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
Astrolabe – constructed in class (drinking straw, cardboard, string and washer)
Celestial sphere

Exercise 1: Limitations of Planispheres

Before beginning this lab, your instructor will lead you in constructing your own planisphere. This planisphere will be very important not just for completing this lab, but also for doing observations at home over the course of the semester.

1. Set your planisphere to 9pm on today's date and hold it so that the words "facing South" are rightside up. Draw the 2-3 constellations that appear closest to the horizon (near the border of the planisphere).

2. Do the same with one of the more sophisticated planispheres located at the front of the classroom, only don't make a drawing yet. This time, once you've aligned the wheel of the planisphere, simply verify that the constellations along the southern horizon are the same as those you drew in 1. Rather than drawing them as they appear on the front side (where they should look more or less the same), flip the whole thing over to its backside and draw the same 2-3 constellations as they appear here.

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. What about the constellations is different between the two drawings? Size? Shape? Orientation relative to the horizon? Describe the difference(s).

4. Find these same constellations on the "celestial sphere" at the front of the classroom. Which of the two planispheres (the one you made or the two-sided one) shows a shape closest to that pictured on the celestial sphere?

5. The celestial sphere is the most accurate representation of the sizes, shapes and relative orientations of the constellations. What about it makes it superior to either planisphere and more like the real sky?

6. Repeat this process of comparing your planisphere, the two-sided planisphere and the celestial sphere for a constellation on the northern horizon and for one near the middle of the planisphere. At which location – northern horizon, southern horizon or middle - are the distortions on the planispheres the greatest? Where are they the smallest?

7. How is the "two-sided" planisphere more accurate than the one you made? Is it more accurate for all three locations (north, south and middle)?

8. What are the implications of what you've discovered here for when you use your planisphere to find things in the night sky? What will you have to watch out for?

Exercise 2 – Rising and Setting

1. 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?

2. Keeping time moving forward, rotate your planisphere until the following constellations appear above the horizon and record the time that this happens for today's date by reading if off on your planisphere: Saggitarius, Ursa Major, Pegasus, and Orion. Record the time that these constellations disappear below the horizon in the same table.

   Note that what you are doing here is mimicking the rising and setting of the constellations. If you keep time moving forward, things will be rising (coming into view on your planisphere) in the East and setting (falling out of view on your planisphere) in the West.

3. Were you unable to complete the table for any of the four constellations? Which one(s) and why?

4. For all constellations that did rise and set, was the amount of time between rising and setting roughly the same for all of them? Why or why not?

5. How are the paths that each of the four constellations take across the sky between rising and setting different (Hint: a rough sketch of the four paths may help here)? Why do you think this is?

Exercise 3: Limitations of the Night Sky Map

1. Manipulate your planisphere to show the sky on January 1st, 15th and 31st at a specific time (any time will do, but it should be the same time for all three). Describe how these views differ. For example, you might describe certain stars or constellations that are or are not visible in one case versus another.

2. Choose a single day in January (any day will do) and do the same for three different **times** – 9pm, 12am and 3am. Describe how these views differ. Is the difference bigger or smaller than for the last question and by how much (this is a good place to employ a fraction… see your instructor if you're not sure how).

3. Rotate your planisphere until the view shown matches the January 2014 sky map as closely as possible. Read off the times that the sky is in this position for January 1st, 15th and 31st and list them.

4. As questions 1-2 revealed, the night sky in January can vary significantly depending on the date and time you are viewing it. In making a map that will work for the **whole month**, the makers of the night sky map have made (a) an assumption about when users will be doing their sky viewing and (b) a compromise in order to make the map valid for the whole month. As best you can tell based on your answers to 1-2, what is the assumption and what is the compromise? Hint: it may help to think first about what dates and times in January the night sky map is NOT valid. You may also find some hints in the text written on the map itself.

5. There is one object marked with a star on the sky map that does not appear on your planisphere. What is it and why isn't it pictured on your planisphere?

6. Are there any similar objects listed on the "sky calendar" along the lefthand side of the sky map? Do these appear on the sky map? Why or why not?

