

Activity 3

Falling Water

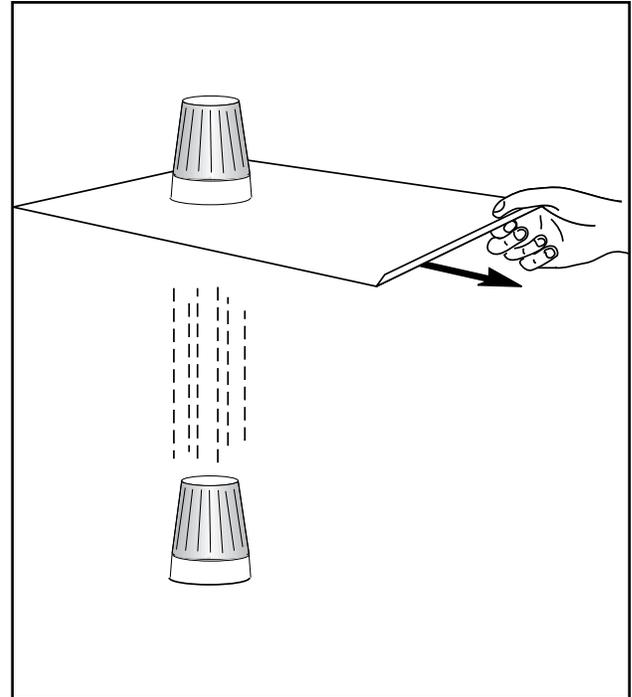
OBJECTIVE:

To demonstrate that free fall eliminates the local effects of gravity.

BACKGROUND:

Weight is a property that is produced by gravitational force. An object at rest on Earth will weigh only one-sixth as much on the Moon because of the lower gravitational force there. That same object will weigh almost three times as much on Jupiter because of the giant planet's greater gravitational attraction. The apparent weight of the object can also change on Earth simply by changing its acceleration. If the object is placed on a fast elevator accelerating upward, its apparent weight would increase. However, if that same elevator were accelerating downward, the object's apparent weight would decrease. Finally, if that elevator were accelerating downward at the same rate as a freely falling object, the object's apparent weight would diminish to near zero.

Free fall is the way scientists create microgravity for their research. Various techniques, including drop towers, airplanes, sounding rockets, and orbiting spacecraft, achieve different degrees of perfection in matching the actual acceleration of a free-falling object.



In this demonstration, a water-filled cup is inverted and dropped. Before release, the forces on the cup and water (their weight, caused by Earth's gravity) are counteracted by the cookie sheet. On release, if no horizontal forces are exerted on the cup when the sheet is removed, the only forces acting (neglecting air) are those of gravity. Since Galileo demonstrated that all objects accelerate similarly in Earth's gravity, the cup and water move together. Consequently, the water remains in the cup throughout the entire fall.

To make this demonstration possible, two additional scientific principles are involved. The cup is first filled with water. A cookie sheet is placed over the cup's mouth, and the sheet and the cup are

MATERIALS NEEDED:

Plastic drinking cup
Cookie sheet (with at least one edge without a rim)
Soda pop can (empty)
Sharp nail
Catch basin (large pail, waste basket)
Water
Chair or step-ladder (optional)
Towels

inverted together. Air pressure and surface tension forces keep the water from seeping out of the cup. Next, the cookie sheet is pulled away quickly, like the old trick of removing a table cloth from under a set of dishes. The inertia of the cup and water resists the movement of the cookie sheet so that both are momentarily suspended in air. The inverted cup and the water inside fall together.

PROCEDURE:

- Step 1.** Place the catch basin in the center of an open area in the classroom.
- Step 2.** Fill the cup with water.
- Step 3.** Place the cookie sheet over the opening of the cup. Hold the cup tight to the cookie sheet while inverting the sheet and cup.
- Step 4.** Hold the cookie sheet and cup high above the catch basin. You may wish to stand on a sturdy table or climb on a step-ladder to raise the cup higher.
- Step 5.** While holding the cookie sheet level, slowly slide the cup to the edge of the cookie sheet.
- Step 6.** Observe what happens.
- Step 7.** Refill the cup with water and invert it on the cookie sheet.

- Step 8.** Quickly pull the cookie sheet straight out from under the cup.
- Step 9.** Observe the fall of the cup and water.
- Step 10.** If your school has videotape equipment, you may wish to tape the activity and replay the fall using slow motion or pause controls to study the action at various points of the fall.

FOR FURTHER RESEARCH:

1. As an alternate or a supportive activity, punch a small hole near the bottom of an empty soda pop can. Fill the can with water and seal the hole with your thumb. Position the can over a catch basin and remove your thumb. Observe the water stream. Toss the can through the air to a second catch basin. Try not to make the can tumble or spin in flight. Observe what happens to the water stream. The flight of the can is a good demonstration of the parabolic trajectory followed by NASA's KC-135. (Note: Recycle the can when you are through.)
2. Why should you avoid tumbling or spinning the can?
3. Drop the can while standing on a chair, desk, or ladder. Compare the results with 1.

