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Lunar Phases Planisphere

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Abstract

This paper describes a lunar phases planisphere with which a user can answer questions about the rising and setting times of the Moon as well as questions about where the Moon will be at a given phase and time. The article contains figures that can be photocopied to make the planisphere.

1. ARTICLE

Student misconceptions in understanding lunar phases are well documented (Lightman and Sadler 1993; Lindell 2001; Lindell and Olsen 2002; Lindell and Sommer 2004; Kavanagh, Agan, and Sneider 2005). The topic is often one of discussion on the Astrolrner Yahoo! Groups discussions. A posted question asking if anyone had developed a lunar phases "planisphere" encouraged me to resurrect the device I developed during the early to late 1980s; this device and its use is the topic of this paper. It was at this time that I learned of a *Lunar Phase Wheel* designed by Mary Urquhart (Urquhart 2010).

The purpose of the device is not, by itself, to teach the cause of the lunar phases but rather to help the student to visualize better, *from the point of view of the observe*r, the angle between the apparent location of the Sun and Moon, and to answer questions such as "if the Sun sets at 6 p.m., at what time would the waxing gibbous Moon set?" The goal is for the student to be able to answer the question without using the planisphere, because practicing with it will aid in visualizing and understanding the geometry that causes the phases.

The device consists of a movable "sky" over a fixed local horizon/meridian. Figure 1, marked at the bottom as "movable," is photocopied to a transparency and placed over a paper or transparency copy of Figure 2, marked as "fixed." Figure 2 shows the stationary horizon as viewed by an observer facing south—the general direction an observer must be facing to see the moon from midnorthern to northern latitudes. Placed on the horizon are the cardinal points such an observer would see: south straight ahead, east to the left and west to the right. (Since the view is that of the observer, north would be behind the back of the observer/user of the planisphere.) In addition, times in 3-h intervals for the approximate location of the Sun in the sky (above and below the horizon) are shown. For simplicity, we assume sunrise is always at 6 a.m. and sunset is always at 6 p.m.

The movable part shows the Moon at its various waxing and waning phases and the Sun. The drawing is not, of course, to scale but is meant to show the relative locations as seen by an observer. However, the Sun and Moon are drawn the same size since their angular sizes are so close. For simplicity, the phases are shown every 45°. Also for simplicity, we neglect the hourly motion of the Moon in relation to the Sun.

The user needs to remember that time is determined by the location of the Sun: noon when on the meridian above the horizon to the south, 3 p.m. when half-way between the meridian and setting, 6 p.m. at setting, midnight when on the meridian below the horizon, etc.

