

Lab: The Effect of Launch Velocity on the Range of a Projectile

Purpose: To determine the relationship between the initial launch velocity of a projectile and its horizontal range

Variables:

Manipulated Variable: Launch Velocity / $\text{m}\cdot\text{s}^{-1}$

Launch velocity is affected by the spring setting on the marble launcher. There are 5 different spring settings, so in this lab we will only be having 5 data points (not ideal, but it's all we have to work with). We will be measuring the time it takes for the launched marble to pass through the photogate at the barrel opening of the cannon in order to calculate the overall initial velocity of the marble.

Responding Variable: Horizontal Range / m

The marble will be watched as it hits the ground, and its landing position marked and recorded. For each launch velocity, the range will be measured at least 8 times. Significant outliers due to launch errors will not be counted in the final data. The final data table will contain 8 trials of range measurements for each of the launch velocities. Range will be measured with a measuring tape starting at the center front of the launcher (directly below the launch point) to the point on the ground where the marble landed.

Controlled Variables:

- **Marble Diameter:** The marble diameter is used to calculate the launch velocity. It is essential that it is measured with precision (i.e. with a Vernier caliper) and is kept constant in order to ensure an accurate velocity calculation for each speed setting. The diameter will be converted to meters before calculating the launch velocity.
- **Vertical Displacement:** The marble launcher has a set vertical displacement, measured between the ground and the bolt at the barrel opening.

Materials Needed:

- CPO Marble launcher
- Plastic CPO marble
- CPO photogate timer (only 1 gate is needed)
- 10-m measuring tape
- Masking tape

Procedure:

1. Measure and record the diameter of your marble.
2. Set your marble launcher to the angle assigned to your class period:
Period 6 = 40.0°
3. Attach a CPO photogate to the end of the marble launcher and attach the photogate to slot "A" on the timer using the included phone cables.
4. Set your timer to "interval" and make sure the "A" light is lit and the screen reads 0.
5. Launch the marble from your assigned trigger position and get a general idea of where it will land.
6. Reset your marble at the proper trigger position and reset the timer.
7. Launch the marble. Set a piece of tape or paper on the floor to mark the landing position of the marble. Tape is better, so it does not move in between trials. Measure the horizontal displacement from the front of the marble launcher to the landing position.
8. Record the time that it took the marble to pass through the photogate (time through "A") in the data table below. If you end up with an outlier (i.e. the time for a launch is significantly different than the other times, or the landing position is significantly different than others for that launch speed), you do not need to include that data in your final table. I recommend that you write them down at first, just in case it really isn't an outlier like you first think.
9. Repeat steps 6-8 for at least 8 launch/landing trials
10. Repeat steps 5 – 9 for each of the other 4 launch speed settings.
11. Obtain data from 1 other group so that you end up with 10 total manipulations

Data and Analysis: Note—everything that is included in your journal must be legible and ultimately in final draft quality (organized, titled, numbered, etc.)

- Create one data table in which you will record all 8 trials of range and time for each of the 5 spring settings for both your launcher and a partner group's launcher. Include the uncertainty for your ranges (you determine what it is based on how you measured it and how confident you are about the landing spot). Include the uncertainty for the time, which is ± 0.0002 s.
- Create a data table in which you will record the following: average range, with uncertainty; average time, with uncertainty; average launch velocity, with uncertainty.
- Show 1 sample calculation for how you determined the launch velocity of the marble.
- Create a graph (and print out) showing the relationship between your MV and your RV.
- Your graph will not initially be linear. Determine what you must do to linearize the graph, then do so.
- Create the data table showing the values you plot on your linear graph.
- Create and analyze your final linearized graph.