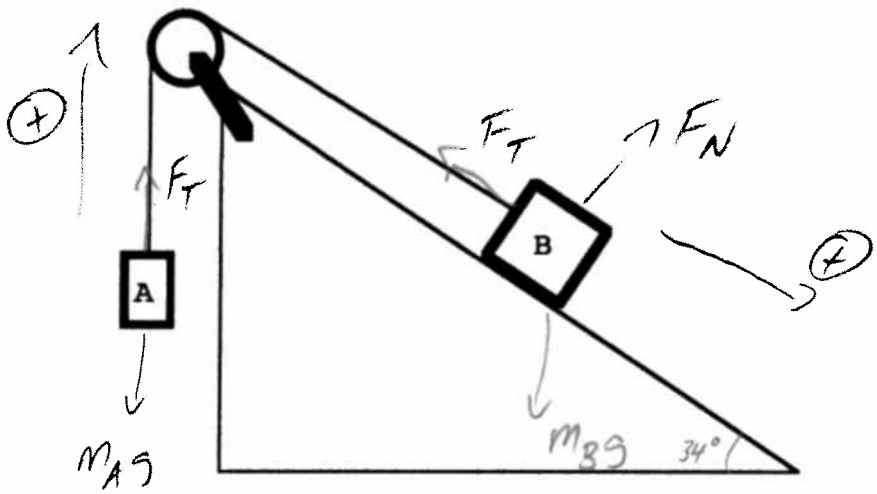
Physics 10154 - Exam #2b

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 5.0 kg mass A hangs vertically while a 21 kg attached mass B slides down a frictionless ramp inclined 34 degrees with respect to the horizontal as shown below. What is the tension in the string connecting the masses?



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

$$m_B: \Sigma F_{\parallel} = m_B g \sin 34^\circ - F_T = m_B a$$

$$F_T = m_A a + m_A g$$

$$m_B g \sin 34^\circ - m_A a - m_A g = m_B a$$

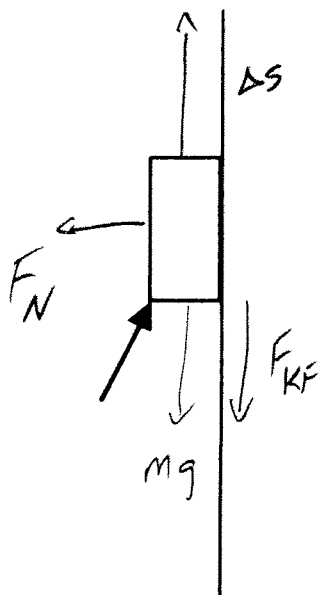
$$m_B g \sin 34^\circ - m_A g = (m_A + m_B) a$$

$$115 - 49 = 26\, a$$

$$a = 2.54 \Rightarrow F_T = (5)(2.54) + (5)(9.8)$$

$$= \boxed{62\ N}$$

2. (30 pts) A 5.0 kg block is sliding up a wall, being pushed by an applied force of 130 Newtons directed 63° above the horizontal. The coefficient of kinetic friction between the block and the wall is 0.25. If the block begins at rest, how fast is it moving after it has moved 1.0 meters up the wall?



$$\Sigma W_F = W_N + W_{App} + W_{grav} + W_{KF} = \tfrac{1}{2}mv^2 - 0$$

$W_N = 0$

$W_{App} = (130)(1.0)\cos 27° = 115.8$

$W_{grav} = -(5)(9.8)(1) = -49$

$W_{KF} = -\mu_k F_N \Delta s$ $\qquad F_N = 59$

$= -\mu_k (F_{App}\cos 63°)\Delta s$

$= -14.8$

$\Sigma W_F = 0 + 115.8 - 49 - 14.8 = 2.5v^2$

$52 = 2.5v^2$

$v = 4.56$

If we use Newton's Laws ...

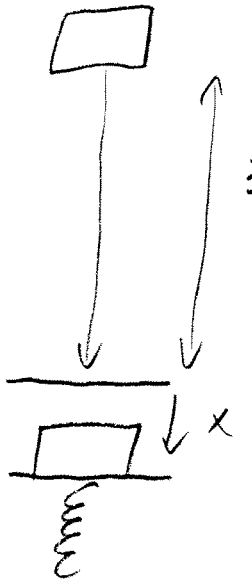
$\Sigma F_{\parallel} = F_{App}\sin 63° - mg - \mu_k (F_{App}\cos 63°) = ma$

$115.8 - 49 - 14.8 = 5a$

$a = 10.4\ m/s^2$

$v^2 = v_0^2 + 2a\Delta y \rightarrow v = 4.56$

3. (30 pts) A 3.0 kg block is dropped (from rest) from a vertical height of 3.5 meters. It lands on the platform of a vertical spring with k = 150 N/m. How far does the block compress the spring before it comes to rest? The 3.5 meter drop does *NOT* include the spring displacement.



$$W_{grav} = mg(3.5 + x)$$

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

$$\Sigma W_F = W_{grav} + W_{spr} = 0 - 0$$

$$mg(3.5) + mgx - \frac{1}{2}kx^2 = 0$$

$$75x^2 - 29.4x - 103 = 0$$

$$x = \frac{29.4 \pm \sqrt{29.4^2 + 4(75)(103)}}{150}$$

$$= 0.196 + 1.19 = \boxed{1.4\ m}$$

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or v when mass lands on spring $= \sqrt{2gh}$

$= 8.28\ m/s$

$$\Sigma W_F = -mgx - \frac{1}{2}kx^2 = 0 - \frac{1}{2}(m)(8.28)^2$$

etc