ASTRONOMY LABORATORY

THE MOON AND ITS PHASES[1]

I. Objectives

The purpose of this lab is to get you to demonstrate and describe the phases of the moon and the relationships between the Sun, Earth, and Moon.

II. Materials

For this lab you will need: 1. a small white ball (preferably a styrofoam ball, but a golf ball or other small ball will work too), 2. a light source (overhead projector, slide projector, lamp with the lamp shade removed), 3. ruler, 4. calculator.

III. Size and Scale

a. Measure the diameter of a model Moon, enter it in the table below. Then, calculate the corresponding model scale size of the Sun-Earth-Moon system. The "*scale*" of a model is the scale size (or length) of one object divided by the actual size (or length) of that object. To calculate the scale size of anything in this model, just multiply the actual size (or length) of the object by the *scale*.

	Actual Size	Scale Size		*Scale*
Diameter of Moon	3.5×10^3 km	_____	$\Longrightarrow$	_____
Diameter of Earth	1.3×10^4 km	_____		
Diameter of Sun	1.4×10^6 km	_____		
Radius of Moon's Orbit	3.8×10^5 km	_____		
Radius of the Earth's Orbit	1.5×10^8 km	_____		

IV. Night and Day

For the first section of this lab you will be pretending that your head is the Earth (the North Pole will be the top of your head, and the South Pole will be under your chin), and a light bulb will be the Sun.

b. Stand facing the light bulb (Sun). Draw and label a diagram illustrating this setup as seen from above your head (above the North Pole of the Earth). Shade the "day" and "night" sides of your head (Earth), and indicate the position of a person who lives on the end of your nose.

[1]Written Spring Semester 2000 by M. Stark, modified Feb. 2005 by M. Stark.

c. As seen from above the North Pole, the Earth rotates counter-clockwise. In the diagram from question *b*, indicate the spots on your head where it is "noon," "sunset," "midnight," and "sunrise".

d. What time of the day would it be for a person that lives on the end of your nose when you are facing the light bulb?

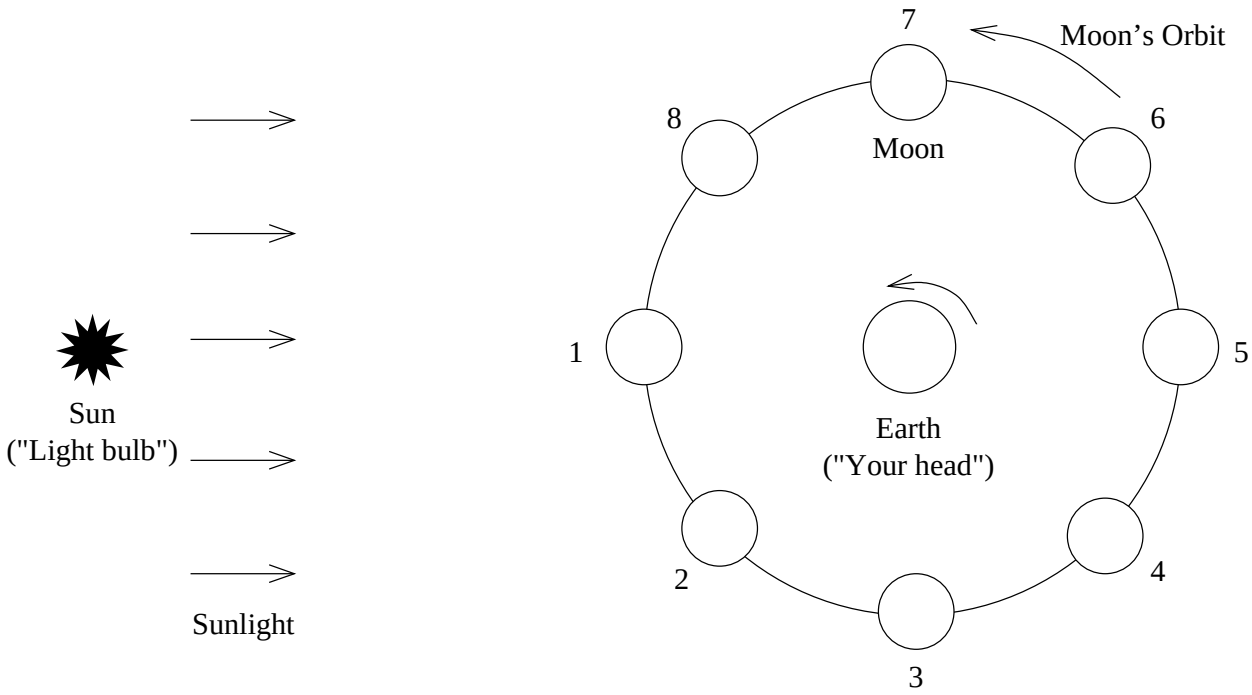
e. Turn a quarter of a circle to the left (so the light bulb is off your right ear). Now what time is it for someone who lives on the end of your nose? (Make a new diagram like question *b* if necessary.)

