Topic: Astronomy - Our Moon

Teacher information:

Note: This lesson takes two or more weeks (starting when the new moon appears that month) to complete, in order to learn about the monthly changes in the moon. The inquiry portion of the Interest section should be completed before any other portions of the lesson. To determine when new moon will occur, go to www.calculatorcat.com/moon_phases/moon_phases.phtml

This lesson is divided into four sections: Interest, Inform, Integrate, and Innovate. The Interest section is meant to invite the student to investigate the subject, to pique interest in the topic. The Inform section gives the meat of the subject, the key information that should be understood. The Integrate section will provide students the opportunity to experiment with and learn to use the information they are learning, integrating new knowledge with prior knowledge. The Innovate section allows the student to practice using the topic information in various ways, and may be used for authentic assessment as well.

Teacher notes for each section:

Interest:

1. Picture - show picture to introduce students to a close-up of our moon.

2. Web work - Allow students to search the NASA website:
   www.nasa.gov/audience/forstudents/5-8/features/index.html
   for additional pictures and information about the stars, our sun, and our moon.

3. Show PowerPoint pretest - "My View of the Moon." You may have students record answers on paper if you desire. You may reshow this PowerPoint after the lesson for a post-test as well.
   Answer Key for My View of the Moon: Only # 8, #9, and #15 are true.

4. Inquiry Project - It is important that this project is started on a new moon. Divide students into groups after they have graphed for two weeks have them combine their maps to form one compromise or "idealized" map or you may choose to make a daily compromise map as a class.

5. Show Video from Zero G Experience - David Callihan to interest students in gravity conditions of the moon.

Inform:

Show PowerPoint – About Our Moon

The About Our Moon PowerPoint is based on the following information (provided for teacher to review and increase their own knowledge).

The moon does not emit any of its own light, but reflects the light of the sun. Our view of the moon is constantly changing as the moon orbits the earth and as the earth rotates on its axis. The changes we see in the shape and location of the moon in the sky are regular in their occurrence because of the regular nature of the rotation and orbit. Our daily view of the moon changes during the lunar orbit of the earth. The moon orbits around the earth once

approximately every twenty-nine days (one lunar month). The moon's rotation on its axis is synchronous with its orbit so we always see the same side of the moon reflecting the sunlight.

The phases that we see are a result of the angle between the earth, moon, and sun as viewed by us from earth. A new moon occurs when the moon is directly between the earth and the sun. At this point, the moon will rise at about 6:00 am and set at about 6:00 pm (on standard, not daylight saving time). The lit side of the moon is toward the sun, so our view is of the dark side only (i.e. we do not see it at all). Following the new moon, the moon (continuing its orbit) moves so that we see an increasing portion of the lit side each night. We call this the waxing crescent moon. In about a week, the angle between the earth, sun, and moon is 90°, allowing us to see half its lighted surface, the first quarter. This 90° angle means the moon rises halfway through the day at about noon, setting about midnight. For the following week, we see more of the moon's surface each night (waxing gibbous) until the full moon which marks the middle of the lunar orbit (and the lunar month). During the full moon, the earth/moon/sun angle is 180° meaning the earth is between the sun and the moon so we see the entire bright half of its surface. The full moon rises near sundown and sets near sunrise (opposite the sun). During the remaining two weeks of the lunar month, the moon wanes through another gibbous moon to the third quarter (the other half of the moon's lit surface is visible rising around noon and setting at midnight). It wanes through another crescent moon and on until it returns to the beginning of the orbital- the new moon.

We view the moon "rising" in the east and "setting" in the west as the earth rotates on its axis. The moon's orbit is nearly in the same plane as the orbits of the planets around the sun, so we view the moon near that plane in the sky called the ecliptic. The tilt of the earth on its axis means the ecliptic is visible (to those in the northern hemisphere of the earth) in the southern sky at varying heights through the seasons.

Integrate:

This section is meant to give students an opportunity to interact with the information that has been presented. This process will solidify the concepts in the students mind and also dispel any misconceptions they may have.

1. Vocabulary - have students find vocabulary words in a science encyclopedia or dictionary as they encounter them in the lesson.

2. Lab - the labs should be conducted together, so that the class can answer the questions as they complete each model demonstration.

3. Research - allow students to use classroom encyclopedias and internet access to find answers to the questions on their own.

