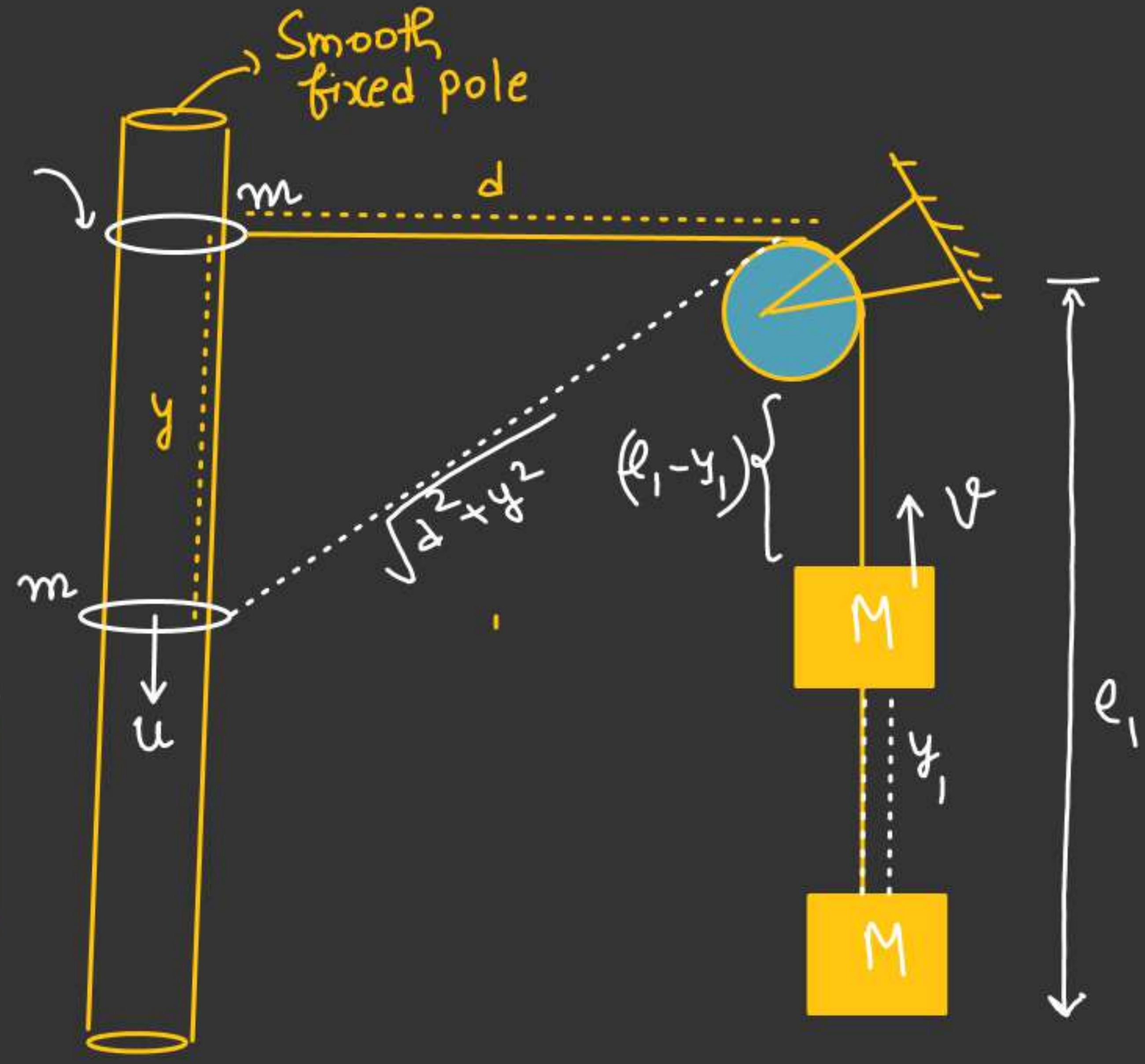
System is released from rest as shown in fig.

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.



