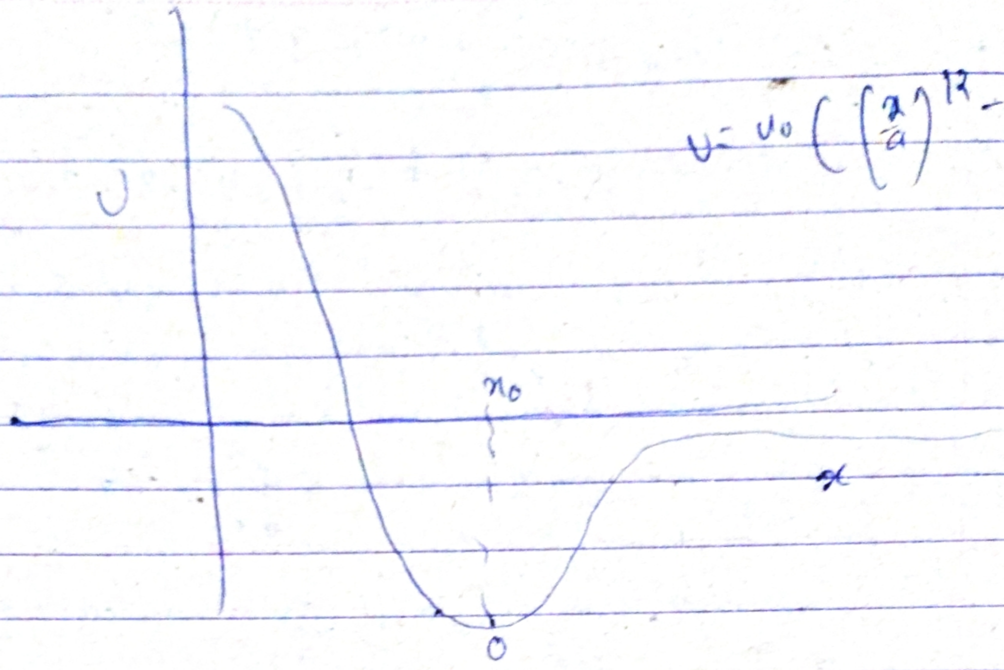


$U = U_0\left(\left(\frac{x}{a}\right)^{12} - 12\left(\frac{x}{b}\right)^{6}\right)$

Q. $U = x^4 - 5x^2$

$F = -(4x^3 - 10x)$

$4x^3 = 10x$ $x = 0$

$x^2 = 2.5$

$x = \pm\sqrt{2.5}$

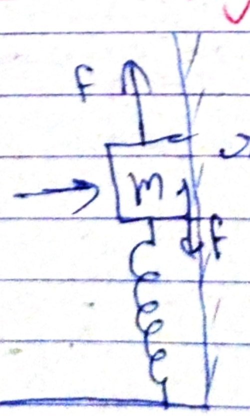
$\frac{d^2U}{dx^2} = 12x^2 - 10$

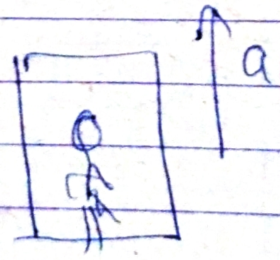
at 0 $U < 0$ unstable

at $\sqrt{2.5}$ ↘ $U > 0$ stable
at $\sqrt{2.5}$ ↗

Work energy theorem

W.E. theorem is very useful in finding the work done by a force whose exact nature is not known to us or find the work done by a variable force whose exact variation is not known to us.





