Nishant Jindal

$m$ = mass of Rope.
$\lambda$ = Linear mass density

Find Min. force applied by the ext. agent to make sure that ball reaches to pully.

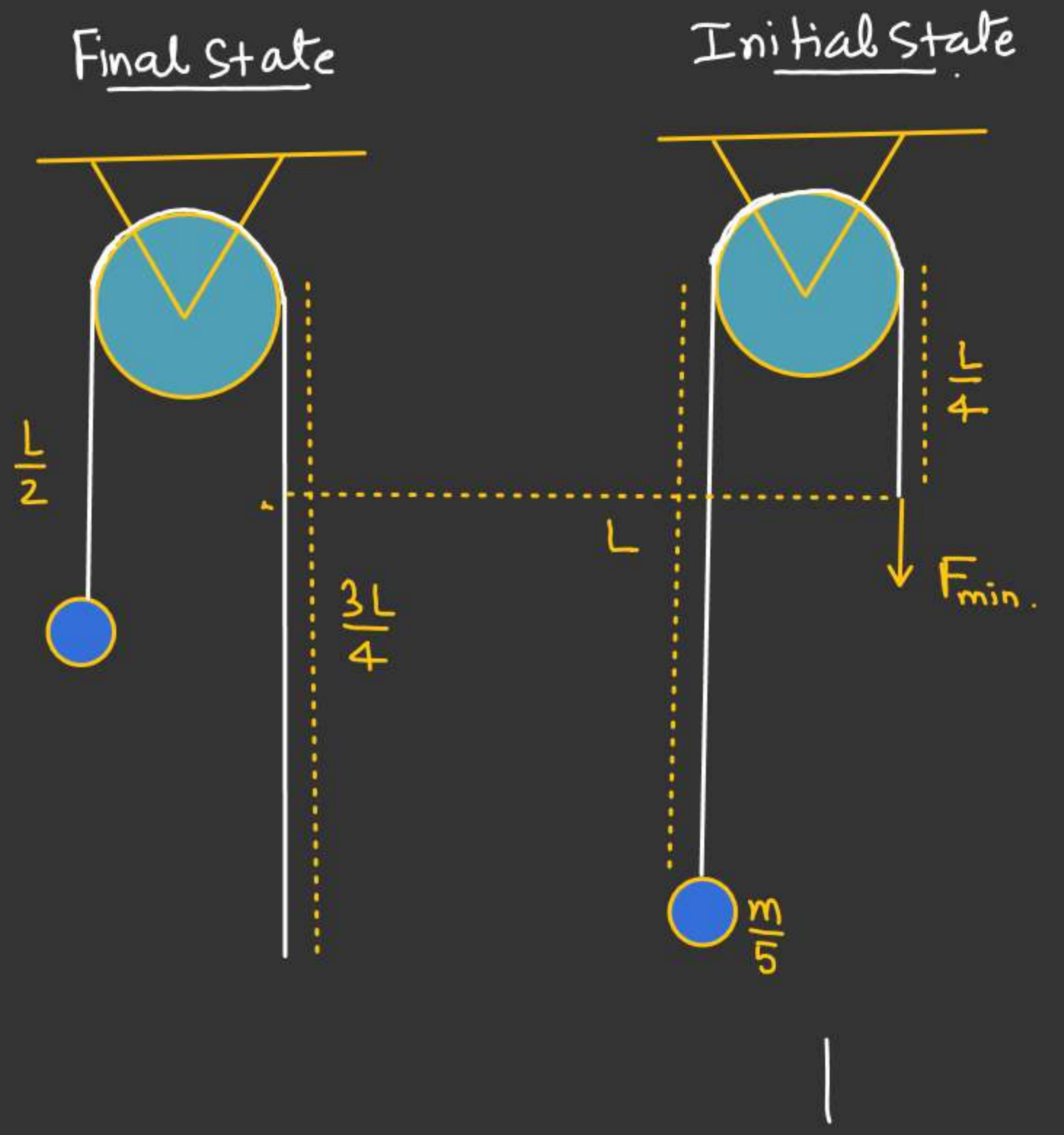
Sol$^n$ Mass of rope = $\lambda\left(L+\frac{L}{4}\right)$
$= \left(\frac{5\lambda L}{4}\right) = m.$

Mass of ball = $\frac{m}{5} = \left(\frac{\lambda L}{4}\right)$ ✓

Mass of System = $\left(\frac{5\lambda L}{4} + \frac{\lambda L}{4}\right)$
$= \frac{6\lambda L}{4} = \left(\frac{3\lambda L}{2}\right)$

