ASTRONOMY 101A (Fall Semester 2002)

LUNAR PHASES, PART I

Objective: Your objective in this exercise is to develop a model for why we see phases of the moon and how to predict the rising and setting times of the moon. You should also have a better understanding of when in the lunar cycle of phases solar and lunar eclipses can occur. This lab will take two recitations to complete.

By the end of today's exercise, you should be able to model with the Styrofoam balls and light source how all the major phases of the moon are formed.

Intro: During the course of a month, the appearance of the moon changes, from fully illuminated (a.k.a. full moon) to completely dark (a.k.a. new moon) and back again. This sequence of lunar phases can be explained if we make the following assumptions:

1. The Moon is spherical in shape.
2. The Moon is visible by reflected Sunlight.
3. The Moon circles the Earth once per month.

Today you will show how the observed phases of the moon are a easy to explain if you make these assumptions. ***Be sure you can answer all the questions in the exercise as there will be a short quiz at the end of today's exercise.***

Procedure: **1) Modeling the Full Moon**

We will start modeling the phases of the moon by simulating the *full moon*.
Do this by modeling the orbit of the moon using a Styrofoam ball held at arm's length. In this model, the moon is the Styrofoam ball, the Earth is you, and the Sun will be the slide projector (which provides all the light which will reflect off our Styrofoam ball "moon").

Standing with the Styrofoam ball held at arm's length, spin around slowly in place counterclockwise. This motion is simulating the moon's orbit around the earth in which on full revolution of the moon around the earth takes 29.5 days from new moon to new moon.

Watching the changing illumination of the Styrofoam ball, rotate until you find the point at which the side of the Styrofoam ball facing you is completely illuminated. If in this model you are the earth, the Styrofoam ball is the moon, and the slide projector is the Sun, then you have now determined where the moon is relative to the Earth and the Sun during *full moon*.

Using what you have just determined about the position of the moon during full moon, add the full moon to the "Diagram of the Moon's Position" on the "Phases of the Moon Worksheet." Label your drawing and be sure to indicate which side of the moon is illuminated in your diagram.

Q: Relative to the Sun and the Earth, where is the moon during Full Moon?

2) Modeling the New Moon

Now model to *new moon*, which occurs when the side of the moon facing us is completely in shadow. Again, rotate counterclockwise in place until the Styrofoam ball appears completely unlit. Add the new moon to the "Diagram of the Moon's Position" on the "Phases of the Moon Worksheet." Again be sure to label the new moon and note which side of the moon is illuminated.

Q: What is the position of the moon during new moon compared to it's position during full moon?

Q: Where is the Earth relative to the Moon and the Sun during New Moon?

Q: Keeping the Styrofoam ball at arm's length, place it directly between your eyes and the slide projector. What astronomical event are you simulating? What is the phase of the moon during this event?

Q: If a total lunar eclipse occurs when the moon passes through the Earth's shadow, what is the phase of the moon during a total lunar eclipse?

[Pause Here Before Continuing]

3) Modeling the Other Major Phases of the Moon

Now that you know where the moon is relative to the earth and sun during full moon and new moon, use the fact that the moon orbits the earth in a counterclockwise direction (as seen from over the north pole of the earth) to figure out where the moon is during *first quarter* and *third quarter*.

Starting with the Styrofoam ball at arm's length in between you and the slide projector (representing the position of the moon during new moon). Rotate slowly counterclockwise until half of the visible side of the moon appears illuminated. At this point, the moon is at *first quarter*. Add the first quarter moon to the "Diagram of the Moon's Position" on the "Phases of the Moon Worksheet." Again be sure to label and note which side of the moon is illuminated.

Q: Which of the following images best represents the appearance of the moon (as seen with "north" up, that is, the way you have this model set up) during first quarter?

Explain your reasoning.

Now continue rotating counterclockwise until you have passed the full moon and you reach the point where the other half of the visible side of the moon appears illuminated. This is *third quarter*. Again add, label, and indicate the position of the third quarter moon on the "Diagram of the Moon's Position."

