AST101IN Spring, 2012 Follette Name_____

Introduction to Astronomical Observations Lab

This lab is designed to familiarize you with the basics of finding and tracking celestial objects and using basic astronomical tools. It will also start you thinking about celestial motions and the rotation, revolution and tilt of the earth's axis. You will sometimes be asked what you think the cause of something you discover is. It is not important that you get these answers completely correct. In fact, a great many people hold incorrect beliefs about them (even Harvard professors as we will learn later!), so simply give me your first intuitive response after you have thought for a minute about what the planisphere or celestial sphere is showing you.

Lab Objectives

1. Learn to use basic astronomical tools such as a planisphere, astrolabe and monthly sky chart.
2. Recognize the particular strengths and weaknesses of a planisphere vs. a monthly sky chart and when to use each.
3. Begin to consider the reason behind distortions, celestial motions and how your view of the sky will differ with time and location.

Lab Materials

Planisphere – constructed in class
Drinking straw, cardboard, string and washer
Celestial sphere

Part 1: Using a Planisphere

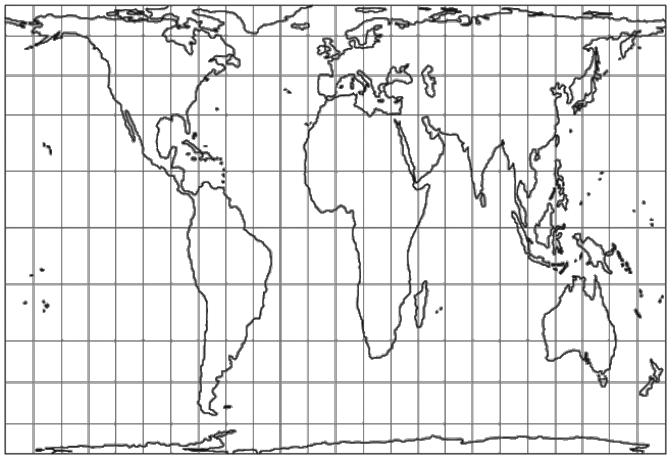
The planisphere is your most basic and reliable tool for finding objects in the night sky. Start by studying the outer and inner dials along the edge of the planisphere. One dial will show a calendar in months and days and the other will show the time in hours. Rotating the inner dial to match up a time of the day with a day of the year shows you what you would see if you went outside at that time on that day and looked up. Along the inside of the planisphere you'll see the directions north, south, east and west. Note that if you orient your planisphere so that each word is rightside up you are seeing the sky as it would appear if you were outside and facing that direction.

1. Set your planisphere to 9pm tonight and hold it so that the word "South" is rightside up. Draw four of the constellations closest to the horizon in the southern sky. Draw and label an arrow pointing towards east and one towards west.

2. Do the same with one of the more sophisticated planispheres located at the front of the classroom, only this time once you've aligned the wheel of the planisphere, flip it over to its backside and again draw what you would see along the southern horizon.

3. In principle, these two drawings represent the exact same thing (the southern horizon as it will appear tonight at 9pm), but they will certainly appear different. **How are your two drawings different and why might this be** (hint: what is the true 3-D shape being represented on your 2-D planisphere?)?

You have just discovered a classic mapping problem! Consider the two maps of the Earth shown below. The Earth, like the Celestial Sphere, is a globe, so when trying to represent its three-dimensional shape on a two-dimensional piece of paper (i.e. a map), distortions are inevitable. One of the maps shows the classic Mercator projection of the globe (probably the type of map you are most used to seeing), which preserves the shape of each continent, but distorts their relative sizes . The other map is an "equal area" projection, which accurately represents the area of each continent, but distorts its shape. ***The important point here is that you cannot represent both simultaneously when you are representing a 3-D sphere on a 2-D sheet of paper.***



Many planispheres solve this mapping problem by minimizing the distortions near the north pole on one side and near the south pole on the other. When you are looking for constellations and other objects near your southern horizon keep in mind that constellations near the horizon are often distorted in shape on your planisphere relative to how they will actually appear in the sky. Generally speaking, the most difficult part of using a planisphere is getting used to the fact that you are looking up at the dome of the sky, which means that you have to imagine bending your planisphere into an arc over your head!

4. 9pm is approximately three hours after sunset. Turn the dial back to 6pm. How much did the stars move? Estimate what fraction of a full rotation has been made by the wheel of your planisphere (hint: what fraction of one 24hour day has passed by?).

5. The rivet in the planisphere represents the north star. In rotating the planisphere from 6pm to 9pm (moving time *forward*), do the stars move clockwise or counterclockwise around this point?

6. Why do you think that the north star can serve as a fixed point on your planisphere (that is, why doesn't it move?)? Draw a picture to support your answer.

