

**Introduction:**

Projectiles travel with two components of motion, X and Y. The acceleration and velocity in the Y direction is independent of the acceleration (if any) and velocity in the X direction. In this module, you will investigate the motion of a simple projectile. Realize that while gravity (acceleration) acts on the projectile in the vertical direction, it does not affect the velocity of the projectile in the horizontal direction.



Projectile Motion

**Procedure:**

- Run the PhET Simulation (<https://phet.colorado.edu/en/simulation/legacy/projectile-motion>)
- The cannon can be moved to add or remove initial Y position and X position.
- The cannon can be pivoted to change the firing angle,  $\theta$ .
- The tape measure can be moved and dragged to measure range to target.
- To fire the cannon, **Fire**.
- To erase the projectile's path, **Erase**.

Be sure air resistance is off and spend some time firing various projectiles.

- Set the initial speed to a value between 10-15 m/s. Choose your favorite projectile.
- Find the range of the projectile at various angles.

$\theta = 30^\circ$ : Range ( $\Delta x$ ) = 12.7 m

$\theta = 70^\circ$ : Range ( $\Delta x$ ) = 9.44 m

$\theta = 40^\circ$ : Range ( $\Delta x$ ) = 14.2 m

$\theta = 80^\circ$ : Range ( $\Delta x$ ) = 5.01 m

$\theta = 50^\circ$ : Range ( $\Delta x$ ) = 14.6 m

$\theta = 10^\circ$ : Range ( $\Delta x$ ) = 5.01 m

$\theta = 60^\circ$ : Range ( $\Delta x$ ) = 12.7 m

$\theta = 45^\circ$ : Range ( $\Delta x$ ) = 14.8 m

Add two more  $\rightarrow$

- Measure the distance from the cannon to the target using the tape measure.
- Move the target to 21.0 m from the cannon. Attempt to hit the target with three different angles by changing the firing angle and initial velocity.

Range ( $\Delta x$ ) = 21.0m  $\theta = 80^\circ$   $v_i = 25 \text{ m/s}$

Range ( $\Delta x$ ) = 21.0m  $\theta = 60^\circ$   $v_i = 15 \text{ m/s}$

Range ( $\Delta x$ ) = 21.0m  $\theta = 30^\circ$   $v_i = 15 \text{ m/s}$

**VERY IMPORTANT**

- ❖ A projectile's velocity ( $v$ ) has an x-component ( $v_x$ ) and a y-component ( $v_y$ ). The x-component ( $v_x$ ) is found by multiplying the magnitude of the velocity by the *cosine* of the angle,  $\theta$ .
- ❖ Similarly, the y-component of velocity is found by multiplying the magnitude of the velocity by the *sine* of the angle,  $\theta$ .

$$v_x = v \cos \theta$$

$$v_y = v \sin \theta$$

So, a projectile fired at 20 m/s at  $65^\circ$  has an x-velocity of  $v_x = 20 \cos 65$  or 8.5 m/s.

The projectile would have a y-velocity of  $v_y = 20 \sin 65$  or 18 m/s.

So, the projectile would fire as far as one fired horizontally at 8.5 m/s and as high as one fired straight up at 18 m/s.

A projectile fired at 30 degrees with a velocity of 15 m/s would have an x-velocity component of 13 m/s and a y-velocity component of 7.5 m/s.

# Answer Key To Projectile Simulation Lab Activity

**United States. Congress. House.  
Committee on Appropriations.  
Subcommittee on Department of  
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