Lunar Phases

First, think about the following questions. (Don’t look up the answer, just try to answer based on what you think. You won’t be marked right or wrong, just think about what you know.)

Question 1: 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 of the earth’s surface, and illuminates part of the moon as it revolves around the earth.

Question 2: 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 3: When viewed from above the North Celestial Pole, the moon
   a) orbits counterclockwise at a rate slower then the earth spins
   b) orbits counterclockwise at a rate faster than the earth spins
   c) orbits clockwise at a rate slower then the earth spins
   d) orbits clockwise at a rate faster than the earth spins

Open the URL:  [http://astro.unl.edu/naap/naap/animations/lps.swf](http://astro.unl.edu/naap/naap/animations/lps.swf)

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 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. 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, and the sun and moon on the globe can be dragged around. In the Diagram Options panel, the show lunar landmark option draws a point of reference to more easily observer lunar rotation and revolution. In the Diagram Options panel, the show time tickmarks option displays the time of day of the observer.

Move the picture of the Earth so that the observer is at noon (with the sun directly overhead.) Increment the moon’s motion by hour (so that one hour passes between each mouse click.) Which direction does the Earth rotate (clockwise or counterclockwise)?

Which direction does the moon appear to move (to an observer on the Earth) relative to the sun? (Hint: Move through a day and watch the sun and moon on the lower right figure.)
Increment the moon's motion by day (so that one day passes between each mouse click). Which direction around the Earth does the moon move from day to day (clockwise or counterclockwise)?

Turn on the “lunar landmark” and move through one month in daily increments. How long does it take the Moon to make one revolution around the Earth? How long does it take for the Moon to make one rotation on its axis? Explain.

Look carefully at the Moon in the main window. What fraction of the Moon is illuminated at the sun at any time? Does this fraction depend on where in its orbit the Moon is? Explain.

Turn on the “time tickmarks”. Beginning with the New Moon, fill in the following table describing when the various moon phases occur:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Moon Rises</th>
<th>Moon Overhead</th>
<th>Moon Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waxing Crescent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Quarter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waxing Gibbous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waning Gibbous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Quarter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waning Crescent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Describe the phase the Moon must be in for the following situations:

a. The moon is overhead at sunset.  
   f. The moon is rising at 9 pm. 

b. The moon is setting at sunrise.  
   g. The moon is overhead at 7 am. 

c. The moon is rising at midnight.  
   h. The moon is setting at 8 pm. 

d. The moon is overhead at 9 am.  
   i. The moon is rising at 10 am. 

e. The moon is setting at 3 am.  
   j. The moon is rising at midnight. 

Label the following name of the following phases, and number them (from 1 to 6) in the order they occur.

In the figure below, bisect the moon twice.
a) Bisect with a line to show the half of the entire moon that is illuminated (and shade the shadowed region if desired).  
b) Bisect with a line to show the half of the moon visible from an observer on earth.  
c) 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. 

Give the correct answers to the three thought questions at the beginning of the activity:

Question 1: _________  Question 2: _________  Question 3: _________