Total weight of the System = $\left(\frac{3\lambda L g}{2}\right)$

for. $F_{min}$, weight on both side of the pully will be equal.
i.e $\left(\frac{3\lambda L g}{4}\right)$



Nishant Jindal

$$W_F + W_{gravity} = \cancel{\Delta KE} \to 0$$

$$W_F = (-W_{gravity})$$

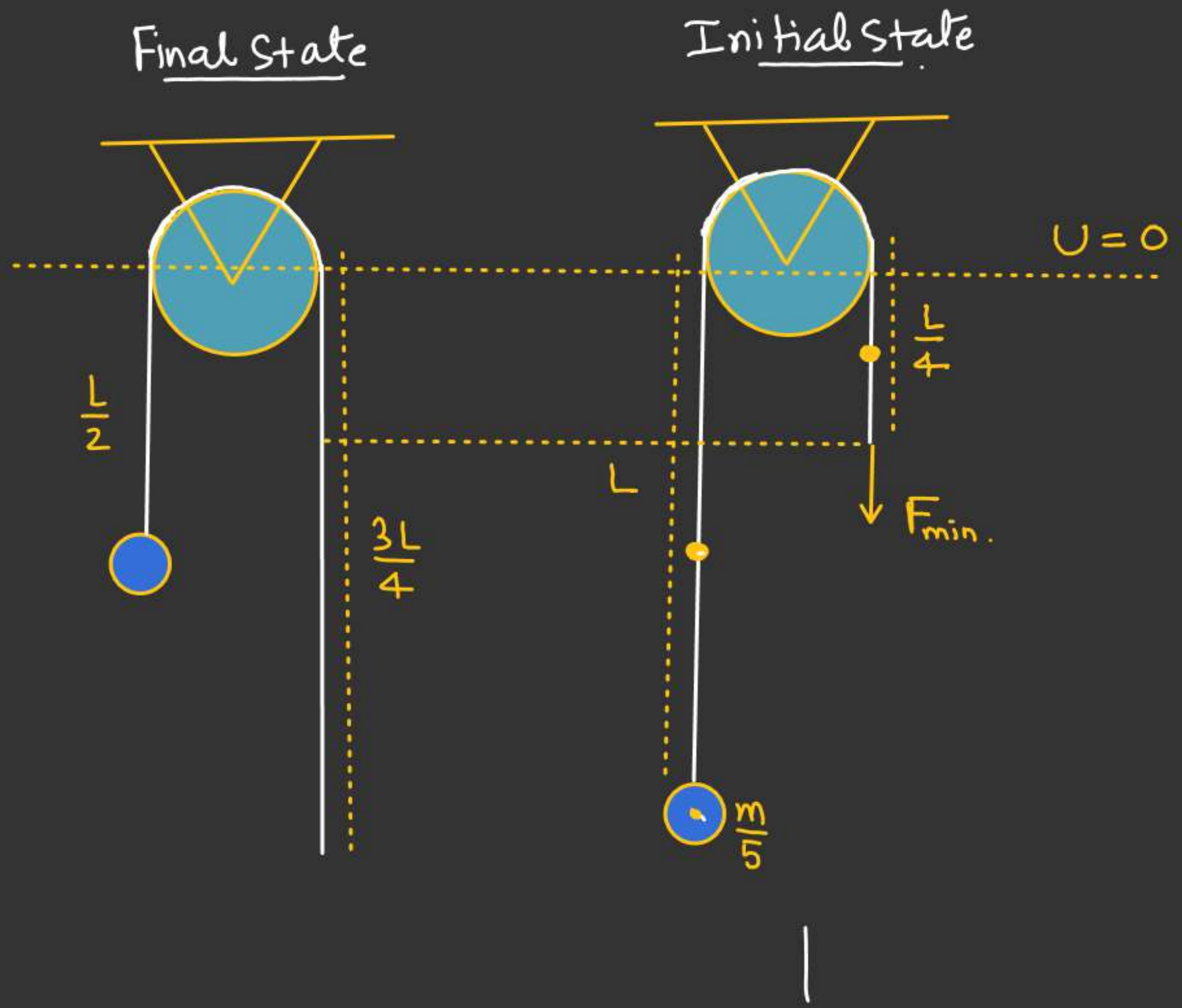
$$W_F = (\Delta U) = U_f - U_i$$

$$U_i = -\left[\lambda \frac{L}{4} g \cdot \frac{L}{8} + \lambda L g \cdot \frac{L}{2} + \frac{\lambda L}{4} g L\right]$$

