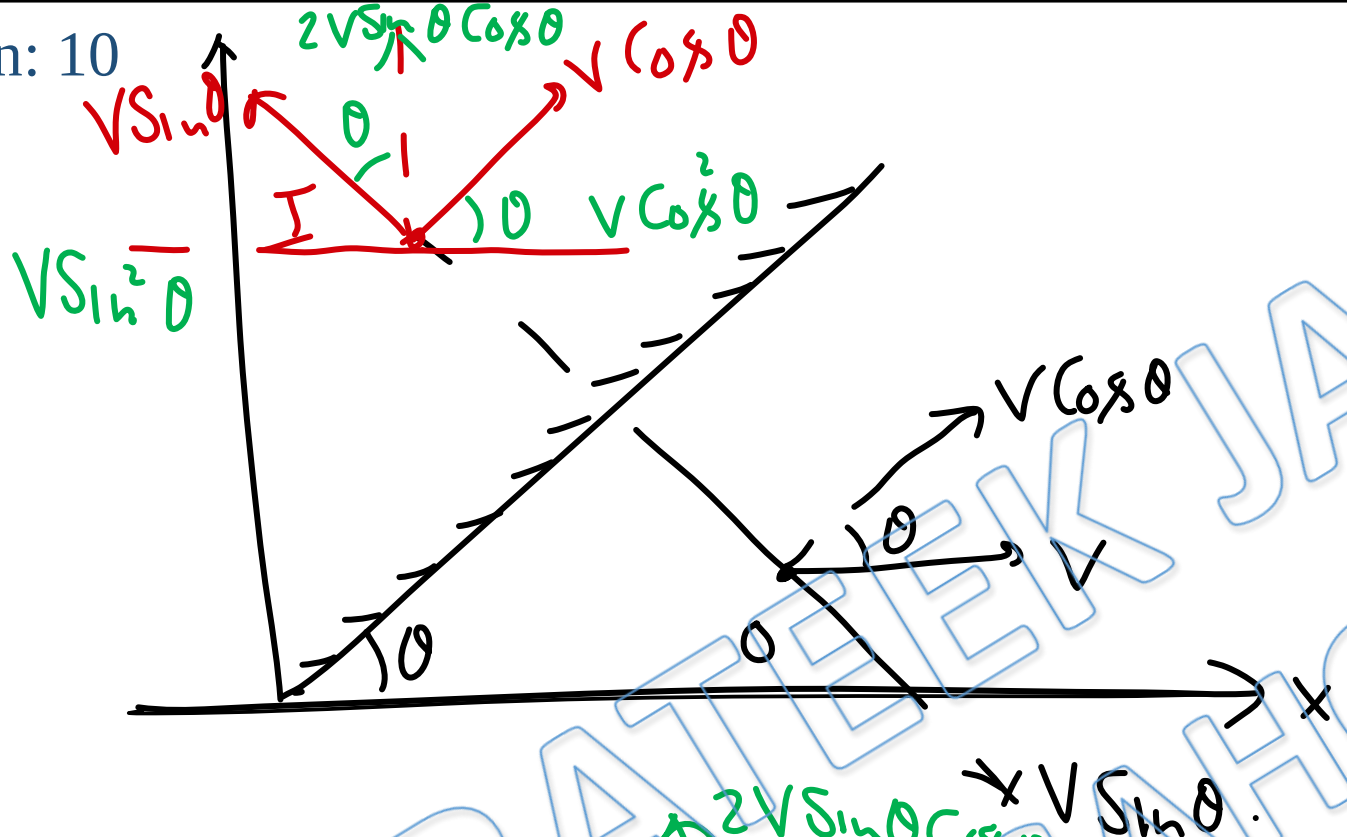
$$\Rightarrow \quad \frac{\ell}{2} - 10 = 75$$

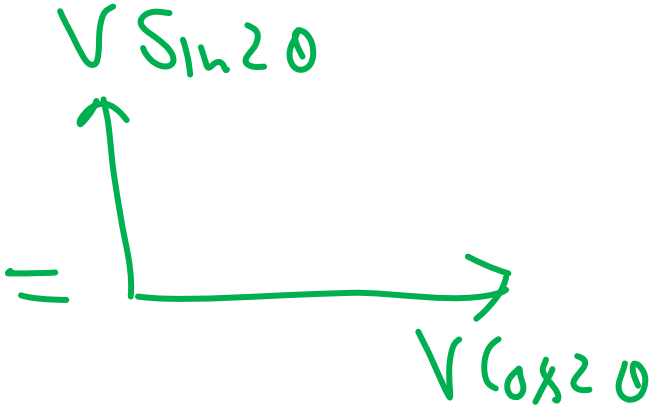
$$\Rightarrow \quad \ell/2 = 85$$

$$\Rightarrow \quad \ell = 170 \text{ cm}$$

Ans (b)