$F_{net} = ma$

$\underbrace{F_{ext} + F_g + F_s}_{C.V.} + F_f + F_{seodo} = m\frac{udv}{dx}$

$$\int F_{net}\, dx = \int m v\, dv$$

$$\boxed{WD_{ext} + WD_{conse.} + W.D._{non\,cons.} + W.D._{seudo} = K_f - K_i}$$

$$WD_{ext} + WD_{non\,con} + WD_{seudo} = (K_f + U_f) - (K_i + U_i)$$

If this is 0

i.e. only conservative force are

then $\boxed{KE_i + U_i = KE_f + U_f}$

$$\{ \because WD_c = -(U_f - U_i) \}$$

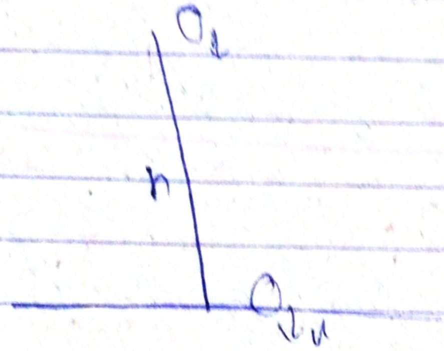
★ work - energy theorm लगाते समय यह ध्यान रखना चाहिए कि work done और K.E same frame पर ली की जाए (क्योंकि दोनों frame पर depend करते हैं) हम work-energy theorem non inertial frame में भी लगा सकते हैं अगर हम seudo का work done count कर ले!

$$W.D_{nc} + W.D_{ext} = \underbrace{(K_f + U_f) - (K_i + U_i)}_{\text{Mechanical energy}}$$

$$\boxed{E = U + K}$$

if only conservative forces are then $\boxed{KE_f + U_f = KE_i + U_i}$

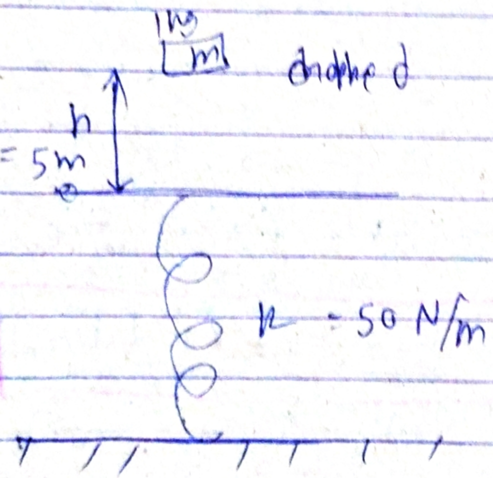
ex.



$mgh + 0 = \frac{1}{2}mu^2 \cancel{+} 0$

$u = \sqrt{2gh}$

ex.



max ~~energy~~ in spring compression

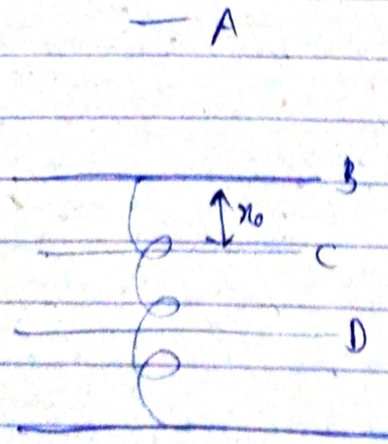
$mgh \cancel{+} \cancel{0} = \frac{1}{2}kx^2 - mgx$