f. Turn another quarter of a turn to the left (now the light bulb will be behind you). Now what time is it for a person who lives on the end of your nose? (Make a new diagram like question *b* if necessary.)

g. Make another quarter of a turn to the left (so the light bulb will be off your left ear). Now what time is it for a person who lives on the end of your nose? (Make a new diagram like question *b* if necessary.)

V. The Phases of the Moon

Now we are going to examine the phases of the moon. Place a model Moon on the end of your pencil. You will be holding the Moon out at arm's length and describing/sketching its appearance at different points in its orbit. Here is a diagram, as seen from above your head (above the Earth's North Pole), of the Moon's orbit around the Earth with the eight different positions we will be examining indicated (note: it is <u>not</u> drawn to scale). In this diagram the Earth rotates counter-clockwise, and the Moon orbits the Earth in a counter-clockwise direction.

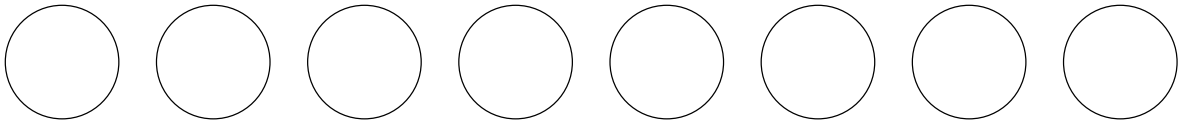


The labeled positions (phases) of the moon have names:

1. New Moon
2. Waxing Crescent (actually any point between 1 and 3)
3. First Quarter
4. Waxing Gibbous (actually any point between 3 and 5)
5. Full Moon
6. Waning Gibbous (actually any point between 5 and 7)
7. Third Quarter (also called Last Quarter)
8. Waning Crescent (actually any point between 7 and 1)

h. In the diagram above, shade the "day" and "night" sides of the Earth <u>as seen from space</u>, label the "noon," "midnight," "sunrise," and "sunset" points on the Earth. Then shade the "day" and "night" sides of the Moon at each point in its orbit <u>as seen from space</u>.

i. Starting with the Moon at position 1, follow the Moon through one orbit around the Earth. Shade these circles to match the appearance of the Moon as seen from the Earth at the eight positions in its orbit indicated in the diagram on page 3.



1. New Moon	2. Waxing Crescent	3. First Quarter	4. Waxing Gibbous	5. Full Moon	6. Waning Gibbous	7. Third Quarter	8. Waning Crescent

j. Describe how the *apparent* shape of the moon changes during one orbit as seen from the Earth. Does the *physical* size and shape of the Moon change during its orbit?

k. At what time of the day would the New Moon be due South in the sky (directly overhead for a person on the end of your nose)? (Look at the diagram for question *h*, or draw one if necessary.) What about the First Quarter Moon? The Full Moon? The Third Quarter Moon?

l. Hold the Moon at the First Quarter Phase position, turn your head to determine what time the Moon rises for a person who lives on the end of your nose (look at where the Sun is to figure out the time, make a diagram if necessary). Repeat with the moon at the Third Quarter Phase position.

m. Could you see the First Quarter Moon at Sunset? Could you see the First Quarter Moon just after noon? (i.e., will the Moon be above the horizon at those times?)

n. Could you see the Third Quarter Moon at Sunset? Could you see the Third Quarter Moon just after Sunrise?

o. An eclipse can occur when the Sun, Earth, and Moon line up (a *lunar eclipse* is when the Moon passes into the Earth's shadow, a *solar eclipse* is when the Moon's shadow falls on the Earth). At what phase(s) can a lunar eclipse occur? At what phase(s) can a solar eclipse occur?

p. Simulate each of these types of eclipses with your model Moon. Which type was easier to make? Based on this, which type do you think would be the most common to see and why?

q. Extra Credit: Why don't we see solar and lunar eclipses every month?

r. Sumarize the facts and ideas presented, including any additional questions you may have. Consider the following questions in your summary: 1. What physical processes (motions, lighing effects, lines of sight, etc.) causes the phases of the moon? 2. Is the moon only visible in the sky at "night"? Why or why not?