$$l_1 + d = L$$

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

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

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

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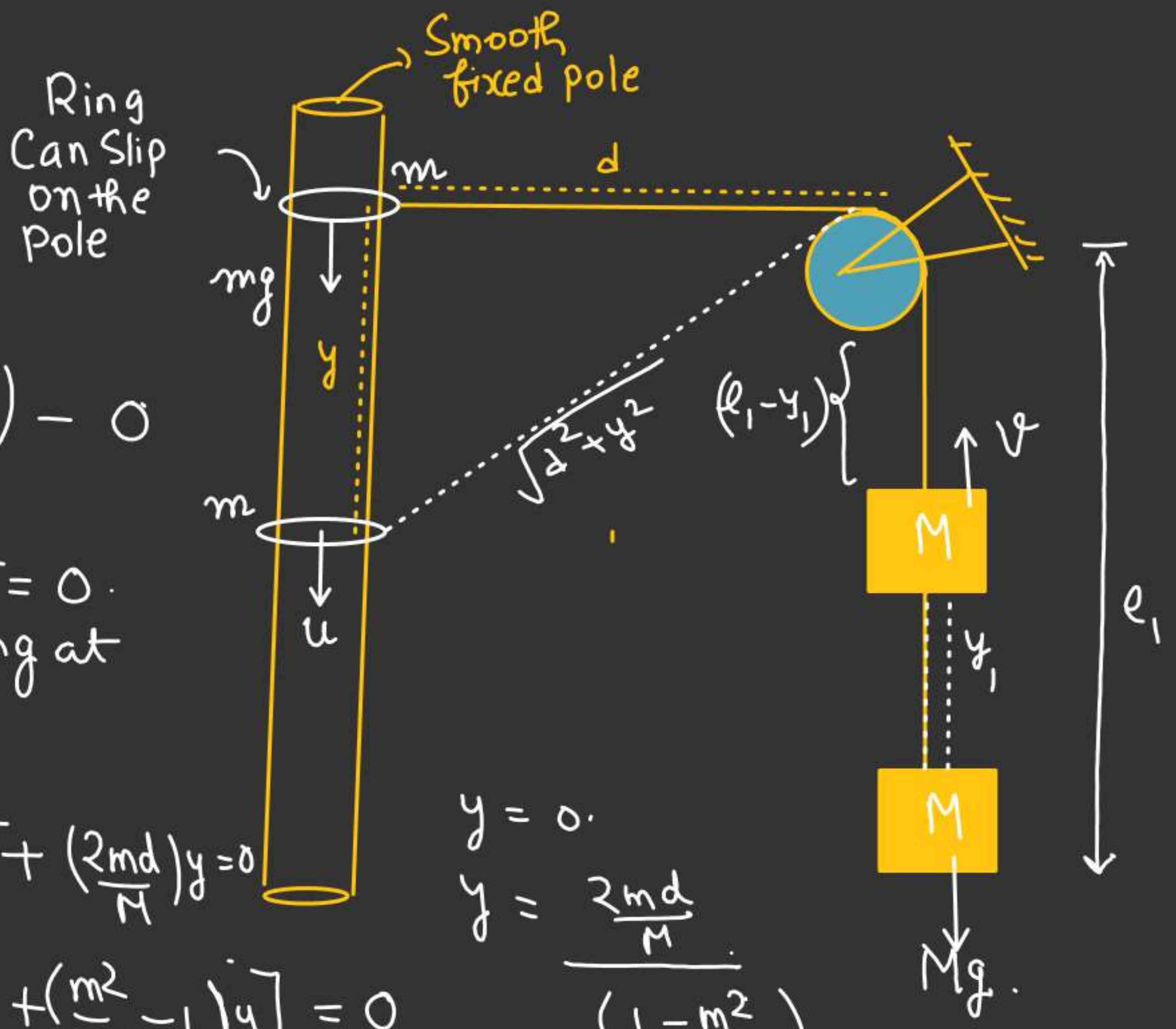
$$\boxed{\sqrt{d^2+y^2} - d = y_1}$$

By work-Energy theorem

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

$$-(Mg)y_1 + mgy = \left(\tfrac{1}{2}mu^2 + \tfrac{1}{2}MV^2\right) - 0$$



$$m\cancel{g}y = M\cancel{g}\,y_1$$

[$u = 0$, $v = 0$. when ring at rest.

$$y = \frac{M}{m}\left[\sqrt{d^2+y^2} - d\right].$$

$$\left(\frac{m}{M}y + d\right)^2 = (d^2+y^2)$$

$$\frac{m^2}{M^2}y^2 + \frac{2md}{M}y + \cancel{d^2} = \cancel{d^2} + y^2$$

$$\left(\frac{m^2}{M^2} - 1\right)y^2 + \left(\frac{2md}{M}\right)y = 0$$

$$y\left[\frac{2md}{M} + \left(\frac{m^2}{M^2} - 1\right)y\right] = 0$$

$y = 0.$

$$y = \frac{\frac{2md}{M}}{\left(1 - \frac{m^2}{M^2}\right)}$$

$$y = \left(\frac{2Mmd}{M^2 - m^2}\right) \text{ Ans}$$

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$$y = \left(\frac{2Mmd}{M^2 - m^2}\right)$$

if $\boxed{m << M}$

$$y = \frac{2\cancel{M}md}{\cancel{M^2}\left(1 - \underbrace{\frac{m^2}{M^2}}_{\Downarrow \atop 0}\right)}$$

$$\boxed{y = \left(\frac{2md}{M}\right)}$$

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$AD = DB = 1m.$

\#. System is released from the position shown in the fig. 2m mass is fixed at the mid point of AB. Find the velocity with which mass 2m hit the wall.

