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ENGERGY CONSERVATION

① No non-Conservative force.

② Defined intial & final state

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

③ Choose as refrance potential as zero potential line.

If above zero potential line $U = +mgh$

If below zero potential line $U = -mgh$

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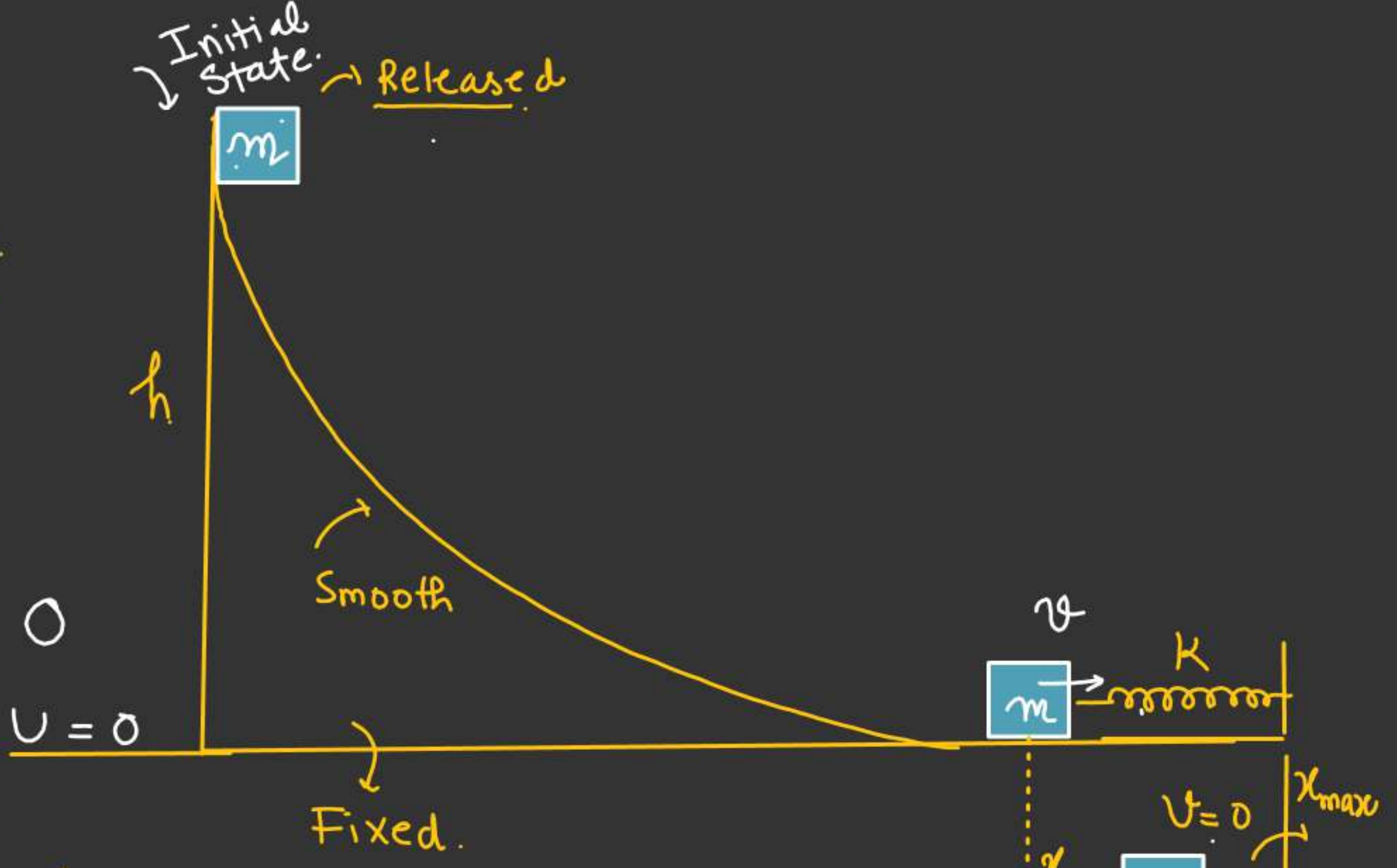
Block is released from rest, Find maximum Compression in the Spring.



