Nishant Jindal

\# Find u_{min} So that bob complete the vertical Circle.

$$\tan\theta = \frac{mg/\sqrt{3}}{mg}$$

$$\tan\theta = \frac{1}{\sqrt{3}}$$

$$\theta = 30^\circ$$

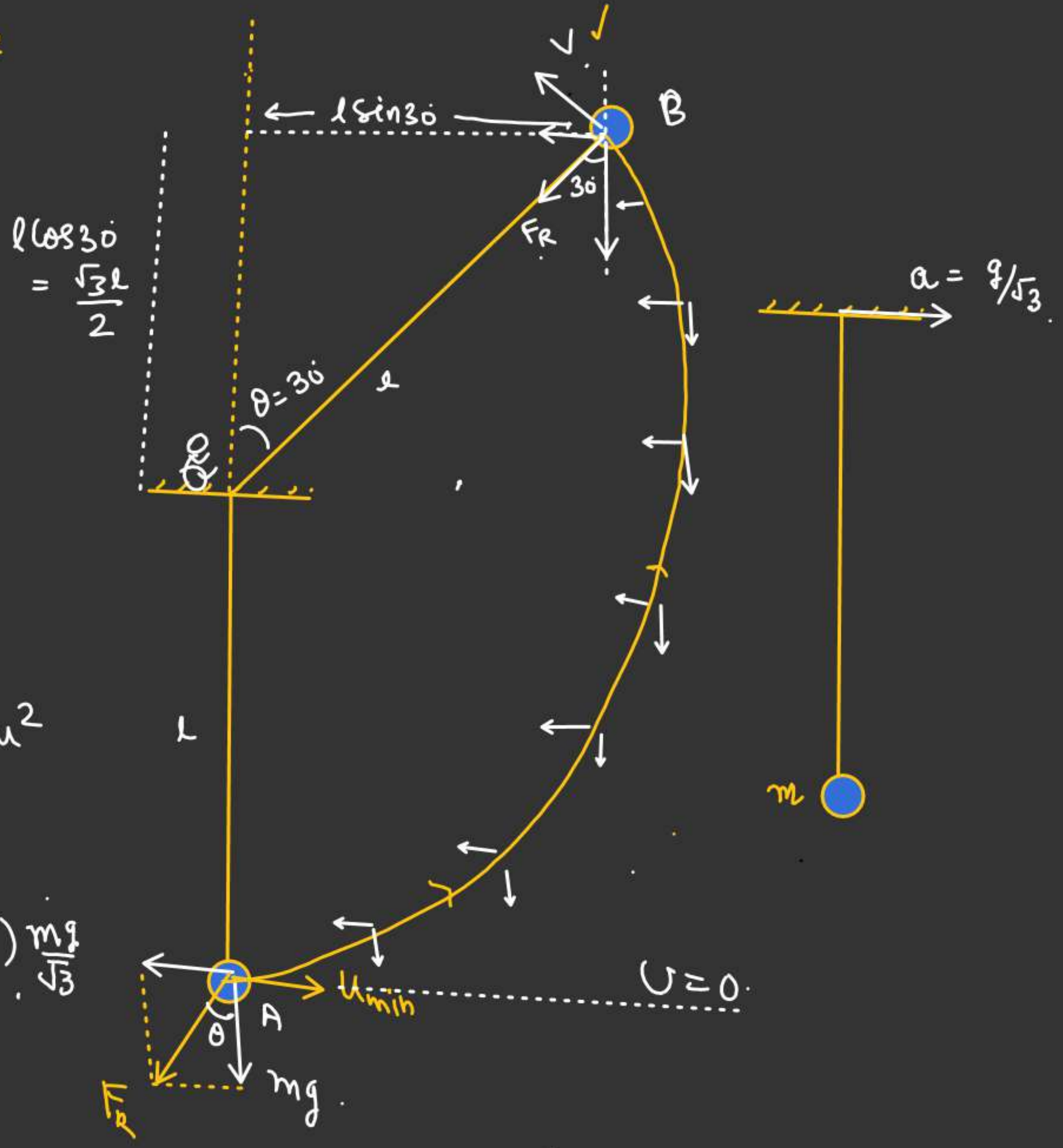
By work-Energy theorem.

