

# PHYS UN1601 Recitation Week 10 Demonstration Problems

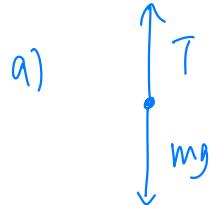
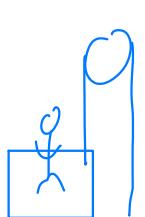
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## Problem 1

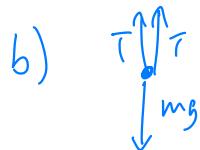
A platform has a rope attached to it which extends vertically upward, over a pulley, and then back down. You stand on the platform. The combined mass of you on the platform is  $m$ .

- Some friends standing on the ground grab the other end of the rope and hoist you up to a height  $h$  at constant speed. What is the tension in the rope? How much work do your friends do?
- Consider instead the scenario where you grab the other end of the rope and hoist yourself up a height  $h$  at constant speed. What is the tension in the rope? How much work do you do?



$$\text{constant velocity} \Rightarrow T = mg$$

$$W = F \cdot \Delta d = mgh$$



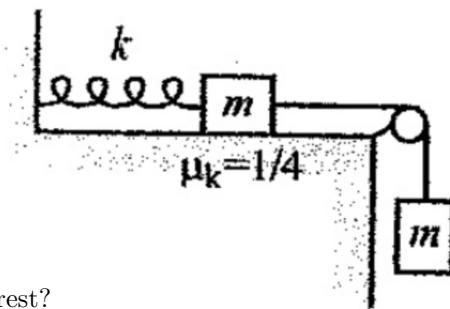
$$2T = mg \Rightarrow T = \frac{mg}{2}$$

but  $\Delta d$  is now  $2h$  (consider the length of rope being displaced)

$$\Rightarrow W = \frac{mg}{2} \cdot 2h = mgh$$

## Problem 2

Consider the system shown to the right, with two equal masses  $m$  and a spring with spring constant  $k$ . The coefficient of kinetic friction between the left mass and the table is  $\mu_k = \frac{1}{4}$ , and the pulley is frictionless. The system is held with the spring at its relaxed length and then released.



- How far does the spring stretch before the masses come to rest?
- What is the minimum value of the coefficient of static friction for which the system remains at rest once stopped?
- If the string is then cut, what is the maximal compression of the string during the resulting motion?

$$a) mgx_0 - \frac{1}{2}kx_0^2 - \mu_k mgx_0 = 0 \quad , \quad x_0 \text{ stopping distance}$$

$$\Rightarrow \frac{1}{2}kx_0^2 + mg(\mu_k - 1)x_0 = 0 \quad \Rightarrow \text{either } x_0 = 0, \text{ or:}$$

$$\Rightarrow x_0 = (1 - \mu_k) \frac{mg}{k} = \frac{2mg}{k} \left(1 - \frac{1}{4}\right) = \frac{3mg}{2k}$$

$$b) f_f \leq \mu_s N, \quad \mu_s N = m g + f_f \Rightarrow \mu_s \left(\frac{3mg}{2k}\right) \leq mg + \mu_k mg$$

$$\mu_s \geq \frac{3}{2} - 1 = \frac{1}{2}$$

$$c) \frac{1}{2}k(x_0^2 - d^2) - \mu_k mg(x_0 + d) = 0$$

$$\frac{1}{2}k(x_0 - d)(x_0 + d) - \mu_k mg(x_0 + d) = 0$$

$$\frac{kd}{2} = \frac{kx_0}{2} - \mu_k mg$$

$$d = x_0 - \frac{2\mu_k mg}{k} = \frac{3mg}{2k} - \frac{mg}{2k} = \frac{mg}{k}$$