

Projectile Motion Simulator

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/projectile-motion/>

Name: _____ Date: _____

Learning objectives

- Explain why horizontal and vertical motion are independent.
- Predict how launch angle affects range and maximum height.
- Identify the angle that maximizes range with no air resistance.

Variables to change

- Launch angle
- Launch speed
- Gravity
- Air resistance (on/off)

Procedure

1. Set gravity to Earth (9.8 m/s^2) and turn air resistance off.
2. Fix the launch speed. Fire at 15° , 30° , 45° , 60° , and 75° , recording the range each time.
3. Fire at 30° and 60° with the same speed and compare the two ranges.
4. Now turn air resistance on and repeat the 45° launch.

Observations

Record range, maximum height, and flight time for each launch angle in a table.

Questions

1. Which launch angle gave the greatest range with air resistance off?
2. How did the ranges at 30° and 60° compare? Why?
3. Does the projectile's mass change its trajectory (air resistance off)? Explain.
4. What happened to the range and the best angle when you turned air resistance on?
5. At the top of the arc, what is the vertical velocity? The horizontal velocity?

Answer key (instructors)

- **1.** 45° gives the maximum range when launched and landing at the same height with no air resistance.
- **2.** They are equal. Complementary angles (adding to 90°) give the same range because the range formula depends on $\sin(2\theta)$, and $\sin(60^\circ)=\sin(120^\circ)$.
- **3.** No. In a vacuum all masses fall with the same acceleration g , so the path depends only on launch speed and angle, not mass.
- **4.** Range decreased and the angle giving maximum range dropped below 45° , because drag removes energy and grows with speed.
- **5.** Vertical velocity is zero at the peak; horizontal velocity stays constant throughout (air resistance off).

A projectile moves under gravity alone once launched. Horizontal velocity is constant while vertical velocity changes at g , so the path is a parabola. With no air resistance, 45° maximizes range and complementary angles share ranges. Air resistance shortens the range and lowers the optimal angle.