Name: ______________________________

Astro 101 – Lab #3

Lab objectives

1) Learn about telescope magnifications, focal lengths and eyepieces
2) Learn about the light gathering power of the human eye verses different telescopes
3) Learn about Galileo's discovery of the moons of Jupiter

Setup

This lab will be performed in the Stellarium (version 0.16.1 or newer) planetarium program. You can access the Stellarium Planetarium program on specific computers at the following computer labs

- OC Bremerton: ST 122 Computers: 1-4 and 41-50
- OC Poulsbo: OCP 106 Computers: 11-13
- OC Shelton: OCS PA2 Computers: 1-2

or you can download a free copy at http://www.stellarium.org/ . Instructions for installing the program and system requirements can be found in the user's guide.

1) Telescope Magnification

1a) Determine the magnifications of two telescopes with a combination of four different eyepieces. Fill out the table by calculating the magnifications with the equation given in class.

Eyepiece Focal length (mm)	Telescope-1000 Focal length 1000mm	Telescope-2000 Focal length 2000mm
40		
20		
10		
4		

Start up Stellarium, set the location to **Seattle**, and set the date & time to **2017–04–12 00:00:00**. Find Jupiter and zoom *in* until you can clearly see the 4 Galilean Moons: Io, Europa, Ganymede & Callisto. Slowly zoom *out* until one of the moon disappears. Then slowly zoom *in* until it reappears.

1b) The largest field of view (FOV) where all 4 Galilean moons can be easily distinguished is: ___________

1c) Approximate the magnification needed to see the 4 Galilean Moons, by using the equation: $\frac{30°}{\mathrm{FOV}}$

Calculate the approximate magnification: ________________

Continue zooming in on Jupiter until you can clearly see the Great Red Spot. Slowly zoom out until you can no longer distinguish it, without difficulty. Then slowly zoom *in* until it reappears.

1d) The largest field of view (FOV) where the Great Red Spot can be easily distinguished is: ____________

1e) Calculate the approximate magnification: ________________

1f) For Telescope-1000, the Galilean Moons can be seen with which of the following eyepieces?

40mm	20mm	10mm	4mm	Circle ***all*** the eyepieces that yield the necessary magnification

1g) For Telescope-2000, the Great Red Spot can be seen with which of the following eyepieces?

40mm	20mm	10mm	4mm	Circle ***all*** the eyepieces that yield the necessary magnification

1h) Explain the advantages & disadvantages of Telescope-1000 over Telescope-2000.
(Hint: the telescope focal lengths of 1000mm & 2000mm are ***not*** the sizes of the mirror/lens.
The telescope light gathering power and resolution depend on the size of the mirror/lens.)

Telescope-1000 Advantages: ____

____

Telescope-1000 Disadvantages: ____

____

2) Telescope Light Gathering Power

2a) Compare the light gathering power of various telescopes, with the human eye. Fill out the table below by calculating how many times more light, a telescope can gather, than the human eye by using the equation given in class.

Table 2a	**Mirror or lens diameter (inches)**	**Light gathering power compared to human eye**	**Limiting magnitude**
Human Eye	0.25	----------	6
Galileo Telescope	1		9.7
Refracting Telescope	3		12.1
Cassegrain Telescope	10		14.7
Newtonian Telescope	20		16.2
Keck Telescope	400		30

The limiting magnitude, listed in column 4, is the faintest brightness detectable with an instrument or the eye. The (apparent) magnitude is a measure of the brightness of an object when viewed from the Earth. The larger the magnitude value, the dimmer the object. For example: a magnitude 2.5 star, like Polaris, is dimmer than a magnitude 0.0 star, like Alpha Centauri (see the Magnitude scale in chapter 17.2 for more information). The human eye can see objects that are brighter than magnitude 6, like Polaris and Alpha Centauri. A telescope can gather a lot more light than the human eye, so you can see much fainter objects with larger magnitudes, like Neptune with a magnitude of 8.

2b) Using Stellarium, find the Great Nebula in Orion. Click on the *Constellations* Icon, the *Constellation Names* Icon, and the *Deep-sky objects* Icon on the *Main-Toolbar* to see the constellations and to label the locations of nebulas and galaxies. Point the cursor over the Great Nebula in Orion and left-click to bring up the *Magnitude* information (Hint: you may need to zoom *in* or zoom *out* on the Great Nebula before left-clicking). Is the Great Nebula in Orion bright enough to be seen with the unaided human eye? If not, then what is the smallest diameter telescope, from Table 2a, that will make it visible? Fill out the answers in the table for the Great Nebula in Orion and for the rest of the objects.

<table>
<tr><th>Object</th><th>Location Information</th><th>Magnitude</th><th>Visible to Eye (Yes/No)</th><th>Smallest diameter Telescope needed to be visible</th></tr>
<tr><td>Great Nebula</td><td>Orion</td><td></td><td></td><td></td></tr>
<tr><td>Crab Nebula</td><td>Taurus</td><td></td><td></td><td></td></tr>
<tr><td>Whirlpool Galaxy</td><td>Ursa Major</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">For the Solar System objects below, set the date to 2017–5–5</td></tr>
<tr><td>Io</td><td rowspan="4">Galilean Moons of Jupiter</td><td></td><td></td><td></td></tr>
<tr><td>Europa</td><td></td><td></td><td></td></tr>
<tr><td>Ganymede</td><td></td><td></td><td></td></tr>
<tr><td>Callisto</td><td></td><td></td><td></td></tr>
<tr><td>Pluto</td><td>Sagittarius</td><td></td><td></td><td></td></tr>
</table>

3) Galileo's discovery of the moons of Jupiter

Galileo's telescope had an effective (or usable) lens size of 1inch and a magnification of 20×.

3a) Objects viewed through Galileo's telescope appear ________ larger than seen with the human eye.

Galileo's telescope had a resolution (resolving power) that is ________ better than the human eye. (Hint: use the equation given in class)

3b) Explain why the Moons of Jupiter were not discovered until the invention of Galileo's telescope, even though several moons are bright enough to be visible to the unaided human eye (Table 2b).

____

____

____

____

____

(Hint: Locate Jupiter and zoom in to a 1.5^{o} FOV, which approximates Galileo's telescope. Then slowly zoom out until you reach a 30^{o} FOV, which approximates the human eye. What do you notice about the 4 Galilean Moons as you are zooming out? Explain why the moons are visible at a 1.5^{o} FOV, and no longer visible at a 30^{o} FOV. The answer is not the brightness of Jupiter compared with its moons.)