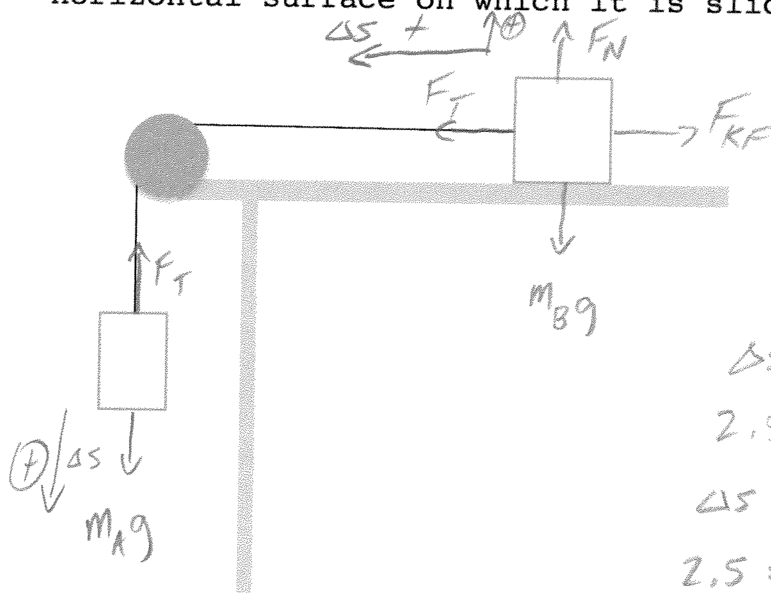
Physics 10154 - Exam #2a

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 thin string and pulley as shown below. Starting from rest, the hanging mass A (4.2 kg) falls 2.5 meters in 1.4 seconds. What is the coefficient of kinetic friction between the other mass B (5.5 kg) and the horizontal surface on which it is sliding?



$\Delta s = 2.5$
$v_0 = 0$
$v = ?$
$a = ?$
$t = 1.4$

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

$2.5 = \frac{1}{2}v(1.4)$ $\quad v = 3.57\,m/s$

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

$2.5 = \frac{1}{2}a(1.4)^2$ $\quad a = 2.55\,m/s^2$

Ch 4 method

$m_A: m_A g - F_T = m_A a$

$m_B: F_T - \mu_K F_N = m_B a$

$F_N - m_B g = 0$

$F_T - \mu_K m_B g = m_B a$

$F_T = m_A g - m_A a$

$m_A g - m_A a - \mu_K m_B g = m_B a$

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

$41.16 - \mu_K(53.9) = (9.7)(2.55)$

$\mu_K = \frac{-16.4}{-53.9} = \boxed{0.30}$

Ch 5 method

$m_A: W_{grav} = m_A g \Delta s$

$W_T = -F_T \Delta s$

$m_B: W_{grav} = 0$

$W_N = 0$

$W_T = +F_T \Delta s$

$W_{KF} = -\mu_K F_N \Delta s$ or $-\mu_K m_B g \Delta s$

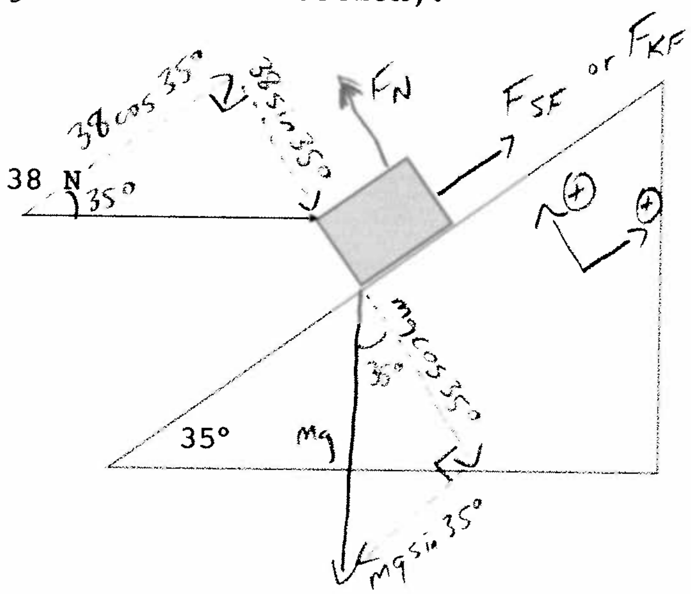
$\Sigma W_F = m_A g \Delta s - \mu_K m_B g \Delta s = \frac{1}{2}(m_A + m_B)v^2 - 0$

$102.9 - \mu_K(134.75) = 61.81$

$\mu_K = \frac{-41.09}{-134.75} = \boxed{0.30}$

2. (35 pts) A 15 kg mass is at rest on a ramp inclined 35° above the horizontal as shown below. A horizontal applied force of 38 N acts on the mass. The coefficient of static friction is 0.41 [redacted]. The coefficient of kinetic friction is [redacted]. 0.27 Does the mass move?

If yes, what is its acceleration (magnitude and direction)?
If no, what is the force of static friction acting on the mass (magnitude and direction)?



$\Sigma F_\perp = F_N - 38 \sin 35° - mg\cos 35° = 0$

$F_N = 21.80 + 120.42 = 142.2\ N$

$F_{SF,MAX} = \mu_s F_N = 58.30\ N$

Assume $a = 0$, find F_{SF}.

$\Sigma F_\parallel = +38\cos 35° + F_{SF} - mg \sin 35° = 0$

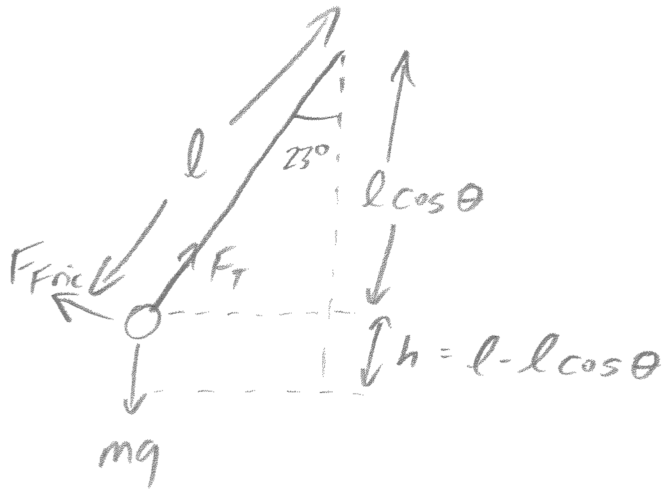
$F_{SF} = mg \sin 35° - 38 \cos 35°$

$= 84.32 - 31.13 = 53.2\ N$

Since F_{SF} (53.2) < $F_{SF,MAX}$ (58.3) the **mass does not move.**

F_{SF} = 53.2 N, up ramp

3. (35 pts) A 2.50 kg pendulum bob is attached to a 1.70 meter long string initially at rest with the string making a 23.0° angle with respect to the vertical. At the lowest point in its motion, the bob's speed is measured to be 1.45 m/s. How much work was done by frictional forces during the bob's descent?



$h = 1.70 - 1.70\cos 23°$

$= 0.135\,m$

$\Sigma W_F = W_T + W_g + W_{Fric} = \Delta K$

$W_T = 0$ since F_T is always $\perp$ to $\vec{ds}$

$W_{grav} = +mgh = 3.3075\ J$

$W_{Fric} = ?$

$\Delta K = \frac{1}{2}(2.5)(1.45)^2 - 0 = 2.628$

$0 + 3.3075 + W_{Fric} = 2.628$

$\boxed{W_{Fric} = -0.679\ J}$