

OUTSIDE LAB 2: Observing the Heavens With a Telescope

OBJECTIVE: *To observe the motion of the Moon in the night sky and to learn how to use a small telescope and to use it to make astronomical observations of prominent celestial objects.*

DISCUSSION:

Galileo's first use of the telescope for serious astronomical observations revolutionized astronomy. He used the telescope to observe the Sun, Moon, planets and stars. In so doing, he made many amazing discoveries including the existence of sunspots and four of the moons which circle Jupiter.

In this laboratory you will use a computer-guided 8-inch Schmidt-Cassegrain telescope to make observations. The optics of this telescope are far superior to the optics of Galileo's telescope. However, do not expect to see images as spectacular as those you see in the pictures in the textbook. Even out of the largest telescope in the world most of these objects would not look as spectacular to your eye as they do in a photograph. The reason is that your eye collects light for about 1/10 of a second before you see an image while a camera connected to a telescope can collect light for hours.

An 8-inch telescope is one for which the diameter of the objective mirror of the telescope is 8 inches (203 mm). The greater the diameter of this mirror, the more light it can capture.

The magnifying power of your telescope is given by the ratio of the focal length of the mirror (f_m) to the focal length of the eyepiece (f_e): $\text{Magnification} = f_m / f_e$. The focal length of your telescope is 2032 mm (6 ft, 8 in). Also, this telescope produces a mirror image of the actual object, with left and right reversed.

You will learn how to set up and align the telescope. Proper alignment allows the telescope's computer to not only find objects in the sky, but also to track them as they move across the sky.

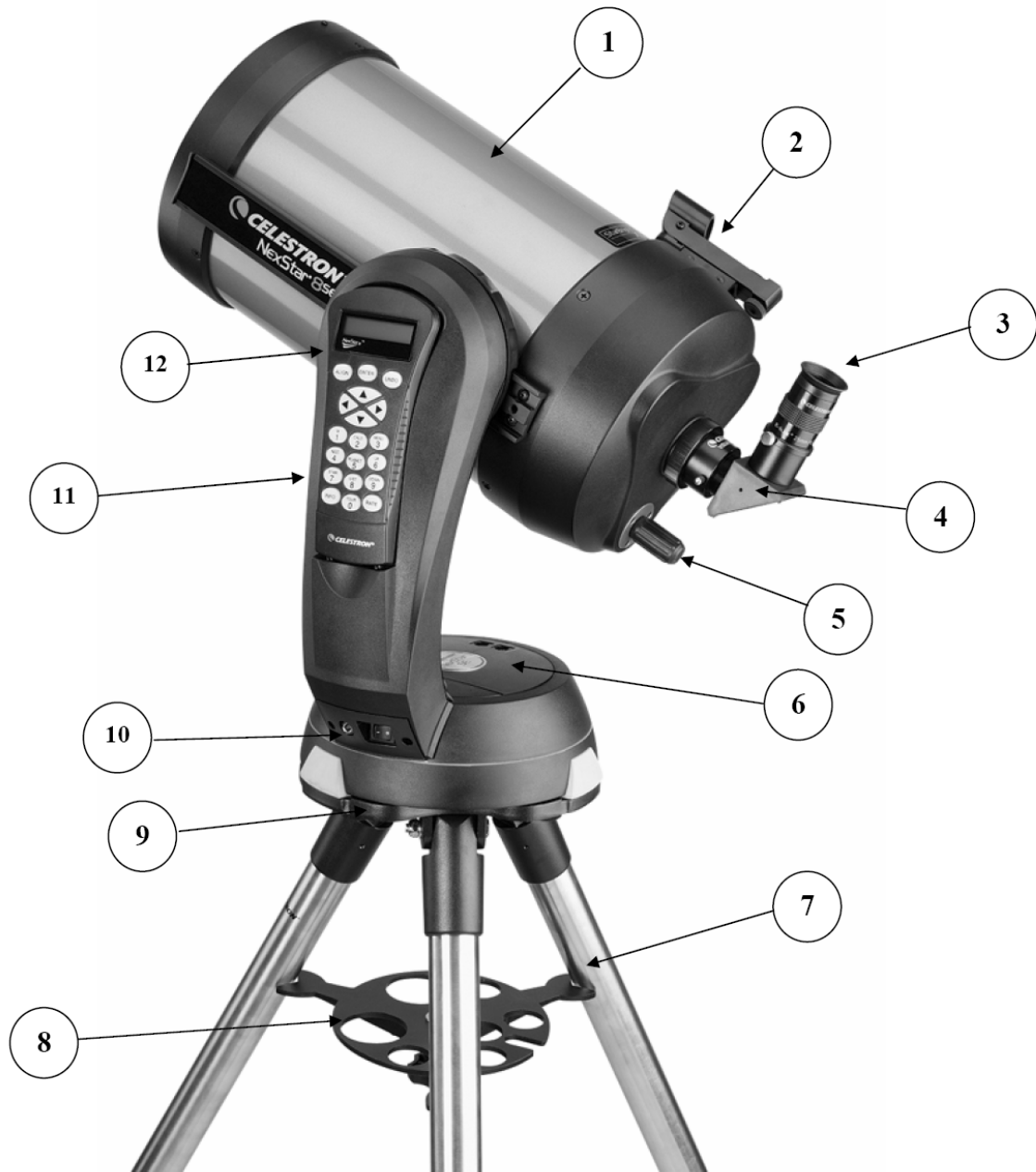
You will also observe some objects that your TA will point out to you. In each case, you will make a detailed sketch of the object, and you will note such properties as color, texture, etc. These notations are important because it is such detailed observations that distinguish scientific inquiry from "tourism." The more detail you can observe in a given object, the better.

