DO NOT TURN THIS PAGE!!!!!

Name: KEY

Physics 50
Spring 2016
Exam 2

MAKE SURE TO SHOW ALL WORK IN COMPLETE DETAIL. NO CREDIT WILL BE GIVEN IF NO WORK IS SHOWN. EXPRESS ALL ANSWERS IN SI UNITS.

1. Define the following terms **without any mathematical definitions**: (2 pts each)

   a) Unit-Vector

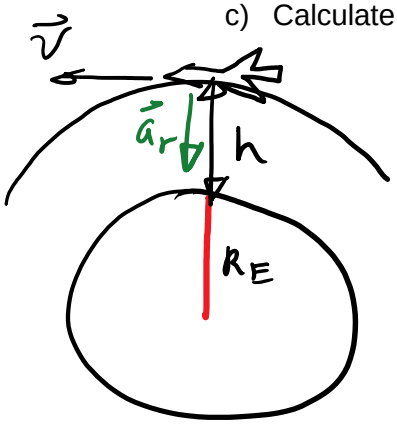
   b) Uniform Circular Motion

   c) Trajectory

   d) Associative Law for vectors

   e) Period of rotation

2. The space shuttle orbits the earth at an altitude of 240 km above surface of earth and with a period 1.48 hrs. The radius of earth is 6380 km. (10 pts)
   a) Calculate the distance it travels in one revolution.
   b) Calculate the speed in its orbit in m/s and mi/hr.
   c) Calculate the magnitude and direction of the acceleration.



a) $d = 2\pi r = 2\pi(R_E + h)$

$= 2\pi(6380 \times 10^3 + 240 \times 10^3 m)$

$= \boxed{4.16 \times 10^7 m}$

b) $v = \frac{d}{T} = \frac{4.16 \times 10^7 m}{1.48 hr \times \frac{3600 s}{1 hr}} = \boxed{7800 \frac{m}{s}}$

$= 7800 \frac{m}{s} \times \frac{60 mph}{26.8 m/s}$

$= \boxed{17{,}500 mph}$

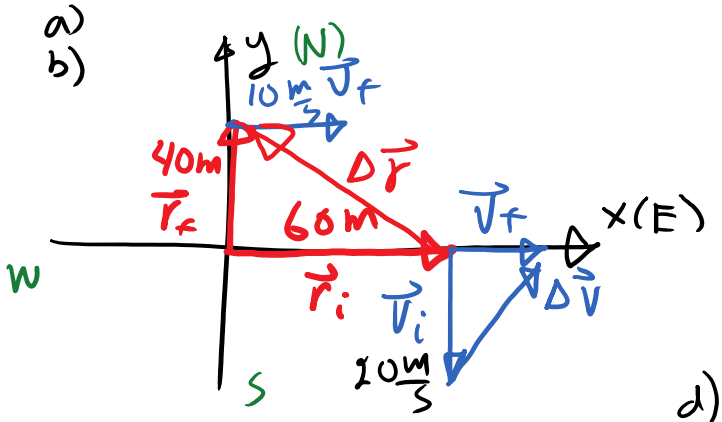
c) $a_r = \frac{v^2}{r} = \frac{\left(7800 \frac{m}{s}\right)^2}{R_E + h}$

$= \boxed{9.2 \frac{m}{s^2}}$

3. At one instant a bicyclist is 60 m due east of a park's flagpole, going south at 20 m/s. Then 30 s later, the cyclist is 40 m due north of the flagpole, going due east with a speed of 10 m/s. On an XY- coordinate system with the flagpole at the origin, for the cyclist in this 30 s time interval: (15 pt)

   a) Draw the position and velocity vectors of the bicyclist as described.
   b) On your graph in part (a) draw the displacement, average velocity, and average acceleration vectors. (the vectors do not have to be drawn to scale.)
   c) Obtain the displacement vector in unit-vector notation.
   d) Obtain the average velocity vector in unit-vector notation.
   e) Obtain the average acceleration vector in unit-vector notation.

a)
b)



c) $\vec{r}_i = 60\hat{i}$

$\vec{r}_f = 40\hat{j}$

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

$= 40\hat{j} - 60\hat{i}$

$\Delta\vec{r} = \boxed{-60\hat{i} + 40\hat{j}}$ (m)

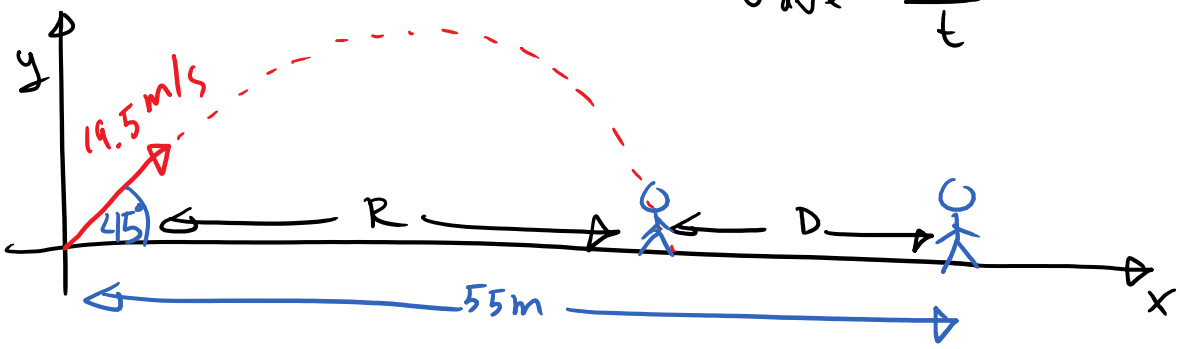
d) $\vec{v}_{ave} = \dfrac{-60\hat{i} + 40\hat{j}}{30}$ $\left(\frac{m}{s}\right)$

e) $\vec{a}_{ave} = \dfrac{\vec{v}_f - \vec{v}_i}{\Delta t}$

$= \dfrac{10\hat{i} - (-20\hat{j})}{30} = \boxed{\dfrac{10\hat{i} + 20\hat{j}}{30}}$ $\left(\frac{m}{s^2}\right)$

4. A soccer ball is kicked from the ground with an initial speed of 19.5 m/s at an angle of 45° with the horizontal. A player 55 m away in the direction of the kick starts running to meet the ball at that instant. The player runs toward the direction in which the ball is kicked. Calculate the average speed of the player if he is to meet the ball just before it hits the ground. (10 pts)

$v_{ave} = \frac{D}{t}$



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

$R = (19.5\cos 45)t$

$R = 38.6\text{ m}$

$D = 55 - R = 16.4\text{ m}$

$v_{ave} = \frac{D}{t} = 5.86\frac{\text{m}}{\text{s}}$

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

$0 = 0 + (19.5\sin 45)t - 4.9t^2$

$t = \frac{19.5\sin 45}{4.9}$

$t = 2.8\text{ s}$