$50 = 25x^2 - 10x$

$\cancel{}\ 10 = 5x^2 - 2x$

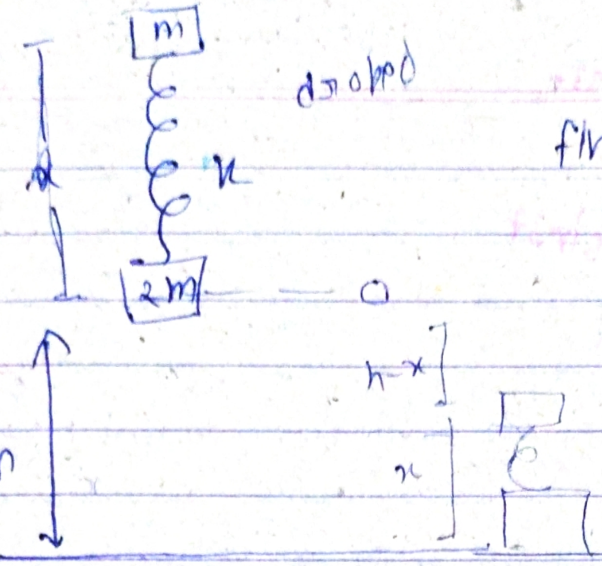
$5x^2 - 2x - 10 = 0$

$$\frac{2 \pm \sqrt{4 + 200}}{10}$$



$mg = kx$

Q.



find out the value of h such that 2m will lift up again.

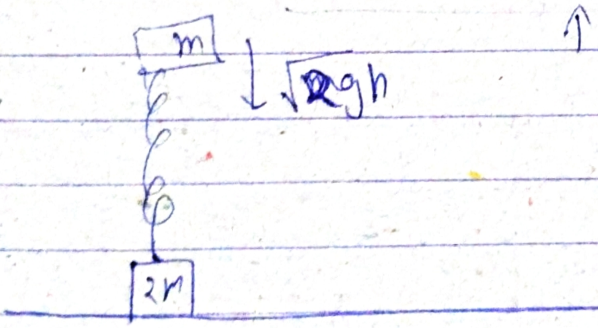
(p=0)

~~mgx~~ = ~~-2mgh ± mg(h-x)~~

~~m/+x = -2mg h - mgh + mgx~~ 2mg=…

$mgx = \cancel{\tfrac{1}{2}}\ -2mgh - \cancel{mg(h-x)}$

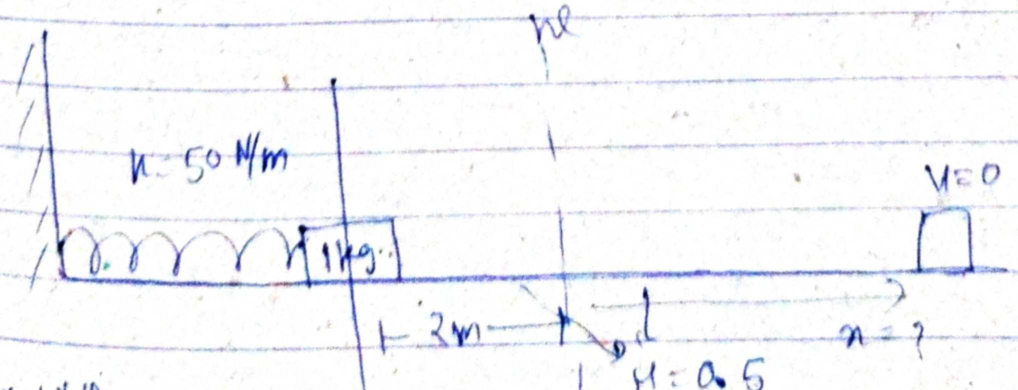
$x = \frac{2mg}{k}$



$$0+0+\frac{1}{2}m\,2gh = \overset{3}{\cancel{\tfrac{1}{2}}}\,mg\frac{2mg}{k} + \frac{1}{2}k\frac{4m^2g^2}{k^2}$$

+0

Q.



