E&M2

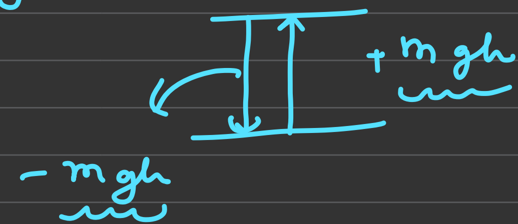
VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

Energy:

Kinetic Energy # : $\frac{1}{2}mv^2$

Potential Energy #

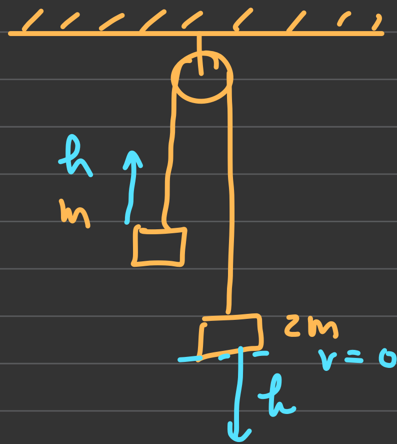


Law of Conservation of Energy: (Total energy conserve)

$$\text{Loss} = \text{gain}$$

$$\text{loss}_1 + \text{loss}_2 = \text{gain}_1 + \text{gain}_2 + \text{gain}_3$$

Ex: " final − initial = change "



released from rest

find speed of blocks when 2m mass goes down with h Height ?

gain = final − initial

loss = initial − final

loss in Potential Energy = gain KE of m and 2m + gain Pot of m

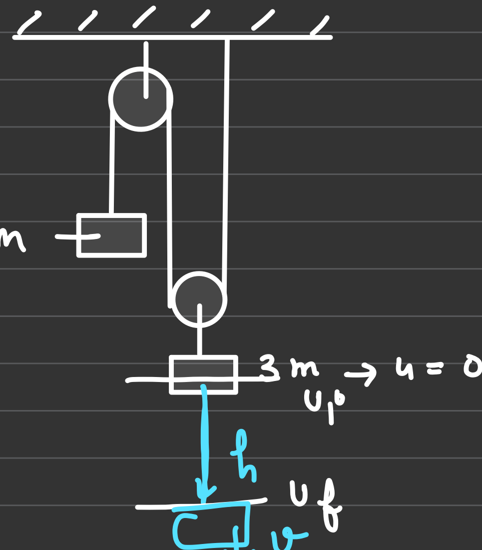
$$\Rightarrow 2mgh = mgh + \frac{1}{2}mv^2 + \frac{1}{2}(2m)v^2$$

$$\Rightarrow mgh = \frac{1}{2}m\left\{v^2 + 2v^2\right\}$$

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

$$\Rightarrow \boxed{\sqrt{\frac{2gh}{3}} = v}$$

Q)



System Released from rest

find speed of m and 3m ?

when "3m goes" down by 'h'

{# loss in GPE of 3m = gain in GPE m + gain KE of m and 3m

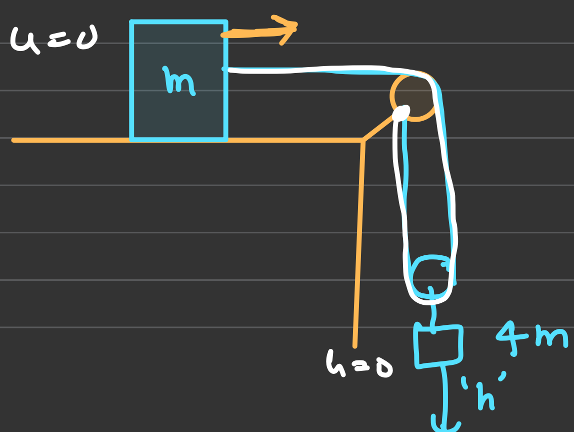
#

$$3mgh = mg(2h) + \left\{\frac{1}{2}3m(v^2)\right\} + \left\{\frac{1}{2}m(2v)^2\right\}$$

$$mgh = \frac{1}{2}m\left[3v^2 + 4v^2\right]$$

$$\boxed{\sqrt{\frac{2gh}{7}} = v}$$

Q)



