Physics 10154 - Exam #2C

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?

$T = 4.4\ hrs = 15840\ s$

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

$= 2.535\times10^{21}$

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

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

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

$= \boxed{4500\ miles}$

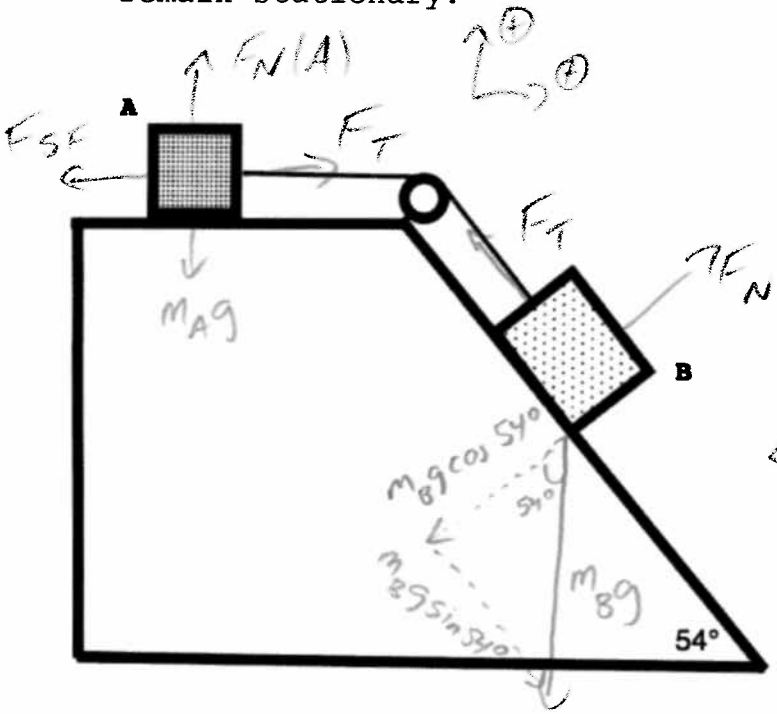
b) $"g" = \frac{GM}{r^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})}{(1.36\times10^{7})^2}$

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

8.0

2. (35 pts) Block A ([redacted] kg) is on a horizontal surface with a coefficient of static friction of 0.45. Block B is on a frictionless slope.

a) If Block B has a mass of 1.5 kg, what is the magnitude and direction of the force of static friction on block A?
b) What is the maximum mass of block B for which the system will remain stationary?



For B:

$\Sigma F_{\parallel} = m_B g \sin 54° - F_T = 0$

$F_T = m_B g \sin 54°$

$= 11.89 N$

For A:

$\Sigma F_x : F_T - F_{SF} = 0$

$F_{SF} = F_T = 12 N$

Just to check, $F_{SF,MAX} = \mu_s F_N$

$= \mu_s m_A g = 13.23 > F_{SF}$, so A doesn't move.

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b) Want $F_{SF} = F_{SF,MAX}$, so $F_T = 13.23 N$

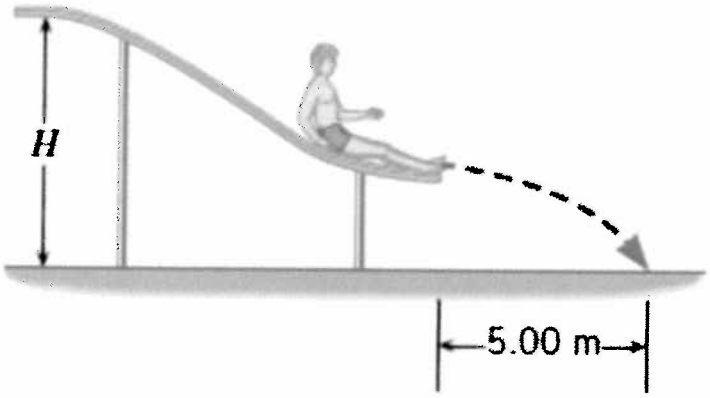
For B, $\Sigma F_{\parallel} = m_B g \sin 54° - F_T = 0$

so $m_B g \sin 54 = 13.23$

$m_B = 1.7 kg$

75.0 kg

3. (35 pts) A slide is constructed so that swimmers, starting from the top of the slide, leave the end of the slide traveling horizontally. One person hits the water 5.00 meters from the end of the slide in a time of 0.420 seconds after leaving the slide. If the initial height of the person above the water is 9.50 meters, how much work is done by kinetic friction during the slide?



Ballistic motion

$\Delta x = 5\ m$
$v_{0x} = ?$
$v_x = ?$
$a_x = 0$
$t = 0.42s$

$v_{0x} = \frac{\Delta x}{t}$

$= 11.9\ m/s$

↑ v at bottom of slide.

$\Delta y = ?$
$v_{0y} = 0$
$v_y = ?$
$a_y = -9.8$
$t = 0.420s$

$\Delta y = v_0 t + \frac{1}{2} a t^2$

$= 0 + \frac{1}{2}(-9.8)(.42)^2$

$= 0.864\ m$

so slide height "h"

$= 9.50 - .864 = 8.636m$

Slide motion

$\Sigma W_F = W_g + W_{KF} = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2$

$mgh + W_{KF} = \frac{1}{2} m v^2 - 0$

↑ use 8.636 ← ↑ use 11.9 ←

$6347.5 + W_{KF} = 5310.4$

$W_{KF} = -1040\ J$