Nishant Jindal

MOTION OF COM

Case $[\Delta X_{com} = 0]$

Find $X = ??$

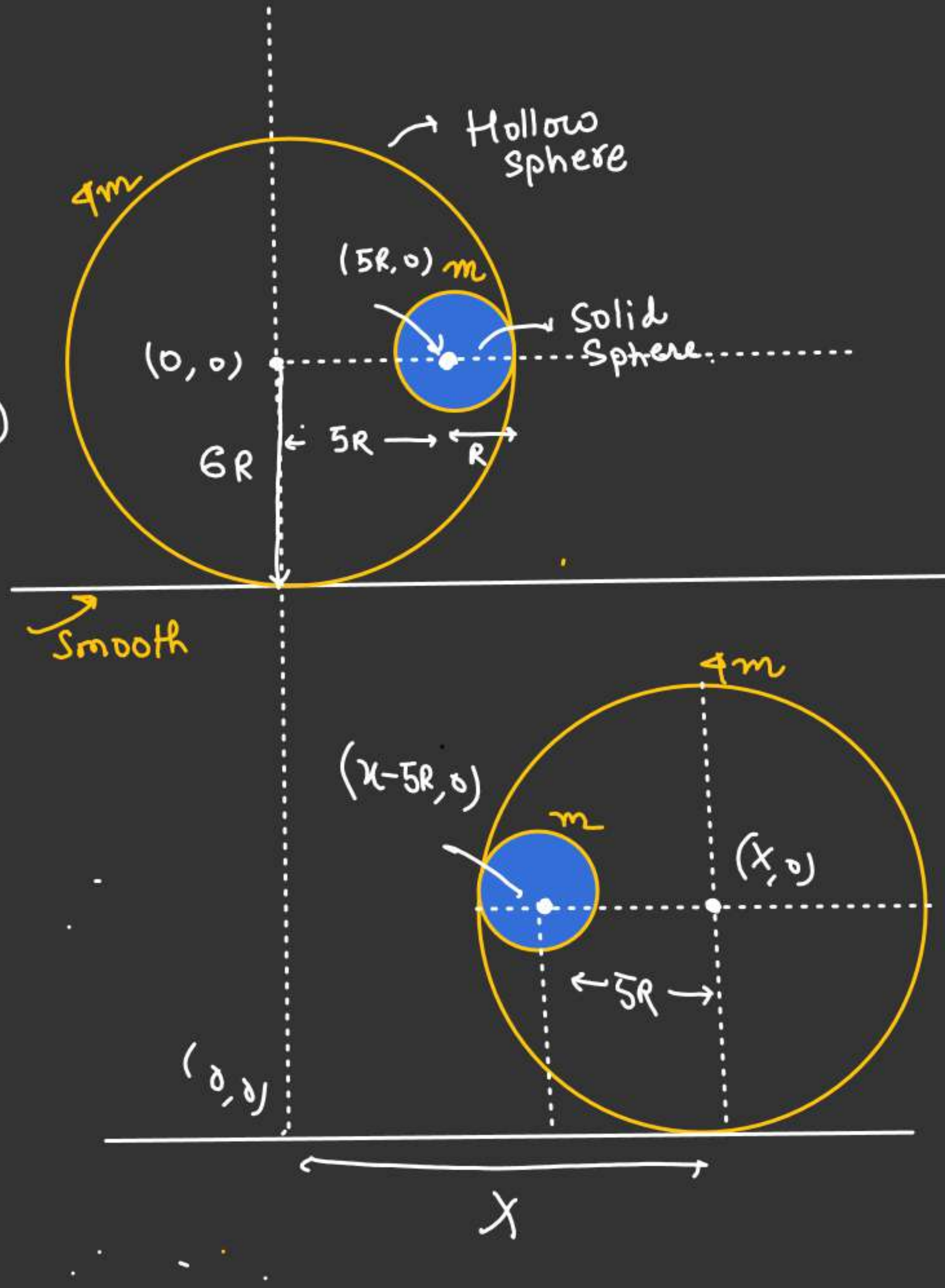
$$(X_{com})_i = (X_{com})_f$$

$$\frac{(4m)(0) + m\cdot(5R)}{\cancel{5m}} = \frac{4mx + m(x-5R)}{\cancel{5m}}$$

$$5mR = 5mx - 5mR$$

$$10\cancel{m}R = 5\cancel{m}x$$

$$\underline{x = 2R}\ \checkmark$$



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Ball is released when string is horizontal. Find displacement of ring when string makes an angle θ from horizonal.