Solution: 10

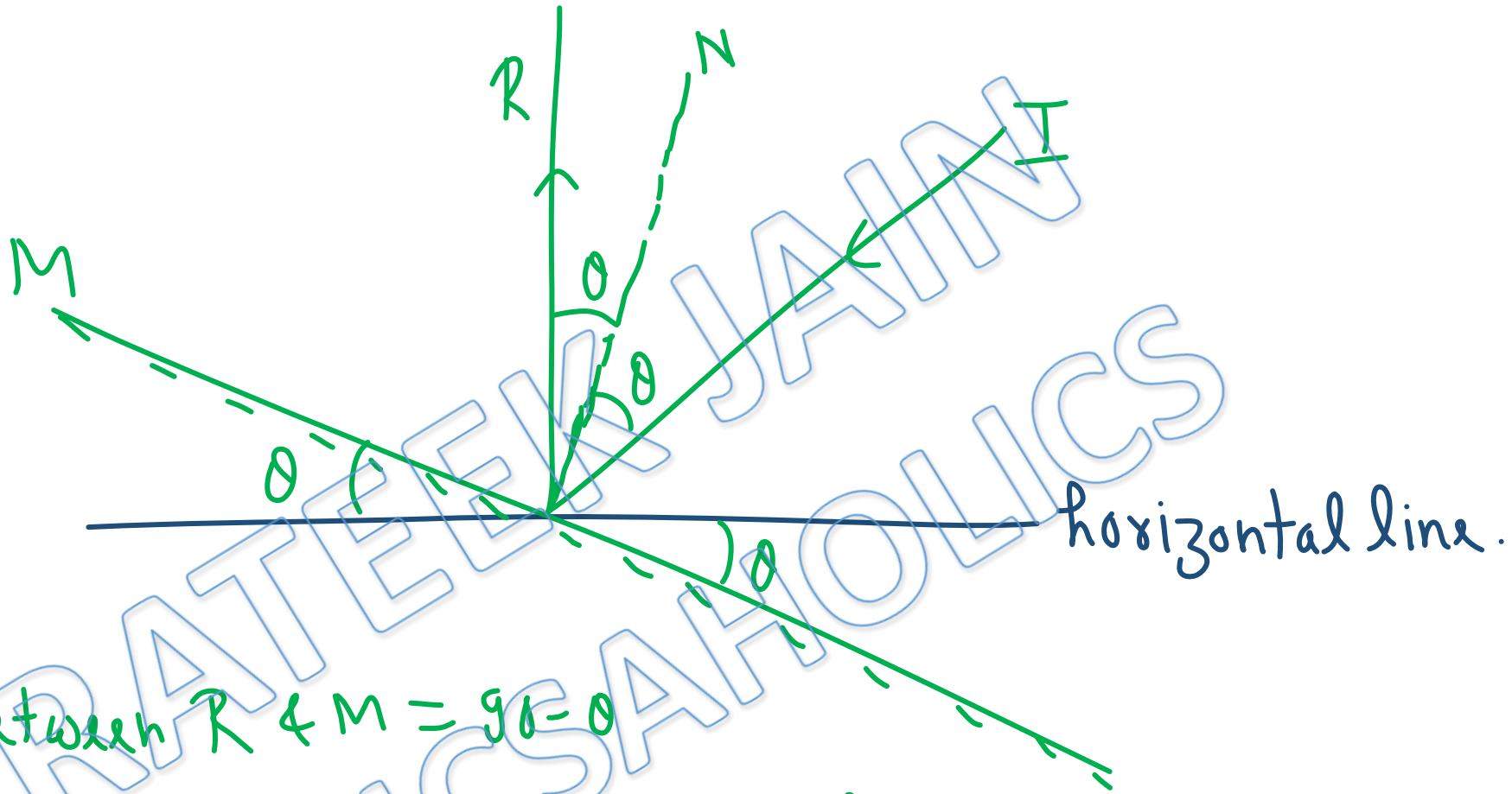


Velocity of Image = $2V\sin\theta\cos\theta\,\hat{i} + V(\cos^2\theta - \sin^2\theta)\,\hat{j}$ = 

