Lunar Landing: Swinging Tray

Overview

Knowing that gravity is responsible for keeping satellites in orbit leads us to the question, why do astronauts appear to float in space? The answer is simple; the Space Shuttle orbiter falls in a circular path about Earth and so does everything in it. Students will learn that gravity acts as a centripetal force and how spacecraft can orbit the Earth or other planets.

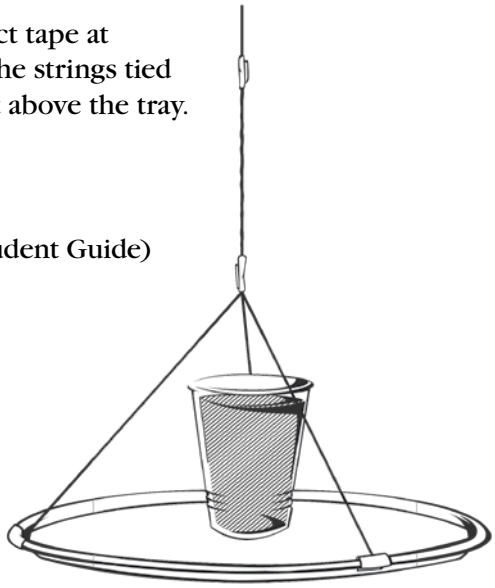
Purpose

Through participation in this demonstration, students will:

- Learn that gravity acts as a centripetal force that keeps satellites in orbit and controls the path of the Moon.

Preparation

1. Gather all materials.
2. Attach strings to the edge of the metal pizza tray securely with duct tape at three triangular points. (Holes can also be drilled in the tray and the strings tied through the holes.) The strings should all come together at a point above the tray.



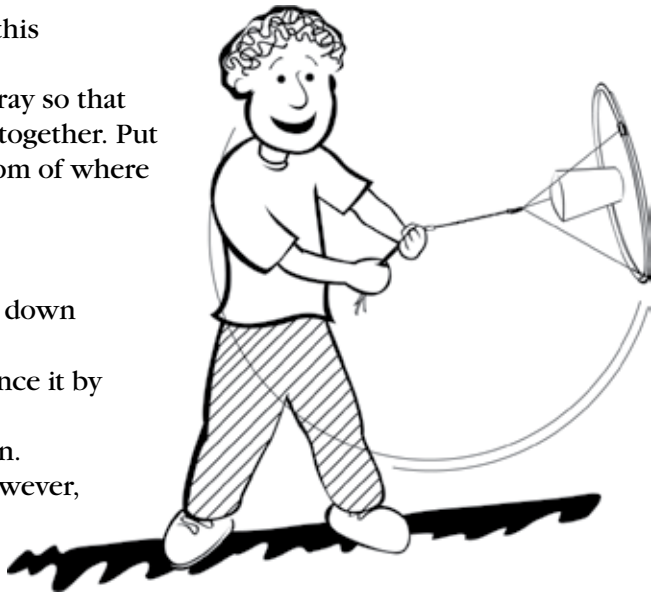
Materials

Per team:

- Student Data Sheets (CD Location: Educator Resources/Guides/Student Guide)
- Metal pizza tray
- String
- Duct tape
- Plastic cup
- Water
- Food coloring
- Hard hat
- Safety glasses

Procedure

1. Conduct this demonstration outdoors and have the students stand far enough back so that they are a safe distance away from the demonstrator.
2. Wear a hard hat and safety glasses while conducting this demonstration.
3. Hold the pizza tray by the strings and spin the pizza tray so that about 15.24 cm to 20.32 cm of the strings are wound together. Put pieces of tape on the strings to hold the top and bottom of where it is wound. Set aside.
4. Put a few drops of food coloring in the water.
5. Fill the plastic cup with water.
6. Ask the students if it is possible to get the cup upside down without spilling the water.
7. Place the water cup in the center of the tray and balance it by holding the strings.
8. Carefully, begin swinging the tray in a circular fashion. The water should stay in the cup as it is swinging; however, when the swinging motion is stopped, the water will spill out.



Questions

1. What do we call the path that the tray moves in? (We call the path an orbit.)
2. If the strings are held at a shorter distance to the tray, shortening the tray's orbit, what happens to the speed of the tray? (The speed increases when the tray's orbit is shorter.)
3. Pulling on the string is acting as a force called? (Centripetal.)
4. What would happen if the centripetal force in this experiment were removed by cutting the string? (The tray would fly out of its orbit in a direction tangent to the orbital path.)

Answer Key/What is happening?

When you spin the tray in a circle, the tray is held in its orbit by the string. You must constantly pull on the string to keep the tray from flying off in a straight line. The force you apply to the tray through the string is the centripetal force.

Similarly, for a satellite that is in orbit around the Earth, it is the Earth's gravity that exerts a centripetal force on the satellite that prevents it from flying off into space. The Earth's gravity pulls on the satellite like you pull on the string to keep the tray traveling in circular motion.

The Moon is a satellite orbiting the Earth, and the Earth is a satellite circling the Sun. The Earth's gravity also keeps the Moon in orbit, and the Sun's gravity keeps the planets orbiting around it.

Source: Toys in Space II and various other sources.