Moons of the Solar System Curriculum

3rd through 5th grades, 45 minutes

Notice

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Objectives

Students will learn:

- Basic definitions of the terms "star," "planet," "moon," and "orbit;"
- Approximate distances between the sun and Earth and Earth and the moon;
- Approximate sizes of the sun, moon, and Earth;
- That our moon cycles through phases, and that this cycle is caused by the changing positions of the sun, moon, and Earth relative to each other;
- That all the other planets in our solar system except for Mercury and Venus have at least one moon;
- Some characteristics of other planets and their moons.

Materials required

- Flashlight and extra batteries
- Laser and light pointers
- Balls for scale model of Earth (6 inches/15cm) and the moon (1.5 inches/4 cm)
- Tape measure at least 15 ft/ 4.6 m long for use in Earth-moon scale demonstration
- Digitarium™ system set for the current location, date, and time with atmospheric effects on and moon enlarged

I. Introduction *(10 minutes)*

A. Inform students that you'll be learning about moons today and that the planetarium is a tool for doing so. You'll be discussing some topics outside the dome, then going inside to learn more.

B. Define the words "star," "planet," and "moon." A star generates light (energy) through nuclear fusion and rotates on its axis, but it remains in an essentially constant position. A planet rotates on its axis and orbits a star. A moon rotates on its axis and orbits a planet while the planet orbits its star.

Note: The above is a very simple and broad definition for planet. If students are interested, discuss the August, 2006 International Astronomical Union definition of a planet (an object that is in orbit around the sun, is large enough for its own gravity to pull it into a nearly spherical shape, and has cleared the neighborhood around its orbit). Why did this definition change Pluto's status?

C. Discuss Earth's moon. Elicit student knowledge: Do we see our moon in the sky all the time? In the exact same place? Does it always look the same? Model the Earth-moon-sun system with three students *[see StellarLunar lesson for details].*

D. Do a distance and size demonstration of Earth and moon:

- Show the earth sphere and ask students to show you with their hands how big they think the moon sphere would be using this same scale.
- Show the actual moon sphere, which is about ¼ the size of the earth sphere.
- Choose a volunteer to estimate how far away the moon should be from the earth in this model (about 30 times the diameter of the earth sphere).
- Discuss the size and location of sun in this scale. With Earth as a 6 inch/15 cm sphere, the moon would be a 1.5 inch/4 cm sphere and the two objects would be 15 ft/4.6m apart. The sun would be 50 ft/15.2 m in diameter and 1.1 miles/1.8km away from the earth sphere!

E. Is Earth the only planet with a moon? Which others have moons? What do they know about other moons?

F. Prepare students for entering the planetarium--method of entry, rules for behavior, etc.

II. Introduction to the Sky/Earth's Moon *(10 minutes)*

A. Inform students that the sky is set for the current time and location. Point out the date and time bar so they can track sky time if they wish. Speed up time to let the sun set, then turn off atmospheric effects and landscape.

B. Before you start learning about moons, it will be helpful to know which direction is which. If you're observing the sky of the northern hemisphere, there's one star in particular that will help you find your directions: Polaris, the north star. Allow a student to point out the Big Dipper with a light pointer, then use the 'pointer stars' to find Polaris. Review the other directions and display the cardinal points.

C. Do the students see Earth's moon in the sky? If not, where is it? Remind students that the moon is orbiting the earth while the earth orbits the sun, so the positions of the sun, moon, and Earth relative to each other change.

D. If the moon is not currently visible, tell students that you are going to speed up time until the moon rises, and point out the approximate rising time. Solicit and test predictions on what time the moon will set. How accurate were the predictions?

E. Position the moon low in the west, and STOP time. Select the moon to make it easier for students to keep track of it, then slowly jump forward day by day until the moon is no longer visible *[this will take seven to nine days]*. Point out that you are viewing the moon at the same time over several days. What do the students notice? *[Moves from west to east; changes shape; etc.]*

F. Why does the moon phase? Because the changing positions of the sun, moon, and Earth relative to each other create different shapes of light reflecting off the surface of the moon that faces Earth. How long does it take for the moon to complete one cycle? About a moonth, or month. Select and zoom in on the moon, then slowly jump forward day by day until the moon completes one cycle.

III. Moons of other planets *(20 minutes)*

A. We've just explored the moon we're most familiar with, our own. Do other planets have moons? Yes, in fact all the planets in our solar system except for Mercury and Venus have moons. Let's take a look at some other moons.

Discuss interesting characteristics of moons of other planets, zooming in on or showing an image of the primary moons using the DVD drive (or USB drive for Alpha 2 users). Are there similarities among all these moons? Differences?

- Mars~~t~~– wo moons as of 9/06; software shows positions of both Phobos and Deimos but not yet accurate shapes *[i.e., don't zoom in on them]*.
- Jupiter~~6~~– 3 moons as of 9/06; software shows the four Galilean moons.

- Saturn~~h~~ as 47 moons as of 6/06; software shows eight: Dione, Enceladus, Hyperion, Iapetus, Mimas, Rhea, Tethys, and Titan.
- Uranus~~h~~ as 27 moons as of 9/06; software shows five: Ariel, Miranda, Oberon, Titania, and Umbriel.
- Neptune~~h~~ as 17 moons as of 9/06; 0 in software.

C. **OPTIONAL:** Change your viewing location to a moon. ***[****Earth's moon and Io work particularly well for this demonstration. You may need to change your longitude and other settings to enable this view.]* Ask students for predictions of what they will see when you speed up time. Watch the planet phase from the surface of the moon, and discuss how the actual view was similar to or different from their predictions.

D. Exit dome and regroup outside.

III. Conclusion *(5 minutes)*

A. When all have exited the dome and been seated outside, review the key concepts of the lesson. What is a star? A planet? A moon? Which planets have moons? Which do not? Why does Earth's moon phase?