$\vec{V}_I = V\cos 2\theta\,\hat{i} + V\sin 2\theta\,\hat{j}$

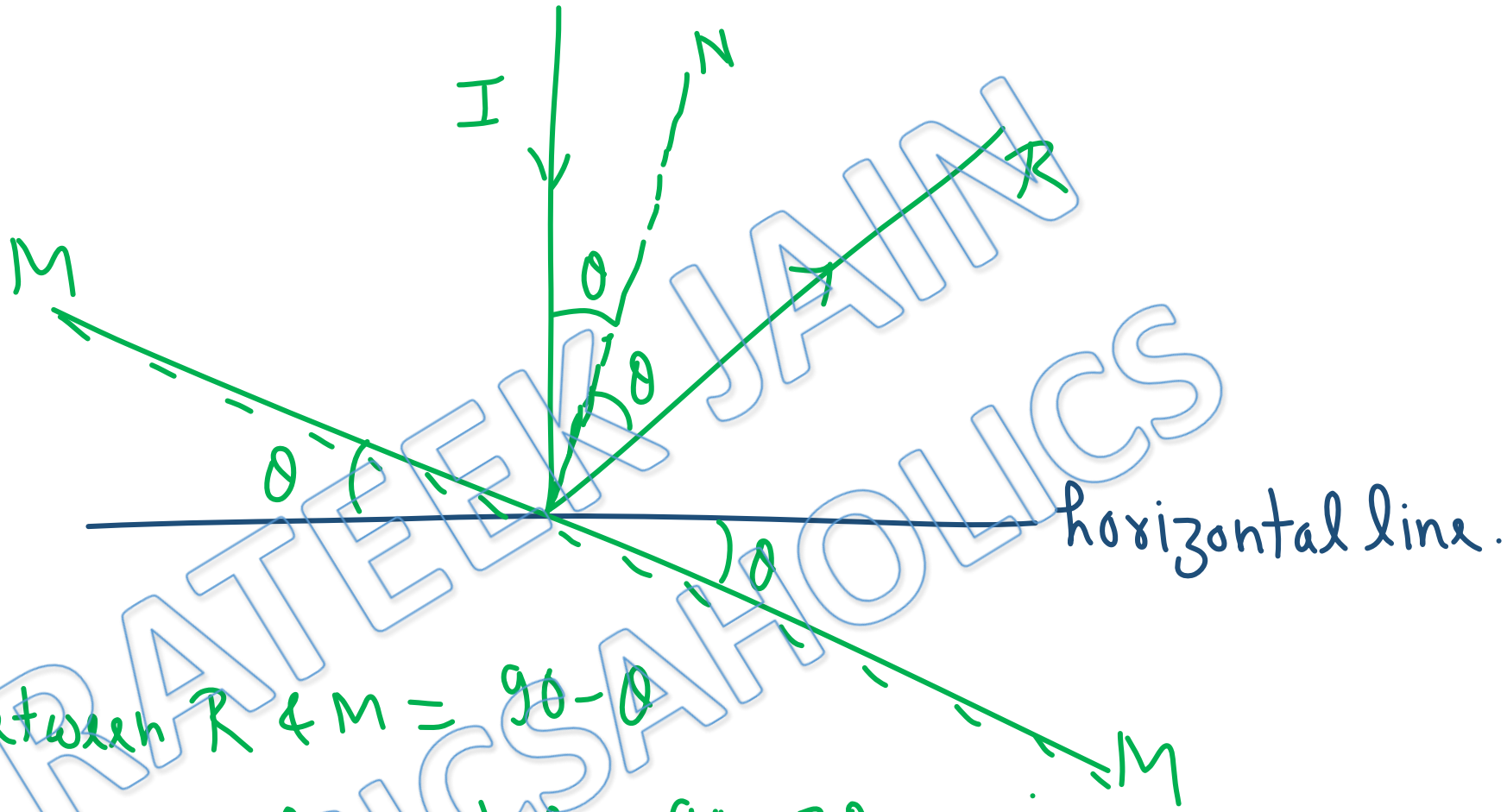
Ans (d)