as seen with the eye

The logo for Wake Forest University, consisting of the words "WAKE FOREST" in a large, bold, serif font above the word "UNIVERSITY" in a smaller, bold, serif font, all contained within a black rectangular border.

as seen through the telescope

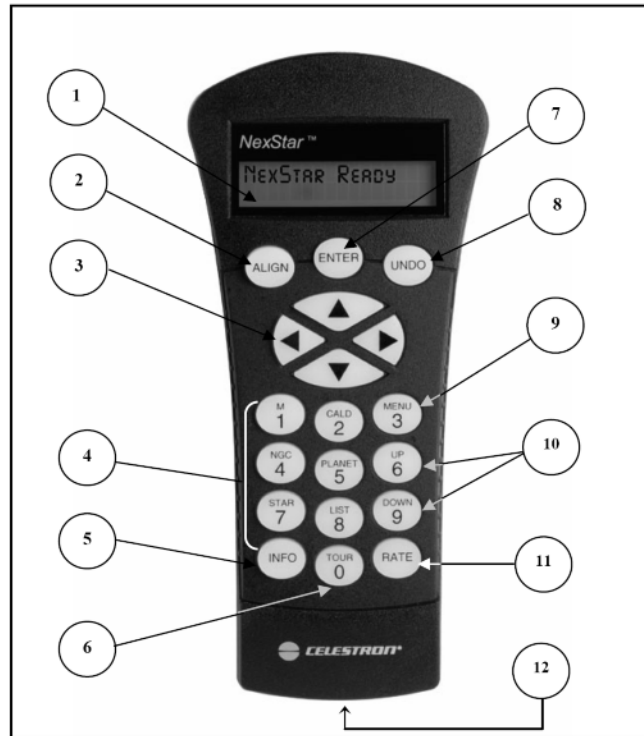
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1	Optical Tube	7	Tripod
2	Star Pointer Finderscope	8	Accessory Tray / Leg Brace
3	Eyepiece	9	Tilt Wedge Plate
4	Star Diagonal	10	ON/OFF Switch
5	Focuser Knob	11	Hand Control
6	Battery Compartment	12	Liquid Crystal Display

