University Physics 1
Lab 4
September 14, 2004
Dr. Addison

Purpose

The purpose of this lab is for you to gain more experience working with projectile motion.

Equipment

1. Ballistic Pendulum Projectile Launcher
2. Meter Stick
3. Protractor
4. Carbon Paper

Theory

To predict where a projectile will land on the floor when it is launched at some angle above the horizontal, it is necessary to first determine the initial speed (muzzle velocity) of the projectile. This can be determined by launching the ball horizontally off the table and measuring the vertical and horizontal distances through which the ball travels. Then the initial velocity can be used to calculate where the ball will land when the projectile is launched at an angle.

Method

MAKE CERTAIN ***that no-one is in the way*** **EACH AND EVERY TIME** ***that you launch the projectile.*** Use Excel to perform your calculations - print them out for your lab book. Excel expects angles in radians for trigonometric functions - but it will convert your angles for you. See the help menus!

Horizontal Launch

For a ball launched horizontally off a table with an initial speed, v_0, assuming air friction is negligible, gravity is the only force that acts. The vertical distance the ball drops can be used to determine the time of flight ($g = 981\text{cm/s}^2$ is a known quantity). Combining this with measurements of the horizontal distance traveled by the projectile, the initial velocity of the projectile can be found. Part of your task is to develop the appropriate equations.

Perform the experiment as follows. First put the projectile on the launcher and cock the trigger. Fire one shot to approximately locate where the projectile hits the floor. At this position, tape a piece of white paper to the floor. Place a piece of carbon paper (carbon-side down) on top of this paper and tape it down. When the ball hits the floor, it will leave a mark on the white paper. Fire about ten shots. Measure the vertical distance from the bottom of the ball as it leaves the launcher. Record this distance. Find the point on the floor that is directly beneath the release point on the launcher Measure the horizontal distance along the floor from the release point to the leading edge of the paper. Measure from the leading edge of the paper to each of the ten dots and record these distances. Use Excel to find the average of the ten distances and record the data. Using the vertical distance and the average horizontal distance, calculate the time of flight and the initial velocity of the projectile.

When you have determined the muzzle velocity, measure the distance over which the projectile was accelerated to determine the acceleration of the projectile. You are again responsible for the analysis.

Launch at an angle

Place the launcher ***on the floor***. Now launch projectiles at angles of 30^0, 45^0, and 60^0. Use the launch velocity from first part to predict where the projectile will land. Which one flies the farthest? How do the ranges of projectiles launched at 30^0 and 60^0 compare with each other? Three shots at each angle will be sufficient. Use the same, calculate the percent error in your measurements for the average distance of flight and the accepted value determined from your calculations. Again your are responsible for the analysis. You will need to allow for the fact that the point of projection is above the landing point. That is, if you call $y_0 = 0$, then y will be negative if you choose to use up as positive.