

Discovery Future Engineers and Scientists in Training

Human Exploration and Development of Space

Microgravity

Falling Water

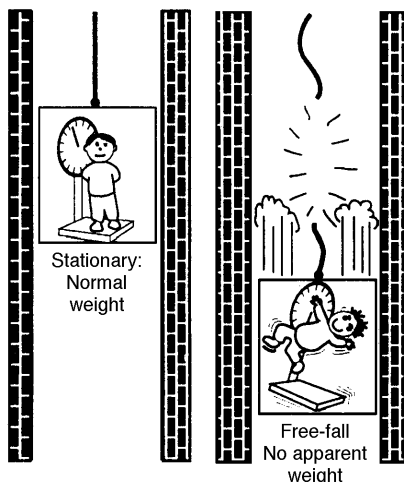
Background

Gravity is a force that pulls any object towards another one. It doesn't matter whether the object is a planet, a cannonball, a feather, or a person.

The amount of force between two objects depends upon how much mass each contains and the distance between their centers of mass. For example, an apple hanging from a tree branch will have less gravitational force acting on it than when it has fallen to Earth. The reason for this is because the center of mass of an apple, when it is hanging from a tree branch, is farther from the center of mass of Earth than when lying on the ground.

Although gravity is a force that is always with us, its effects can be greatly reduced by the simple act of falling within a gravitational field. NASA calls the resulting reduction of gravity's effects a microgravity environment.

You can get an idea of how microgravity is created by looking at the elevator diagram. Imagine riding in an elevator to the top floor of a very tall building. At the top, the cables break, and gravity causes the car and you to fall. In other words, you and the elevator car are accelerating downward at the same rate due to gravity alone. Because you and the elevator car are falling together, you feel like you could float inside the car. If you stood on a scale, your weight would not register because the scale would be falling too. The ride is lots of fun until you get to the bottom.



Most of NASA's microgravity facilities use this concept of falling. For instance, a drop tower is like a high-tech elevator shaft. A small experiment package is suspended from a latch at the top and then released. For some drop towers, when the test is ready, air from the shaft is pumped out so the package will fall more smoothly. Cameras, recording equipment, and data transmitters are used to record the experimental results.

Because of gravity and the design of drop towers, experiments follow a straight-line path towards Earth. Objects that are thrown, shot, or launched so that only gravity and air resistance are acting on it do not fall in a straight line, but rather follow a parabolic path. As soon as they are released, however, such objects are in free-fall, just like dropped experiments. So, special airplanes that follow parabolic flight paths, and rockets that use up their propellant and are in free-fall, can be used to perform microgravity experiments. In fact, spacecraft that are in orbit around Earth can also be used for microgravity research because they are actually falling around Earth.

Activity

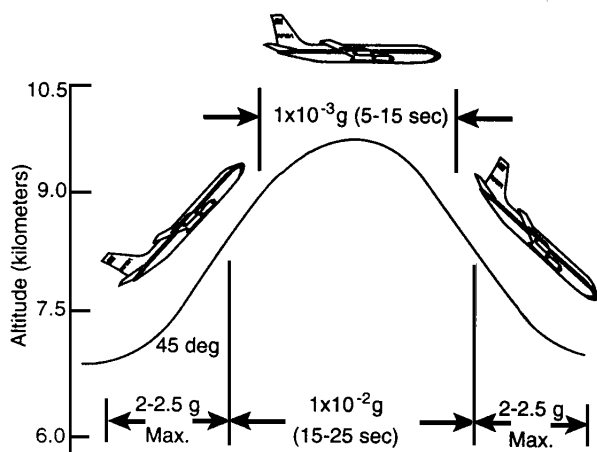
Plastic bottles of water are dropped and thrown to help visualize how being in free-fall creates a microgravity environment.

- Materials:
- Empty plastic bottle
 - Pin or nail
 - Container of water
 - Meter stick
 - Catch basin
 - Drop cloth
 - Paper towels

1. Remove the labels from an empty 16 oz. or 1 liter plastic soda or juice bottle. Punch a small hole (5 mm diameter) on the side of the bottle, near the bottom.
2. Cover the hole with a finger and fill the bottle with water.

3. While holding the bottle over a catch basin, or outside in a place you can get wet, remove your finger from the hole and watch what happens.
4. Cover the hole again and refill the bottle with more water.
5. Uncover the hole and drop the bottle, being careful not to rotate the bottle. Watch what happens to the water.
6. Cover the hole and refill the bottle. Uncover the hole and throw the bottle up in the air, being careful not to rotate the bottle. Watch what happens to the water.
7. Cover the hole, refill the bottle, stand back about 2 meters from the catch basin and carefully throw the bottle towards the basin (or throw it to another person who will catch the bottle). Watch what happens to the water.

When you put water into a bottle on Earth, the water fills up the bottom of the bottle because of the properties of liquids, because water is more dense than the surrounding air, and because of gravity. For the same reasons, water will flow out of a hole in a bottle and fall towards the ground. When the bottle of water is dropped or thrown through the air, the bottle/water system is in free-fall and, therefore, experiences a microgravity environment. In such an environment, the effects of gravity are reduced compared to what we experience on Earth. The bottle and water are both falling together under the influence of gravity and no water comes out of the hole.



The NASA Lewis Research Center Connection

NASA Lewis Research Center in Cleveland, Ohio, has two drop facilities: the Zero-G Facility which provides 5.2 seconds of microgravity conditions and the 2.2 Second

Drop Tower which provides 2.2 seconds of microgravity. Both of these facilities are used to do experiments that need very short periods of microgravity conditions and to test equipment that is being designed for use on orbiting laboratories. In particular, the Microgravity Science Division at NASA Lewis uses these facilities, NASA's "Vomit Comet" airplane, sub-orbital rockets, and orbiting spacecraft such as the Space Shuttle Orbiters, Mir, and the planned International Space Station to study fluids and combustion in a microgravity environment.

Learn More by Using the World Wide Web

Find out about the NASA Lewis Research Center's Drop Facilities:

<http://zeta.lerc.nasa.gov/new/facility.htm>

Visit the Microgravity Fluids Physics Website at NASA Lewis Research Center:

<http://zeta.lerc.nasa.gov/6712/home6712.htm>

Visit the Microgravity Combustion Science Website at NASA Lewis Research Center:

<http://zeta.lerc.nasa.gov/expr3/combust.htm>

Visit the Microgravity Science Division Educational Page:

<http://zeta.lerc.nasa.gov/new/school.htm>

Visit the National Center for Microgravity Research on Fluids and Combustion K-12 Educational Programs page:

<http://www.ncmr.org/education.html>

More information about NASA Microgravity Research Program is available at:

<http://microgravity.msfc.nasa.gov/>

More information about NASA Lewis Research Center is available at:

<http://www.lerc.nasa.gov/>

The Microgravity teacher's guide for grades 5-12 can be accessed at:

<http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Microgravity/>

This activity is adapted from "Microgravity in the Classroom," *Microgravity—A Teacher's Guide with Activities in Science, Mathematics, and Technology*, NASA EG-1997-08-110-HQ.