Outdoor Lab 1 - A First Look at the Stars

Objective: To find our way around the sky by identifying the brightest stars and constellations, and by measuring some angles in the sky.

1 INSIDE PREPARATIONS

1.1 Review of tonight's sky

The stars visible outside tonight are shown in the Field Guide (FG) on sky map 12, in the section 06 following p 53. There are two versions of the map, with and without star names. The maps are to be held above your head and tilted down to the horizon in the direction you are looking.

Outside we will also use the map attached to this document, and the M5 star atlas. Check that these are essentially the same as in the FG, and identify a few of the main constellations in the M5 atlas, starting with Orion, containing the bright stars Betelgeuse and Rigel. Jupiter will also be prominently visible, and easy to find since it is the brightest object in the sky. Examine map 1 in the M5 atlas, centered on Polaris which lies within 1 of the North celestial pole (NCP). Note the position of Polaris with respect to the W of Cassiopeia and the pointers Merak and Duhbe of the Big Dipper in Ursa Major. Note also the hr markers around the outside of the map.

1.2 Measuring angles

An important aspect of locating and identifying celestial objects is their positions. There is no perception of depth in space, but we can describe the apparent position of a star or planet using angles. For example, we can specify the angle between two stars, or the altitude (Alt) and azimuth (Az) of a single star. Recall that Alt is the angle from the horizon up to the star, and Az is the angle from the North horizon (measured Eastwards) to the point on the horizon immediately beneath the star. In all these cases, the angle means the angle between lines in the two directions that meet at us, or at our eyes. One rough way to measure large angles is to point with straight arms in the two directions at the same time, and to estimate the angle between your arms.

A second way is to remember some typical angle sizes: e.g., at arms length, the width of a fist including your thumb is about 10° and the width of your little finger is about 1°. A more accurate way to measure angles is with some kind of measuring device. We shall use a simple angle ruler that, when held at arms length at right angles to your arm, will measure angles. Simple trigonometry tells us that the angle θ (in degrees) subtended at our eye by an object of size s (across our line of sight) at a distance D from us, is given by the formula

$$\theta = \frac{360\mathrm{s}}{2\pi\mathrm{D}} = 57.3\frac{\mathrm{s}}{\mathrm{D}} \tag{1}$$

when the angle is not too large. For $\theta = 1^\circ$, then D = 57.3 s. We use this to construct an angle ruler. It turns out that the distance from my eye to my outstretched hand is about 57 cm, and this is a reasonable approximation for most ordinary sized people. Thus from the formula, a length (s) of 1 cm held across the line of sight is not a bad approximation to an angle of 1°. Across the bottom margin the last page I have marked intervals of 1 cm and labeled them in degrees. Now you can use this ruler to measure the angle between two points or stars. Hold it at arms length, at right angles to your line of sight. Line the zero position up with one star, and read the angle

where it matches the other star. Use your angle ruler to check the finger and fist estimates given above. Unless you have unusual hands or arms, the angles should be fairly close to those given.

2 AT THE OBSERVATORY

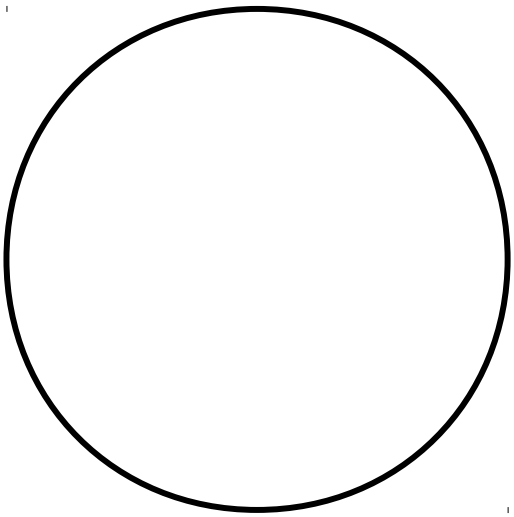
Take a look around the sky and identify some of the brightest stars and constellations. Circle the constellations you recognize in Fig. 1. Locate your zenith (Alt = 90°) and convince yourself that you could see half the celestial sphere down to the horizon, if it weren't for the city buildings.

