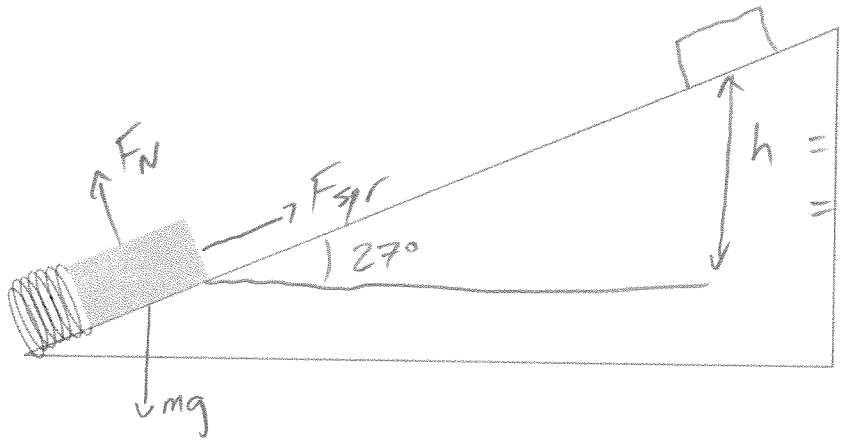
Physics 10154 - Exam #2b

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. (30 pts) A spring is placed at the bottom of a frictionless ramp, parallel to the ramp, inclined 27° above the horizontal. A 1.5 kg mass, initially at rest, compresses the spring by 38 cm. The spring launches the mass up the ramp, and the mass travels a total of 5.2 meters up the ramp as measured from its starting point (38 cm on the spring and 4.82 meters beyond that) before stopping. What is the spring constant, k?



$v_0 = 0$

$v = 0$

$W_N = 0$

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

$W_{grav} = -mgh$

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

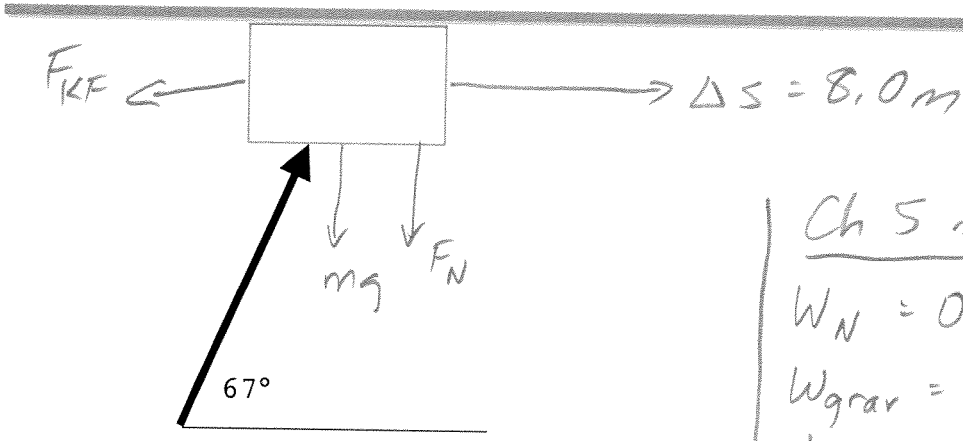
$0 + \frac{1}{2}kx^2 - mgh = 0$

$\frac{1}{2}k(.38)^2 - (1.5)(9.8)(2.36) = 0$

$.0722k = 34.692$

$\boxed{k = 480\ N/m}$

2. (35 pts) A 14-kg block is sliding across a rough ceiling, pushed by a 210 Newton applied force directed 67° above the horizontal. The coefficient of kinetic friction between the block and ceiling is 0.22. If the block starts from rest (assume it moves), how many seconds does it take for the block to slide horizontally 8.0 meters?



Ch 4 method

$\Sigma F_{\parallel} = 210\cos 67° - \mu_k F_N = ma$

$\Sigma F_{\perp} = 210\sin 67° - mg - F_N = 0$

$F_N = 210\sin 67° - (14)(9.8)$

$= 56.1\,N$

$210\cos 67° - (.22)(56.1) = 14a$

$69.7 = 14a \Rightarrow a = 4.98\,m/s^2$

$\Delta s = 8.0$
$v_0 = 0$
$v = ?$
$a = 4.98$
$t = ?$

$8.0 = 0 + \frac{1}{2}(4.98)t^2$

$\boxed{t = 1.8\,s}$

Ch 5 method

$W_N = 0$

$W_{grav} = 0$

$W_{App} = (210)(8.0)\cos 67°$

$= 656.4\,J$

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

$= -(.22)(56.1)(8.0)$

$= -98.7\,J$

$\Sigma W_F = 557.7 = \frac{1}{2}mv^2 - 0$

$v = 8.93\,m/s$

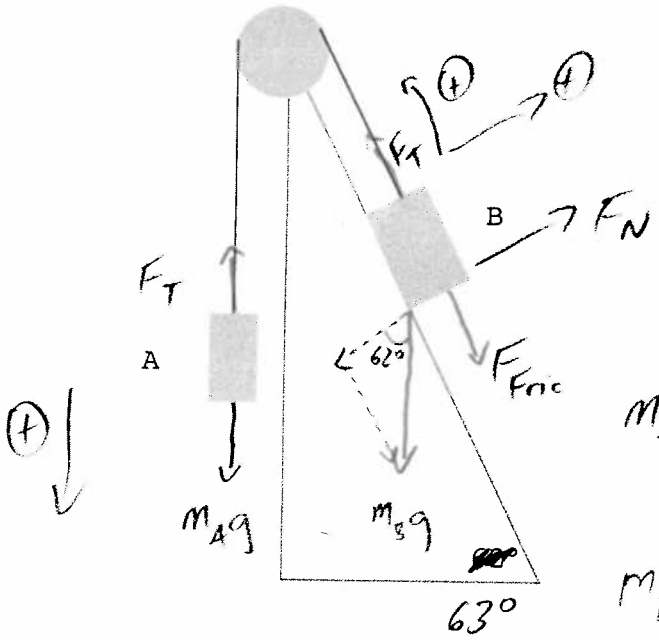
$\Delta s = 8.0$
$v_0 = 0$
$v = 8.93$
$a = ?$
$t = ?$

$8.0 = \frac{1}{2}(0 + 8.93)t$

$\boxed{t = 1.8\,s}$

3. (35 pts) Mass A (12 kg) hangs vertically from a pulley and is connected by a thin string to mass B (17 kg), which is on a 63° inclined ramp. Both masses are initially at rest. The coefficient of static friction between mass B and the slope is 0.75. The coefficient of kinetic friction is 0.45.

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



For m_B: $\Sigma F_\perp = F_N - m_B g \cos 63° = 0$

$F_N = 75.6\ N$

$F_{SF,MAX} = \mu_S F_N = 56.7\ N$

Assume $a = 0$

m_A: $\Sigma F_y = m_A g - F_T = 0$

so $F_T = m_A g = 117.6$

m_B: $\Sigma F_{//} = F_T - m_B g \sin 63° - F_{SF} = 0$

$F_{SF} = F_T - m_B g \sin 63°$

$= 117.6 - 148.4 = -30.8$

↑ from assumed direction in diagram.

Since $F_{SF}(30.8) < F_{SF,MAX}(56.7)$

mass B does not move

$F_{SF} = 31\ N$, up ramp