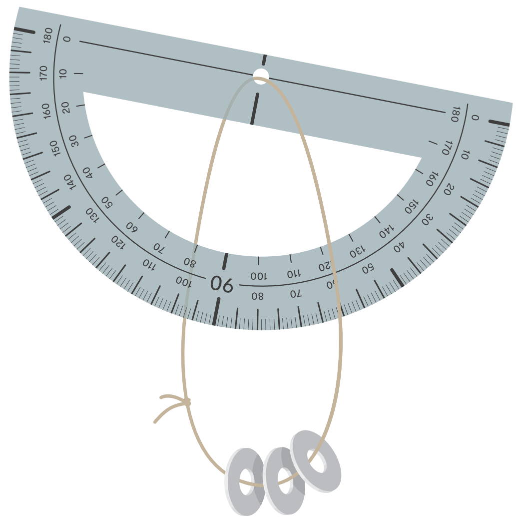
CURIOSITY AT HOME

ASTRONOMICAL NAVIGATION

Sailors in the past would often use the stars to navigate. In this experiment, you'll be finding your position using nothing but the stars and a special tool known as an astrolabe!

MATERIALS

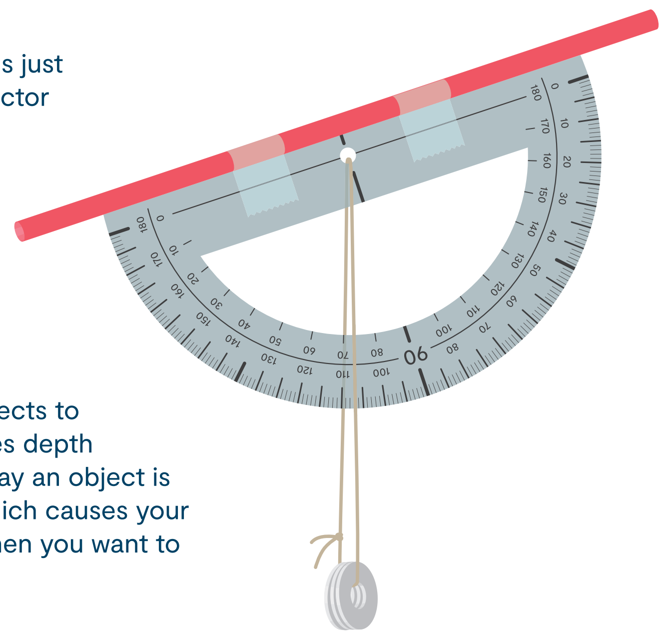
- Plastic protractor (or print out a paper protractor and attach a straw, pencil or other thin, sturdy object to the straight edge for easier use)
- About 12 inches of sturdy string
- Three small washers (or substitute a large bead, an eraser, a pencil, or anything with a bit of weight that you can easily tie a string to)
- Straw (optional)
- Science notebook or paper
- Something to write with



PROCEDURE

Making the Astrolabe:

- An Astrolabe is a tool used to make astronomical measurements. We can make a simple version of one using some common items.
- Tie or tape one end of the string to the center of the flat side of the plastic protractor.
- Tie the washers to the other end of the string, so that the string is just longer than the radius of the protractor. When holding the protractor with the flat side facing up, the washers should be hanging down just below the center of the curved arc of the protractor.
- Optional to tape a straw to the top of the flat side of the protractor. This will provide a more accurate measurement.



Finding your Dominant Eye:

In the human body, your eyes don't do an equal amount of work. One eye provides a bit more information about the location of objects to your brain; this is called your dominant eye. Your weak eye provides depth perception while following the dominant eye's lead. The farther away an object is from you, the more your weak eye relies on your dominant eye, which causes your weak eye to see that object in a different spot. Because of this, when you want to

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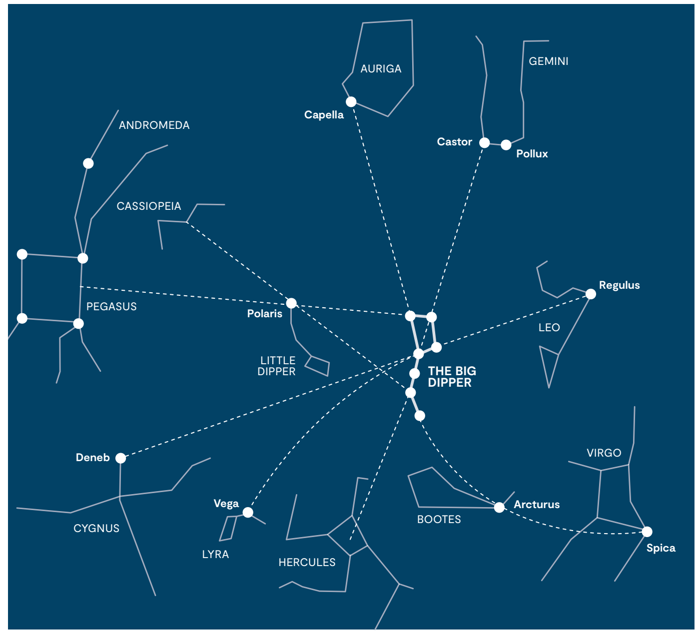
accurately tell the exact location of something (such as in astronomy), it's best to make that measurement with your dominant eye.

