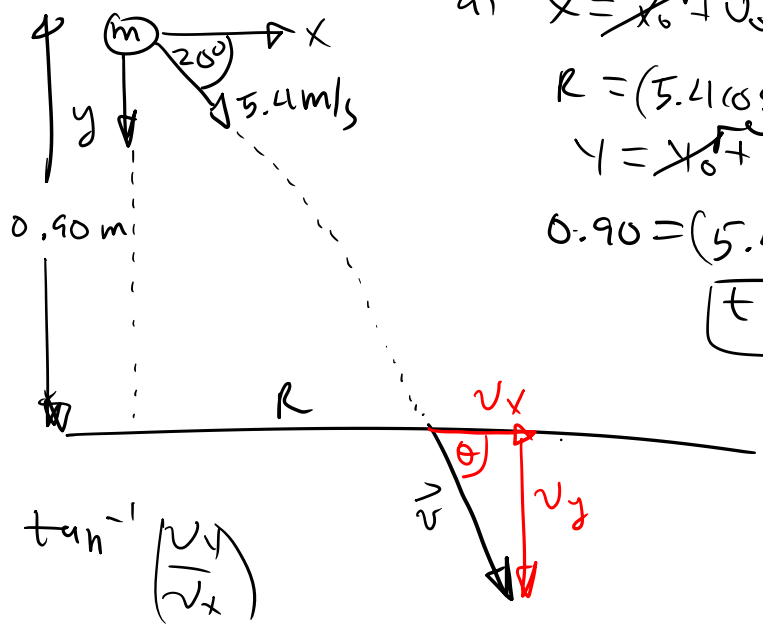
Name: KEY

Physics 50/Winter 2016
EXAM 2

Make sure to show all work in complete detail! NO CREDIT WILL BE GIVEN IF NO WORK IS SHOWN!!!! Unless indicated, state all answers in SI units.

1. In a game of basketball, a forward makes a bounce pass to the center. The ball is thrown with an initial speed of 5.4 m/s at an angle of 20° below the horizontal. It is released 0.90 m above the floor (10 pts)

   a) Calculate the horizontal distance traveled by the ball before bouncing.
   b) Calculate the angle at which it hits the floor.



a) $x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

$R = (5.4\cos 20)t$

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$0.90 = (5.4\sin 20)t + 4.9t^2$

$t = 0.28\ s$

$v_x = v_{0x} = 5.4\cos 20°$

$= 5.07\ \frac{m}{s}$

$v_y = v_{0y} + a_y t$

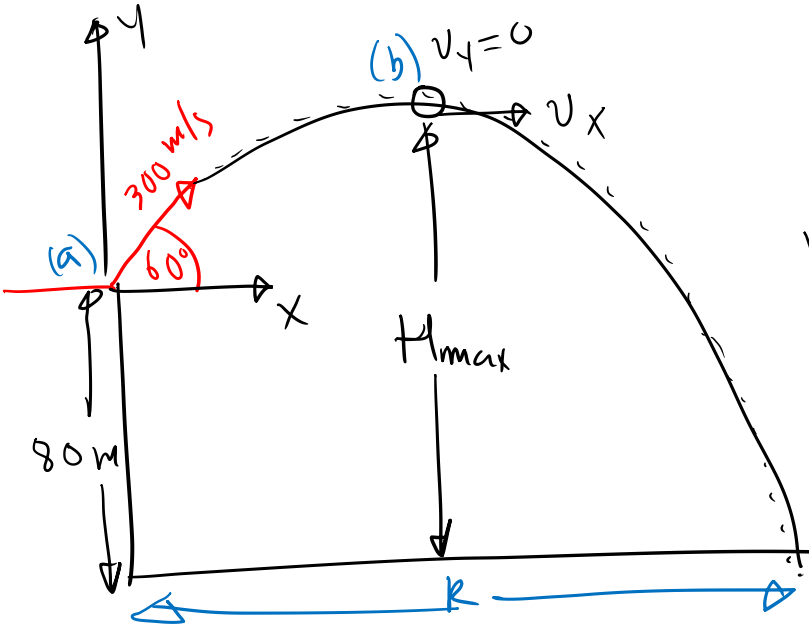
$= 5.4\sin 20 + 9.8(2.80)$

$v_y = 4.59\ \frac{m}{s}$

$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$\theta = 42°$

2. A cannon is elevated at an angle of 60° with the horizontal. It fires a ball with a speed of 300 m/s from the top of a 80 m high building. (10 pts)
   a) Calculate the maximum height from the ground.
   b) How long is the ball in the air?
   c) What is the horizontal range of the ball?



a) (a) → (b) $v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$

$0 = (300\sin 60)^2 - 19.6(H_{max} - 80)$

$H_{max} = 3523\text{ m}$

b) (a) → (c)

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$-80 = (300\sin 60)t - 4.9t^2$

