EXPERIMENT 3
PROJECTILE MOTION

I. THEORY

The purpose of this experiment is to measure the initial velocity of a ball that is fired from a projectile launcher (spring gun) by measuring its horizontal and vertical displacement. You will use the equations of motion for projectile motion to calculate the initial velocity.

II. LABORATORY PROCEDURE

Note: You must wear safety glasses for this lab.

1. Clamp the Projectile Launcher at the end of one of the fixed lab stations. Your instructor will demonstrate how.
2. Set the Projectile Launcher to an angle of 30.0°.
3. There is a picture of the ball near the end of the launcher. We will consider this picture to coincide with the initial position of the ball when it begins its free fall motion. Measure the distance from the bottom of the ball pictured on the side of the launcher to the floor of the lab room. Make sure your meterstick is vertical! This will be the starting height of the projectile.
4. For measuring the horizontal displacement of the ball, it is useful to place a small piece of blue painter's tape on the floor with a dot marking the point directly below the bottom of the ball pictured on the side of the launcher.
5. Use the rod provided with the projectile launcher to push the plastic ball into the projectile launcher. For the entire experiment the short range on the projectile launcher will be used for all runs. Be sure the indicator bar is in the appropriate position. NOTE: The projectile launcher will sometimes launch the ball unexpectedly. Never look into the barrel of the loaded projectile launcher or have your face close to it. After loading, check that the angle is still set to 30.0°. You should perform this check each time you load the ball.
6. Place a two-meter stick on the floor with its zero centimeter mark on the dot on your blue tape. Launch the ball. If your meterstick is well aligned with the path of the ball, the ball will strike it or very near to it. Adjust the meterstick so that the ball hits the ground very near to it. (You may have to reload and fire the projectile several times.)
7. Now you will make 3 measurements of the horizontal displacement. Load the ball and fire as before. One group member should watch for where the ball strikes the ground and estimate the reading on the meterstick to the nearest 1 cm. Your 3 measurements should be within about 5 cm of each other. If they are not, consult your instructor.
8. Repeat steps 2 through 7 for an angle of 60.0°.

III. CALCULATIONS AND ANALYSIS

1. Make a table with 4 columns labeled: Launch Angle (°), Initial Height (cm), Horizontal Displacement (cm) and Calculated Initial Speed (cm/s). For the Horizontal Displacement Column use the average of your 3 measurements.
2. You will be left a little "on your own" for finding the Initial Speed but these next steps are intended to help you begin.
    a. Draw a picture showing the ball at the moment it leaves the launcher (initial position) and at the moment just before it strikes the ground (final position). Draw in a velocity vector for the ball at each time. What do you know about the initial velocity? What do you know about the final velocity?
    b. Choose and draw in your picture an origin and x and y-axes. Make a list of the 11 quantities that appear in the constant acceleration equations of motion for 2 dimensions. Determine what you know about each.
    c. Set-up and solve a system of equations for the unknown initial speed.
3. Determine the percent difference between your two calculated initial speeds.
4. For the case of the 60.0° launch angle, determine the maximum height above the lab room floor that the ball reached.