Phys 10154 - Fall 2006 - Exam #7A

Be sure to answer with the proper units and significant figures. Indicate your answers clearly with boxes. SHOW ALL WORK. Even if your answer is correct, I will deduct points if I can't see how you solved the problem. Both problems are worth 50 points.

1. A turntable with a radius of 35 ~~cm~~ mm has a coin placed on the outer rim. The turntable initially completes 75 revolutions per minute, and it is accelerated to 130 rev/min over the course of 12 seconds. After 12 seconds, it rotates at a constant rate of 130 rev/min. Find:

a) The angular acceleration during the 12 sec time interval.
b) The linear displacement of the coin during the 12 sec.
c) The total acceleration of the coin the instant before the 12 sec interval ends.

d) While the turntable moves at a constant rate of 130 rev/min, what must be the minimum coefficient of static friction between the coin and turntable to keep the coin from flying off the turntable?

$r = .035\ m$

$\omega_0 = 75 \frac{rev}{min} \cdot \frac{1\ min}{60\ s} \cdot \frac{2\pi\ rad}{1\ rev} = 7.85\ rad/s$

$\omega = 130 \frac{rev}{min} = 13.6\ rad/s$

a) $\omega = \omega_0 + \alpha t \qquad \alpha = \frac{\omega - \omega_0}{t} = \frac{13.6 - 7.85}{12} = \boxed{.48\ rad/s^2}$

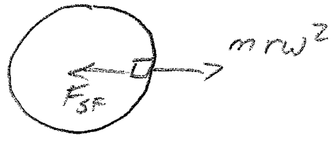
b) $\Delta\theta = \frac{1}{2}(\omega + \omega_0)t = \frac{1}{2}(7.85 + 13.6)(12) = 129\ rad$

$\Delta s = r\Delta\theta = \boxed{4.5\ m}$

c) $a_{tan} = r\alpha = .0168\ m/s^2$

$a_{rad} = r\omega^2 = 6.5\ m/s^2 \qquad a_{tot} = \sqrt{a_t^2 + a_r^2} = \boxed{6.5\ m/s^2}$

d)



$\Sigma F_{rad} = \mu_s F_N - mr\omega^2 = 0$

$\mu_s mg = mr\omega^2$

$\mu_s = \frac{r\omega^2}{g} = \boxed{0.66}$

2. A new launching system will attempt to fling a payload vertically upward as far as possible. If the system gives the object an initial speed of 4500 miles/hour, what is the maximum altitude above Earth's surface that can be reached by the object before it begins falling back toward the ground? Ignore air resistance.

$V_0 = 4500 \text{ mi/hr} = 2011 \text{ m/s}$

The Mass of Earth is 5.98×10^{24} kg
The Radius of Earth is 6.38×10^{6} m
The Gravitational Constant is 6.67×10^{-11} N-m^2/kg^2

$$\Sigma W_F = W_{grav} = \Delta K$$

$$-(U_f - U_i) = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mv_0^2$$

$$U_i - U_f = 0 - \tfrac{1}{2}mv_0^2$$

$$U_i = -\frac{GMm}{R_E} = -6.25 \times 10^7 \, m$$

$$U_f = -\frac{GMm}{R_E + h} = -\frac{3.99 \times 10^{14} \, m}{R_E + h}$$

$$-6.25 \times 10^7 + \frac{3.99 \times 10^{14}}{R_E + h} = -\tfrac{1}{2}(2011)^2$$

$$\frac{3.99 \times 10^{14}}{R_E + h} = 6.05 \times 10^7$$

$$R_E + h = \frac{3.99 \times 10^{14}}{6.05 \times 10^7} = 6.595 \times 10^6 \, m$$

$$h = 2.15 \times 10^5 \, m \quad \text{or} \quad \boxed{2.2 \times 10^5 \, m}$$

or 134 mi