$\Delta X_{com} = 0 \qquad (F_{ext})_x = 0$

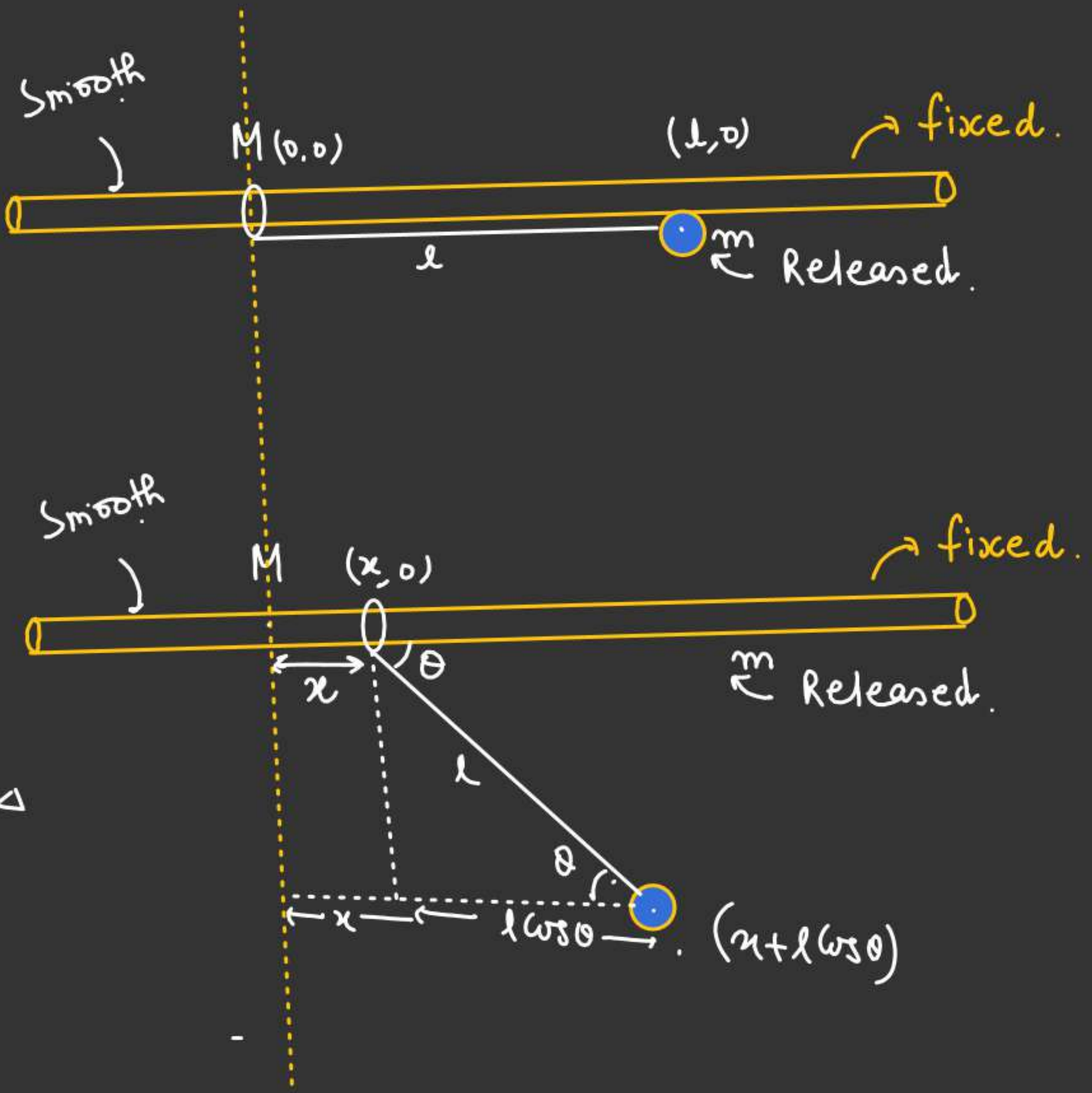
$$X_{com_i} = (X_{com})_f$$

$$\frac{m\ell}{\cancel{M+m}} = \frac{Mx + m(x+\ell\cos\theta)}{\cancel{M+m}}$$

$$m\ell = (M+m)x + m\ell\cos\theta$$

$$m\ell(1-\cos\theta) = (M+m)x$$

$$x = \frac{m\ell(1-\cos\theta)}{(M+m)}$$ ✓



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M-2