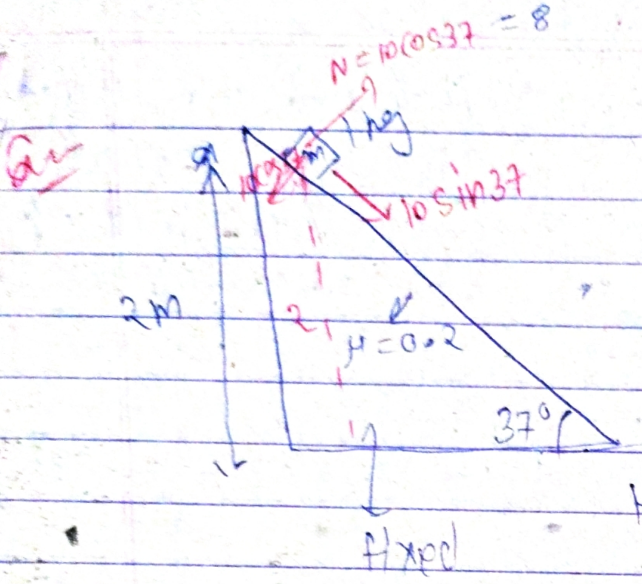
f = 0.5 × 1 × 10

= 5

$\overset{2}{\cancel{10}} \times \frac{4}{\cancel{5}} = 8$

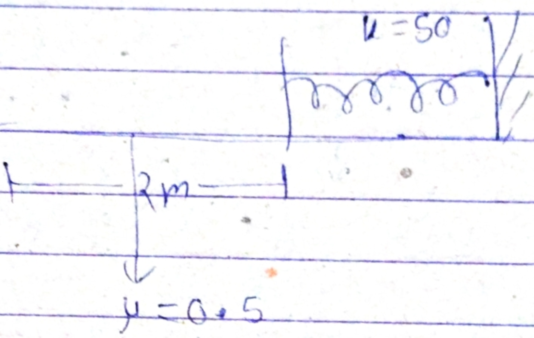
$f = 0.2 \times 8$
$= 1.6$

Qu



$\frac{3}{5} = \frac{2}{x}$

$x = \frac{10}{3}$

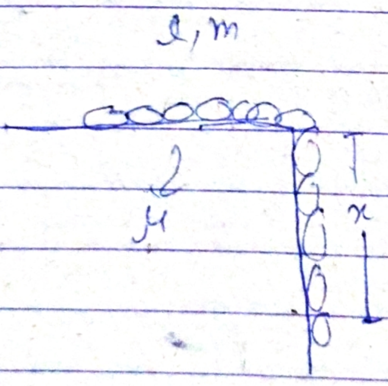


Find maxm compression in spring

Solve.

$$-\left(\frac{10}{3} \times 1.6\right) - 5(2+x) = 0 + \frac{1}{2} \times 50 \times x^2$$
$$- 0 - 2 \times 1 \times 10$$

Ex

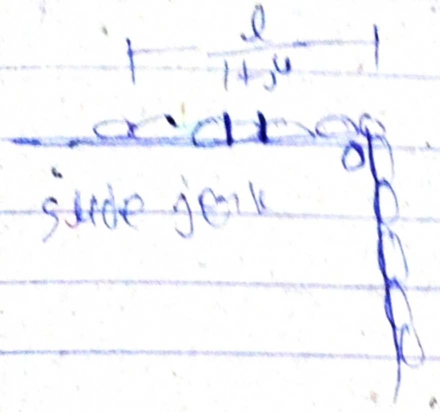


Find out minimum value of l so that chain in equilibrium.

$$\frac{\cancel{m}}{\cancel{l}} \times x \times \cancel{g} \times \cancel{x} = \mu \cancel{g}\left((l-x) \times \frac{\cancel{m}}{\cancel{l}}\right)$$

$$x^2 = \mu l - \mu x$$
$$x^2 + \mu x - \mu l = 0$$
$$\frac{-x \pm \sqrt{x^2 + 4\mu l}}{2}$$
$$\frac{-\mu \pm \sqrt{\mu^2 + 4\mu l}}{2}$$

$$x = \mu l - \mu x$$
$$x(1+\mu) = \mu l$$
$$x = \frac{\mu l}{1+\mu}$$
$$l - x = \frac{l}{1+\mu}$$



find out the work doe by friction when chain become verticle

$$W_f \; -\left(mg\frac{l}{2}\right) + \; -\left(\overset{k_i}{0} \cancel{+} \overset{U_i}{\frac{mg}{2}\,\frac{\mu l}{1+\mu}}\right)$$

$$\text{work by friction} \int dF = -\int_0^{\frac{l}{1+\mu}} \mu \frac{M}{l}\, dx\, g \cdot x$$

