Rising and Setting of the Moon

Activity UCIObs – 6
Grade Level: 3 – 5

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Standards: This activity addresses these California Science Content Standards:
Gr 3 *Earth Science:*
4b. Students know the way in which the Moon's appearance changes during the four-week lunar cycle.
4d. Students know that Earth is one of several planets that orbit the Sun and that the Moon orbits Earth.

What Is This Activity About?

In this activity students will do hands-on experiments and learn that each different phase of the Moon rises and sets at a different time of day. Children also learn that the time of day is set by the location of the Sun relative to an observer on the Earth, and the time of day is different for people at different positions on the Earth.

What Will Students Do?

Together the class will experiment with a lamp as the Sun, a Styrofoam ball as the Moon, and a student as an observer on the Earth. They will vary the location of the Moon in its orbit and the Earth will rotate to discover when different phases of the Moon rise and set. Subsequently each student or group of students will independently use a Moon Rise/Set Demo to discover when different phases of the Moon rise and set.

Tips and Suggestions:

This exercise is an excellent follow-on to the Activity UCIObs-5 Exploring Phases of the Moon. Use a dark room and a bright lamp as the Sun and a styrofoam ball as the Moon. Make sure to hold the Moon slightly above the children's heads so the "Earth" doesn't shadow the Moon. Optional activities discussed here include the reasons for and timing of ocean tides and eclipses.

What Will Students Learn?

Concepts: Phases of the Moon, Positions of the Moon and Sun in the Sky
Inquiry Skills: Visualizing, Ordering, Predicting, Inferring
Big Ideas: Spatial Reasoning, Patterns of Change

What you will need to create the Moon Rise/Set Activity Demos:

Note that you can make the Moon Rise/Set Demos once and use them for a number of years because they are durable, but some students like using them so much that they will beg to take them home. Also note that if you do not have the time to make Demos for each student or group then you can make one copy with all three pages printed on transparency paper and show it on an overhead projector so that all students can see. However you will then have to go through illustrating each phase of the moon together with the class following along rather than have the students use the Demos themselves. We strongly recommend having students use the Demos individually so they get the most out of this activity.

For each copy of the Moon Rise/Set Activity Demo per student or group of students, you will need:

1 copy of page 7 made on white cardstock paper
1 copy of pages 8 and 9 made on transparency paper
1 brass fastener
Hole punch
Scotch tape

Teacher Preparation:

1. Build a Moon Rise/Set Activity Demo for each student or group of students: (1) Make the photocopies (see above for details), (2) Punch holes at the "+"s and center of the Earth using the hole punch, (3) Fasten the three together so that the Sun on the card stock is on the bottom, the moon on the transparency is in the middle, and the Earth on the transparency is on the top, and (4) To make the demo durable, tape the legs of the brass fastener to the white cardstock on the backside.

2. If you are unfamiliar with basic astronomy and moon phases, please read the accompanying document entitled Night_Sky_Lectures.pdf by T. Smecker-Hane. This will teach you all you need to know to do this experiment.

What you will need during class:

Pencil (1 per group)
Lamp that can shine in all directions (i.e., a lamp base with a bare 100 to 150 Watt bulb and no lampshade)
Styrofoam Ball
1 copy of the East/West designations (pages 10-11) on cardstock
1 copy of the exercise (pages 12-14) for each group
1 Moon Rise/Set Activity Demo per group (see above)
Optional: Black plastic garbage bags or butcher paper to tape over windows and darken the classroom

Teacher's Classroom Instructions:

1. This activity will take approximately 45 to 60 minutes to complete.

2. Cover the windows with garbage bags or butcher paper. Outside light will mess up the shadows and can lead students to draw the wrong conclusions.

3. Hand out the exercises.

4. Draw Figures 1 and 2 on the blackboard.

5. Review the Moons with the class (ideally you will have done *Activity UCIObs-5 Exploring Moon Phases* with the class previously). Remind them that the Time Sequence # refers to resent the numbered locations of the Moon in Figure 1. Review the names of the phases of the moon and the time sequence that you determined.

6. Explain that the Moon rises and sets at different times depending on what phase it is in, meaning where the Moon is located relative to the Sun and Earth. In fact, for some phases the Moon can be seen in the day time! Each unique phase rises/sets at a different time and, by experimenting like we did to determine the phases, we can figure out what those times are. In fact, if I told you what phase the moon is in today, you should be able to predict where in the sky the Moon will be at a given time. Alternatively, you can tell what time of day it is by observing the Moon's phase and its position in the sky.