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

$$mgh + 0 = [U_{block} + U_{spring}] + 0$$

$$mgh = 0 + \frac{1}{2}kx_{max}^2$$

$$x_{max} = \sqrt{\frac{2mgh}{K}}$$

$$W_{mg} + W_N + W_{springforce} = \Delta K.E$$

$$W_{mg} = -\Delta U = U_i - U_f = mgh - 0$$

$$W_N = 0,$$

$$W_{\substack{spring\\force}} = (-\Delta U) = U_i - U_f = 0 - \frac{1}{2}kx_{max}^2 = -\frac{1}{2}kx_{max}^2$$

$$mgh + 0 - \frac{1}{2}kx_{max}^2 = 0$$

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(b) Find velocity of block if compression in the spring is half of its maximum compression

$$U_i + K.E_i = \underline{U_f} + K.E_f$$

$$\downarrow$$

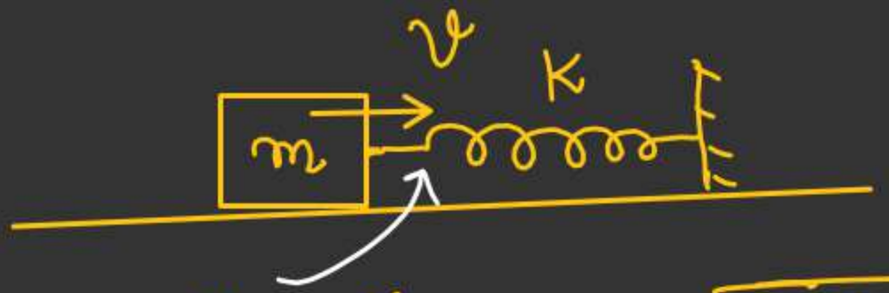
$$mgh + 0 = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$$

$$mgh = \frac{1}{\cancel{2}}\cancel{k} \times \frac{1}{4} \times \left(\frac{\cancel{2}mgh}{\cancel{k}}\right) + \frac{1}{2}mv^2$$

$$mgh - \frac{mgh}{4} = \frac{1}{2}mv^2$$

$$\frac{3}{4}\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$$

$$\underline{v = \sqrt{\frac{3gh}{2}}}$$



$$x = \frac{x_{max}}{2} = \frac{1}{2}\sqrt{\frac{2mgh}{K}}$$

$$\Downarrow$$

Compression in Spring (given)

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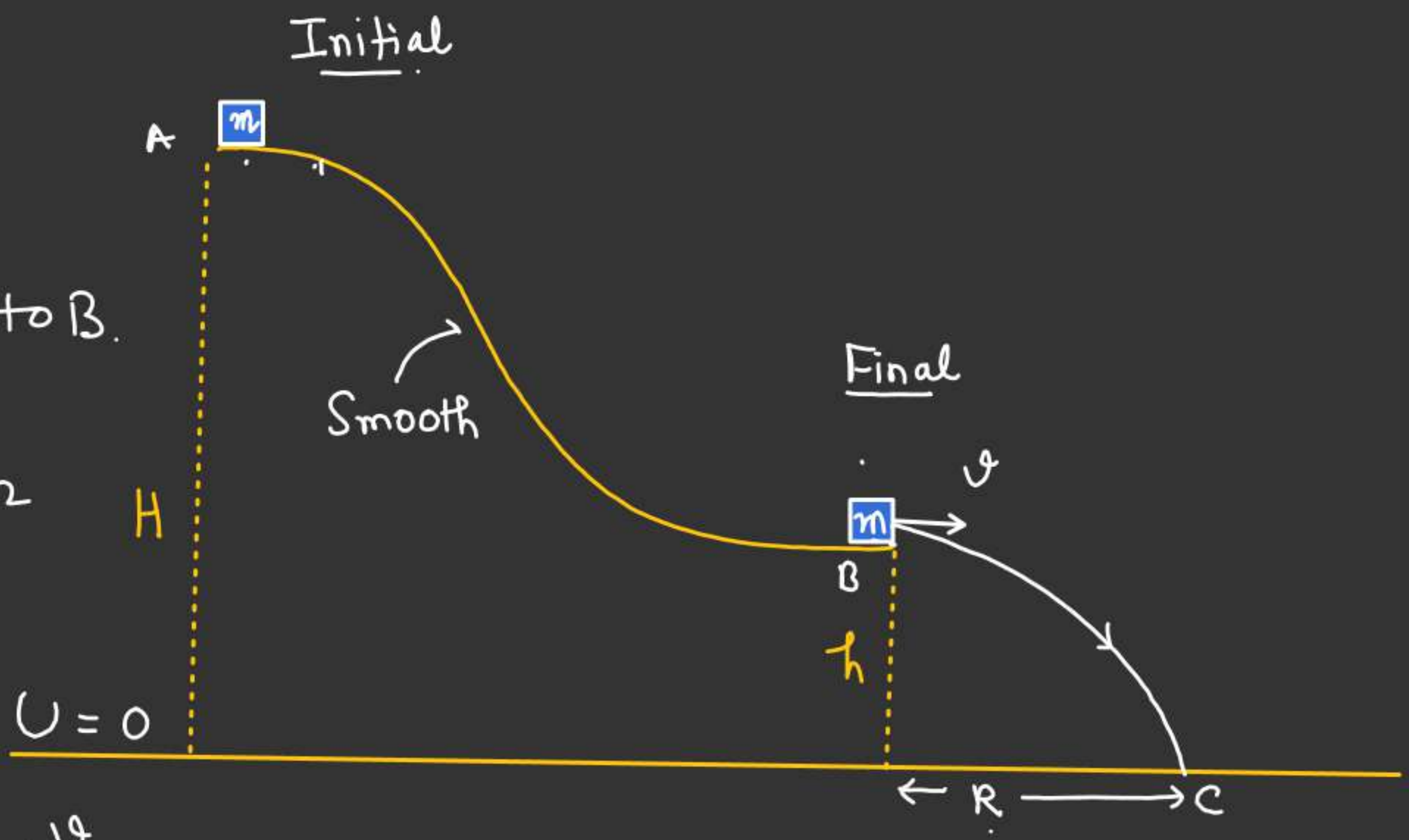
\# Block is released from rest
Find the value of $\underline{h}$ for maximum range.