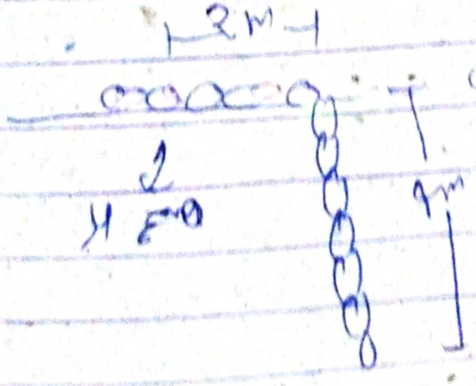
find out speed of chain when it becomes verticle.

$$-\frac{\mu mg l}{2(1+\mu^2)} = \left(\frac{1}{2}mu^2 \cancel{+} - mg\frac{l}{2}\right) - \left(0 + \right.$$

$$\frac{m}{l}\,\frac{\mu l}{(1+\mu)} \cdot g\,\frac{\mu l}{1+\mu} \times \frac{1}{2}$$

M=12kg

Qus

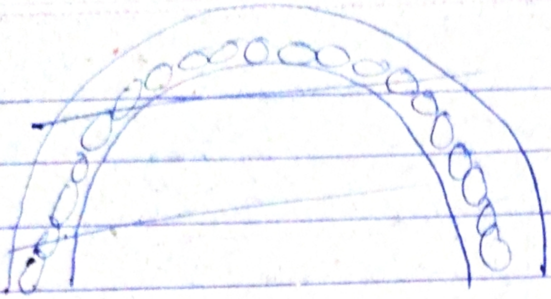


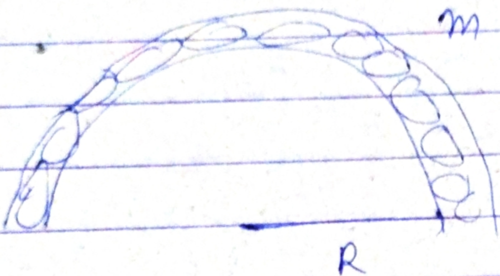
find speed when chain becomes verticle

$$0 \cancel{4} - \left(\frac{12}{6}\times 4\right)\times 10 \times 2 = \frac{1}{2}\times 12\, u^2 - 12\times 10$$

$u = \frac{10}{\sqrt{3}}$ Ans

ex.





jerk (chota sa)

find out speed when it become vertical

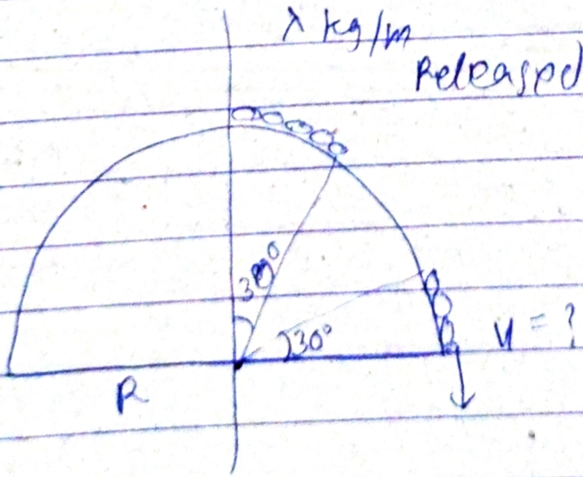
$$0 + \frac{\cancel{m}g2R}{\pi} = \frac{1}{2}\cancel{m}u^2 - \frac{\cancel{m}g\pi R}{2}$$