"Smooth surface"

released from rest

when 4m goes down by h then find speed of 4m and m?

loss in PE of "4m" = gain in KE of 4m and m

$$4mgh = \frac{1}{2}4m(v)^2 + \frac{1}{2}m(2v)^2$$

$$4mgh = 2mv^2 + 2mv^2$$

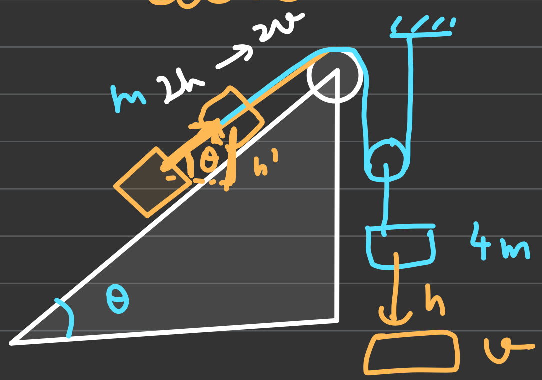
$$4mv^2 = 4mgh$$

$$v = \sqrt{gh}$$

Q) "Smooth surface"

System Released from rest.

find speed of 4m and m when 4m goes down by 'h'



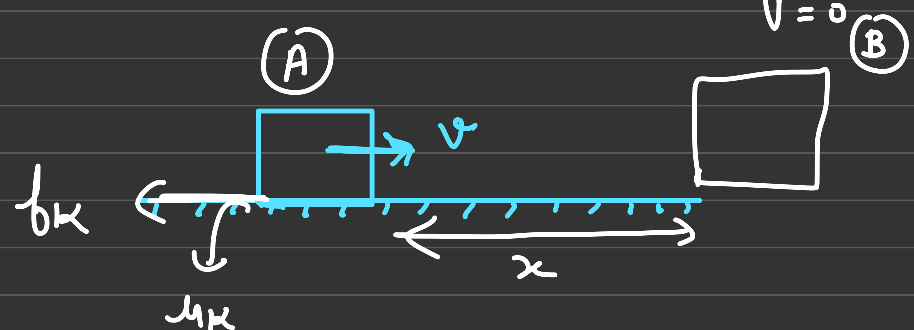
$$\sin\theta = \frac{h'}{2h}$$

$\Rightarrow$ loss in GPE of 4m = gain GPE of m + gain KE of m and 4m

$$\Rightarrow \left\{ 4mgh = mg(\underbrace{2h \sin\theta}) + \frac{1}{2}4m(v)^2 + \frac{1}{2}m(2v)^2 \right\}$$

$v =$

friction:



loss in KE = work done against friction

$$\underline{\underline{\frac{1}{2}mv^2}} = \underline{f_k \times [\text{Distance of Slipping}]}$$

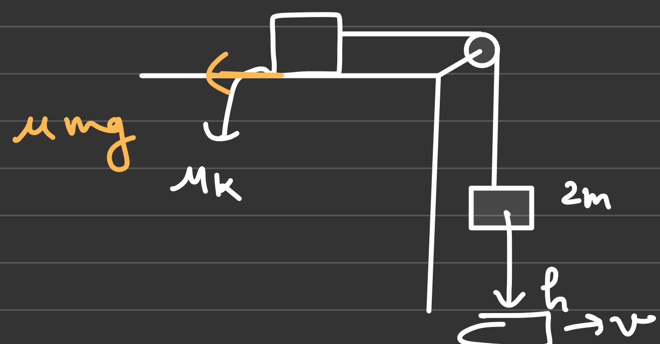
$$\frac{1}{2}\cancel{m}v^2 = \mu_k \cancel{m}g\,[x]$$

$$v^2 = 2\mu_k g x$$

=

Speed of 2m and 'm'