1. **Liquid Crystal Display (LCD) Window:** Has a dual-line, 16 character display screen that is backlit for comfortable viewing of telescope information and scrolling text.
2. **Align:** Instructs the NexStar to use a selected star or object as an alignment position.
3. **Direction Keys:** Allows complete control of the NexStar in any direction. Use the direction keys to center objects in the StarPointer finderscope and eyepiece.
4. **Catalog Keys:** The NexStar has a key on the hand control to allow direct access to each of the catalogs in its 40,000 object database. The NexStar contains the following catalogs in its database:

- Messier:** Complete list of all Messier objects.
- NGC:** Select list of all the deep-sky objects in the Revised New General Catalog.
- Caldwell:** A combination of the best NGC and IC objects.
- Planets:** All 8 planets in our Solar System plus the Moon and Sun.
- Stars:** A compiled list of the brightest stars from the SAO catalog.
- List:** For quick access, all of the best and most popular objects in the NexStar database have been broken down into lists based on their type and/or common name:
 - Named Stars:** Common name listing of the brightest stars in the sky.
 - Named Objects:** Alphabetical listing of over 50 of the most popular deep sky objects.
 - Double Stars:** Numeric-alphabetical listing of the most visually stunning double, triple and quadruple stars in the sky.
 - Variable Stars:** Select list of the brightest variable stars with the shortest period of changing magnitude.
 - Asterisms:** A unique list of some of the most recognizable star patterns in the sky.



5. **Info:** Displays coordinates and useful information about objects selected from the NexStar database.
6. **Tour:** Activates the tour mode, which seeks out all the best objects for a given month and automatically slews the NexStar to those objects.
7. **Enter:** Pressing *Enter* allows you to select any of the NexStar functions, accept entered parameters and slew the telescope to displayed objects.
8. **Undo:** *Undo* will take you out of the current menu and display the previous level of the menu path. Press *Undo* repeatedly to get back to a main menu or use it to erase data entered by mistake.
9. **Menu:** Displays the many setup and utilities functions such as tracking rate and user defined objects and many others.
10. **Scroll Keys:** Used to scroll up and down within any of the menu lists. A double arrow symbol on the right side of the LCD indicates that the scroll keys can be used to view additional information.
11. **Rate:** Instantly changes the rate of speed of the motors when the direction buttons are pressed.
12. **RS-232 Jack:** Allows you to interface with a computer and control the NexStar remotely.

Warning: Never touch any optical surface. Never attempt to clean or dry the telescope yourself. If you suspect something is dirty or damp and needs cleaning, please ask your TA for assistance. Cleaning a telescope improperly can permanently ruin it.

SETUP 1: Inventory

Your group will be given an accessory kit. Go through the kit and check that all of the parts listed are present. Shake the LED flashlight a few times and turn it on to make sure it is working properly. If anything is missing, notify your TA. List missing items below.

Accessory Kit # _____ 32 mm Plössl lens and 2 caps 25 mm Plössl lens and 2 caps 12.5 mm Plössl and 2 caps 2X Barlow lens w/ screw and cap Red, Green, Blue, and Gray filters

Missing items:

Now you are ready to start assembling your telescope. Check for all of the equipment listed.

Missing items: _____

Telescope # _____ Star diagonal attached with 2 screws Diagonal plug and 2 screws Main tube cover AC power adapter
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Assemble the telescope as follows:

- a) Remove all of the caps from the telescope and carefully set them aside. Insert the 32 mm Plössl lens into the star diagonal. Tighten the screws.
- b) Turn on the power for the star pointer. Look through the finder scope to make sure you can see a red dot in the direction you are looking. The brightness can be controlled by adjusting the same knob that turns the finder scope on and off.

SETUP 2: Updating time and coordinates

- a) Make sure the AC power adapter is plugged in. Turn on the NexStar system by flicking the switch on the base of the fork. The handheld control should display **NexStar SE Press ENTER to begin alignment.**

Follow the instructions to select the **SkyAlign** method.

- b) The displayed time will be wrong. You must now enter the correct time and coordinates.
 - Press **UNDO**.
 - Verify that the correct Longitude, **80°16'45" West**, is entered. Confirm or edit if necessary.
 - Verify that the correct Latitude, **36°07'55" North**, is entered. Confirm or edit if necessary.