πR

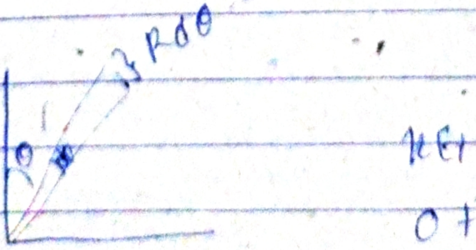
$$5\pi R + \frac{20R}{\pi} = \frac{u^2}{2}$$

$$10\pi R + \frac{40R}{\pi} = u^2$$

ex.



$$dP = \int_0^{\pi/6} \lambda R\, d\theta\, g \sin\theta$$



$KE_i + UE_i = KE_f + U$

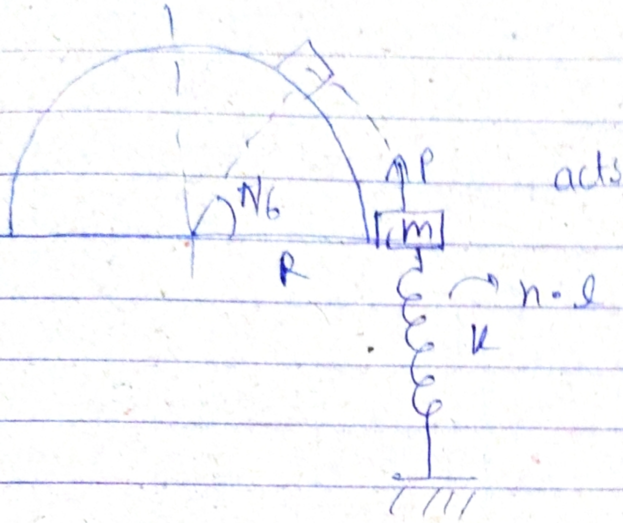
$0 + UE_i = \frac{1}{2}mu^2 + U_f$

Calculate v

$$U_i = \int_0^{\pi/6} \lambda R^2 g \sin\theta\, d\theta$$

$$V_f = \int^{\pi/2} \lambda R^2 g \sin\theta\, d\theta$$

Ex.



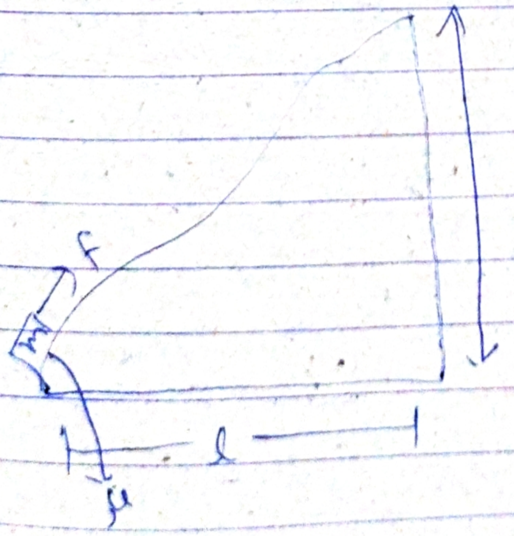
acts such that m moves slowly.

$$\cancel{WD_N}^{0} + WD_S + WD_g + WD_P = 0 - 0$$

$$WD_P = (U_f - U_i)$$

$$= mg\frac{R}{2} + \frac{1}{2}k\left(\frac{\pi R}{6}\right)^2 - 0$$

Ex. F such that slowly slowly moves



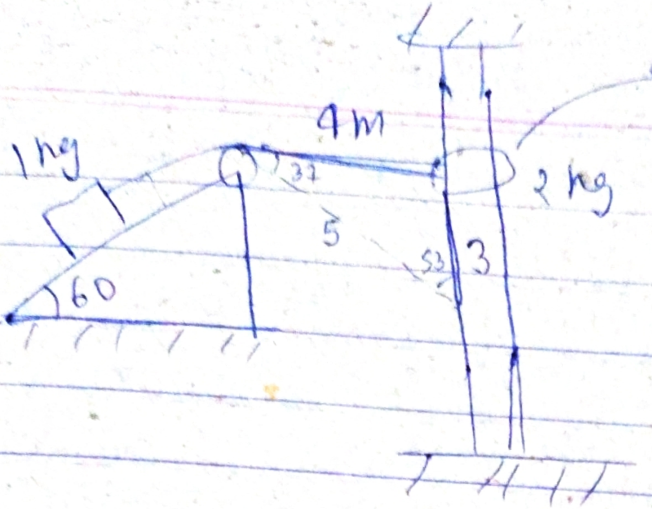
find out work done by F ~~such that~~ when particle reach top most point