$BD = \sqrt{2^2 + 1^2} = \sqrt{5}m.$

By Constrain relation

$v \sin\theta = v_1$ [Velocity along the string must be same]

$\frac{2v}{\sqrt{5}} = v_1.$

L = Total length of String

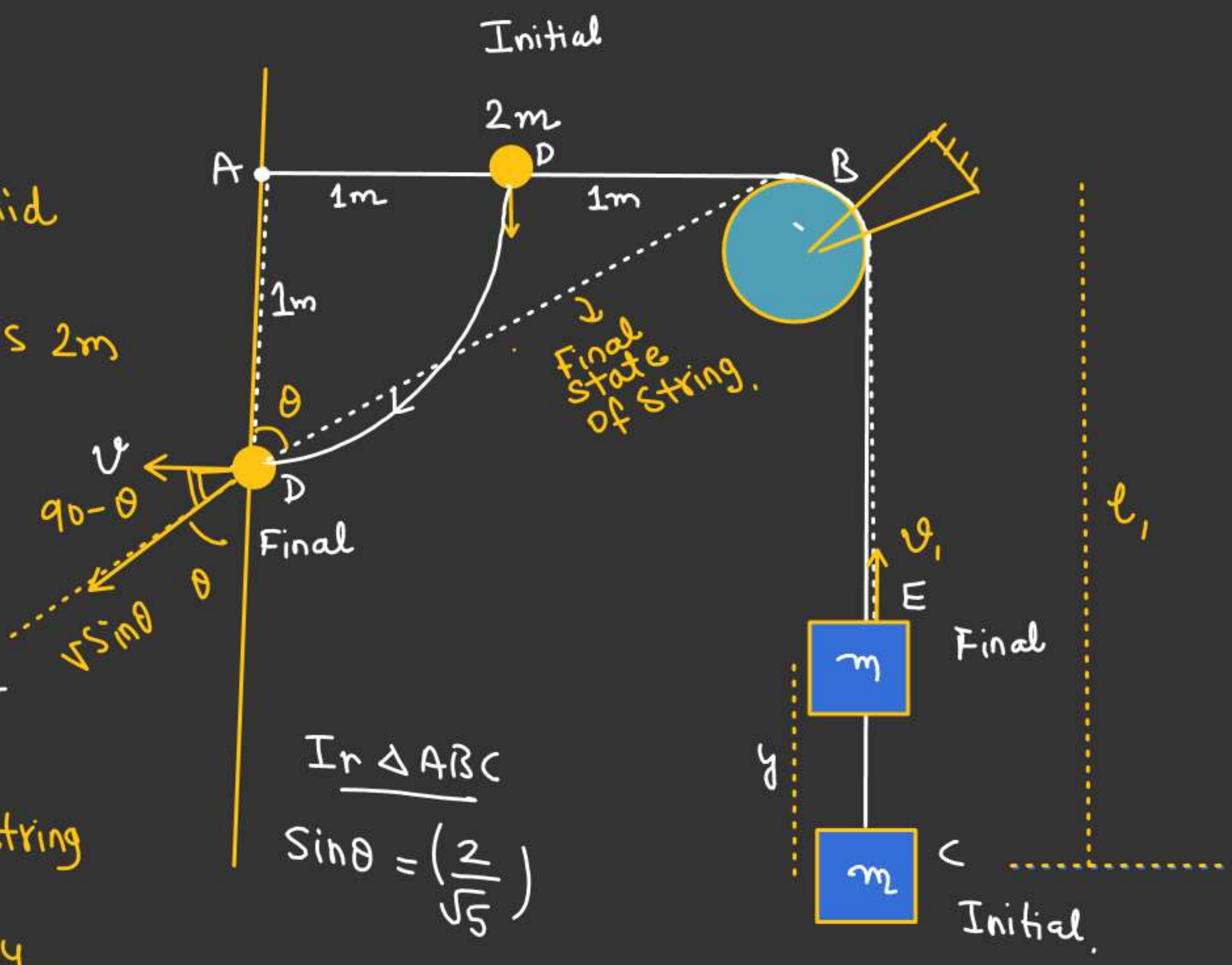
$(l_1 + 2 = L)$ —①

$AD + DB + BE = L$

$1 + \sqrt{5} + (l_1 - y) = L$ —②

$1 + \sqrt{5} + (\cancel{L} - 2) - y = \cancel{L}$

$(\sqrt{5} - 1) = y.$



In △ABC

$\sin\theta = \left(\frac{2}{\sqrt{5}}\right)$

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$$\frac{2v}{\sqrt{5}} = v_1$$

$$y = (\sqrt{5}-1)$$

By work-Energy therome.

