Navigation tools like astrolabes or quadrants measure the angle of the Sun as it appears in the sky to an observer on the Earth’s surface. Knowing that angle can help you calculate your latitude, an essential measurement for determining your global position. Use the instructions below to create a quadrant that works much like the astrolabe in the video but is simpler to build.

**Building the Quadrant**

Materials: printed quadrant template (attached), drinking straw, string, washer or other small weight, glue/tape, cardboard/stiff paper, scissors, paper clip (Figure 1)

1. Cut out quadrant template along the outer black lines. Glue template to cardboard and cut the cardboard to match the template. Using scissors or a pen, carefully punch a hole through the little circle near the right angle side of the quadrant. (Figure 2)

2. Cut the string 8 inches in length, put one end through the hole and tie it to the paperclip in the back of the quadrant. Adjust the length of the string so it can swing freely and hangs just below the front side of the quadrant and tie the end to the washer. (Figure 3)

3. Glue or tape the straw onto the quadrant where it says, “Attach Straw Here”, leaving some of the straw hanging over the edges on both sides of the quadrant. (Figure 4)

4. Cut a cardboard circle with a 2-inch diameter. Carefully punch a hole in the center of the circle and fit it over the edge of the straw. (Figure 5)

Now that you have a completed quadrant, use it to find your latitude.

The astrolabe was probably invented by the Greeks in the 1st or 2nd century BC. In fact, the word astrolabe means “star taker” in Greek!
Taking a Sighting
As explained in the video, finding your latitude at noon is pretty easy! First you need to use the quadrant to measure the angle between the Sun and an imaginary point above your head called the zenith. Then you need to adjust for the position of the Earth in our orbit around the Sun by finding today’s date in a declination table (attached).

1. Standing in an open area around noon local time, hold the quadrant with one hand and point the straw toward the Sun. Do not look directly into the Sun! Be sure to allow the weighted string to swing freely along the curved edged of the quadrant. You should be able to read the numbers.

2. The sun’s light will cause a shadow to appear on the side away from the Sun. Hold a sheet of paper next to the quadrant to see this shadow. (Figure 6)

3. Adjust the position of the quadrant. When it is lined up correctly, light will travel through the straw and a clear light circle will appear in the center of the shadow. (Figure 7)

4. Take the reading of degrees (rounded to the nearest whole number). (Figure 8)

5. Find today’s date on the declination table. The table lists degrees (first number) and minutes (second number). If the number of degrees is positive, add it to the measured angle; if it is negative subtract it from the measured angle.

Congratulations! You have now found your latitude!

Use the declination chart to answer these thought questions:

1. What time of year is the declination the largest positive or negative number? What is the weather like then?
2. What time of year is the declination close to zero? What is the weather like then?
3. What does this suggest about declination’s relationship to the seasons?
4. This declination chart is for the northern hemisphere. How could you make it work in the southern hemisphere?

Answers at the bottom of the declination chart

The quadrant can also be used at night by using the North Star instead of the Sun. You don’t need to worry about declination and you can look through the straw to line up the star!
NAVIGATION IN THE AGE OF EXPLORATION
BUILDING A QUADRANT - FIGURES 1-5

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5
NAVIGATION IN THE AGE OF EXPLORATION
TAKING A SIGHTING - FIGURES 6-8

figure 6

figure 7

figure 8
## NAVIGATION IN THE AGE OF EXPLORATION

### Declination Table

As the Earth revolves around the Sun, the angle between the equator and the Sun’s position in the sky changes. This angle is called declination and it is important to finding your latitude. Find the date on which you make your sighting on the chart below. If the number is positive, add it to the angle you measured with the quadrant; if it is negative, subtract it. The quadrant’s scale is not very precise, so we can use only the first number (whole degrees) to simplify our calculation. If you want more of a math challenge, include the second number (minutes), but remember that 60° = 1° (i.e. 50° - 7°10' = 42° 50'). Because one degree of latitude is equal to sixty nautical miles of distance, small mistakes can cause large navigation errors! How could we take more accurate measurements?

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### Answers to thought questions on page 2:

1. Declination is highest during winter and summer solstice. Temperatures are at their coldest or hottest. Days are shortest and longest.
2. Declination is near zero during spring and fall equinoxes. Temperatures are mildest. Days have equal amounts of sunlight and darkness.
3. Declination is related to the Earth’s tilt on its axis which bring seasonal changes.
4. Reverse all “+” and “-” for southern hemisphere.

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NAVIGATION IN THE AGE OF EXPLORATION

QUADRANT TEMPLATE

Attach Straw Here

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