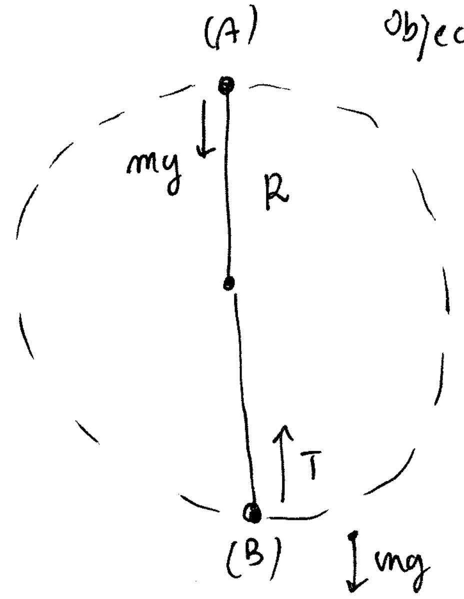
MIDTERM 2 KEY

(1)

Object is in uniform rotational motion

(a)



At (A): $\cancel{m}g = F_c = \cancel{m}\omega^2 \cdot R$

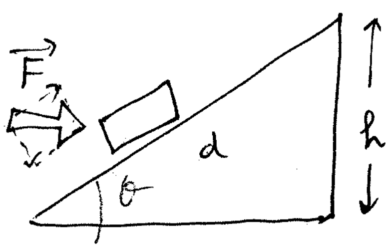
$$\Rightarrow \underline{\omega} = \sqrt{\frac{g}{R}} = \underline{1 \ \frac{rad}{s}}$$

(b)

At point (B): $T_B - mg = m\omega^2 \cdot R$

$$\Rightarrow \underline{T_B} = 2mg = 2 \times 0.1 \times 9.8 \approx \underline{2 \ [N]}$$

(2) (a)



Must find force along the incline

$$\begin{cases} F_{\parallel} = F \cdot \cos\theta = \underline{10 \ [N]} \\ d = 1 \ [m] \end{cases} ; \ h = d \cdot \sin(\theta) = 0.71 \ m$$

Use conservation of energy:

$$W_F = \Delta E + \cancel{W_f} = \Delta E_K + \Delta U_G = \frac{1}{2} m v_f^2 + mg \cdot h$$

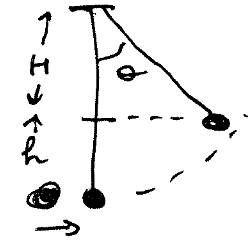
$$\begin{cases} W_F = F_{\parallel} \cdot d = 10 \\ mgh = mg\, d \cdot \cancel{\sin}\,\theta = \end{cases} \Rightarrow \frac{1}{2} m v_f^2 = F_{\parallel} \cdot d - mgh = 10 - 7 = \underline{3 \ [J]}$$

$$\Rightarrow v = \sqrt{\frac{2 \times 3}{1}} = \sqrt{6} \ m/s = 2.45 \ m/s$$

(b) Conservation of energy again, $\frac{1}{2} m v_f^2 = mg h'$

$$\Rightarrow h' = \frac{\frac{1}{2} m v_f^2}{mg} = \frac{3}{9.8} \approx 0.3 \ [m] \Rightarrow d' = \frac{0.3}{\cos(\theta)} = 0.42 \ m$$

(3) (a) Find initial velocity by conservation of momentum:



$$(m_1+m_2)v_f = m_1 \cdot v \Rightarrow v_f = \frac{1}{2}v = 2\ m/s$$

Since the objects will rotate:

$$\omega = \frac{v}{R} = \frac{2}{2} = 1\ rad/s$$

(b) Conservation of energy; find max height from lowest point.

$$\frac{1}{2}\cancel{(m_1+m_2)}\, v^2 = \cancel{(m_1+m_2)}\cdot g \cdot h$$

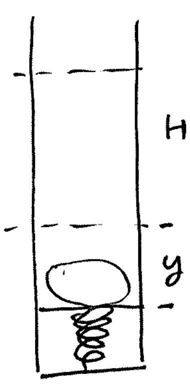
$$h = \frac{v^2/2}{g} = \frac{2}{9.8} \approx 0.2\ m$$

According to the rotational geometry:

$$h = R - H = R - R\cdot\cos\theta = R(1-\cos\theta)$$

$$\Rightarrow \cos\theta = 1 - \frac{h}{R} = 1 - \frac{0.2}{2} = 0.9 \Rightarrow \cos\theta = 26^\circ$$

(4)



(a) Use conservation of energy: $\cancel{W} = \cancel{\Delta E_k} + \Delta U_G + \Delta E_E + W_f$

$$mg\cdot H - mg(+y) + 0 - \frac{1}{2}ky^2 + F_f\cdot(H-y) = 0$$

$$H(mg+F_f) = +\frac{1}{2}ky^2 + F_f\cdot y + mg\cdot y = \frac{1}{2}ky^2 + y(mg+F_f)$$

$$\Rightarrow H = y + \frac{1/2\, ky^2}{mg+F_f} = -0.1 + \frac{100\times 10^{-2}}{1+1} = +0.4\ m$$

$y = -0.1\ m$

(b) Will not go down, since $F_f = mg$. It will remain at maximum height. :)