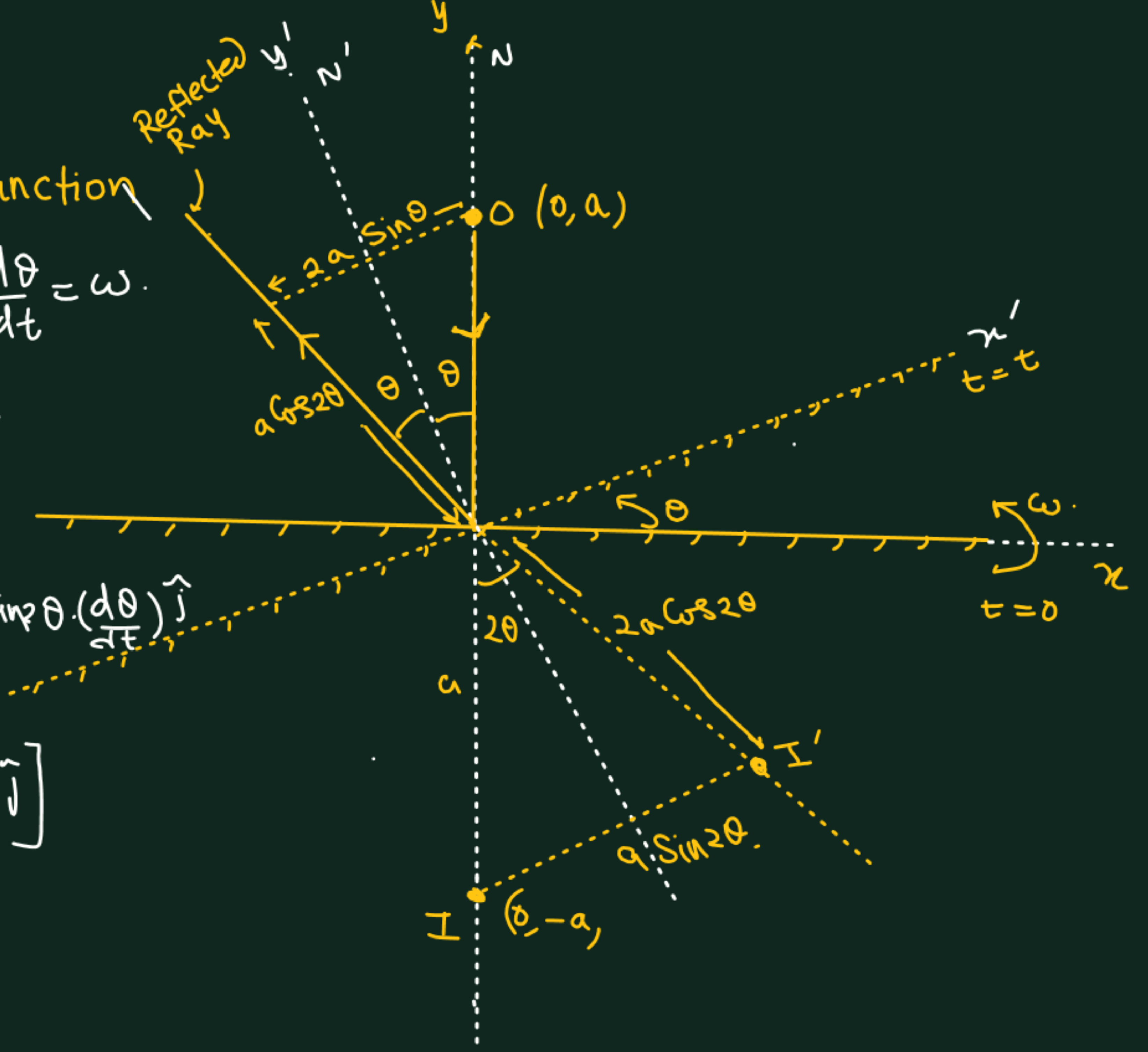
Nishant Jindal

Mirror Starts rotating with Constant ω about z-axis.
Find velocity of image as a function of time if $t < \left(\frac{\pi}{2\omega}\right)$.

$$\frac{d\theta}{dt} = \omega.$$



$$\vec{r}_{I'} = a\sin 2\theta\,\hat{i} - a\cos 2\theta\,\hat{j}$$

$$\vec{V}_{I'} = \frac{d\vec{r}_{I'}}{dt} = a(\cos 2\theta)\left(2\frac{d\theta}{dt}\right)\hat{i} + 2a\sin 2\theta\left(\frac{d\theta}{dt}\right)\hat{j}$$

$$\vec{V}_I = 2a\omega\left[\cos 2\theta\,\hat{i} + \sin 2\theta\,\hat{j}\right]$$