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

$$(2mg)1 - mgy = \frac{1}{2}(2m)v^2 + \frac{1}{2}mv_1^2$$

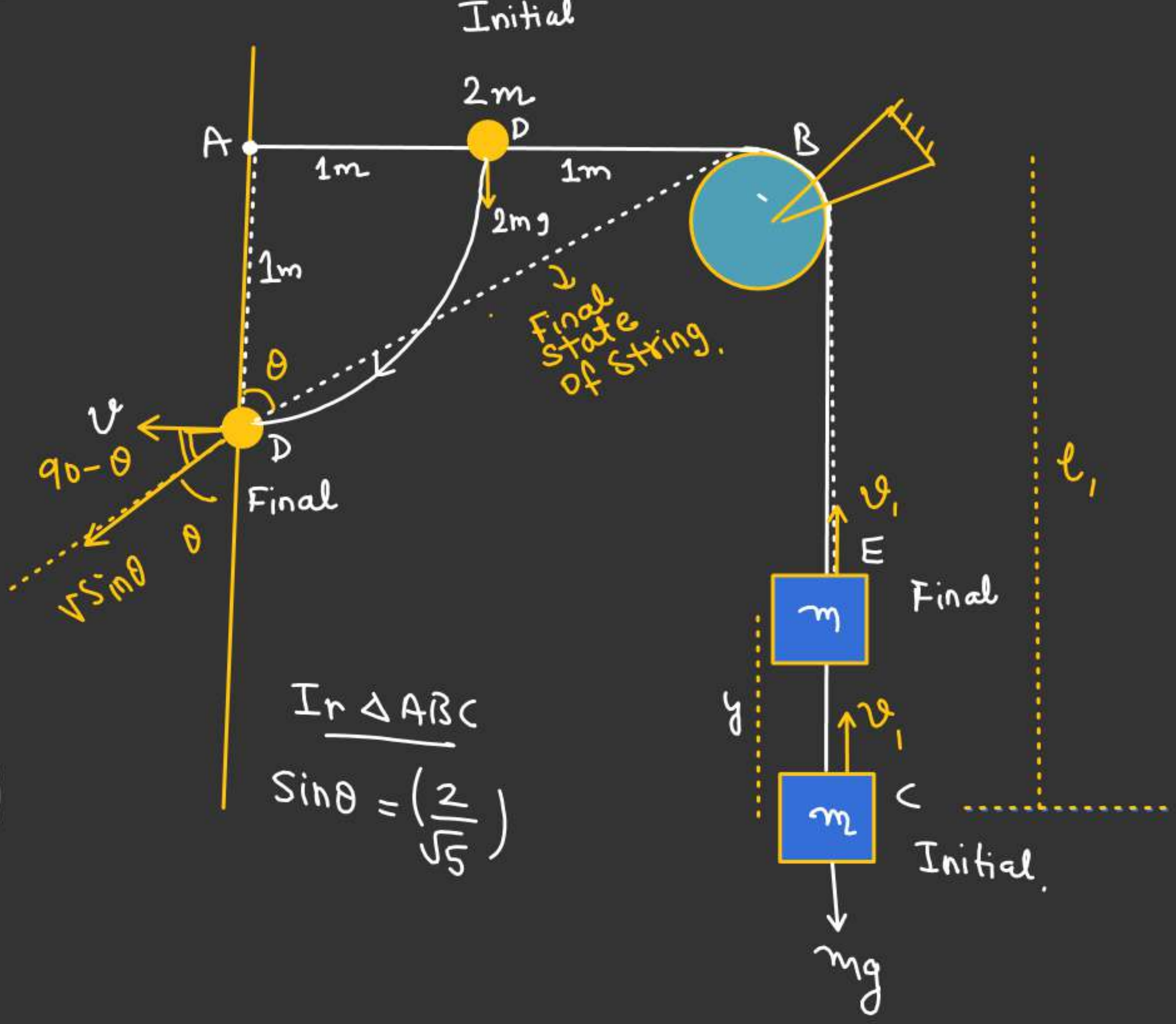
$$(2mg) - mg(\sqrt{5}-1) = mv^2 + \frac{m}{2} \times \left(\frac{4v^2}{5}\right)$$

$$= \left(mv^2 + \frac{2mv^2}{5}\right)$$

$$3mg - \sqrt{5}mg = \left(\frac{7mv^2}{5}\right)$$

$$\sqrt{\frac{5g}{7}(3-\sqrt{5})} = \underline{v}$$

AD = DB = 1m (given)