7. Place the Sun (the lamp) on the right hand side of the classroom (similar to Figure 1) and pick a student to be the Moon and a student to be the observer on Earth. Explain that an observer on Earth can see only **half of the day/night sky** at any given time because the Earth itself blocks half the sky from view.

8. Explain that the Earth rotates once on its axis every 24 hours (one day). When viewed from above looking down on the Earth's North pole (or observer's head), the Earth rotates counter-clockwise. Noon is when the observer on Earth is directly facing the Sun, midnight is when he/she if facing opposite the Sun. Experiment to show this by having the Earth hold the card with **East (Rising)** (see page 22) in his/her **Left Hand** and a card with **West (Setting**) (see page 23) in his/her **Right Hand.** As he/she rotates counter-clockwise (as viewed from above), things come into view (rise) in the East and set in the West. Now illustrate the positions for 6 am (Sun on the Eastern horizon) and 6 pm (Sun on the Western horizon.).

9. Do an example of the Moon rising/setting with the class. Have the Moon stand so that it is in the Full Moon phase (#5 in Figure 1):

   M – E – S

   Rotate the Earth counter clockwise in the direction shown by the arrow to mimic the passing of time. Show that the Full Moon rises at 6pm, is highest in the sky at midnight and sets at 6 am. It is not visible in the sky at noon because the Earth itself blocks the Moon from view. Have the students fill in the Table in the exercise for the Full Moon.

10. Do a second example to illustrate a **<u>First Quarter Moon</u>** (#3 in Figure 1), which occurs one week before the Full Moon:

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    M
    |
E – S
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Show that the First Quarter Moon rises at noon, is highest in the sky at sunset (6pm), and sets at midnight. Therefore, this moon cannot be seen in the sky at all from midnight to noon when the Earth itself blocks the Moon from view. Have students fill in the Table fore the First Quarter Moon.

11. Pass out the Moon Rise/Set Demos. Now go through the same two examples (Steps 7 & 8) using the Demos. Have students write the answers in the Table in their exercise.

12. Now have the students work independently to fill in the rest of the exercise. Walk around the classroom helping students and checking answers (see Table 2 on the next page). Encourage students to have a vigorous debate when they do not agree on the answer. While they are working you can write Table 2 on the blackboard (leaving the answers blank). When finished, discuss the answers with the class. The answers are shown in the Table 2 below.

Table 2: Moon Phase Rise/Set Times

Time Sequence #	Moon Phase	Rise Time	Highest Overhead Time	Set Time
1	New	6 am	Noon	6 pm
2	Waxing Crescent	8 am	2 pm	8 pm
3	First Quarter	Noon	6 pm	Midnight
4	Waxing Gibbous	4 pm	10 pm	4 am
5	Full	6 pm	Midnight	6 am
6	Waning Gibbous	8 pm	2 am	8 am
7	Third Quarter	Midnight	6 am	Noon
8	Waning Crescent	4 am	10 am	4 pm

Helpful Hints: Keep the cardstock oriented to that the Sun is on the right hand side as in Figure 1. Keep Figure 1 on the blackboard so students know where to put the Moon relative to the Earth and Sun for the different phases.

Some students will quickly see the pattern that develops. The time that the moon is highest overhead is 6 hours after Rise Time and Set Time is 12 hours after Rise Time.

You will need to help students with the Gibbous and Crescent phases by explaining to them that those phases are different from Full and New, respectively, by 30 degrees/ 90 degrees x 6 hrs = 2 hrs. Do one example of this with the class following along.

13. Explain that the students can take the figures of the Moon home with them. If time permits, you can discuss the terrain features and the Apollo landings in class. Exploring http://google.com/moon is excellent if you have an internet connection and LCD projector available in the classroom.

14. **Optional Outdoor Activity:**

Tell students that the phase of the Moon today is _____. Note that you can find this out by consulting a calendar that lists moon phases or by looking on the web at http:// www.briancasey.org/artifacts/astro/moon.cgi.

Have students figure out when the Moon will:
rise (_____),
be highest in the sky (_____), and
set (_____).

Will it be in the sky right now? Yes/No.