Energy Conservation from A to B.

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

$$mgH + 0 = mgh + \frac{1}{2}mv^2$$

$$mg(H-h) = \frac{1}{2}mv^2$$

$$v = \sqrt{2g(H-h)}$$

$$t_{BC} = \sqrt{\frac{2h}{g}}$$

$$h = \frac{1}{2}g t_{BC}^2$$

$$R = t_{BC} \cdot v$$

$$R = \sqrt{\frac{2h}{g}}\sqrt{2g(H-h)}$$

$$R = 2\sqrt{h(H-h)}$$

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$$R = 2\sqrt{h(H-h)}.$$

For R to be maximum, or minimum.

$$\frac{dR}{dh} = 0$$

$$2\frac{d}{dh}\left(\sqrt{Hh-h^2}\right) = 0$$

put $Hh-h^2 = t$.

$$\frac{d}{dh}\sqrt{t} = \frac{d}{dt}\sqrt{t} \times \frac{dt}{dh}$$

$$= \frac{1}{2\sqrt{t}}(H-2h)$$

$$= \left(\frac{H-2h}{2\sqrt{Hh-h^2}}\right)$$

$$\frac{H-2h}{2\sqrt{Hh-h^2}} = 0$$

$$h = \frac{H}{2} \quad \text{Ans}.$$

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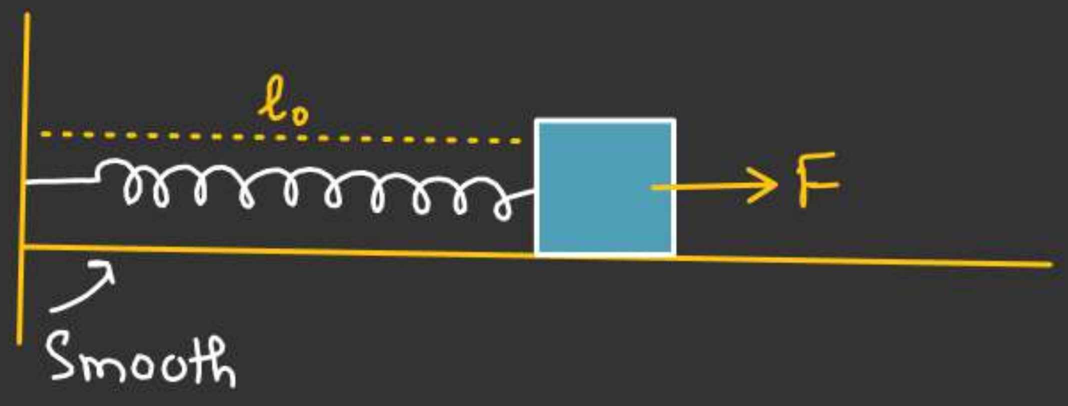
Q.

l_0 = Natural length of the Spring

k = Spring Constant.