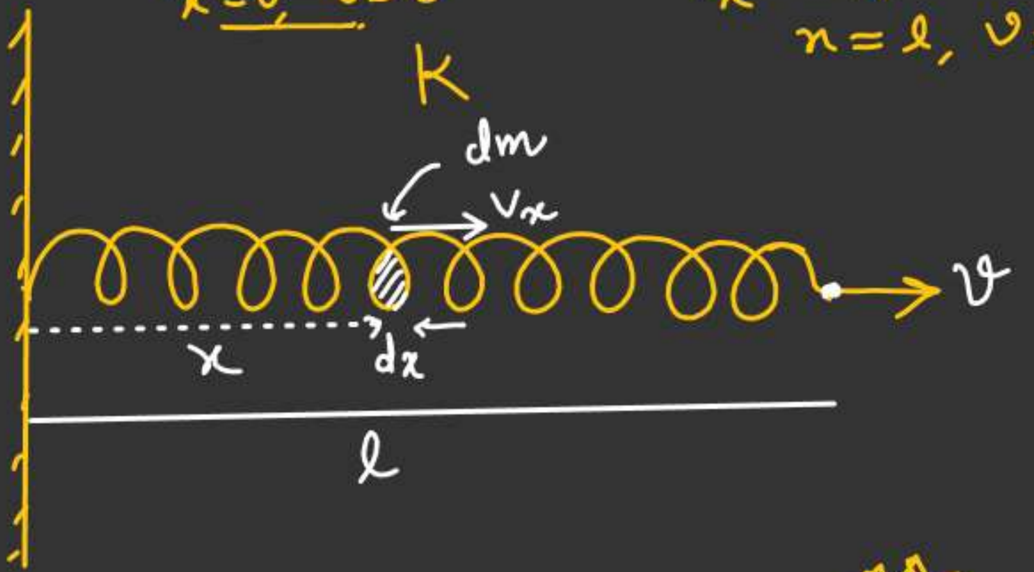


In △ABC

$$\sin\theta = \left(\frac{2}{\sqrt{5}}\right)$$

Case of Massive Spring

Uniform Spring, mass of Spring $= M$



$v =$ velocity of spring of its free end i.e when spring of length l.

$V_x =$ linear function of x

Velocity per unit length $= \frac{V}{l}$

$$V_x = \left(\frac{V}{l}x\right)$$

$$dm = \left(\frac{M}{l}dx\right)$$

$$dK.E = \frac{1}{2}dm\,V_x^2$$

$$d(K.E) = \frac{1}{2}\left(\frac{M}{l}dx\right)\left(\frac{V^2}{l^2}\cdot x^2\right)$$

$$\int_0^{K.E} d(K.E) = \frac{MV^2}{2l^3}\int_0^l x^2\,dx$$

$$K.E = \frac{1}{2}\frac{MV^2}{\cancel{l^3}}\times\frac{\cancel{l^3}}{3}$$

$$\boxed{K.E = \frac{1}{2}\left(\frac{M}{3}\right)V^2}$$

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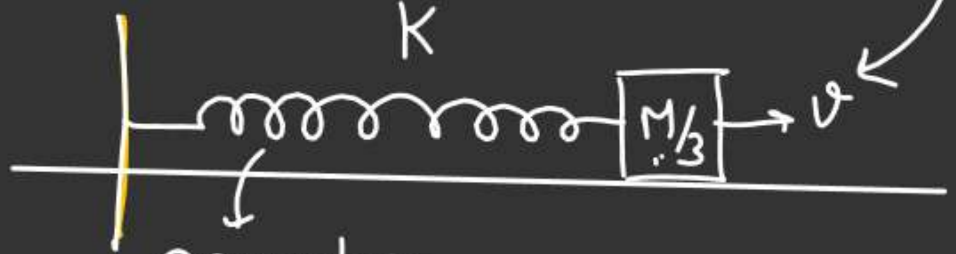
TRICK.