Will it be in the eastern (rising) or in the western (setting) half of the sky or nearly overhead?

_____

Go outside and check. Even if the answer is that it is NOT visible right now, you can still verify that it is not.

Figure 1: The geometry of the Earth, Moon and Sun over the course of one 28-day lunar. Eight positions of the Moon are illustrated and their numbers correspond to the phases shown below in Figure 2.

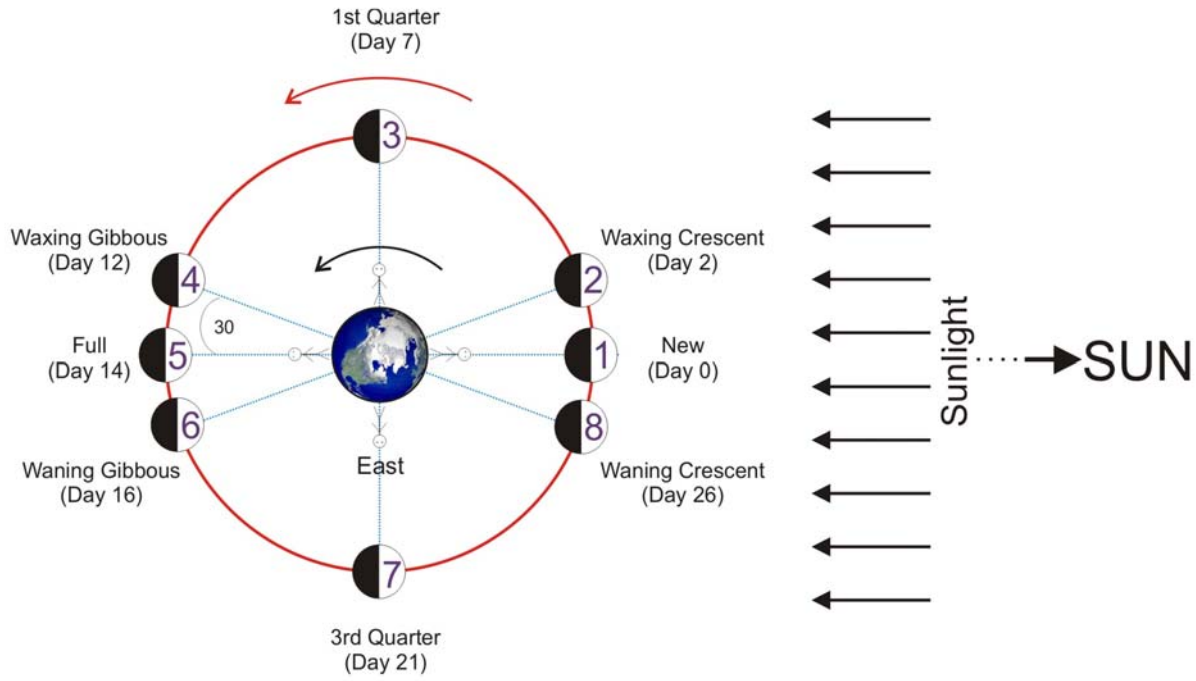
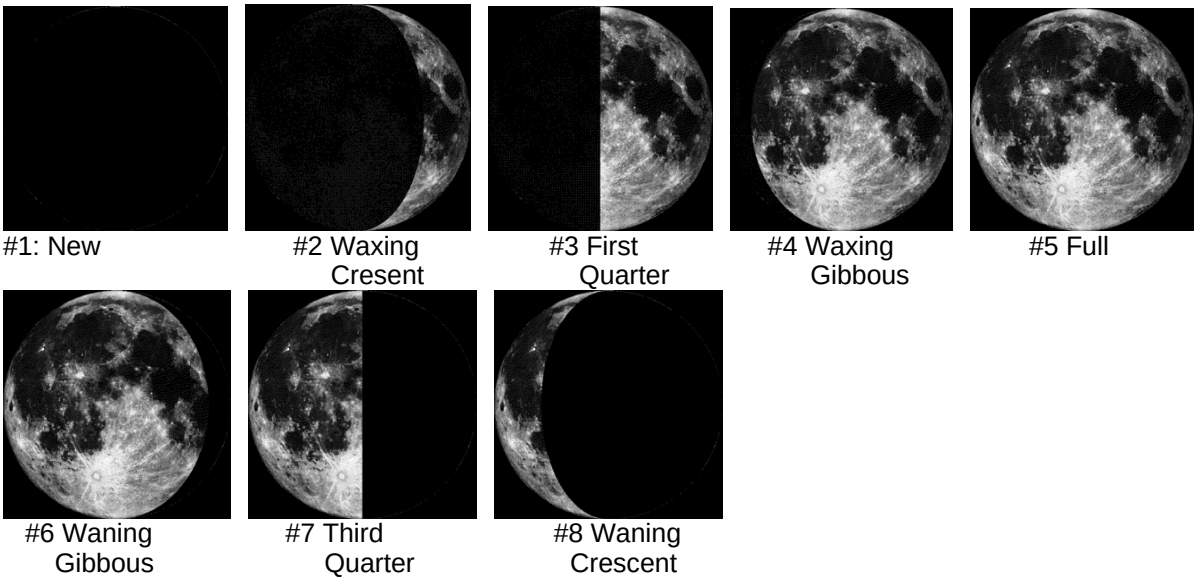
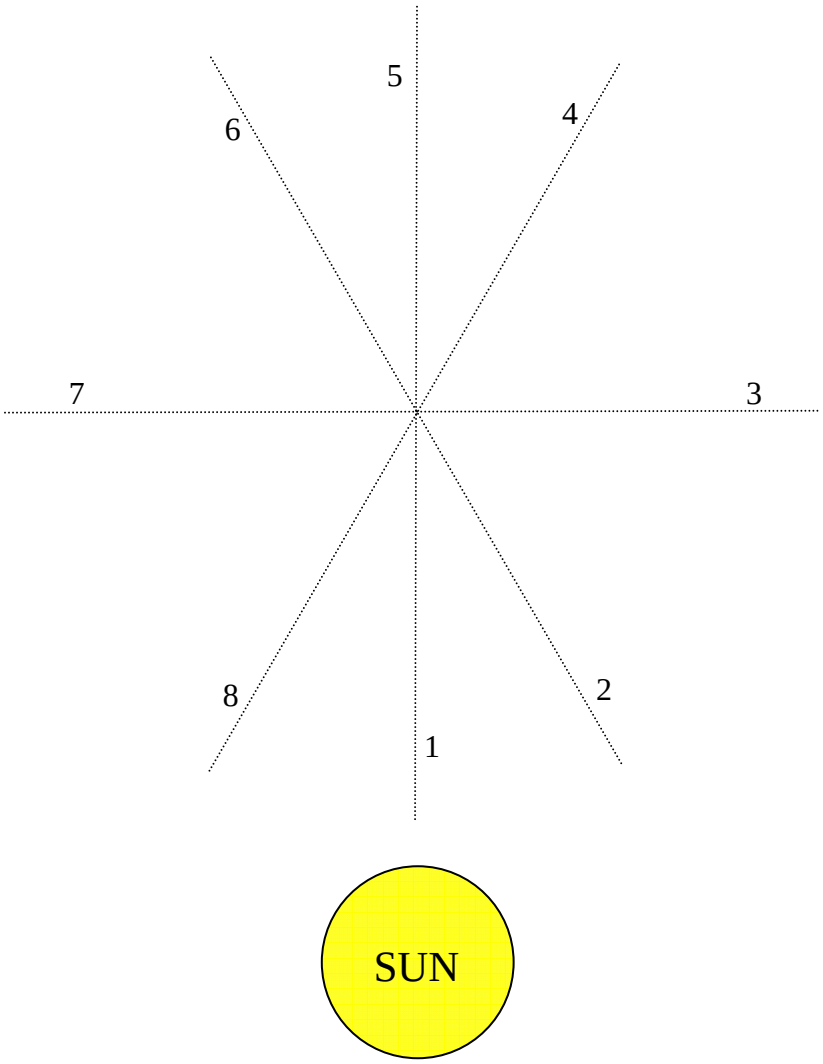