2.1 Polaris

Using the star maps locate Polaris. It is not so easy to find as it is fairly faint and the city lights of mid town are bright. It lies 30° from the W of Cassiopeia and the pointers of the big dipper; the pointers are 5° apart. Once you can see Polaris you know (roughly) where the NCP is, and the direction of due North on Earth (the horizon point directly below Polaris). Keep walking in this direction and you will eventually reach the North pole. You will notice that contrary to common belief, the avenues of Manhattan (and Broadway in our part of town) are not oriented N-S. Measure as accurately as possible the altitude of Polaris. You cannot see the exact horizon so start from one arm held accurately horizontal. Your angle ruler will not be long enough so you will need to place more than one, end to end to build up the height.

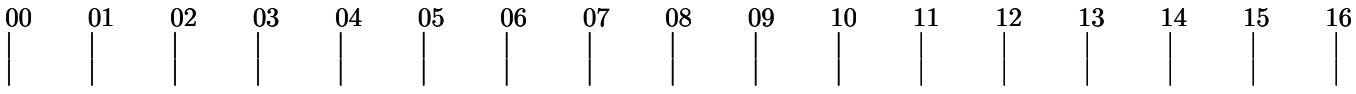
Altitude of Polaris =_____

Use your binoculars, and look at Polaris through them. Can you verify you are actually looking at Polaris? It takes some practice to know how bright a star should look through the binoculars. Draw the field of stars centered on Polaris as you see it in the binoculars:



2.2 Altitude and Azimuth

Locate and measure the Alt and Az of the objects in the following table. For Alt use the angle ruler, for Az use the arm method. Remember Az is measured from North (below Polaris) through East.



Star	Altitude	Azimuth
Sirius		
Betelgeuse		
Aldebaran		

2.3 Angular Separation

Locate and measure with your ruler the angular separation of the following. Note too, which is the brighter of each pair.

Pair	Separation	Brighter Component
The ends of Orion's belt		
Betelgeuse - Rigel		
Castor - Pollux		

2.4 Colors

The colors of stars are subtly different. They are typically described as: blue-white, white, yellow-white, yellow, orange, red. Describe the colors of the following.

Star	Color
Rigel	
Betelgeuse	
Pollux	
Aldebaran	
Capella	

2.5 Star time

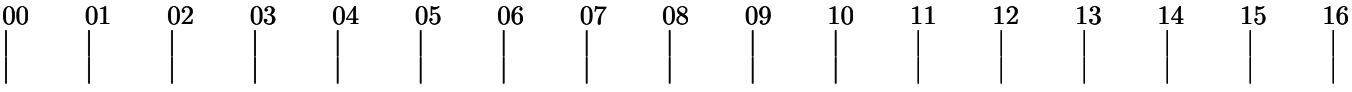
Study the sky near Polaris using the M5 map 1. The circles are lines of Declination and the radial lines are lines of Right Ascension, marked around the outside in hours. Compare the map with the sky and orient it so that they match up. Read the RA grid marker that is highest in the sky.

RA =_____

This line of RA runs from Polaris through the zenith to the South horizon. Its value is called the sidereal time. As the sky turns its value increases like a clock.