Innovate:

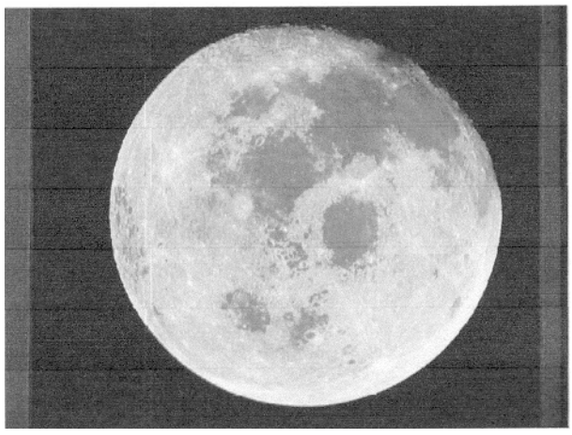
1. Illustrate - Use this task as an authentic assessment. Allow discussion and group collaboration to increase opportunities for all students to express understanding.

2. Demonstrate - Encourage students to demonstrate their understanding of lunar motion to others.

3. Other Subjects - take this astronomy lesson into math and language class, allowing crossover of understanding.

Interest

1. Picture: View of a full Moon photographed from the Apollo 11 spacecraft 10,000 nautical miles from the Moon. Source - NASA.



2. Webwork: Search the NASA website for additional pictures and information about the stars, our sun, and our moon. Share your favorite find with the class.
http://www.nasa.gov/audience/forstudents/5-8/features/index.html

3. Complete the "My View of the Moon" Pretest.

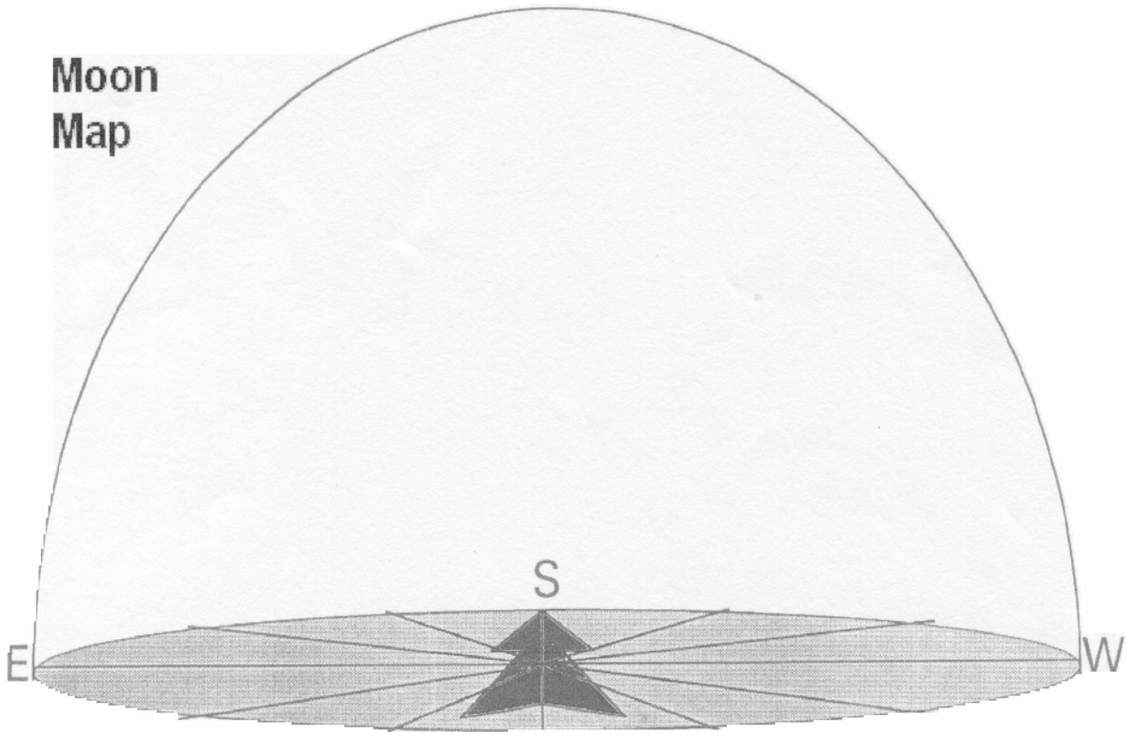
4. Inquiry Project: Phases of the Moon.

Materials: Moon Map, pencil, compass, GPS unit.

1. Note the shape and position of the moon at the same time each night for two weeks, beginning at the new moon. (Check a calendar to determine date of new moon.) Graph the shape and location of the moon each day on the diagram (Moon Map) provided. Face directly south as you take your reading from the same location each night. Use your GPS unit to determine the south direction, and to mark your exact location. Then take your reading from the same location nightly. You will not be able to see the moon on very cloudy nights, simply graph as many as possible. This will be fine unless almost all of the nights that month are cloudy. If that unlikely event occurs, you may need to redo your graphing another month.

