Moon Phases

Scientific Background

The moon travels around the earth in an elliptical orbit. The moon travels from **west** to ***east*** around the earth. (Due to the earth's rotation the moon ***appears*** to rise in the east and move toward the west). The average distance of the moon from the earth is 384,000 kilometers (240,000 miles). The lunar month is actually 27 _ days; but, the earth is traveling through space in its orbit around the sun, so that the time from one full moon to the next is just over 29 days. The moon rotates on its axis west to east, the same direction that it revolves around the earth. The period of rotation is exactly the period of revolution for the moon.

The moon appears larger when rising because we see it in comparison to other objects such as buildings and trees. It also appears yellow or orange when rising and setting. This is because the reflected light from the moon must pass through longer sections of the earth's atmosphere; in doing so the blue rays are reflected and scattered by dust particles. This is the same phenomenon that causes the red sunsets.

As the moon travels around the earth we see different amounts of the half of the moon that is in sunlight. During the lunar month the moon goes through a continuous change from complete darkness (new moon) to complete light (full moon) and then back to complete darkness. As the moon goes from new moon to full moon we term the phase waxing. The moon's change from full moo to new is called waning.

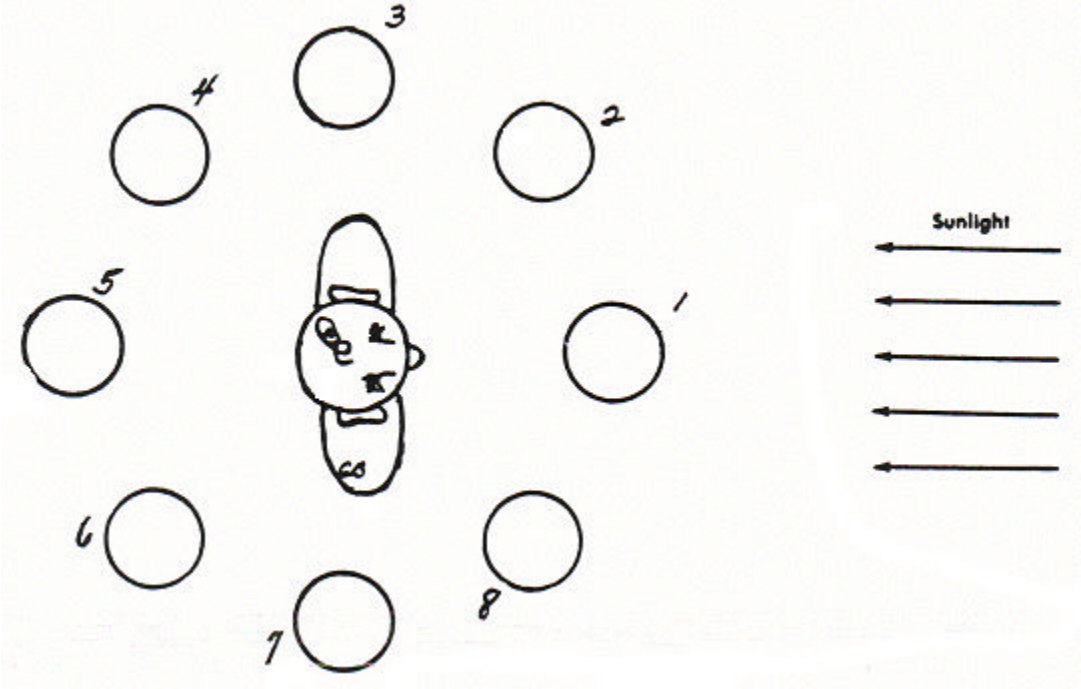
Outside of the romantic, aesthetic, and mythical qualities of the moon one of the important societal implications is that it causes tides on the earth. Tides result because the moon's pull of gravity makes a bulge in the water on the earth's side facing the moon. Tides have been proposed as one potential source of energy.

Using the figure provided

1. Show the direction of the moon orbiting the earth as you (the earth observer) see it.

2. Draw the phases of the moon as you observed.

3. Identify waxing and waning on your diagram.



Task: Construct a model using the facts and materials provided to show why the moon apparently "changes shape" (phases).

Materials:

Large styrofoam ball (the moon)
Light source (sun)
Student's head and eyes (earth observer)

Rules:

1. In this activity you will work with a partner and will take turns being the earth observer.

2. Your model will show the positions of the earth, the moon and the sun needed to see (earth observer view) the following shapes.

3. It will be necessary to have lights out (other than the light source) while doing this activity.

4. Several teams may share the same light source.

5. While you are playing the earth's observer your partner will be holding the large Styrofoam ball (moon) in one of the positions (1 → 8), being careful not to obstruct the light (sun).

6. As you (earth observer) view the moon you will rotate yourself on the chair to view the moon directly in front of you.

7. The partner holding the moon (Styrofoam ball) will start at position 1 as shown in the diagram then position 2, position 3, …

Fact 1: The Earth rotates on its axis one full turn in about 24 hours.