$$WD_F + \cancel{WD_N}^{0} + WD_g + WD_f = 0$$

$$WD_F = -WD_g - WD_f$$

$$-mgh$$

$$\Rightarrow \frac{1}{2}\lambda \frac{R\pi}{6}u^2 + \frac{\lambda R^2 g}{2}(2-\sqrt{3}) = 0 + \frac{\lambda R^2 g}{2}$$



find out speed of 1kg when load falls 3 m.

$2 \times 10 \times 3 - 1 \times \frac{\sqrt{3}}{2} \times 10 = \frac{1}{2} \times 1 \times u^2 + \frac{1}{2} \times 2 \times (u')^2$

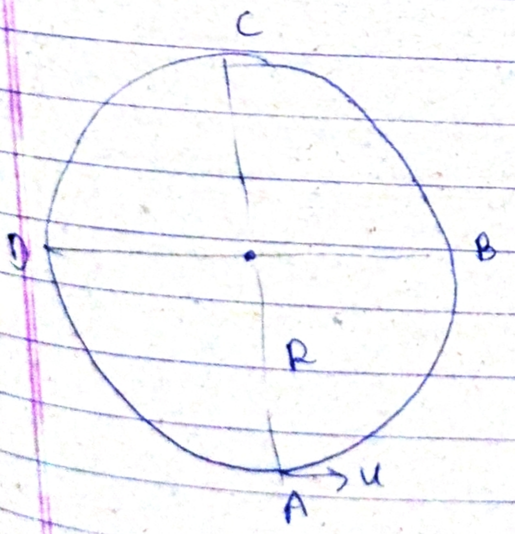
$u \cos 60 \cos 37 = u' \cos 53$

$\frac{u}{\cancel{2}} \frac{\cancel{4}\,2}{\cancel{5}} = \frac{\cancel{5}}{3}$

$\frac{2u}{3} = u'$ $\qquad u' \times \frac{3}{5} = u$

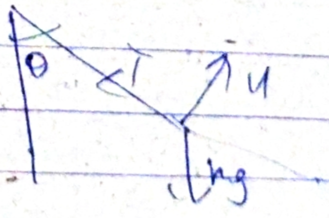
$v' \cancel{7}$

Verticle circular motion =)



for circular motion T > 0 (everywhere)

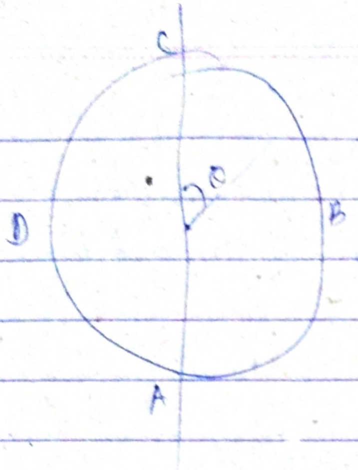
from A - B



$T = mg\cos\theta + \frac{mu^2}{R}$

$\theta \uparrow \cos\theta \downarrow u \downarrow T \downarrow$

but never zero



$\frac{mu^2}{R}$ θ ↓ cosθ ↑ u ↓

$T = \frac{mu^2}{R} - mg\cos\theta$

T ↓

$T_{min} > 0$

$T_{min} = T_C$

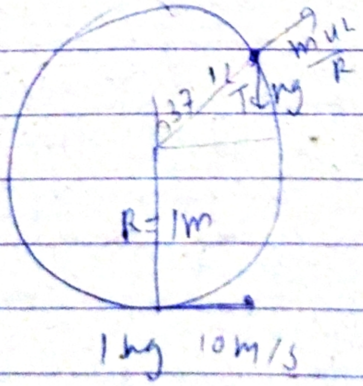
$\frac{1}{2}mu^2 = \frac{1}{2}mu^2 - 2mgR$

