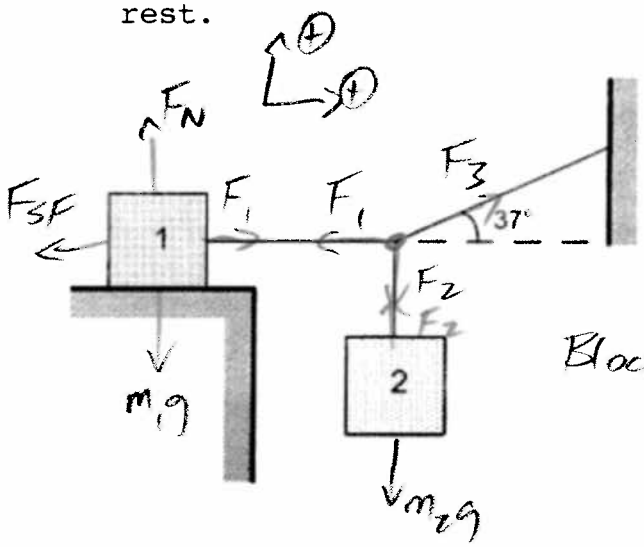
Physics 10154 - Exam #2B

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. (35 pts) Block 1 is 55 kg. The coefficient of static friction between block 1 and the table is 0.48. Find the maximum weight of block 2 for which the system will remain at rest.



"Maximum weight of block 2" means system on the verge of moving, so $F_{SF} = \mu_s F_N$

Block 1: ΣF_x: $F_1 - \mu_s F_N = 0$

$F_1 = \mu_s mg$

$= (.48)(55)(9.8)$

$= 258.7\ N$

Ropes:

ΣF_x: $F_3 \cos 37° - F_1 = 0$

ΣF_y: $F_3 \sin 37° - F_2 = 0$

Since $F_1 = 258.7$, $F_3 = \frac{258.7}{\cos 37°} = 323.95\ N$

$F_2 = F_3 \sin 37° = 194.96\ N$ round to 2 sf

Since $F_2 = m_2 g$, max weight $= 190\ N$

2. (30 pts) The International Space Station (ISS) maintains a roughly circular orbit with an altitude of 242 miles above the Earth's surface.

a) What is the orbital velocity if the ISS, in miles/hour?
b) How many orbits does the ISS complete in 1.00 days?

$h = 242 \text{ miles} = 3.89 \times 10^5 \text{ m}$

$r = h + R_E = 6.78 \times 10^6 \text{ m}$

a) $v_{orbit} = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})}{6.78 \times 10^6}}$

$= 7670 \text{ m/s} \cdot \frac{1 \text{ mi}}{1609 \text{ m}} \cdot \frac{3600 \text{ s}}{1 \text{ hr}}$

$= \boxed{17,200 \text{ mi/hr}}$

b) $T = \frac{2\pi r}{v} = \frac{2\pi (6.78 \times 10^6)}{7670}$

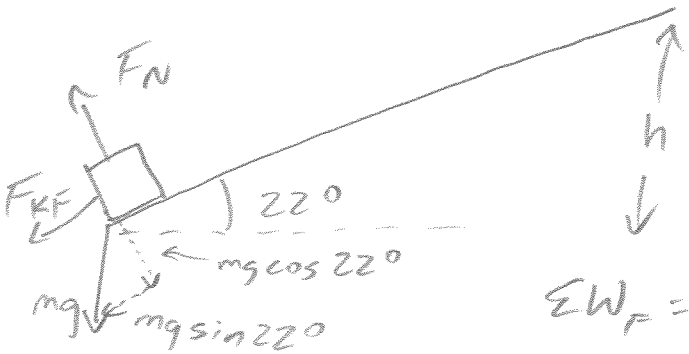
$= 5554 \text{ s}$

$1 \text{ day} = 86400 \text{ s}$

so # of orbits $= \frac{86400 \text{ s}}{5554 \text{ s/orbit}} = \boxed{15.6 \text{ orbits}}$

3. (35 pts) A 3.88 kg block is given an initial velocity of 12.5 m/s at the base of a long ramp inclined 22.0° above the horizontal. The block slides along the ramp for 17.1 meters before coming to a halt.

a) What is the work done by kinetic friction on the block?
b) What is the coefficient of kinetic friction between the block and the ramp?
c) How far would the block have gone up the ramp in the absence of friction?



a) $h = 17.1 \sin 22°$

$= 6.406\ m$

$\Sigma W_F = W_N + W_g + W_{KF} = \Delta K$

$W_N = 0$

$W_g = -mgh = -243.58\ J$

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

$= -\mu_k mg\cos 22° \Delta s = ?$

$\Sigma W_F = 0 - 243.58 + W_{KF} = 0 - \frac{1}{2}mv_0^2$

$-243.58 + W_{KF} = -303.13$

$W_{KF} = -59.5\ J$

b) $-\mu_k mg\cos 22° \Delta s = -59.5$

$-\mu_k (3.88)(9.8)\cos 22°(17.1) = -59.5 \Rightarrow \mu_k = .0988$

c) $\Sigma W_F = W_g = \Delta K$

$-mgh = 0 - \frac{1}{2}mv_0^2$

$h = \frac{v_0^2}{2g} = 7.97$

$\Delta s = \frac{h}{\sin 22°} = 21.3\ m$