Projectile Motion Lab

Introduction

Projectile motion is a path traveled by an object influenced by the initial velocity, launch angle, and the acceleration due to gravity. In this experiment you will predict the spot a steel ball will land after being launched.

Objectives

In this experiment, you will

- Measure the initial velocity of a steel ball using a Vernier Projectile Launcher.
- You will apply the ideas from two-dimensional kinematics to predict the impact of a ball in projectile motion.
- Don’t forget to take into account the different trial variations in the speed measurements when calculating point of impact.

Materials

1. Computer
2. Vernier Projectile Launcher
3. Vernier lab quest
4. Small cardboard box
5. Steel ball
6. Meter stick
7. Waxed paper

Initial Set Up

1. Position the launcher next to the edge of your table. Eventually you will fire a ball horizontally that will travel several meters, so plan for this when choosing a location.
2. Use the lower knob on the back of the unit to adjust the position of the launch chamber until level. Then tighten the knob to maintain this position.

3. Next, use the upper knob on the back of the launcher to set the scale to 0 degrees. Move the scale so the notch of the launcher chamber is at 0 degrees. This setting accounts for deviation of the tabletop from horizontal.
4. Connect the projectile launcher to the labquest.
5. Connect the hand pump to the projectile launcher. Set the release pressure by adjusting the range knob. Turn the knob clockwise for higher pressure and higher launch speed. Turn the knob counter-clockwise for lower pressure and lower launch speed.
6. Remember to select a release pressure that is appropriate. Keep pumping the pump until you hear at least three small release sounds, then wait for the pressure to stabilize which should be about five seconds. Also do not change the release pressure for the rest of the lab or your prediction will be incorrect.

Procedure

1. First insert the steel ball into the launch chamber with your index finger and push the ball into the barrel.
2. Pump the hand pump until it reaches your selected pressure. Now keep pumping until you hear the three small release sounds. Wait five seconds for the pressure to stabilize.
3. Collect data using the following steps:
    a. Click the “collect” button to start data collection.
    b. Hold the cardboard box so you can catch the ball right after it leaves the projectile launcher. Do not let the ball hit the floor. This is important.
    c. When you want to launch the ball, press and hold the arm button, and then press the launch button.
    d. Record the speed in the data table.

4. Repeat this process, catching the ball with the cardboard box until you complete a total of 10 launch speed measurements. Record the values of the speed in Table 1.

5. Review your speed data of each trial and calculate the average speed values and identify the maximum and minimum values. Record those values in Table 2.

6. Determine the launch height by:
    a. Measuring the distance for the tabletop to the floor.
    b. The launch chamber of the projectile launcher is 0.146 m above the surface of the table. So determine the total distance the ball will fall.
    c. Record this total height value as the launch height, in table 2.
7. Identify the floor origin and table offset:
    a. The launch point is clearly marked on the projectile launcher. Position the projectile launcher so that you can figure out the distance from the launch point to the edge of the table, in line with the launch barrel. You will need this offset distance for later calculations. Record the offset values in table 2.
    b. Use a meter stick to locate the floor location just below the table edge. Mark this point with table as it will serve as the floor origin.
8. Determine the predicted impact point range:
    a. Use the average speed value to calculate your prediction for the range. The range is the horizontal distance the ball will travel. Record this prediction as the predicted range for the average speed in Table 3.
    b. Subtract the table offset from the predicted range and record that value in Table 3 for predicted floor distance for the average speed.
    c. To account for variations seen in the speed measurements, repeat the calculation for the minimum and maximum speeds. These two new points show the limits of impact range to be expected, considering the variations of the speed measurements. Record the predicted ranges and floor distances for the max and min speeds on the data table.

10. Tape a piece of waxed paper to the floor that is big enough to account for the different variations that you previously calculated. Remember that the waxed paper must be lined up with the launch chamber.

11. Next launch the ball and allow it to strike the floor for the first time. Measure the distance from the floor origin to the actual impact point and enter the floor distance in the Table 4. Now calculate the range for the actual impact.

Range = floor distance + table offset

Data Table

Table 1

trial	Speed (m/s)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Table 2

Maximum speed	m/s
Minimum speed	m/s
Average speed	m/s
Table height, h	m
Table offset, x_0	m

Table 3

	Predicted range (m)	Predicted floor distance (m)
Average speed		
Maximum speed		
Minimum speed		

Table 4

	Floor distance (m)	Range (m)
Actual impact		

Analysis Questions

1. Would you expect any value prediction based on experimental measurements to be exact numbers? explain.
2. Was your impact point between your maximum and maximum impact predictions? Was your prediction successful or not?
3. You accounted for variations in the speed measurement in your range prediction. Are there other measurements you used which affect the range predictions? What are they?
4. Did you account for air resistance in your prediction? How or how not?