Physics 10154 - Exam #7A

Answer the following two questions. Be sure to clearly indicate your answer with a circle or box. Show all work. If I cannot see how you arrived at an answer, I will deduct points!

1. A rocket is launched into the air with some initial speed and is then in free-fall. Ignoring friction, suppose the rocket reaches a maximum altitude above the Earth's surface of 1200 miles. What must be the initial velocity of the rocket?

Hint: You may not use mgh for gravitational potential energy, nor can you assume constant acceleration since gravitational force gets weaker as you move further from the Earth.

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

$-(U_f - U_i) = K_f - K_i$ $\quad (1200\ mi = 1.93 \times 10^6\ m)$

$U_i - U_f = K_f - K_i$

$U_i = -\frac{GMm}{R_E} = -\frac{(6.67\times10^{-11})(5.98\times10^{24})m}{6.38\times10^6} = -6.252\times10^7\ m$

$U_f = -\frac{GMm}{R_E+h} = -\frac{(6.67\times10^{-11})(5.98\times10^{24})m}{6.38\times10^6+1.93\times10^6} = -4.800\times10^7\ m$

$K_i = \frac{1}{2}mv_0^2$

$K_f = 0$

$-6.252\times10^7 m + 4.800\times10^7 m = 0 - \frac{1}{2}mv_0^2$

$-1.452\times10^7 = -\frac{1}{2}v_0^2$

$\boxed{v_0 = 5400\ m/s}$

2. A child stands at the rim of a merry-go-round of radius 2.2 meters. The merry-go-round starts from rest and accelerates uniformly at a tangential rate of 1.4 m/s2.

a) At what time, t, does the tangential acceleration equal the centripetal acceleration?

b) How much angular distance (in radians) has the merry-go-round moved through during its acceleration?

c) Assuming the merry-go-round continues rotating at a constant speed (from part b) after the initial period of acceleration, what must be the coefficient of static friction between the child's shoes and the merry-go-round if he is on the verge of slipping during this period of constant motion?

a) $\frac{v^2}{r} = 1.4 \Rightarrow v^2 = (1.4)(2.2) \Rightarrow v = 1.755\ m/s$

$\Delta s =$
$v_0 = 0$
$v = 1.755\ m/s$
$a = 1.4\ m/s^2$
$t =$

$v = v_0 + at$

$1.755 = 0 + 1.4t$

$\boxed{t = 1.3\ s}$

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b) $v^2 = v_0^2 + 2a\Delta s$

$1.755^2 = 0^2 + 2(1.4)\Delta s \qquad \Delta s = 1.1\ m$

$\Delta\theta = \frac{\Delta s}{r} = \boxed{0.50\ rad}$

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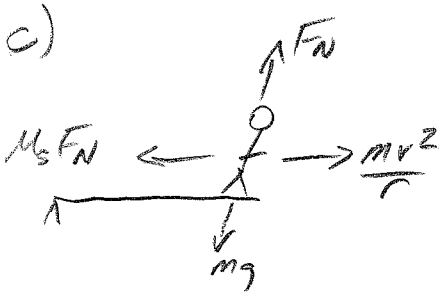
c)



$\Sigma F_{rad} = \frac{mv^2}{r} - \mu_s mg = 0$

$\frac{v^2}{r} = \mu_s g$

$\mu_s = \frac{v^2}{rg} = \frac{(1.755)^2}{(2.2)(9.8)} = \boxed{0.14}$