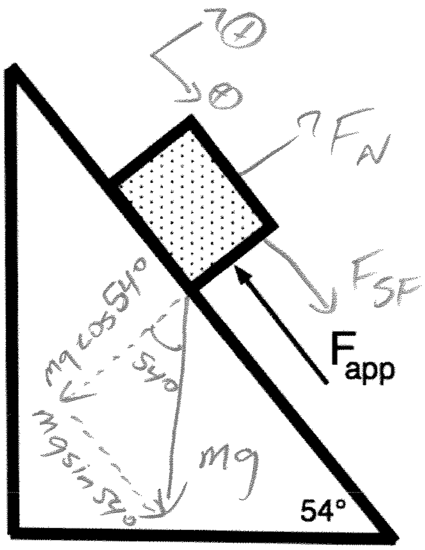
Physics 10154 - Exam #2D

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 95-N applied force is parallel to the incline below, pushing on an 8.2 kg block initially at rest on an incline with a coefficient of static friction of 0.68. Does the block move? If no, find the magnitude and direction of the force of static friction. If yes, justify your answer mathematically.



$mg\sin 54° = 65\text{ N}$ down ramp

$F_{App} = 95\text{ N}$ up ramp

so F_{SF} points down ramp

Assume $a = 0$

$\Sigma F_{\parallel} = F_{SF} + mg\sin 54° - F_{App} = 0$

$F_{SF} = F_{App} - mg\sin 54°$

$= 95 - 65.01 =$ **30 N, down ramp**

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

$= \mu_s mg\cos 54°$

$= (.68)(8.2)(9.8)\cos 54° = 32\text{ N}$

since $F_{SF} < F_{SF,MAX}$, block doesn't move

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

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

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

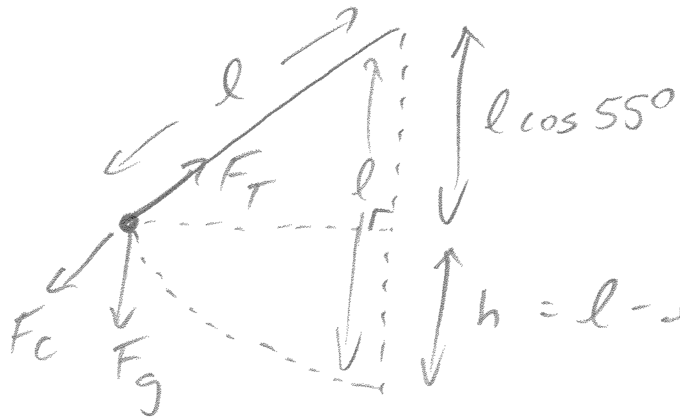
b) $$T = \frac{2\pi r}{v} = \frac{2\pi (6.78 \times 10^6)}{7670}$$

$$= 5554 \text{ s}$$

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

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

3. (35 pts) A swing is made from a 3.80 m rope that will tolerate a maximum tension of 945 Newtons without breaking. Initially, the swing hangs vertically. The swing is then pulled back at an angle of 55.0° with respect to the vertical and released from rest. Assuming there are no frictional forces, what is the mass of the heaviest person who can ride the swing?



$h = l - l\cos 55° = 1.62$

$$\Sigma W_F = W_T + W_c + W_g = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mv_0^2$$

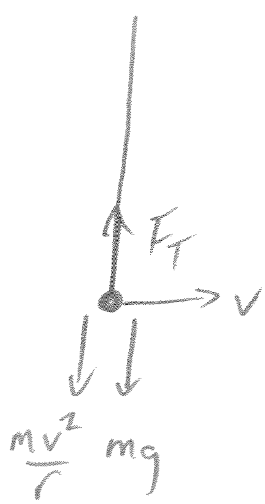
$$W_T = W_c = 0 \text{ (both radial)}$$

$$W_g = +mgh$$

$$0 + 0 + mgh = \tfrac{1}{2}mv^2 - 0$$

$$v = \sqrt{2gh} = 5.636 \text{ m/s}$$

At bottom



$$\Sigma F_{rad} = \frac{mv^2}{r} + mg - F_T = 0$$

$$m(8.36) + m(9.8) = 945$$

$$18.16m = 945$$

$$\boxed{m = 52.0 \text{ kg}}$$