Lab Activity on the Moon's Phases and Eclipses

Objectives

When you have completed this lab you should be able to…

1. Demonstrate and illustrate how the relative positions of the sun, earth and moon cause the phases of the moon as seen from earth.
2. Given a drawing or photograph of the moon in any phase, be able to correctly name that phase and draw a diagram showing the relative positions of Earth, the moon and the sun for that phase.
3. Given a diagram showing any possible set of relative positions of Earth, the moon and the sun, determine the name of the moon phase and draw what the moon would look like in that phase.
4. State which way the moon revolves around Earth and describe a method for figuring this out.
5. Demonstrate why we always see the same side of the moon (the face side of the "man in the moon")
6. Demonstrate what causes lunar and solar eclipses.
7. Explain why eclipses don't happen every month

Lab Activity #1: What do You Think Causes the Phases of the Moon?

Activity: Draw a diagram, explaining any theories you have about why the moon goes through phases. Briefly explain your theory to your group members. At this point, don't evaluate your idea or anyone else's. Just let each person state his/her ideas.

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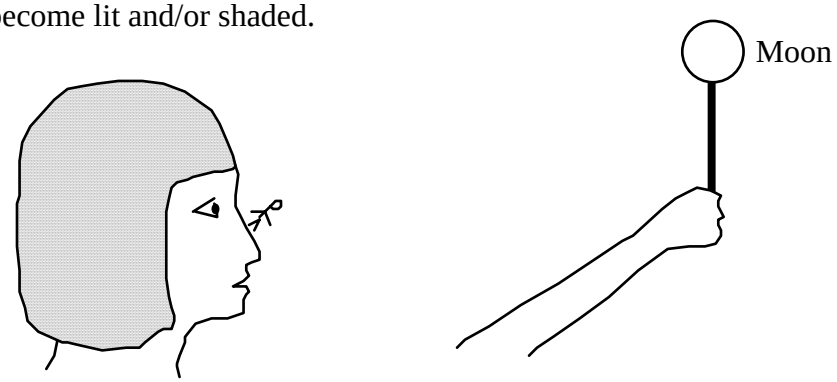
Lab Activity #2: Modeling the Phases of the Moon[1]

Materials: White polystyrene ball, 3 inches in diameter (to represent the moon)[2]
Pencil or other "stick"
Glowing light bulb (to represent the sun)

Activity:

1. Place the ball on the pencil.
2. Your instructor will turn on one light bulb and turn off all other lights in the room. The light bulb represents the sun, the white ball represents the moon and your head represents the earth. Imagine your nose as a giant mountain on the Earth's northern hemisphere with a tiny person standing on it (partially sideways), looking at the moon--see diagram below.
3. Hold the pencil with the white ball on it at arm's length in front of you and a little above your head. Slowly rotate your body, keeping the "moon" in front of you and watching as various parts of the white ball become lit and/or shaded.



Questions:

1. Draw diagrams showing the positions of the light bulb, your head, and the white ball (all as seen from the ceiling) for each of the following phases:
   a. Full Moon (the part of the ball that you can see is fully lit):

[1]This lab activity was modified from Activity A-3 of the chapter entitled "Our Moon's Phases and Eclipses" in *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook:* The Astronomical Society of the Pacific, San Francisco (1995).

[2] A Styrofoam ball will not do; the ball must be opaque. We got our *Polystyrene* balls from Molecular Model Enterprises, 116 Swift St., P.O. Box 250, Edgerton, WI 53334, (608)884-9877. We got 3 inch diameter balls for $.45 each and 7/8 inch diameter balls for $.12 each.

b. Quarter Moon (the part of the ball that you can see is half lit):

c. New Moon (the part of the ball that you can see is fully in shadow):

2. At any given time, what percentage of the model moon is <u>actually</u> lit? _____. Why?

   If you are unsure of the answer to this question, watch the white ball as a partner repeats the activity described above.

Lab Activity #3: Determining which way the moon revolves around Earth

Materials: 3" diameter white polystyrene ball (to represent the moon) on a pencil
Glowing light bulb (to represent the sun)

Introduction

We have all known, from a very young age, that the moon revolves around Earth and that it takes about a month to do so--hence the word *mo(o)nth*. But have you ever stopped to wonder which way the moon revolves around Earth? Does it revolve from east to west (clockwise when looking down on Earth's north pole) or from west to east (counterclockwise when looking down on Earth's north pole)? In this activity, we will figure out the answer to this question.