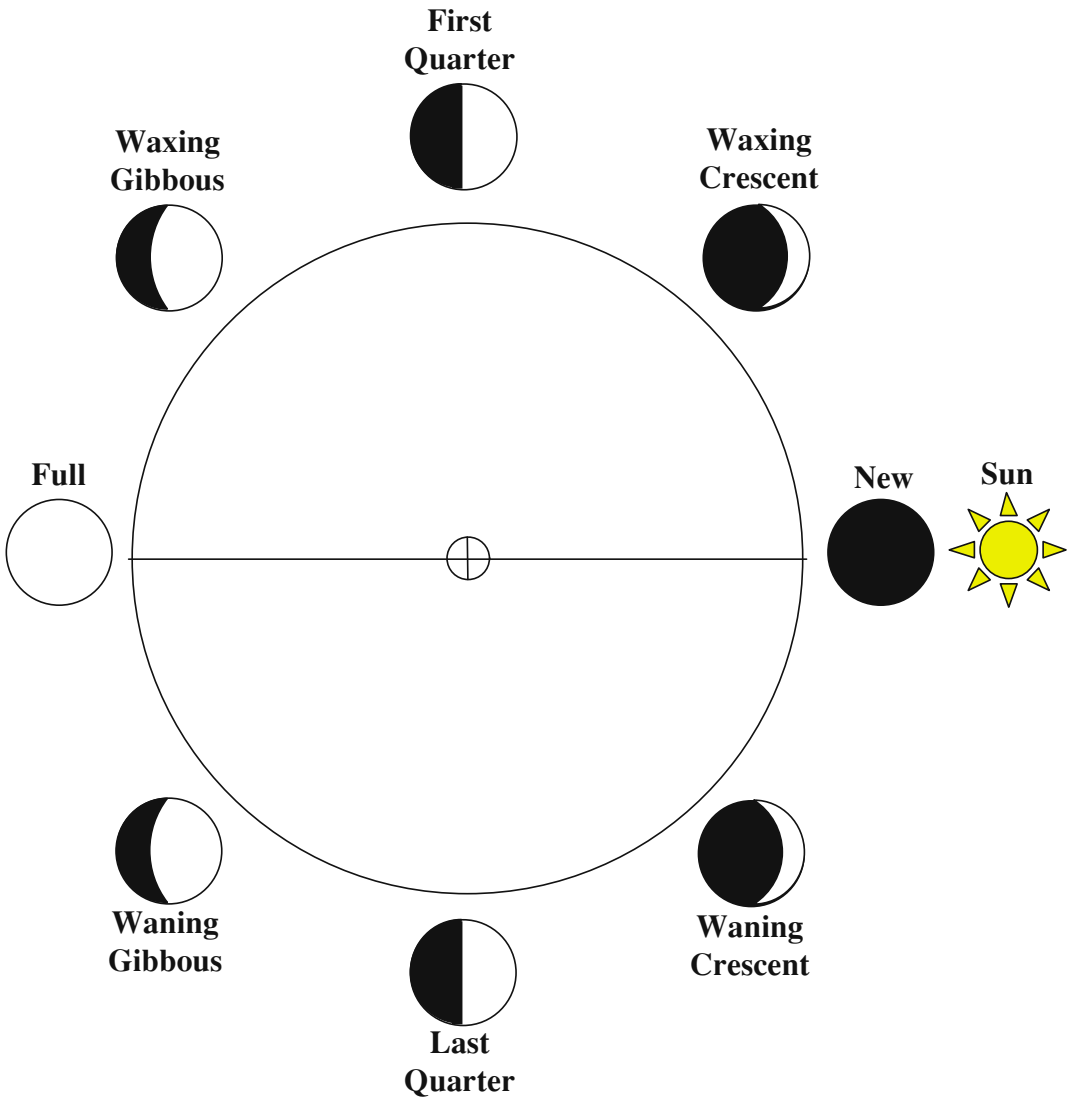

Figure 1. Movable

2. ASSEMBLY

The assembled lunar planisphere will have the movable transparency piece on top of the fixed one. (Two transparency pieces could be used on an overhead projector for teaching students how to use it.) The small circle at the center of each figure is to be carefully cut so that a brass brad can be inserted to hold the two pieces together and provide a pivot point during use. A thumbtack or pushpin could be used in place of the brass brad if the fixed Figure 2 were placed on a piece of cardboard.

3. EXAMPLES OF USE

The use of the planisphere is best described through some specific examples. The stationary piece is always held with the horizon parallel to the ground.

1. New Moon: set the movable piece so that New Moon (and the Sun) are setting (on the western horizon). One sees that the New Moon sets, then, at sunset, which is 6 p.m. Rotating the movable piece so that the New Moon is rising shows that it rises at 6 a.m.
2. Waxing Crescent: set the movable piece so that the waxing crescent Moon is setting. Given the location of the Sun at 9 p.m. on the dial, we see that the waxing crescent Moon sets at 9 p.m. Moving the waxing crescent to its rising location in the east will show that it rises at 9 a.m. Rotate the top piece so that the Moon is traveling across the sky above the horizon; notice that the right side of the waxing Moon as seen by the observer is illuminated by the Sun.

