

# Understanding Weightlessness

## Activity Objectives

- To investigate free fall and weightlessness
- To understand that objects dropped from a resting position are in free fall
- To understand that objects tossed into the air are in free fall
- To understand that orbiting objects are in free fall

## Materials

- ✓ Awl or other sharp instrument
- ✓ Towels (for cleanup)
- ✓ Two buckets
- ✓ Two-liter plastic soda bottle
- ✓ Water (enough to fill the bottle)

## Background

Objects are in free fall when gravity is the only force affecting their motion. Free fall occurs when objects are dropped from a resting position or tossed into the air (disregarding air friction). Orbiting objects are also in free fall because gravity is the only force affecting their motion. In this activity, students demonstrate free fall using water in a bottle.

## Instructions

Have a student volunteer read the following statement, and discuss with the class: When objects are dropped from a resting position, we say they are in free fall.

- How would you describe free fall?
- What makes objects fall when you drop them?
- Why is the fall described as free?

### Part A: Basic Free Fall

1. Use an awl or other sharp instrument to poke a small hole in the side of the bottle, near the bottom.
2. Put your finger over the hole.

3. Fill the bottle with water.
4. Balance the bottle in the palm of your hand and hold it as high as you can over the buckets. (The further the bottle falls, the easier it is to make observations.)
5. Remove your finger from the hole and observe.
6. Before the water empties, drop the bottle into a bucket.
7. Repeat this process several times and note the results.

### Questions

What do you observe when you unplug the hole?

Describe what happens when you drop the bottle.

How is gravity acting on the bottle and water?

How could you prevent the bottle from falling freely after you let it go?

Describe a situation in which you have been in free fall. What did it feel like?

### Part B: Advanced Study of Free Fall

1. Using the same bottle as in Part A, put your finger over the hole in its side and fill the bottle with water.
2. Toss the bottle into the air without spinning it. Do this several times and note the results.

### Questions

Watch the water stream during the activity. When does it flow?

When does it stop flowing?

Why does it flow?

Why does it stop flowing?

Orbital motion is a type of free fall. How are the falling bottle and water like an orbiting Space Shuttle and its crew?

### **Extension**

Suspend a small object from a spring scale. Drop the object and scale, and watch what happens

to the scale's needle. If possible, film this process and watch the apparatus fall in slow motion. (The scale shows an object's weight while it is held, but as soon as it is dropped, the needle returns to zero and stays there for the duration of the fall. During free fall, an object is effectively weightless throughout the fall since its weight cannot pull the scale's spring.)

### **Glossary**

Free Fall - occurs when gravity is the only force affecting an object's motion; for example, when an object is dropped from a resting position, tossed into the air, or is in orbit.

Gravity - the attraction between masses. Gravity is one of the four natural forces; it has infinite range and obeys the inverse square law.

Weightlessness - a condition in which no object will register any weight on a typical scale. This occurs during any type of free fall, but it does not imply an absence of gravity.