7. Perhaps you have noticed that some of the objects you would expect to see in the night sky are missing. Comets, asteroids, planets and the moon all move over the course of months and years relative to background stars so you will not find them on your planisphere! Look at the attached printout of the January 2012 sky calendar from www.skymaps.com. This is essentially an estimate of what you would see if you were to go outside any *evening* in the month of *January, 2012* and look up. It should approximately line up with what you see on your planisphere if you set it for 9pm on January 15th. Manipulate your planisphere to verify that it is not necessarily the same as what you would see on January 1st or 31st at 9pm , nor is it the same as what you would see on January 15th at 3am. **Describe how those views differ from that shown on the sky map. Does the sky map truly represent the night sky as it would appear at any time in January? What are it's limitations?**

This monthly sky map is a useful tool and a good companion to your planisphere because it shows you the approximate location of planets, comets and other moving objects in the night sky (except for the moon, which moves too quickly through the sky even over the course of one month)

8. Which planets are visible on the January map? **List each visible planet, the constellation that it is in, and the approximate time of day that it will rise and set** (hint: once you've found the constellations that it is in, turn the dial on your planisphere so that it is rising (make sure its on the right horizon!) and the same for setting and read off the time that it will be in that position on January 15th).

Planet	Constellation	Rise Time	Set Time

9. Now, examine the sky calendar along the lefthand side of the front page. It lists several other visible planets during the month of January. Which planets are they and why aren't they visible on the map on the righthand side? (hint: consider your answer to question 7).

10. Return to your planisphere and note the dashed line running through it labeled "the ecliptic". *The ecliptic is the plane of our solar system, or the path that the sun and planets take across the sky as seen from Earth*. Which constellations does this line pass through? List them below. (hint: there should be 13!)

11. By what name are these constellations known in popular culture?

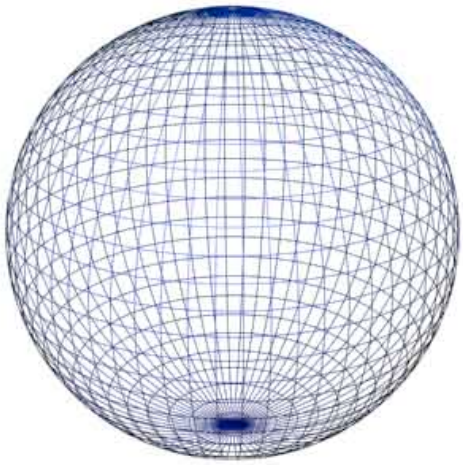
12. Set the date and time on your planisphere to noon on your birthday. Line up a ruler connecting the labels "North" and "South" (this line is called the meridian, and it marks halfway between east and west, which is approximately where the sun should be at noon every day) and find where the ruler intersects the ecliptic. Which constellation is this point closest to? Does it match your zodiac sign (hint: probably not!)?

Group Member	Zodiac Sign	Constellation Sun in on Your B-day

13. According to what you learned in lab #1, why isn't the sun in your zodiac sign on your birthday?

14. Make a list of all of the constellations that can be found at the southernmost point on the horizon over the course of the year.

15. Now, together with your lab partner, locate these constellations on one of the "Celestial Spheres" located in the front of the classroom. What shape do they make on the Celestial Sphere and where is that shape located? Sketch it on the sphere below.

