World in Motion Curriculum

For 6th-8th grades, 50 to 60 minutes

Notice

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Objectives

Students will learn:

- The names and appearances of four or more constellations visible from their location;
- That most objects in the solar system are in regular and predictable motion;
- That the regular and predictable motion explains such phenomena as the day, the year, phases of the moon, and eclipses;
- That gravity keeps Earth, the other planets, and Earth's moon in their orbits;
- How to recognize a planet in the night sky; and
- The difference between normal and retrograde planetary motion.

Materials required

- Flashlight
- Posters of at least four currently visible constellations
- Earth on a stick (globe with handles at north and south poles to represent axis)
- Earth, moon, and sun juggling balls
- Laser and light pointers

I. Introduction *(10 minutes)*

A) Inform students that you'll be exploring astronomy today. Review the definition of astronomy, and inform students that you'll be focusing on motion in the solar system. What are some things that are in motion in our solar system? Inform students that our entire solar system is actually in motion: it is orbiting around the center of the Milky Way galaxy. It takes about 250 million years to complete just one of these orbits.

B) Discuss Earth's basic motions ***[****rotation and revolution****]***, and use two volunteers to model the earth/sun system ***[****everything will rotate and revolve counterclockwise****]***. What is the significance of each of these motions? ***[****One rotation equals one day; one revolution equals one year.****]*** Have the volunteers return to their seats. How can we tell that Earth is in motion as opposed to Earth staying still while everything travels around it? ***[****See the background page for information resources.****]***

C) Earth has a natural satellite, the moon. The moon, like the earth, both rotates and revolves. It revolves around the earth while the earth is revolving around the sun. Choose three new volunteers to help model this system ***[****again, everything will rotate and revolve counterclockwise****]***. Inform students that the moon rotates on its axis much more slowly than Earth does, which is why we always see the same face of the moon. The moon completes one rotation in about 27.3 days. In fact, the moon takes the same amount of time to rotate once on its axis as it does to complete one revolution around the earth. Have the volunteers return to their seats.

C) Define/discuss the term 'orbit.' All the planets in our solar system have regular, predictable orbits, as does Earth's moon. What keeps the bodies in their orbits? ***[****Gravity.****]*** What is gravity? ***[****The <u>Facts on File Dictionary of Astronomy</u> defines gravity as 'the ability of all material bodies to attract each other.'****]*** Any object that has mass has gravity, and the strength of an object's gravity depends on the size and density of the object.

D) Inform students that they'll continue exploring motion and its effects inside the dome. Introduce rules, expectations, etc., then enter.

II. Current night sky *(15 minutes)*

A) ***[****When all are in and seated, darken the planetarium to allow students to better see the night sky.****]*** Inform students that they're seeing the sky as it would look at about ______ p.m./a.m. tonight. You'll first need to figure out which direction is which in the planetarium. Ask them if they know a star that can help them find their directions ***[****in the northern hemisphere****]***. Right, Polaris, the north star. How can we find Polaris? ***[****If no one knows it, share the trick of finding the Big Dipper first—let a student point it out with a LIGHT pointer—then using the pointer stars to lead you to Polaris.****]***

B) If Polaris is the north star, what part of the sky is this by Polaris? Right, north. So what direction is over here ***[****move your pointer to the south****]***? Repeat for east and west, then review the directions as a group. Turn on the cardinal points to help students remember which direction is which.

C) Point out Ursa Major with your laser pointer, turn on the line drawing of the bear, and then display the artwork. Share a quick story or interesting fact about Ursa Major.

D) Show three other constellations in different parts of the sky, once again turning on the line drawings and then the artwork for each. Share a quick story or interesting fact about each constellation you point out.

E) Ask students what they think will happen if we advance three hours in time. Take predictions, then move forward three hours. ***[****Use the menu to jump the three hours all at once, rather than simply speeding up time.****]*** Why did our view of the stars change? ***[****Because Earth completed one-eighth of a rotation, as well as a very tiny fraction of one revolution.****]*** Repeat for different spans of time, such as one week, one month, etc.

F) Point out the north star again ***[****or allow a student to do so****]***, then speed up time. Ask students why we always see the north star in about the same spot in the sky. Why would our view of that particular star remain the same? Use the Earth on a stick to model how our north pole is tilted about 23.5 degrees toward Polaris.