Solution: 11



angle between R & M = 90 - θ

angle of R with horizontal = 90 - θ + θ = 90°



angle between R & M = $90 - \theta$

angle of R with horizontal = $90 - 2\theta$

Ans (d)

Solution: 12

length of spot of reflected light on screen = AB

$$\tan\theta_1 = \frac{H}{2H} = \frac{OA}{IO}$$

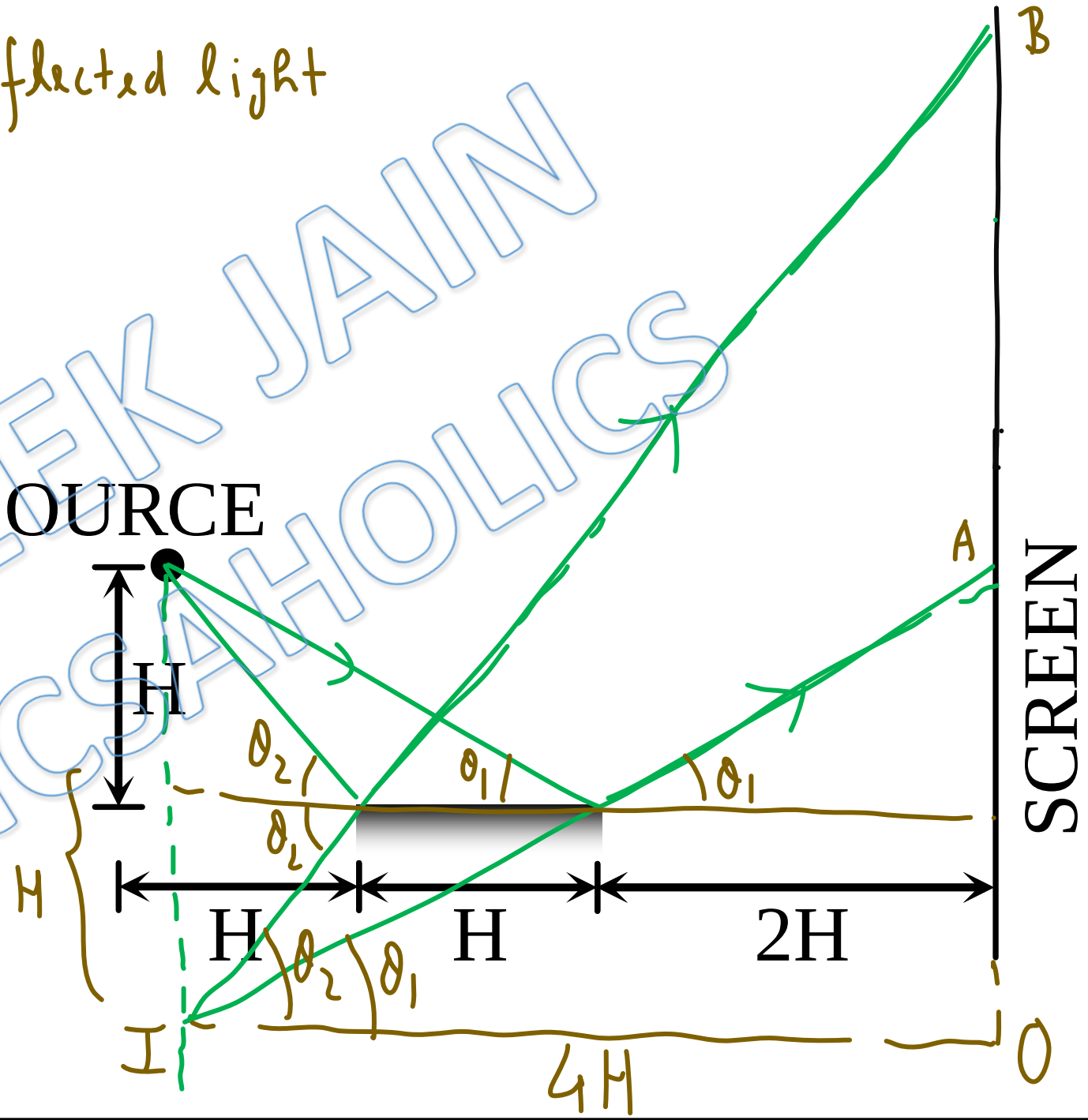
$$\Rightarrow \quad OA = \frac{IO}{2} = 2H$$

$$\tan\theta_2 = \frac{H}{H} = \frac{OB}{IO}$$

$$\Rightarrow \quad OB = IO = 4H$$

$$\Rightarrow \quad AB = 4H - 2H = 2H$$

Ans (a)



