The Earth in Motion through Space

Objectives
- Students will understand that the moon and earth have a predictable motion which explains the concepts of day, year and phases of the moon.
- Students will learn how to use a guide in order to find the names and general appearance of the Zodiac constellations.
- Students will learn the general concept of latitude on the earth and how it relates to what can be seen in the sky at differing northern latitudes.
- Students will draw the stars that make up each Zodiac constellation to give them a higher degree of recognition when they are searching for a specific Zodiac constellation.

Suggested Grade Level:
Ninth - Tenth

Subject Area:
Astronomy
Math
Science
Geography

Timeline
At least four class periods/hours are needed for students to build their model of earth, introductory discussion of the activity, the activity and the summary. More time if extensions are to be done.

Background Discussion and Preparation:
Teachers - Begin with a discussion of some general aspects of our solar system in order to assess the overall prior class knowledge and be sure to regress and review if needed. Ask what objects are in motion in our solar system? Discuss that not only are there objects in our solar system that are in motion, but our entire solar system takes about 250 million years to complete just one orbit around our Milky Way Galaxy. Discuss the Earth's and moons motions—both orbits and rotations. Hand out a copy of signs of the Zodiac worksheet to each student. These constellations tend to be difficult to recognize. Students will draw their own stars on these diagrams as you show each sign on an overhead screen. Have students draw the stars that make up the specific sign of the Zodiac onto their signs of the Zodiac worksheet making sure they follow the luminosity concept of the brighter the star, the larger the star is drawn on the constellation. Explain and show why we always see the same face of the moon and that the moon completes one rotation in about 27.3 days. The moon takes the same amount of time to rotate once as it does to make one orbit about earth. Use a student’s earth and your moon, along with volunteers as needed to demonstrate these concepts.
Students – Know the background of the above elements.

**Materials**
Use the link below for your diagrams of each of the 12 constellations of the Zodiac and trace *only the general outline* of the figures to use as the student worksheet. These traced pages can be single paged or reduced in size and arranged on a couple of sheets of paper if you wish before you photocopy them for your students. Use the following link (or something similar) for the diagrams:

http://enrich.sdsc.edu/teachertech/downloads/kaprosps.pdf

A visual guide of the Zodiac constellations with their order placement in the northern hemisphere. A Zodiac wheel is linked below:


A student designed and built model of Earth that has a handle sticking out of both the north and south poles. This should be done on a prior day with a large Styrofoam ball (or similar) and popsicle sticks (or similar). Students are required to have the north latitude lines drawn on their model of earth. Major geographic features should also be included; ie…continents and oceans. Spheres to represent the Sun and our moon. A pointer, preferably a laser, but a meter stick will suffice. A star on the ceiling in the center of the room representing Polaris (North Star). Student worksheet as described above along with teacher transparencies of constellations. A light bulb, at least 200W to represent the sun during the phases of the moon portion of the activity.

**Lesson**

1. **Vocabulary**
   Solar System - The sun together with the nine planets and all other celestial bodies that orbit the sun.
   Milky Way Galaxy - the galaxy containing the solar system: *consists of millions of stars that can be seen as a diffuse band of light stretching across the night sky.*
   Orbit – Is the path in space of one body around another. Orbits are usually elliptical in shape, although the orbits of planets scarcely depart from circles.
   Rotation - The act or process of turning around a center or an axis: *the axial rotation of the earth.*
   Zodiac – Is a region of the night sky that corresponds to the Sun’s pathway, containing 12 zodiacal constellations.

2. Begin by explaining that Polaris does not move in the night sky and how to locate Polaris by using the Big Dipper as a reference. Then ask “if Polaris
is the North Star, in what direction or part of the sky is Polaris found?" (north) Then you can use the laser pointer or meter stick to have your students identify South, East and West. You may want to place S, E and W labels on those walls depending on the cognitive level of your class.

3. Now ask how long it takes the Earth to move in a full orbit about the Sun? (one year) Explain that the path followed by the Sun, which is actually caused by our rotation and orbit, is called the ecliptic, and any constellation contained in the ecliptic is called a zodiac constellation.

4. Then ask what your students know about the Zodiac constellations? You may either let students discuss briefly what they know about the Zodiac or give them a few interesting facts that you have prepared. Have students refer to their Zodiac worksheets during the discussion.

5. Now position a student’s earth anyplace in its orbit about the Sun and ask what will happen if the earth advances three hours in time. After students have made their predictions move ahead three hours. Why did the view of the stars change? (Because the earth has completed 1/8 of a rotation, along with a small fraction of one orbit.) Repeat for different amounts of time; day, week, month and year.

6. Don’t forget to bring students attention the fact that Polaris is not moving. Ask why our view of the North Star remains the same? Use a students Earth to model how our planet is tilted 23.5 degrees. Discuss earth latitudes lines at this point. Explain the relationship between the angles of Polaris in the sky versus the latitude you are standing at. (they are the same)

7. Remind students of the predictable motions of the bodies in the solar system. Introduce the concept of using these movements to predict things such as eclipses and phases of the moon. Ask what the term “phases of the moon” means? Ask what causes the moon phases? Then have students pretend that their earths are now our moon. Their head will be the earth and the moon will orbit the earth. Turn on the bright light to represent the sun and have the students hold their moon at arms length. Have them slowly move their feet to pivot the moon around their head. They should pay particular attention to see what part of the moon is illuminated and be able now to explain why. Check for understanding as needed.

8. Ask students what a lunar and solar eclipse is and what the similarities and differences are between the two types of eclipses? (shadow on moon—lunar and shadow on earth—solar). Students can demonstrate this for themselves using their head as the earth and their earth they made as a temporary moon. Make sure to call their attention to size relationships and distances between the sun, earth and moon. Guide them to the understanding that during a lunar eclipse the whole moon is dark (if you want to explain that it is really a deep red as a side concept, do that now). During a solar eclipse only a small circle of shadow is cast on a particular part of the earth. In other words, everyone on the sun side of earth does not see the eclipse. Only those in the umbra (full shadow)
see a full blockage of the sun. Those in the penumbra (partial shadow) see a partial eclipse and the rest see nothing but a normal sky.

9. Introduce the “ecliptic” and explain to students that this is where the Zodiac constellations are found. Review the sun, earth, and moon system, along with the importance of being able to recognize the Zodiac constellations in order to know where to look and at what time of year, for the planets in the sky at certain times of the year.

Extensions
1. Train students on how to use planispheres to locate planets and constellations.
2. If budget and time allows, have a star party with your students to enable them to apply what they have learned.

Evaluation
- Students did understand that the moon and earth have a predictable motion which explains the concepts of day, year and phases of the moon.
- Students did learn how to use a guide in order to find the names and general appearance of the Zodiac constellations.
- Students did learn the general concept of latitude on the earth and how it relates to what can be seen in the sky at differing northern latitudes.
- Students did draw the stars that make up each Zodiac constellation to give them a higher degree of recognition when they are searching for a specific Zodiac constellation.
- Check students Zodiac worksheet for accuracy with the stars they drew.
- Observe students motions and verbal answers when discussing the moon phases. Have someone to demonstrate for the class a solar verses lunar eclipse.
- Ask what star does not move in the night sky?
- Ask what the name of the position in space that contains the Zodiac constellations is called? How do the Zodiac constellations help guide us through the sky?

Resources
Space Foundation Summer Institute Astronomy Principles binder.

The American Heritage Dictionary


Dr. Cherilynn A. Morrow and Michael Zawaski, Boulder CO.

http://enrich.sdsc.edu/teachertech/downloads/kaprosps.pdf