We will do this by using the time-honored scientific technique of "predicting" what we would observe IF a particular possible answer were correct. If we don't observe what we predicted, then we know that that particular possible answer is wrong. If we do, indeed, observe what we predicted, then that possible answer has a high probability of being correct.[3] In this case, we have only two possible reasonable answers to our question, so the most reasonable right answer should be easy to determine by elimination.

Activity: For each possible answer to the question of which way the moon revolves around Earth (west-to-east or east-to-west), use the "moon on a stick" to "predict" which side of the moon (left or right) would be lit during the waxing[4] phases and which side of the moon would be lit during the waning[4] phases--as seen from the northern hemisphere.

Questions:

1. Complete this table	Side of the moon that would be lit during the waxing phases (right or left)	Side of the moon that would be lit during the waning phases (right or left)
If the Moon revolves from east to west (clockwise when looking down on Earth's north pole)		
If the moon revolves from west to east (counterclockwise when looking down on Earth's north pole)		

2. According to your observations of the moon (as part of the moon project),

   a. Which side of the moon is actually lit during the waxing phase? _____

   b. Which side of the moon is actually lit during the waning phase? _____

3. Conclusion: Which way does the moon actually revolve around Earth?

[3] In science, we can only rule out wrong answers; we cannot prove right answers. We can be very very confident that a particular answer is correct but we can never be absolutely 100% sure—this limitation is an inherent aspect of the scientific method.

[4] The waxing phases of the moon are when the lit portion of the moon is getting bigger from one night (or day) to the next; the waning phases are when the lit portion of the moon is getting smaller each night (or day).

Lab Activity #4: Synthesizing Your Understanding of the Phases of the Moon

Materials: 3" diameter white polystyrene ball (to represent the moon) on a pencil
Glowing light bulb (to represent the sun)
Partially completed "pop-up" moon diagram on card stock

Activity: Follow the instructions below to complete diagram on the card stock, turning it into a pop-up diagram. The circle in the center of the diagram represents the Earth and the eight small circles around it represent the moon at eight different positions on its orbit around Earth. Note that this pop-up diagram is not to scale. For reference, here are the earth and moon in the correct proportions with regard to both size and distance:

Moon Earth

Instructions

1. On the diagram, write "To the sun" with an arrow pointed in the appropriate direction.
2. The partially-cut-out rectangles all around the diagram will show what the moon would look like to a person living near the equator who looks up through a skylight and sees the moon on eight different days (or nights) in the moon's cycle. Fold each rectangle up to represent a skylight above the person's head.
3. For each of the eight positions of the moon, darken[5] the appropriate part of each circle in each "skylight" to show what the moon looks like to the person on Earth, directly below the moon. Draw each sketch in the box "above" the appropriate moon position ("Right side up" will be different for each moon-and-box pair; the Earth will be at the bottom for each).
4. "Above" each moon sketch, write the correct name for the phase of the moon (new, waxing crescent, waning crescent, 1st quarter, 3rd quarter, waxing gibbous, waning gibbous, full).[6]
5. "Below" each sketch of the moon, write the approximate day in the moon's 29-day cycle.

[5]Darken the part of the moon that is not visible; leave the "lit" portion of the moon white.

[6] Definitions of the phases:

Full Moon	The moon is full when the side we see is 100% illuminated. A full moon looks like a perfect circle.
New Moon	The moon is new when the side we see is dark. We cannot see a new moon at all.
Crescent Moon	A crescent moon is shaped like a crescent; a smaller proportion of the moon is illuminated than is the case during a quarter moon.
Quarter Moon	The moon is called a quarter moon when it looks like a half circle.
Gibbous Moon	A gibbous moon is shaped like a lopsided football; a larger proportion of the moon is illuminated than is the case during a quarter moon.
Waxing Moon	The moon is waxing when the illuminated portion of the moon is getting a little bit **bigger** every day.
Waning Moon	The moon is waning when the illuminated portion of the moon is getting a little bit **smaller** every day.

Lab Activity #5: Why Do We Always See the Same Side of the Moon?

Introduction: Have you ever noticed that the pattern of light and dark spots (forming a "man" or "rabbit" in the moon) is the same all the time, no matter what phase the moon is in? This is because, from Earth, we can only see one side of the moon (See Figure 20.3 on p. 520 of the textbook or this cool(!) web site movie: http://antwrp.gsfc.nasa.gov/ apod/ap991108.html or this very sharp still image: http://antwrp.gsfc.nasa.gov/apod/ image/0001/fm1222_gendler_big.jpg). The other side of the moon is always turned away from us--to see a photograph of the far side of the moon, go to the following web site: http://antwrp.gsfc.nasa.gov/apod/ap981008.html.