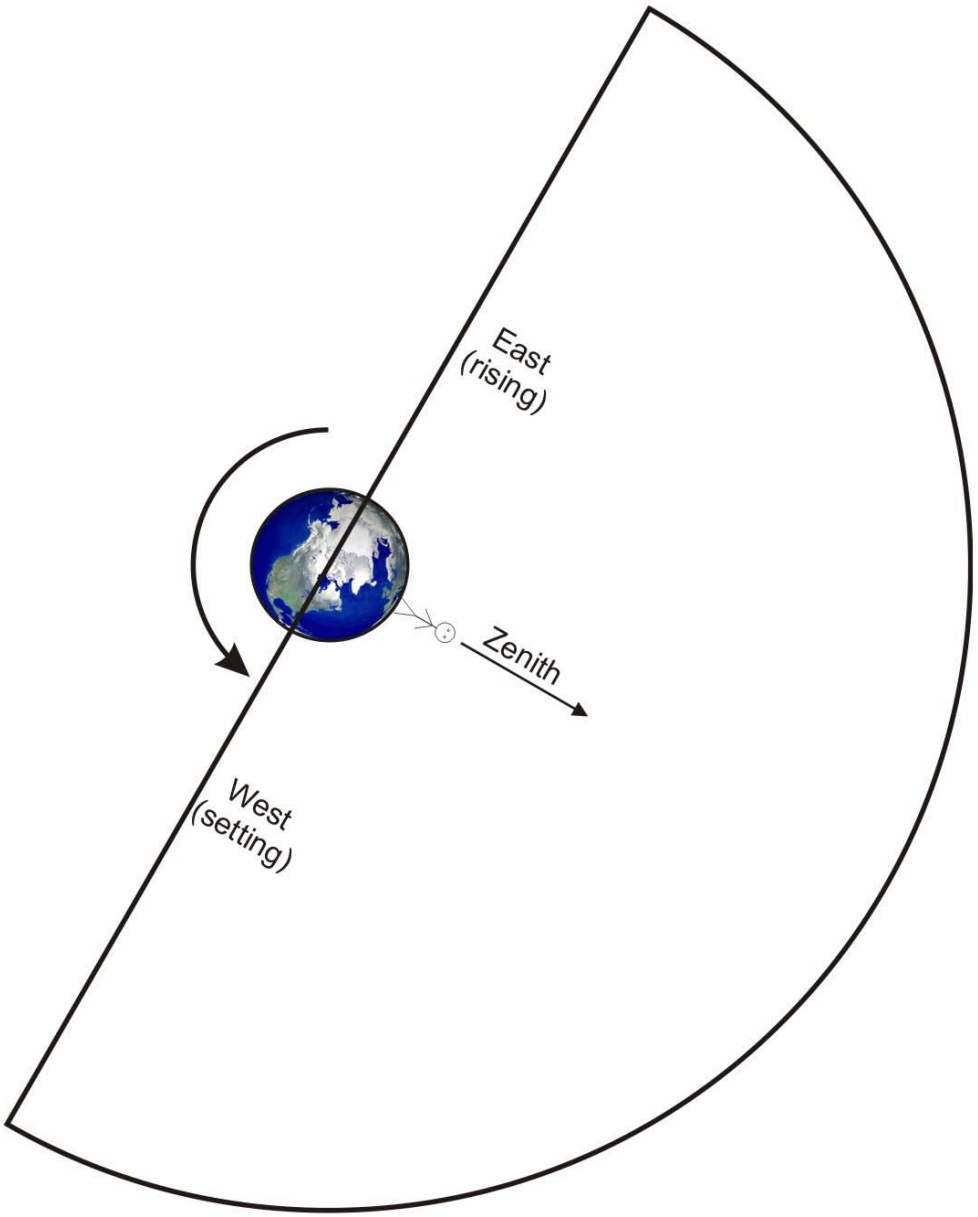
Figure 2. Time Sequence of Moon Phases

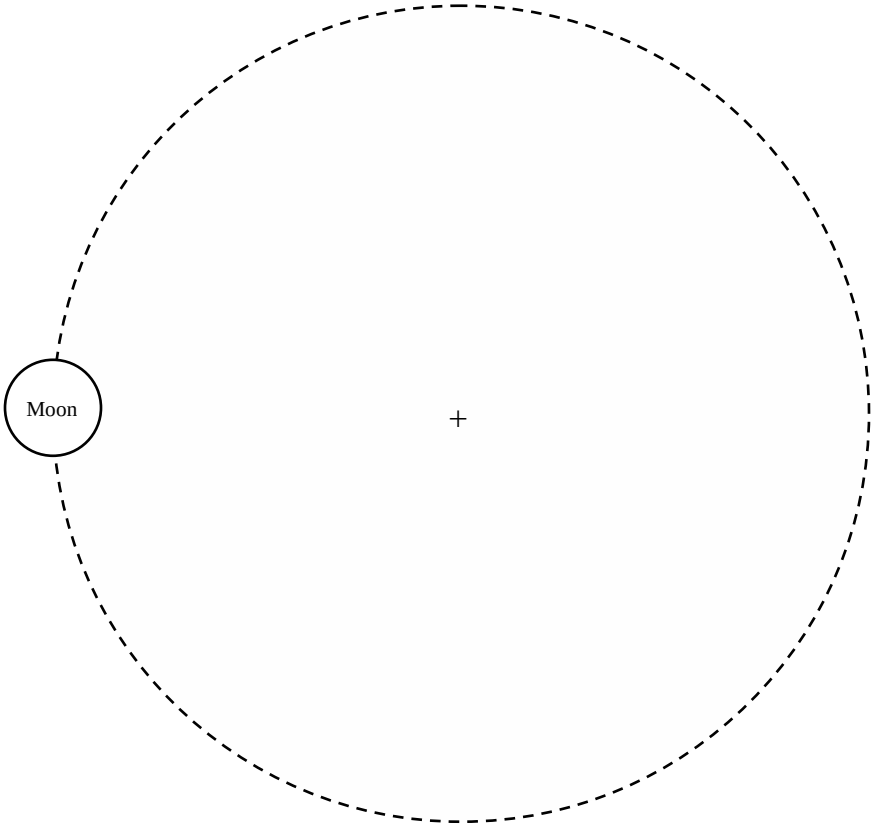


MOON RISE/SET ACTIVITY DEMO

Instructions: (1) Rotate the Moon so that it lies in the correct position relative to the Earth and Sun for the moon phase that you are asked to explore, and (2) Rotate the Earth counter clockwise in the direction of the arrow and you will see what comes into view for the observer. Objects rise on the observer's Eastern horizon and set on the observer's Western horizon. The time of day for the observer depends on the position of the Sun in the observer's sky.




East
(rising)
Zenith
West
(setting)


Moon

EAST

(Rising)

WEST

(Setting)

