0.1 Introduction

Even the most casual observer will notice that the appearance of the Moon is constantly changing. The range of lunar phases is shown in Fig. 1. The entire sequence of phases shown in this figure takes about four weeks. In fact, our definition of, and the word Month, derive from the 29.5 day lunar cycle. Why does Moon behave like this? Even the ancient Greeks understood that they could explain these phases by assuming the Moon was a spherical object that was being illuminated by the Sun. As the Moon revolved around the Earth, the changing angles between the Sun, the Moon, and the observer would produce the changing appearance of the Moon. Today you are going to understand how these phases arise with some simple experiments.

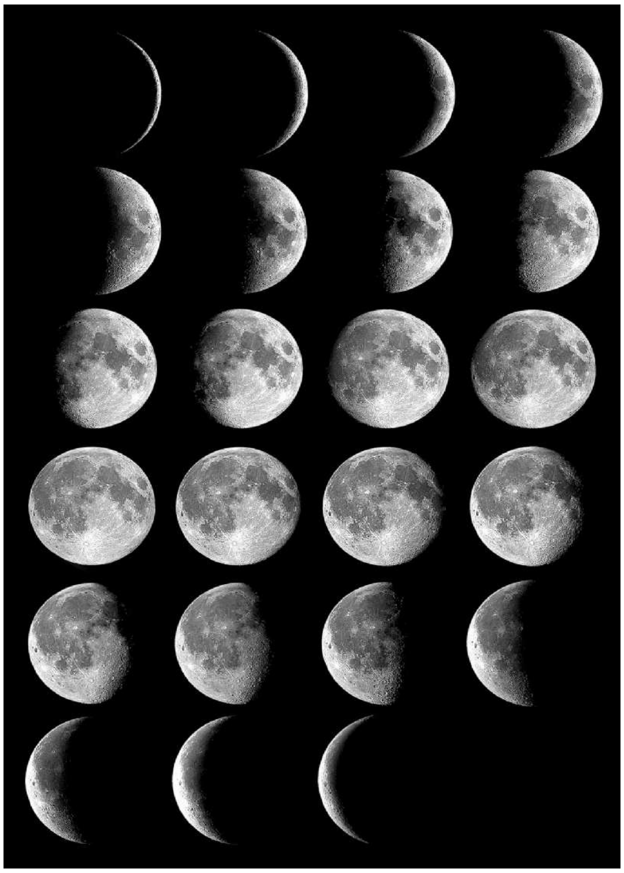
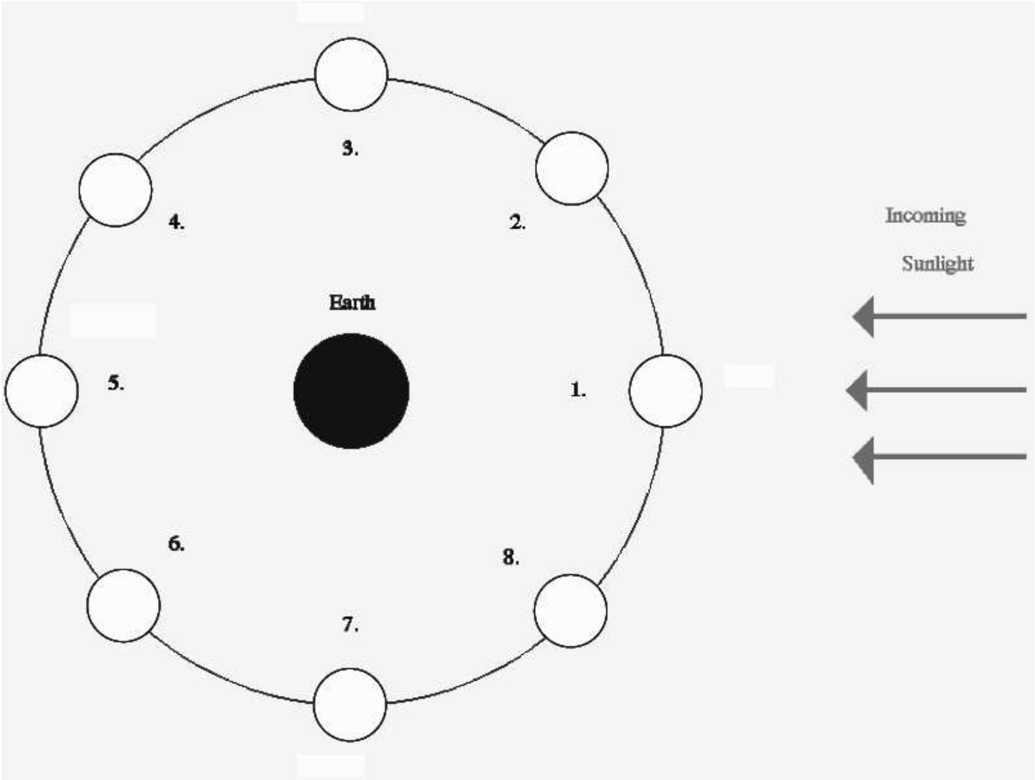