θ



loss in GPE of '2m' = "gain in KE of m and 2m"

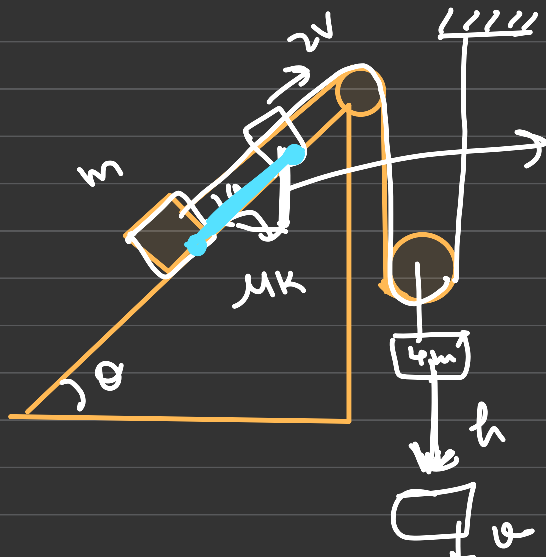
+ work done against friction

$$\# \quad 2mgh = \frac{1}{2}2m(v^2) + \frac{1}{2}m(v)^2 + \{f_k\{\text{dist slipping}\}\}$$

$$2mgh = \cancel{m}v^2 + \frac{1}{2}\cancel{m}v^2 + \mu_k mg\{h\}$$

Speed of m and 4m?

θ)



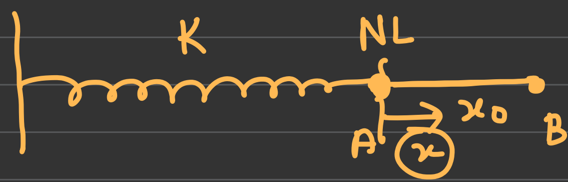
{ loss GPE of 4m = gain in KE of 4m and m + gain PE of m + work done against friction

$$4mgh = \frac{1}{2}4m(v^2) + \frac{1}{2}m(2v)^2$$
$$+$$

$mg(2h\sin\theta) + \left\{\mu_k mg\cos\theta \times 2h\right\}$

Spring Potential Energy:

a) elongation:



"work done by ext agen from A to B slowly is called change in spring Pot. Energy"

\# $W_{ext} = \Delta U + \cancel{\Delta K}$ 0

$W_{ext} = \Delta U \longrightarrow A \to B$

$\int_0^{x_0} Kx\,dx = U_B - U_A$ $F = kx$

$+\frac{1}{2}kx_0^2 = U_B - \cancel{U_A}$ 0

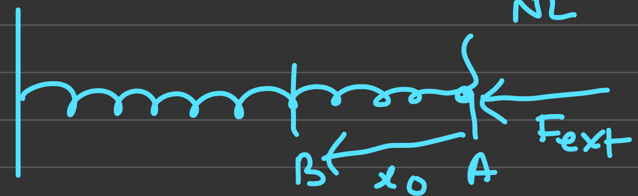
gain

$U_B = \frac{1}{2}kx_0^2$

b) Compress:

NL

Slowly



$$W_{ext} = (\Delta U) \qquad F_{ext} = kx$$

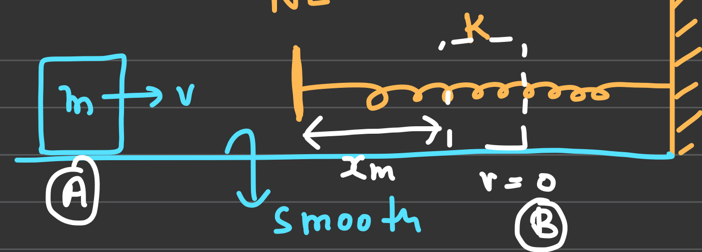
$$\int_0^{x_0} kx\,dx = (\Delta U)$$

$$\frac{1}{2}kx_0^2 = U_B - \cancel{U_A}\,0$$

$$U_B = +\frac{1}{2}kx_0^2$$

Q)

a)



(i) find maximum compression in Spring?