$$|\vec{V}_I| = \underline{(2a\omega)}.$$

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M-2 ★★

$$x = 2a\cos\theta \cdot \sin\theta$$
$$= a\sin 2\theta \; ✓$$

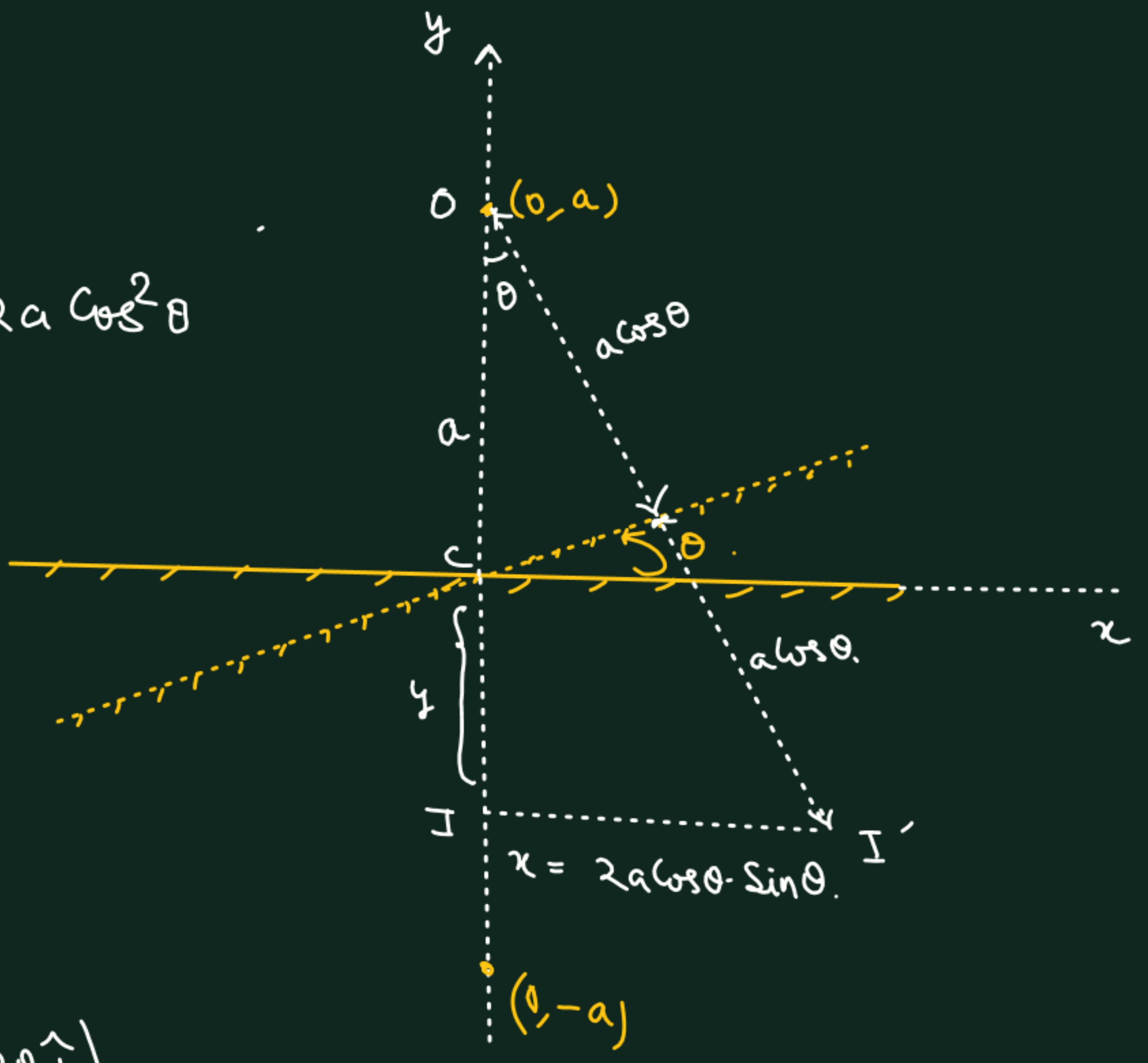
$$OI = 2a\cos\theta \cdot \cos\theta = 2a\cos^2\theta$$

$$CI = y = 2a\cos^2\theta - a$$
$$= a(2\cos^2\theta - 1)$$
$$= a\cos 2\theta \; ✓$$

$$\vec{r} = x\hat{i} - y\hat{j}$$

$$\vec{r} = a\sin 2\theta\,\hat{i} - a\cos 2\theta\,\hat{j}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = 2a\omega(\cos 2\theta\,\hat{i} + \sin 2\theta\,\hat{j})$$