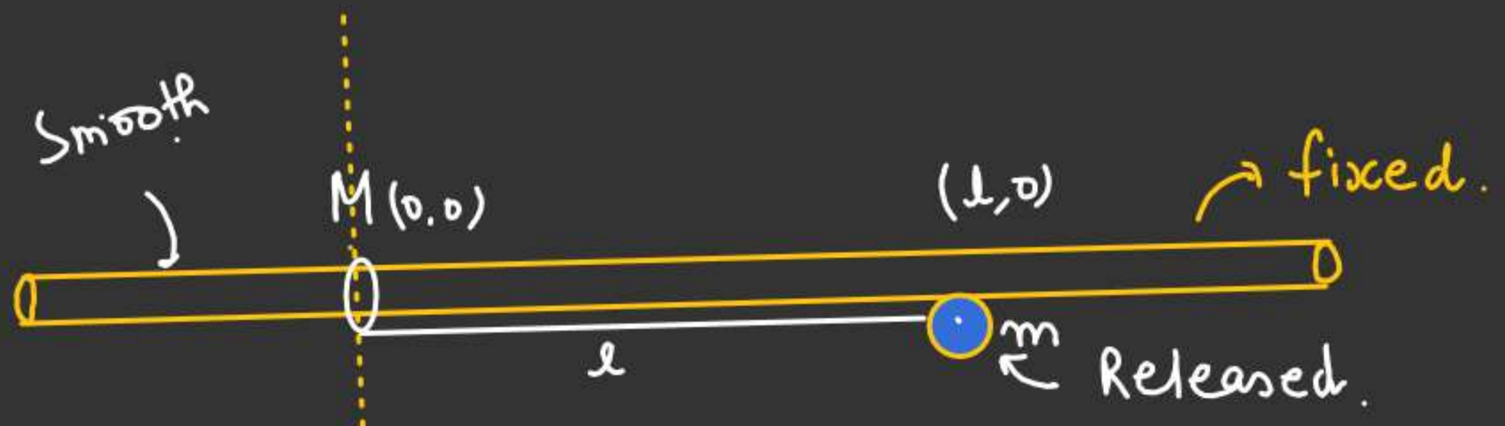
$$\Delta X_{com} = 0$$

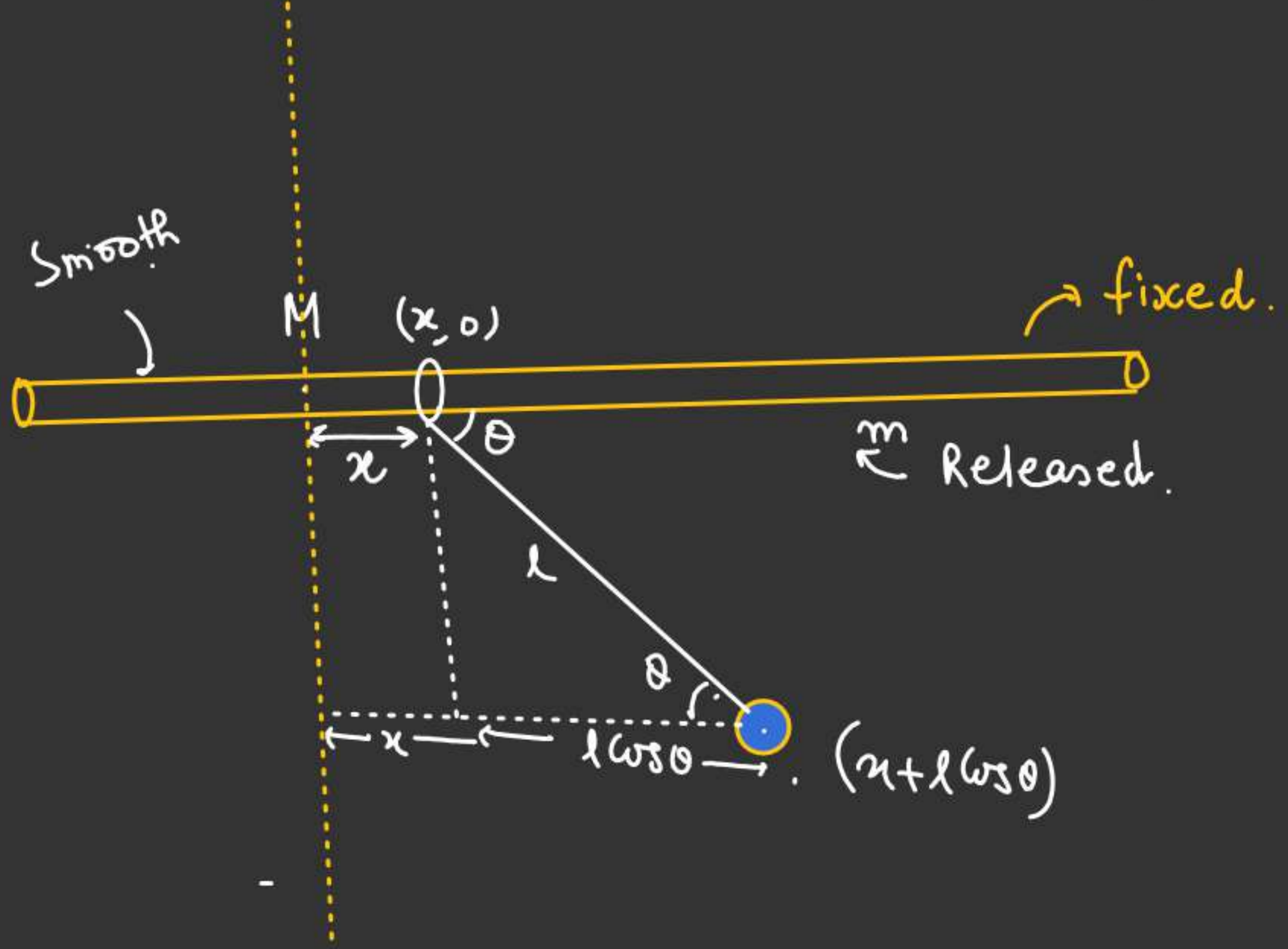
$$\frac{M(\Delta x)_{Ring} + m(\Delta x)_{ball}}{M+m} = 0$$

$$\frac{M(x-0) + m(x+l\cos\theta - l)}{M+m} = 0$$

$$(M+m)x = ml(1-\cos\theta)$$

$$x = \frac{ml(1-\cos\theta)}{M+m}$$





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Case of Explosion in Mid-air

