1 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 later exercises.

Each person in group should follow the directions in the sextant manual to learn to read the vernier and adjust the mirror, then practice looking through it and taking an altitude.

You should set up controlled conditions so you can compare with measurements made by others. Stand at one end of the hallway and measure the angular height of the door at the other end. Make sure you are all standing the same distance from the door and measuring the height the same way. **Repeat your observations several times and record all of your measurements.** Compare with other students and keep practicing to see how precise you can make your measurements. This is a good time to make sure you understand how to rock the sextant to get the best measurement.

Come up with a final value for the angular height and estimate your precision. Remember: precision is a number! A good procedure might be to discard any "outliers", take the average for your value, and the standard deviation for your precision.

2 Computer: Latitude, longitude, and time

Materials

computer with planetarium software

Instructions

Your latitude, longitude and the current time determine what you will see in the sky. In the exercise you will explore their effects on what you see.

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.

"To transit" is for a celestial object to cross the meridian. An object is at its highest point in the sky when it transits. (Note that a transit can also mean when one body passes in front of another.)

"The altitude" of an object is the angle between it and the horizon. The zenith has an altitude of 90°.

"A sextant" is a device for measuring angles precisely, particularly altitudes.

"The azimuth" of an object is the angle between its direction and due North, increasing to the East. Something above the Eastern horizon has an azimuth of 90°.

View the sky as it would appear right now from the roof. **Record your latitude, longitude, and the time.** Always specify what kind of time you are using, i.e. EST, EDT, UT.

First just watch the motion of objects in the sky over the course of the whole night. **Which stars move the greatest angular distance across the sky? Which stars move the least? Are there stars which never set? Where are they?** I'm looking for regions of the sky, not the names of particular stars.

In light of what you've just found, which star(s) would you use as a "compass" to orient yourself?

Describe a procedure for using a sextant to determine when a star or planet transits. For which stars would this be easiest? For which would it be hardest?

Now pick a bright star in the south-eastern sky to keep track of. Watch its motion. **Record the azimuth, altitude, and time when it transits.**

Exploring longitude

Set your time to when your star transits. Change your longitude by 30 degrees to the West in the planetarium software. **What time does the star transit now?** Explain your result.

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?**

How could you determine your latitude using the Sun? Hint: you will need to make multiple observations. **If you also have a watch telling you the time at a known location (like the Greenwich Meridian at** $0°0'0"$**) then you can also determine your longitude from the same observations. How?**

3 On paper: Finding longitude from transit times

Materials

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 on this particular day. **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). 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?

4 Outdoor: A first look at the sky

Materials

Turn Left at Orion pages, sky charts, list of planets that are up, lab notebooks

Instructions

Find as many of the summer "guideposts" from *Turn Left at Orion* as you can. Find any planets that are up. Find Polaris. Find at least three constellations.

5 Outdoor: A second look at the sky

Materials

Turn Left at Orion pages, sky charts, list of planets that are up, lab notebooks

Instructions

Find as many constellations as you can. If it is very clear: **figure out what constellation the Moon, Mars, and Saturn are in, and draw their positions with respect to the bright stars in the constellation.**