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Distance to the Moon

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Distance to the Moon

Before Apollo 11 astronauts Neil A. Armstrong and Edwin E. "Buzz" Aldrin, Jr. stepped on the moon on July 20, 1969, people had studied the moon by eye, telescope and images from spacecraft. As long as people have looked at the moon, they have wondered how far away it is from Earth. The average distance to the moon is 382,500 kilometers. The distance varies because the moon travels around Earth in an elliptical orbit. At perigee, the point at which the moon is closest to Earth, the distance is approximately 360,000 kilometers. At apogee, the point at which the moon is farthest from Earth, the distance is approximately 405,000 kilometers.

Objective:
In this activity participants will use sports balls as scale models of Earth and the moon and use string to demonstrate the mathematical relationship between the size of Earth and the moon and the distance between the two.

Materials:
basketball (or blow-up globe of Earth a similar size to a basketball)
softball
10-meter length of string
small model of the space shuttle orbitor (or other small object to represent the shuttle or International Space Station)

Engage:
Begin a discussion with participants about the Apollo missions to the moon. Ask how many people have walked on the moon *(12)*; ask about the number of women *(0)*. Remind the girls in the audience that both men and women can be space explorers today, so women will be part of a crew to return to the moon in the future. Explain that although NASA continues to use robotic missions, such as the Lunar Reconnaissance Orbiter, or LRO, and the Lunar Crater Observation and Sensing Satellite, or LCROSS, to learn more about the moon, NASA has not sent people to the moon since 1972. Ask how far away the moon is and how long participants think a trip to the moon would take. *(Rockets using current propulsion systems take between 2.5 and 4 days to arrive at the moon.)* Tell participants that a simple model will help illustrate the unique mathematical relationship the moon has to Earth.

Ask one participant to hold the basketball and stand in the corner of the room as Earth. Give a second participant the softball to represent the moon. These two balls have a scale relationship similar to that of Earth and moon. The moon has a diameter one-fourth the size of Earth's diameter. Using this same scale, ask the person holding the moon to decide how far away the moon should be from Earth. Other participants in the audience may provide assistance. Once the people are in position, share these facts to help adjust and verify the distance between the two objects in the model:

- The circumference of Earth (distance around Earth at the equator) is approximately 40,000 kilometers (25,000 miles).
- The distance to the moon is 10 times the circumference of Earth, or approximately 400,000 kilometers (250,000 miles).

By wrapping a string around the basketball ten times (or wrapping it around the ball once and using that length to find the total length), the scale distance between the moon and Earth can be determined. Ask one participant to hold the string at Earth, another to stretch the string out to the end. The end of the string is where the moon should be. Compare how close the participants were in their prediction.

Now show participants the space shuttle model. Ask them where on that string the shuttle orbits. Have one person stand at the point agreed on by the group. *(Most people will guess about half-way to the moon.)* Explain that the shuttle actually flies in low-Earth orbit, which is again a mathematical relationship in this scale model.

- Low-Earth orbit is only about 400 kilometers (250 miles) above the surface of Earth.

On our scale model, the shuttle should be approximately one centimeter from the basketball.

Ask participants to think about the design of the space shuttle. What features does the shuttle have that make it well-suited to fly in the upper part of the atmosphere? Then think about the features of an Apollo spacecraft. The new Orion capsule, part of the Constellation spacecraft NASA plans to use for future space exploration, is similar to the Apollo capsules, only larger.

Ask participants what else orbits in low-Earth orbit. *(Satellites, many different kinds to help with communications, weather data, and to house telescopes like the Hubble Space Telescope, are all in low-Earth orbit.)*

Explain:
To explain more about low-Earth orbit, watch the NASA eClips™ video segment, *Our World: The International Space Station*, which can be viewed or downloaded at: www.nasa.gov/education/nasaeclips. This segment can be viewed in high definition using the following direct link to YouTube/NASA eClips™: http://www.youtube.com/watch?v=1lXTtaYVdNs .

Extend:
To learn more about NASA's Constellation program watch the NASA eClips™ video segment, *Our World: Constellation – NASA's Next Generation Spacecraft*, which can be viewed or downloaded at: www.nasa.gov/education/nasaeclips.
This segment can be viewed in high definition at the following direct link to YouTube/NASA eClips™: http://www.youtube.com/nasaeclips#p/c/31002AD70975DC1B/16/_vl7GFCKK9c .

To learn more about apogee and perigee moons, watch the NASA eClips™ video segment, *Launchpad: Moon Magic*, which can be viewed or downloaded at: www.nasa.gov/education/nasaeclips .
This segment can be viewed in high definition by using this direct link to YouTube/NASA eClips™: http://www.youtube.com/nasaeclips#p/c/D7BEC5371B22BDD9/3/_m1bt8_lnB0 .