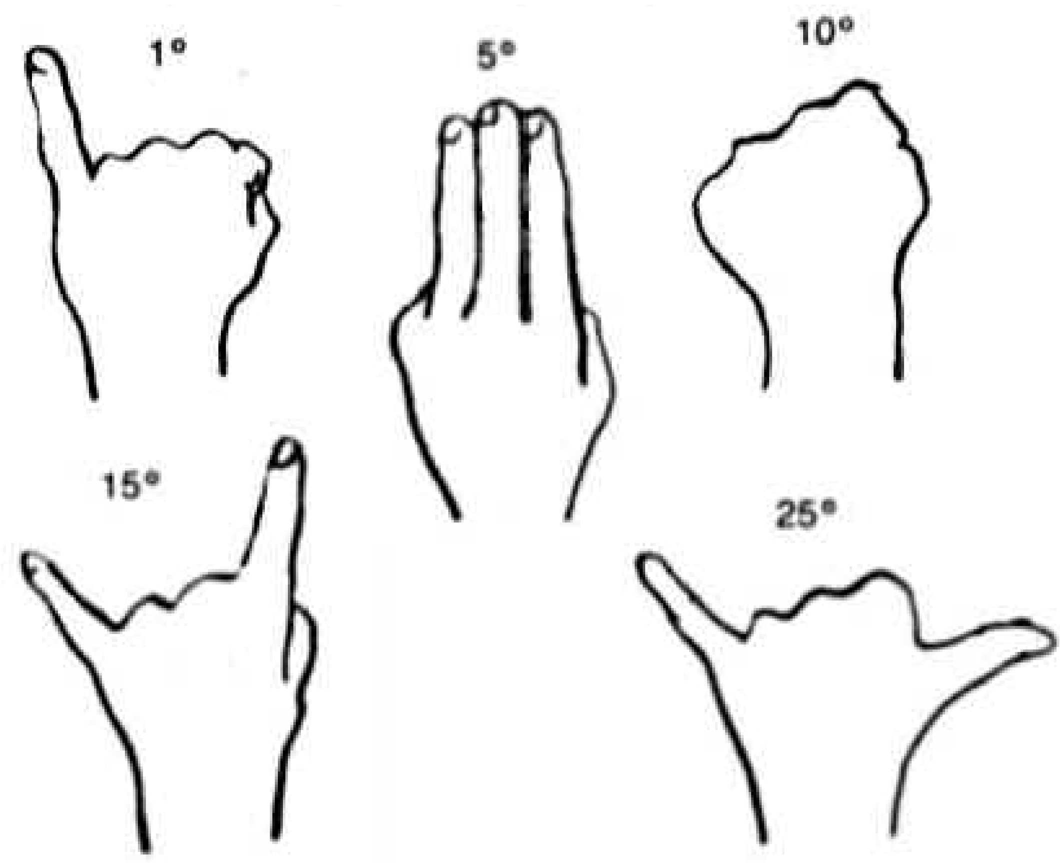
Exercise 4 – Zodiac Sign

1. For each group member, set the date and time on your planisphere to noon on that person's 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 where the sun should be at noon). Find where the ruler intersects the line labeled "ecliptic". Which constellation is this point closest to? Does it match what you believe to be your zodiac sign? In principle it should, as this is the location that the sun is in at noon on your birthday, which is the definition of zodiac sign.
2. Are you surprised by this? Does it agree with or contradict what you learned in the last lab?

Exercise 5 – Measuring Angles

"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****.*



You can also measure angles with a simple astronomical tool called an Astrolabe, which you will construct together with your instructor.

1. Together with your lab partner, stand with your backs against the front wall of the classroom. Make a fist and finger measurement of the height of the rear wall of the classroom and record it in a table like the one below. Then, make the same measurement using your astrolabes and record it as well.
2. Step outside and do the same (each lab partner makes both fist and finger + astrolabe measurements) for two more objects (lamppost, star, etc.) and record these as well.
3. Once you have completed all of the measurements, compare them. How similar were your measurements to your partner's? How similar were your fist and finger measurements to your astrolabe measurements?

	Lab Partner 1	**Lab Partner 2**
Example	Astrolabe: 24 degrees Fist and Finger: two fists + 1 finger = 21 degrees	
Rear Wall		

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. If you answer both questions correctly, demonstrating that you are now a fully competent astronomical observer, you may leave.

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