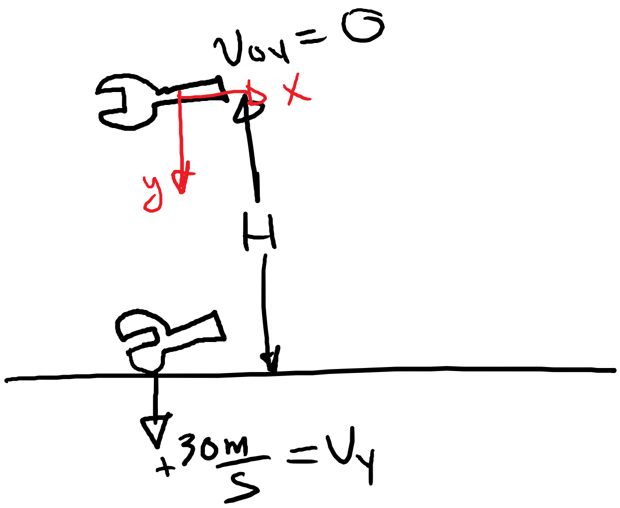
DO NOT TURN THIS PAGE!!!!!

Name: KEY

Physics 2A
Winter 2010
Exam 1

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. At a construction site a pipe wrench fell from rest and struck the ground with a speed of 30 m/s. (10 pts)
    a) Calculate the height it was dropped from.
    b) Calculate how long it was falling.
    c) Draw the graph of a vs t, v vs. t, and y vs. t.



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

$(30)^2 = 2(9.8)(H - 0)$

H = 45.9 m

b) $v_y = v_{0y} + a_y t$, with $v_{0y} = 0$

$30 = (9.8)t$

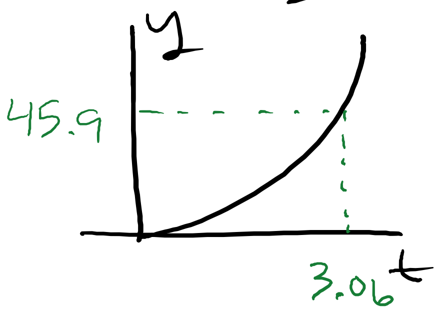
t = 3.06 s

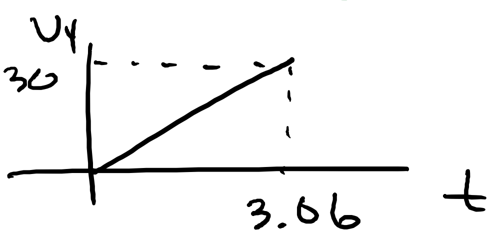
c) $y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$, with $y_0 = 0$, $v_{0y} = 0$

$y = 4.9t^2$

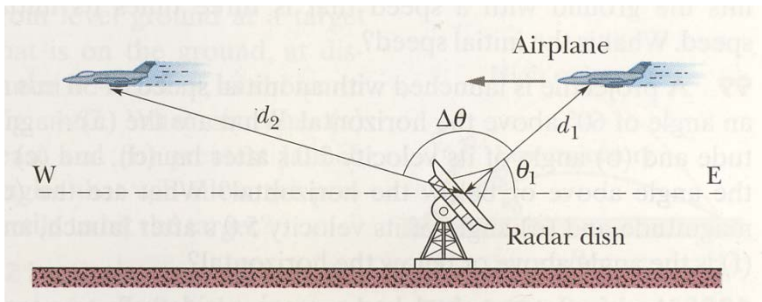
$v_y = 9.8t$

$a_y = +9.8 \frac{m}{s^2}$

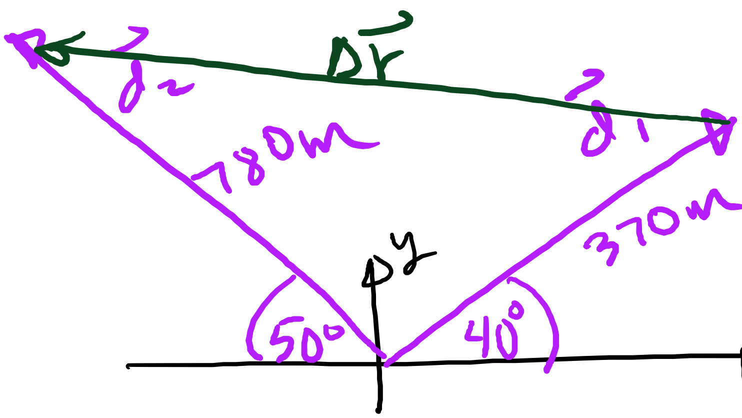




2. In the figure below, a radar station detects an airplane approaching directly from the east. At first observation, the plane is at d_1 = 370 m from the station and at θ_1 = 40º above the horizontal. The airplane is tracked through an angular change $\Delta\theta$ = 130º ; its distance is then d_2 = 780 m. (10 pts)
   a) Sketch the displacement vector of the plane in the figure below.
   b) Find the displacement of the plane during this time in unit-vector notation.
   c) Calculate the magnitude and direction of the displacement vector.



b) $\Delta\vec{r} = \vec{d}_2 - \vec{d}_1$



$\vec{d}_1 = 370\cos 40\,\hat{i} + 370\sin 40\,\hat{j}$

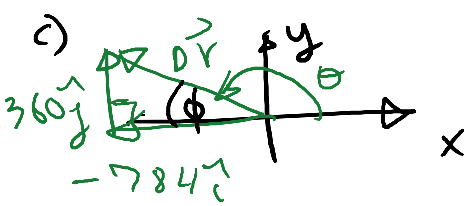
$\vec{d}_1 = 283\hat{i} + 238\hat{j}$

$\vec{d}_2 = -780\cos 50\,\hat{i} + 780\sin 50\,\hat{j}$

$\vec{d}_2 = -501\hat{i} + 598\hat{j}$

$\Delta\vec{r} = -784\hat{i} + 360\hat{j}$ m

c)



