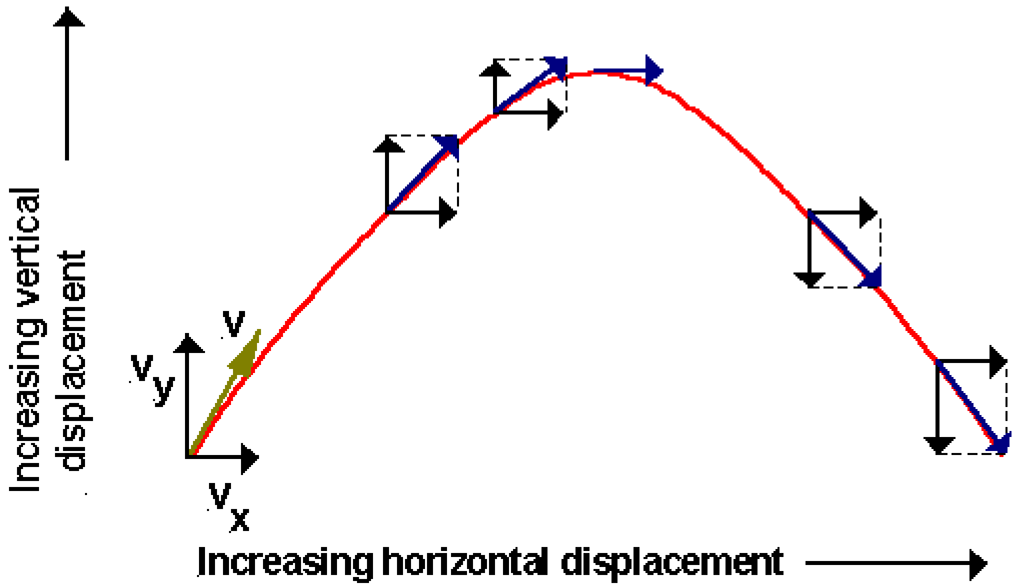
PROJECTILE MOTION

A dense object projected horizontally near the surface of the Earth will travel in two dimensional motion with a constant horizontal component of velocity and a vertical component that changes at rate of approximately 9.80 m/s^2. The exact value of "g", the acceleration due to gravity, will depend upon the experiment's location. The following diagram shows the components of velocity at various times during the flight. Notice that the horizontal component does not change, while the vertical component gets smaller and smaller as the ball goes up, reaches zero at the top, and becomes larger and larger as the ball comes back down. This change in vertical component of velocity indicates downward acceleration.



APPARATUS

Projectile launcher and Ball	
Carbon and white paper	Masking tape
Meter stick	Lab ruler
Plumb bob	C-Clamp

Purpose

The purpose of today's experiment is to determine the initial velocity of a projectile fired horizontally. The initial velocity will be used to predict the range of the projectile fired at 30°. The predicted range will be compared with the measured range.

Procedure and Analysis

1. Before starting the experiment, draw a sketch to show the path of the ball in the air when it is fired horizontally. On this sketch draw the coordinate system you are going to use. Then draw a motion diagram for the **horizontal** motion of the ball. On the same sketch also draw the motion diagram for the **vertical** motion of the ball. Be sure to pick the same direction to be positive in your coordinate system and on your motion diagrams. Next to each motion diagram write position as a function of time, velocity as a function of time, and acceleration that describe that particular motion.

2. Clamp the gun to the laboratory bench so that it will fire horizontally. Make sure that the gun has an unobstructed firing range.

3. Test fire the gun to see where the ball hits the floor. Tape a sheet of white paper to the floor centered where the ball on average hits. Place a sheet of carbon paper, carbon side down, over the white sheet.

4. Fire the ball ten times; there should be a record on the white sheet of where the ball hit the floor each time. Measure the average range of the trajectory (horizontal distance travelled by the ball), and the vertical drop of the trajectory. Remember to record all relevant uncertainties.

5. Calculate the time of flight. Then use this time to calculate the initial velocity of the ball.

6. Suppose the ball is now launched with the same spring gun (same speed) but at a 30° angle with respect to horizontal. Draw a sketch to show the path of the ball in the air when it is fired horizontally. On this sketch draw the coordinate system you are going to use. Then draw a motion diagram for the **horizontal** motion of the ball. On the same sketch also draw the motion diagram for the **vertical** motion of the ball. Be sure to pick the same direction to be positive in your coordinate system and on your motion diagrams. Next to each motion diagram write position as a function of time, velocity as a function of time, and acceleration that describe that particular motion.

7. Do the necessary calculations to predict the horizontal distance travelled by the ball when it is fired at 30° with respect to horizontal.

8. Tilt the gun to 30° angle and repeat steps 2 and 3.

9. Measure the average range of the projectile, and compare this to your prediction.