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

$$-\left(\frac{mg}{\sqrt{3}}\right)\left(\frac{l}{2}\right) - mg\left(l + \frac{\sqrt{3}l}{2}\right) = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$-\left[\frac{mgl}{2\sqrt{3}} + \frac{\sqrt{3}mgl}{2} + mgl\right] = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 \quad (\text{Pseudo}) \ \frac{mg}{\sqrt{3}}$$

$$\left(\frac{mgl + 3mgl + 2\sqrt{3}mgl}{2\sqrt{3}}\right) = \frac{1}{2}mu^2 - \frac{1}{2}mv^2$$



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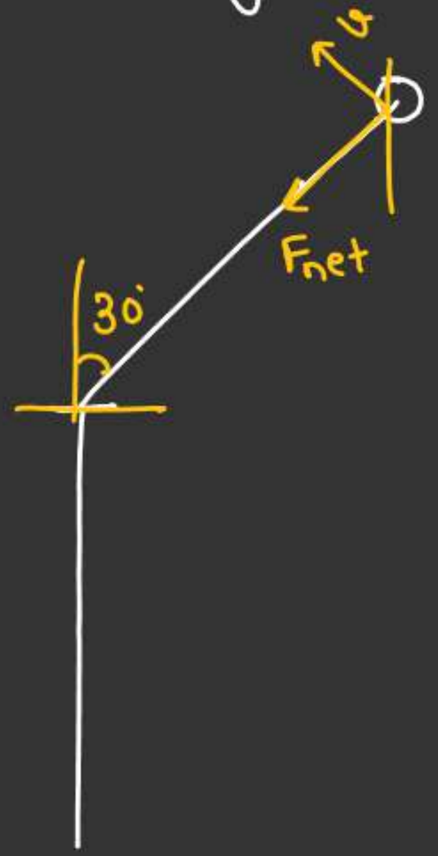
$$\left(\frac{mgl + 3mgl + 2\sqrt{3}mgl}{2\sqrt{3}}\right) = \frac{1}{2}mu^2 - \frac{1}{2}mv^2 \quad \text{— (1)}$$

Net Centripetal when String at $\theta = 30^\circ$ from vertical



$$F_{net} + T = \frac{mv^2}{l}$$

For V to be min, $T = 0$

$$\sqrt{\left(\frac{mg}{\sqrt{3}}\right)^2 + (mg)^2} = \frac{mV_{min}^2}{l}$$

$$\frac{2mg}{\sqrt{3}} = \frac{mV_{min}^2}{l}$$

$$mV_{min}^2 = \frac{2mgl}{\sqrt{3}} \rightarrow \text{Put in (1)}.$$

For U_{min} v should be v_{min}.

$$\frac{mU_{min}^2}{2} = \left(\frac{4mgl + 2\sqrt{3}mgl}{2\sqrt{3}}\right) + \frac{1}{2}mV_{min}^2$$

$$\frac{\cancel{m}}{\cancel{2}}U_{min}^2 = \frac{\cancel{2}\cancel{m}gl(\sqrt{3}+2)}{\cancel{2}\sqrt{3}} + \frac{1}{\cancel{2}} \times \left(\frac{\cancel{2}\cancel{m}gl}{\sqrt{3}}\right)$$

