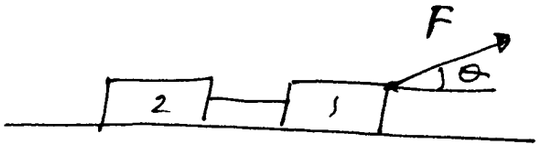
PH 111

MIDTERM # 2 - KEY

1.



$F = 2\ N$

(a) $(m_1 + m_2)a = F \cdot \cos\theta$

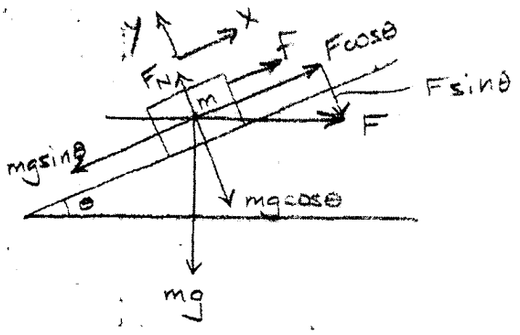
$$\Rightarrow \cos\theta = \frac{(m_1 + m_2)a}{F} = \frac{0.2 \cdot 5}{2} = 0.5$$

$$\Rightarrow \theta = \cos^{-1}(0.5) = \underline{60^\circ} \quad \left(\underline{\frac{\pi}{3}\ \text{rad}}\right)$$

(b) $m_2 \cdot a = T$

$$\Rightarrow T = 0.1 \cdot 5 = \underline{0.5\ [N]}$$

(2)



$m = 1\,kg$, $\theta = 45°$, $F = 2N$

$F\cos\theta = 2\cos 45° = 1.41\,N < mg\sin\theta = (1\,kg)(9.8\,m/s^2)\sin 45° = 6.93\,N$

$\Rightarrow$ box slides down incline.

$\Sigma F_y = 0 = F_N - mg\cos\theta - F\sin\theta$

$\Rightarrow F_N = mg\cos\theta + F\sin\theta$

$= (1\,kg)(9.8\,m/s^2)\cos 45° + (2N)\sin 45°$

$= 8.34\,N$

$\Sigma F_x = ma = F\cos\theta + f_f - mg\sin\theta = F\cos\theta + \mu_k F_N - mg\sin\theta$

$\Rightarrow ma = (2N)\cos 45° + (0.2)(8.34N) - (1\,kg)(9.8\,m/s^2)\sin 45°$

$= 1.41N + 1.69N - 6.93N$

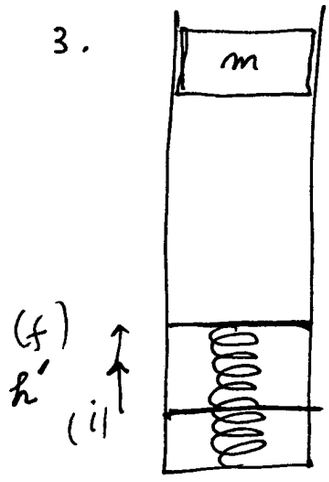
$= -3.85\,N \Rightarrow \boxed{a = -3.85\,m/s^2}$

$W_f = -\mu_k F_N d = -\mu_k(mg\cos\theta + F\sin\theta)d = \boxed{-1.69\,J}$

$\Sigma F_x = 0 = F\cos\theta + F - mg\sin\theta + F_2$

$\Rightarrow F_2 = mg\sin\theta - F\cos\theta - \mu_s F_N = \boxed{2.18\,N}$

3.



$k = 200\ N/m$

$m = 10\ kg$

$H = 1\ m$

$F_f = 50\ N$

$(h > 0)$

(a) Conservation of energy

$$0 = \Delta U_G + \Delta U_E + W_f$$

$$0 = -mg(H+h) + \frac{1}{2}kh^2 + F_f(H+h)$$

$$0 = -100(1+h) + 100h^2 + 50(1+h)$$

$$\Rightarrow -50(1+h) + 100h^2 = 0$$

$$\Rightarrow 2h^2 - h - 1 = 0 \Rightarrow h = \frac{1 \pm \sqrt{1+8}}{4} = 1,\ -0.5$$

$$\Rightarrow \underline{h = 1\ m} \quad \text{(compression)} \qquad (0.973\ m)$$

(b)

~~$0 = \Delta U_G + \Delta U_E + W_f$~~

~~$0 = mgh' + \cdots$~~

~~assume $h' \neq 0$ the distance from lowest point~~

If object reaches rest length, will do so with $E_K > 0$

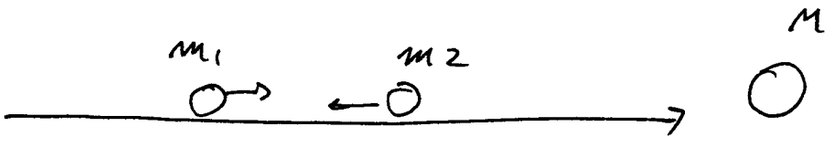
$$\Rightarrow 0 = E_K + \Delta U_G + \Delta U_E + W_f$$

$$\Rightarrow E_K = -\Delta U_G - \Delta U_E - W_f = -(mg)\cdot h + \frac{1}{2}ky^2 - F_f \cdot y$$

$$= -100 + 100 - 50 < 0$$

No will not reach rest length.

4.



$v_1 = +1\ m/s$ $\qquad m_1 = 10\ g$

$v_2 = -1\ m/s$ $\qquad m_2 = 3.3\ g$

(a)

$$(m_1+m_2)v = m_1v_1 + m_2v_2$$

$$\Rightarrow v = \frac{0.01 - 0.0033}{0.0133} = \frac{2/3}{4/3} = \underline{\underline{0.5\ m/s}} \text{ to right}$$

(b)

$$v_f = \frac{(m_1+m_2)-M}{(m_1+m_2+M)}\,v = -\frac{1}{2}v$$

$$\Rightarrow \quad 2(m_1+m_2) - 2M = -(m_1+m_2) - M$$

$$\Rightarrow M = 3(m_1+m_2) = \underline{\underline{40\ g}} \quad (0.04\ kg)$$

(c) Same as in case of inelastic collision

$$\Rightarrow v_{com} = \underline{\underline{0.5\ m/s}} \text{ to right}$$