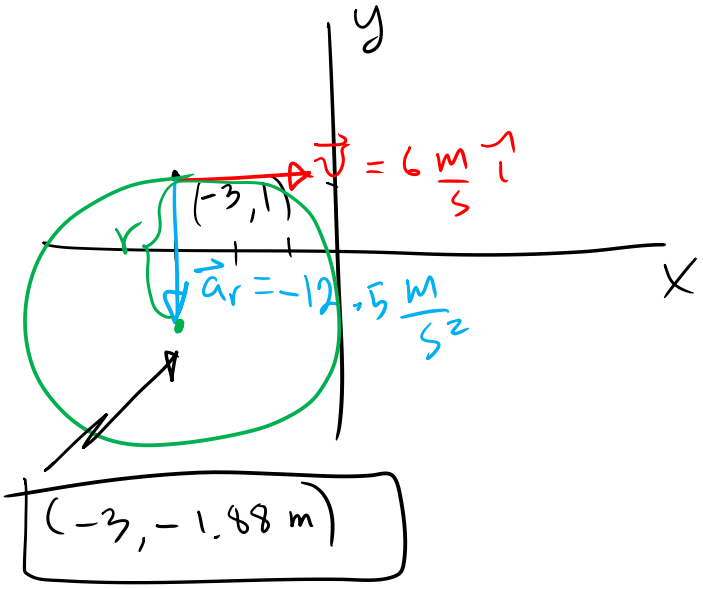
$t = 53.3\text{ s}$

c) $R = v_{0x}t$

$= (300\cos 60)53.3\text{ s}$

$= 7995\text{ m}$

3. A particle moves in uniform circular motion, over a horizontal xy- plane. At one instant, it moves through the points (- 3.0 m, 1.0 m) with a velocity of +6.00**i** m/s and an acceleration of -12.5**j** m/s^2. Calculate the x and y-coordinates of the center of the circular path. (5 pts)



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

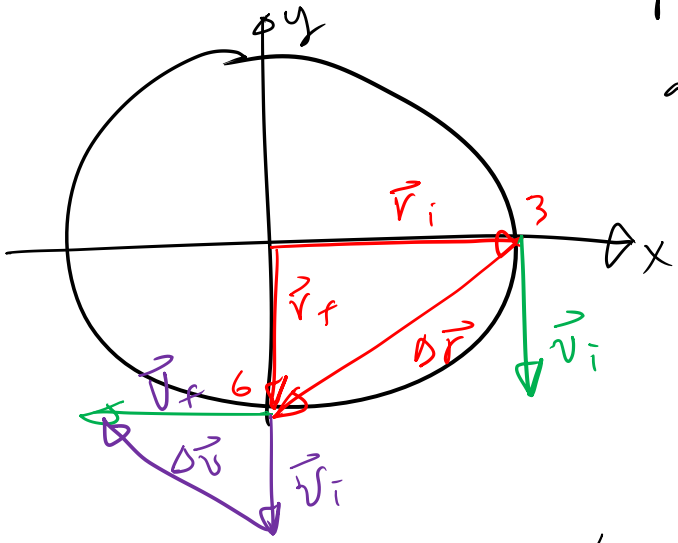
$$r = \frac{v^2}{a_r} = \frac{(6)^2}{12.5}$$

$r = 2.88$ m

4. A clock has a 20 cm second hand. From the 3 PM mark to the 6 PM mark, for the ***tip of the second*** hand, calculate the: (15 pts)

   a. Displacement vector in unit-vector notation.
   b. Average velocity vector in unit-vector notation.
   c. Average acceleration vector in unit-vector notation.
   d. Calculate the magnitude and direction of the instantaneous acceleration at the 6 PM mark.

Use a coordinate system with the origin at center of the clock with the +x axis along the 3 PM mark and the +y axis along the 12 PM mark. Express your answers in units of cm, sec.



$\vec{r}_i = 20\hat{i}$, $\vec{r}_f = -20\hat{j}$

a) $\Delta\vec{r} = \vec{r}_f - \vec{r}_i$

$\Delta\vec{r} = -20\hat{j} - 20\hat{i}$ cm

b) $\vec{v}_{ave} = \frac{\Delta\vec{r}}{\Delta t} = \frac{-20\hat{i} - 20\hat{j}}{15s}$

c) $\vec{a}_{ave} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{15s}$

$v_i = v_f = \frac{2\pi r}{T} = \frac{2\pi(20)}{60} = \frac{2\pi}{3}\frac{cm}{s} = 2.1\frac{cm}{s}$

$\vec{v}_i = -\frac{2\pi}{3}\hat{j}$, $\vec{v}_f = -\frac{2\pi}{3}\hat{i}$ $\Rightarrow$ $\vec{a}_{ave} = \frac{2\pi}{(3)(15)}(-\hat{i} + \hat{j})$ $\frac{cm}{s^2}$

d) $a_r = \frac{v^2}{r} = 0.22\,cm/s^2$ $\uparrow \vec{a}_r$