Physics 10154 - Exam #2B

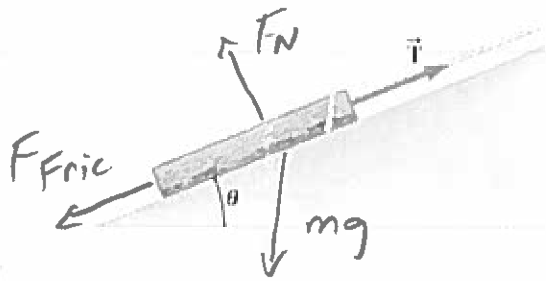
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (35 pts) A 1950-Newton log is initially at rest on a ramp inclined 27.5° above the horizontal. The coefficient of static friction between the log and ramp is 0.850. The coefficient of kinetic friction is 0.645. A tension force directed parallel to the ramp as shown below has a magnitude of 2580 N.

$m = \frac{1950}{9.8} = 199$ kg

a) Does the log move? Justify your answer.

b) If the log does not move, what is the magnitude and direction of the force of static friction on the log? If the log does move, what is the magnitude and direction of its acceleration?



$mg_{\parallel} = 900$ N down

$F_T = 2580$ N up, so

friction will point ↙ to oppose $F_{\parallel}$ or motion.

Assume $a = 0$ $\Sigma F_{\perp} = F_N - mg\cos 27.5° = 0$

$\Sigma F_{\parallel} = F_T - mg\sin 27.5° - F_{SF} = 0$

$F_{SF} = 2580 - 900 = 1680$ N

$F_{SF,MAX} = \mu_s F_N = \mu_s (mg\cos 27.5°) = 1470$ N

Since $F_{SF} > F_{SF,MAX}$, **log moves**

Find a:

$\Sigma F_{\parallel} = F_T - mg\sin 27.5° - \mu_k F_N = ma$

$2580 - 900 - (.645)(mg\cos 27.5°) = 199a$

$564.36 = 199a$ ⇒ **$a = 2.84$ m/s², up ramp**

2. (30 pts) A satellite circles the Earth in an orbit whose radius is 3.30 times the Earth's radius. (a) What is the orbital period of the satellite (<u>in hours</u>) and (b) What is the orbital velocity of the satellite (<u>in miles/hour</u>)?

a) $r = 3.30 R_E \rightarrow 2.105 \times 10^7 m$

$$T^2 = \frac{4\pi^2 r^3}{GM} = \frac{4\pi^2 (2.105 \times 10^7)^3}{(6.67 \times 10^{-11})(5.98 \times 10^{24})}$$

$$= 9.237 \times 10^8$$

$$T = 30392 \text{ s}$$

$$= \boxed{8.44 \text{ hrs}}$$

b) $$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})}{2.105 \times 10^7}}$$

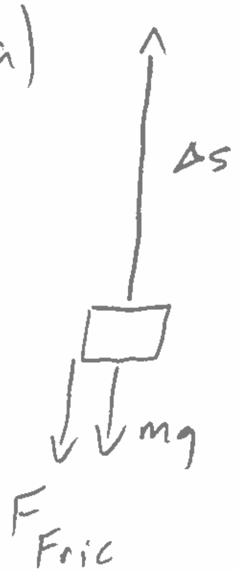
$$= \sqrt{1.895 \times 10^7}$$

$$= 4353 \text{ m/s} \cdot \frac{1 \text{ mi}}{1609 \text{ m}} \cdot \frac{3600 \text{ s}}{1 \text{ hr}}$$

$$= \boxed{9740 \text{ mi/hr}}$$

3. (35 pts) A 1.50-kg object is launched vertically upward with an initial speed of 28.4 m/s. Due to air resistance, the object doesn't rise to quite the same maximum height as it would if we were dealing with an ideal problem. Instead, the object rises to a maximum height of 38.9 meters. (a) How much work is done by the resistive force during this motion? (b) What is the magnitude of the average resistive force on the object?

a)



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

$$W_g = -mg\Delta s = -571.83$$

$$W_{Fric} = ?$$

$$\Delta K = 0 - \tfrac{1}{2} m v_0^2 = {}^{-}604.92$$

$$-571.83 + W_{Fric} = {}^{-}604.92$$

$$\boxed{W_{Fric} = -33.1\ J}$$

b)

$$W_{Fric} = F_{Fric} \cdot \Delta s \cdot \cos 180^\circ$$

$$-33.1 = F_{Fric} \cdot (38.9) \cdot (-1)$$

$$\boxed{F_{Fric} = 0.851\ N}$$