$$U_{min}^2 = \left(\frac{2\sqrt{3}gl + 6gl}{\sqrt{3}}\right)$$

$$U_{min}^2 = \left[2gl + 2\sqrt{3}gl\right]$$

$$U_{min} = 2gl(1+\sqrt{3})^{1/2} \checkmark$$

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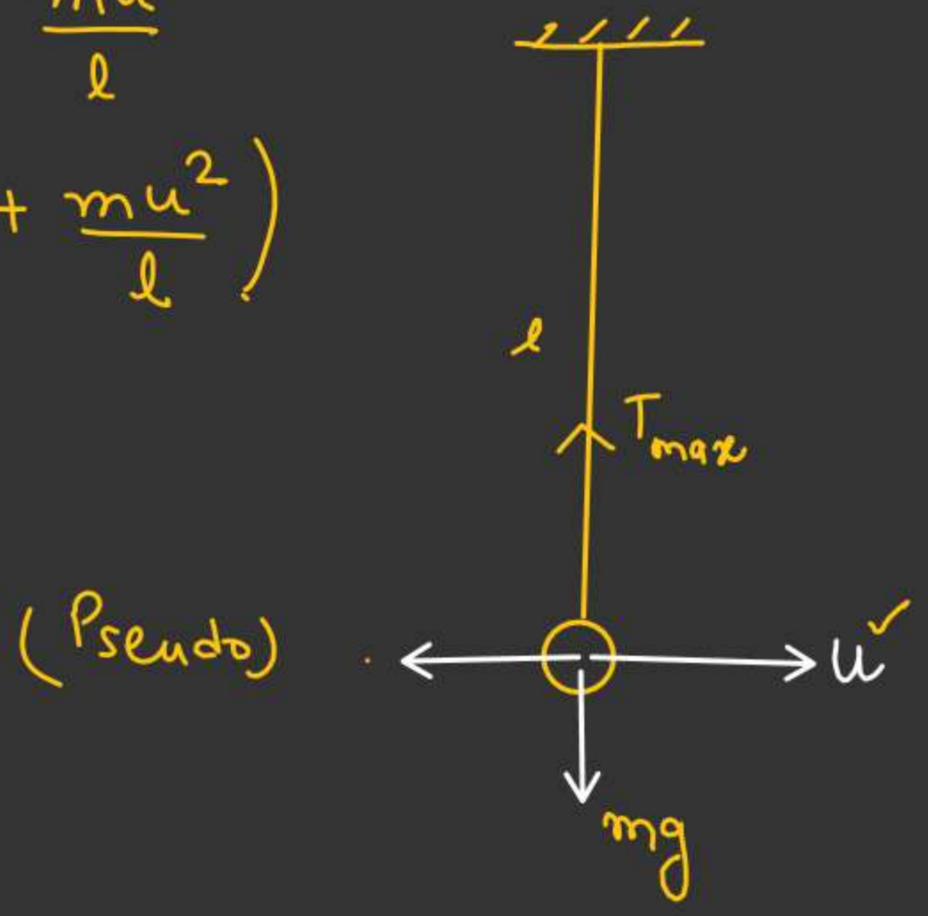
