Indoor Lab 4 - The Moon

Objectives: To explore some aspects of the Moon's orbit, phases, and topography

1 The Waxing crescent Moon

The Moon first becomes visible in its phase cycle a few daays after the new moon - in the waxing crescent phase. We shall first review how this looks in the sky using SN.

Using the table in the FG (starts on p 350), find the date of the next new moon. Set up SN for NY, looking W at 5 PM, for the new moon day, plus two days, when is usually first seen. (Technical note: make sure the moon is activated using View/Solar System/Planets-Moons). Set the time rate to 100, and start the clock.

Watch the sun set and the moon appear. Perhaps you have seen this many times in the real sky.

The moon sets down and to the (left /right):_____

The horns of the crescent moon point (up /down) and to the (left /right):_____

The latter should be obvious when you realize where the sun is. Note that if you set the date to that of the new moon, the moon sets at nearly the same time as the sun, and the edge is not lit up, so it is not seen.

2 The Changing Phases

In the days following the new phase, the moon becomes more and more prominent in the evening sky and the phase changes as well. With the time set to aboout 6:30 PM so it is just about dark, set the time interval to 1 solar day and make single time steps to see what happens.

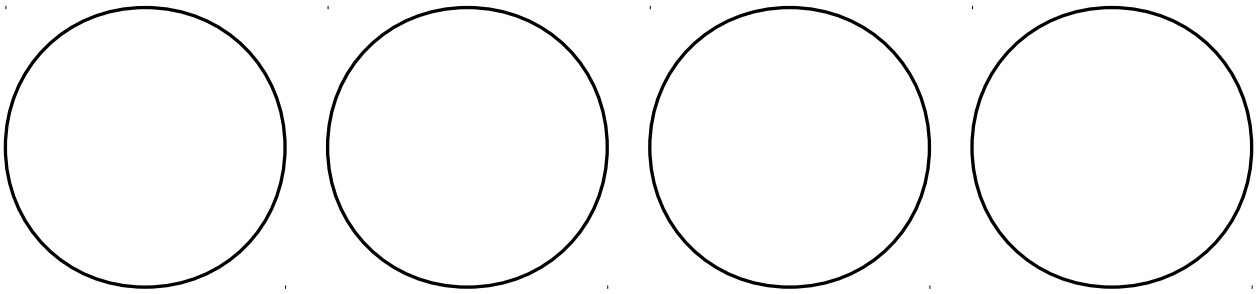
Relative to the Sun, the Moon moves progressively to the(East /West):_____

How do we know where the moon will be during the cycle? The following table covers the main points during the cycle. Turn on the Meridian (View /AltAz /Meridian), set the clock speed to 3000, and for the date of each phase given in the FG for the next cycle, stop the clock just as the moon transits the meridian to the South. (Note: The Dec can change a lot - why?) Enter the transit time to the nearest hour in the table:

Phase	Transit Time
New	
First Quarter	
Full	
Third Quarter	
New	

For intermediate phases, you can estimate the transit time between those in the table, and for rising and setting times of the moon you can add approximately 6 hr.

Based on the table, try the following: For each of the phases and times listed, describe where the moon will be and draw its phase as seen on the sky (that is, assume down on the page is the direction towards the horizon). If necessary, assume we are in New York City.



(a) Full - 6 PM (b) 1st Qtr - 12 M (c) 3rd Qtr - 12 M (d) Waning Crescent - 6 AM

3 The Moon's Orbit

The speed with which the moon changes its position is quite remarkable. To see this set up as follows: Double click Moon in Find to lock it; click off daylight and horizon; click Options /Orientation /Ecliptic and View /Ecliptic Guides /The Ecliptic (to select the ecliptic); also turn on the constellation boundaries and labels, and set the clock rate to 10,000.

You should see the Moon traveling in its orbit against the background stars and changing phase at the same time. It circles the sky in 27.3 days (one sidereal month)

Using single time steps, count how many days on average the moon spends in each constellation:_____

Calculate what the above should be from the sidereal period, assuming each constellation is 30° wide:_____

The Nodes: You will see that the moon does not follow the ecliptic exactly but crosses it at some points; these are the nodes of the orbit which are important for understanding eclipses, which we will discuss later in the semester.

How many nodes are there:_____

In which constellations are the nodes at present:_____

*Phase Cycle:*The phases do not follow the sidereal period exactly, because the Sun is also moving (around the ecliptic); the phase period is 29.5 days (one synodic month). Carefully examine when the full moons occur in the moon's orbital journey, and list the sequence of constellations in which successive full moons occur:

_____

Explain the sequence:_____

4 The Moon Close Up

The moon close up on SN is a bit like the moon as it appears in binoculars. To visit, make sure it is still locked, and set the field of view to 1°. Run the clock until the moon is full, then stop it.

Study the picture. using the map in the back of the Atlas identify the main lunar features: the mares, the biggest craters, and the craters with rays.

Sizes: How big is a mare or crater? The diameter of the moon is 3,480 km (2,160 miles). Measure the angular diameter of the moon to the nearest tenth of an arcminute using the angular measurement cursor, and enter the result in the table below. Now measure the angular diameter of the Mare Crisium (which is easy to identify with the naked eye), and the crater Plato - which is an example of a fairly large crater (you may need to increase the magnification to measure Plato). Use your measurement to calculate the size of Crisium and Plato in km:

Feature	Size in arcminutes	Size in km
Moon		
Mare Crisium		
Plato		

Lunar Day: How long does sunlight fall at a given place on the moon? Choose a crater (Copernicus for example). Single step the clock until the terminator (shadow edge) just touches it as the sun rises at this point. Note the date and time. Run the clock and stop it just as the shadow touches it as the sun sets. Note the date and time again. Give the difference to the nearest half day.

Continuous sunlight on the moon lasts:_____

What fraction of the 29.5 day cycle is this:_____

Orbit Effects: Besides phases, the actual appearance of the moon has some subtleties. To see two of them, click Options /Solar System /Planets-Moons /Surface Grid, which sets up a grid on the moon and shows the poles. Set the clock speed to about 100,000. You will see two effects:

- Libration: The moon appears to roll slightly side ways and up and down. Of course the changing phases make this less obvious, but look at Mare Crisium and you will see the effect. The effect is due mainly to the elliptical shape of the moon's orbit: the moon points toward the center of the ellipse, so we get to see around the edges a little bit, so we see more than 50% of the surface (actually 59 %).
- Size: The second effect is that the moon gest bigger and smaller over time. By using single steps, estimate the time (to within one day) between successive maxima.

Time between maxima:_____

Is this reasonable:_____

5 The Far Side

There is no permanent *dark side* of the moon, but there is a far side that is not visible from the Earth. You can visit it with SN. It takes some space navigation. First set the moon to the new phase (so that the far side will

be illuminated). Then in Find, click Moon, and in the pull down menu next to it click Go There. When there, adjust the field of view, and using the mouse drag round the moon to see the lighted (far) side.

There is one striking difference in appearance between the familiar face and the far side.

What is it:_____