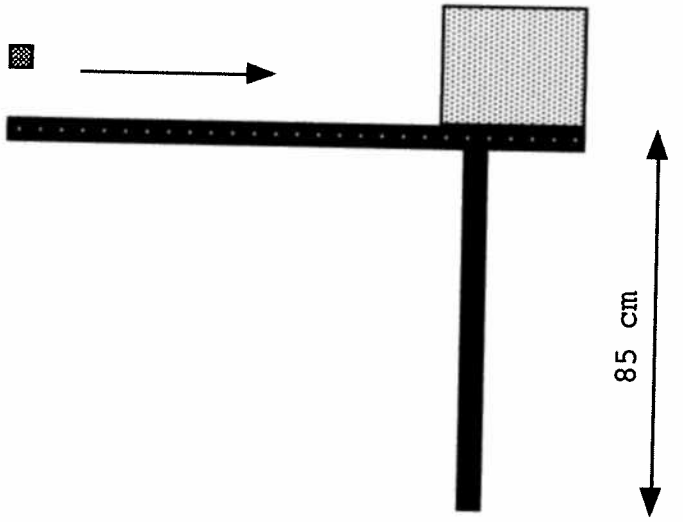
Physics 10154 - Exam #3a

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. (40 pts) A 350 gram block rests at the edge of a table 85 cm above the ground. A 12 gram bullet is fired into the block, and the bullet embeds itself in the block. After the impact, the bullet-block mass lands a horizontal distance of 1.6 meters from the bottom of the table. What was the initial velocity of the bullet?



X	Y
$\Delta x = 1.6$	$\Delta y = .85m$
$V_{ox} = ?$	$V_{oy} = 0$
$V_x = ?$	$V_y = ?$
$a_x = 0$	$a_y = 9.8$
$t = ?$	$t = ?$

y-motion: $\Delta y = V_{oy} t + \frac{1}{2} a_y t^2$

$0.85 = 4.9 t^2 \longrightarrow t = 0.4165$

x-motion: $\Delta x = V_{ox} t =$

$1.6 = V_{ox}(.4165) \longrightarrow V_{ox} = 3.84$

Collision: $m_1 V_{1i} + m_2 V_{2i} = (m_1 + m_2) V_f$

$.012 V_{1i} + 0 = .362(3.84)$

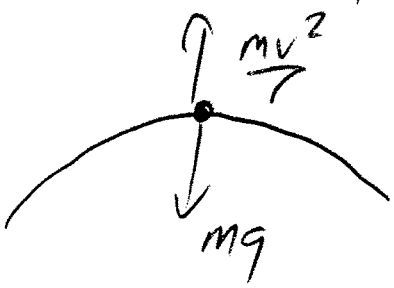
$V_{1i} = 116 \rightarrow$ **120 m/s**

2. (30 pts) A ferris wheel is out of control and accelerating uniformly at a rate of 0.25 m/s^2. Suppose the wheel began moving from rest and has a radius of 7.5 meters.

a) How much time will elapse before people who aren't strapped in start getting thrown off the top (when the centrifugal force overcomes their weight)?

b) How many revolutions will the ferris wheel make in this time?

At top of wheel, want $\frac{mv^2}{r} = mg$



$\frac{v^2}{r} = 9.8$

$v^2 = (9.8)(7.5)$

$v = 8.57\ m/s$

$\Delta s = ?$

$v_0 = 0$

$v = 8.57$

$a = 0.25\ m/s^2$

$t = ?$

$v = v_0 + at$

$8.57 = 0 + .25t$

$\boxed{t = 34\ s}$

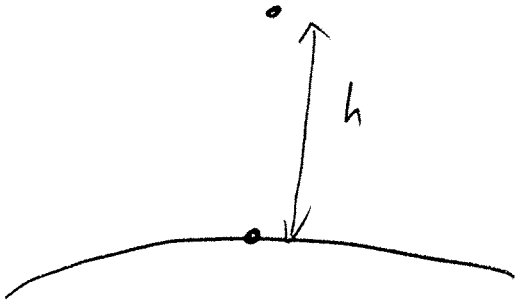
$v^2 = v_0^2 + 2a\Delta s$

$(8.57)^2 = 0 + 2(.25)\Delta s$

$\Delta s = 146.9\ m \cdot \frac{1\ rev}{2\pi(7.5)\ m} = \boxed{3.1\ rev}$

3. (30 pts) A rocket is launched straight up from the surface of the Earth with an initial velocity of 15,800 miles/hour. To what maximum altitude above the Earth's surface will the rocket rise? Please keep in mind the acceleration due to gravity is not constant for this problem.

$V_0 = 15800\ mi/hr = 7062\ m/s$



$W_{grav} = \Delta K$

$-(U_f - U_i) = \Delta K$

$U_i - U_f = K_f - K_i$

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

$= -6.25\times10^{7}\ m$

$U_f = -\frac{GM_E m}{r} = -\frac{3.99\times10^{14}\ m}{r}$

$K_i = \frac{1}{2}mv_0^2 = 2.49\times10^{7}\ m$

$K_f = 0$

$-6.25\times10^{7}\ m - \left(-\frac{3.99\times10^{14}\ m}{r}\right) = -2.49\times10^{7}\ m$

$\frac{3.99\times10^{14}}{r} = -2.49\times10^{7} + 6.25\times10^{7}$

$r = \frac{3.99\times10^{14}}{3.76\times10^{7}} = 1.06\times10^{7} = R_E + h$

$\boxed{h = 4.22\times10^{6}\ m}$ or 2600 miles