Maximum Tension at lowest point

$$T_{max} - mg = \frac{mu^2}{l}$$

$$T_{max} = \left(mg + \frac{mu^2}{l}\right)$$



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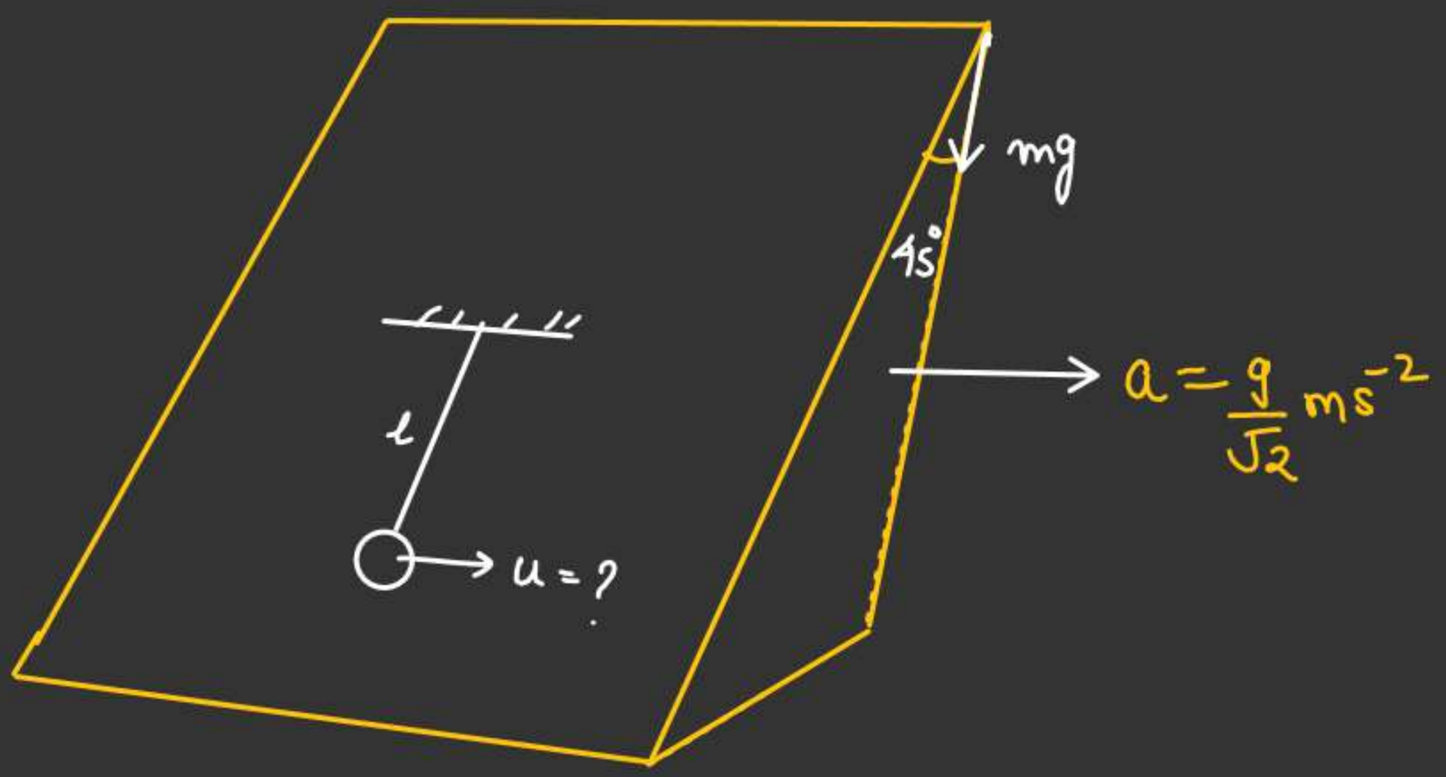
H.W