Block pulled by a Constant force F. when Spring at its natural length.



① Find x_{max} i.e Maximum elongation in the Spring.

② Find v_{max} of the block.

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M-1. By Force Concept

At Equilibrium.

$$F = Kx$$

$$x = \left(\frac{F}{K}\right)$$

$$x_{max} = 2x = \left(\frac{2F}{K}\right)$$

Work-Energy theorem.

$$W_F + W_{spring\,force} + \cancel{W_N}^{\,0} + \cancel{W_{mg}}^{\,0} = \Delta K.E$$

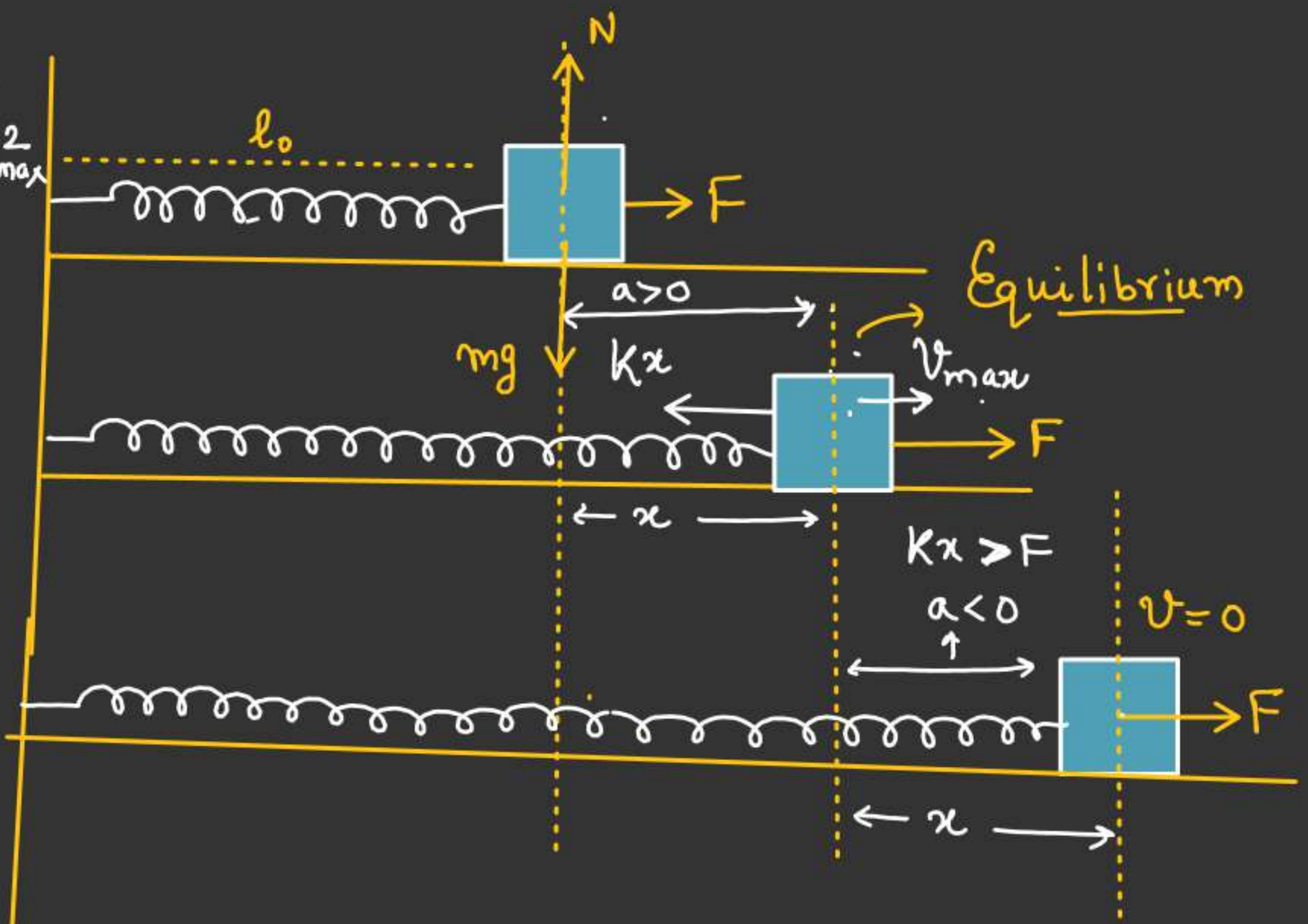
For Maximum elongation block must be at rest at that Moment

