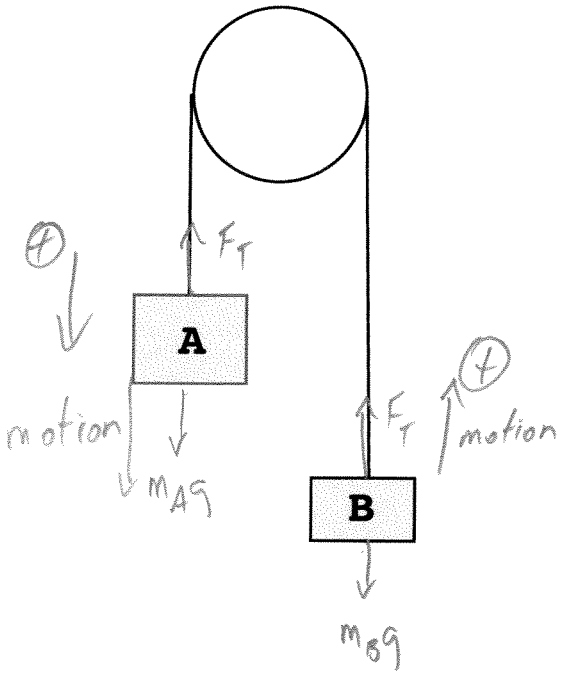
Physics 10154 - Exam #2a

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. (30 pts) Two masses are connected by a massless string over a frictionless pulley as shown. Mass A is 8.0 kg, and mass B is 5.0 kg. The system is released from rest. How much time does it take for mass A to move 85 cm?



Ch 4 method

Sign convention: + in direction of motion for both masses.

$m_A: \Sigma F_y: m_A g - F_T = m_A a$

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

$F_T = m_B a + m_B g$

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

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

$a = \frac{(8-5)(9.8)}{(8+5)} = 2.26\ m/s^2$

$v_0 = 0$

$\Delta s = 0.85$

$\Delta s = v_0 t + \frac{1}{2} a t^2$

$0.85 = 0 + \frac{1}{2}(2.26) t^2$

$t = 0.87\ s$

Ch 5 method

$W(m_A g) = m_A g \Delta s$

$W(T_A) = -F_T \Delta s$

$W(m_B g) = -m_B g \Delta s$

$W(T_B) = F_T \Delta s$

$(m_A + m_B)$

$\Sigma W_F = m_A g \Delta s - m_B g \Delta s = \frac{1}{2} m v^2 - 0$

$(8)(9.8)(.85) - (5)(9.8)(.85) = \frac{1}{2}(13) v^2$

$v = 1.96$

$v_0 = 0$

$\Delta s = 0.85$

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

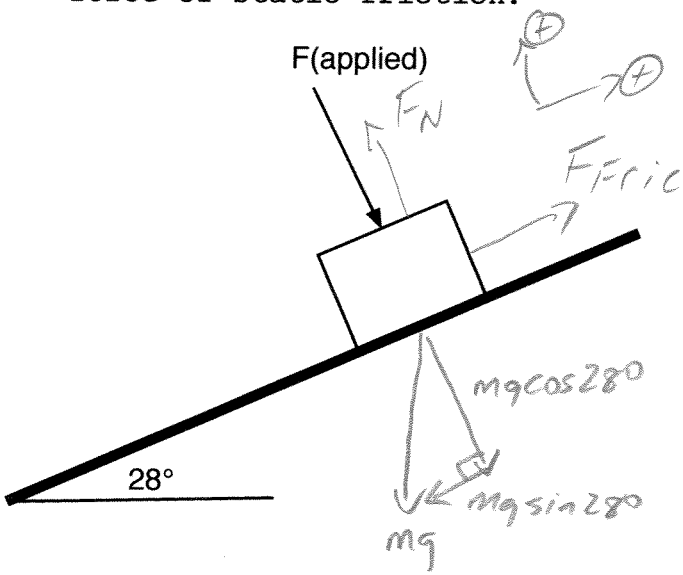
$0.85 = \frac{1}{2}(1.96) t$

$t = 0.87\ s$

2. (35 pts) The coefficient of static friction between the 12 kg crate and the incline below is 0.23. An applied force of 22 Newtons directed perpendicular to the ramp is attempting to hold the crate in place.

a) Does the crate move? Justify your answer mathematically.

b) If yes, what is the magnitude and direction of the acceleration (assume the coefficient of kinetic friction is 0.15)? If no, what is the magnitude and direction of the force of static friction?



$\Sigma F_\perp = F_N - F_{App} - mg\cos 28° = 0$

$F_N = 22 + (12)(9.8)\cos 28°$

$= 125.8\,N$

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

$= 28.9\,N$

If $a = 0$,

$\Sigma F_{||} = F_{SF} - mg\sin 28° = 0$

$F_{SF} = (12)(9.8)\sin 28°$

$= 55.2$

Since $F_{SF}(55.2) > F_{SF,MAX}(28.9)$, crate moves

$\Sigma F_{||} = F_{KF} - mg\sin 28° = ma$

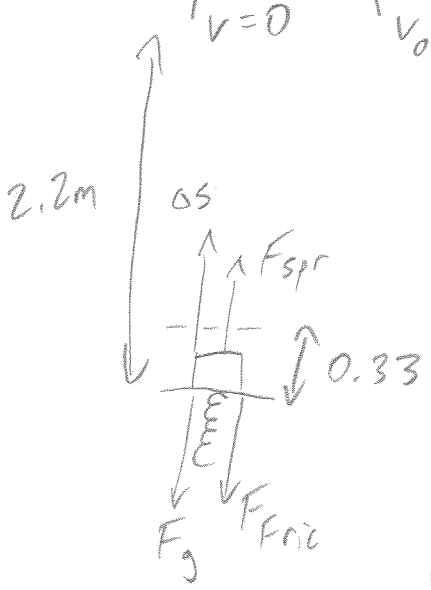
$(0.15)(125.8) - (12)(9.8)\sin 28° = (12)a$

$18.87 - 55.2 = 12a$

$a = -3.0$

$\therefore$ 3.0 m/s², down ramp

3. (35 pts) A vertically oriented spring (k = 720 N/m) is compressed by 33 cm. A 1.5 kg mass is placed on the spring and released from rest. After the launch, the mass reaches a maximum height of 2.2 meters above the release point. How much work is done by frictional forces in this problem?



$$W_{spr} = +\frac{1}{2}kx^2$$

$$= \frac{1}{2}(720)(.33)^2 = 39.2\ J$$

$$W_g = -mg\Delta s$$

$$= -(1.5)(9.8)(2.2) = -32.3\ J$$

$$W_{Fric} = ?$$

$$W_s + W_g + W_F = \Delta K$$ starts & ends at rest

$$39.2 - 32.3 + W_F = 0$$

$$\boxed{W_F = -6.9\ J}$$