U_{min} so that bob complete the Vertical Circle.



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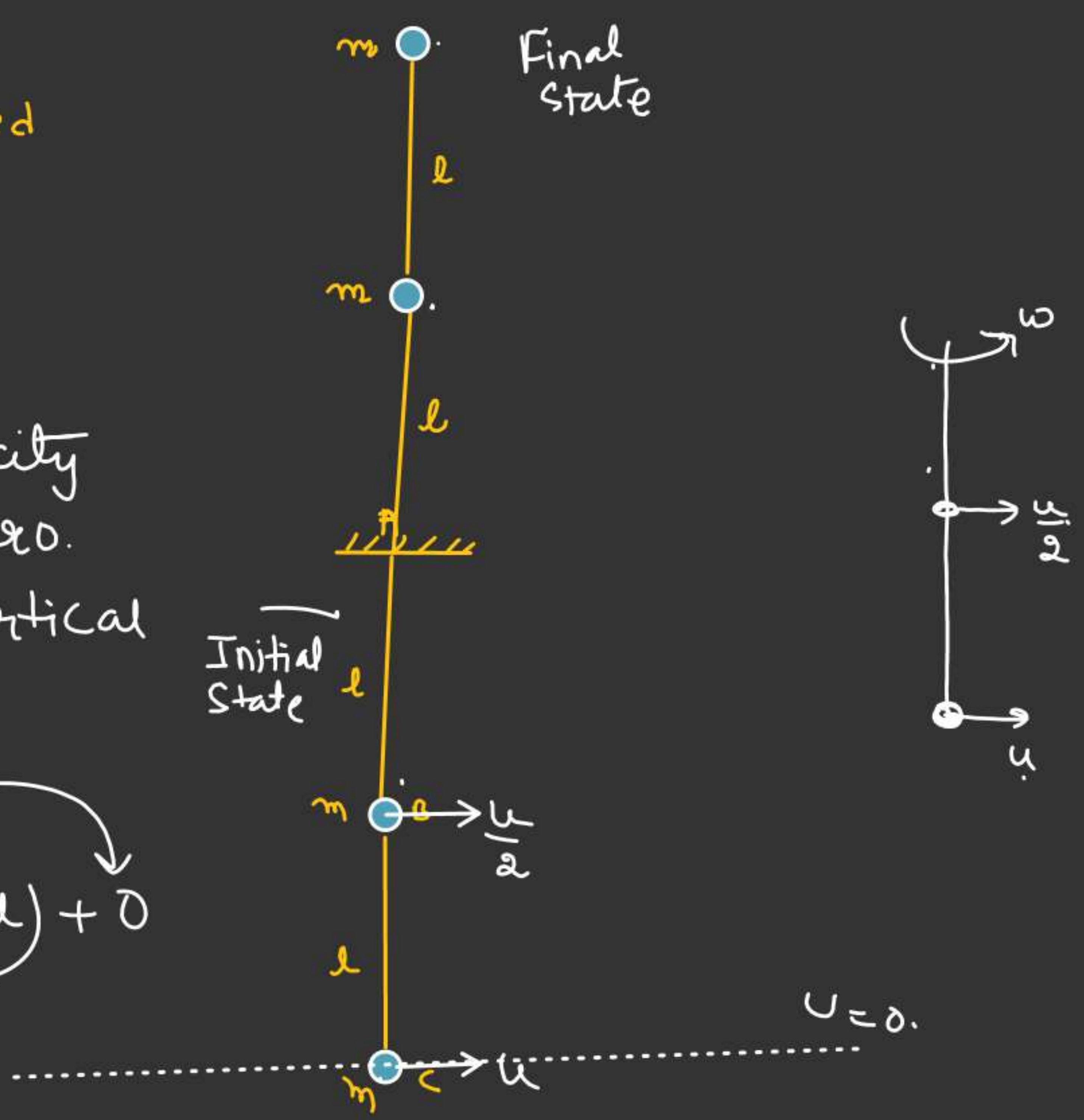
\# . Two light rods AB and BC.
Two identical masses are attached to the light rod.
Find min u so that the system complete the vertical circle.



