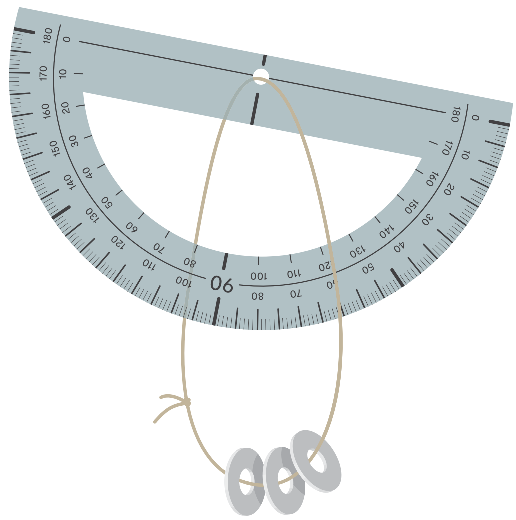
CURIOSITY AT HOME
ASTRONOMICAL NAVIGATION

Patterns in the night sky have been used by people around the world to help with navigation. In this experiment, you'll be finding your position using nothing but the stars and a special tool known as an astrolabe!

MATERIALS

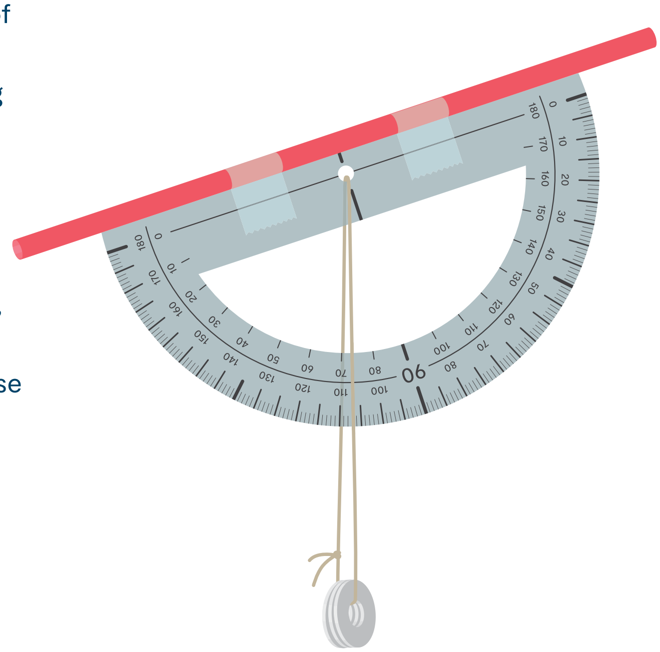
- Plastic protractor (or print out a paper protractor and attach a straw, pencil or other thin, sturdy object to the straight edge for easier use)
- About 12 inches of sturdy string
- Three small washers (or substitute a large bead, an eraser, a pencil, or anything with a bit of weight that you can easily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



PROCEDURE

Making the Astrolabe:

- 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 height 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.
- Tape a straw to the top of the flat side of the protractor. This step is optional, but will provide a more accurate measurement, as well as stabilizing your protractor if you use a paper one.
- Now that you've built your astrolabe, it's time to learn how to use it. First, you'll need to find your dominant eye.



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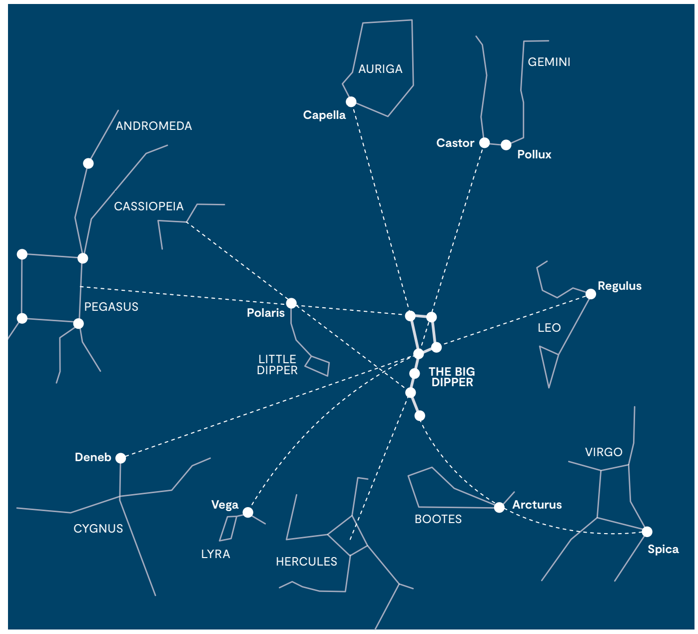
Finding your Dominant Eye:

- In the human body, one eye works a little bit harder and provides more information about the location of objects to your brain. This is called the dominant eye. When you want to 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!
- Now that you've found your dominant eye, it's time to use your astrolabe.

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 (see the star chart to the right).
- 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. 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.



Big Dipper – Star Chart

- 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.

Recorded Angle (Number Between 90 and 180 Degrees)	−	90 Degrees (Angle Between Hanging String and Horizon)	=	Altitude Angle (Angle Betwen 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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EXPLORE MORE

- Now that you've found Polaris and the Big Dipper, you can also use these stars as a sort of stellar calendar to tell you the season.
- To tell the season by looking at the stars, go outside with an adult just when the stars are becoming visible after sunset. It's important to look at the right time, because the stars also move over the course of the night.
  - Shortly after the sun sets in the spring, the Big Dipper will be at its highest point in the night time sky and appear to be upside-down.
  - In the summertime, the Big Dipper will have moved one quarter circle counterclockwise so that it is to the west of Polaris and the bowl of the dipper is below the handle.
  - Another quarter turn, and in the fall the Big Dipper is facing right side up and is at its lowest point in the night sky.
  - Finally, in the wintertime, the Big Dipper will have turned so that it's to the east of Polaris, with the dipper above the handle.
- Make your observations of the Big Dipper circling around Polaris and with practice, you'll be able to tell what month it is based on the stars.

WHAT'S HAPPENING?

- Polaris's position in space lines up with Earth's North Pole. By measuring how high Polaris appears above their horizon, observers can find their current latitude, or position north or south of the equator. At the North Pole Polaris would be directly overhead because the North Pole is pointing at Polaris. At the equator, Polaris would be on the horizon line. Note that this method can only be used to calculate latitude in the northern hemisphere, as Polaris is only visible north of the equator.

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3-5 GRADE EXPLORATION

- Why do you think the stars appear to be in different places at different times of night and in different seasons of the year? Are the stars really moving, or is something else?
- By looking at your shadow at noon and comparing its length, you can safely determine the height of the Sun in the sky without looking at it. If you watched your shadow over a year, you'd notice that it's shortest in the summer and longest in the winter. What does the change in length of shadow tell you about the height of the sun in the sky?
- Why might the sun's height in the sky appear to change over the course of the year?
- It's safe to look at stars in the night sky, but not at the Sun. What does that tell us about how close we are to the Sun versus other stars?

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6–8 GRADE EXPLORATION

- Using your astrolabe, you can tell what latitude you're at. But there's no way to tell your longitude (distance east or west from the Prime Meridian) using the stars. To determine longitude, you need to tell when it's noon at your location, then determine the local time when it's noon in Greenwich, which is located on the Prime Meridian. 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?
- Why do you think the stars appear to be in different places at different times of the year?
- 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 could 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 (**Warning:** 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?