

## Lunar Phase Simulator – Student Guide

### Background Material

Answer the following questions after reviewing the background pages for the simulator.

Question 1: Which of the following statements is true?

- a) There is no such thing as a “dark side” of the moon. We can, over time, see the full surface of the moon.
- b) There is no such thing as a “dark side” of the moon. The whole moon is illuminated during a full moon.
- c) There is a “dark side” of the moon. It is the side that is perpetually in shadow.
- d) There is a “dark side” of the moon. It is the side of the moon that always points away from the earth.

Question 2: What causes the phases of the moon?

- a) The earth’s shadow on the moon as it revolves around us.
- b) The fraction of the moon illuminated by the sun that we see changes as the moon revolves around us.
- c) Half of the moon is made of dark rock that doesn’t reflect light. As the moon rotates, we see more and less of the dark rock.
- d) The light from the sun reflects off the earth’s surface, and illuminates part of the moon as it revolves around the earth.

Question 3: Correctly match the following words to their meanings.

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|-----------|--|
| gibbous ● | ● to increase in size, quantity, volume, intensity, etc.         |
| waning ●  | ● decrease in magnitude, importance, brilliancy, intensity, etc. |
| waxing ●  | ● convex, rounded – also hunch-backed, having a hump             |

Question 4: The moon

- a) rises in the east and sets in the west.
- b) rises in the west and sets in the east.
- c) rises in the south and sets in the north.
- d) doesn’t “rise” and “set” per se, it is always visible in an observer’s sky but can only be seen at night when the bright sun doesn’t obscure its presence.

Question 5: When viewed from above the North Celestial Pole, the moon

- a) orbits counterclockwise at a rate slower than the earth spins
- b) orbits counterclockwise at a rate faster than the earth spins
- c) orbits clockwise at a rate slower than the earth spins
- d) orbits clockwise at a rate faster than the earth spins

## Familiarizing Yourself with the Simulator

The items below will help familiarize yourself with the controls and usability features of the simulator.

- If you have not already done so, launch the *NAAP Lunar Phase Simulator*
- The main panel has sunlight, the earth, and moon. The earth and moon can be dragged with the mouse.
- Below the main panel, there are animation controls. The moon and earth can be dragged, even while animating.
- The increment buttons move both the moon and earth by the specified time.
- The *Moon Phase* panel shows the current moon phase. Drop down menus will jump to a predefined position. Note that the phases, such as crescent and gibbous, are more broad than the particular point chosen by the presets.
- The *Horizon Diagram* panel displays the point of view of the observer (and you are second observer looking down on that observer).
- The observer globe can be dragged around for convenience.
- The sun and moon on the globe can be dragged around.
- In the *Diagram Options* panel, the *show angle* option shows the earth-moon-sun angle. The phases are technically defined in terms of this angle. It is there for convenience/interest only.
- In the *Diagram Options* panel, the *show lunar landmark* option draws a point of reference to more easily observe lunar rotation and revolution.
- In the *Diagram Options* panel, the *show time tickmarks* option displays the time of day of the observer.

## Earth – Moon – Sun

This section explores the earth-sun-moon geometry and relationship. The items below are specific activities to perform to help you understand and answer the questions in this section.

- Hide the content of the *Moon Phase* panel and the *Horizon Diagram* panel by clicking on the *hide* button in those panels.
- Click on the moon or earth and drag them around or watch them animate. Observe how they rotate and which way they rotate.

- Increment the time by day, hour, and minute. Observe how the earth and moon change position with respect to each other.
- Carefully observe the moon graphic as it moves around the earth. The moon is also spinning around its own axis of rotation. Use the lunar landmark if desired.

Question 6: As viewed from the simulator (above the earth's North Pole), which direction does the moon rotate, clockwise or counterclockwise? Which direction does the earth rotate? moon: \_\_\_\_\_ earth: \_\_\_\_\_

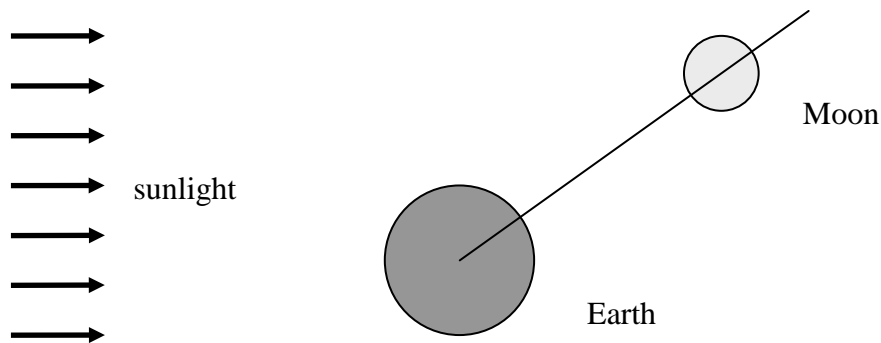
Question 7: If the simulator time is incremented by one day, why doesn't the earth appear to move with respect to the sun in the simulator, but the moon does? \_\_\_\_\_  
 \_\_\_\_\_

Question 8: At all times, how much of the moon's entire surface is lit by sunlight? When the moon is opposite of the sun, how much of the shadowed part of the moon is visible? \_\_\_\_\_  
 \_\_\_\_\_

Question 9: How many times does the moon rotate around its own axis in the time it takes the moon to make one (sidereal) revolution around the earth? \_\_\_\_\_  
 \_\_\_\_\_

Question 10: In the figure below, bisect the moon *twice*.