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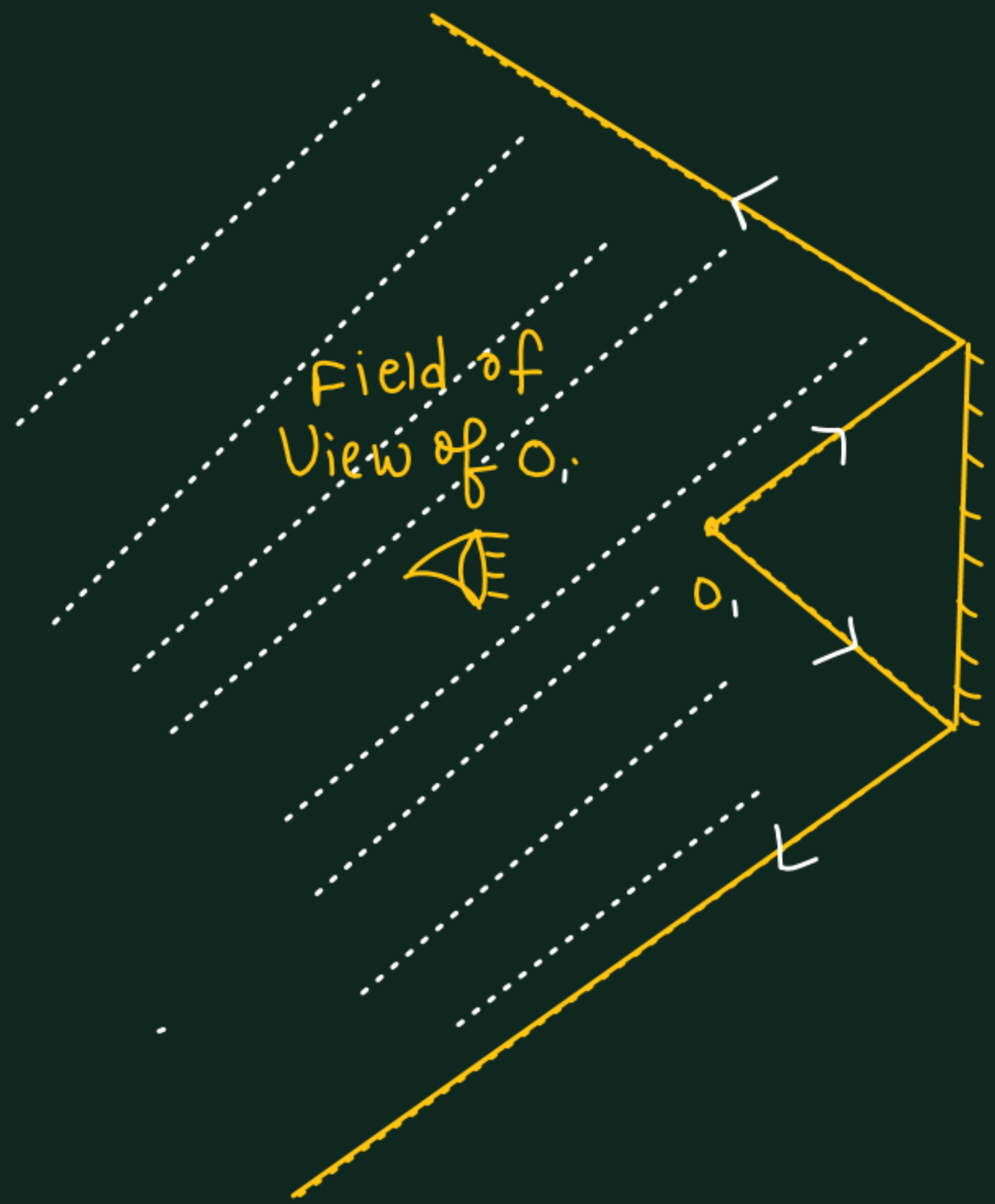
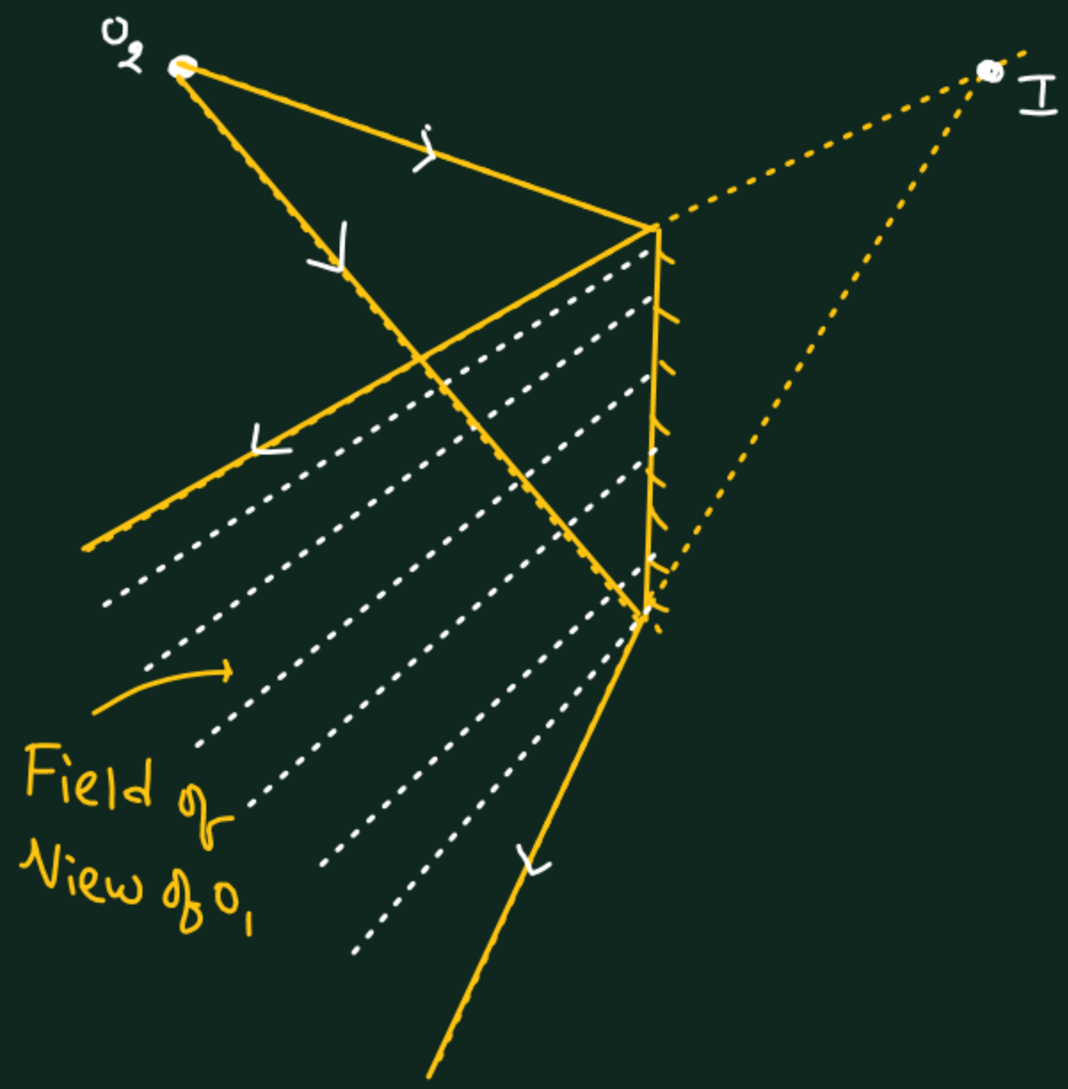
★★

