Physics 10154 - Exam #2a

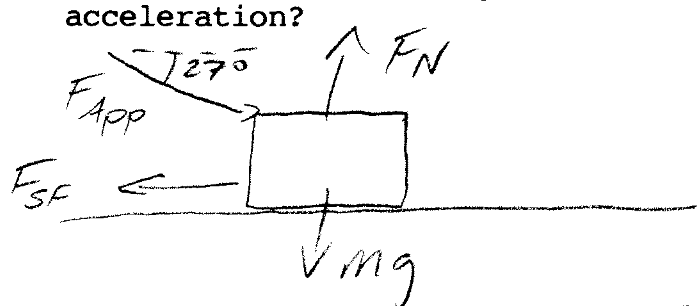
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. <u>Clearly indicate your answer with a circle or box</u> and remember to include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

1. (40 pts) A crate has a mass of 35 kg and is being pushed by an applied force of 220 Newtons directed 27° below the horizontal. The coefficient of static friction between the crate at the floor is 0.52. The coefficient of kinetic friction is 0.35.

a) Does the crate move?

b) If no, what is the magnitude and direction of the force of static friction on the crate? Show this on your diagram.

If yes, what is the magnitude and direction of the crate's acceleration?



$$\Sigma F_{\perp} = F_N - mg - F_{App} \sin 27° = 0$$

$$F_N = (35)(9.8) + (220) \sin 27° = 443\ N$$

$$F_{SF,MAX} = \mu_S F_N = (0.52)(443) = 230\ N$$

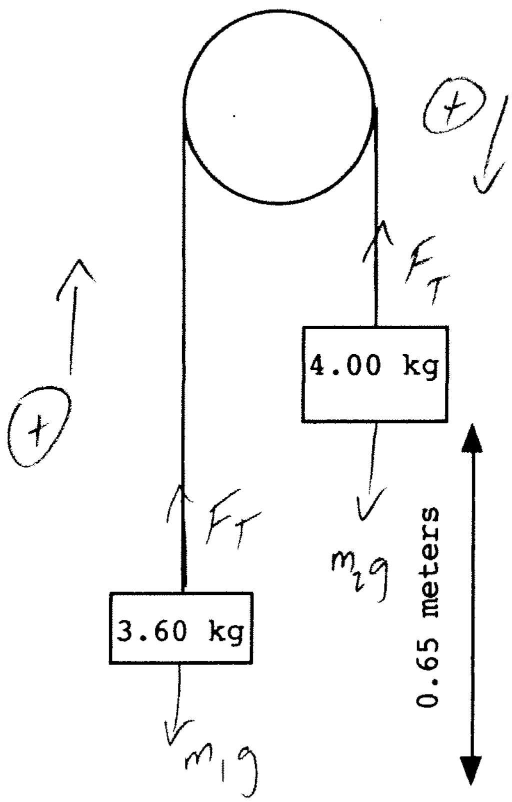
$$\Sigma F_{\parallel} = F_{App} \cos 27° - F_{SF} = 0 \quad \Leftarrow \text{assume no motion}$$

$$F_{SF} = 220 \cos 27° = 196\ N$$

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

$F_{SF} = 200N$, opposing F_{App}

2. (30 pts) For the vertical pulley system shown below, the 4.00 kg mass is 0.65 meters above the floor. If the system is released from rest, how many seconds elapse before the 4.00 kg mass hits the floor?



Forces, individual masses

$$\Sigma F_1 = F_T - m_1 g = m_1 a$$

$$\Sigma F_2 = m_2 g - F_T = m_2 a$$

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

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

$$a = \frac{(m_2 - m_1)}{m_1 + m_2} g$$

$$= \frac{0.40}{7.60}(9.8) = 0.516 \text{ m/s}^2$$

$$\Delta y = v_{oy} t + \tfrac{1}{2} a_y t^2$$

$$0.65 = 0 + \tfrac{1}{2}(.515) t^2 \quad \boxed{t = 1.6 \text{ s}}$$

Forces, system: $\Sigma F = m_2 g - m_1 g = (m_1 + m_2) a$

proceed as above

Work-energy: $W(m_1 g) + W(T_1) + W(T_2) + W(m_2 g) = \Delta K$

$$-m_1 g h + F_T h - F_T h + m_2 g h = \tfrac{1}{2}(m_1 + m_2) v^2 - 0 \text{ (rest)}$$

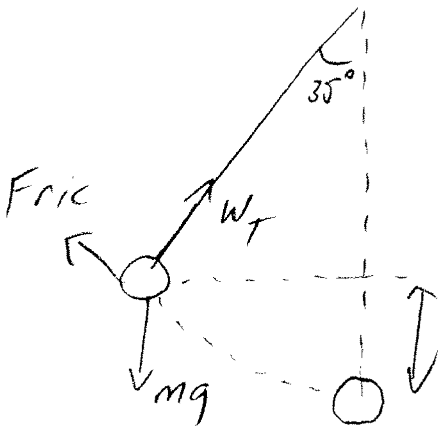
$$(0.40)(9.8)(0.65) = \tfrac{1}{2}(7.6) v^2$$

$$v = 0.819$$

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

$$.65 = \tfrac{1}{2}(0 + .819) t \quad \boxed{t = 1.6 \text{ s}}$$

3. (30 pts) A 12 kg mass is attached to a 3.0-meter long pendulum bob, and the system is released from rest when the pendulum's string makes a 35° angle with the vertical. If frictional forces do -12 Joules of work on the mass as it falls to its lowest point, what is the speed of the mass at the lowest point of its motion?



$$h = 3 - 3\cos 35° = 0.543\ m$$

$$\Sigma W_F = W_T + W(mg) + W(Fric) = \tfrac{1}{2}mv^2 - 0$$

($W_T \to 0$; 0 → rest)

$$mgh - 12 = \tfrac{1}{2}mv^2$$

$$(12)(9.8)(.543) - 12 = \tfrac{1}{2}(12)v^2$$

$$63.86 - 12 = 6v^2$$

$$\boxed{v = 2.9\ m/s}$$