

Projectile Motion

Purpose: To gain experience at working problems involving freely falling projectiles
 To determine the initial velocity of a projectile from its vertical motion
 To determine the range of a projectile and compare with its measured value

Equipment: Air powered rocket, bicycle pump, launch platform, stopwatch, 35°, 40°, 45°, 50°, 55°, and 60° wedges, measuring tape, small carpenter level.

Introduction: The initial velocity of a projectile can be determined by shooting the projectile straight up and measuring the total time of flight. The equation that relates the velocity, v , of a falling body to the time, t , that it has fallen is

$$1) \quad v = g t$$

where, g , represents the acceleration of gravity.

Since it is easier to measure the total time (up and down) that a projectile is in the air, the time of fall, t , for this equation will be obtained by dividing the total time of flight by 2.

The range, R , of a projectile is the total horizontal distance traveled. It can be determined from the laws of physics using the equation

$$2) \quad R = \frac{v^2 \sin(2\theta)}{g}$$

Where, v , is the initial velocity of the projectile and, θ , is the angle (with respect to the horizontal) of the projectile's initial velocity. The sine function (abbreviated Sin) is given here for several common angles:

Sin (70°) = 0.940	Sin (100°) = 0.985
Sin(80°) = 0.985	Sin (110°) = 0.940
Sin(90°) = 1.000	Sin (120°) = 0.866

Procedure: **Note: Please exercise great care in firing your rockets. Check around you and make sure that no one is in the line of fire when your rocket leaves the launch pad.**

1. Set up your rocket so that it is pointed vertically upward. Attach the bicycle pump to the rocket and complete enough strokes of the pump so that the rocket is released and travels upward. Practice this several times, counting the strokes so that you can reliably predict when the rocket will fire. Measure the total time of travel (up and down) for your rocket. Repeat three times and calculate the average time. Put your data in the table below:

Times for Vertical Rocket Firing

Trial	Total Time (s)	Average Total Time (s)	Average Time Falling (s)	Initial Velocity (m/s)
1				
2				
3				

2. Find the initial velocity of your rocket by using equation 1. Be sure to use the "average time falling" from the above table in your calculation. Put the result in the above table.

$$v = g t = \boxed{9.8 \text{ m/s}^2} \times \boxed{} = \boxed{}$$

3. Using the same procedure as in step 1, launch your rocket so that the initial direction of the rocket is inclined with respect to the horizontal at one of the available angles between 35° and 60° . Use the appropriate wedge for the angle that you have chosen to tilt the launch platform and record the chosen angle in the box in the title of the table below. Measure the range of the rocket with the tape measure. Repeat three times and record your data in the table below. Using the above equation for the range, calculate the theoretical value for the range and record. Find the percent difference between your measure range and the theoretical value.

Range Data for Initial Angle =

Trial	Measured Range (m)	Average Range (m)	Range from Equation 2 (m)	Percent Difference
1				
2				
3				

4. If time permits repeat step 3 for a different initial angle using a different wedge. Record your data in a table similar to that shown in step 3.
5. Discuss possible sources of error in your experiment? What role does the force of air drag play in affecting the results of your experiment?