FIELD OF VIEW





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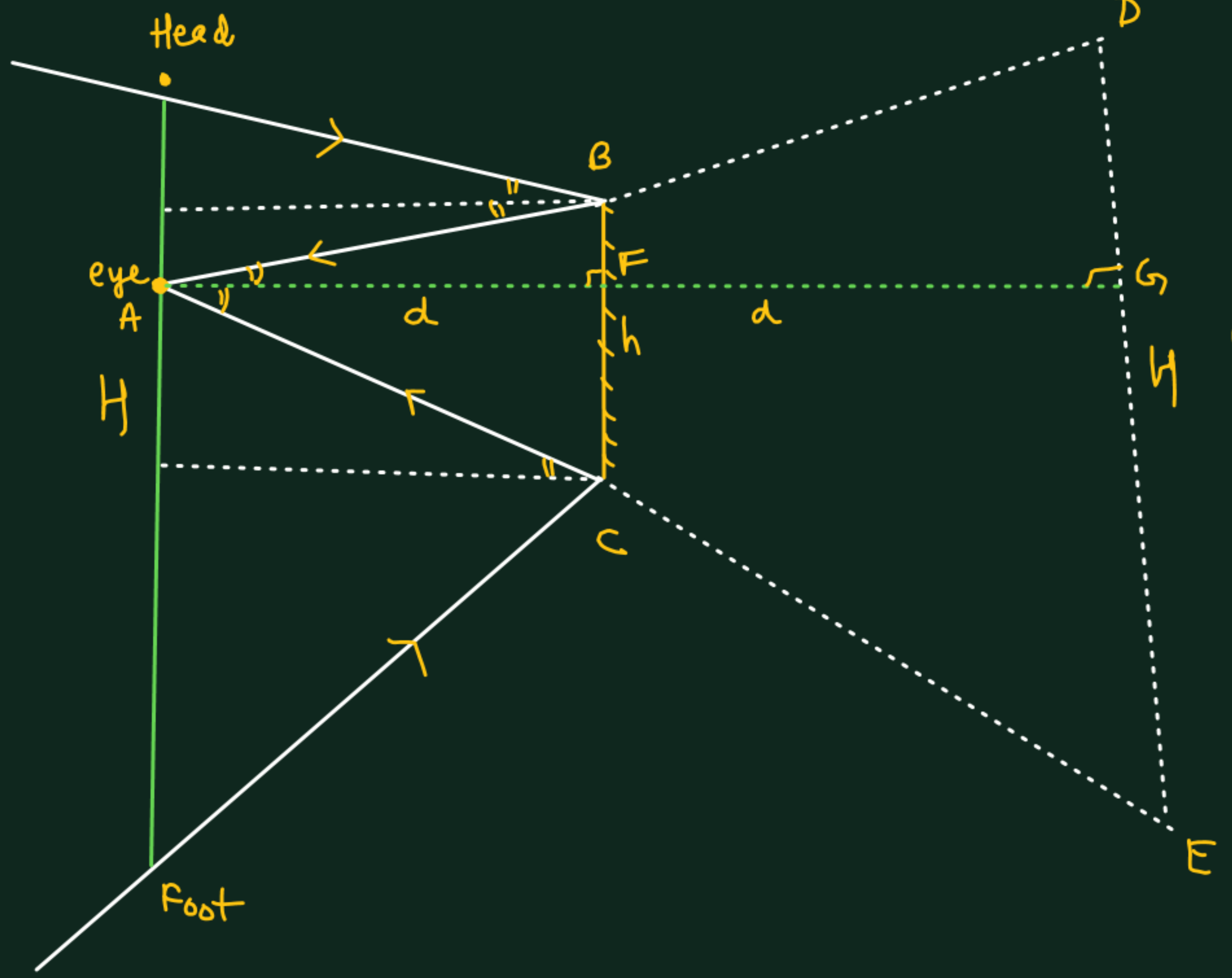
Q: Minimum height of Mirror so that a person see its full image.



$\Delta ABC \cong \Delta ADE$.

