A.6 Phases of the Moon

I. Introduction

Earth has only one natural satellite, the Moon. It is the one of the largest satellites in the solar system. It takes the Moon 29.5 days to orbit around the Earth, and it always shows the same side towards the Earth. In this activity we are going to study the most noticeable feature of the Moon, the phase. The phase of the Moon is a result of the relative angles between the Moon, Earth, and Sun.

![Diagram of the phases of the Moon](image)

Figure A.15: The phase of the Moon seen from the Earth depends on the relative positions of the Sun, Earth, and Moon.

II. Reference

- 21st Century Astronomy, Chapter 2, pp. 43 – 46.

III. Materials Used

- ball
- light bulb
IV. Activities

Lunar Phases

1. Turn on the light bulb. We are going to pretend the bulb is the Sun. Hold a ball at arm’s length. Which side of the ball is illuminated? Which side is in shadow?

2. In Fig. A.15, shade the dark sides of the Moon and the Earth. The side facing away from the Sun is always in the dark.

3. We are going to measure all angles from the direction of the Sun (0°) in the counterclockwise direction. Find the angle to the Moon at each location on the orbit.

4. Pretend your head is the Earth. The ball is going to represent the Moon. Hold the ball in your hand and stretch your arm. As you spin counterclockwise, the Moon orbits around you. Notice that the Moon is illuminated by the Sun from different angles with respect to the Earth. At 0°, your head, the ball, and the bulb are aligned in a straight line. You can see only the dark side of the Moon. It is the new moon.

5. Now rotate counterclockwise by 45°. You should be able to see a crescent moon. Sketch the phase and label the phase. Keep rotating by 45°, and for each angle, sketch and label the phase.

<table>
<thead>
<tr>
<th>New Moon</th>
<th>0°</th>
<th>45°</th>
<th>90°</th>
<th>135°</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="new_moon.png" alt="" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Full Moon</th>
<th>180°</th>
<th>225°</th>
<th>270°</th>
<th>315°</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="full_moon.png" alt="" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure A.16: Lunar phases and corresponding angles between the Sun and Moon.

What time does a full moon rise?

We can use Fig. A.15 to find what time the Moon of a particular phase rises or sets. Also, we can find the time of the transit. The transit is the time when the Moon, or any celestial body, is exactly on the local celestial meridian (LCM).

1. The local time is defined by the position of the Sun in the sky. When the Sun is on the LCM, it is the local noon. From Fig. A.15, find the local time for the transit for each lunar phase.
Table A.15: The transit depends on the phase of the Moon.

<table>
<thead>
<tr>
<th>lunar phase</th>
<th>rise</th>
<th>transit</th>
<th>set</th>
</tr>
</thead>
<tbody>
<tr>
<td>new moon</td>
<td></td>
<td>12:00 noon</td>
<td></td>
</tr>
<tr>
<td>first quarter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>full moon</td>
<td></td>
<td>12:00 midnight</td>
<td></td>
</tr>
<tr>
<td>third quarter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. The Moon rises 6 hours before the transit and sets 6 hours after the transit. Find when each lunar phase rises and sets.

V. Questions

1. What is the phase of the Moon if the angle between the Sun and Moon is 150° in the counterclockwise direction?

2. What is the phase of the Moon during a solar eclipse?

3. Your younger brother swears that he saw a crescent moon at midnight. Can you trust him? Explain your reasoning.

VI. Credit

To obtain credit for this lab, you need to turn in appropriate tables of data, observations, calculations, graphs, and a conclusion as well as the answers to the above questions. Do not forget to label axes and give a title to each graph. Show your work in calculations. A final answer in itself is not sufficient. Don’t leave out units. In the conclusion part, briefly summarize what you have learned in the lab and possible sources of error in your measurements and how they could have affected the final result. (No, you cannot just say