$$U_i = -\lambda L^2 g \left[\frac{1}{32} + \frac{1}{2} + \frac{1}{4}\right]$$

$$U_i = -\lambda L^2 g \left[\frac{1+16+8}{32}\right]$$

$$U_i = -\lambda L^2 g \left(\frac{25}{32}\right)$$



Nishant Jindal

$U_f = ??$

$$U_f = -\left[\frac{\lambda 3L g}{4}\cdot\left(\frac{3L}{8}\right) + \frac{\lambda L g}{2}\left(\frac{L}{4}\right) + \frac{\lambda L}{4} g\frac{L}{2}\right]$$

$$U_f = -\lambda L^2 g\left[\frac{9}{32} + \frac{1}{4}\right]$$

$$= -\lambda L^2 g\left[\frac{9+8}{32}\right]$$

$$= \left(-\frac{17\lambda L^2 g}{32}\right)$$

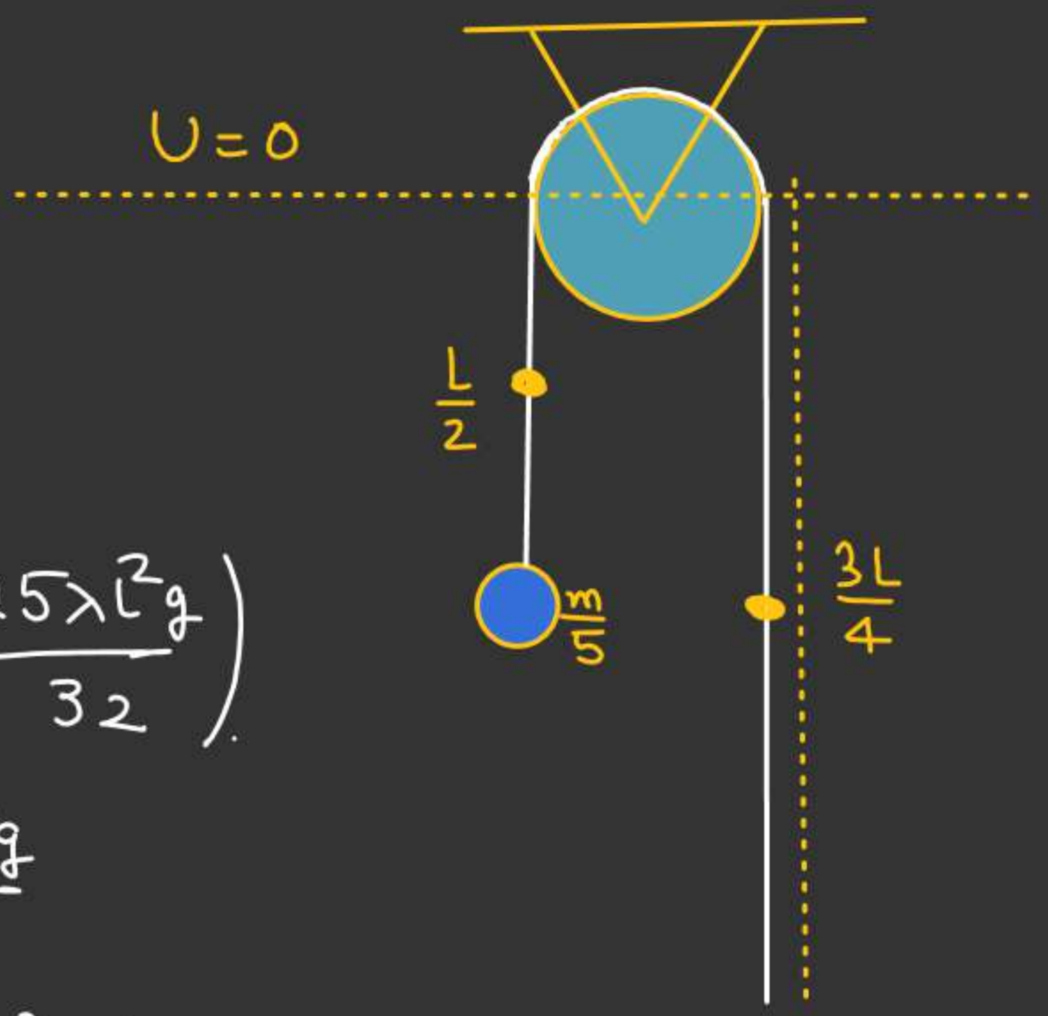
$$W_f = U_f - U_i$$

$$= -\frac{17\lambda L^2 g}{32} - \left(-\frac{25\lambda L^2 g}{32}\right)$$

$$= -\frac{17\lambda L^2 g}{32} + \frac{25\lambda L^2 g}{32}$$

$$= \frac{8\lambda L^2 g}{32} = \left(\frac{\lambda L^2 g}{4}\right) \text{ Ans} \checkmark$$