- Face a point or small object at least ten feet away, and look right at it.
- Make a triangle with your thumbs and index fingers, and hold your hands so that point is inside the triangle.
- Close one eye, then the other. If you can't see the point with one eye, that's your weaker eye. If you can, that's your dominant eye!



Big Dipper – Star Chart

Using the Astrolabe:

- On a clear and cloudless night, go outside with an adult and find a place where you can clearly see the stars.
- Find the Big Dipper in the night sky.
- Find the two stars of the Big Dipper's "pan" that are farthest from the "handle". Then make an imaginary line, connecting those two stars and continue following the line they make. The first bright star that this line connects to is called Polaris, also known as the north star!
- Using your dominant eye, look down the straight edge of your Astrolabe toward Polaris, lining up the edge as close as you can get it to point right at Polaris. Or look through the straw and line up Polaris in the center of the straw. Let the string hang freely as you do this.
- Once the string stops swinging, pinch it into place. Then look at the angle on the protractor where the string is hanging, reading the outer numbers (90–180 degrees). Record this number. It is the measurement of the angle between the line you sighted towards Polaris and the hanging weight, which is pulled straight down due to gravity.
- Next we need to subtract the angle of the horizon so that we are left with just the angle of Polaris above the horizon. The angle between the straight down hanging weight and the horizon is 90 degrees, so subtract 90 degrees from your recorded number.

$$X - 90 = Y$$

(X) Recorded Angle (number between 90–180 degrees) — **(90)** degrees (angle between hanging string and horizon) = **(Y)** Altitude Angle (angle between the horizon and Polaris)

- This altitude angle is also an approximation of your latitude, or distance from the equator. This measurement will usually get you within about 5 degrees of your true latitude.
- What latitude measurement did you get? Try measuring 2–3 more times to practice the accuracy of your measurement and record your measurements in your science notebook. Then look up the actual latitude of your location. How close was your approximation?

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WHAT'S HAPPENING?

The star Polaris is directly above the north pole, making it ideal for navigation. By measuring how high Polaris appears above their horizon, observers can find their current latitude, or position north or south of the equator. Note that this method can only be used to calculate latitude in the northern hemisphere, as Polaris is only visible north of the equator.

Observing Polaris is also useful for determining the seasons. All the other stars in the night sky will appear to rotate around Polaris. So, by measuring where a star is relative to Polaris, you can tell what season it is without ever looking at a calendar. Some ancient cultures could even tell the exact day, just by looking at the stars!

EXPLORE MORE

Some of the best stars to use for your "stellar calendar" are a group of three very bright stars called the Summer Triangle. The three stars are named Vega, Deneb, and Altair, and finding them is fairly easy, since they're all the brightest stars in their constellations!

1. Locate the Big Dipper.
2. Imagine drawing a line between the two stars in the Pan, closest to the handle.
3. Continue that line out of the top of the pan. The first bright star that line reaches is Deneb!
4. Make that line again through the two stars in the Pan closest to the handle, but this time, have it curve gently away from Polaris. You should find it reaching a very bright star, somewhat close to Deneb. That is Vega!
5. Finally, draw an imaginary line between Vega and Deneb. This is one side of the triangle. On the opposite side of that line from the Big Dipper, about the same distance away, should be a bright star. It roughly aligns with the middle of the line between Deneb and Vega. That's Altair!
6. Connect those three stars with imaginary lines. That's the Summer Triangle!

Watch the Summer Triangle throughout the summer especially just after sunset. During summer, it will be in the eastern sky at sunset, and will move into the western sky at sunset during the fall. Around January 1st, it should have completely vanished. If you use your astrolabe to track the location of all the stars in the Summer Triangle on each solstice and equinox, then you could measure it at any time to figure out what time of year it is, without ever looking at a calendar!

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GRADE 6–8 EXPLORATION

- Using this method, you can tell what latitude you're at, and the time of year. But there's no way to tell your longitude (distance east or west from the Prime Meridian, which is like a vertical equator) using the stars. To determine longitude, you need to tell when it's noon at a particular place (sailors of old chose Grennich, England), then determine the local time when it's noon in Grennich. For sailors in the past, determining longitude was impossible, until the invention of a specific device. What was that device? How would it be used? Once you know those two times, how do you determine your longitude? Can you think of any other ways you could find your longitude?
- The method you're using to find your latitude, while a good approximation, is actually somewhat inaccurate. What problems in this method can you think of, which might cause this inaccuracy? How might you try to fix these problems?
- Using Polaris as your guiding star is only possible if Polaris is visible in the sky. But during the day, or if you were too far South, it would be impossible to see. How would you find North in those circumstances? What limitations would those methods have?
- If you were to measure the sun's position above the horizon at noon (do NOT try this — looking directly into the sun can damage your eyes), you would notice that the sun rises higher above the horizon in summer than in winter. A good way to tell this without looking into the sun is to measure your shadow; it should be at its shortest at noon on the Summer Solstice, and at its longest at noon on the Winter Solstice. With this in mind, what do you think is happening to cause this effect?