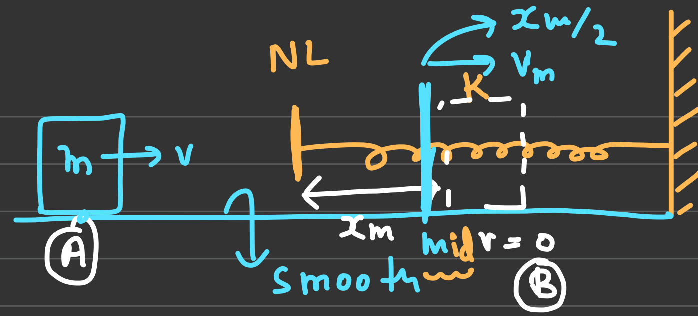
(i) $A \rightarrow B$ {Law of Cons. of Energy}

$$\left\{\frac{1}{2}mv^2 - 0\right\} = \left\{\frac{1}{2}kx_m^2 - 0\right\}$$

$$x_m = \sqrt{\frac{mv^2}{k}} = \left\{v\sqrt{\frac{m}{k}}\right\}$$

max. compression

(ii) find speed of m when compression is half of maximum compression?



$\left(\frac{x_m}{2}\right)$

(i) $A \longrightarrow m$ { moving Rightward }

$$\frac{1}{2} m (v^2) - \frac{1}{2} m (V_m)^2 = \left\{\frac{1}{2} K \left(\frac{x_m}{2}\right)^2 - 0\right\}$$

$$\boxed{\frac{1}{2} m (v^2) - \frac{1}{2} m V_m^2 = \frac{1}{2}\frac{K}{4}\left\{\frac{v^2 m}{K}\right\}}$$

Ans

(ii) B – m (moving leftward)

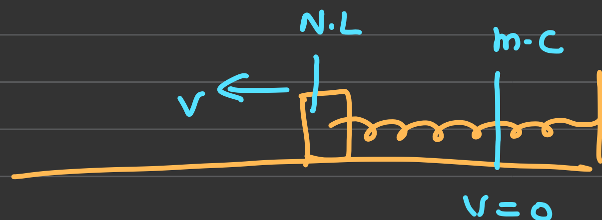
loss in Spring PE = $\left(\frac{1}{2} m V_m^2 - 0\right)$

$$\underbrace{\frac{1}{2}Kx_m^2 - \frac{1}{2}K\left(\frac{x_m}{2}\right)^2} = \underbrace{\frac{1}{2}mv_m^2 - 0}$$

$V_m =$

(iii)