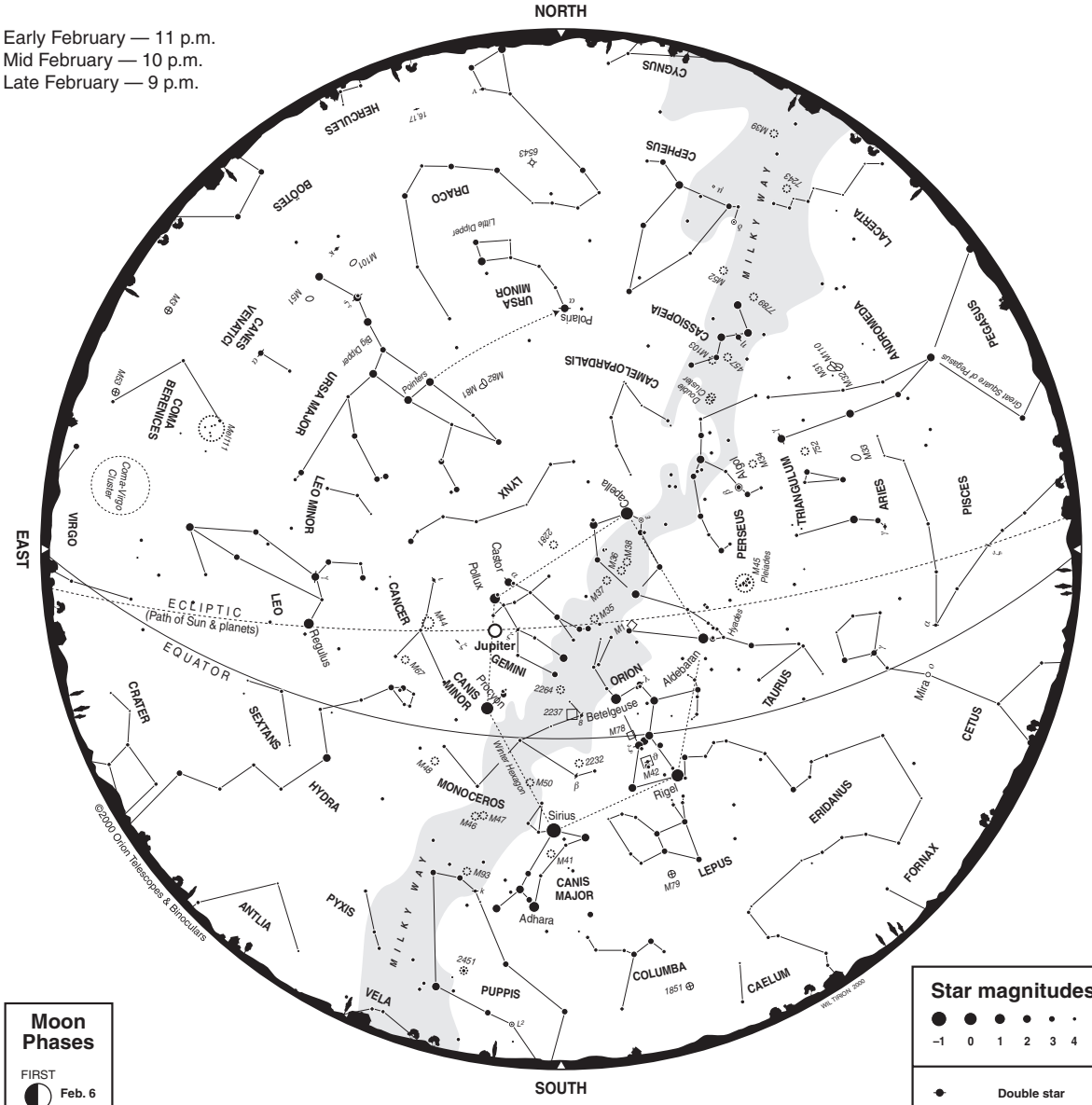
2.6 Magnitudes

Compare Orion or Gemini with the detailed star maps in the M5 atlas. Find the faintest star you can just see in the sky in this region.
Read its magnitude from the atlas:_____
Find a faint star in the atlas in this region that you cannot see with your naked eye.
What magnitude is it:_____
Locate it with binoculars. Can you see it now:_____



The Evening Sky for February, 2014

Early February — 11 p.m.
Mid February — 10 p.m.
Late February — 9 p.m.



Moon Phases

FIRST — Feb. 6
FULL — Feb. 14
LAST — Feb. 22
NEW — Mar. 1

Star magnitudes

–1 0 1 2 3 4 5

- Double star
- Variable star
- Open cluster
- Globular cluster
- Diffuse nebula
- Planetary nebula
- Galaxy

How To Use This Chart

This chart depicts the evening sky for the times indicated above. The edge represents the horizon; the chart's center is the point overhead. Hold a printout of the chart out in front of you so the horizon marked with the direction you're facing is down. Then match the stars on the map with the real stars in the sky.

The chart shows the sky as seen from 40° north latitude. When viewing from a lower latitude, stars in the southern sky will appear higher above the horizon while those in the northern sky will be lower. When viewing from a latitude higher than 40°, the opposite will be true.

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16