Navigate Your Way

Did you know ship captains use trigonometry to help them safely sail the seas? Explore how to take measurements like an early ocean navigator as you create and use your own sextant!

TEKS:

MATH 4.1A: The student is expected to apply mathematics to problems arising in everyday life, society, and the workplace.
MATH 4.7C: The student is expected to determine the approximate measures of angles in degrees to the nearest whole number using a protractor.
MATH 5.1A: The student is expected to apply mathematics to problems arising in everyday life, society, and the workplace.
MATH 5.1D: The student is expected to communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate.

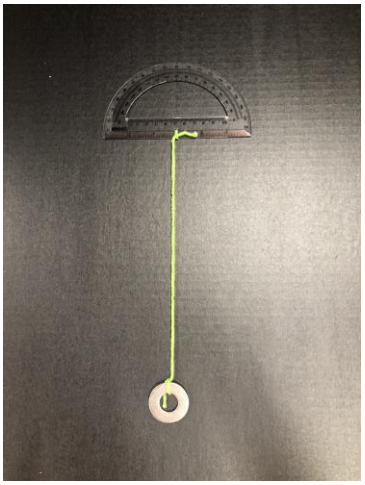
Materials:

- Masking tape
- Pencil
- 15" piece of yarn or string
- Plastic protractor
- 12" ruler
- Washer

How To:

Making the Sextant

1. Tie a washer to one end of the yarn or string.
2. Many protractors have holes in the middle of the straight edge of the tool. If yours has this hole, tie the end of the string opposite the washer through the hole. If your protractor does not have a small hole, either tie or tape your string to the midpoint of the protractor.



3. Next, use masking tape to secure the protractor to the ruler within 1 inch of one end of the ruler. The straight edge of the protractor should align with the straight edge of the ruler. Make sure you do not pinch the string in between the ruler and protractor—it needs to be able to move freely!

Using the Sextant

1. Taking a measurement on a sextant is called "sighting." To do this, raise your sextant to eye level. Line up the top edge of the ruler to one eye, while the arc of the protractor is facing down and the string is hanging down across the arc of the protractor. The string and washer act as a plumb line, which is a line with a weight at one end.
2. Find an object in the room that you want to practice sighting with the sextant. With the ruler at eye level, line up the opposite end of the ruler with the object you want to sight.
3. Notice that as you move the angle of your sextant, the plumb line always stays perpendicular to the ground because of gravity. If you look closely, the plumb line also moves along the readings on the protractor. This is key to sighting with a sextant.
4. Once your object is in the line of sight along the top of the ruler, have a friend see where your plumb line falls on the readings of the protractor. This reading is called your zenith angle. Record this reading in a table like the one below.
5. The altitude angle is the angle that the object is above the horizontal (the ground). To calculate the altitude angle, use this equation: *altitude angle = 90° - zenith angle*. Record the altitude angle in the table below.

Object	Zenith Angle (protractor reading)	Altitude Angle (90° - zenith angle)

6. Practice sighting various objects! Try to measure the angle of the Sun throughout different times of the day and see how it changes – but be safe by not looking directly at the Sun!

STEM Explanation:

Many ships today use a variety of technologically advanced tools to navigate. Before Global Positioning Systems (GPS), echo sounders, and magnetic compasses were invented, many ships used a sextant while traveling the open sea. Sextants are instruments with a graduated arc of 60 degrees. They are used as a sighting mechanism that measures angular distances between objects for navigational purposes, especially in the ocean to measure the altitude of the Sun and stars.

The zenith angle is the angle between whatever you are sighting and the vertical. The altitude angle is the measurement between the horizontal and the object you are sighting. You can find the altitude angle by using the following equation: *altitude angle = 90° - zenith angle*. With trigonometry, navigators can use these angles to calculate the time of sunrise and sunset, as well as measuring the change in position of a star.

Career Connection:

Maritime navigation systems engineers design, simulate, and test navigation and communication systems to verify operation and software modifications. They evaluate steering control, speed logs, echo sounders, and magnetic compasses onboard to develop programming and equipment standards for all vessels. This specialized type of electrical engineer also assists in diagnosing and repairing electronic navigational equipment.

Resources:

https://science.howstuffworks.com/dictionary/astronomy-terms/sextant-info.htm
https://solarscience.msfc.nasa.gov/suntime/sxtnt_tchr.pdf
https://www.pveducation.org/index.php