The user should notice that during a given night, as the Moon (and Sun) cross the sky from east to west,

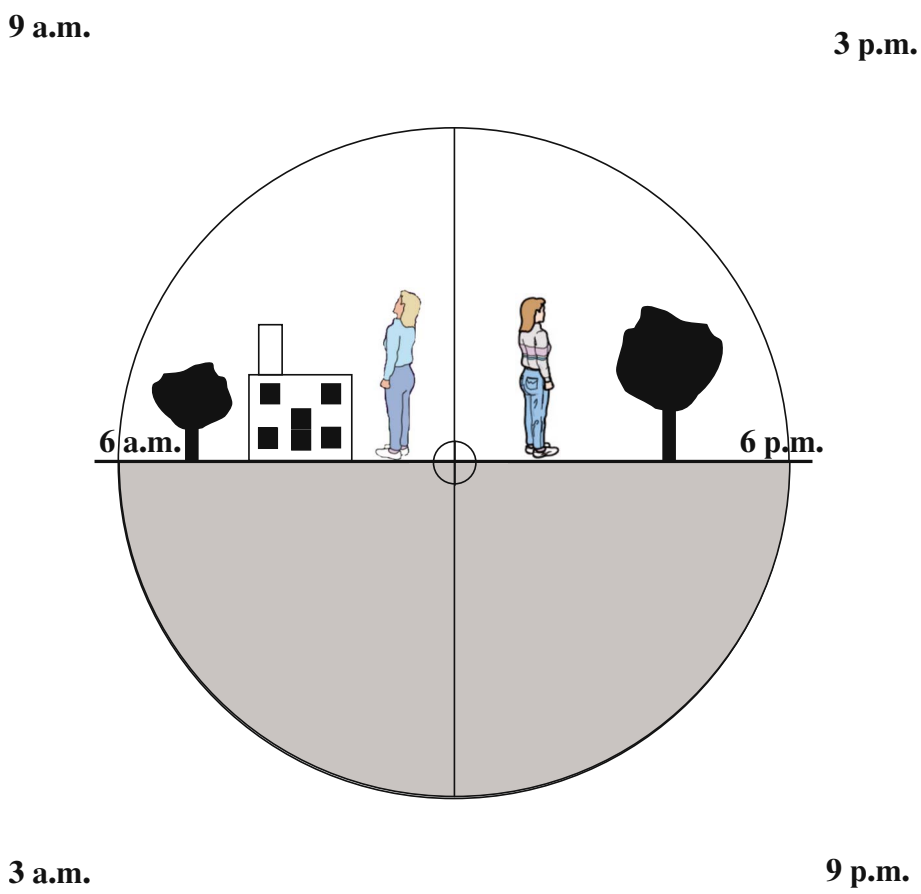

Figure 2. Fixed

the phase remains the same throughout the night. In other words, the angle between the Sun and Moon (45° for crescent, 90° for quarter, and 135° for gibbous), is constant throughout the night as the Earth rotates underneath the distant Sun, Moon, and stars.

3. Waning Gibbous: Set the waning gibbous to rising. From the location of the Sun, it is 9 p.m. with a set time of 9 a.m. Rotate the top piece so the waning gibbous Moon is traveling across the sky above the horizon; notice that the left side of the waning Moon, as seen by the observer, is illuminated by the Sun. We can turn the question around and ask: where in the sky is the Last Quarter Moon at noon? Turning the top piece to noon (the Sun on the meridian) shows the last quarter Moon to be setting.

4. SAMPLE QUESTIONS TO ASK STUDENTS

1. Describe the location of the Sun at 3 a.m.? 9 p.m.?
2. At what time did the first quarter Moon rise? Set?
3. At what time will the First Quarter Moon be visible on the meridian?
4. At what time will the First Quarter Moon be on the meridian below the horizon?
5. Will the waning crescent Moon be visible at 2 a.m.?

6. What is the angle between the waning gibbous Moon and Sun at moonrise? When is the Moon visible on the meridian? At moonset? When is the Moon on the meridian below the horizon?
7. Describe the location of the Third (Last) Quarter Moon at 3 p.m.?
8. Set the lunar planisphere to show where the Moon would be at noon during a solar eclipse. Describe your finding.
9. Set the lunar planisphere to show where the Moon would be at 9 p.m. during a lunar eclipse. Describe your finding.

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