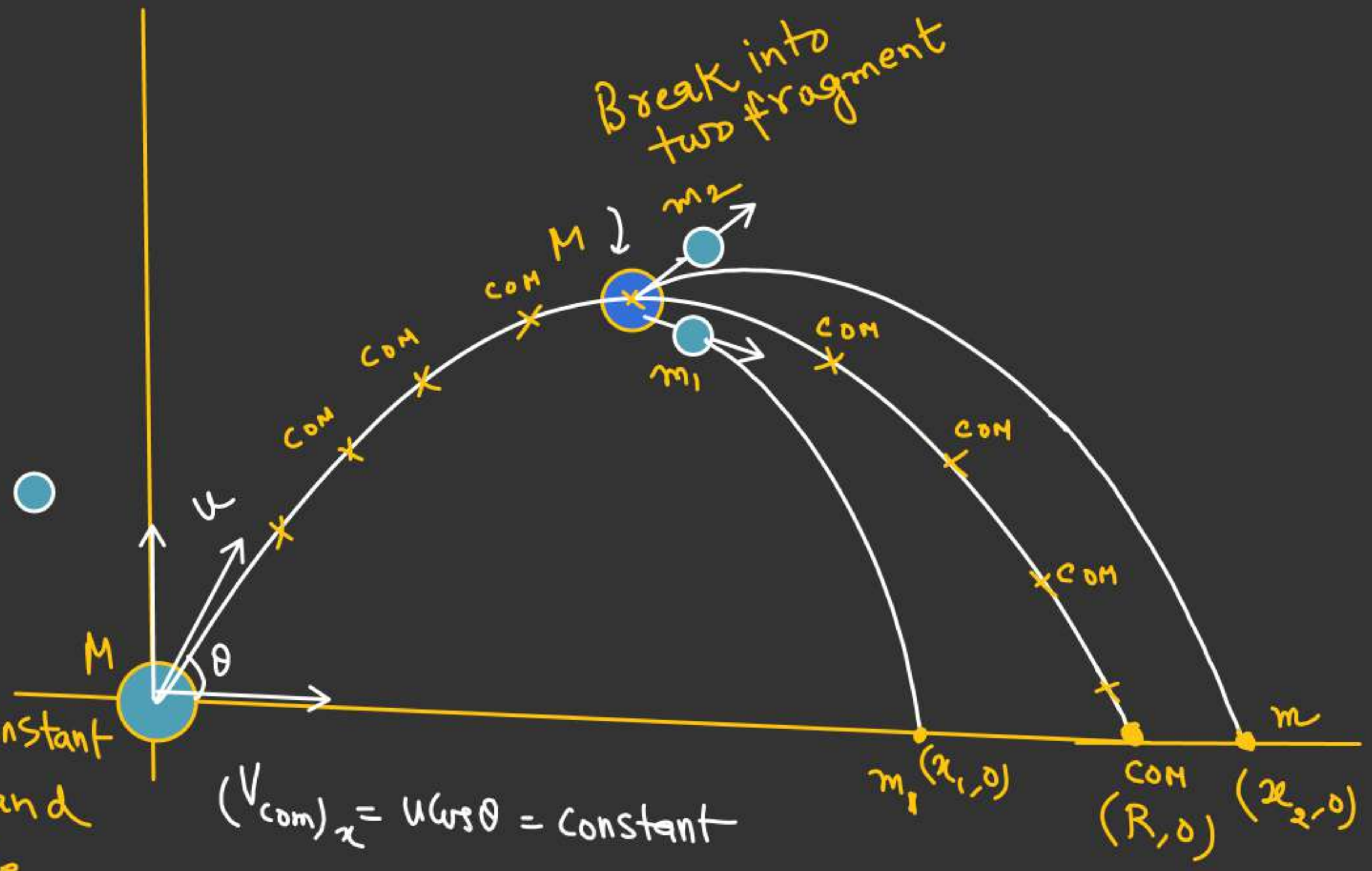
$$x_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$\Downarrow$

$$R = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$\downarrow$

Range of projectile.



$(V_{com})_x = u\cos\theta = \text{constant}$

$(F_{ext})_x = 0$

Note:- Since No external force in x-direction so Velocity of COM remain Constant in x-direction. so COM land at range of the projectile

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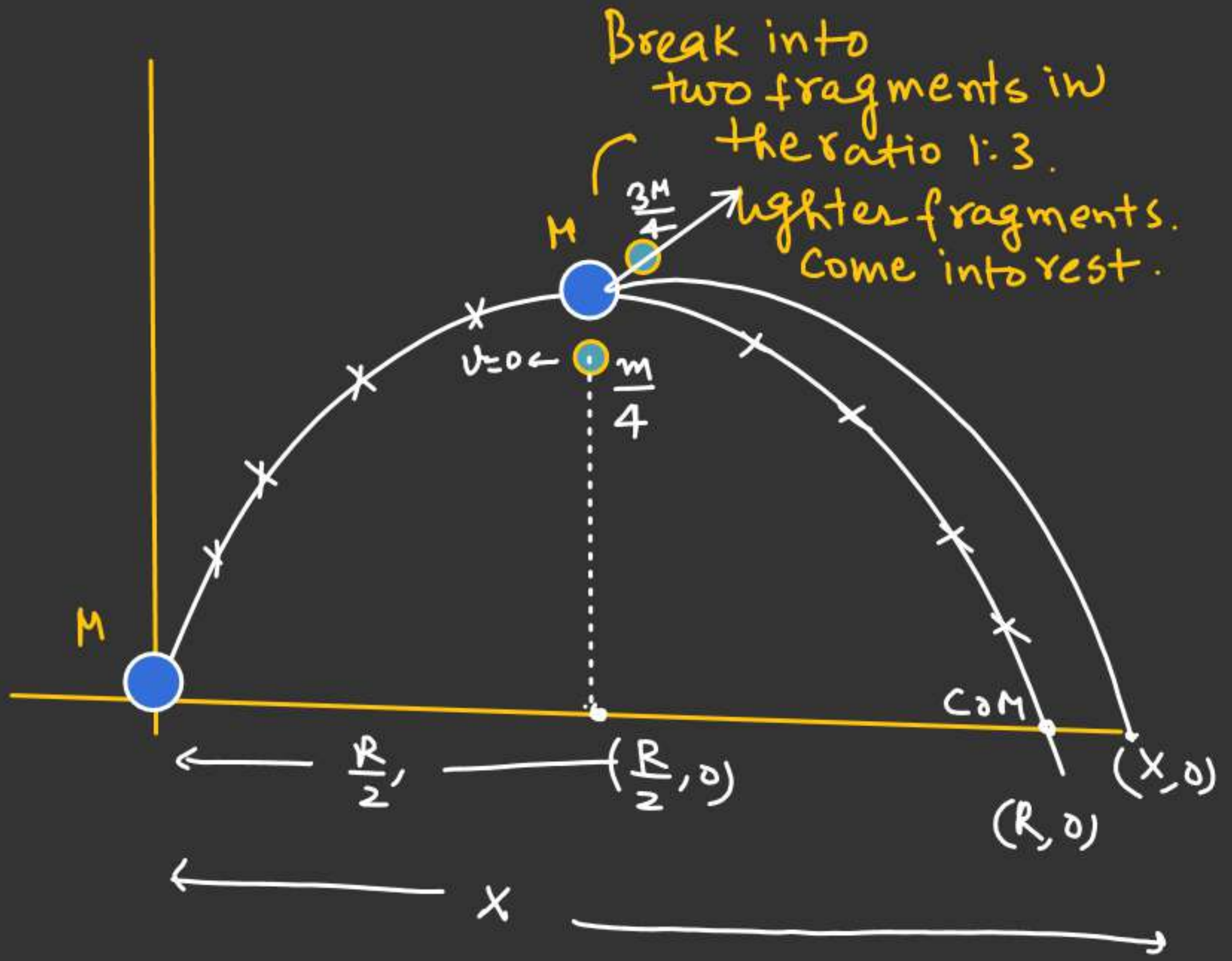
Find the distance of heavier fragment from the point of projection if R be the range of projectile



