Exercise set one

In groups of 2–3 do these exercises in the following sequence: exercise 1 in small groups, then discuss with whole class. 2 and 3 in either order. 4 if weather permits, then 5 and 6 in order.

1 Discussion: Things in the sky

Discuss the following. **Record your thoughts in your lab notebooks.**

1. What kinds of things do we see in the sky?
2. Rank them roughly in order of distance from us on the ground.
3. Do these rankings vary from object to object?
4. Do your rankings vary over time?
5. Setting aside atmospheric phenomena, consider each of the things you listed: If you went outside and saw it/one in the sky would it be in roughly the same place 6 hours later, 24 hours later, a month later, six months later, a year later? We will explore this further in a later exercise.

2 Indoor: Learn to use a sextant

Materials

sextant, sextant manual

Instructions

A sextant is a device for accurately measuring the angle between the horizon and a celestial object (and other angles, too). This angle is called the "altitude" of an object. This is the fundamental measurement of celestial navigation, as you will learn in several later exercises.

Each person in group should follow the directions in the sextant manual to learn to read the vernier, then practice looking through it and taking an altitude. Use an object as far away from you as possible and find some convenient horizontal thing to use as a false horizon. A lightbulb down a hall works well.

3 Computer: Learn to use planetarium software

Materials

computer with planetarium software, "Seasonal Objects: Summer" (p.100-1, *Turn Left At Orion* 2nd Edition: 1998, Consolmagno and David, Cambridge University Press), lab notebook

Instructions

Make sure each person understands how to do the following:

1. Figure out how to view the sky as it looks right now from our current location.
2. Find the summer "guideposts" from the *Turn Left at Orion* book.

3. Take note of the orientation of the stars with respect to the cardinal directions (i.e., you want to know which way to face to find particular stars).
4. Find out what planets are up now and where they are in the sky and record this in your lab notebook. Do the same for next week's lab time.

Also, while you're at the computer, make sure your watch is not too far off (by more than a minute or so) of the time given at `http://tycho.usno.navy.mil/cgi-bin/timer.pl`. If it's off by more than a minute or so either reset it or record the offset in your lab notebook. Note that you need to reload this page to update the time.

4 Outdoor: A first look at the sky and use of a sextant

Materials

sextant , sextant manual, "Seasonal Objects: Summer" (p.100-1, *Turn Left At Orion* 2nd Edition: 1998, Consolmagno and David, Cambridge University Press), watch, lab notebook

Instructions

Find as many of the summer "guideposts" from *Turn Left at Orion* as you can. Find any planets that are up. **Record your observations.**

Each person should use a sextant to take the altitude of a star you can identify. This will be difficult. Remember that the altitude is the distance above the "true horizon". **Record the object name, time, altitude, and the precision with which you think you measured the altitude.**

5 Computer: Latitude, longitude, and time

Materials

computer with planetarium software, lab notebook, calculator (you can use the one on the computer)

Instructions

Your latitude, longitude and the current time determine what you will see in the sky. In the exercise you will explore how they change what you see in the sky.
If the weather was clear and you did the outside exercise tonight: View the sky as it appeared when you made your altitude measurement with the sextant. Check your measurement using the planetarium software. Were you within the precision you claimed?
Otherwise: View the sky as it would appear right now from the roof. Write down the time.

Exploring time

First, some definitions.

"The zenith" refers to the point directly overhead in the sky.

"The meridian" is the line running north-south through the zenith.

"Transit" A celestial object is said to "transit" when it crosses the meridian. (A transit can also mean when one body passes in front of another.)

Write down the time you are currently viewing in the planetarium software.

First just watch the motion of objects in the sky over the course of the whole night. **Which stars (in what part of the sky or which constellations) move most? Which stars move least? If you wanted to be able to go outside at any time tonight and orient yourself with respect to the cardinal directions, what stars would you use?**

Now pick a star in the south-eastern sky to keep track of. Watch its motion and how its altitude changes from hour to hour over the course of the whole night. **What is its azimuth when it reaches its maximum altitude? Answer the same question for the star Deneb in the constellation Cygnus.**

Using a sextant (and a clock), how would you determine when an object is crossing the meridian?

Watch the motion of a star in Ursa Major, the Big Dipper. **Why is it different from the last two stars?**

Exploring longitude

Set your time back to when your first star transited. Change your longitude by 30 degrees to the west in the planetarium software. What time does the star transit now? How about the other two stars? Move another 30 degrees to the west. What time do your stars transit now? **Determine from this how fast the Earth rotates (in degrees per hour).** Does that make sense? (Think about the length of the day.)

Exploring latitude

Set your location back to where you started.

This time I'm leaving things up to you a little more. Explore how the sky changes as you change your latitude, and answer the following question: **If you wanted to be able to go outside at any time of night and determine your latitude using only a sextant, how would you do it?**

6 On paper: Finding longitude from transit times

Materials

lab notebook, calculator, globe (optional)

Instructions

Draw a (large) circle to represent a view of the Earth looking straight down on the North pole. Indicate which direction the Earth is rotating in this diagram. It may help to refer to a globe first and think about where things rise and set.

Draw a single line of longitude. Let's say that line is going through New York (longitude 73d 59m 39s) and the time is midnight Eastern Daylight Time.

Now consider the star Scheat (pronounced "SHEE-at") in Pegasus that transits the New York meridian at midnight. **Draw an arrow representing the direction to that star on your paper.**

Now draw a second line of longitude $45°$ **to the west (**$118°59'29"$**, which goes near Los Angeles). Figure out how fast the Earth rotates in degrees per hour.** (Hint: think about the length of the day). **What time (EDT) will it be when Scheat transits in LA? What will the local**

time be when Scheat transits in LA? What will the local time be, approximately, anywhere in the world when Scheat transits there?

Now lets switch the problem around. It's September 22nd and you're on an island somewhere in the pacific. You have a watch still set to Eastern Daylight Time, a sextant, and a list of New York meridian transit times for various stars. Your list tells you that on the night of September 22nd, Scheat transits at 23:52 EDT (11:52pm EDT) in New York. You start taking observations when Scheat starts to get high in the northern sky. You determine that Scheat has reached its maximum altitude when your watch says 5:17am EDT (though you know the sun only set about 5 hours ago).

Are you west or east of New York? How many degrees of longitude are you from New York? What is your longitude?