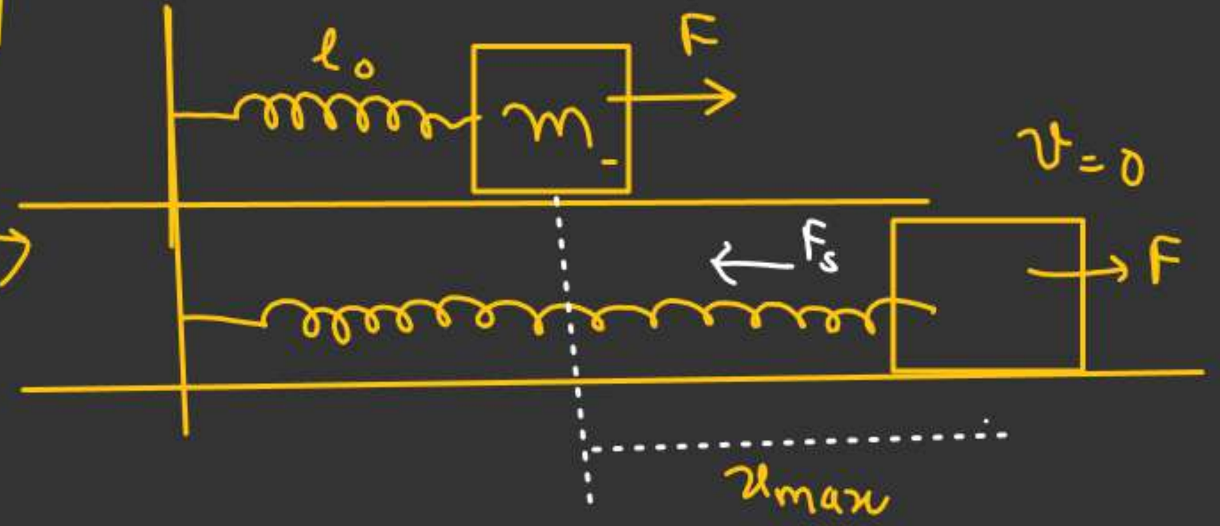
$$\Delta K.E = K.E_f - K.E_i$$
$$= 0$$

$$Fx_{max} - \frac{1}{2}Kx_{max}^2 = 0$$

$$x_{max} = \left(\frac{2F}{K}\right).$$

$$W_{spring} = -\Delta U$$
$$= U_i - U_f$$
$$= 0 - \frac{1}{2}Kx_{max}^2$$





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For $v_{max} = ??$

v_{max} always at Equilibrium position.

At $x = \left(\frac{F}{K}\right)$ Equilibrium.