$$R = X_{com} = \frac{\frac{M}{4}\left(\frac{R}{2}\right) + \left(\frac{3M}{4}\right)X}{M}$$

$$MR = \frac{MR}{8} + \left(\frac{3M}{4}\right)x$$

$$\left(\frac{3\cancel{M}}{4}\right)x = MR - \frac{MR}{8} = \frac{7\cancel{M}R}{8}$$

$$x = \frac{7R}{\cancel{8}_2} \times \frac{\cancel{4}}{3}$$

$$x = \left(\frac{7R}{6}\right)$$

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AA!

L·M·C

$[\vec{p} = m\vec{v}]$

Linear Momentum Conservation

By Newton's 2nd law

$$(\vec{F}_{ext})_{net} = \frac{d\vec{p}}{dt}$$

if $(\vec{F}_{ext})_{net} = 0$

$$\frac{d\vec{p}}{dt} = 0$$

$$\vec{p}_{system} = \text{Constant}$$

$$\Delta\vec{p}_{system} = 0 \Rightarrow \boxed{(\vec{p}_i)_{system} = (\vec{p}_f)_{system}}$$

Momentum Conservation

$$\vec{p}_{system} = M\vec{V}_{com}$$

$$\Downarrow$$

$$[m_1\vec{v}_1 + m_2\vec{v}_2 \dots + m_n\vec{v}_n] = M\vec{V}_{com}$$

if $(\vec{V}_{com})$ = constant.

