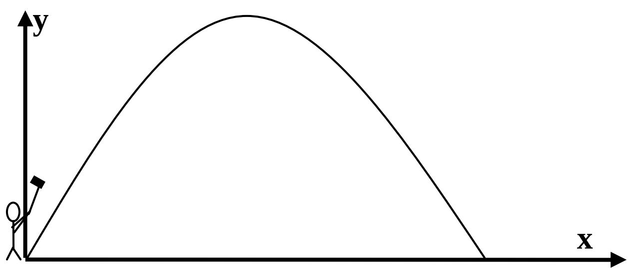
Physics 151 Class Exercise: Projectile Motion

1. A golfer tees off on level ground, giving the ball an initial speed of 52 m/s and in initial direction of 32º above the horizontal.

a) Make a drawing of the golfer and the ball's trajectory. Clearly indicate the origin and the direction of the x and y axes.



b) Calculate the initial velocities in the x and y directions.

$$v_{ox} = v_0 \cos\theta = \left(52\frac{m}{s}\right)\cos(32°) = 44.1\frac{m}{s}$$

$$v_{oy} = v_0 \sin\theta = \left(52\frac{m}{s}\right)\sin(32°) = 27.6\frac{m}{s}$$

c) Calculate the length of time it takes the ball to reach the peak of its trajectory?

Known:	Solve:	Not Involved:
v_{oy} = 27.6 m/s	t	y
v_y = 0		
a = -9.81 m/s		

$$v_y = v_{0y} + at$$

$$t = \frac{v_y - v_{0y}}{a} = \frac{-27.6\frac{m}{s}}{-9.81\frac{m}{s^2}} = 2.81s$$

d) Calculate the total length of time the ball is in the air. Total time = 2 * Peak time = 5.62 s

e) Calculate the distance from the tee where the ball lands. $x = v_x t$ = (44.1 m/s)(5.62 s) = 248m

f) Check this value by recalculating it using the Horizontal Range formula.

$$R = \frac{v_o^2}{g}\sin 2\theta = \frac{\left(52\frac{m}{s}\right)^2}{\left(9.81\frac{m}{s^2}\right)}\sin 64° = 248\,m$$

2. An artillery officer is practicing on a firing range on a flat stretch of ground. She endeavors to hit a target 885m away with an artillery shell. The artillery gun fires shells with a muzzle velocity of 96.1 m/s.

a) At what **angle<u>s</u>** can she orient the gun. (Hint: Consider the angles/quadrants where two angles have the same sin value.)

$$\sin 2\theta = \frac{gR}{v_0^2} = \frac{\left(9.81\frac{m}{s^2}\right)(885m)}{\left(96.1\frac{m}{s}\right)^2} = 0.94$$

Thus 2θ can be 70º or 110º. Thus θ can be 35º or 55º

b) What is the difference in "time to impact" for the two trajectories.

$$t_1 = \frac{v_{oy}}{a} = \frac{\left(96.1\frac{m}{s}\right)\sin 35°}{\left(9.81\frac{m}{s^2}\right)} = 5.6s$$

$$t_2 = \frac{v_{oy}}{a} = \frac{\left(96.1\frac{m}{s}\right)\sin 55°}{\left(9.81\frac{m}{s^2}\right)} = 8.0s$$

$\Delta t = 2.4s$

Since this is the difference in time to the peak – the total difference for the path is 4.8s.

c) What is the difference in "peak height" for the two trajectories.

Known:	Solve:	Not Involved:
v_{0y} = 55.1 m/s	y	t
v_y = 0		
a = -9.81 m/s		

$v_y^2 = v_{0y}^2 + 2ay$

$$y_1 = \frac{-v_{0y}^2}{2a} = \frac{\left(96.1\frac{m}{s}\sin 35°\right)^2}{2\left(9.81\frac{m}{s^2}\right)} = 154.9m$$

$$y_1 = \frac{-v_{0y}^2}{2a} = \frac{\left(96.1\frac{m}{s}\sin 55°\right)^2}{2\left(9.81\frac{m}{s^2}\right)} = 315.8m$$

$\Delta y = 161m$

d) Draw a crude sketch of the gun, target, and the two trajectories in the space below.