Lab: Projectile Motion (PhET) AP Physics

Background
Two-dimensional motion can be analyzed by considering the horizontal and vertical components of motion independently.

Objectives
To catch the cannonball!

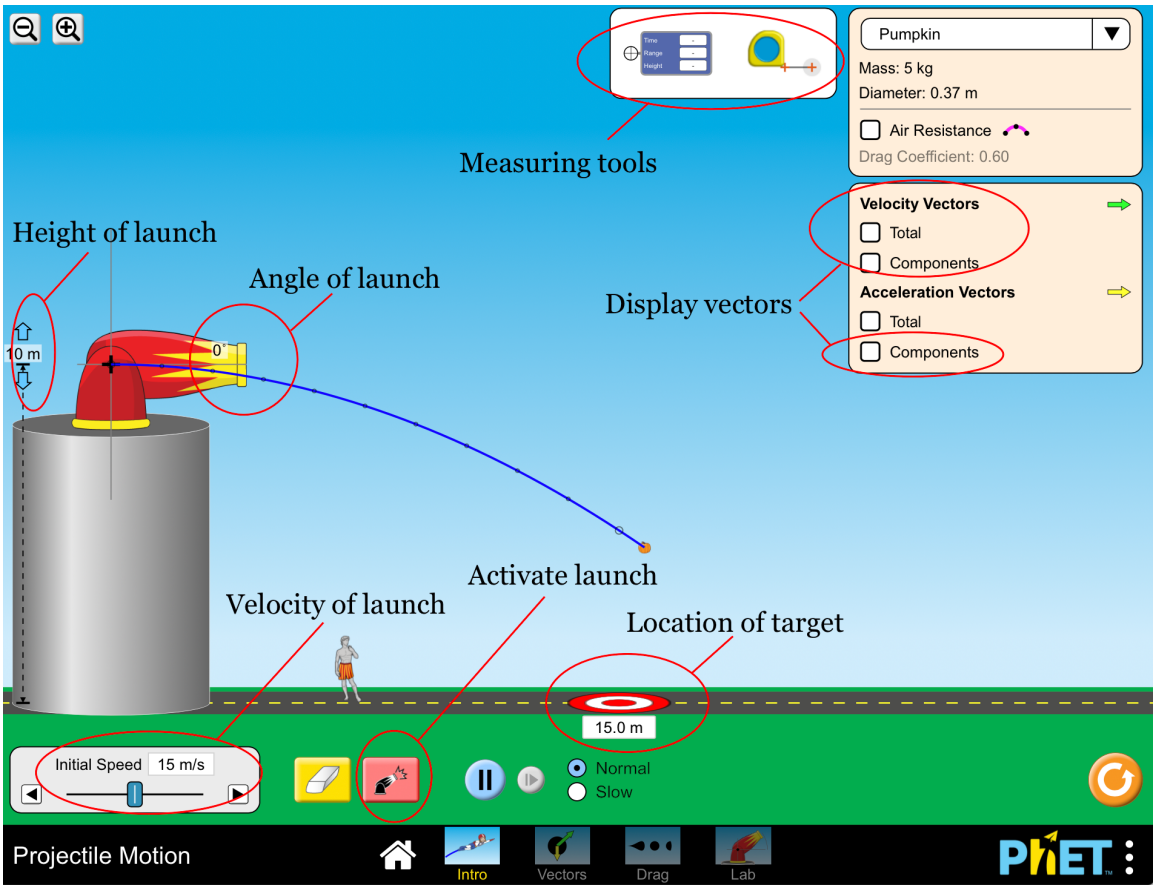
Equipment
- Computer
- Internet connect (to access PhET website)

Procedure

In this online-based experiment you'll be running a series of simulations of projectile motion to learn some of the ways two-dimensional motion can be analyzed.

Part A. Familiarize yourself with the Software

1. Go to https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html and select the *Intro* simulation.



2. Familiarize yourself with the various quantities that can be changed in the simulation. Because we are not considering air friction ("drag") at this point, leave the "air resistance" option unchecked.

3. As you experiment with the various quantities, be sure you run some trials with the *velocity* or *acceleration vectors* enabled. Does the vertical velocity change (or not) as you expect it to? Does the vertical acceleration change (or not) as you expect it to? Does the horizontal velocity change (or not) as you expect it to?

Part B. Catch the Pumpkin / Cannonball / Human / Car / Piano

1. Still using the *Intro* mode in the Projectile Motion simulation, select an object that you wish to shoot from the cannon. With air friction turned off, your choice of object will not effect the outcome of the lab. Your choice of projectile is a purely aesthetic one.
2. Select an arbitrary (non-zero) cannon height, velocity, and cannon angle for your projectile. Record these values in a data table. *Do not launch your object yet!*
3. Based on your choices for the values above, and without launching your object, calculate the following quantities. (This is the most significant part of the activity; be sure to clearly indicate problem-solving strategy with diagrams, formulae with variables first before subbing in values, etc.)
   a. initial horizontal and vertical components of velocity
   b. maximum height
   c. total time in the air till touchdown
   d. horizontal displacement from takeoff position-time
   e. final velocity just before impact (angle and direction)
4. Once you have solved for all of these values, go ahead and launch your object. Use the measuring tools to identify your predicted values where possible (maximum height, time in air, horizontal displacement), and comment on how well your predictions matched the measured values.

Part C. Additional Questions

1. When this experiment is conducted in the lab, students launch a small steel ball off a table. Before actually launching the ball, they take measurements to calculate a predicted landing distance and place a small cup at that location, in an effort to "catch the ball."

   It is often the case that the ball lands short of the cup. Some lab groups, however, launch their ball and find that it lands beyond the cup. Identify a potential source of uncertainty that would explain each of these results.