4) Considering the Progression of Moon Phases

Now that you have determined where the moon is during new moon, 1st quarter, full moon, and 3rd quarter occur, now consider how the moon's appearance changes during the 29.5 days of a moon's orbit.

At any point between these four main lunar phases, the name of the moon's phase is determined by how its appearance as seen from earth changes. Between New and Full Moon, the illumination is increasing from night to night, so the Moon is said to be *waxing*. Similarly, between Full and New Moon, the illumination is decreasing or *waning*. Between third quarter and first quarter, less than half of the Moon is illuminated, so the Moon is *crescent*-shaped. Between first quarter and third quarter, more than half of the Moon is illuminated, so the Moon has a *gibbous* shape.

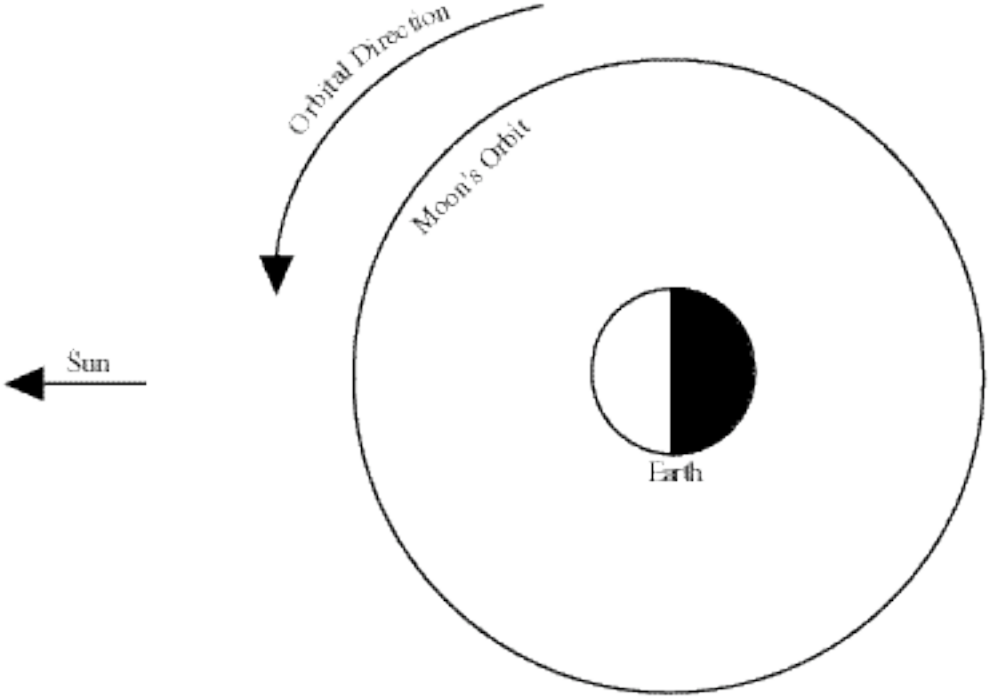
Q: Using the model of the moon's phases we have developed, determine where the moon is halfway between 3rd quarter and new moon and draw the appearance of the moon during this time below:

Q: What is this phase called?

Q: Estimate how many days after new moon this phase of the moon occurs.

Phases of the Moon Worksheet

Diagram of the Moon's Position (as viewed from over the North Pole)



Summary Questions

Q: Does the moon moving in and out of the Earth's shadow cause the phases of the moon? If not, what is the cause of the observed phases of the moon?

Q: Would the phases of the moon look different if the moon was not spherical (e.g. if it was a cube)?

Q: About how many days between a new moon and the 1st quarter moon?

Q: If the last new moon occurred Sept. 7, what is the current phase of the moon? Also, estimate on what dates the next new moon, full moon, and 3rd quarter moon occur? Explain your reasoning.