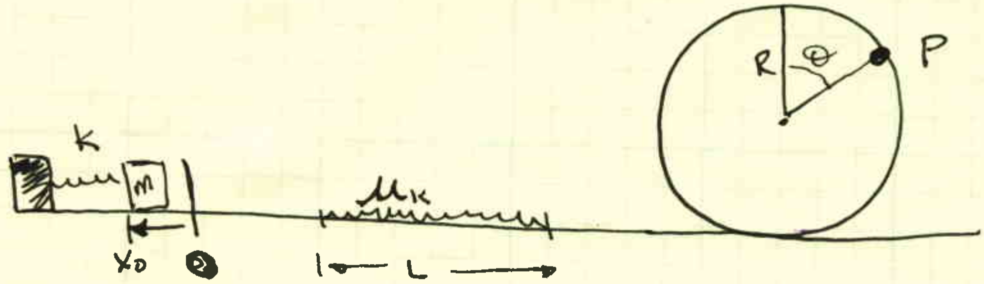
Loop-the Loop Ride With friction ①/2



$\Delta X = X_0$

TRACK frictionless EXCEPT segment "L".
μ_K = coefficient f.
$\Delta X = X_0$: initial compress
m: mass of object.

Q: $X_0 = 0$ so (m) falls off at P?

Oh! $V_p = 0$!

System

1 Body - Block m.

Interactions:

Leg A: spring, gravitation

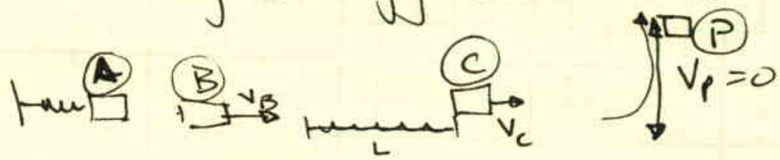
Relevant: $F = -k\Delta x$

Leg B: hits Rough:

Relevant: $f = \mu N$

Model

All of this is Best Modelled Using Energy Conservation

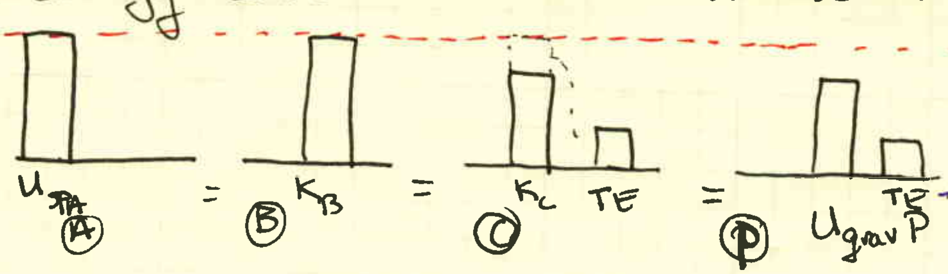


$C \to P$:

comes off Rough with V_c -

goes to P & $V_p = 0$ in order to fall off

Model: Energy conservation & transformations



Thermal Energy is the form of Energy that is due to the Work by friction: $W_f = +TE$

$$E_A = E_B = E_C = E_P$$

$$U_{sp(A)} = K_B = K_C + W_{friction} = U_{grav\,P} + W_{fC}$$

due to Nonconservative force friction:

No new transformation of Energy out of ME form.

Loop-the-Loop Ride with friction

E-conservation generates a lot of equalities.

$$E_A = U_{sp\,A} = \frac{1}{2}kx_0^2$$

$$E_B = K_B = \frac{1}{2}mv_B^2$$

$$E_C = K_C - W_f = \frac{1}{2}mv_C^2 + \mu m g L$$

A place for confusion... You must think this thru each time.

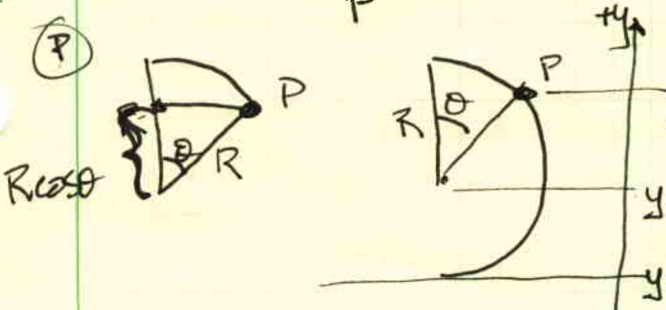
Ⓒ $W_{by\,fric} = \vec{f}\cdot\Delta\vec{s} = (\mu m g)(\cos 180^\circ)(L)$

$= -\mu m g L. = -$ Thermal Energy.

SIGN: friction usually does negative work. The negative means some mechanical energy is being transformed into some other form of energy. So, at the end of the process of work done by frict, an increase in some energy form shows up. OFTEN this is thermal energy, so at the END of the process it is reasonable to write the total energy as including the new form as T.E.

$$E_P = U_{grav@P} = mgy_P = mgR(1+\cos\theta)$$

Ⓟ



$$y_P = R + R\cos\theta = R(1+\cos\theta)$$

Re-Read Problem!

Q=? for x_0! $E_A = \frac{1}{2}kx_0^2 = \frac{1}{2}mv_B^2 = E_B$.

and $E_B = \frac{1}{2}mv_C^2 + \mu m g L = E_P$

$= (mgR(1+\cos\theta) + \mu m g L.)$

$$\frac{1}{2}kx_0^2 = mgR(1+\cos\theta) + \mu m g L$$

$$x_0^2 = 2\frac{m}{k}gR(1+\cos\theta) + \frac{2\mu m g}{k}L$$

$$x_0 = \sqrt{\frac{2mg}{k}\{R(1+\cos\theta) + \mu L\}}$$

Puzzler

in order for (m) to get to the top

L must be shortened.

So that at this x_0 it gets up there.

How much must L be shortened? Is it possible?

$\Delta L = (R/\mu)[1-\cos\theta]$ Yes.