$$\frac{h}{H} = \frac{AF}{AG}$$

$$\frac{h}{H} = \frac{d}{2d}$$

$$\boxed{h = \frac{H}{2}}$$ **

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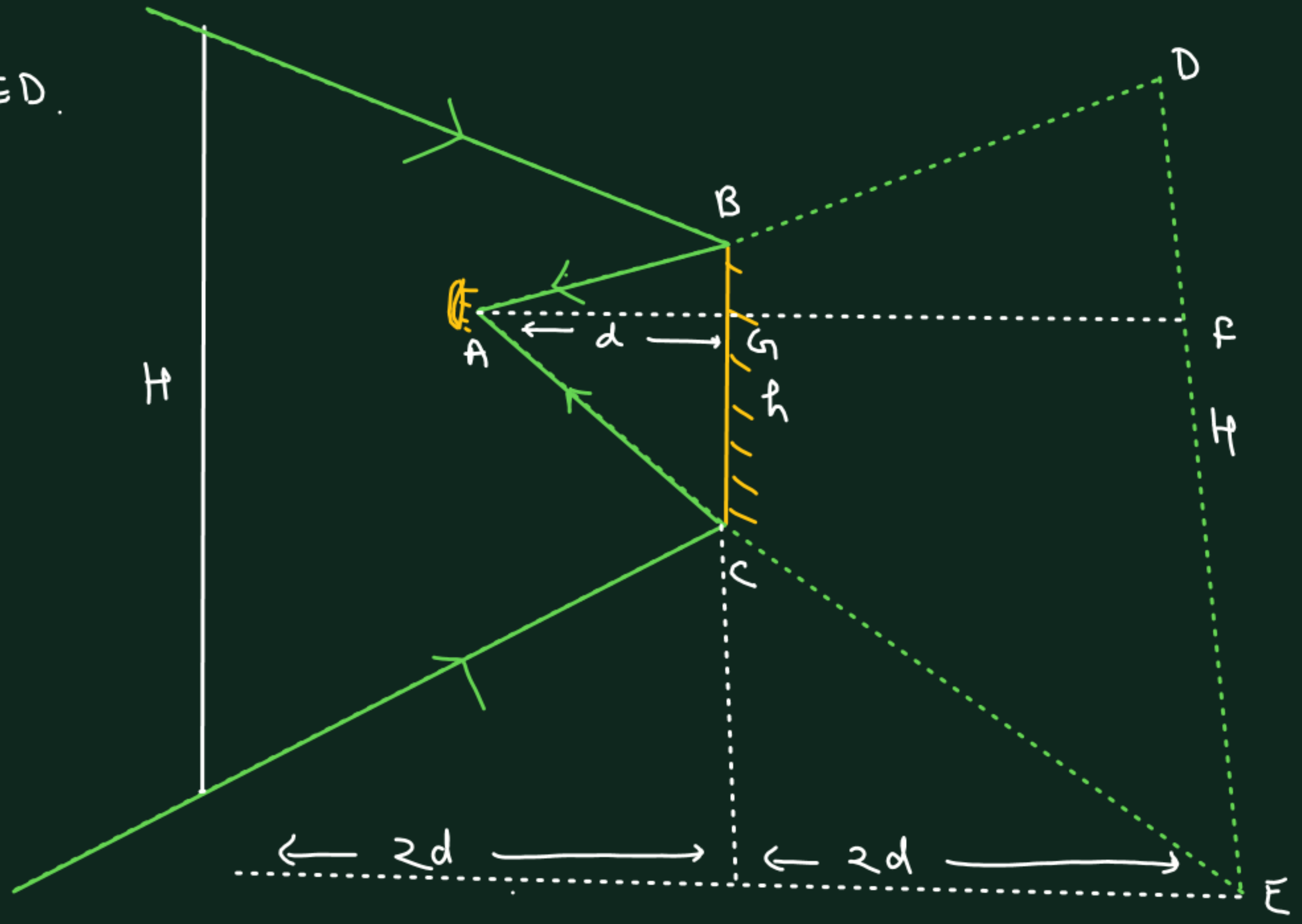
★★: Min height of Mirror, so that person see the full image of a wall. Person at the Mid-point of Wall and Mirror

In $\triangle ABC$ and $\triangle AED$.