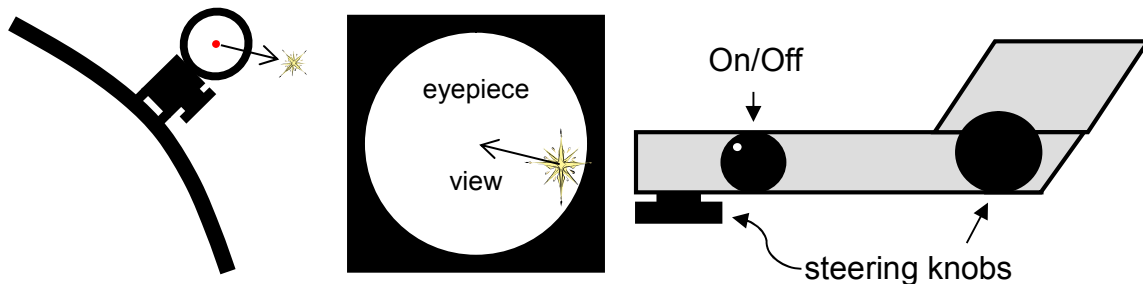
- Enter the current military time to within 15 seconds. Then press **ENTER**.
- Update the remaining information as prompted.

SETUP 3: Aligning the telescope

This involves successively pointing the telescope at three bright objects using the arrow keys on the control pad. *Do not move the telescope by hand!* Any bright star or planet will do, but select three objects that are far apart in the sky. Do not use the Moon.

a) The screen should say **Center Object 1**.

- Using the control pad, align the red dot of the star pointer with your first object. Press **ENTER**.
- The object should now be visible in the eyepiece. If you do not see the object in the eyepiece, slowly pan the sky with the control pad until it is visible. Use the control pad to center the object in the eyepiece.
- *If the object is centered in the eyepiece but not centered in the star pointer*, use the steering knobs on the star pointer until it too is aligned.
- Press **ALIGN**.



b) The screen should say **Center Object 2**. Select a second object and repeat the above procedure.

c) The screen should say **Center Object 3**. Select a third object and repeat the above procedure.

d) After a few seconds, the screen should say **Match Confirmed**. If so, press **ENTER** and proceed with your observations. If the screen says **Align Failed**, follow the on-screen instructions to repeat the process.

OBSERVATIONS:

This exercise is concerned with observing celestial objects. Your TA will provide you with a list of objects that you are to observe.

- a) When you have found each object in the telescope, call your TA over and have him or her initial that you have found the object.

Each person in a lab group must find at least 1 of these objects.

Object	TA's Initials	
_____	_____	
_____	_____	
_____	_____	Telescope Proficiency Test
_____	_____	_____
_____	_____	
_____	_____	

- b) For each observation, make a sketch along with comments about what you see regarding color, details that come into and out of focus, etc.
- c) Specific instructions for certain objects that may or may not be visible:
 - i. The Moon: Instructions for observing the Moon are given in the appendix.
 - ii. Venus and Mercury: Determine the phase that the planet is in.
 - iii. Mars: Note the size of the disk under high and low power. Note the color and any details.
 - iv. Jupiter: Sketch not only Jupiter but also the moons that are visible, taking care to orient them accurately. Identify the moons in your sketch using the program Starry Night. Are any of the moons casting a shadow on Jupiter?
 - v. Saturn: Note both the disk and the rings. What are their relative proportions? Can you see any details of the disk or of the rings? Can you tell which way the rings are tilted? Can you see the shadow of the rings on Saturn? Plot any visible moons and identify them using Starry Night.
 - vi. Open clusters: How many stars are in the cluster? Note the distribution of the stars and any variations in color or brightness.
 - vii. Globular clusters: Note the shape of the cluster. Can you see individual stars in the cluster?

Wrap up:

When you are done with your observations,

- a) Turn off the telescope and the finder scope
- b) Remove the lens, and put the lens caps back on it
- c) Replace the cover on the telescope, and replace the cap on the star diagonal.
- d) Check that all parts are present in the accessory kit. List any missing parts below.

