

Projectile Lab – Horizontal Launch

Link for online lab:

<https://phet.colorado.edu/en/simulation/projectile-motion>

OBJECTIVES:

- Draw motion diagrams for a horizontally launched projectile.
- Investigate the factors affecting range of a horizontally launched projectile.
- Determine height of launch and gravitational field strength at a location by using a horizontally launched projectile and performing curve fitting on linearized data.

PROCEDURE:

Click on the Intro window.

Part 1 – Motion Diagrams

1. In the **Velocity Vectors** box, choose “Components”. Keeping rest of the settings on default, fire the projectile and observe how the vectors change as the projectile falls to the ground.
 - a) Draw a motion diagram showing velocity components at different locations.
 - b) How do the two velocity components change as the projectile moves?
 - c) Explain the physical reason for your observation in part (b)?
2. Reset the simulation. Now in the **Velocity Vectors** box, choose “Total”. Fire the projectile and observe how the velocity vector changes as the projectile falls to the ground.
 - a) Draw a motion diagram showing the velocity vector at different locations.
 - b) How do the magnitude and direction of the velocity vector change as the projectile moves?
 - c) How is the velocity vector related to the path of the projectile (i.e. how is this vector drawn in relation to the path)?
3. Reset the simulation. Now in the **Acceleration Vectors** box, choose “Total”. Fire the projectile and observe how the acceleration vector changes as the projectile falls to the ground.
 - a) Draw a motion diagram showing the acceleration vector at different locations.

b) How do the magnitude and direction of the acceleration vector change as the projectile moves?

c) Explain the physical reason for your observation in part (b)?

Part 2 – Range vs. Mass of projectile – Height & Launching speed constant

4. Reset the simulation. For constant values of height (10 m) and initial speed (15 m/s), fire the projectile for 5 different masses (Pumpkin, Golf ball, Tank shell, Human, Car).

a) Does the range of the projectile depend on its mass?

b) Explain the physical reason for your observation in part (a)?

Part 3 – Range vs. Launching speed of projectile – Height & Mass constant

5. Reset the simulation. For constant values of height (10 m) and mass (Pumpkin), fire the projectile for 5 different initial speeds (0, 5, 10, 15, 20 m/s).

a) Take a screen shot showing the five trajectories and paste it here.

b) Using the Time and Range tool, collect data in the following data table. Time and Range tool is accessible in the top right corner of the simulation and looks like this:



Measure Time and Range at the location where projectile hits the ground.

Mass Pumpkin (kg)	Launch Height H (m)	Launch Speed v_x (m/s)	Time of flight T (s)	Range R (m)
5	10	0		
5	10	5		
5	10	10		
5	10	15		
5	10	20		

6.

a) Does time of flight for the projectile depend on its initial speed?

- b) Explain the reason for your observation in part (a)?
- c) Does range of the projectile depend on its initial speed?
- d) Explain the reason for your observation in part (c)?
7. Range of a horizontally launched projectile is given by: $R = v_x \sqrt{\frac{2H}{g}}$
 Explain how you can graphically obtain launch height H, by plotting R vs. v_x .
 Use this graph to calculate H and compare it with known value of 10 m.
 (Paste the graph with linear fit here.)

Part 4 – Range vs. Launching height of projectile – Mass & Launching speed constant

8. Reset the simulation. For constant values of launching speed (15 m/s) and mass (Pumpkin), fire the projectile for 5 different launching heights (5, 7, 10, 13, 15 m).
- a) Take a screen shot showing the five trajectories and paste it here.
- b) Using the Time and Range tool, collect data in the following data table.

Measure Time and Range at the location where projectile hits the ground.

Mass Pumpkin (kg)	Launch Speed v_x (m/s)	Launch Height H (m)	Time of flight T (s)	Range R (m)	Range Squared R^2 (m ²)
5	15	5			
5	15	7			
5	15	10			
5	15	13			
5	15	15			

- 9.
- a) Does time of flight for the projectile depend on its initial height?
- b) Explain the reason for your observation in part (a)?
- c) Does range of the projectile depend on its initial height?

d) Explain the reason for your observation in part (c)?

10. Range of a horizontally launched projectile is given by: $R = v_x \sqrt{\frac{2H}{g}}$

Explain how you can graphically obtain gravitational field strength g , by plotting R^2 vs. H .

Use this graph to calculate g and compare it with known value of 9.81 m/s^2 .

(Paste the graph with linear fit here.)