$$\frac{BC}{DE} = \frac{AG}{AF}$$

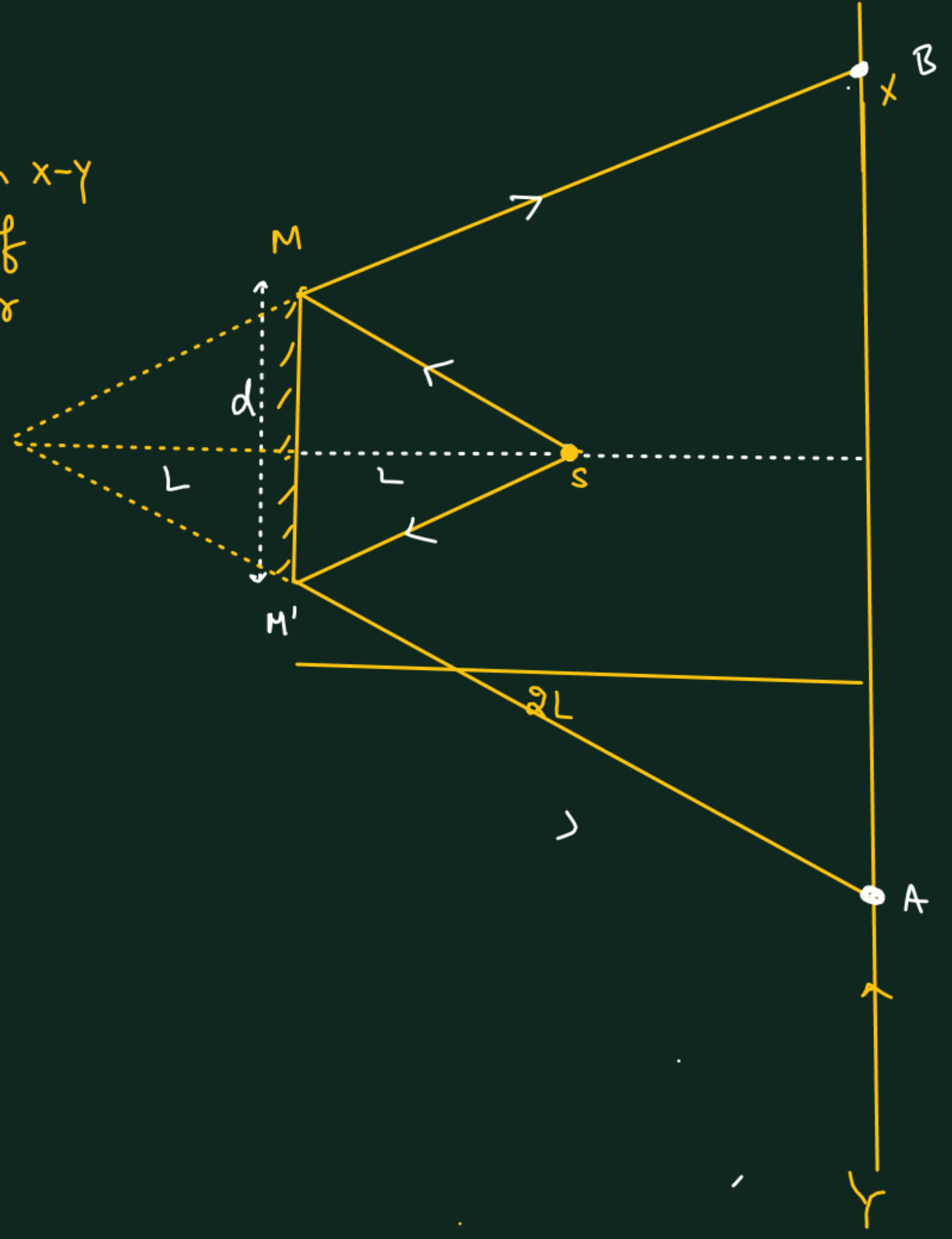
$$\frac{h}{H} = \frac{d}{3d}$$

$$\boxed{h = \frac{H}{3}}$$ ★★



Man walk's along the line X-Y. Find the length on X-Y where Man see the image of light Source on the Mirror

$(AB = 3d)$



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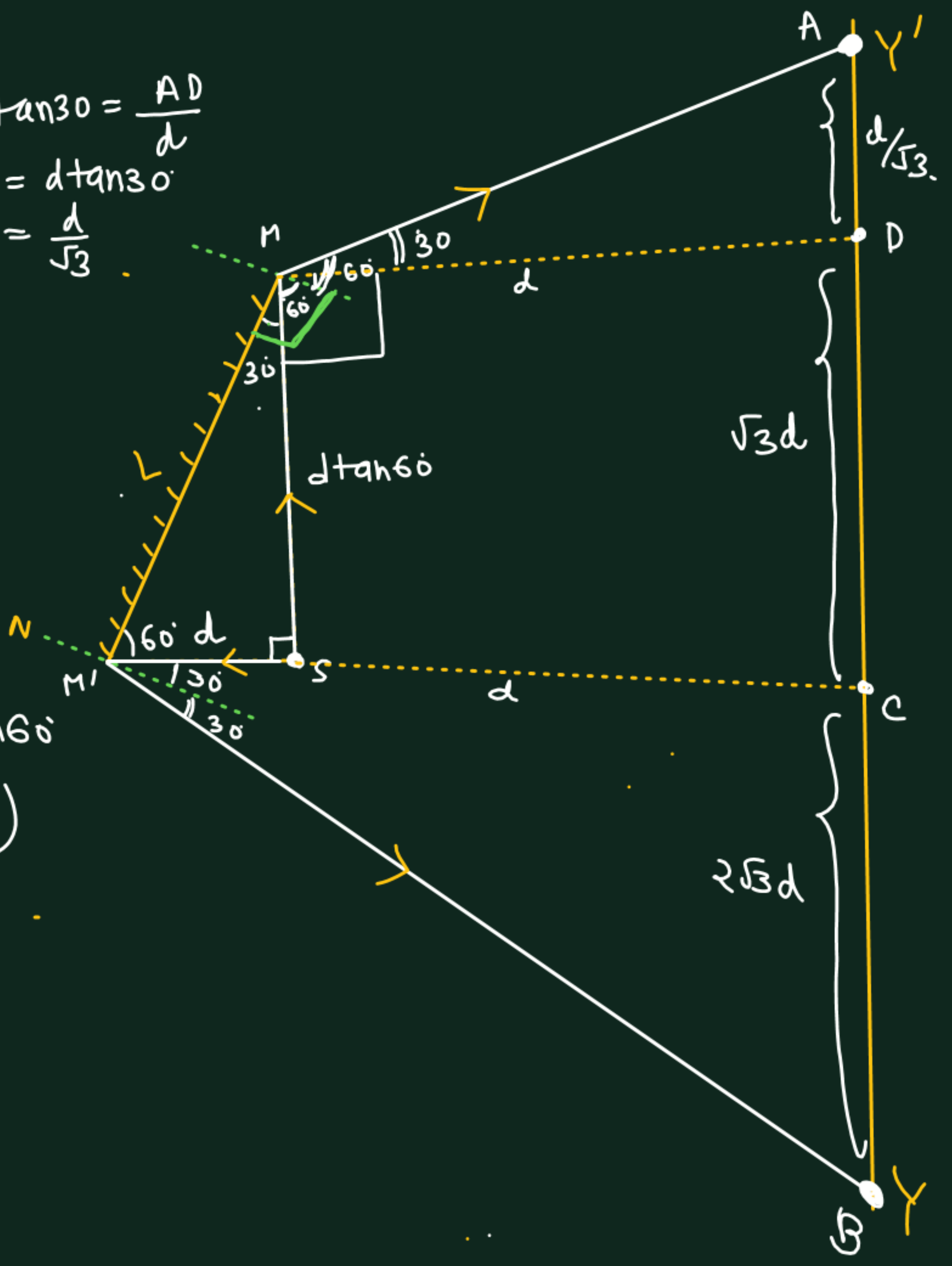
Q: Find the length on YY' for which a man walking along YY' see the image of Source.
(Ans in terms of d)