then

$$[m_1\vec{v}_1 + m_2\vec{v}_2 \dots + m_n\vec{v}_n] = \text{Constant}$$

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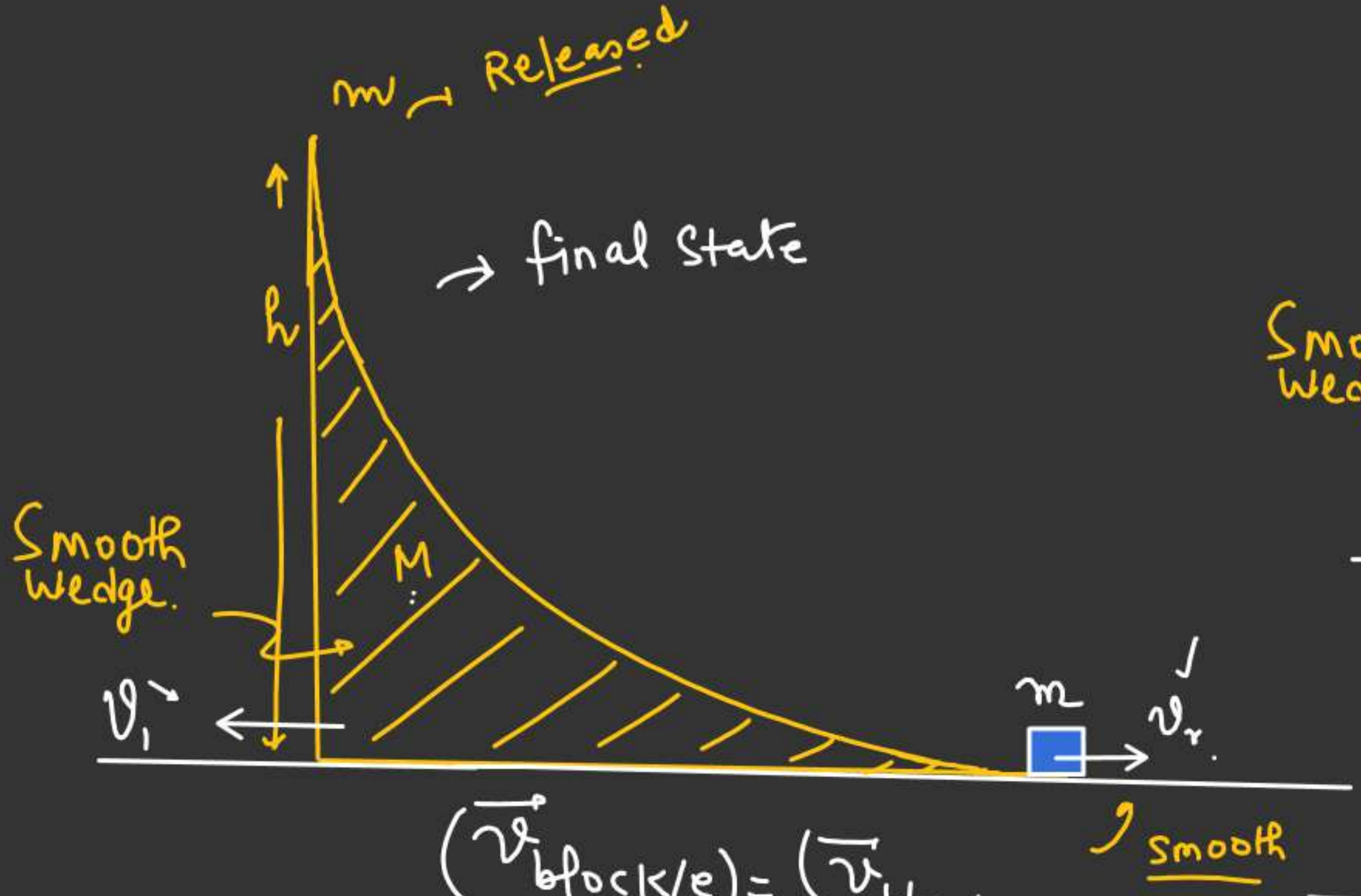
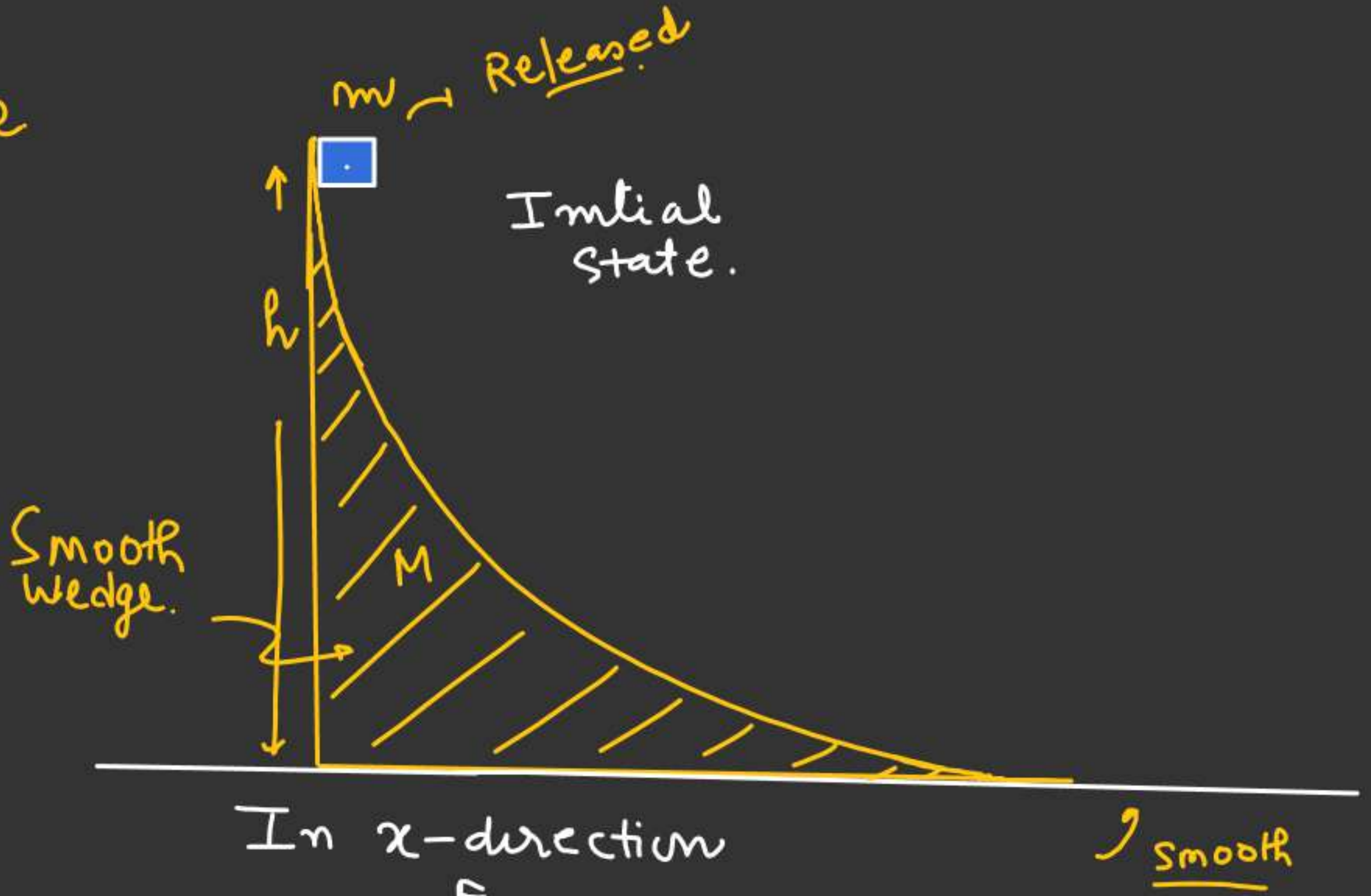
(*) L.M.C

- Apply L.M.C in the direction where net external force is zero.
- While conserving Linear Momentum Velocity of each particle must be w.r.t Earth. ✓

Find the velocity of wedge When block just leave the wedge





$$(\vec{v}_{block/E})_x = (\vec{v}_{block/wedge})_x + (\vec{v}_{wedge})$$

$$= v_r\hat{i} - V_1\hat{i}$$

$$= (v_r - V_1)\hat{i}$$

In x-direction

$F_{ext} = 0$.