$\Delta r = \sqrt{(-784\,m)^2 + (360\,m)^2}$

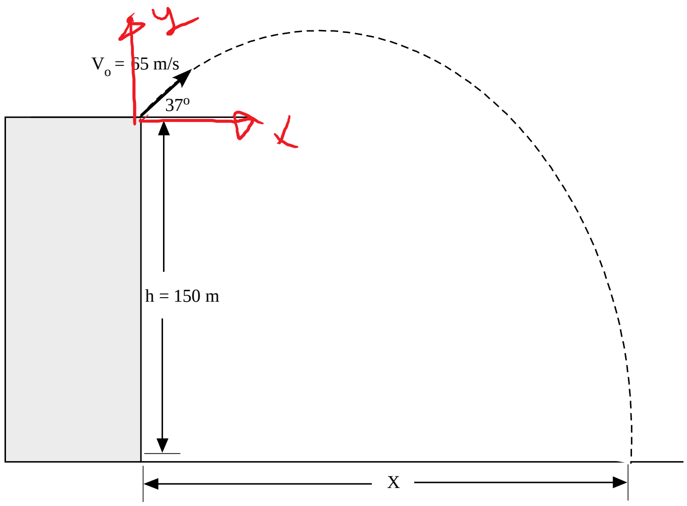
$= 863\,m$

$\varphi = \tan^{-1}\left|\frac{360}{-784}\right|$

$\varphi = 24.7°$

$\theta = 180 - \varphi = 155.3°$

3. A projectile is thrown from the edge of a building with an initial speed of 65.0 m/s at an angle of 37° with the horizontal. The height of the building is 150 m. See figure below. (10 pts)



$a_x = 0$

$a_y = -g = -9.8 \frac{m}{s^2}$

a) Calculate the time for the projectile to strike the ground.
b) Calculate the range X of the projectile.

a) $y = y_0 + v_{oy}t + \frac{1}{2}a_y t^2$

$-150 = (65 \sin 37)t - 4.9t^2$

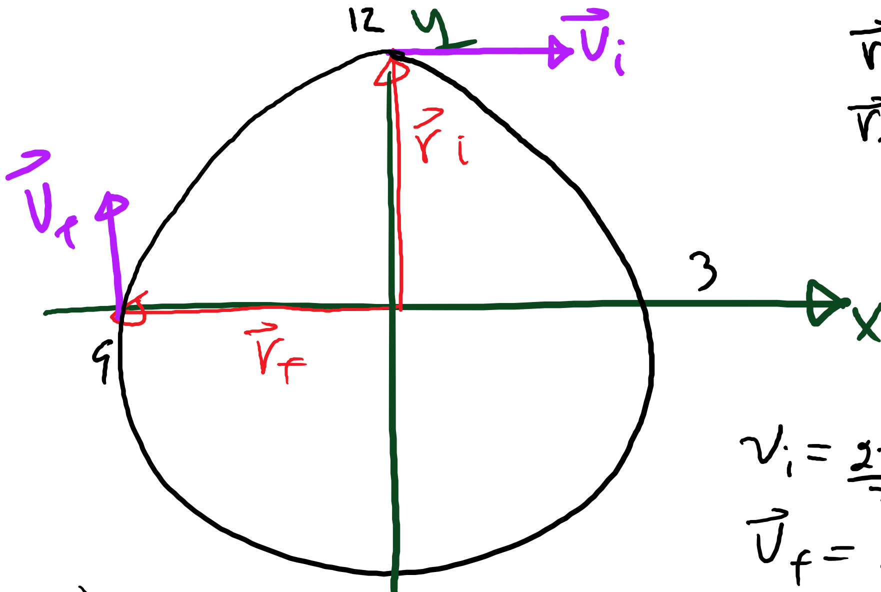
$t = 10.8 s$

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

$x = (65 \cos 37)(10.8) = 561 m$

4. A clock has a second hand of length 20 cm. From the 12 P.M mark to the 9 P.M mark, for the tip of the second hand, :

a) Calculate the displacement vector in unit-vector notation.
b) Calculate the average velocity vector in unit-vector notation.
c) Calculate the period of rotation.
d) Calculate the speed.
e) Calculate the instantaneous acceleration vector in unit-vector notation as it passes through the 6 P.M mark.
f) Calculate the average acceleration vector in unit-vector notation.



$\vec{r}_i = 20\hat{j}$ (cm)

$\vec{r}_f = -20\hat{i}$ (cm)

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

$v_i = \frac{2}{3}\pi\left(\frac{\text{cm}}{\text{s}}\right) = v_f$

$\vec{v}_i = \frac{2\pi}{3}\hat{i}$

$\vec{v}_f = \frac{2\pi}{3}\hat{j}$

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

$= -20 \quad -20\hat{j}$

b) $\vec{v}_{ave} = \frac{\Delta\vec{r}}{\Delta t} = \frac{-20\hat{i} - 20\hat{j}}{45\text{ s}}\left(\frac{\text{cm}}{\text{s}}\right)$

c) $T = 60\text{ s}$

d) $v_i = v_f = \frac{2\pi}{3}\frac{\text{cm}}{\text{s}}$

e) $a_r = \frac{v^2}{r} = \left(\frac{2\pi}{3}\right)^2\frac{1}{20}\left(\frac{\text{cm}}{\text{s}^2}\right)$

f) $\vec{a}_{ave} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{\frac{2\pi}{3}\hat{j} - \frac{2\pi}{3}\hat{i}}{45}\left(\frac{\text{cm}}{\text{s}^2}\right)$