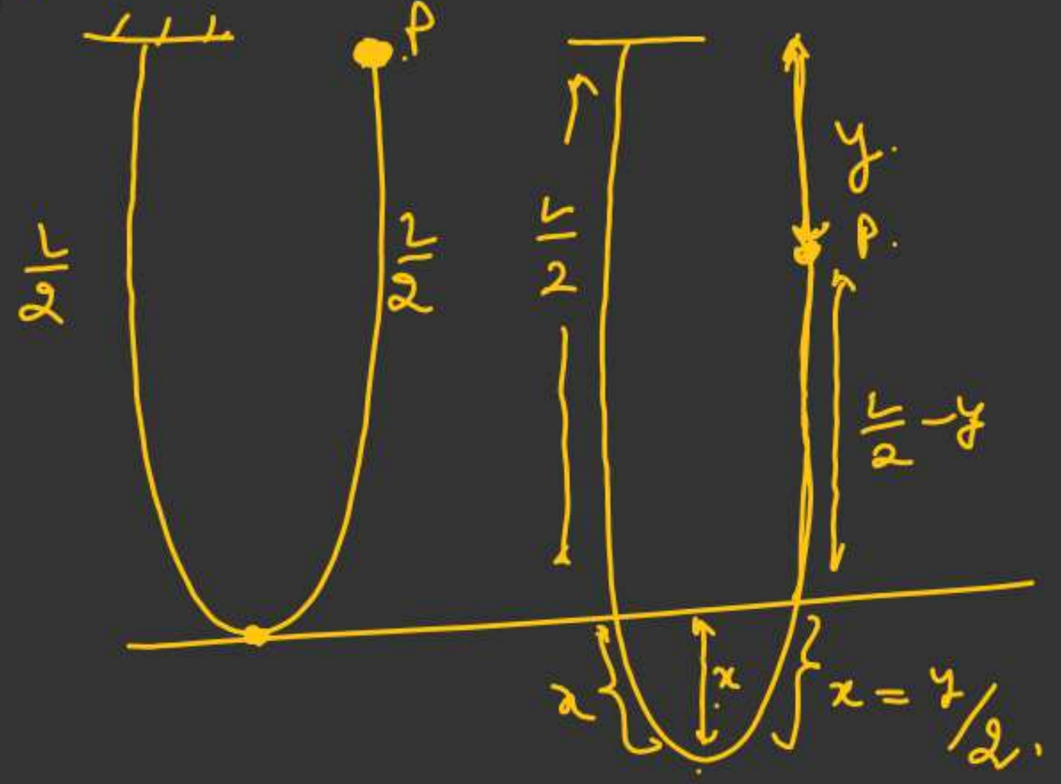
Final State



Nishant Jindal

$v_p = \underline{f(y)}$.