K·E of Massive Spring $= \frac{1}{2}\left(\frac{M}{3}\right)v^2$

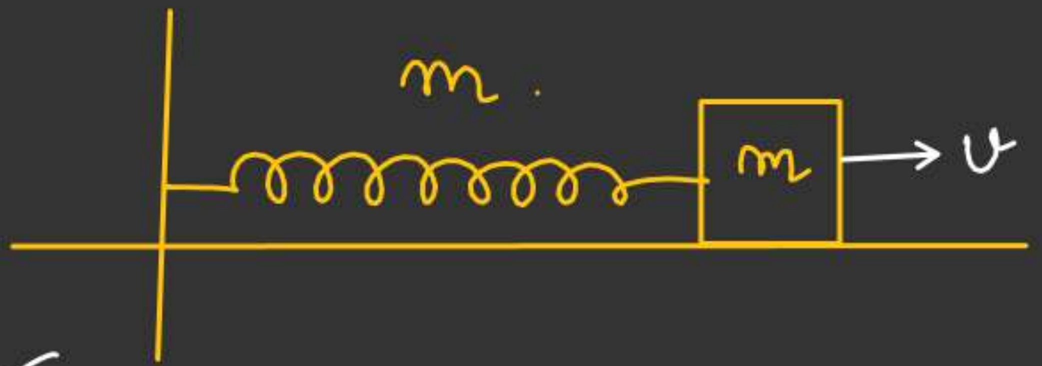
Equivalent System



massless Spring

$K{\cdot}E = \frac{1}{2}\left(\frac{M}{3}\right)v^2$

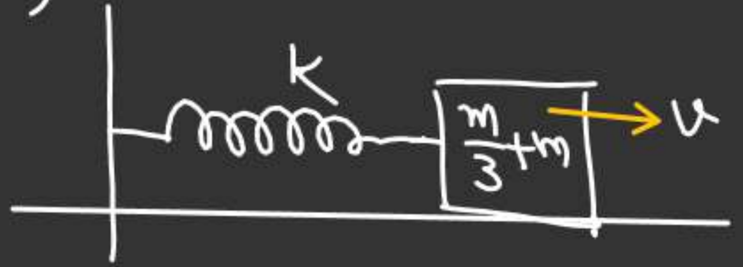
#



Find $K{\cdot}E_{system} = ??$

$K{\cdot}E_{system} = (K{\cdot}E)_{spring} + (K{\cdot}E)_{block}$

Eq. System $= \frac{1}{2}\left(\frac{4m}{3}\right)v^2 = \frac{2m}{3}v^2$ Ans.



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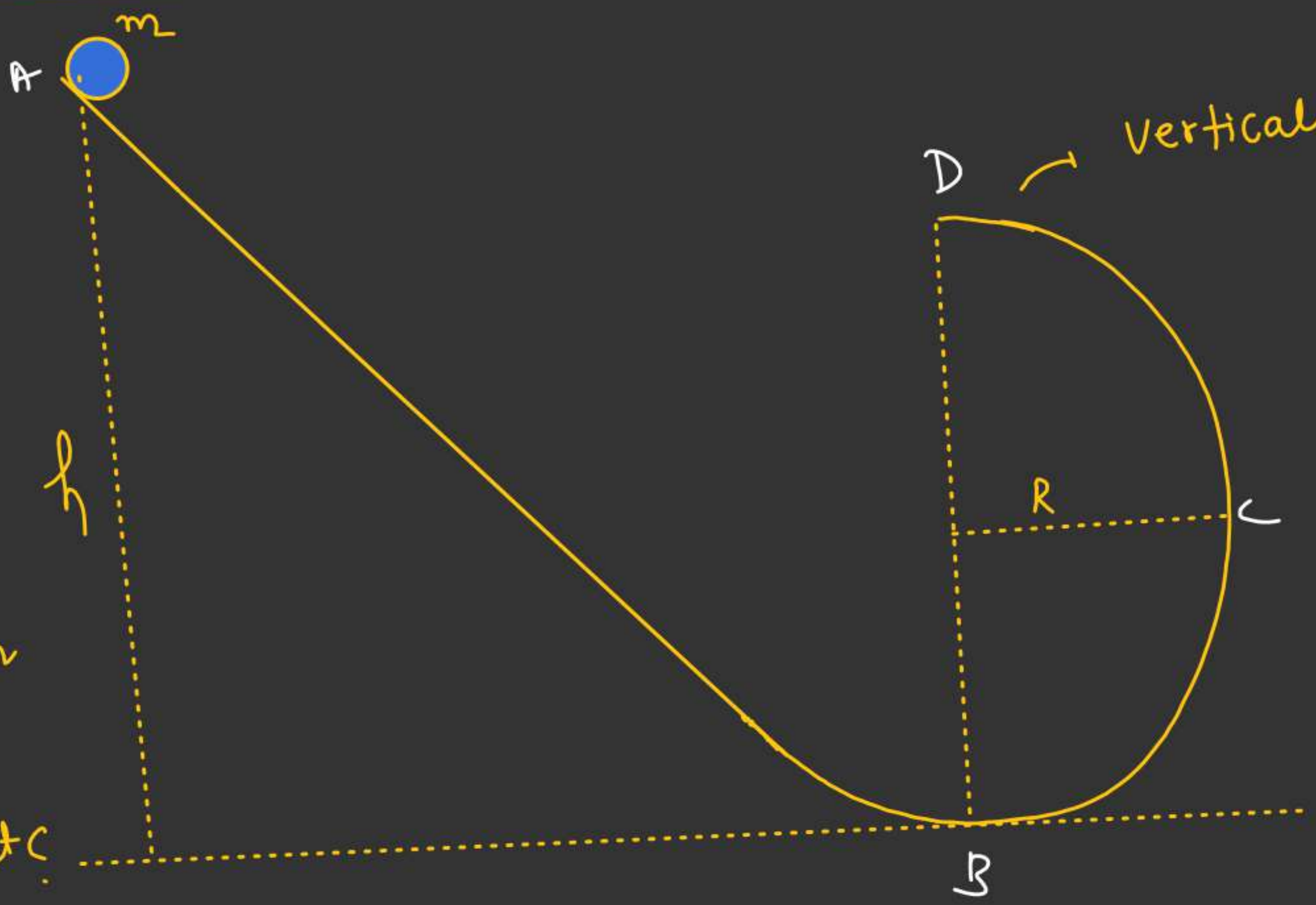
Block on a Smooth Vertical track

