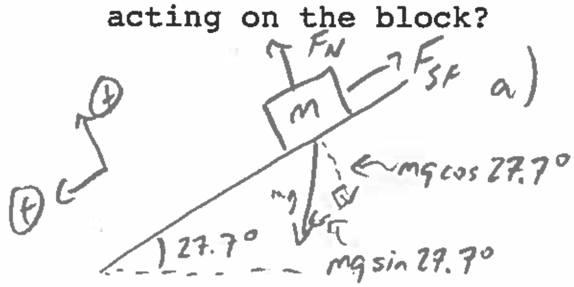
# Physics 10154 - Exam #2A

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. (35 pts) A 35.0-kg block is initially at rest on a 27.7° inclined plane. The coefficient of static friction between the block and the incline is 0.368.

a) Does the block remain at rest? Justify your answer.
b) If a force is applied on the block with a magnitude of 77.0 Newtons directed parallel to and up the incline, what is the magnitude and direction of the force of static friction acting on the block?




a) $\Sigma F_{\perp} = F_N - mg\cos 27.7° = 0$

$\Rightarrow F_N = 303.69$

$F_{SF,MAX} = \mu_s F_N = 112\ N$

$\Sigma F_{\parallel} = +mg\sin 27.7° - F_{SF} = 0$, assumes block doesn't move

$F_{SF} = mg\sin 27.7° = 159.4\ N$

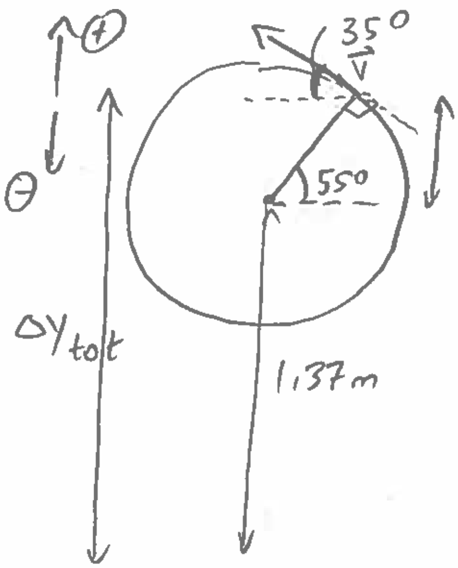
Since $F_{SF} > F_{SF,MAX}$, block moves

b) $\Sigma F_{\parallel} = mg\sin 27.7° - F_{SF} - F_{App} = 0$

$F_{SF} = mg\sin 27.7 - F_{App} = 159.4 - 77.0$

$= 82.4\ N$, up ramp

2. (30 pts) A small rock is tied to the end of a 54.0 cm long string and twirled around in a vertical circle at a constant speed so that it completes 1.58 revolutions per second. When the string makes an angle of 55.0° above the horizontal and the rock is on its way up, the string is cut, and the rock is in free-fall. The center of the circle is 1.37 meters above the ground. How much time does it take for the rock to land on the ground after the string is cut?

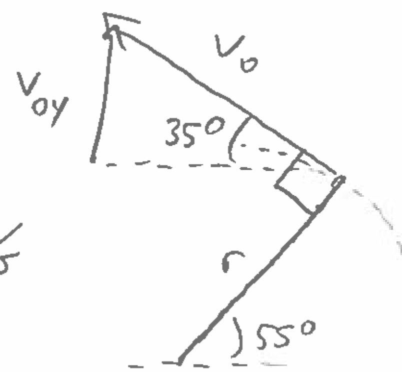



$h = .54 \sin 55° = 0.442\ m$

$\Delta Y_{tot} = 1.37 + 0.442 = 1.812\ m$

$T = \frac{1}{f} = \frac{1}{1.58} = 0.633\ s$

$V = \frac{2\pi(.54)}{.633} = 5.36\ m/s$




y-motion

$\Delta y = -1.812$

$V_{oy} = +5.36 \sin 35° = 3.07\ m/s$

$v_y = ?$

$a_y = -9.8\ m/s^2$

$t = ?$

$v_y^2 = v_{oy}^2 + 2a_y \Delta y = (3.07)^2 + 2(-9.8)(-1.812)$

$= 9.45 + 35.5152 = 44.97$

$\Rightarrow v_y = -6.71\ m/s$ (going down)

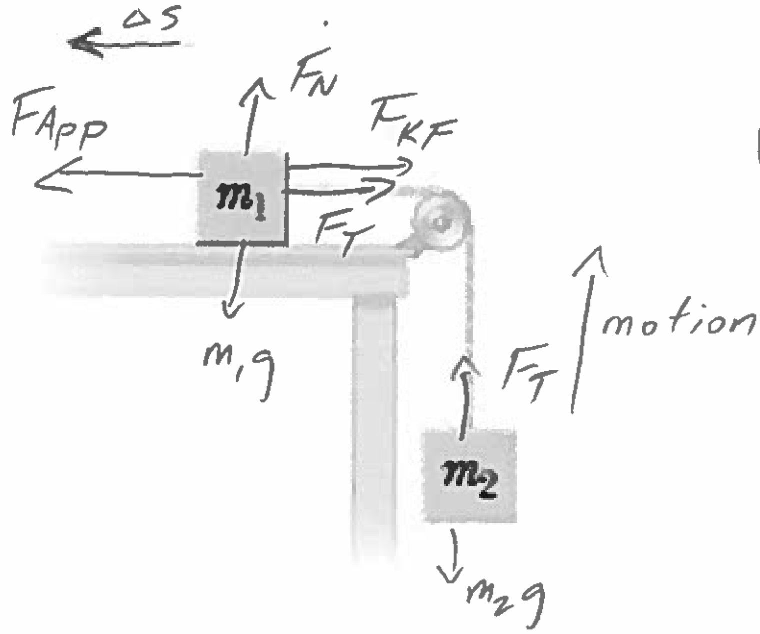
$v_y = v_{oy} + a_y t$

$-6.71 = 3.07 - 9.8t$

$\Rightarrow t = \frac{9.78}{9.8} = \boxed{0.998\ s}$

3. (35 points) In the situation shown below, $m_1$ = 1.25 kg, $m_2$ = 2.50 kg, and the coefficient of kinetic friction between $m_1$ and the table is 0.740. Starting from rest, an applied force of 41.0 N pulls $m_1$ to the left 88.0 cm. Assume $m_1$ and $m_2$ move together with the same speed and acceleration.

a) What is the final velocity of $m_1$?
b) How much work is done by kinetic friction on $m_1$?
c) If there were no friction in this problem, what would be your answer to part (a)?




$W_N = 0$

$W_{grav,1} = 0$

$W_{T,1} = -F_T \Delta s$

$W_{KF} = -\mu_K m g \Delta s$

$W_{grav,2} = -m_2 g \Delta s$

$W_{T,2} = +F_T \Delta s$

$W_{App} = +F_{App} \Delta s$

$$\Sigma W_F = -F_T \Delta s + F_T \Delta s - \mu_K m_1 g \Delta s - m_2 g \Delta s + F_{App} \Delta s = \frac{1}{2} m_{TOT} v^2 - 0$$

$$-7.98 - 21.56 + 36.08 = \frac{1}{2}(3.75) v^2$$

$$6.54 = 1.88 v^2$$

$$\boxed{V = 1.87 \text{ m/s}}$$

b) $\boxed{W_{KF} = -7.98 \text{ J}}$

c) $\Sigma W_F = -21.56 + 36.08 = 1.88 v^2$

$14.52 = 1.88 v^2 \rightarrow \boxed{V = 2.78 \text{ m/s}}$