

### Horizontal and Vertical Dropped Objects

**Description:** This demo shows that horizontally shot and vertically dropped objects will hit the ground at the same time.

**Typical Courses:** PHYS 101, PHYS 105, PHYS 111

**Turn-Key:** Yes (Required, instructor must pick up, prepare, and return)

**Specialist/TA Led:** No (must be led by instructor)

**Time:** 5-10 minutes

#### **Learning Outcomes:**

- Students should be able to:
  - Understand and explain that gravity acts only in the vertical direction
  - Explain why a horizontally shot object and a vertically dropped object fall at the same rate
  - Explain assumptions of this physical system (i.e., neglecting air resistance, zero vertical velocity)

#### **Prerequisite Student Knowledge:**

- Before seeing this demo, students should be confident:
  - With vector quantities and vector notion
  - Explaining gravity
  - Contrasting the acceleration of gravity and force due to gravity

#### **Materials:**

- Spring-loaded apparatus
- Ball bearings of various sizes and masses

#### **Procedures:**

1. Unpack apparatus
2. Place two chosen ball bearings and place one on each side of the apparatus
3. Load the spring by pulling the spring end of the apparatus until it locks
4. Pull trigger to shoot/release the two ball bearings

#### **Sample Demo Questions:**

1. Think-Pair-Share:
  - a. Explain demo
  - b. Ask students to talk in pairs (i.e., think-pair-share) about which object will hit the ground first.
  - c. Have pairs share with a second pair and come to consensus.
  - d. Ask class for one or two opinions and explanations.
  - e. Show demo
  - f. Ask pairs to reconvene and develop final explanation
2. Clickers:
  - a. Explain demo
  - b. Ask students to answer with clickers/phones which object will hit the ground first
  - c. Ask for one or two opinions and explanations
  - d. Show demo
  - e. Ask students to submit short online explanation for demo results
3. Student-Led:

- a. Before showing demo apparatus, ask students something like: “How does horizontal velocity affect an object’s vertical motion?”
- b. Ask students to come up with a quick “experiment” they could do to test this (e.g., students could propose throwing and dropping two pencils)
- c. Ask for student volunteer(s) to conduct mini-“experiment” at front of class
- d. Ask for explanation from class (think-pair-share, clicker, etc.)
- e. Show demo
- f. Ask students for final explanation