Name: _____ **Date:** _____

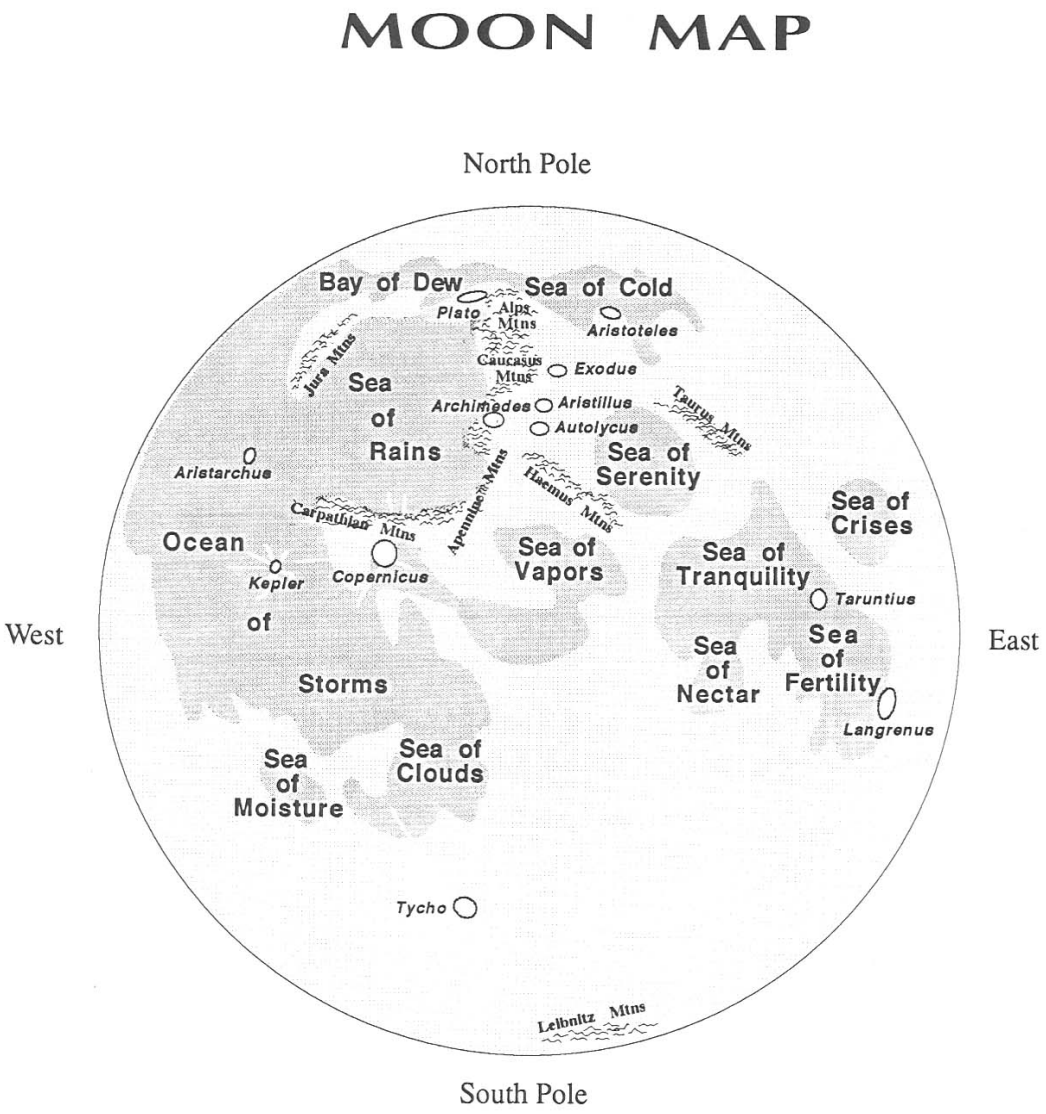
Moon Phase Experiment #2

Use the Moon Rise/Set Demo to determine when each phase of the moon rises, is highest overhead (nearest the zenith) and sets. Remember to specify whether the time is am or pm.

Time Sequence #	Moon Phase	Moon Image	Time When It Rises	Time When Its Highest Overhead	Time When It Sets
1	New				
2	Waxing Crescent				
3	First Quarter				
4	Waxing Gibbous				
5	Full				
6	Waning Gibbous				
7	Third Quarter				
8	Waning Crescent				

Figure 3. A high resolution image of the Moon from NASA. At home, you can explore an interactive map of the Moon and Apollo landing sites at http://google.com/moon.

Figure 4. A schematic of the Moon with its major terrain features labeled from "Universe at Your Fingertips: An Astronomy Activity and Resource Notebook" (a publication of Project Astro at the Astronomical Society of the Pacific, ed. A. Franknoi, 1995).



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Optional Activities

I. Tides

Discuss how ocean tides are produced. This is an excellent lesson especially for children living in coastal communities. The Moon's gravitational pull causes a high tide on the side of the Earth that is closest to the Moon, and the larger distance between the Moon and the far side of the Earth leads to the lowest gravitational pull and thus highest tides on the side of the Earth that is farthest from the Moon. In between, 90 degrees different in longitude from where the high tides are occurring, are the places on the Earth where low tides occur. This Moon Rise/Set activity then naturally lends itself to a discussion of why the times of day when high tide occurs (twice each day, 12 hours apart) vary with the phase of the Moon.

Tides will be highest when the Moon is highest overhead (nearest the zenith) and 12 hours afterward (see column 4 in Table 2). For example, high tides occur at midnight and noon when the Moon is in the Full Moon phase.

II. Eclipses

Discuss eclipses. The E/M/S do not all in the exactly the same orbital plane. The Moon's orbital plane is tipped by 5 degrees relative to the plane of the Earth's orbit around the Sun. Because the planes are tilted, we do not see eclipses every month. Describe the location of the E/M/S when there is a solar eclipse (the Moon lies between the Earth and Sun) and a lunar eclipse (the Earth lies between the Sun and Moon).

III. Google Moon

This would require a teacher to have access to a computer and LCD display in the classroom. In collaboration with NASA and the US Geological Survey, Google.com has created a very interesting website, http://www.google.com/moon, which features an interactive map of the Moon that includes information about the 6 Apollo landing sites with information, photos and short videos. It allows you to look at both low and high resolution images of the Moon as well as contour maps to explore the heights/depths of the craters. Students will be captivated by exploring the Moon's terrain and the details given about the Apollo missions serve as a very good history lesson.