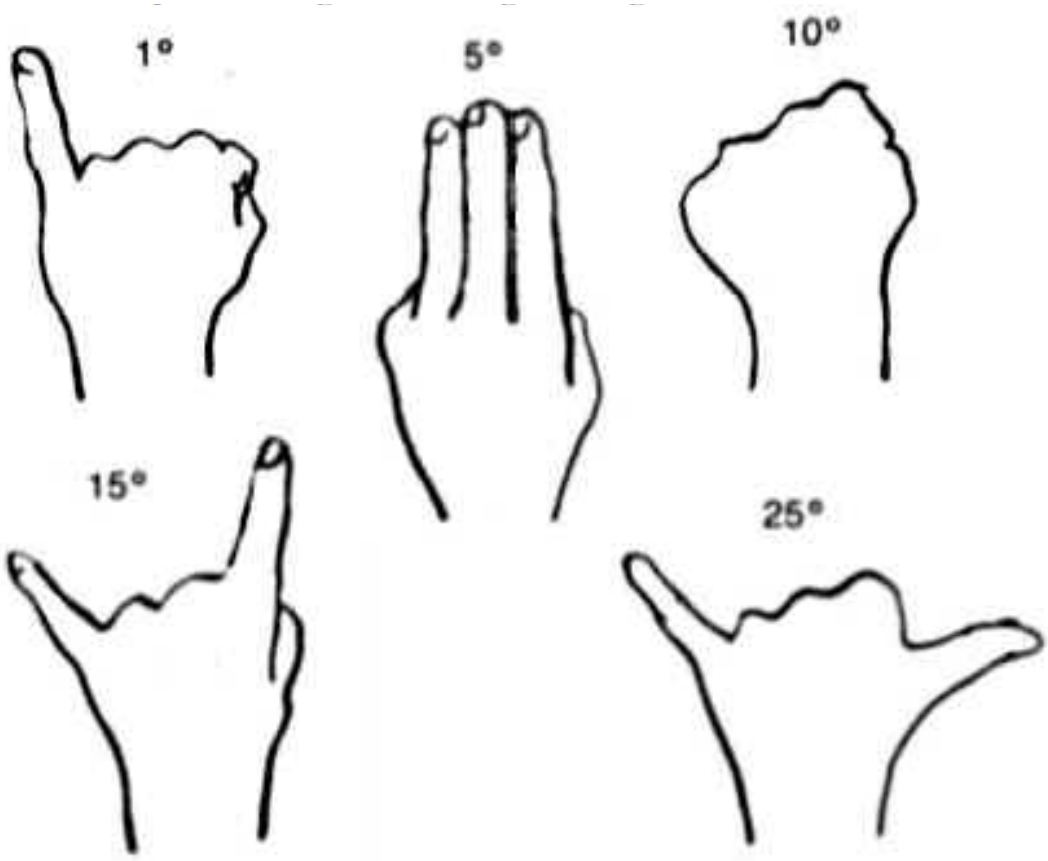


16. Are there constellations on the celestial sphere that do not appear anywhere on your planisphere? If so, where are they located relative to the shape you drew in question 17 and what do you think the physical reason is behind this (what blocks your view of these constellations?)?

Part 3: Astrolabe

"Distances" between objects in the night sky are generally measured in degrees rather than in units of length. This is an unambiguous way of specifying their positions relative to each other. Imagine, for example, that you told me that two stars are one inch apart. What does that mean exactly? Did you hold a ruler out at arm's length to measure it or did you hold it right up to your eye? What if my arms are longer than yours or I place my ruler at a different location? I'll measure a different distance between those stars in inches than you did! Angles, on the other hand, are repeatable no matter who is doing the observation. For example, if you stand outside and point one arm straight at your horizon and one arm straight overhead, the angle between your two arms will always be ninety degrees no matter how tall you are or how long your arms are.

There are two simple ways to measure angles between objects in the night sky. The first rough (though surprisingly accurate) way is to use the most basic human tool – your hand! The pictures below tell you roughly how big an angle is covered (or "subtended") by your hand in each position. Note that for all of these your hand ***should be held at arms length away from you****.*



Of course, measurements like those above are not 100% accurate; in fact, NO scientific measurement is ever 100% accurate! They vary from person to person with the size of hands and fingers and the length of arms (not by much though).

You can also measure angles with a simple astronomical tool called an Astrolabe. Instructions will be provided here to construct an Astrolabe, which you will use to complete your first homework (make sure you're confident about how to use it before you leave the classroom tonight!)

Step 1: Obtain a piece of cardboard, a straw, some string and a washer from your instructor.

Step 2: Tear off the very last sheet of this lab (labeled "Quadrant Template"), and cut out the shape you find there.

Step 3: Paste this to your piece of cardboard and cut that to match. Cut the grey slits per the instructions.

Step 4: Insert the straw through the grey slits.

Step 5: With a pen or scissors, carefully punch a hole in the paper and cardboard at the location Labeled "Point A". Thread your string through this hole and tie it.

Step 6: Let the string dangle to a couple of inches below the bottom of your astrolabe. Attach the washer there and trim the string.

Using the Astrolabe

1. Together with your partner, stand with your backs against the back wall of the classroom facing the white board. Sight the top of the white board through the straw. The washer on your astrolabe should be hanging towards the floor. With the top of the whiteboard kept in your view through the straw, pinch the string where it is hanging against the cardboard of the astrolabe and hold it. Look now at your astrolabe. You should be able to read a number of degrees off of the dial along its edge. Note that there are two sets of numbers along this edge. **Record your measurement relative to each set of numbers** (estimate to the nearest degree) **in the table below and then record your partner's measurement as well.** They should be very similar if you are both using your astrolabes properly! Next, choose two other objects in the room or the hallway and do the same with them, recording what you find in the table on the next page.

	Your Measurements	**Your Lab Partner's Measurements**
Example	Astrolabe: 24 degrees Fist and Finger: two fists + 1 finger = 21 degrees	
White Board		

Prepare to Observe!

Before you leave tonight, you need to do two more things. First, be sure to take a piece of red cellophane, which you will use to cover your flashlight when you do observations at home. Second, check out with your instructor, who will ask you two questions about using your planisphere and astrolabe and will sign out a planisphere to you. If you answer both questions correctly, demonstrating that you are now a fully competent astronomical observer, you may leave.

Quadrant Template