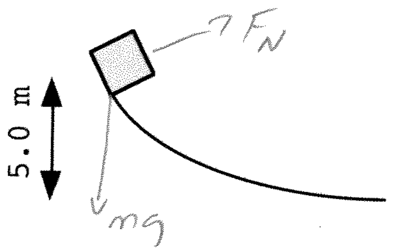
Physics 10154 - Exam #2c

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 4.0 kg mass is initially at rest at the top of a 5.0 meter high curved ramp. The mass slides down the ramp and has a final velocity of 8.2 m/s at the bottom of the ramp. What is the work done by friction while the mass slides down the ramp?



$W_N = 0$ $\quad$ $W_{KF} = ?$

$W_{grav} = mgh$

$$\Sigma W_F = W_N + W_{grav} + W_{KF} = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$$

$$0 + mgh + W_{KF} = \frac{1}{2}mv^2 - 0$$

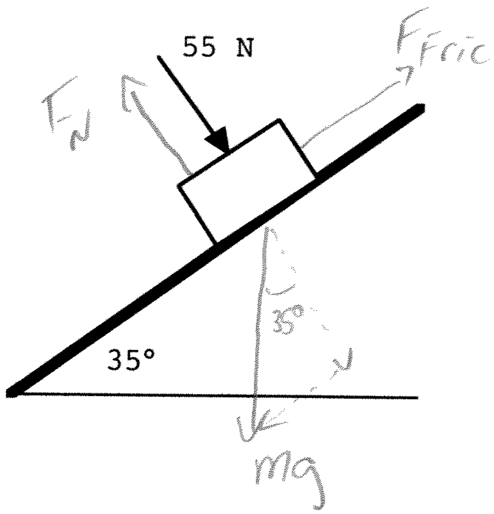
$$(4)(9.8)(5) + W_{KF} = \frac{1}{2}(4)(8.2)^2$$

$$196 + W_{KF} = 134.5$$

$$\boxed{W_{KF} = -62\ J}$$

2. (40 pts) A 12.0 kg crate is initially at rest on a ramp inclined 41° above the horizontal. An applied force of 55 N is directed perpendicular to the ramp as shown. The coefficient of static friction between the crate and ramp is 0.40, and the coefficient of kinetic friction is 0.25.

Does the crate move? If not, what is the magnitude and direction of the force of static friction? If it does move, determine the magnitude and direction of its acceleration.



$$\Sigma F_{\perp} = F_N - 55 - mg\cos 35° = 0$$

$$F_N = 55 + (12)(9.8)\cos 35°$$

$$= 151.3$$

$$F_{SF,MAX} = \mu_s F_N = 60.5\,N$$

Assume $a = 0$

$$\Sigma F_{\parallel} = mg\sin 35 - F_{SF} = 0$$

$$(12)(9.8)\sin 35 - F_{SF} = 0$$

$F_{SF} = 67.5$ too big, so it moves

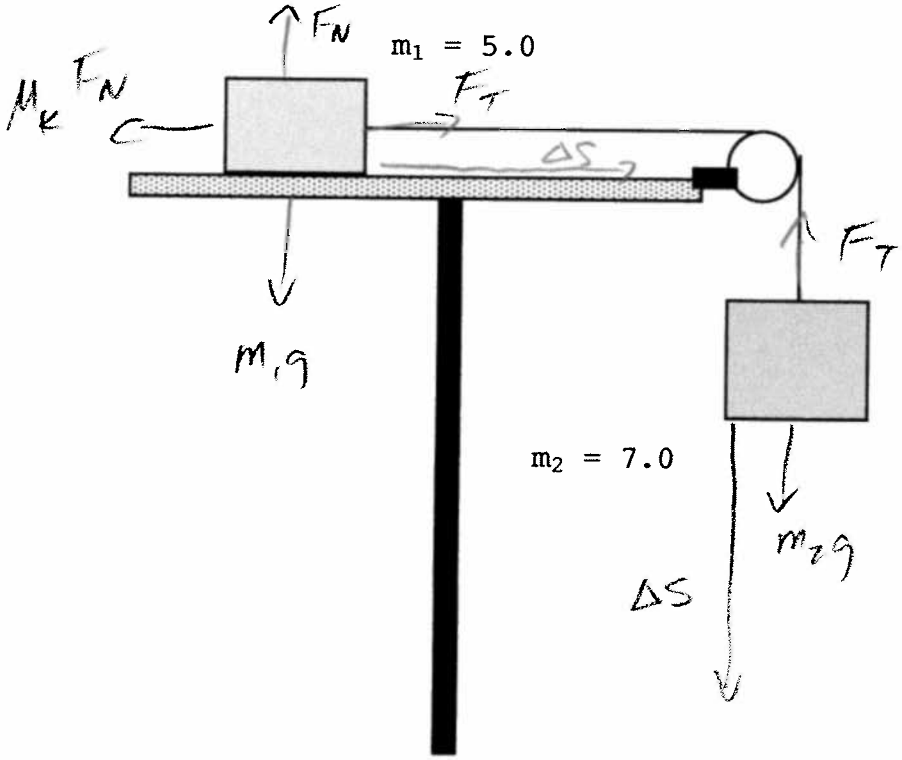
$$\Sigma F_{\parallel} = mg\sin 35° - \mu_k F_N = ma$$

$$(12)(9.8)\sin 35° - (0.25)(151.3) = (12)a$$

$$67.45 - 37.83 = 12a$$

$a = 2.5\ m/s^2$, down ramp

3. (30 pts) Two masses are connected by a light string over a pulley as shown below. The coefficient of kinetic friction between the mass m_1 and the table is 0.20. How long (in seconds) does it take for mass m_2 to move downward 4.0 meters if the system is released from rest (assume the masses move)?



$W_N(m_1) = 0$

$W_{grav}(m_1) = 0$

$W_T(m_1) = F_T \Delta s$

$W_{KF}(m_1) = -\mu_k m_1 g \Delta s$

$W_T(m_2) = -F_T \Delta s$

$W_{grav}(m_2) = m_2 g \Delta s$

$$\Sigma W_F = -\mu_k m_1 g \Delta s + m_2 g \Delta s = \tfrac{1}{2}(m_1 + m_2)v^2 - 0$$

$$-(.20)(5)(9.8)(4) + (7)(9.8)(4) = \tfrac{1}{2}(12)v^2$$

$$-39.2 + 274.4 = 6v^2$$

$$v = 6.26 \text{ m/s}$$

$$\Delta s = \tfrac{1}{2}(v_0 + v)t$$

$$4.0 = \tfrac{1}{2}(0 + 6.26)t$$

$$\boxed{t = 1.3 \text{ s}}$$

Alt:

$$\Sigma F(m_1) = F_T - \mu_k m_1 g = m_1 a$$

$$\Sigma F(m_2) = m_2 g - F_T = m_2 a$$

$$m_2 g - m_1 a - \mu_k m_1 g = m_2 a$$

$$m_2 g - \mu_k m_1 g = (m_1 + m_2)a$$

$$a = 4.9 \text{ m/s}^2$$

$$\Delta s = v_0 t + \tfrac{1}{2}at^2 \Rightarrow 1.3 \text{ s}$$