Missing items: _____

Sketches and Comments:

Sketches and Comments:

Sketches and Comments:

OBSERVING THE MOON

The Moon can be extremely bright when viewed through an 8" telescope. To reduce the brightness to a comfortable level, screw the gray filter onto the bottom of your eyepiece.

You should first look at the Moon under low power. On the next three pages you will find several large circles drawn. Fill in one of these circles with a detailed sketch of the moon. Using the map provided, label those features that you recognize. Also, label the compass points (N, E, S, W) of the Moon and record the moon's phase and the date of observation. Then, using the high-power eyepiece, make detailed sketches of several parts of the moon's surface.

"What do I look for?"

First, find the *terminator*, that is the line between the day and night sides of the Moon. Sketch this line carefully to give yourself a good reference for the rest of your picture. It will be slightly rugged due to the mountains. Notice how it stretches from pole to pole.

Second, look for a few other distinct objects (large craters, mountain ridges, etc.) to use as other reference points and carefully position and sketch them.

Next, find the *maria*: the large, flat, dark areas. These are areas where lava has overrun and smoothed over part of the older, rougher areas on the moon. Sketch their borders as best you can; some borders will be very sharp, others more vague.

Look for any prominent *craters*. You will most likely find these close to the terminator, where shadows cast the surface into sharp relief. Take a close look at their interiors: some craters have a distinct mountain peak in the middle, where the surface rebounded after a meteor impact. Others now consist only of a ring of mountains rising from a small *mare*; the lava that formed the *mare* has obliterated the interior.

During the gibbous and full phases of the moon, bright *rays* stretching from several of the younger craters become evident. These consist of soil blasted from the crater by the meteorite impact.

Try to locate and name a few of the sharpest *mountain ridges* bordering the maria. The ones near the terminator should be easily seen.

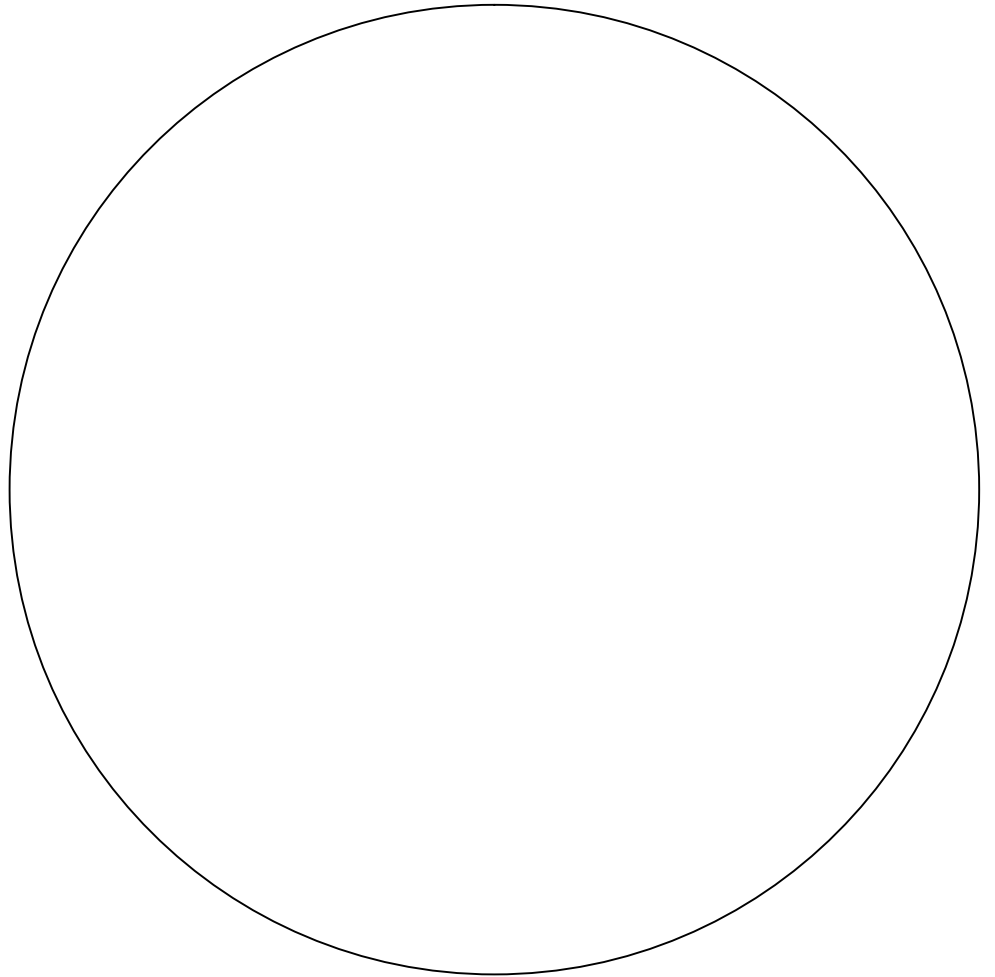
If the phase is just right, you may be able to see some of the larger *rilles* on the Moon. These are river-like channels on the surface.