Materials: Two people
Photographs of the "near" and "far" sides of the moon

Activity: Examine the photographs of the "near" and "far" sides of the moon; note how unfamiliar the "far" side of the moon looks. Choose one person to model the moon and one to model Earth. Have both people stand up and then have the "moon" revolve around "Earth" so that "Earth " can only see the "moon's" face, never the back of the "moon's" head.

Questions:

1. For each 360° revolution of the "moon" around "Earth," how many times did the "moon" rotate (spin about its axis) 360°? Explain.

2. What would happen if the "moon" did not rotate (e.g. always faced the front of the classroom) as it revolved around "Earth?"

3. Does the real moon rotate? If so, how long does it take to complete one 360° rotation? Explain the reasoning behind your answer.

Lab Activity #6: What Causes Solar and Lunar Eclipses?[7]

Materials: White polystyrene ball, 3 inches in diameter (to represent the moon)
Pencil or other "stick"
Glowing light bulb (to represent the sun)

Activity: As in activity #2, hold the ball out in front of you, but hold it level with your eye. Face the light bulb and hold the ball so that it blocks the light; it may help to close one eye.

Question: 1. What kind of eclipse are you modeling?[8] _____

More Activity: Now face away from the light bulb and hold the ball so that the shadow of your head covers the ball.

Question: 2. What kind of eclipse are you modeling? _____

More Questions:

3. What phase is the moon in during a lunar eclipse? _____

4. What phase is the moon in during a solar eclipse? _____

5. Describe what causes a lunar eclipse. Draw a diagram to illustrate your answer.

6. Describe what causes a solar eclipse. Draw a diagram to illustrate your answer.

[7]This lab activity was modified from Activity A-4 of the chapter entitled "Our Moon's Phases and Eclipses" in *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook:* The Astronomical Society of the Pacific, San Francisco (1995).

[8] A solar eclipse happens during the day, when the sun is not visible at a time when it should be. A lunar eclipse happens at night, when the moon is orange and VERY faint when it should be bright white.

Lab Activity #7: Why Don't We Have Solar and Lunar Eclipses Every Month?

Introduction: As you know, in any given place, a total lunar eclipse occurs less than once a year. And a total solar eclipse is a once-in-a-lifetime phenomenon (I've never seen one). In this activity, we will figure out why. We will do this by making a true-to-scale model of the moon and Earth (the sun will NOT be to scale in this model).

Materials: 3" diameter white polystyrene ball (to represent the EARTH this time) on a pencil
7/8" diameter white polystyrene ball (to represent the MOON)
paperclip
Overhead Projector (to represent the sun)

Activity: Lunar Eclipse

1. "Unbend" one fold of the paperclip and insert the end into the 7/8" diameter polystyrene ball, providing a "stick" for holding up the ball.
2. As a group, go to the room adjacent to the lab room where the overhead projector is set up, bringing one model moon and one model Earth along. With one person holding the moon and one person holding the Earth, place the moon and Earth exactly 8 feet apart[9] in a line with the projector so as to model a lunar eclipse true to scale.[10]
3. Move the moon or Earth slightly up or down, noticing how precisely the moon and Earth must line up in order for a lunar eclipse to occur.

Questions:

1. Why don't we have a lunar eclipse every month? Draw a diagram to illustrate your answer.
   Hint: the plane of the moon's orbit around the earth is 5° off of the plane of the earth's orbit around the sun.

2. Will a lunar eclipse be visible from every place on Earth that is facing the moon? Explain the reasoning behind your answer and draw a diagram to illustrate your answer.

3. A lunar eclipse only lasts a few hours. Why?

[9] Note: the tiles in the room are exactly one foot square.

[10] If we were to model the sun correctly to scale with this model Earth and moon, the sun would be 29 feet in diameter and located 1.2 miles away, as far from here as is the corner of 9th St. and Main St.

Activity: Solar Eclipse: Now model a solar eclipse.

Questions:

4. Why don't we have a solar eclipse every month? Draw a diagram to illustrate your answer.

5. Will a solar eclipse be visible from every place on Earth that is facing the moon? Explain the reasoning behind your answer and draw a diagram to illustrate your answer.

6. A solar eclipse only lasts a few minutes. Why?

End-of-Lab Thought Questions

1. Will the moon have the same phase at all locations on Earth (North America, Europe, Venezuela, Argentina)? Explain the reasoning behind your answer.

2. What makes the moon rise and set? Does it do so at the same time every day? Why or why not?

3. How long does a “day” last on the moon (i.e. how many hours/days/weeks of daylight does any given spot on the moon experience between sunrise and sunset)? How do you know?