Solution: 13

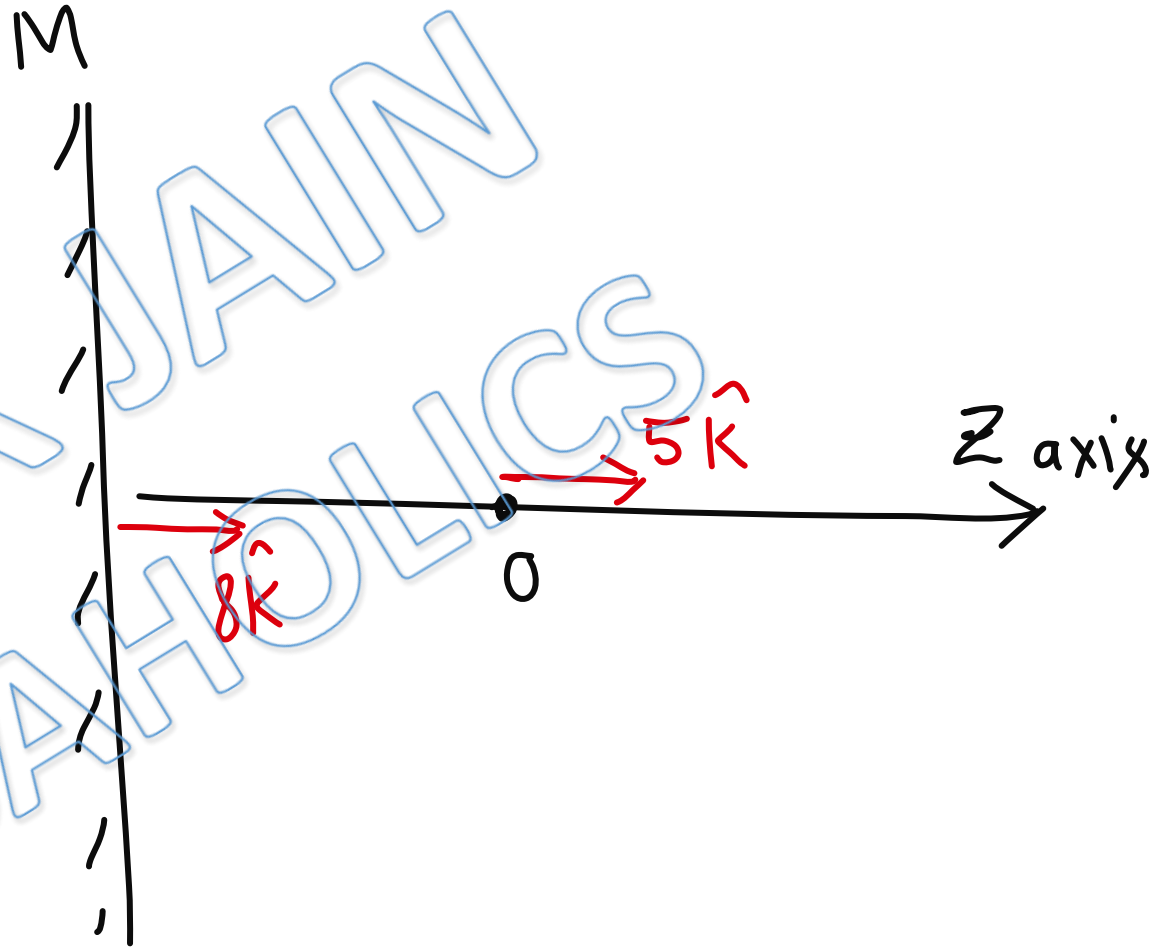
for Motion along z axis

$$V_I = 2V_M - V_0$$

$$= 16 - 5 = 11$$

Component of velocity of image along x axis is equal to that of object. Same statement is valid for component along y axis.

$$\Rightarrow \vec{V_I} = 3\hat{i} + 4\hat{j} + 11\hat{k}$$



Ans (b)

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