find speed of block when leaving the spring



$\underbrace{m.C \to N.L}$

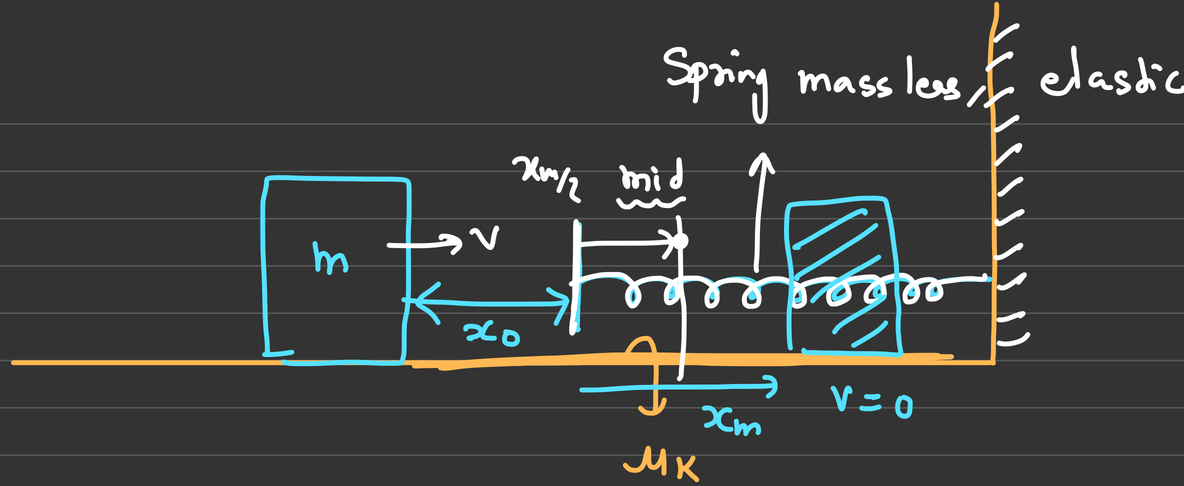
$$\left(\frac{1}{2}kx_m^2 - 0\right) = \left\{\frac{1}{2}mv_L^2 - 0\right\}$$

$$\left\{v_L = \underbrace{\sqrt{\frac{k}{m}}\cdot x_m}\right\}$$

$$V_L = \sqrt{\frac{K}{\cancel{m}}} \cdot v \cdot \sqrt{\frac{\cancel{m}}{k}}$$

$V_L = v$ speed

8)



(i) find maximum compression of spring?

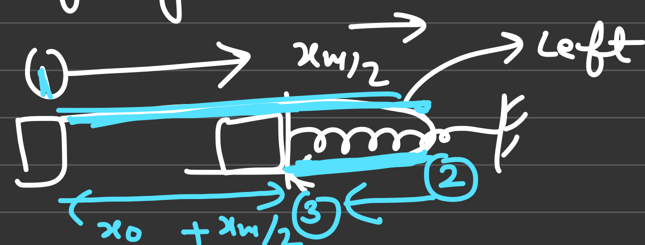
loss in KE of block = gain spring P.E + work done against friction

$$\left(\frac{1}{2} m v^2 - 0\right) = \left(\frac{1}{2} K x_m^2 - 0\right) + f_K \times \text{distance of slipping}$$

$$\frac{1}{2}mv^2 = \frac{1}{2}kx_m^2 + \mu_k mg\{x_0 + x_m\}$$

(ii) find Speed of block when Compression Half of max. Compression?

a) when going right



$$\Rightarrow \frac{1}{2}mv^2 - \frac{1}{2}mv_m^2 = \frac{1}{2}k\left(\frac{x_m}{2}\right)^2 + \mu_k mg\left(x_0 + \frac{x_m}{2}\right)$$

??

b) when going leftward: (① − ③)

$$\Rightarrow \frac{1}{2} m v^2 - \frac{1}{2} m v_m^2 = \left\{ \frac{1}{2} K \left(\frac{x_m}{2}\right)^2 - 0 \right\} + \underset{\text{friction}}{\text{w.D}}$$

$$\Rightarrow \frac{1}{2} m v^2 - \frac{1}{2} m v_m^2 = \frac{1}{2} K \left(\frac{x_m}{2}\right)^2 + \underline{\{\mu_K m g\}\left\{ x_0 + \frac{3}{2} x_m \right\}}$$

2 − 3

$$\left\{ \frac{1}{2} K x_m^2 - \frac{1}{2} K \left(\frac{x_m}{2}\right) = \left(\frac{1}{2} m v_m^2 - 0\right) + \mu_K m g \left(\frac{x_m}{2}\right) \right\}$$

Pre-class → {Vertical Circular motion
momentum Conservation}

#

{ DTs # → 1 → Level 1
→ 1 → Level 2 }

dill { INE A ⟶