Hint ✓




$$\cancel{\frac{L}{2}} + 2x + \cancel{\frac{L}{2}} - y = \cancel{L}$$

$$y = 2x$$

$$x = y/2$$

Nishant Jindal

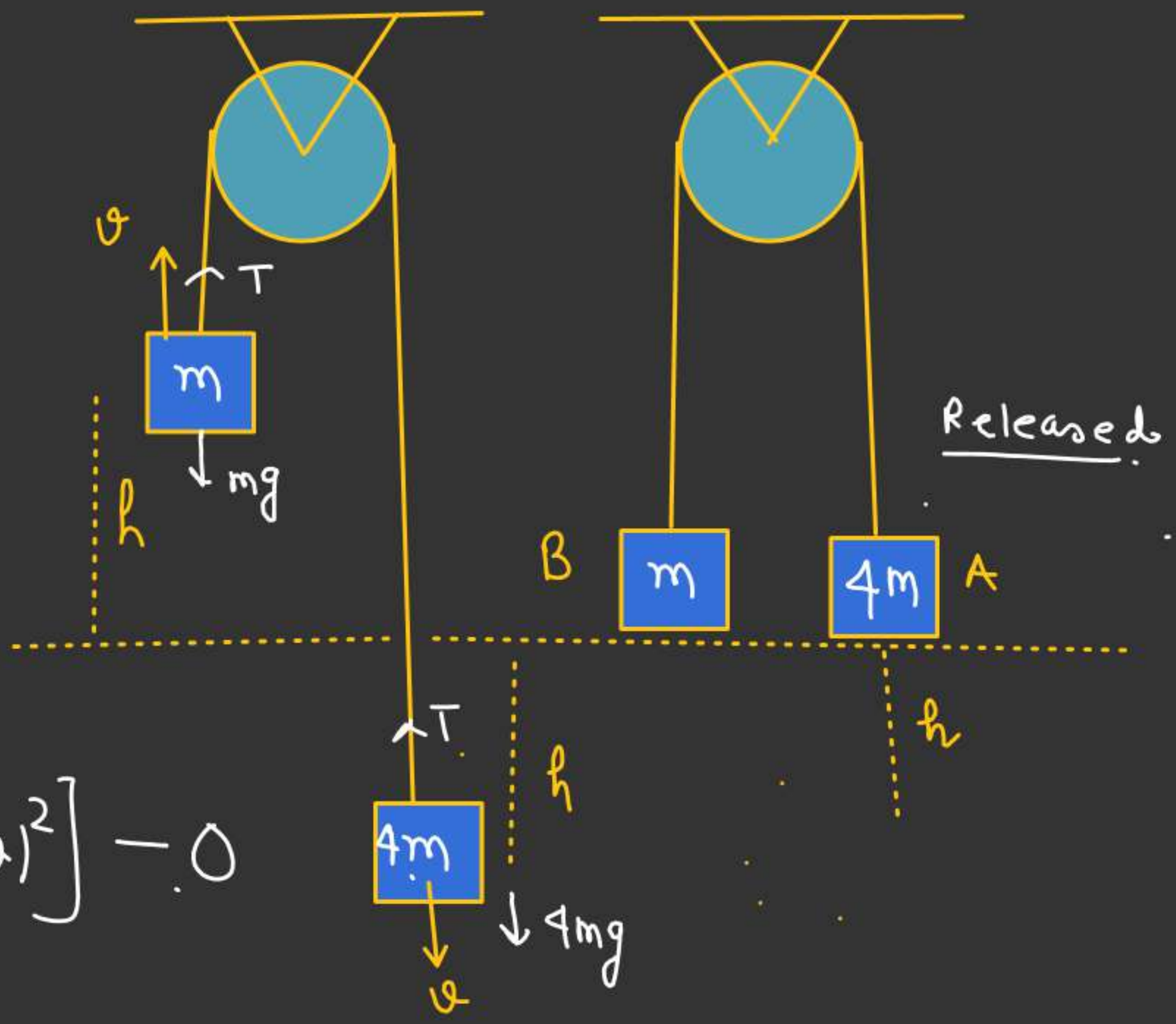
# Constrain Motion in Energy Conservation

a) Find the velocity of both the blocks when 4m is at at $h$.

b) Work done by tension on A. ✓

c) Work done by tension on B.

