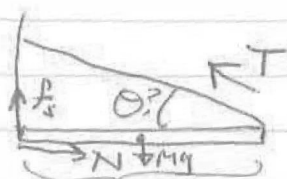# Solutions to Practice Quiz 4. Phy 2048C.

Problem 1. (a)

$$\sum \tau = 0 \qquad \sum F_x = 0 \qquad \sum F_y = 0$$

$$-Mg\frac{L}{2} + T\sin\theta L = 0 \qquad N - T\cos\theta = 0 \qquad T\sin\theta + f_s - Mg = 0$$

Solve system of eqns. for θ

$$T\cos\theta = N \quad ; \quad N\mu_s + T\sin\theta - Mg = 0$$

$$Mg = T(\cos\theta \mu_s + \sin\theta)$$

$$\frac{-T(\cos\theta\mu_s + \sin\theta)}{2} + T\sin\theta = 0 \implies \frac{-\mu_s}{2} + \tan\theta - \frac{\tan\theta}{2} = 0$$

divide by $\cos(\theta)$

$$\tan\theta = \mu_s \implies \boxed{\theta = \tan^{-1}(\mu_s)}$$

Problem 1 (b)

$\rightarrow$ Solve for X

$$\sum \tau = 0 \qquad \sum F_x = 0 \qquad \sum F_y = 0$$

$$-Mg\frac{L}{2} - Mgx + T\sin\theta L = 0 \qquad N - T\cos\theta = 0 \qquad T\sin\theta + f_s - 2Mg = 0$$

$$N = T\cos\theta \qquad T\sin\theta + \mu_s T\cos\theta = 2Mg$$

$$-2MgL - 4Mgx + 4T\sin\theta L = 0$$

$$-2Mg(L + 2x) + 4T\sin\theta L = 0 \qquad\qquad -2x(T\sin\theta + \mu_s T\cos\theta) =$$
$$L(T\sin\theta + \mu_s T\cos\theta) + 4T\sin\theta L$$

$$(T\sin\theta + \mu_s T\cos\theta)(2x + L) + 4T\sin\theta L = 0 \qquad X = -\frac{L}{2} + \frac{2T\sin\theta L}{T\sin\theta + \mu_s T\cos\theta} \approx 0.44m$$

Problem 1 ©

Solve for μ_s ; $X = 0.1\,m$

$$X = -\frac{L}{2} + \frac{2\sin\theta\,L}{\sin\theta + \mu_s\cos\theta}$$

$$\left(\frac{X}{L} + \frac{1}{2}\right)(\sin\theta + \mu_s\cos\theta) = 2\sin\theta$$

$$\boxed{\mu_s = \frac{2\sin\theta\left(\frac{X}{L} + \frac{1}{2}\right)^{-1} - \sin\theta}{\cos\theta} \approx 0.63}$$
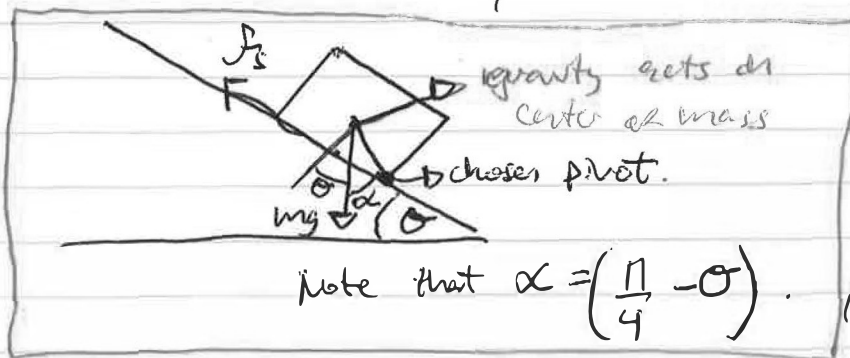
This is good algebra practice.

Problem 2. Compare θ when it slides and when it tips
which one is less?

$$\sum\tau = 0 \qquad\qquad \sum F_{y'} = 0$$

$$mg\sin\left(\frac{\pi}{4}-\theta\right) = 0 \quad ; \quad mg\cos\theta = N$$

gravity acts on center of mass
chosen pivot.
Note that $\alpha = \left(\frac{\pi}{4} - \theta\right)$.

$$\boxed{\theta = \frac{\pi}{4}}$$

$F_{x'} = 0$

$mg\sin\theta - f_s = 0$

$mg\sin\theta - \mu_s\,mg\cos\theta = 0$

$\tan\theta = \mu_s$

$\theta = \tan^{-1}(\mu_s)$

$\theta = 43°$

$\boxed{43 < 45\ \text{hence it slides}}$

Problem 3.

$$\Sigma Z = 0$$
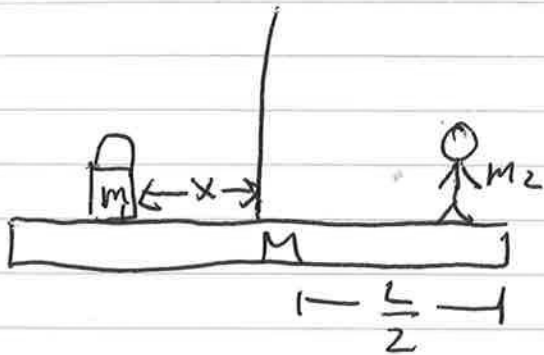
$$- m_2 g \frac{L}{2} + m_1 g X = 0$$

$$X = \frac{m_2}{m_1} \frac{L}{2} = 0.76 \, m$$

Problem 4

$D \Rightarrow$ Days
$A_0 \Rightarrow$ Ahmed initial

$S_0 \Rightarrow$ Sebas initial
$S_1 \Rightarrow$ " final in scenario 2

Scenario 1
$$A_0 - 75 \times D = 900$$
$$S_0 - 25 \times D = 0$$

Scenario 2
$$A_0 - 25D = 2100$$
$$S_0 - 75D = S_1$$

Solve for S_1

$$A_0 = 2100 + 25 D$$

$$2100 + 25D - 75D = 900$$

$$D = -(900 - 2100)/50$$
$$= 24$$

$$S_0 = 25(24) = 600$$

$$\boxed{S_1 = 600 - 75 \times 24 = -1200}$$