Finally, a note on orientation. The Sun rises in the east and sets in the west on the Moon just as on Earth (though a bit more slowly). Therefore, during the waxing phases the eastern side of the Moon is illuminated, and during the waning phases the western side is illuminated.

**Moon Circle
- Low Power View -**

Date: _____

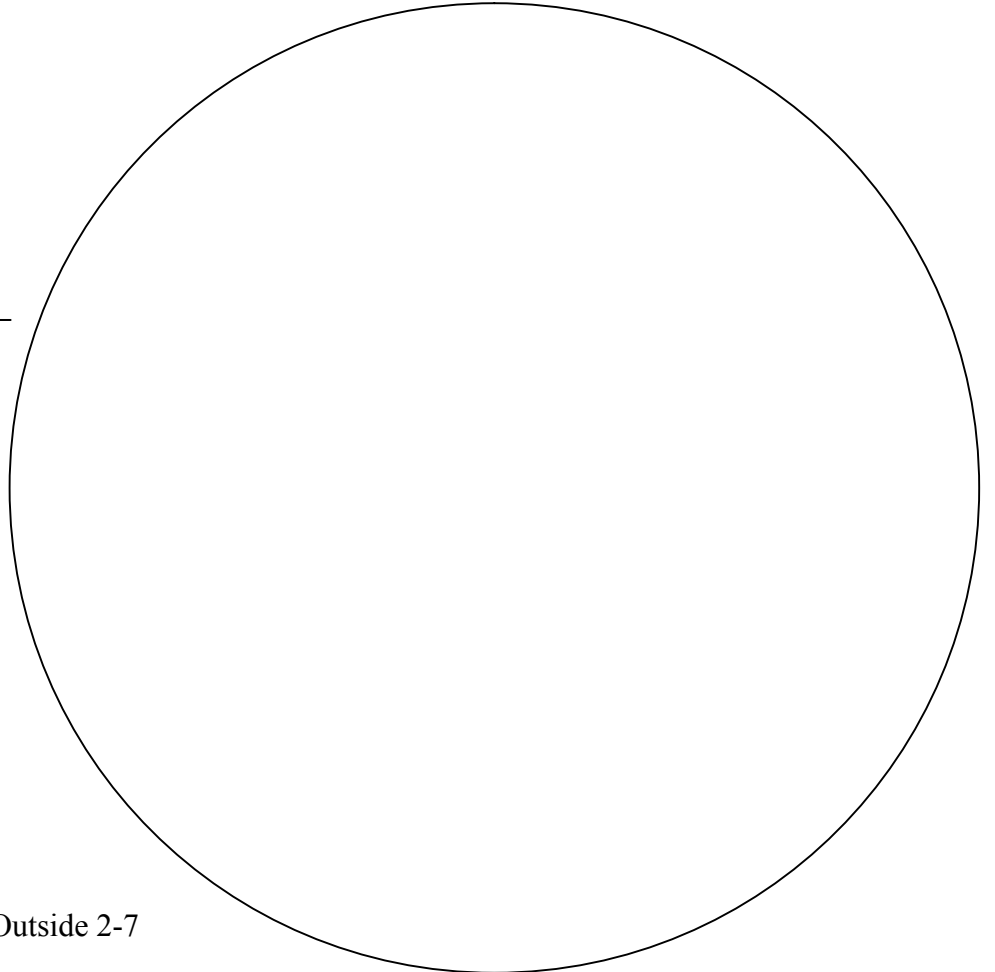
Phase: _____



**Moon Circle
- High Power View 1 -**

Date: _____

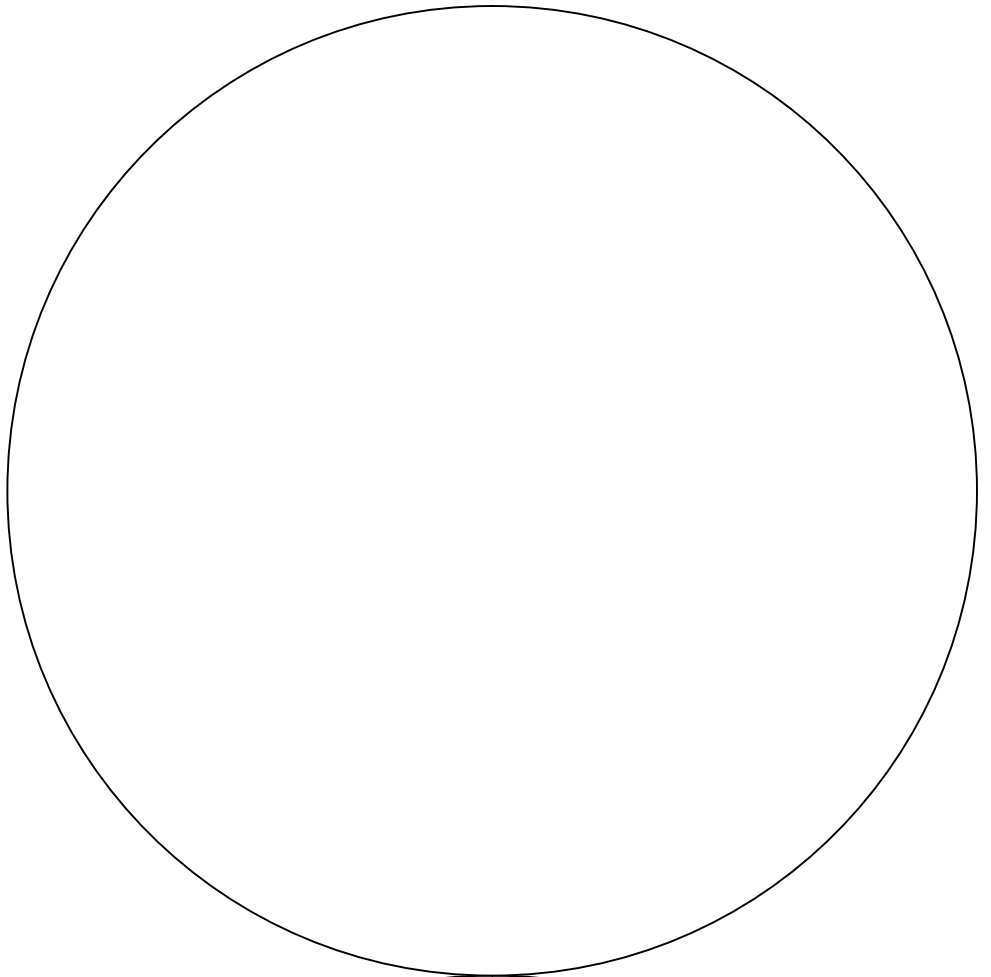
Phase: _____



**Moon Circle
- High Power View 2 -**

Date: _____

Phase: _____



**Moon Circle
- High Power View 3 -**

Date: _____

Phase: _____

