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) A satellite in a circular orbit around the Earth has a period of 4.4 hours.

a) What is the altitude of the satellite above the Earth's surface, in miles?
b) What is the acceleration due to gravity at this altitude?

a) $T = 4.4\ hrs = 15840\ s$

$$r^3 = \frac{GMT^2}{4\pi^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})(15840)^2}{4\pi^2}$$

$$= 2.535\times10^{21}$$

$$r = 1.36\times10^{7}\ m$$

$$h = r - R_E = 1.36\times10^{7} - 6.38\times10^{6}$$

$$= 7.255\times10^{6}\ m$$

$$= \boxed{4500\ miles}$$

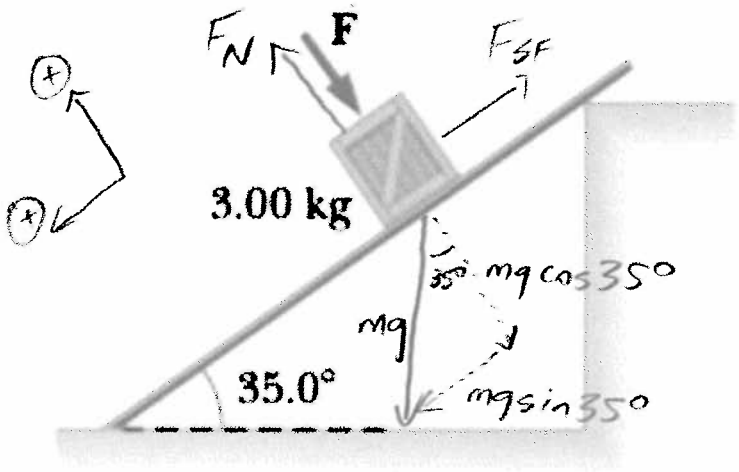
b) $$"g" = \frac{GM}{r^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{(1.36\times10^{7})^2}$$

$$= \boxed{2.2\ m/s^2}$$

2. (35 pts) The coefficient of static friction between the crate and the incline is 0.210.

a) If the applied force shown is equal to 125 N and the crate remains stationary, what is the force of static friction acting on the crate?

b) What is the minimum applied force required in order to ensure the crate does not begin to slide?



a)

$\Sigma F_\perp = F_N - F_{App} - mg\cos 35° = 0$

$\Sigma F_{||} = mg\sin 35° - F_{SF} = 0$

$F_{SF} = mg\sin 35°$

$= 16.9\ N$, up ramp

Just to check $F_N = 125 + mg\cos 35° = 149\ N$

$F_{SF,MAX} = \mu_s F_N = 31.3\ N$, so no motion

b) Need $F_{SF} = F_{SF,MAX}$ at threshold of motion

so $\mu_s F_N = 16.9\ N$

$F_N = \frac{16.9}{0.210} = 80.5\ N$

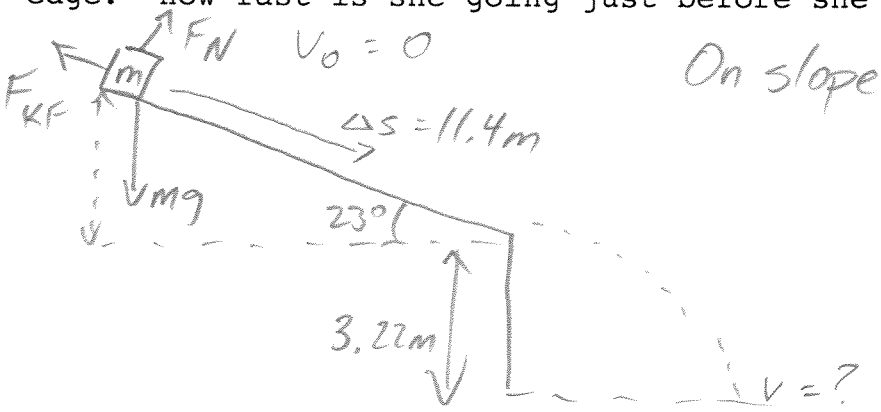
We know $F_N = F_{App} + mg\cos 35°$

so $F_{App} = F_N - mg\cos 35°$

$= 80.5 - 24.1 = 56.4\ N$

3. (35 pts) A skier, starting from rest, moves down a slope that makes a 23.0° angle below the horizontal. The coefficient of kinetic friction between her skis and the snow is 0.140. She skis a distance of 11.4 meters along the slope before coming to the edge of a small cliff.

Without slowing down, she skis off the cliff and lands downhill at a point whose vertical distance is 3.22 meters below the edge. How fast is she going just before she lands?



On slope, $h = 11.4 \sin 23° = 4.45\ m$

$\Sigma W_F = W_{grav} + W_N + W_{KF} = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$

W_{grav} (entire motion) $= +mgh = m(9.8)(4.45+3.22) = 75.2m$

$W_N = 0$

W_{KF} (on slope only) $= \mu_k F_N \Delta s \cos 180°$

$= -\mu_k \underline{mg\cos 23°}\,\Delta s$

$= -(.140)m(9.8)(\cos 23°)(11.4)$

$= -14.4\ m$

$\Sigma W_F = 75.2m + 0 - 14.4m = \frac{1}{2}mv^2 - 0$

$60.8 = \frac{1}{2}v^2$

$v = 11.0\ m/s$