$(\vec{\Delta p})_{\text{system in x-direction}} = 0$.

$$(\vec{p}_i)_{system} = (\vec{p}_f)_{system}$$

$$0 = -MV_1\hat{i} + m(v_r - V_1)\hat{i}$$

$$(M+m)V_1 = mV_r$$

$$V_1 = \left(\frac{mV_r}{M+m}\right) \leftarrow (1)$$

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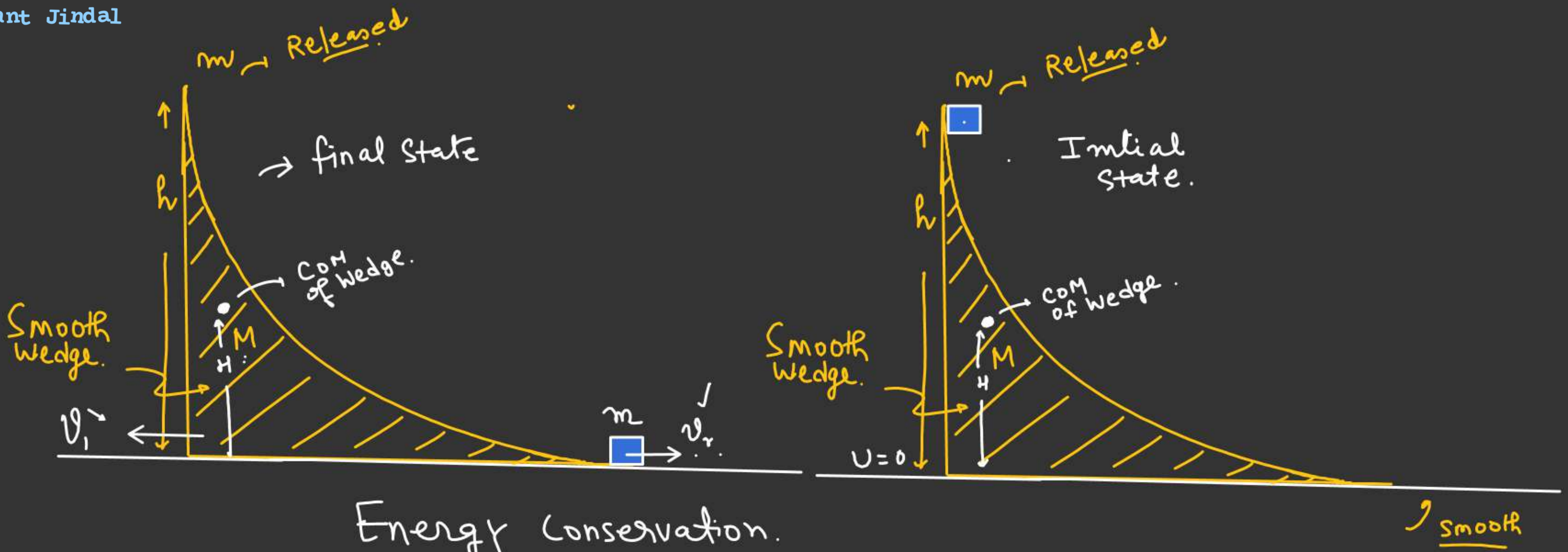

Energy Conservation.

$$\cancel{MgH} + mgh = \cancel{Mg}H + \frac{1}{2}Mv_1^2 + \frac{1}{2}m(v_r - v_1)^2$$