d) Net work done by tension. $= 0$




$$W_{gravity} + \cancel{(W_T)}_{system} = \Delta K.E$$

$$4mgh - mgh = \left[\frac{1}{2}(4m)v^2 + \frac{1}{2}m(v)^2\right] - 0$$

$$3mgh = \frac{1}{2} \times 5m \times v^2$$

$$v = \sqrt{\frac{3gh}{5}}$$ ✓

$$(W_T)_A = -T \cdot h \qquad T = \frac{2m_1m_2g}{m_1+m_2}$$

$$T = \left(\frac{2 \times 4m \times m}{4m+m}\right)g$$

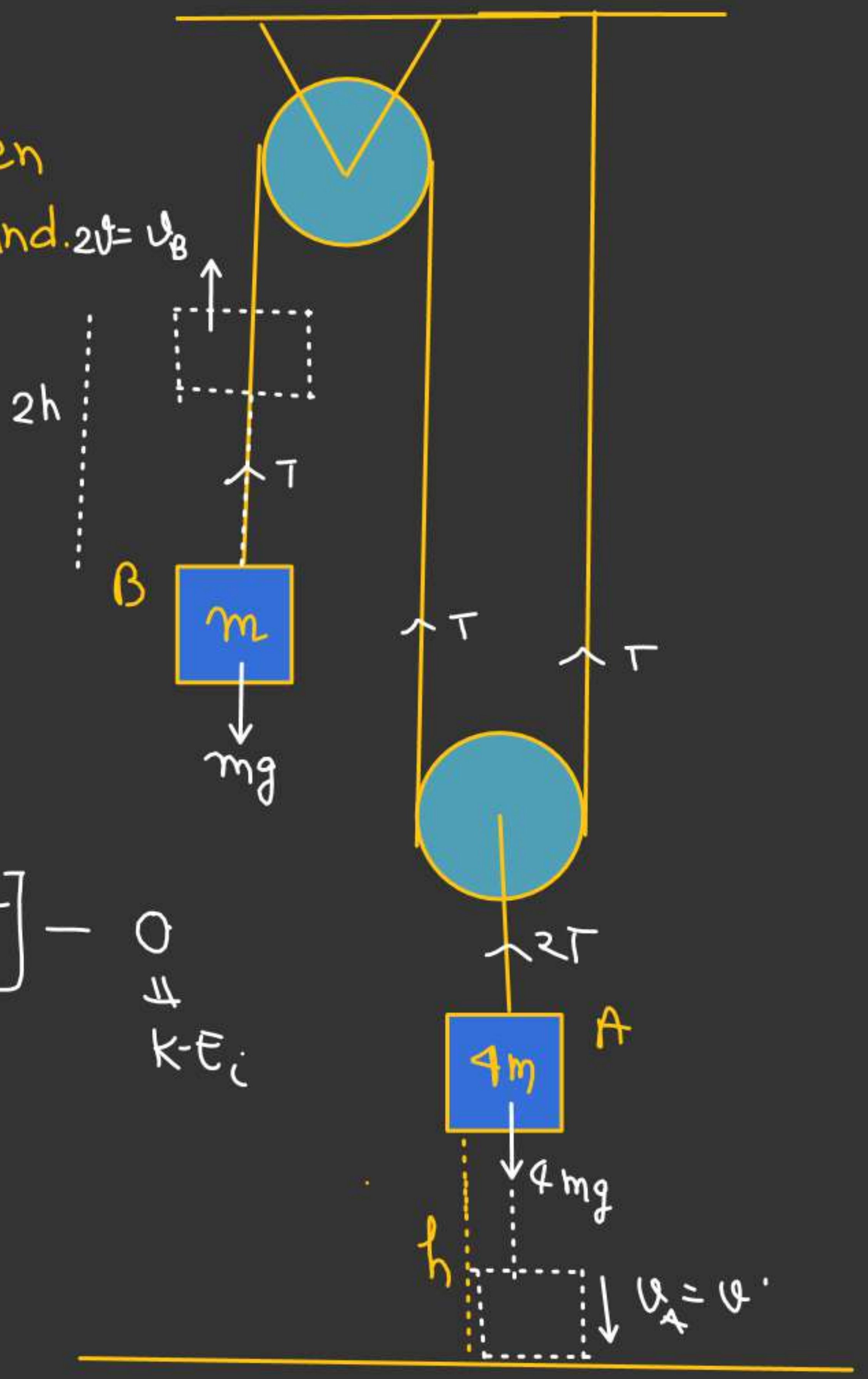
$$(W_T)_A = \left(-\frac{8mgh}{5}\right) \qquad T = \frac{8mg}{5}$$

$$(W_T)_B = +\frac{8mgh}{5}.$$

$$(W_T)_{net} = 0.$$

Nishant Jindal

\# System is released from rest. Find velocity of A and B when A just about to hit the ground. $2v = v_B$




$$-2Tv_A + Tv_B = 0$$

$$v_B = 2v_A$$

If $v_A = v, \quad v_B = 2v$

$$y_B = 2y_A$$

$$y_B = 2h$$

$$W_{gravity} = \Delta K.E$$

$$4mgh - mg(2h) = \underbrace{\left[\frac{1}{2}(4m)v^2 + \frac{1}{2}m(2v)^2\right]}_{K.E_f} - \underbrace{0}_{K.E_i}$$