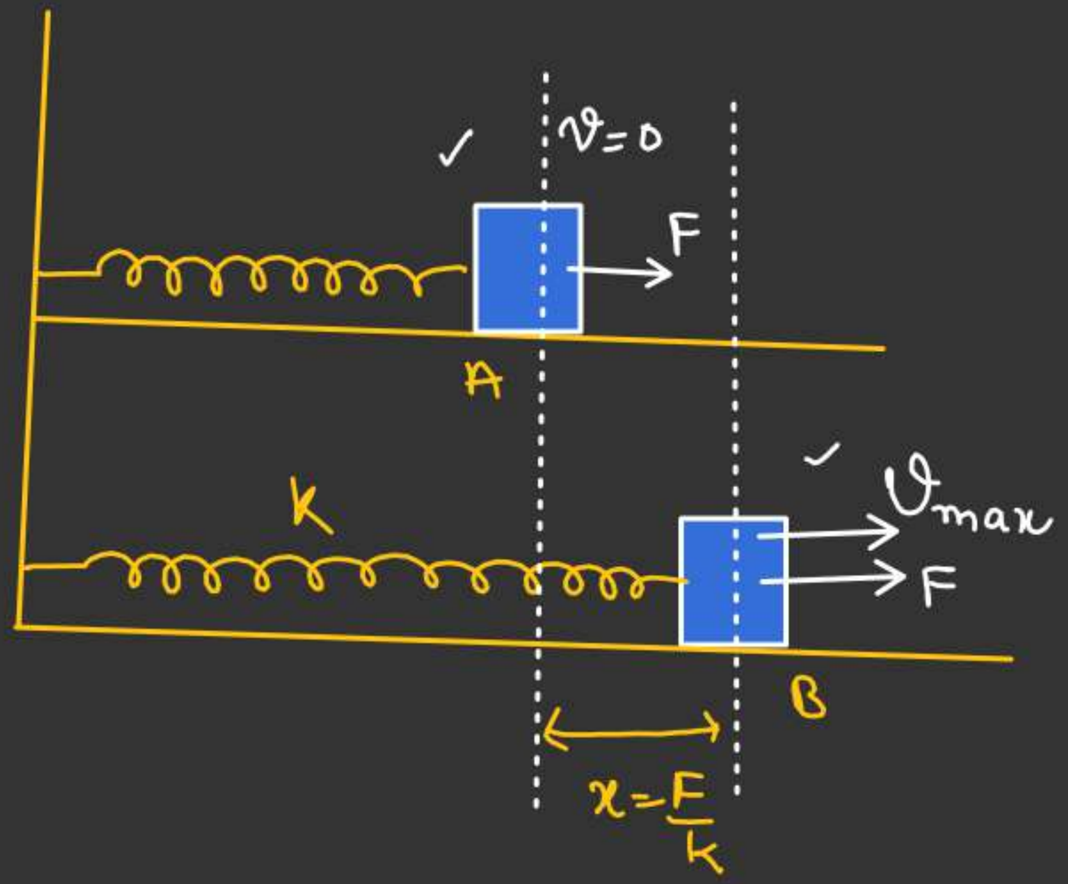
Work-Energy theorem from A to B.

$$W_F + W_{spring} = \Delta K.E$$

$$F \cdot \left(F/K\right) - \frac{1}{2}K\left(\frac{F}{K}\right)^2 = \frac{1}{2}mv_{max}^2 - 0$$

$$\frac{F^2}{K} - \frac{F^2}{2K} = \frac{1}{2}mv_{max}^2$$

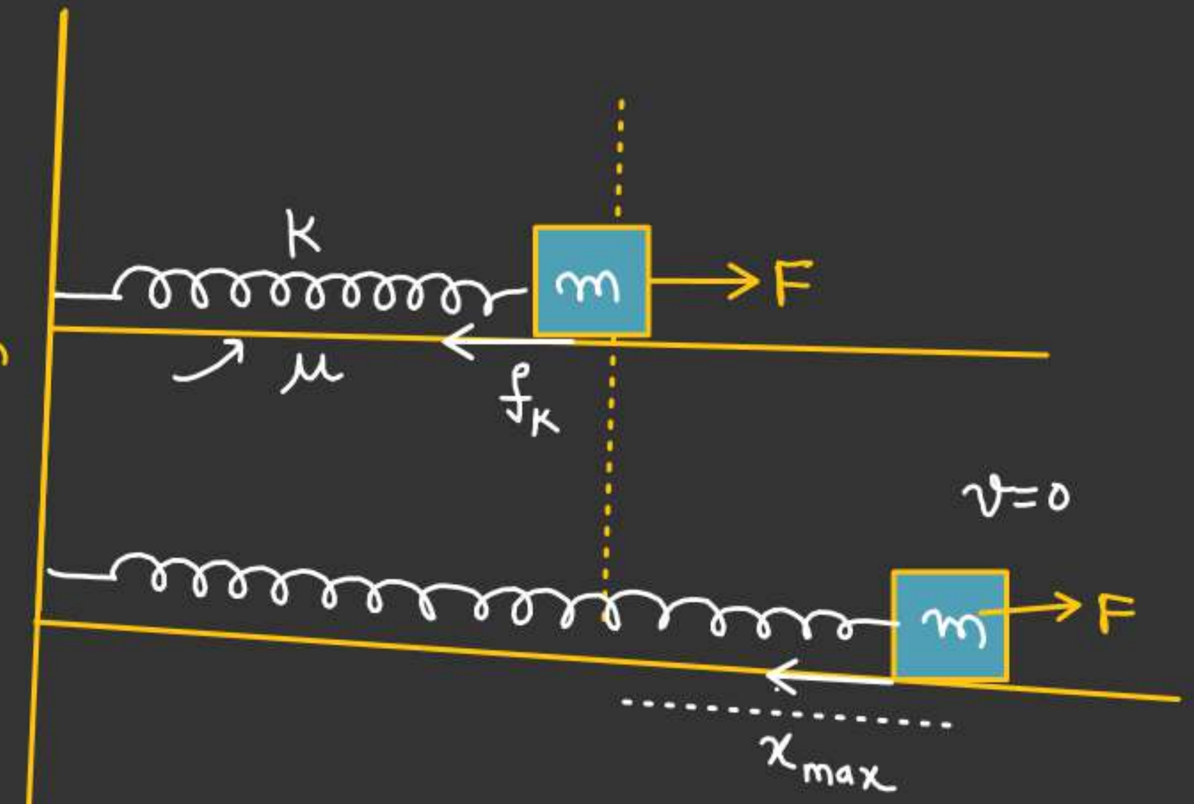
$$\frac{1}{2}mv_{max}^2 = \frac{F^2}{2K} \Rightarrow \left[v_{max} = \frac{F}{\sqrt{mK}}\right] ✓$$