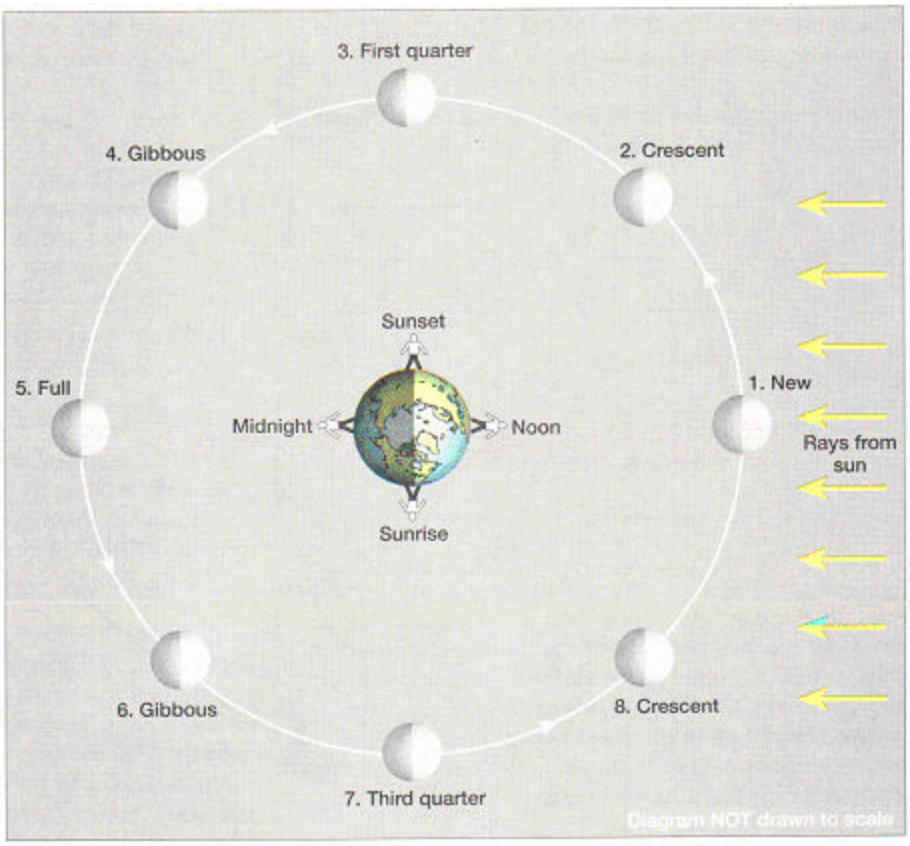
Fact 2: The moon "shines" by reflected sunlight.

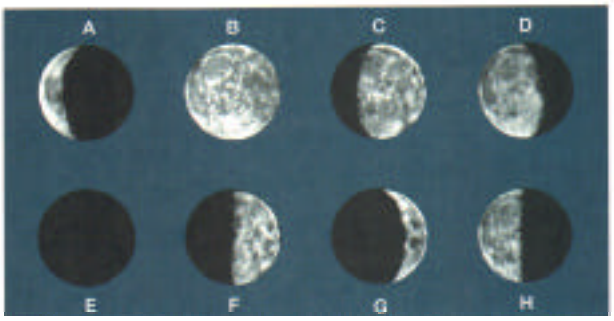
Fact 3: Moon phases have nothing to do with the shadow of the earth.

Fact 4: The moon travels in an orbit (revolves) around the earth once in about 28 days.

Fact 5: The moon is much closer to the earth than the sun. Distance to moon ~ 256,000 miles; distance to sun ~ 93 million miles.

Figure 20.2 The lunar cycles as viewed from above the Northern hemisphere of Earth, including phases of the moon as observed from earth (A-H).





Phases from Earth

1.For each of the eight positions of the moon In Figure 20.2, draw a line through the moon which separates the half of the moon that is ***visible from Earth*** (the half directly toward Earth) from the half which cannot be seen.

2. As the moon journeys from position 1 to position 5. The proportion of ***its illuminated side visible from Earth*** is (increasing, decreasing). Circle your answer.

3. As the moon journeys from position 5 to position 8, the proportion of its illuminated side visible from Earth is (increasing, decreasing).

4. Complete the following by matching each of the drawings of the of the lunar phases as seen from Earth in Figure 20.2 (A-H) with the Moon's appropriate position (1-8) on the figure. (next page)

Position Number	Letter of Phase Seen from Earth	Name of Phase
1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____
7.	_____	_____
8.	_____	_____

Observe the time of day (noon, sunset, etc.) represented by four positions of the earthbound observer on Figure 20.2. Note that an observer can be see the moon approximately 90^{o} on either side of his or her location- that is, about _ of a circle in both directions. Using the 8 positions of the moon in its orbit and the times represented on earth, answer questions 5-13.

5. The new moon is highest in the sky to an earthbound observer at (noon, sunset, midnight, sunrise). Circle your answer.
6. The full moon appears highest in the sky to an earthbound observer at (noon, sunset, midnight, sunrise). Circle your answer.
7. Throughout the lunar cycle, the moon moves further(eastward, westward) in the sky each day. Therefore, to an earthbound observer, the time of day when the moon is highest in the sky becomes progressively (earlier, later). Circle the correct responses.
8. Can a full moon be observed from earth by an observer positioned at noon? Explain the reason for your answer.