Figure 1: The changing phases of the Moon.

- *Goals:* To understand the origin of the phases of the Moon
- *Materials:* small spheres (representing the Moon), with two different colored hemispheres, and a flashlight (representing the Sun).

0.1.1 Exercise 1

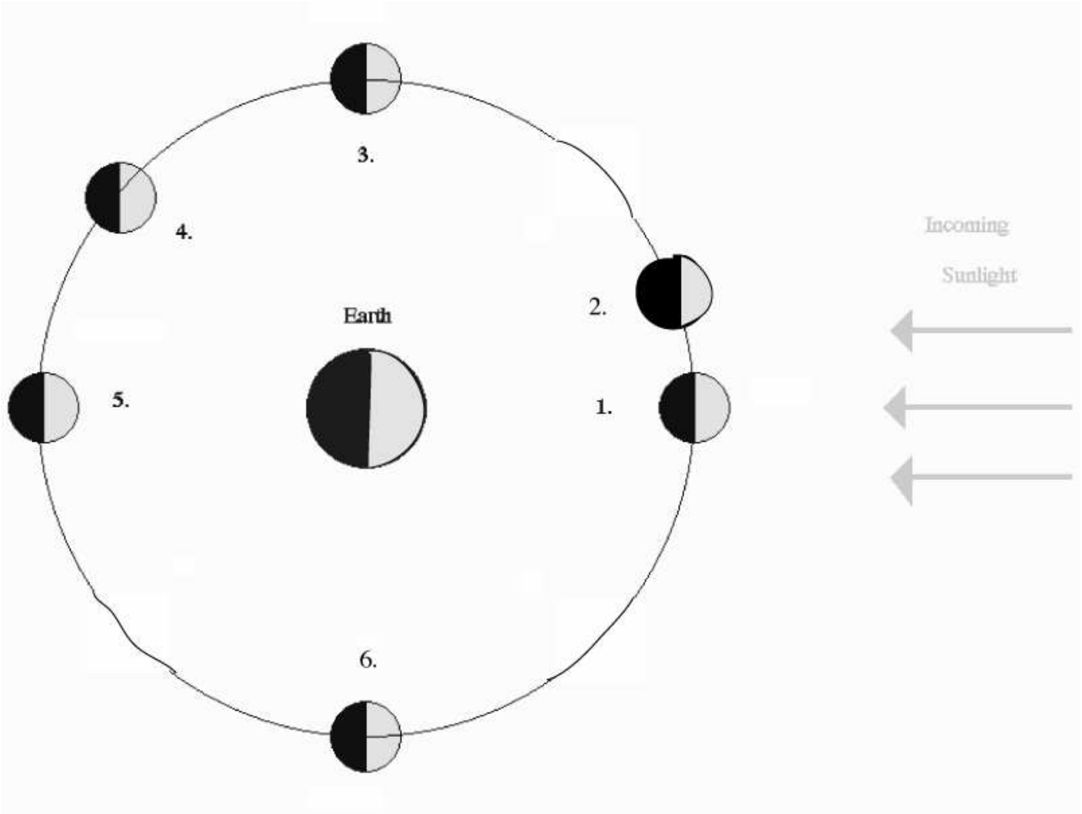
The figure below shows a “top view” of the Sun, Earth, and eight different positions (1-8) of the Moon during one orbit of the Earth. Note that the distances shown are **not** drawn to scale. The Sun is located far to the right, but it illuminates parts of the Earth and the Moon.