$\tan 30 = \frac{AD}{d}$

$AD = d\tan 30$

$= \frac{d}{\sqrt{3}}$

In $\triangle M'CB$

$\tan 60 = \frac{CB}{M'C}$

$CB = M'C\tan 60$

$= (2d\sqrt{3})$

$AB = \frac{d}{\sqrt{3}} + \sqrt{3}d + 2d\sqrt{3}$

$= \left(\frac{10d}{\sqrt{3}}\right)$ Ans

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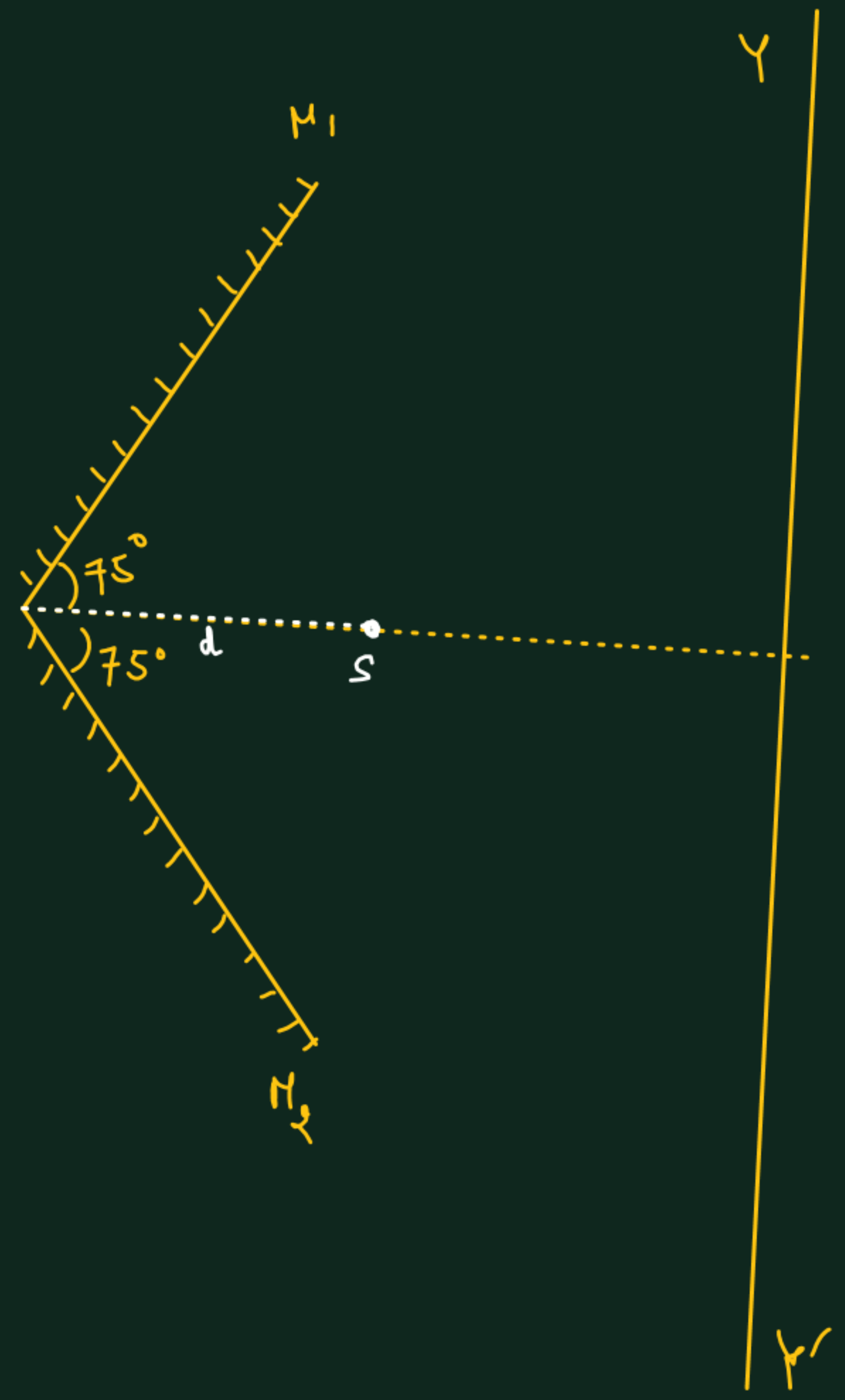
\# Person Moving along YY'.
Find the length on YY' so that person see the two image of Source.



