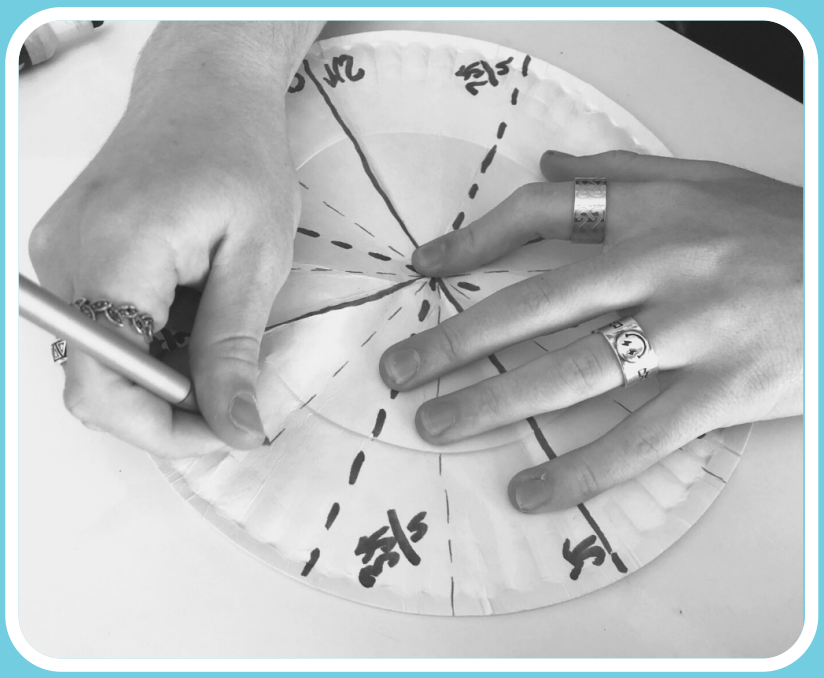
STEM Sims™

Unit Circle



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Do you need an idea for a scientific study?
Try out one of our ideas or make one of your own.

Sine, cosine, and tangent are some basic trigonometric functions that have a variety of applications. Take the following brief quiz to see how much you already know about some basic trigonometric functions. See the bottom of page 4 to check your answers.

1. The Greek word “trigonon” is the derivation for the mathematical word trigonometry. What does the word “trigonon” mean?
   a. one angle and measure
   b. two angles and measure
   c. three angles and measure
   d. four angles and measure

2. Who is most credited with creating trigonometry?
   a. Hipparchus
   b. Aristotle
   c. Newton
   d. Galileo

3. What is the name of an instrument used to measure the angle of elevation as a tool to measure tall objects?
   a. manometer
   b. barometer
   c. altimeter
   d. clinometer

4. Which mathematician is created with first studying the sine trigonometric ratios and developing a table of sines?
   a. Aryabhatta
   b. Sastra
   c. Sanskirt
   d. Gupa

5. During the second century, the Egyptians’ measurement of Earth’s circumference was accurate to modern measurements within about what percentage?
   a. 2%
   b. 10%
   c. 25%
   d. 40%

How Tall is That Tree?

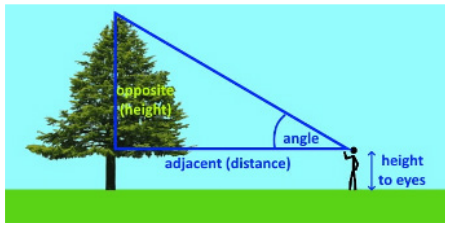
What if you need to find the height of a very tall tree and you don't want to climb the tree to find out its height? Trigonometry to the rescue! You can use trig and a couple of simple tools to find the height of some very tall things. Get started now measuring the height of tall objects?

Materials

1 – protractor 1 – long tape measure 1 – notecard

Procedure

1. Locate a tall object outside in a flat piece of ground.
2. Find a flat location some distance away from the tall object. Place a mark on the ground.
3. Use a long tape measure to find the distance from your mark on the ground to the base of the tall object. Enter this value in Table 1 as the distance to the object.
4. If you do not have a long tape measure, walk towards the tall object, and count the number of normal walking steps from your mark on the ground to the base of the tall object. Assume each step you take is one meter. Enter this value in Table 1 as the distance to the object.
5. Return to your mark on the ground, hold the notecard at eye level, and sight along the bottom of the notecard to the very top of the tall object. Place a mark on the notecard that shows the top of the object.



6. Use the protractor to measure the angle between the bottom of the notecard and the mark you made on the notecard.
7. Record in Table 1 the angle to the top of the tall object.
8. Use a calculator to find the tangent of the angle to the top of the object. Enter this value into Table 1.
9. Multiply the tangent value times the distance to the tall object.
10. Add the height from the ground to your eye level in meters to the product of step 10. This is

Table 1. Tall Object Measurements

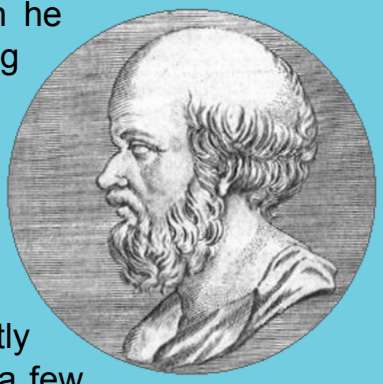
Measurement	Value
Distance to Tall Object (m)	
Protractor Angle (degrees)	
Tangent Angle	
Height of Tall Object (m)	

Questions

1. What does the tangent function measure?

Unit Circle

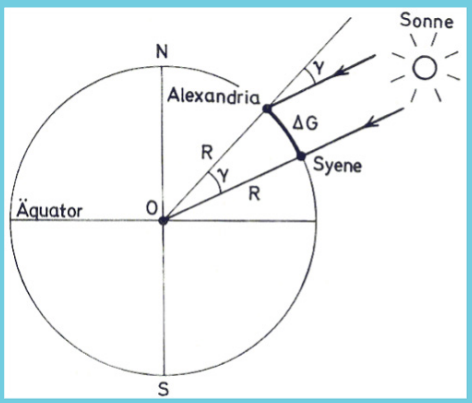
Eratosthenes and Earth's Circumference



Eratosthenes lived in Egypt over 2,000 years ago. Even though he had no modern measurement tools, satellite images, or a very long measuring tape he was able to determine the circumference of Earth relatively accurately. He used some creative thinking, local knowledge, and a little bit of geometry to find the distance around Earth.

He lived in Alexandria and read about a city called Syene near his town where on a certain day of the year, when the sun was directly overhead a deep well, that no shadows were cast in the well for a few minutes. The sun was reflected off the water at the bottom of the well. He also knew that on that same day in Alexandria, a shadow would be cast by an object that was placed vertically.

Since Syene was close to Alexandria, he knew the distance between the two towns. With a protractor, he measured the angle of the shadow cast in Alexandria by the vertical stake on the same day that no shadow was cast in Syene in the deep well. The stake's shadow angle was about 7 degrees, which when he divided the total "circle" angle of Earth of 360 degrees by the 7 degrees came out with a value about 50. He then reasoned that the distance of 500 miles between Syene and Alexandria was about 1/50 of the way around the entire globe. Multiplying 500 miles by 50, he determined Earth's circumference to be about 25,000 miles. He was accurate within about 100 miles of the actual distance measurement.



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Answers: Page 2 Answers: 1) c, 2) a, 3) d, 4) a, 5) a. **Page 3 Answers:** How Tall is That Tree?1) Tangent is a ratio the length of the opposite side to the adjacent side for a given right triangle.