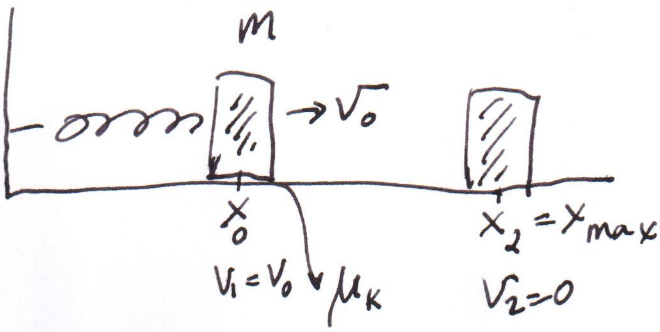
1.

(a)



(b) The moment after the block is struck
The total energy of this system is $\frac{1}{2} m v_0^2$
When the block is arrested @ position x_2
this is also the max distance the block will travel, $x_2 = x_{max}$
$V_2 = 0$

from conservation of energy, we have

$$\frac{1}{2} k x_{max}^2 = \frac{1}{2} m V_0^2 - \underbrace{\mu_k m g (x_{max} - x_0)}$$

this part is due to the negative work of the frictional force.

$$\frac{1}{2} k x_m^2 + \mu_k m g x_m - \left(\frac{1}{2} m v_0^2\right) - \mu_k m g x_0 = 0$$

If you get to this far you get full points

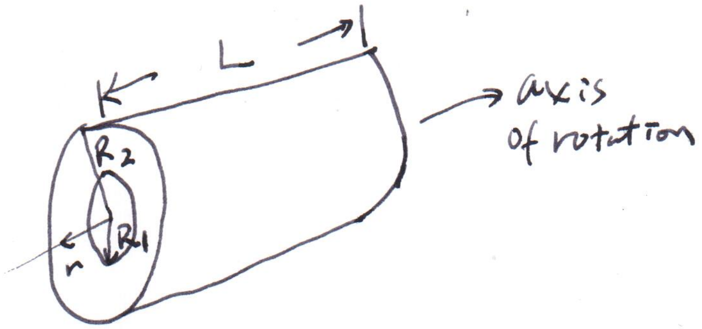
Solve this equation → $x_m = \pm\sqrt{\frac{b^2 - 4ac}{2a}}$

$$X_{max} = x_m = \pm\sqrt{\left(\frac{\mu_k m g}{k}\right)^2 + \frac{m V_0^2}{k} - \frac{\mu_k m g}{k}}$$

Rejecting the negative root.

#2.

(a) Annular cylinder



By definition

$$I = \int dm\, r^2$$

$$dm = 2\pi r\, dr\, L\rho$$

M = Total mass

$$= \pi R_2^2 L\rho - \pi R_1^2 L\rho$$

$$= \pi L\rho (R_2^2 - R_1^2)$$

$$\therefore I = \int_{R_1}^{R_2} 2\pi r\, dr\, L\rho \cdot r^2$$

$$= 2\pi L\rho \int_{R_1}^{R_2} r^3 dr$$

$$= 2\pi L\rho\, \frac{1}{4}(R_2^4 - R_1^4)$$

$$= 2\pi L\rho\, \frac{1}{4}(R_2^2 + R_1^2)(R_2^2 - R_1^2)$$

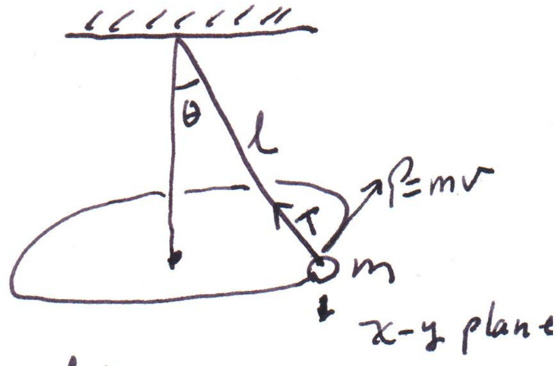
Plug in $M = \pi L\rho (R_2^2 - R_1^2)$

$$\therefore I = \frac{1}{2} M (R_1^2 + R_2^2)$$

(b) In the case of a solid cylinder, $R_1 = 0$

$$\therefore I_{solid} = \frac{1}{2} M R_2^2$$

#3



in this 2D model, the net force on x and y are

$$\sum F_x = m a_x ; \quad T\sin\theta = \frac{mv^2}{r^2}$$

T = the tension of the rope

$$\sum F_y = m a_y \quad T\cos\theta = mg$$

$$\therefore \quad \frac{\sin\theta}{\cos\theta} = \frac{v^2}{rg} \rightarrow v^2 = rg\frac{\sin\theta}{\cos\theta}$$

$$v = \sqrt{rg\frac{\sin\theta}{\cos\theta}}$$

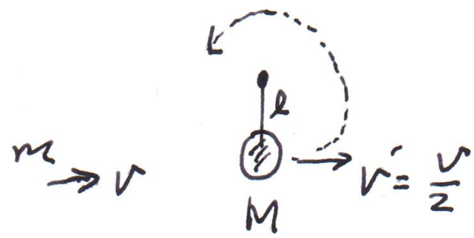
L = angular momentum

$$= r \times p$$

$$= rmv\sin\theta = rmv\sin 90^\circ$$

$$= rm\sqrt{rg\frac{\sin\theta}{\cos\theta}} = \sqrt{m^2 g r^3 \frac{\sin\theta}{\cos\theta}}$$

4



From total momentum
Coservation

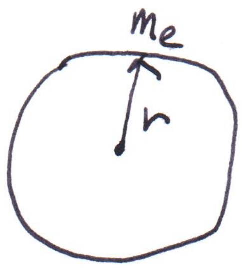
$$E_{bob} = E_{bob} = \frac{1}{2} M v'^2 = Mg \cdot 2l = E_{f,\text{ after the bullet}}$$

$v' = \sqrt{4gl}$, v' is the speed of the bob after the bullet passing

$$\underset{\text{total momentum}}{mv} = \underset{\text{moment of the bob}}{Mv'} + \underbrace{\tfrac{1}{2} v \cdot m}_{\text{momentum of the bullet after passing through the bob}}$$

$$\Rightarrow v = \frac{4M}{m}\sqrt{gl}$$

#5 In a Bohr Model, the electron is making circular motion around the ~~atm~~ nucleus.



L = angular momentum

$= r \times p = rmv$,

$\omega = \frac{2\pi}{T}$, T = period

$v = \omega r$

$= rm\omega r$

$= m\left(\frac{2\pi}{T}\right) r^2$

plug in numbers

$$L = (9.11 \times 10^{-31}\ kg)\left(\frac{2 \times 3.14}{0.53 \times 10^{-10}}\right) \cdot (0.53 \times 10^{-10})^2$$

$$= 1.06 \times 10^{-44}\ kg\,m^2/sec$$