Block is pulled by constant force F when spring at its natural length.

Find a) $x_{max} = ?$ $\Rightarrow$ Maximum elongation in the spring.

b) $v_{max} = ?$



By work- Energy theorem

$$W_F + W_{f_K} + W_{spring} = \Delta K.E$$

$$F \cdot x_{max} - \mu mg \cdot x_{max} - \frac{1}{2} K x_{max}^2 = 0$$

$$F - \mu mg = \frac{1}{2} K x_{max}$$

$$x_{max} = \left[\frac{2(F - \mu mg)}{K} \right] \text{ Ans.}$$

$$W_{spring} = -\Delta U$$
$$= U_i - U_f$$
$$= 0 - \frac{1}{2} K x_{max}^2$$

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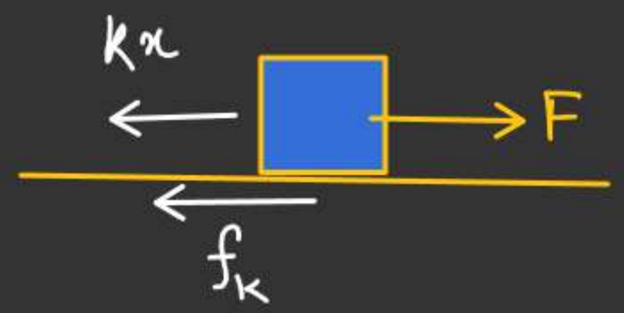
For v_{max}

At Equilibrium



$$F = Kx + f_k$$

$$F = Kx' + \mu mg$$

$$\frac{F - \mu mg}{K} = \underset{\Downarrow}{x}$$

elongation at Equilibrium

Work-Energy theorem

$$W_F + W_{spring} + W_{f_k} = \Delta K.E$$

$$F \cdot x - \frac{1}{2}Kx^2 - \mu mgx = \frac{1}{2}mv_{max}^2 - 0$$

$$F\left(\frac{F-\mu mg}{K}\right) - \frac{1}{2}\cancel{K}\frac{(F-\mu mg)^2}{\cancel{K^2}} - \mu mg\left(\frac{F-\mu mg}{K}\right) = \frac{1}{2}mv_{max}^2$$

$$\left(\frac{F-\mu mg}{K}\right)\left[F - \left(\frac{F-\mu mg}{2}\right) - \mu mg\right] = \frac{1}{2}mv_{max}^2$$

$$\frac{(F-\mu mg)^2}{\cancel{2}K} = \frac{1}{\cancel{2}}mv_{max}^2 \Rightarrow v_{max} = \sqrt{\frac{(F-\mu mg)^2}{mK}}$$

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H.W.

H.C. Verma

Q. No (1 to 21)

Q. No (31 to 37)

Q- No (40 to 43)

Q. No (47, 48, 51)