Solⁿ :- At the highest point velocity of the system will be zero. to just complete the vertical circle

$$U_i + K.E_i = U_f + K.E_f$$

$$mgl + \frac{1}{2}m\left(u^2 + \frac{u^2}{4}\right) = (mg\,3l + mg\,4l) + 0$$

$$mgl + \left(\frac{5mu^2}{8}\right) = 7mgl$$

$$\frac{5\cancel{m}u^2}{8} = 6\cancel{m}gl \Rightarrow \boxed{u = \sqrt{\frac{48gl}{5}}}$$ ✓

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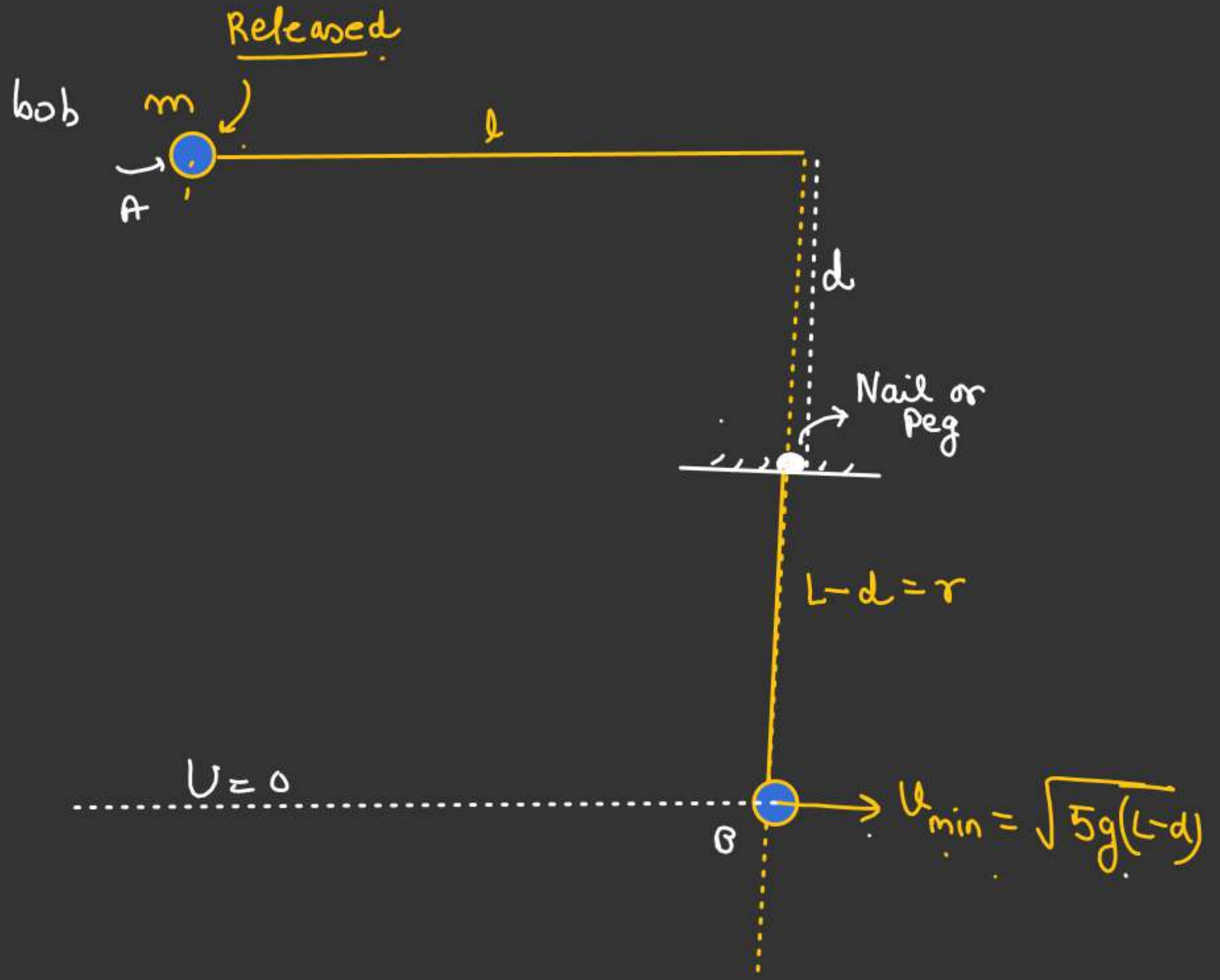
Find 'd' So the bob just Complete the vertical Circle.



$$mgl = \frac{1}{2} m v_{min}^2$$

$$\cancel{m}\cancel{g}l = \frac{1}{2} \times \cancel{m} \times 5\cancel{g}(l-d)$$

$$\frac{2l}{5} = l - d$$

$$\underline{\underline{d}} = l - \frac{2l}{5} = \left(\frac{3l}{5}\right)$$

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Range of α so that ball complete the track.

AB = Range of projectile

$$AB = \frac{v^2 \sin 2\alpha}{g}$$

Energy Conservation from D to A.

