Name		
Partner(s)		
Date		
Grade		
Category	**Max Points**	**Points Received**
On Time	5	
Printed Copy	5	
Lab Work	90	
Total	100	

Telescopes

1. Introduction

The most basic astronomical instrument is the **TELESCOPE**. A telescope collects light from and magnifies an astronomical object. Until the end of the 19th century, all observational work in astronomy was based on observations made at the eyepiece of a telescope. Nowadays, even though astronomical research relies on much more sophisticated types of measurements, an introductory course in astronomy should develop familiarity with small telescopes and their use in observing the objects discussed in lecture.

The main point of this lab will be to familiarize students with setting up and using a small telescope. A total of 6 telescopes will be made available. Four of the telescopes are **REFRACTORS**, which use lenses to collect light and form an image. Two of the telescopes are examples of the other major class of telescope, the **REFLECTOR**, which uses a mirror. Two of the refractors to be used have lenses with diameters of 100 and 120 mm, respectively. The other two refractors are Rich Field Telescopes with lenses 80mm in diameter and a short **FOCAL LENGTH**. More details are given in Table 1 found on the next page. Each pair of students will be assigned to one type of telescope. After this exercise, students should be able to set up these telescopes during field trips and make observations of objects discussed in class.

The activities to be carried out in this project consist of the following. Students will set up a telescope on the roof of Van Allen Hall and prepare it for observation.

Eyepieces of different focal length will be used as the telescopes observe distant objects in Iowa City and its surroundings, noting the different MAGNIFICATION (see further discussion of magnification below). The SETTING CIRCLES of the telescope will be adjusted, and used to point the telescope towards the Moon or the planet Venus, which may be visible during the lab period.

The last part of the exercise will be to return to the roof at night (during Clear Sky Patrol) during a 3 week period. You will be expected to properly adjust the setting circles and find an astronomical object for which the telescope is well suited, such a star cluster or double star.

2. Telescope Magnification and Properties

An important concept in this project is that of the magnification of a telescope. It is expressed as a number greater than one, and indicates how much a bigger an astronomical object looks through the telescope than it would if viewed with the naked eye alone. Alternatively, the object looks like you are closer to it by a factor equal to the magnification. **If your telescope has a magnification of 100X, the object looks like it would with the unaided eye if you were 1/100 of your actual distance.** This is the way a telescope allows us to see an object “up close”.

The magnification is determined by the focal length of the telescope (the distance between the lens or mirror and the point where the light rays come to a point) **F1**, and the focal length of the eyepiece **F2**. The magnification of the telescope is then given by M=F1/F2.The characteristics of the telescopes which will be used in this exercise are given in the table below.

TABLE 1 - TELESCOPE PROPERTIES

TELESCOPE	APERTURE DIAMETER (mm)	FOCAL LENGTH, F1 (mm)
Orion ShortTube 80	80	400
Orion SkyView Pro 100	100	600
Orion SkyView Pro 120	120	1000
Celestron C8	203.2	2000

Image 1 - Orion Short-Tube

Image 2 - Orion SkyView

Image 3 - Celestron C8

Setting up the Telescope

Once you and your lab partner have been assigned a telescope, take it to the roof and set it up. The teaching assistant will help you with this. All of the telescopes have the following features in common:

1. a tripod on which the telescope is mounted
2. a "wedge" or other type of mount which orients the telescope in the Celestial Coordinate System
3. the telescope proper (eyepiece holder)

In setting up the telescope, be sure the mount is polar aligned, which means that its axis is pointing towards the north celestial pole. In the daytime, this can only be done very roughly.

Canging the Magnification

The teaching assistant will point out a remote object, such as the tops of the smoke stacks on the university power plant, or the dome on City High School. Pick an eyepiece with a fairly long focal length (at least 25mm) and put it in the telescope. Point the telescope at the remote object, and focus. Use the data table below to record your observations.

Next, put an eyepiece with a short focal length, 10mm or less in the telescope and refocus. Make corresponding notes in the table above. Note the difference in the appearance of the distant object as you change eyepieces. Go to at least one other telescope, preferably one quite different from the one you have been using, and check out the distant object through it. Note the magnification that your fellow students have calculated for that telescope, and compare the appearance of the object with the observations you made with your own telescope.

TABLE 2 – REMOTE OBJECT OBSERVATIONS

TELESCOPE	EYEPIECE FOCAL LENGTH (mm)	MAGNIFICATION

Adjusting the Setting Circles

Most astronomical telescopes have a pair of dials called setting circles. These tell the **RIGHT ASCENSION** and **DECLINATION** at which the telescope is pointing. Setting circles can be extremely useful in finding astronomical objects which otherwise are hard to locate in the sky. If the telescope is set up properly, the declination setting circle will give an accurate reading. However, the Right Ascension setting circle must be adjusted or calibrated for each observing session.

The way this is done is to point the telescope at an obvious object (for example, the star Vega) of known coordinates, then adjust the Right Ascension setting circle to equal that of the object. Once the setting circles are set, the observer can point the telescope to any pair of celestial coordinates. During the nighttime observing session (see final page), we will carry out the procedure described above. However, in the daytime session on the roof, we will do an approximate calibration of the setting circles. For daytime observations, follow the steps below.

1. Point your telescope due south. A good way to do this is to use the Theodolites to establish the direction south, find an object to point at, then point at the same object with your telescope.
2. Ask your teaching assistant will give you the value of the **LOCAL SIDEREAL TIME**. The Local Sidereal Time is defined to be the Right Ascension of an object on the meridian at that moment. Obviously, sidereal time changes in the same way that standard time does.
3. Now "dial in" the sidereal time on the Right Ascension setting circle of your telescope. Your setting circles are now calibrated.

The teaching assistant will give you the coordinates of an object which is up in the sky. This could be the Moon, the planet Venus, or (for the larger telescopes) the planet Jupiter. Move your telescope to the coordinates see if you have properly aligned your setting circles by viewing the object. If it is cloudy during your session, try and proceeded with the calibration and pointing procedure anyway. It will familiarize you with the mechanics of this operation. Record your observations in the table indicated below.

TABLE 3 – SETTING CIRCLES CALIBRATION

OBJECT	RA	DEC	RESULT?