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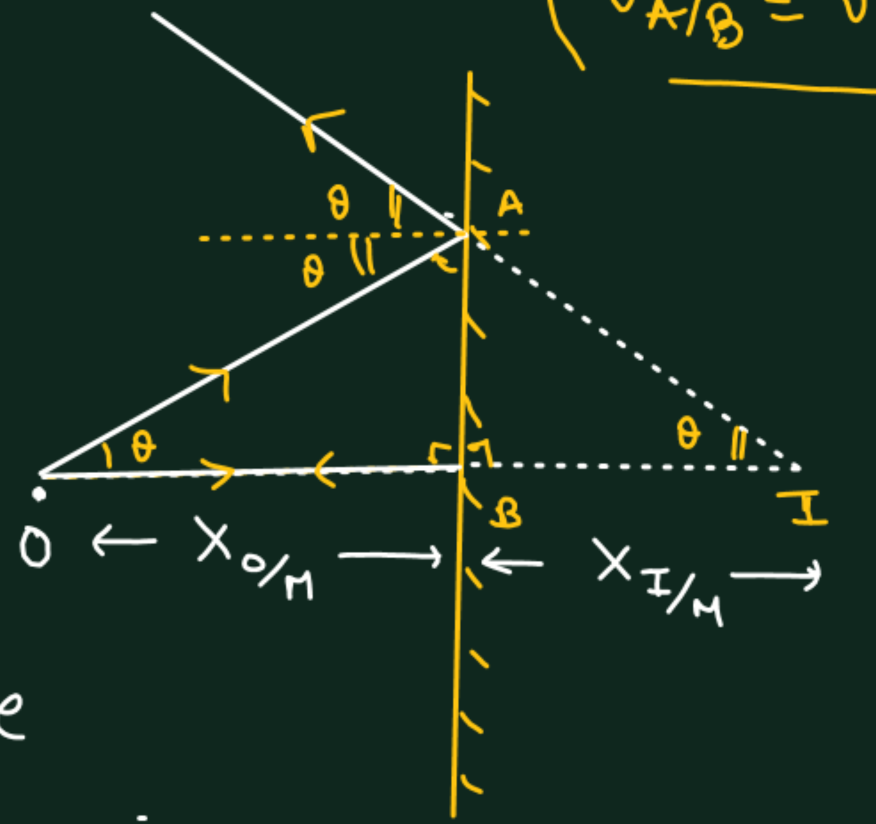
Velocity of image w.r.t plane Mirror

$\Delta OAB \cong \Delta ABI \hookrightarrow (X_{O/M} = X_{I/M})$

$\left(\vec{V}_{A/B} = \vec{V}_{A/E} - \vec{V}_{B/E}\right)$



$\vec{X}_{O/M} = -\vec{X}_{I/M}$

$\vec{X}_{O/M}$ = ⊥ distance of object w.r.t Mirror

$\vec{X}_{I/M}$ = ⊥ distance of image w.r.t Mirror

Differentiating both side w.r.t time

$$\frac{d}{dt}(\vec{X}_{O/M}) = -\frac{d}{dt}(\vec{X}_{I/M})$$

$$\boxed{\vec{V}_{O/M} = -\vec{V}_{I/M}} \Rightarrow \vec{V}_O - \vec{V}_M = -(\vec{V}_I - \vec{V}_M)$$

$$\boxed{\underbrace{\vec{V}_I}_{\text{w.r.t Earth}} = 2\underbrace{\vec{V}_M}_{\text{w.r.t Earth}} - \underbrace{\vec{V}_O}_{\text{w.r.t Earth}}} \Rightarrow \text{Perpendicular to the Mirror}$$

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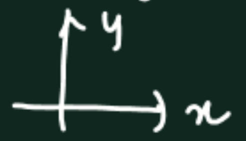
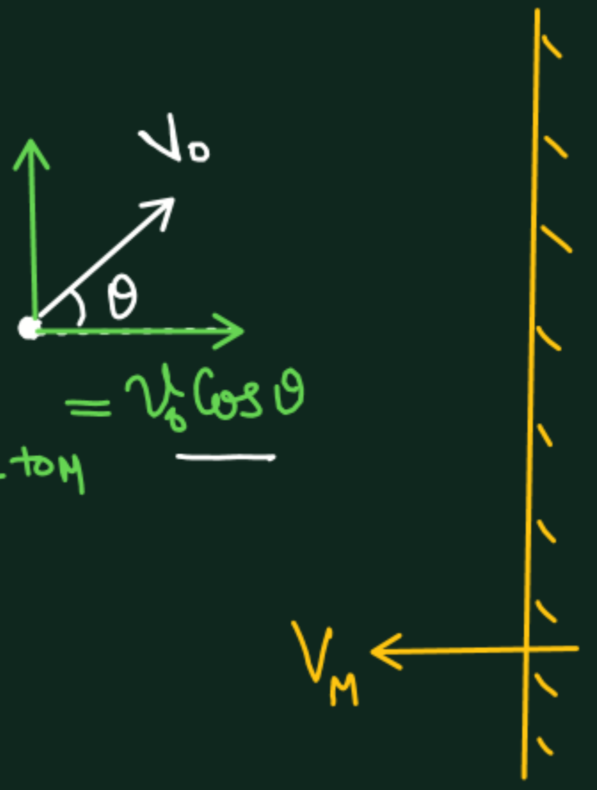
V_o, V_M w.r.t Earth, velocity of image = ??



$(v_o)_{\parallel \text{ to } M} = v_o \sin\theta$



$(v_o)_{\perp \text{ to } M} = v_o \cos\theta$

$(v_I)_{\parallel \text{ to } M} = (v_o)_{\parallel \text{ to } M} = v_o \sin\theta$

$(v_I)_{\perp \text{ to } M} = ??$

$$\vec{X}_{o/M} = -\vec{X}_{I/M}$$

Perpendicular to Mirror

$$(\vec{V}_I)_{\perp \text{ to } M} = 2\vec{V}_M - (\vec{V}_o)_{\perp \text{ to } M}$$

$$= -2V_M\hat{i} - V_o\cos\theta\,\hat{i}$$

$$= -(2V_M + V_o\cos\theta)\hat{i}$$

$$\vec{V}_I = \vec{V}_{\parallel \text{ to } M} + \vec{V}_{\perp \text{ to } M}$$

$$= -(2V_M + V_o\cos\theta)\hat{i} + (v_o\sin\theta)\hat{j}$$