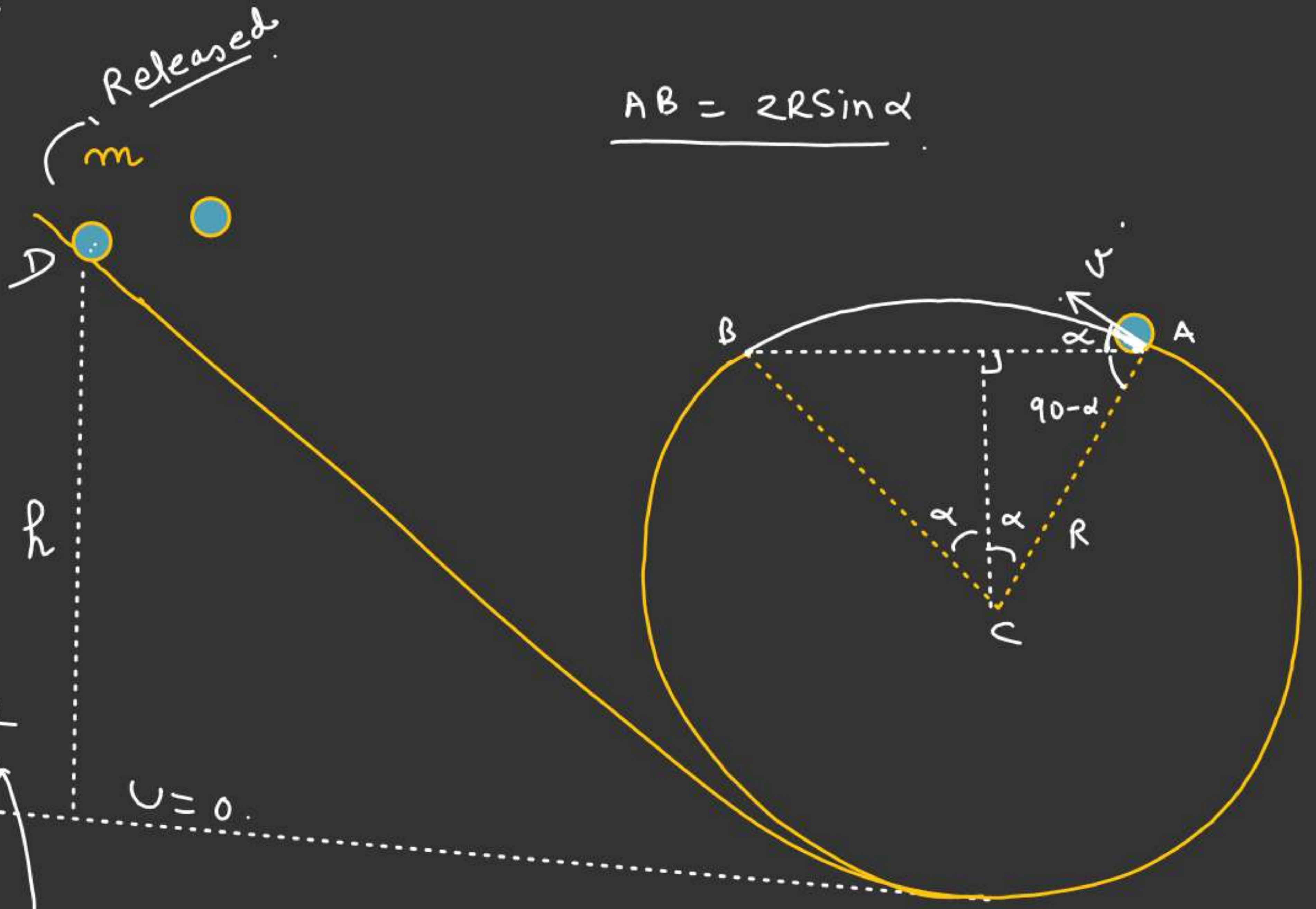
$$mgh = mg(R + R\cos\alpha) + \frac{1}{2}mv^2$$

$$AB = 2R\sin\alpha$$

$$\cancel{2}R\cancel{\sin}\alpha = \frac{v^2}{g}\cancel{2}\cancel{\sin}\alpha \cdot \cos\alpha$$

$$v^2 = \left(\frac{gR}{\cos\alpha}\right)$$

$$AB = 2R\sin\alpha$$



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$$mgh = mg(R+R\cos\alpha) + \frac{1}{2}mv^2$$

$$AB = 2R\sin\alpha$$

$$\cancel{2}R\cancel{\sin}\alpha = \frac{v^2}{g}\cancel{2}\cancel{\sin}\alpha \cdot \cos\alpha$$

$$v^2 = \left(\frac{gR}{\cos\alpha}\right)$$

$$mgh = mgR + mgR\cos\alpha + \frac{mgR}{2\cos\alpha}$$

$$\frac{h}{R} = 1 + \cos\alpha + \frac{1}{2\cos\alpha}$$

$$\frac{h}{R} = \frac{2\cos\alpha + 2\cos^2\alpha + 1}{2\cos\alpha}$$

$$\Downarrow$$

$$K$$

$$2K\cos\alpha = 2\cos\alpha + 2\cos^2\alpha + 1$$

$$2\cos^2\alpha + 2(1-K)\cos\alpha + 1 = 0.$$

$$\boxed{\cos^2\alpha + (1-K)\cos\alpha + \frac{1}{2} = 0.}$$

$$D \geq 0.$$

$$(1-K)^2 - 4\times 1\times \frac{1}{2} \geq 0. \quad — (1)$$

$$\cos\alpha \leq 1. \quad — (2)$$

$$\frac{-(K-1) \pm \sqrt{(K-1)^2 - 2}}{2} \leq 1.$$

$$-(K-1) \pm \sqrt{(K-1)^2 - 2} \leq 2$$

$$\sqrt{(K-1)^2 - 2} \leq (K+1)$$