1) At which position do you think there is the greatest amount of the Moon’s surface being illuminated, and at which position is there the least amount of the Moon’s surface being illuminated? Or is there no difference? Explain. (5 pts)

0.1.2 Exercise 2

The figure below shows a “top view” of the Sun, Earth, and six different positions (1-6) of the Moon during one orbit of the Earth. Note that the distances shown are **not** drawn to scale.



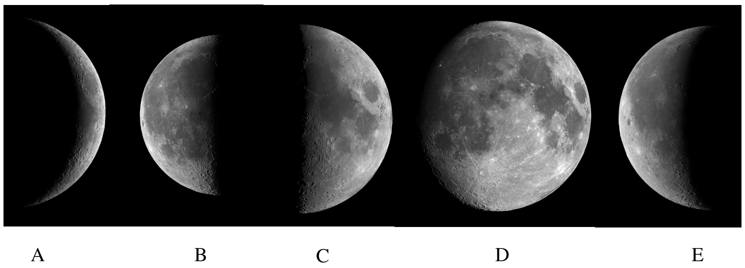
Ranking Instructions: Rank (from *greatest* to *least*) the amount of the Moon’s illuminated surface that is **visible from Earth** for the six positions (1-6) shown. (5 pts)

Ranking Order: Greatest A: ____, B: ____, C: ____, D: ____, E: ____, F: ____Least

2) Explain your reasoning for ranking them this way (5 pts):

0.1.3 Exercise 3

Shown below are different phases of the Moon as seen by an observer in the Northern Hemisphere at different times during the month (but not in order!).



Ranking Instructions: Using Fig. 1, put these five phases in the correct order, beginning shortly *after* New Moon (5 pts).

Ranking Order:

First phase is 1:________, 2:________, 3:________, 4:________, 5:________ Last phase.

Or, if you think all of these phases would be visible at the same time indicate that here: ______ (indicate with an X).

0.1.4 Exercise 4

In the set of figures below, the Moon is shown in the first quarter phase at different times of the day (or night). Assume that sunset occurs at 6 p.m. and that sunrise occurs at 6 a.m.

Instructions: Determine the time at which each view of the Moon would have been seen, and write it on each panel of the figure.

0.1.5 Exercise 5

In the set of figures below, the Moon is shown overhead, at its highest point in the sky, but in different phases. Assume that sunset occurs at 6 p.m. and that sunrise occurs at 6 a.m.

Instructions: Determine the time at which each view of the Moon would have been seen, and write it on each panel of the figure.

0.1.6 Exercise 6

In the two sets of figures below, the Moon is shown in different parts of the sky and in different phases. Assume that sunset occurs at 6 p.m. and that sunrise occurs at 6 a.m.

Instructions: Determine the time at which each view of the Moon would have been seen, and write it on each panel of the figure.

0.1.7 Additional Question

After you have completed the six Exercises and are comfortable with Moon phases, and how they relate to the Moon's orbital position and the time of day that a particular Moon phase is highest in the sky, you will be verbally quizzed by your instructor (*without the Exercises available*) on these topics. You will use the dual-colored sphere, and the flashlight, and a person representing the Earth to illustrate a specified Moon phase (appearance of the Moon in the sky). You will do this for three different phases. **(18 points)**

Name:____________________________
Date:______________________________

0.1.8 Take-Home Questions

The following questions are worth **11 points** each.

1. If the Earth was one-half as massive as it actually is, how would the time interval (number of days) from one Full Moon to the next in this 'small Earth mass' situation compare to the actual time interval of 29.5 days between successive Full Moons? Assume that all other aspects of the Earth and Moon system, including the Moon's orbital semi-major axis, the Earth's rotation rate, etc. do not change from their current values.

2. If you were on Earth looking up at a Full Moon at midnight, and you saw an astronaut at the center of the Moon's disk, what phase would the astronaut be seeing the Earth in? **Draw a diagram to support your answer.**