

Lab 02: Projectile Motion

OBJECTIVE

In this experiment you will be measuring the range of a projectile and comparing your results with your calculations from the projectile's equations of motion.

This experiment is adapted from Vernier *Physics with Computers* experiments using *Logger Pro*.

EQUIPMENT

computer
Vernier computer interface
Logger Pro
two Vernier Photogates
ball (1 to 5 cm diameter)
masking tape

plumb bob
ramp
two ring stands
two right-angle clamps
meter stick or metric measuring tape
target

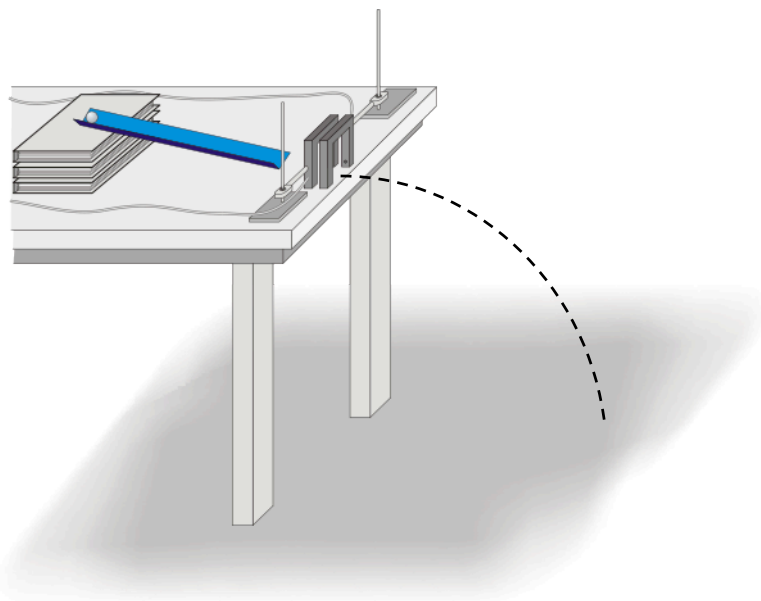


Figure 1

PROCEDURE

1. Set up the ramp on a table so that a ball can roll it, across a short section of table, and off the table edge as shown in Figure 1.
2. Position the Photogates so the ball rolls through each of the Photogates while rolling on the horizontal table surface (but *not* on the ramp). Approximately center the detection line of each Photogate on the middle of the ball. Connect Photogate 1 to DIG/SONIC 1 of the interface and Photogate 2 to the corresponding second port. To prevent accidental movement of the Photogates, use tape to secure the ring stands in place.
3. Mark a starting position on the ramp so that you can repeatedly roll the ball from the same place. Roll the ball down the ramp through each Photogate and off the table. Catch the ball as

soon as it leaves the table. **Note:** Do not let the ball hit the floor during these trials or during the following velocity measurements. Make sure that the ball does not strike the sides of the Photogates. Reposition the Photogates if necessary.

4. Open the file “08 Projectile Motion” in the *Physics with Computers* folder. A data table and two graphs are displayed; one graph will show the time required for the ball to pass through the Photogates for each trial and the other will display the velocity of the object for each trial.
5. You must enter the distance, Δs , between Photogates in order for *Logger Pro* to calculate the velocity. The program will divide this distance by the time interval Δt it measures to get the velocity ($v = \Delta s / \Delta t$). Carefully measure the distance from the beam of Photogate 1 to the beam of Photogate 2. (It may be easier to measure from the leading edge of Photogate 1 to the leading edge of Photogate 2.) To successfully predict the impact point, you *must* enter an accurate measurement. Enter the distance into *Logger Pro* by selecting Column Options ▶ Velocity from the Data menu. In the equation field, change the 0.1 to the actual separation of your gate in meters. Click to complete the edit.

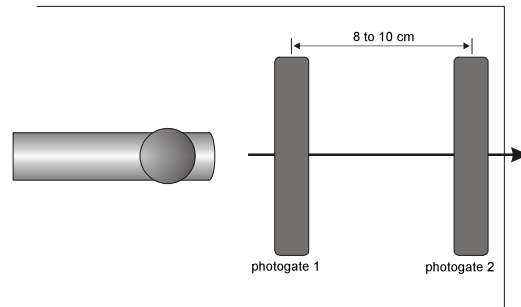


Figure 2

6. Click . Check to see that the Photogates are responding properly by moving your finger through Photogate 1 and then Photogate 2. *Logger Pro* will plot a time interval (Δt) value for each instance you run your finger through Photogate 1 or Photogate 2. Click , then click again, to clear the trial data and prepare for data collection.
7. Roll the ball from the mark on the ramp, through both Photogates, and catch the ball immediately after it leaves the table. Repeat nine times. Take care not to bump any of the Photogates, or your velocity data will not be precise. Data collection will stop after two minutes. If you need more time, click to restart, choosing Append. After the last trial, click to end data collection. Record the velocity for each trial number in the data table.
8. Determine the average, maximum, and minimum values by clicking once on the velocity vs. time graph and then clicking the Statistics button, .
9. Carefully measure the distance from the table top to the floor and record it as the table height h in the data table. Use a plumb bob to locate the point on the floor just beneath the point where the ball will leave the table. Mark this point with tape; it will serve as your *floor origin*.

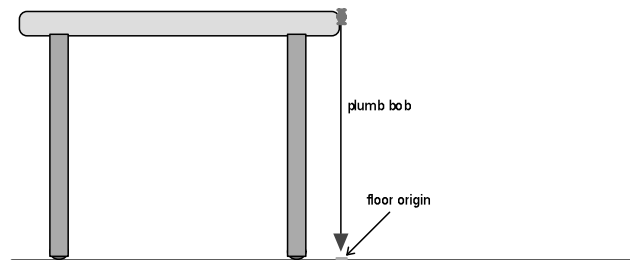


Figure 3

10. Use your velocity value to calculate the distance from the floor origin to the impact point where the ball will hit the floor. Mark your predicted impact point on scrap paper taped to the. Be sure the impact point is along the line of the track.
11. To account for the variations you saw in the Photogate velocity measurements, repeat the calculation in Step 10 for the minimum and maximum velocity. These two additional points show the limits of impact range that you might expect, considering the variation in your velocity measurement. Mark these points on the paper as well.
12. Release the ball from the marked starting point, and let the ball roll off the table and onto the paper. Mark the point of impact in pencil. Measure the distance from the floor origin to the actual impact and enter the distance in the data table.
13. Change the angle of the ramp and repeat Steps 2-12.

Each student is required to turn in a completed worksheet by the end of the lab session unless otherwise indicated by the lab instructor.