Track is Smooth.
Ball is released from rest

1. Find h_{min} so that ball Complete the Vertical track.

2. Find Normal reaction at C under condition on 1st part.

3. Total accleration of ball at C.



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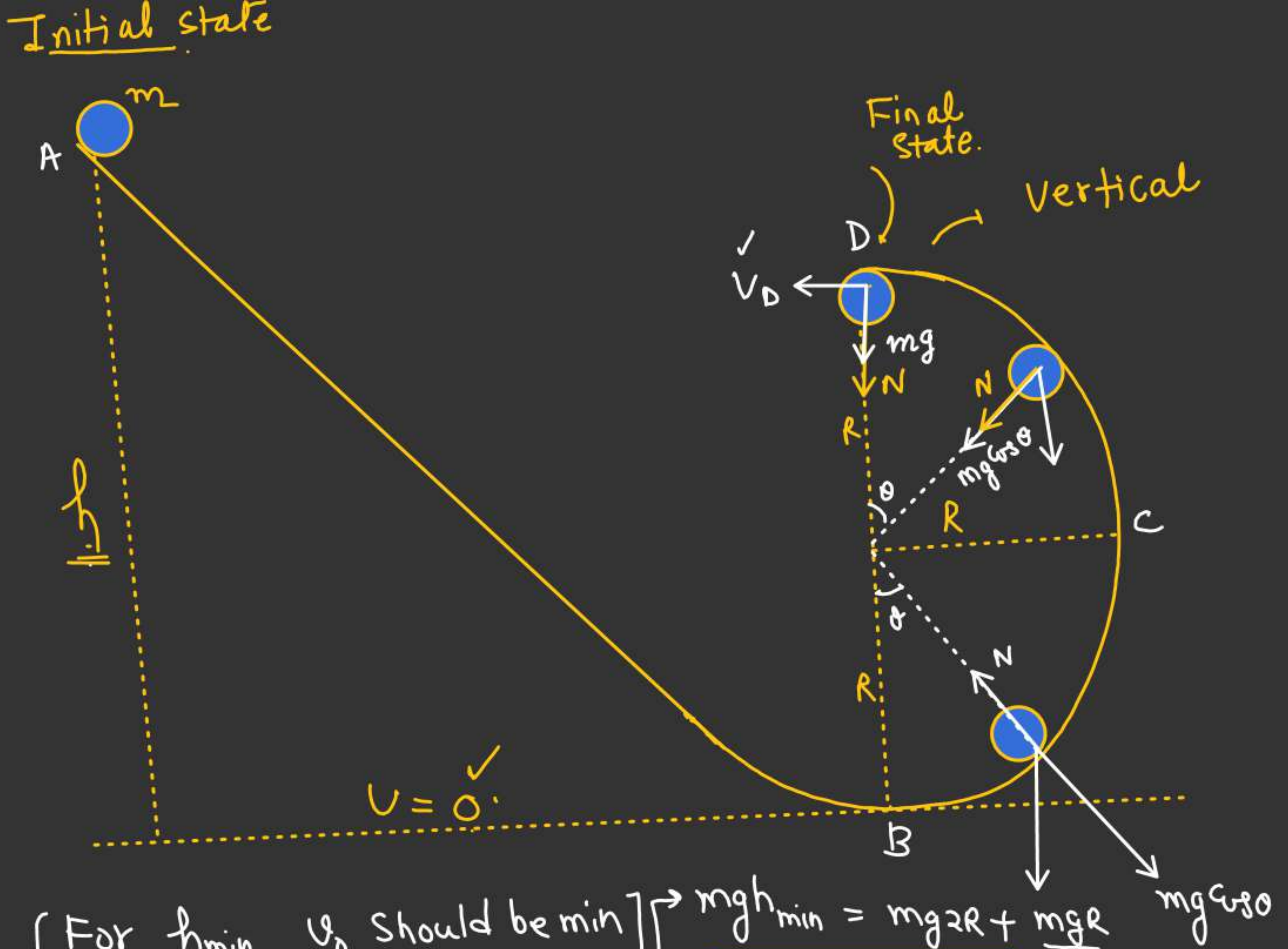
⇒ For BC zone.
$N \neq 0$.

⇒ In CD zone.
N and $mg\cos\theta$ same direction so there is a possibility that ball will loose contact.

