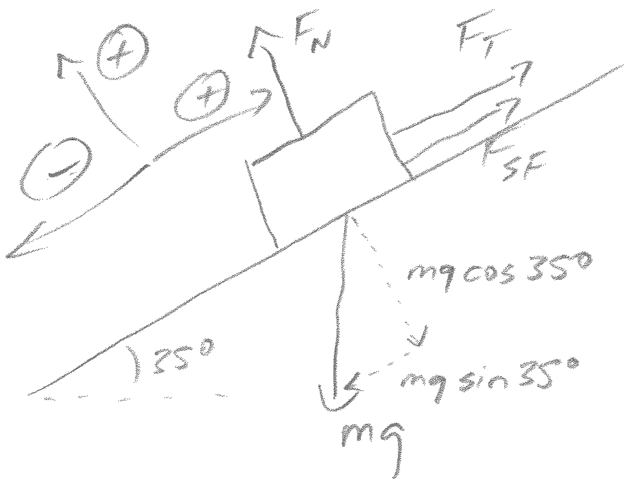
Physics 10154 - Exam #2a

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. (40 pts) A 120 kg crate is initially at rest on a ramp inclined 35° above the horizontal. A rope attached to the crate pulls it parallel to the ramp and in a direction up the ramp with a tension force of 450 N. The coefficient of static friction between the crate and the ramp is 0.45. The coefficient of kinetic friction is 0.32.

Does the crate move?
If yes, what is the magnitude and direction of its acceleration?
If no, what is the magnitude and direction of the force of static friction acting on the crate?



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

$$F_N = mg\cos 35° = 963\,N$$

If $a = 0$ $\quad \Sigma F_{\parallel} = -mg\sin 35° + F_{SF} + F_T = 0$

$$F_{SF} = mg\sin 35° - F_T$$

$$= 674.5 - 450 = 224.5\,N$$

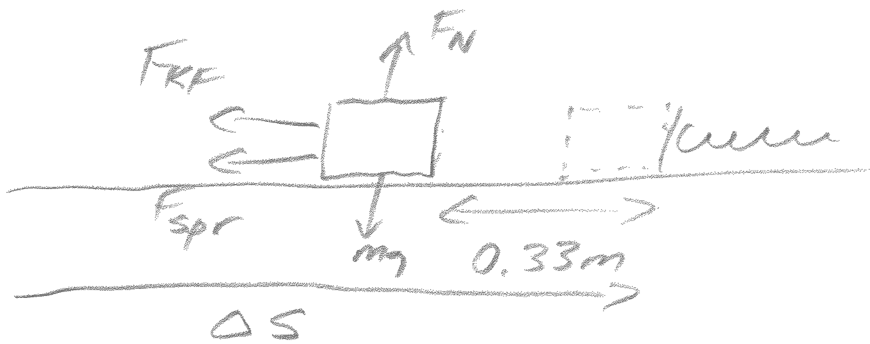
$$F_{SF,MAX} = \mu_S F_N = (0.45)(963) = 433\,N$$

Since $F_{SF} < F_{SF,MAX}$, crate doesn't move

$$\boxed{F_{SF} = 220\,N,\ \text{up ramp}}$$

2. (30 pts) A 3.0 kg wooden block is given an initial speed of 3,5 ~~7.5~~ m/s along a rough horizontal table with a coefficient of kinetic friction of 0.22 between the table and the block. After moving some distance along the surface, the block encounters a relaxed horizontal spring with k = 45 N/m. It compresses the spring by a maximum value of 33 cm before coming to rest.

Keeping in mind that friction continues to act on the block even while the spring is slowing the block down, what is the total horizontal distance travelled, including the distance while on the spring?



$$\Sigma W_F = W_N + W_{grav} + W_{KF} + W_{spr} = \Delta K$$

$$W_N = 0 \qquad (\cos 90° = 0)$$

$$W_{grav} = 0 \qquad (\cos 90° = 0)$$

$$W_{KF} = \mu_K F_N \Delta s \cos 180° = -\mu_k mg\Delta s$$

cos 180° F_N

$$W_{spr} = -\tfrac{1}{2}kx^2$$

$$-\mu_k mg\Delta s - \tfrac{1}{2}kx^2 = 0 - \tfrac{1}{2}mv_0^2$$

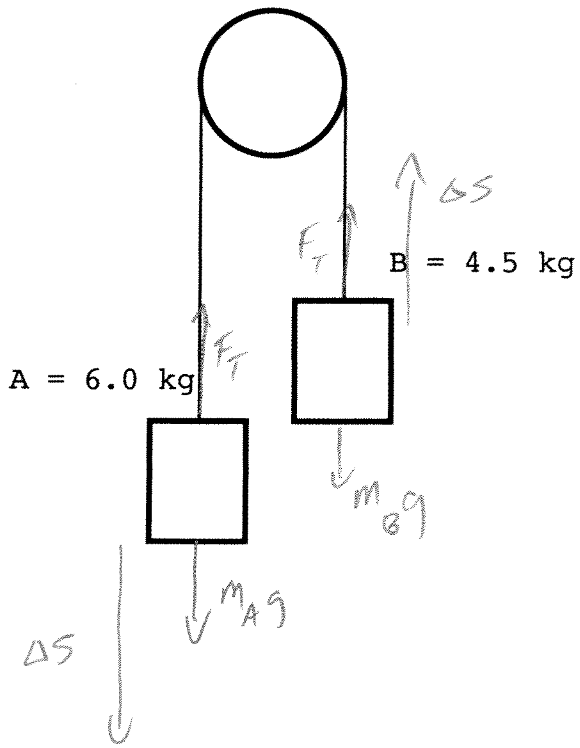
$$-(0.22)(3)(9.8)\Delta s - \tfrac{1}{2}(45)(.33)^2 = -\tfrac{1}{2}(3)(3.5)^2$$

$$-6.47\Delta s - 2.45 = -18.38$$

$$-6.47\Delta s = -15.93$$

$$\boxed{\Delta s = 2.5\,m}$$

3. (30 pts) Two masses are connected by a light string over a massless, frictionless pulley, initially at rest. After they are released, mass A drops 1.2 meters. How fast is mass A moving at this point?



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

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

$$W_T(B) = F_T \Delta s$$

$$W_{grav}(B) = -m_B g \Delta s$$

$$m_A g \Delta s - m_B g \Delta s$$

$$\Sigma W_r = m_A g \Delta s - m_B g \Delta s = \tfrac{1}{2}(m_A + m_B) v^2 - 0$$

$$70.56 - 52.92 = \tfrac{1}{2}(10.5) v^2$$

$$\boxed{v = 1.8 \text{ m/s}}$$

Alt: $\Sigma F_A : m_A g - F_T = m_A a \Rightarrow F_T = m_A g - m_A a$

$\Sigma F_B : -m_B g + F_T = m_B a$

$$-m_B g + m_A g - m_A a = m_B a$$

$$(m_A - m_B) g = (m_A + m_B) a \Rightarrow a = \frac{(1.5)(9.8)}{10.5} = 1.4$$

$$v^2 = v_0^2 + 2a\Delta s$$

$$v^2 = 0 + 2(1.4)(1.2) \Rightarrow \boxed{v = 1.8 \text{ m/s}}$$