2. At the end of the two weeks, get together with other students who have graphed the moon. Modify your moon maps within your group to come up with an idealized moon map.

3. Check your moon map with a reference on the orbit of the moon to determine its accuracy.


Moon
Map
S
E
W

Inform

View PowerPoint - About our Moon.

Integrate

1. Vocabulary:

ecliptic -
eclipse -
synchronous -
reflect -
orbit -
axis -
wax-
wane -

2. Lab: Eclipses and Lunar Phases

Part One: Eclipses - A Meter Stick Earth-Moon Model

To study eclipses of the sun and moon it is useful to have a scale model of the earth and moon fastened to a meter or yardstick. Place the earth at one end of the stick and the moon at the other end. You can study eclipses using the sun itself; a floodlight or overhead projector will also work.

To make the moon and earth in the model accurately enough, shape them from clay. Use the following dimensions:

Moon diameter = 0.6 cm Earth diameter = 2.22 cm

It is important to make the diameters accurate. There is a tendency to make the moon and earth too large. Use large bent paper clips, tape, and rubber bands to make brackets for mounting the balls of clay on the stick at their proper distance. Yon can fasten the paper clip of the earth model with tape or rubber bands. The moon model paper clip should be mounted to the stick with a rubber band so that its distance from the earth model can be varied.

The distance between the actual earth and moon varies from about 357, (XX) km to 407,000 km. The relative earth to moon distances for your model should be 61.9cm, 66.25 cm and 70.59 cm. If the scale model is designed with enough accuracy and the sun is then used to cast shadows of the earth and moon models, these shadows will also be to scale.

Use your model to study eclipses. If conditions permit, go outside and use the sun to cast a shadow of the moon on the earth model as you answer the questions below. If conditions do not permit working with the sun, use an overhead projector or even a floodlight.

Lab Part One Questions:

1) In the model, can you get the shadow of the earth to fall on the moon?
   a) What is the phase of the moon when this occurs?
   b) About how many degrees do you estimate the moon has to be swung above or below the center of the shadow to be out of the shadow?
   c) Why doesn't a lunar eclipse occur once each month?
   d) Is the shadow uniformly dark? Why or why not?
   e) Can a lunar eclipse occur only at midnight? Why, or why not?
   f) What determines how long a lunar eclipse will last?
   g) Why is the eclipse sometimes only partial?

2) In the model, can you get the shadow of the moon to fall on the earth?
   a) What is the phase of the moon when this occurs?
   b) About how many degrees do you estimate the moon has to swing up or down to move the shadow to above or below the earth?
   c) Why doesn't a solar eclipse occur once a month?
   d) Is the shadow uniformly dark? Why, or why not?
   e) Can a solar eclipse occur only at noon? Why, or why not?
   f) What determines how long a solar eclipse will last?
   g) Why is the eclipse sometimes only partial?

Part Two: Lunar Phases

Use a 2-3" Styro-foam ball and a light source (either the sun or a bright light bulb) to demonstrate the process of why we see the lunar phases as we do. Hold the ball next to you at arms length in front of the light source. Presume the ball is the moon and you are the earth, the light source is the sun. Experiment with moving the ball until you can duplicate the phases of the moon as you are looking at the ball.

Lab Part Two Questions:

1) Explain why we see the phases of the moon as we do.
2) When does the new moon rise and set?
3) Approximately what time does the full moon rise and set?
4) Approximately what time do the quarter moons rise and set?

3. Research: Find the answers to the following:

a) Why don't lunar and solar eclipses occur during each lunar cycle?
b) When is the next lunar eclipse?
c) When is the next solar eclipse?
d) List the constellations along the Zodiac.

Innovate

1. Illustrate:

Make a poster showing the positions of the earth and moon (hint: show the earth in the middle and the moon orbiting the earth) at all the different lunar phases.

2. Demonstrate

Use your Meter Stick Earth-Moon Model (from 1.3.3 B Lab Part One) to demonstrate both lunar and solar eclipses to your parents, siblings, or friends.

3. Other Subjects:

To relate these studies to other subjects try the following:

Math

- Review measuring and naming angles.
- When you view the moon at the same time daily, the moon changes position in the sky according to its orbit the moon traverses the sky we see (180° in about fourteen days). How many degrees will it travel each day?

Language

- Write a paragraph about what you learn about our universe from looking at the night sky.