Physics 10154 - Fall 2018 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) The Moon completes one orbit around the Earth every 27.3 days. Assume a circular orbit, and answer with 3 SF.

a) Find the orbital radius of the Moon's orbit (miles).
b) Determine the Moon's orbital velocity (miles/hour).

$$T = 27.3 \text{ days} \cdot \frac{86400 \text{ s}}{\text{day}} = 2.359 \times 10^6 \text{ s}$$

$$r^3 = \frac{GMT^2}{4\pi^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})(2.359\times10^6)^2}{4\pi^2}$$

$$= 5.622 \times 10^{25}$$

$$r = 3.83\times10^8 \text{ m} \cdot \frac{1 \text{ mile}}{1609 \text{ m}}$$

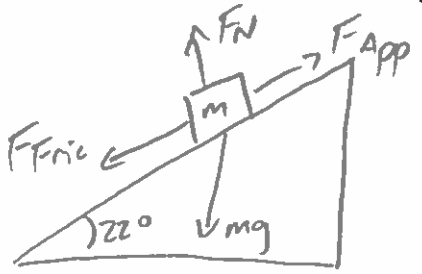
$$= \boxed{238{,}000 \text{ miles}}$$

b) $$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67\times10^{-11})(5.98\times10^{24})}{3.83\times10^8}}$$

$$= 1021 \text{ m/s} \cdot \frac{3600 \text{ s}}{\text{hr}} \cdot \frac{1 \text{ mi}}{1609 \text{ m}} = \boxed{2280 \text{ mi/hr}}$$

2. (35 pts) A 55-kg crate is initially at rest on a rough inclined plane that makes an angle of 22° above the horizontal. An applied force of 450 Newtons acts on the crate in a direction parallel to and up the incline. The coefficient of static friction is 0.40, and the coefficient of kinetic friction is 0.24.

a) Does the crate move?
b) If yes, what is its acceleration (magnitude and direction)? If no, what is the magnitude and direction of the force of static friction acting on the crate?



Parallel component of gravity is $mg\sin 22° = 202N$. F_{App} is larger so F_{Fric} points down ramp

$$F_{SF,MAX} = \mu_S F_N = \mu_S mg\cos 22° = 200N$$

$$\Sigma F_{\parallel} = F_{App} - mg\sin 22° - F_{SF} = 0$$

$$F_{SF} = 450 - 202 = 248N$$

Since $F_{SF} > F_{SF,MAX}$, the block moves.

b) $$\Sigma F_{\parallel} = F_{App} - mg\sin 22° - \mu_K mg\cos 22° = ma$$

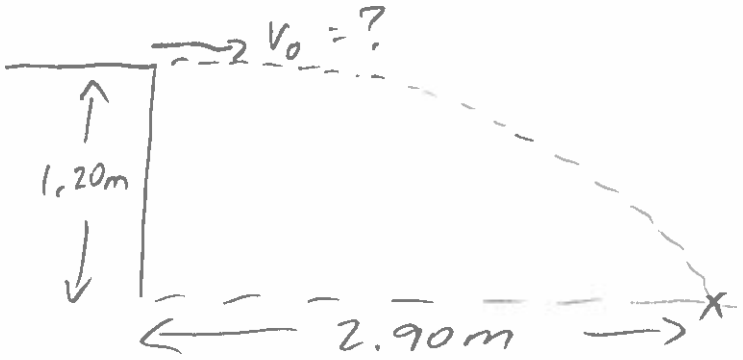
$$450 - 202 - 120 = 55a$$

$$128 = 55a$$

$a = 2.3\ m/s^2$, up ramp

3. (35 pts) A 3.50-kg block is sliding across a rough, horizontal table with an initial speed of 6.40 m/s. It travels some unknown distance across the table, losing some speed in the process, before sliding horizontally off the edge and landing 2.90 meters horizontally away from the table. Assume the tabletop is 1.20 meters above the ground.

How much work is done by frictional forces as the mass slides across the table?



Free-fall motion:

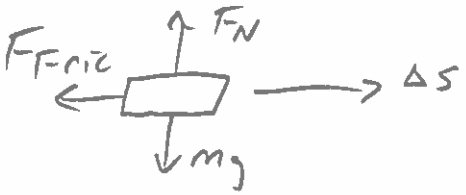
$\Delta x = 2.90\,m$	$\Delta y = 1.20\,m$
$v_{0x} = ?$	$v_{0y} = 0$
$v_x = ?$	$v_y = ?$
$a_x = 0$	$a_y = 9.8\,m/s^2$
$t = ?$	$t = ?$

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

$1.20 = 4.9 t^2$

$t = 0.495\,s$

$$v_{0x} = \frac{\Delta x}{t} = \frac{2.90}{.495} = 5.86\ m/s$$



$W_N = 0$

$W_{grav} = 0$

$W_{Fric} = ?$

$\Delta K = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2$

$= \frac{1}{2}(3.50)(5.86^2 - 6.40^2)$

$= -11.6\ J$

$0 + 0 + W_{Fric} = -11.6\,J$

$\Rightarrow \boxed{W_{Fric} = -11.6\ J}$