⇒ For ball to complete the vertical track its velocity at D Never be zero



By Energy Conservation

$$mgh = mg2R + \frac{1}{2}mv_D^2 \quad (1)$$

Net Centripetal force at D.

$$N + mg = \frac{mV_D^2}{R} \quad (2)$$

$N = 0$

$$mg = \frac{mV_D^2}{R} \Rightarrow mV_D^2 = mgR \rightarrow \text{put in Eq}^n \ (1)$$

[For h_{min}, v_D Should be min and for $(V_D)_{min}$ $N = 0$]

$$mgh_{min} = mg2R + \frac{mgR}{2}$$

$$\boxed{h_{min} = \frac{5R}{2}}$$

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(2)

$$N_c = \frac{mV_c^2}{R}$$

By Energy Conservation.

$$mg\frac{5R}{2} = mgR + \frac{1}{2}mv_c^2$$

$$\frac{5mgR - 2mgR}{\cancel{2}} = \frac{mV_c^2}{\cancel{2}}$$

$$\frac{5R}{2} = h$$

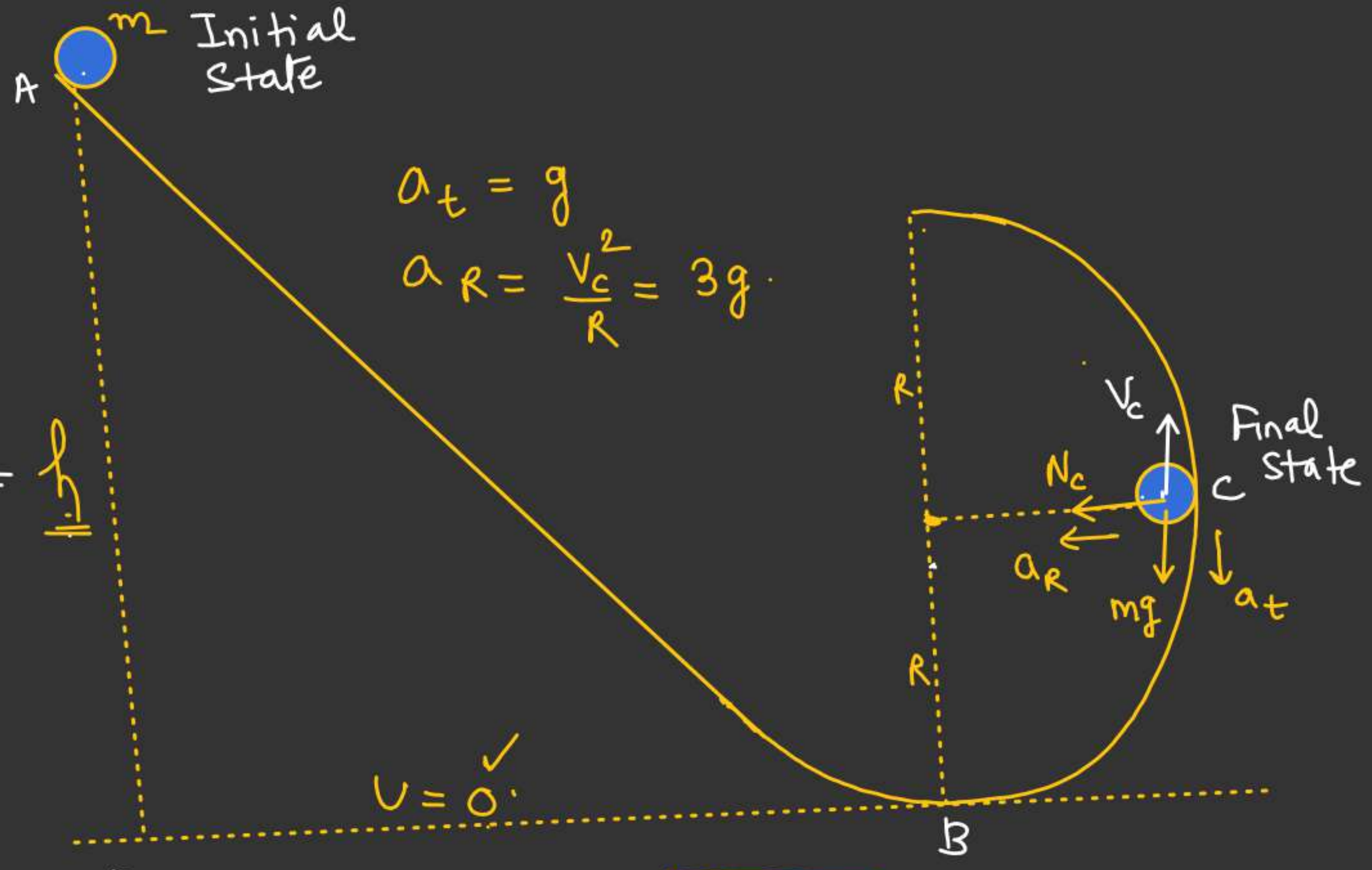
$$3\cancel{m}gR = \cancel{m}V_c^2$$

$$V_c^2 = 3gR$$

$$V_c = \sqrt{3gR}$$

$$N_c = 3mg$$

Initial state



$$a_t = g$$

$$a_R = \frac{V_c^2}{R} = 3g$$

(3) $a_c = ??$ $\Rightarrow$ $a_c = \sqrt{a_t^2 + a_R^2}$

$$= \sqrt{9g^2 + g^2}$$

$$= \sqrt{10}\,g$$