

# Simulating Orbits

Activity provided by Jason Foundation for Education

Grade: 6<sup>th</sup> – 8<sup>th</sup> grade

**Goal:** This activity will demonstrate the proper relationship between the altitude and the velocity of a satellite and how this makes satellite communications possible.

**Objective:** Students will:

- Simulate a geosynchronous (stationary) orbit.
- Simulate the relationship between velocity and the altitude of orbits.
- Describe some properties of orbits and the effect that changing the radius of its orbit would have on the speed of a satellite.

**Materials:**

- Small Nerf <sup>TM</sup> ball or any lightweight ball
- Two meters (about two yards) kite string or wrapping twine

**Introduction:**

Explain that the closer a satellite is to the surface of the Earth, the faster it must travel to stay in orbit. A satellite at 320 kilometers (200 miles) above the earth (high enough to be above most of the atmosphere, which would slow a satellite) must orbit the Earth at approximately 22,000 kilometers/hour (13,700 miles/hour). At this speed the satellite would orbit faster than the Earth's rotation, and would appear to be moving around the Earth relative to an observer standing still on the Earth's surface. At an altitude of about 36,000 kilometers (22,300 miles), a geosynchronous satellite appears to stand still but really moves at a speed of 11,000 kilometers/hour (6,800 miles/hour). The satellite makes one orbit of the Earth every 23 hours and 56 minutes at that speed and altitude, which moves it along in synchrony with a stationary observer on the Earth.

**Activity:**

1. Tie the string around the ball just tightly enough to make a slight indentation in the ball.
2. Clear a large area in the center of the room, or take students outdoors or to the gym. Have a volunteer swing the ball "satellite" above his or her head, just fast enough to keep the ball traveling in a horizontal orbit. Ask the class to observe the speed of the ball at the end of the string.
3. Instruct the volunteer to wind up one third of the string and repeat the swing, then to wind it up again so only a third of the original length remains and swing again, keeping the ball and string horizontal. Ask students what difference they observe. (The closer the ball is to the pivot point – the swinger – the faster it has to move to stay horizontal.) Emphasize this conclusion: The more the string is shortened, the faster the ball must move to stay in orbit.
4. Explain: The hand holding the string represents the Earth. The ball on the string represents a satellite that is constantly orbiting the Earth. The closer the satellite is to the Earth, the faster it must move to remain in orbit.

**Conclusion:**

Review the activity. The closer a satellite is to the Earth, the stronger the Earth's gravitational pull and the faster the satellite must move to avoid falling to the Earth. Low-Earth satellites orbit at about 28,000 kilometers/hour (17,400 mile/hour) and pass around the Earth in 23 hours, 56 minutes, the time of one rotation of the Earth. This is the relationship that **Arthur C. Clarke** discovered.