$$2mgh = \left[2mv^2 + 2mv^2\right]$$

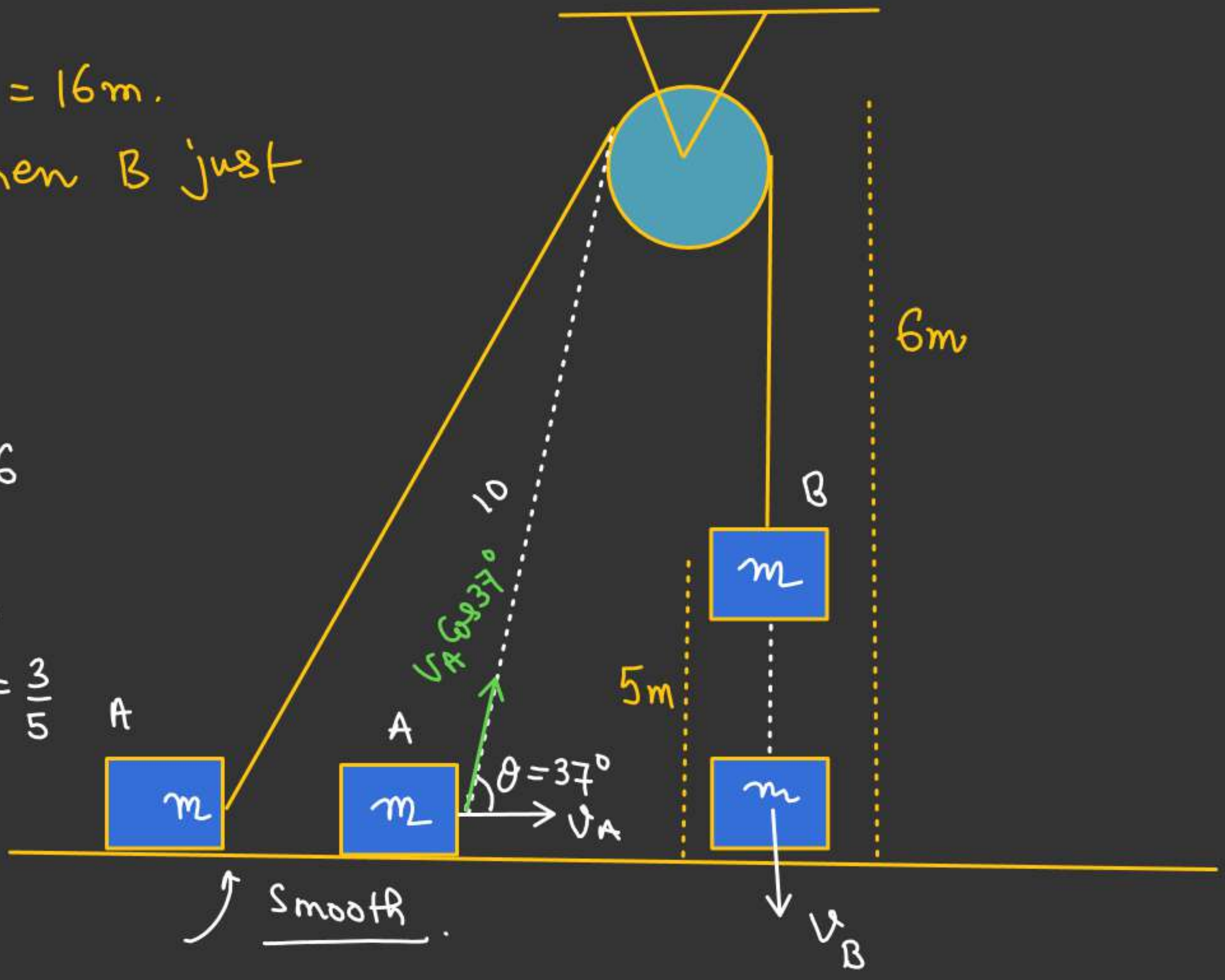
$$\frac{gh}{2} = v^2 \Rightarrow v = \sqrt{\frac{gh}{2}} \checkmark$$

Nishant Jindal

\# System is released from rest as shown in fig.

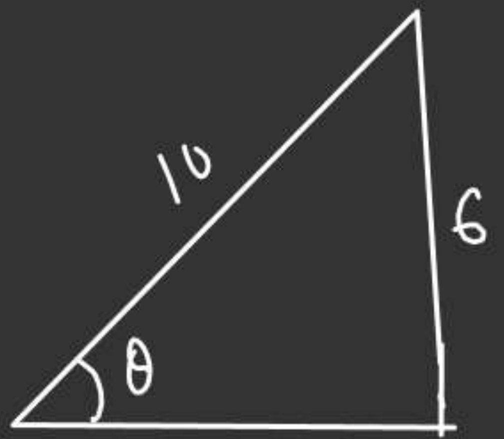
L = Total length of the string = 16m.

Find velocity of A and B when B just about to hit the ground.




$v_B = v_A \cos 37°$

$v_B = \left(\frac{4v_A}{5}\right)$




$\sin\theta = \frac{6}{10} = \frac{3}{5}$

$\theta = 37°$

$W_{gravity} = (\Delta K.E)$

$\Downarrow$

$5mg = \left(\frac{1}{2} \times m v_B^2 + \frac{1}{2} m v_A^2\right)$

$5\cancel{m}g = \frac{1}{2}\cancel{m}\left(\frac{16}{25}+1\right)v_A^2$

$10g = \frac{41}{25}v_A^2 \Rightarrow v_A^2 = \frac{2500}{41} \Rightarrow v_A = \frac{50}{\sqrt{41}}$ m/s. $v_B = \frac{4}{5} \times \frac{50}{\sqrt{41}} = \frac{40}{\sqrt{41}}$ m/s.