$v_1 = ?$

$v_r = ?$

$$mgh = \frac{1}{2}Mv_1^2 + \frac{1}{2}m(v_r - v_1)^2 \quad \text{— (2)}$$

put $v_r = \frac{(M+m)v_1}{m}$

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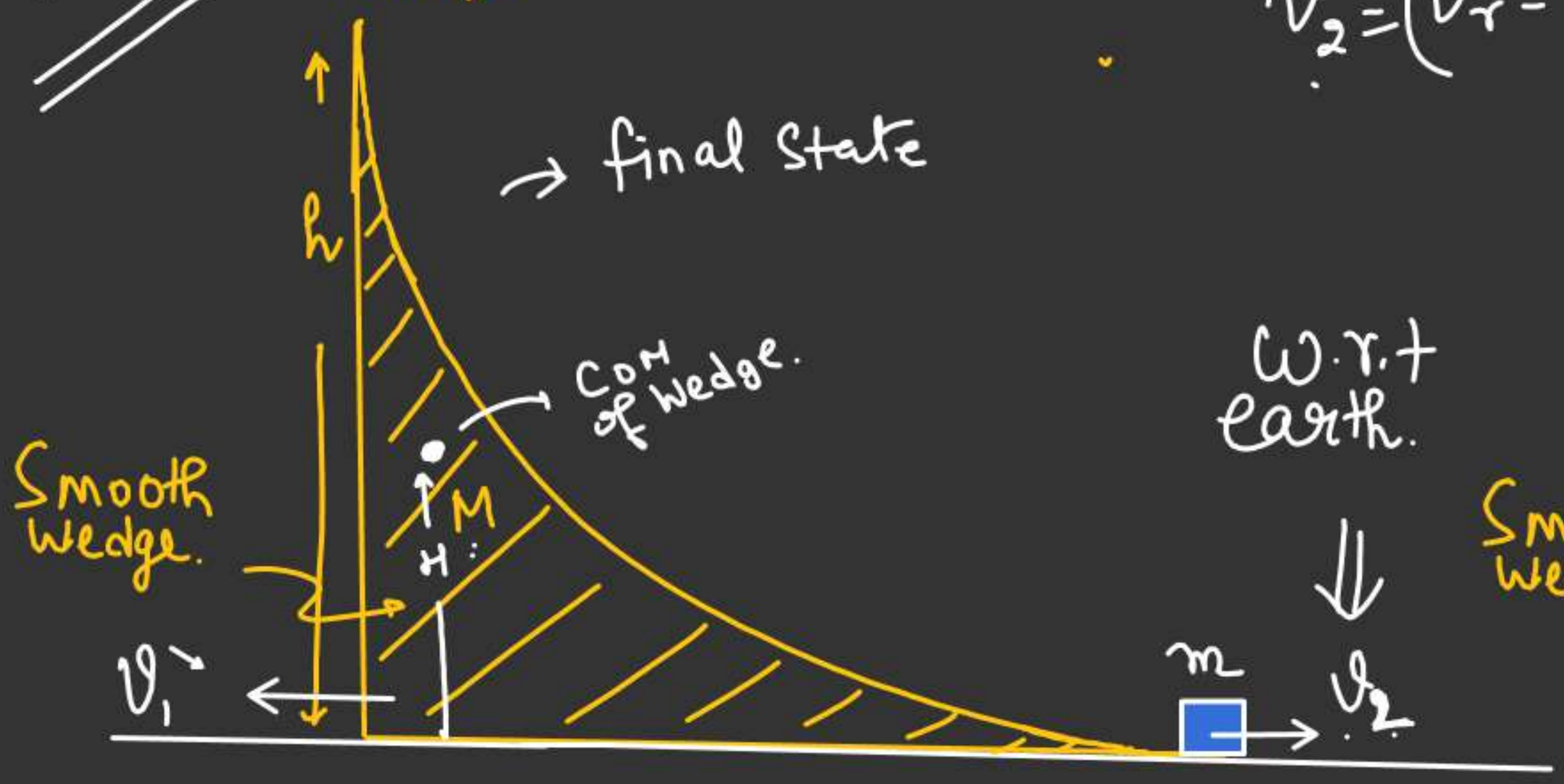
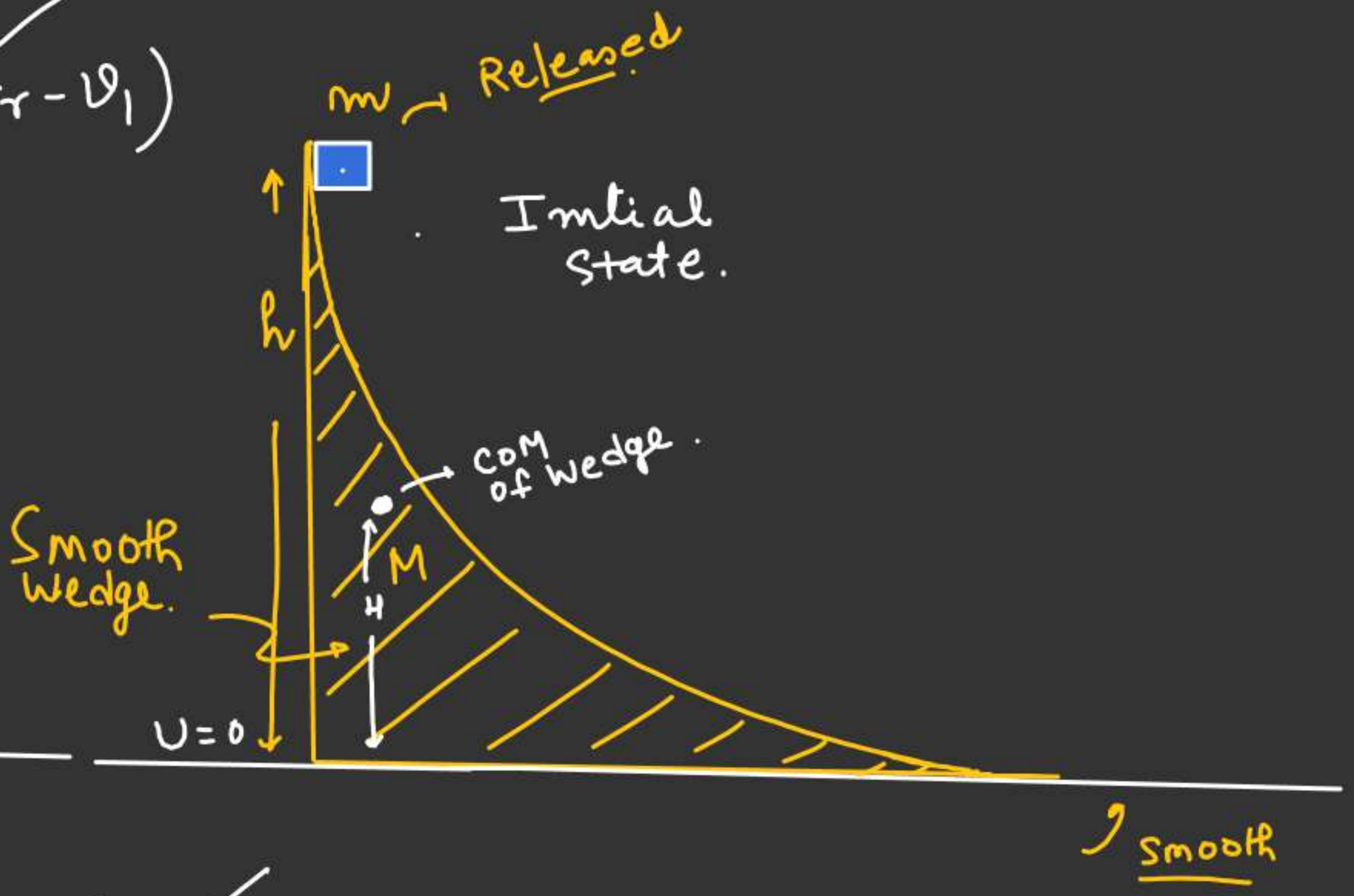
M-2

$$v_2 = (v_r - v_1)$$





L.M.C

$$0 = mv_2 - Mv_1 \quad -(1)$$

Energy

$$mgh = \frac{1}{2}mv_2^2 + \frac{1}{2}Mv_1^2 \quad -(2)$$