   _____

   _____
9. A full moon first becomes visible to an earthbound observer positioned at (noon, sunset, midnight, sunrise) and she or he must look (eastward, westward) to see the rising moon. Circle the correct response.
10. Can the first- and third-quarter lunar phases be observed during the daylight hours? Explain the reason to your answer.

    _____

    _____
11. At approximately what times will the first-quarter moon rise and set?

Rise: _____ Set: _____

12. At approximately what times will the third-quarter moon rise and set?

Rise: _____ Set: _____

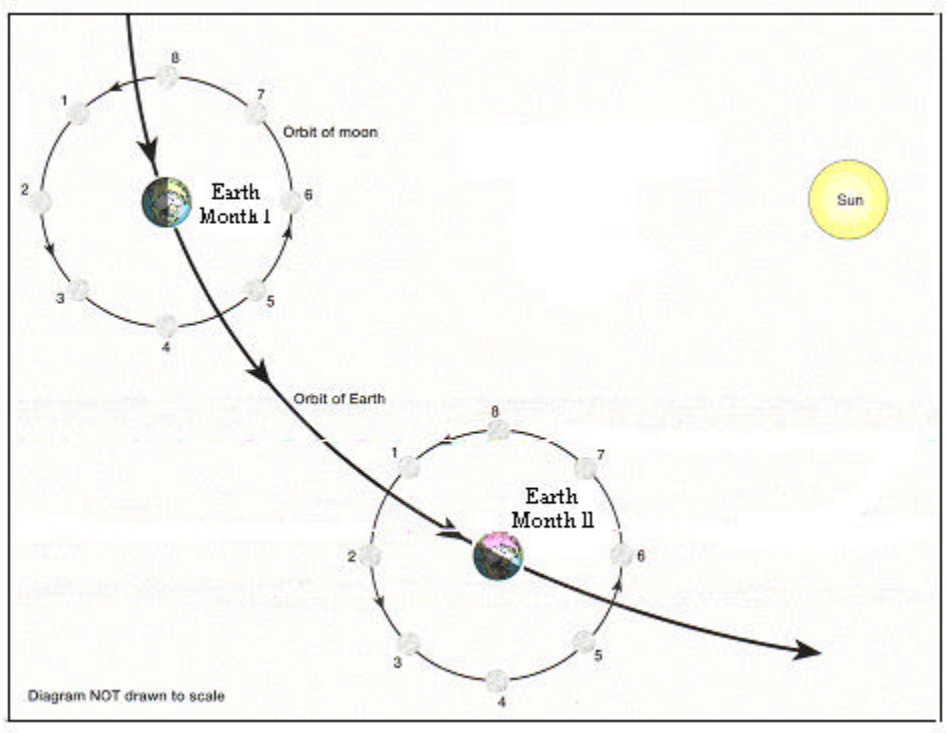
13. Assume a crescent-phase moon is observed in the early evening in the western sky. During the next few days the moon will be rising (earlier, later) and the visible, illuminated portion of the moon will become progressively (larger, smaller). Circle your answers.

Synodic and Sidereal Months. The time interval required for the moon to complete a full cycle of phases in 29.5 days, a period of time called synodic month. This complete cycle of phases of the moon (i.e. new-moon to the next new-moon). Although the cycle of phases requires 29.5 days, the true period of the moon's 360^{o} revolution around the Earth takes only 27.3 days and is known as the sidereal month. The difference of approximately 2 days resulting from the fact that as the moon revolves around the Earth, the Earth-moon system also is moving around the sun.

Figure 20.3 illustrates an exaggerated month of motion of the earth-moon system around the sun. Refer to the figure to answer questions 14-22.

14. On month 1 of figure 20.3, indicate the dark half of the moon on each of eight lunar positions by shading the appropriate area with a pencil.
15. Select from the eight lunar positions in Month 1, and indicate which represents the following lunar phases.

Phases	**Lunar Position (Month 1)**
New-moon	_____
Third quarter	_____
Full-moon	_____
First quarter	_____



On Month 1, label the position of the new-moon phase with the words “new moon.”

16. In Month II of Figure 20.3, lunar position number (1, 3, 5, 7) represents the new-moon phase. Circle your answer and label the position of the new moon phase on Month II with the words “new moon.”

Begin with the position of the new-moon Phase in Month I, and imagine revolving the moon 360^{o} around Earth while at the same time moving it to Month II.

17. After a 360^{o} revolution beginning at the new-moon phase in Month I, the moon is located at position (6, 7, 8) in Month II. Circle your answer.

18. A complete 360^{o} revolution of the moon around Earth is called a _____ month, which takes _____ days.

19. The position of the moon you determined in question 18 occur (before, after) the moon completes a full cycle of phases from Month I to Month II. Circle your answer.

20. In Month II, when the moon moves the additional distance in its orbit, from position 6 to 7, and again is at the new-moon phase, it will have completed a _____ month, which takes _____ days.

21. In your own words, explain the difference between a sidereal and synodic month.
_____
_____