

Objective:

Students will learn about how the force of gravity works to keep satellites in orbit around the Earth and other planets.

Arkansas State Standards Addressed:

Science:

NS.1.4.8

Develop a *hypothesis* based on prior knowledge and observations

NS.1.4.11

Generate conclusions based on evidence

NS.1.4.13 Use simple equipment, age appropriate tools, technology, and mathematics in scientific investigations (e.g., balances, hand lenses, microscopes, rulers, thermometers, calculators, computers)

ESS.10.5.1 Compare the properties of planets in our solar system:

- Size
- Shape
- Density
- Atmosphere
- Distance from the Sun
- Orbital path
- Moons
- Surface
- Composition

ESS.10.8.2

Identify variables that affect the amount of gravitational force between two objects:

- Mass of the objects
- Distance between two objects

Speaking and Listening

SL.5.1: Engage effectively in a range of *collaborative conversations/discussions*

Activity:

What is a satellite? A satellite is any object that orbits the Earth or another planet. It can be made by humans, such as Sputnik or the International Space Station, or can be a natural satellite like Jupiter's moons. But how can satellites orbit around Earth or another planet without flying off into space? There are two main reasons why satellites can stay in orbit: the pull of gravity and the satellite's speed. Gravity is a force of attraction that exists between any two objects that have mass. First, have students explore the force of gravity by dropping a pencil from their hands. Ask "Why does the pencil fall to the ground instead of stay in the air?" Explain that the pencil falls as a result of the Earth's gravitational pull on the pencil's mass.

But, how does gravity work to keep satellites in orbit, and what shape is their orbital path? Have students predict the shape of the orbit and the effect that speed will have upon the satellite, and conduct a test with a yo-yo. Hold the string of a yo-yo and spin it around in one direction. Tell students that the string represents the force of gravity pulling the object back to the center, and that the circular shape of the yo-yo represents the satellite in orbit. What shape is the orbit (elliptical)? What happens when you spin the yo-yo faster? Slower? The speed of the satellite keeps the object from falling back to Earth.

Materials needed for this activity include:

- A yo-yo
- A pencil

As an extension of this activity, students can explore gravity further by calculating their weight on other planets and making predictions about which planet has a stronger gravitational pull based on its size. Please see the *What is Your Weight on Mars?* activity for more details.

Additional Resources at Bentonville Public Library:

The following are a selection of resources about space and planets in our solar system which are available at Bentonville Public Library. All items are available for checkout at Bentonville Public Library; call numbers are included in brackets. Online resources are available through BPL's Student Portal: <http://www.bentonvillelibrary.org/student-portal/>

Books

- *Astronaut Academy* by Steve Martin. [JNF 629.4 MAR]
- *Beyond the Solar System: Exploring Galaxies, Black Holes, Alien Planets, and More—A History with 21 Activities* by Mary Kay Carson. [JNF 520.9 CAR]
- *Exploring Comets, Asteroids, and Other Objects in Space* by Nancy Dickmann. [JNF 523 DIC]
- *Little Kids First Big Book of Space* by Catherine D. Hughes. [JNF 520 HUG]
- *The Magic School Bus: Lost in the Solar System* by Joanna Cole and Bruce Degen. [JNF 523.3 COL]
- *Our Solar System* by Simon Seymour. [JNF 523.2 SIM]
- *Pluto's Secret: An Icy World's Tale of Discovery* by Margaret A. Weitekamp and David DeVorkin. [JNF 523.49 WEI]
- *Space Exploration: Primary Sources* by Peggy Saari. [JNF 629.4 SAA]
- *The Space Race* by Peter Benoit. [JNF 629.4 BEN]
- *Totally Wacky Facts About Exploring Space* by Emma Carson Berne. [JNF 629.13 BER]
- *Welcome to Mars: Making a Home on the Red Planet* by Buzz Aldrin. [JNF 523.43 ALD]

Online Resources

(K-4) PebbleGo

"The Planets" PebbleGo. www.pebblego.com January 13, 2017

"What Is The Solar System" PebbleGo. www.pebblego.com January 13, 2017

(K-4) PowerKnowledge Earth Space Science

"All About Gravity." *PowerKnowledge Earth & Space Science*, Rosen Publishing,

<http://www.pkearthandspace.com/article/594/all-about-gravity>. Accessed 12 January 2017.

(5-6) World Book Student

Oberright, J. E. "Satellite, Artificial." *World Book Student*. World Book, 2017. Web. 13 Jan. 2017.

Learn More:

Meyer, Robinson. "Some High Schoolers Built a Satellite and NASA Just Sent It Into Space." *The Atlantic*, <http://www.theatlantic.com/technology/archive/2013/11/some-high-schoolers-built-a-satellite-and-nasa-just-sent-it-to-space/281681/> 20 November 2013. Accessed 13 January 2017.

NASA Explorer/Early Satellites: <https://www.nasa.gov/missions/science/f-satellites.html>

NASA International Space Station: https://www.nasa.gov/mission_pages/station/main/index.html

NASA Jet Propulsion Laboratory: <http://www.jpl.nasa.gov/>

NASA Kennedy Space Center: <https://www.nasa.gov/centers/kennedy/home/index.html>

Smithsonian Institution: National Air and Space Museum, *Exploring the Planets*: <https://airandspace.si.edu/exhibitions/exploring-the-planets/online/solar-system/>

Explore Space Exhibit Information:

Explore Space: A Cosmic Journey, a traveling exhibition for libraries, is part of the STAR Library Education Network (STAR_Net) led by the National Center for Interactive Learning at the Space Science Institute. Exhibit partners include the American Library Association, the Lunar and Planetary Institute, and Afterschool Alliance. Explore Space is supported through a grant from the National Science Foundation.



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