III. Predictions based on movement *(20 to 30 minutes)*

A) Remind students of the regular, predictable motions of the earth and other bodies in the solar system. Introduce the concept of using these movements to predict phenomena such as the phases of the moon and eclipses. What does the term 'phases of the moon' mean? What causes the phases of the moon? ***[****If the moon is visible, zoom in on it; if the moon is not visible, move forward in time until it is, then zoom in on it.****]***

With the moon displayed on the zenith, advance in time day by day to allow students to observe the changing phases. If time allows, briefly introduce the phase names ***[****see the 'StellarLunar' curriculum for more information****]***. Do the students see a pattern in the way the light moves across the face of the moon? Can they predict what the light would look like if you moved forward in time one week? Why would it be important to be able to predict the phases of the moon?

B) Ask if any of the students have ever witnessed a lunar or solar eclipse. What are their memories of the event? What's the difference between the two types of eclipses? ***[****In a lunar eclipse, the moon is blocked by the earth's shadow; in a solar eclipse, the sun is blocked by the moon.****]*** Demonstrate the arrangement of the sun, earth, and moon during eclipses using the juggling balls, but be sure to point out that the juggling balls are not to scale; the sun in real life is about 400 times larger than the moon, and the earth is about four times larger than the moon.

Astronomers are able to predict with great accuracy when the next eclipse will occur, as well as what regions of the earth will experience it. In fact, people have been able to predict eclipses for hundreds of years. The Babylonians started predicting lunar eclipses around 700 BCE, based on their detailed observations of previous eclipses. Why would people want to be able to predict eclipses?

C) **OPTIONAL:** If time allows, discuss how the plane of the moon's orbit is inclined five degrees from the plane of the ecliptic. If the plane of the moon's orbit lay exactly in the plane of the ecliptic, a solar eclipse would take place at each new moon and a lunar eclipse at each full moon. Model this using the earth, moon, and sun juggling balls. ***[****Again: be sure to point out that the juggling balls are not to scale.****]*** Watch the moon cross the ecliptic: display the ecliptic, turn on the moon zoom and moon/planet labels, then move forward in time week by week. Turn off planet labels before starting the next section.

D) What else is in motion in our solar system? Right, the other planets. How can we recognize planets in the sky? ***[****See the Planets curriculum.****]*** Do the students see anything they believe is a planet? As with the planets curriculum, allow three or four students to use a light pointer to point out planet candidates. How will we test the predictions? If necessary, lead students to the idea that you'll need to speed up time ***[****move forward in time week by week until planetary motion becomes obvious****]*** and watch for movement against the background of the stars. Were any of the three candidates really planets? Zoom in on each visible planet for a closer look. ***[****If Jupiter or Saturn is visible, zoom in and then speed up time so that students can see the Galilean moons or Titan orbit their planet.****]***

E) After pointing out the currently visible planets, zoom back out to the regular night sky, turn on the planet labels, and move forward in time week by week until planetary motion becomes obvious. Ask students to carefully observe how the planets are moving. What do they notice? ***[****They should notice that the planets usually move from west to east, but that they sometimes move from east* *to west.]* If no one notices retrograde motion, draw students' attention to it. What causes this? ***[****See the 'Planets' curriculum or background resources.****]*** Turn on planet trails to make planetary motion more obvious. ***[****Mercury makes the most interesting trails.****]***

F) **OPTIONAL:** Use the images in the “Planet Tour” folder in the “World_In_Motion” directory on the lesson slides CD to discuss the planets in order.

G) **OPTIONAL:** Inform students that Ptolemy, an astronomer from ancient Greece, had an elaborate explanation for motion in our solar system, including retrograde motion. Briefly explain Ptolemy's idea of epicycles, eccentrics, and equants, using the slide as a visual aid.

H) **OPTIONAL:** Discuss comets and their regular, predictable, but eccentric movement, using Halley's comet as an example.

I) Inform students that one of the results of Earth's movements is sunrise, and of course light from the sun will block light from the stars and planets. Turn on Earth's atmosphere, speed up time, and let the sun 'rise' in the planetarium. Prepare students for exiting the planetarium, then head out.

IV. Conclusion *(5 minutes)*

A) Ask students what they learned today. In what ways does the earth move? What keeps Earth and the other planets in orbit around the sun? What is retrograde motion?