

PHY 111 L/ 213L: College Physics I Lab & General Physics I Lab
Laboratory Reports
Fall 2020
Baker

30 points are possible on lab reports
Use 12 point font and double spacing

A sample lab report is included starting on the next page.

Laboratory reports must have the following:

- (1 pts) Heading with student's name (lab partner(s), if applicable), date performed, and title of the experiment
- (2 pts) Object of experiment—State the purpose of the experiment or lab exercise. (1-3 sentences)
- (5 pts) Experimental Set-up – A labeled diagram of the experiment and equipment and a paragraph explaining the experimental set-up.
- (10 pts) Principles—Explain the scientific principles involved in the experiment or exercise, using complete sentences. (3-5 complete paragraphs)

This section should include a statement and explanation of the physical laws demonstrated during the lab, the definition of any terms, a statement and justification of any assumptions made, and an introduction of the equations used in the lab. Also include any relevant diagrams. Do not include a procedure here.

- (7 pts) Data— A brief description of the data collected and data tables or graphs with explanations of data taken and results of all relevant calculations. Be sure to include units and label plots and axes.
- (5 pts) Conclusions—Provide a summary based on your analysis of the data obtained. What do your data suggest? What trends do you see? Make comparisons, if applicable. Include sources of uncertainty in the measurements.

Sample Lab Report

Maggie Sherer

Partners: None

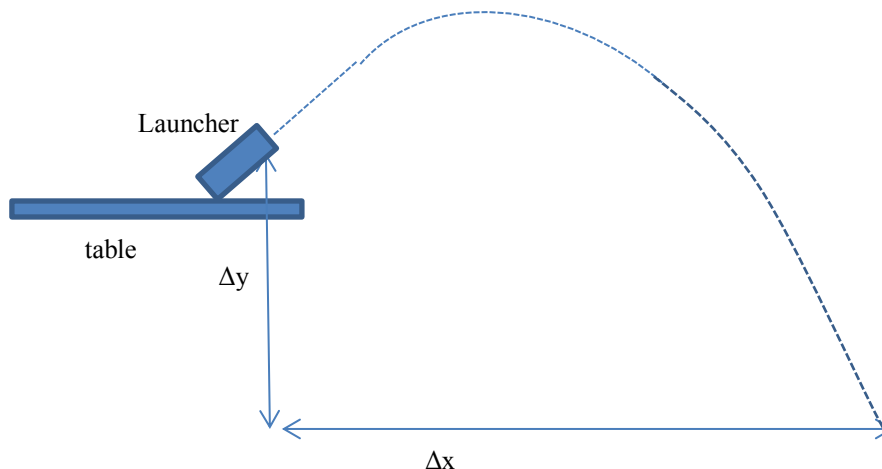
Date performed: Sept. 3, 2015

Projectile Motion

Object of Experiment: During this lab, we used the kinematic equations in both the horizontal and vertical directions in order to measure the velocity of a ball from a projectile launcher and predict where the ball would land when the launcher was launched at an angle. We then measured the distance of the ball when launched at an angle to compare to our theoretical prediction.

Experimental Set-up:

A short range projectile launcher was clamped to a table. A metal ball was launched first horizontally in order to find the initial velocity, and then launched at an angle in order to find the distance it travelled horizontally before hitting the floor. The height from the floor to the position of the metal ball at launch was measured as Δy and the horizontal distance from the floor directly below the launcher to the position the projectile landed was measured as Δx as shown in the figure below.



Principles:

Projectile motion occurs when an object is launched into the air and the only acceleration acting on the object is the acceleration due to gravity in the vertical direction. Therefore, there is no acceleration in the horizontal direction and the vertical and horizontal motions are independent of each other. Projectile motion results in a parabolic path for the object through the air. Pure parabolic projectile motion assumes there is no air resistance acting on the object as it travels through the air.

Because the motions in the horizontal and vertical directions are independent of each other, the kinematic equations can be used separately in each direction. In the horizontal direction, the displacement of the object is given by:

$$\Delta x = v_{0x}t \quad (1)$$

where v_{0x} is the initial velocity in the x direction and t in the amount of time the object is in the air. The amount of time the object is in the air is dependent on the motion in the vertical, y, direction. The displacement in the y direction is given by:

$$\Delta y = v_{0y}t + 0.5gt^2 \quad (2)$$

where v_{0y} is the initial velocity in the y direction and g is the acceleration due to gravity on Earth which is equal to -9.8m/s^2 .

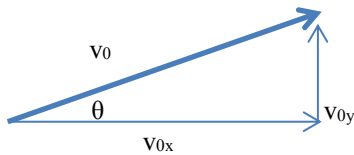
If a projectile is fired in the completely vertical direction, then the initial velocity, v_0 , is equal to the initial velocity in the x direction, v_{0x} . This concept can be used to find the initial velocity of a launcher. By measuring the height of the launcher, Δy can be found. Then, from equation 2, the time that the object is in the air can be calculated since it is known that the initial velocity in the y direction is zero when fired horizontally. Once the time is known, the initial velocity of the launcher can be found by experimentally

determining Δx , the displacement in the horizontal direction, by firing the projectile and measuring how far away it lands in the horizontal direction.

Once the initial velocity of the launcher is known, the range, or displacement in the x direction can be predicted for any launch angle, θ . For a given angle, θ , the components of the initial velocity can be found using trigonometric functions as follows:

$$v_{0x} = v_0 \cos(\theta)$$

$$v_{0y} = v_0 \sin(\theta)$$



Once the components of the initial velocity are known, equation 2 from above will give the time of flight and then equation 1 will give the predicted range for the projectile.

Data:

First the projectile was launched horizontally. The height of the launch point above the floor was measured, Δy , and from that the time that the projectile would be in the air, t , was calculated. Then the projectile was launched 5 times and the horizontal distance from the launcher to center of the landing points of the projectile, Δx , was measured. The spread in Δx was estimated by measuring the linear distance from the two points farthest apart and then we calculated the ratio of this spread to Δx to find a percentage of the spread compared to the range. From the average value of Δx and the equations in the principles section, we calculated the initial velocity. These values are shown in the table below.

Δy measured	1.12 meters
t calculated	0.48 seconds
Δx measured to center of spread	1.87 meters
Spread of Δx measured	4 cm
%spread of range calculated	2.1%
v_0 calculated	3.90 m/s

We were then given a launch angle of 40 degrees. From this and the equations in the principles section, we calculated the initial velocity in the horizontal and vertical directions, the time of flight of the projectile and the theoretical range of the projectile. We then used the percentage error found earlier to calculate the minimum and maximum values for the range based on the uncertainty in the initial velocity. These values are shown in the table below. Finally, we fired the projectile and measure the actual range, x measured.

v_{0x} calculated	2.99 m/s
v_{0y} calculated	2.51 m/s
t calculate	0.80 seconds
x calculated	2.38 meters
x(min) and x(max) calculated	2.33 - 2.43 meters
x measured	2.31 meters

Conclusions:

Our percent error between our measured range on 2.31m and our expected range of 2.38m is 2.9% which is just slightly higher than the 2.1% error that could be expected from the spread in the range when the launcher was fired horizontally. One possible explanation is that air resistance affected our projectile. This is likely since our projectile fell short of our expected range and air resistance would cause this as it would slow down the projectile. Another source of error is the uncertainty in the angle measurement. We were only able to set our angle to within about 1 degree and this uncertainty was not taken into account when calculating the minimum and maximum expected range. Even with our slightly larger than expected percent error, we were able to hit the target which shows that the kinematic equations can be used to predict where a projectile will land.