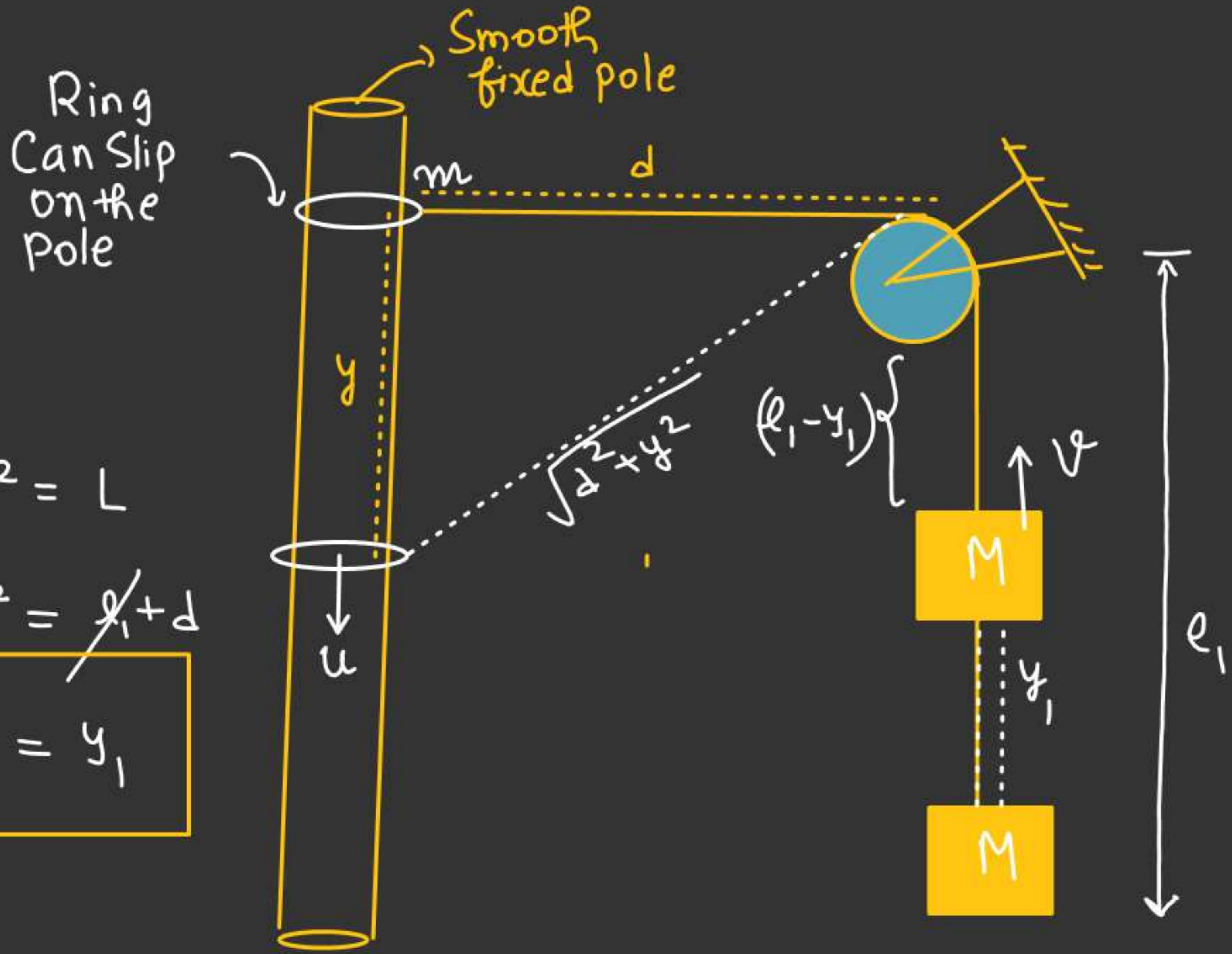
Nishant Jindal

# System is released from rest as shown in fig.

Find the distance covered by ring when velocity of the ring become zero for the 1st time.

M = Mass of block.

m = mass of ring.




$$l_1 + d = L$$

$$l_1 - y_1 + \sqrt{d^2+y^2} = L$$

$$\cancel{l_1} - y_1 + \sqrt{d^2+y^2} = \cancel{l_1} + d$$

$$\boxed{\sqrt{d^2+y^2} - d = y_1}$$