- Bisect with a line to show the half of the entire moon that is illuminated (and shade the shadowed region if desired).
- Bisect with a line to show the half of the moon visible from an observer on earth.
- Mark the region that is both visible from earth *and* illuminated by the sun. That region will be the phase of the moon we on earth see.



## Lunar Phases

This section will help you familiarize yourself with the phases of the moon. They are directly correlated to the relative positions of the earth, sun, and moon.

- If not currently enabled, show the *Moon Phase* by clicking the show button.
- Click on and drag the moon in the main panel. Note when the moon is illuminated on the right hand side and when it is illuminated on the left hand side.
- Use the phase presets. Make sure you are familiar with the eight primary phases. They should be memorized in some fashion.

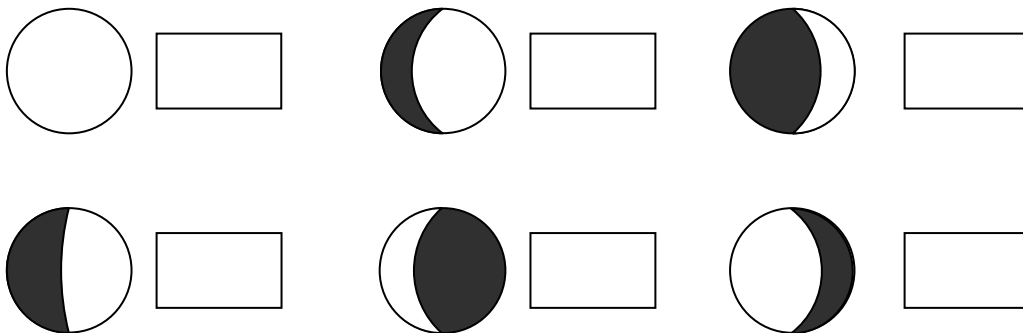
Question 11: When the *visible* face of the moon is less than 50% illuminated, what kind of phase is it: crescent or gibbous? \_\_\_\_\_

Question 12: Between the time of the new moon and the full moon, is the moon increasing the percent illuminated from day to day or decreasing? What kind of crescent and gibbous moon is it? \_\_\_\_\_  
\_\_\_\_\_

Question 13: In the figure for Question 10, imagine yourself standing on the earth looking at the moon directly overhead. Is the illuminated portion of the moon that we see (the section you marked) on the right hand or left hand side? What phase of moon is it? \_\_\_\_\_  
\_\_\_\_\_

Question 14: How long does it take for the moon to go through a complete cycle of phases? \_\_\_\_\_  
\_\_\_\_\_

Question 15: Label the following phases in the correct order (1-6) starting with the new moon (even though the new moon is not shown).



## Observer and Moon

This section will correlate the moon with the observer's sky. How the moon changes position in the sky from day to day will be explored.

- If not currently enabled, show the *Horizon Diagram* by clicking the show button.
- The observer is in a mid-Northern hemisphere latitude. Note how the moon is in the southern sky (as is the sun).
- Think about the following situations both from the observer's perspective in the small globe, but also from the perspective of looking down on the observer from space as depicted in the main panel.
  - Sun directly overhead. What "time" is it?
  - Where is the sun when it rises?
  - What must be the earth-observer-moon relationship for the moon to be directly overhead? Does it have to be noon?
  - Where is the moon when it rises?
- Put the moon and sun in the observer's day-time sky (you may have to rotate the observer/earth in the main panel).
  - increment the time by hours – how does the sun and moon move?
  - increment the time by days – how does the moon move with respect to the sun?

**Tip:** The "show time tickmarks" and "show angle" are options for your use and convenience.

Question 16: Is the full moon visible during the daytime? If it isn't, is the moon still full?

Why or why not? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Question 17: Does a *waning* moon set in the west before or after the sun will? Explain why this is true from an observer looking at the earth from above the North Pole (i.e. the simulator's view). \_\_\_\_\_

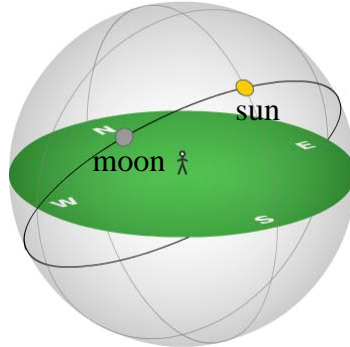
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Question 18: The figure below shows the moon in what phase and what time of day is it?  
What time did the moon reach its highest point in the sky? \_\_\_\_\_

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Question 19: In the figure above, draw and label the moon's location 48 hours later. Will the moon be visible during the day time 14 days later? \_\_\_\_\_

Explain your answer: \_\_\_\_\_

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Question 20: Draw and label the full moon and sun at 6:00 A.M. on the figure below. (If necessary or useful, draw an arrow to one or both spots.)