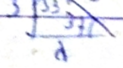
$T_C = \frac{mu^2}{R} = \frac{mu^2 - 4mgR}{R}$

$\frac{mu^2}{R} - 4mg - mg \geq 0$

$u \geq \sqrt{5Rg}$

Que





$h = 1 + \frac{4}{3}$

$0 + \frac{1}{\cancel{2}} \times 1 \times \overset{50}{\cancel{100}} = \frac{1}{2}v^2 + 10 \cdot$

$T = \frac{mu^2}{R} = u^2$

$= 64$

$50 - \frac{90}{3} = \frac{v^2}{2}$

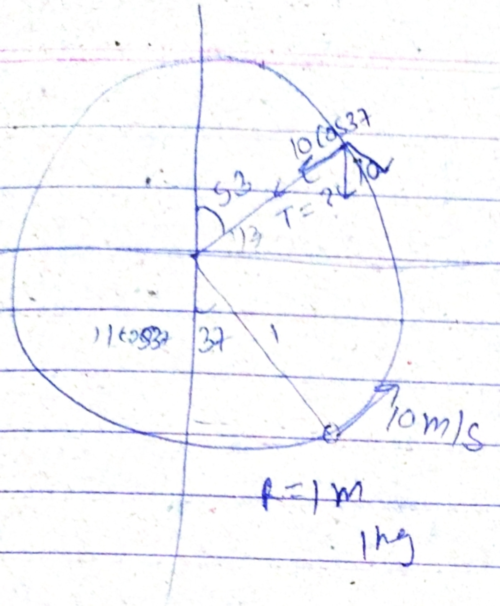
100 − [illegible] = u

$u = 8$

$T = \frac{mu^2}{\cancel{R}} - \frac{mg\,4}{4}$

64

$\boxed{u = 8m/sec}$



$T = \frac{mu^2}{r} - 10\cos 37$

$\frac{1}{2}\,100 + 0 = \frac{1}{2}mu^2 +$

$(\cos 37 + \sin 37)g$

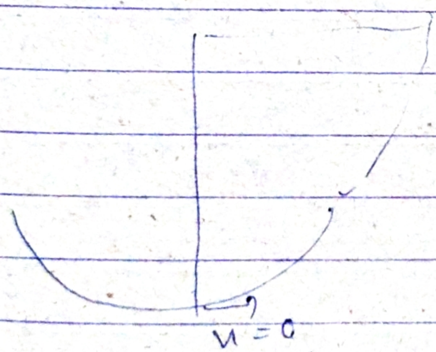
$50 = \frac{mu^2}{2} + \frac{7}{\cancel{5}} \times \cancel{10}^{2}$

$2 \times 36 = mu^2$

$T = 72 - 10\,\frac{4}{5}$

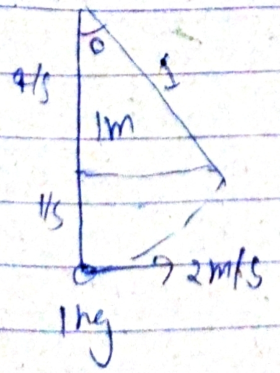
$= 64$

for pendulum



$0 < u < \sqrt{2gR}$

Q. find out max^{m} angle possible



$\frac{1}{2}mu^2$

$\frac{1}{\cancel{2}} \times 1 \times \cancel{2}^2 = 1 \times 10 \times h$

$h = \frac{1}{5}$

$\cos\theta = \frac{4}{5}$