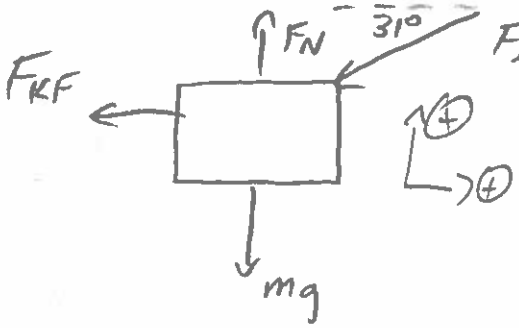
# Physics 10154 - Exam #2B

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) A 54.0-kg block is sliding across a rough horizontal surface with an initial speed of 16.5 m/s. Seeing a helpless puppy some unknown distance in front of the block, a brave astronomer estimates that the block must have an acceleration of at least -8.50 m/s² to stop before hitting the puppy. The astronomer attempts to stop the block by applying a constant force of 325 Newtons in a direction 31.0° below the horizontal. The coefficient of kinetic friction is 0.422. Does the block stop in time to save the puppy?




$\Sigma F_y = F_N - F_{App}\sin 31° - mg = 0$

$F_N = F_{App}\sin 31° + mg$

$= 696.6\ N$

$\Sigma F_x : -F_{KF} - F_{App}\cos 31° = ma$

$-\mu_K F_N - F_{App}\cos 31° = ma$

$-293.96 - 278.58 = 54a$

$a = -10.6\ m/s^2$, block stops in time

Could also be done with work-energy, many different ways, $\Delta s$ to puppy = 16.0 m.

Find $\Delta s$ that results in $v = 0$, compare to 16.0 m.

2. (30 pts) A geosynchronous satellite orbits the Earth with an orbital period of exactly 23 hours and 56 minutes. What is the distance of this satellite from the center of the Earth, expressed in Earth radii? Answer with 2 SF.

$$T = 86160\,s$$

$$r^3 = \left(\frac{GMT^2}{4\pi^2}\right)$$

$$= \frac{(6.67\times10^{-11})(5.98\times10^{24})(86160)^2}{4\pi^2}$$

$$= 7.50\times10^{22}\,m^3$$

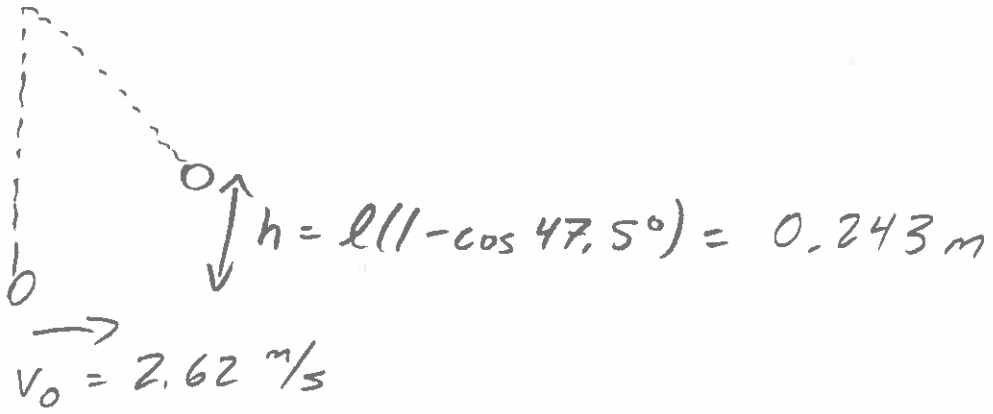
$$\Rightarrow r = 4.22\times10^{7}\,m \cdot \frac{1\,R_E}{6.38\times10^{6}\,m}$$

$$= \boxed{6.6\,R_E}$$

3. (35 points) A small pendulum bob of mass 1.25 kg is attached to a string of length 75.0 cm. Initially, the string is vertical, and the rock is at the bottom of a pendulum arc. The rock is given an initial horizontal speed of 2.62 m/s, and by the time the bob stops at its maximum height, the string makes an angle of 47.5° with respect to the vertical.

a) How much work was done by frictional forces on the rock during this motion?

b) If there were no friction, what angle would the string make with the vertical when the stops at its maximum height?




a) $\Sigma W_F = W_g + W_{Fric} = \Delta K$

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

$= -2.981 + W_{Fric} = -4.290$

$$\boxed{W_{Fric} = -1.31\ J}$$

b) $\Sigma W_F = -mgh = -\frac{1}{2}mv_0^2$

$$h = \frac{v_0^2}{2g} = 0.350$$

$0.350 = .750(1 - \cos\theta)$

$0.467 = 1 - \cos\theta \Rightarrow \theta = \cos^{-1}(.533) = \boxed{57.8°}$