

<b>Lesson Title: Measuring Earth's Circumference as Eratosthenes</b>		<b>Geo 4.6</b>
<b>Utah State Core</b> Geometry Content Standards 2-4 Process Standards 1-4		
<b>Summary</b>		
In this lesson, students read the book <u>The Librarian Who Measured the Earth</u> . Using quotes from the books and questions on the worksheet, they work through the process that Eratosthenes used to measure the Circumference of the Earth.		
<p style="text-align: center;"><b>Enduring Understanding</b></p> <p>Using geometry properties, Eratosthenes measured the circumference of the earth two thousand years ago and came within 200 miles of current accurate measurements. One can measure the circumference of any circle using arcs and angles.</p>	<p style="text-align: center;"><b>Essential Questions</b></p> <ul style="list-style-type: none"> <li>• How did Eratosthenes measure the circumference of the earth?</li> </ul>	
<p style="text-align: center;"><b>Skill Focus</b></p> <ul style="list-style-type: none"> <li>• Using Circle properties to solve problems</li> </ul>	<p style="text-align: center;"><b>Vocabulary Focus</b></p>	
<b>Materials</b> Calculators, Geometer's Sketchpad		
<b>Launch</b>		
<p><b>Explore</b></p> <ul style="list-style-type: none"> <li>• How do you find an arc length if you know the angle and the circumference?</li> <li>• How do you find the circumference if you know an arc length and its angle?</li> </ul>		
<b>Summarize</b>		
<b>Apply</b>		
<b>Assess</b>		

**Directions**

Read The Librarian Who Measured the Earth (by Kathryn Lasky) up to the point where the quotes begin in the activity below. Then let students discuss their ideas about how Eratosthenes could possibly have measured the circumference two thousand years ago.

Inform them that they already have learned the necessary circle properties to solve this problem. Now they just have to think like Eratosthenes thought.

This activity should be used as a major assessment for understanding and use of circle properties.

Design a rubric for rating students on their work. Some possible categories for evaluation are:

- Communication of thinking and strategies
- Problem solving strategies
- Mathematical reasoning
- Accuracy and solution quality

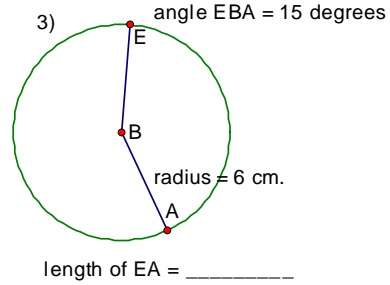
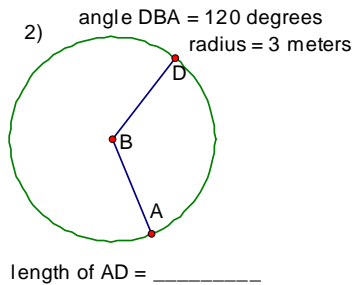
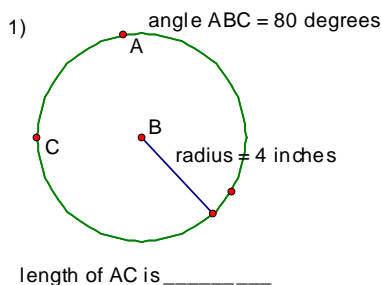
## Geo 4.6      **Measuring Earth's Circumference as Eratosthenes Did**

The following quotes are taken from “The Librarian Who Measured the Earth” by Kathryn Lasky. Read the quotes and pretend to be Eratosthenes. The questions asked below are those he probably asked himself as he worked to measure the circumference of the earth.

*“Nobody had ever thought of measuring the size of such a large circle as the circumference of the earth—nobody except for Eratosthenes. Perhaps he imagined the earth as a grapefruit. If it is sliced in half, you can see its sections. In order to measure the distance all the way around the edge of the grapefruit (the circumference), you would need to know only the distance along the edge of one section (the arc) and how many of these same-size sections it would take to make up the whole grapefruit.”*

1) Think about a grapefruit with a 2 inch radius, and pretend that the 12 grapefruit sections are congruent. Use what you know about finding circumference and angles in a circle, figure out a way to find the arc length without measuring it.

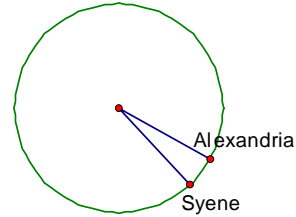
2) Practice finding arc lengths. Show all work below.



3) Why could Eratosthenes not use this method?

4) "Eratosthenes pictured a section of the earth whose outside edge ran from Alexandria to Syene (SI-ee-nee), a city in southern Egypt. If he could figure out the distance between Alexandria and Syene, and if he could measure the inside angle of the section they created, he would be able to calculate the earth's circumference."

What did Eratosthenes know in order to draw this conclusion?



5) "Eratosthenes realized that the sun could help him with his angle problem, and he picked Syene for a reason. He had heard from a caravan passing through Alexandria that on the twenty-first day of June at precisely midday, the sun would shine directly down a certain well in Syene, lighting up the well but casting no shadows on its walls. But at the exact same time in Alexandria, shadows would be cast.

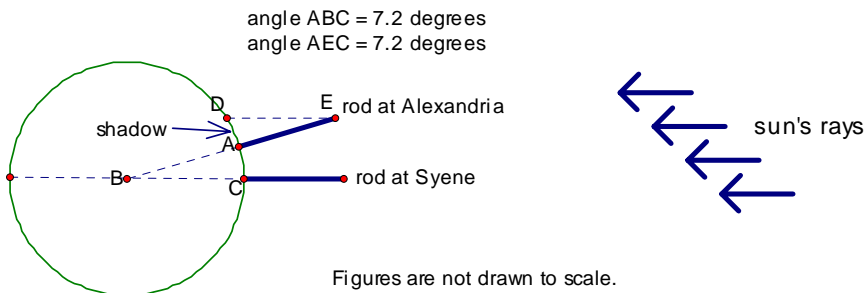
Why would this be the case?

6) "Eratosthenes knew a thing or two about shadows and angles. He knew you could measure the angle of the sun by the shadow it cast. And he knew, from the mathematical texts he had read, that the angle of the sun in Alexandria at noon on June 21 would be the same as the angle that lay at the center of the earth making the inside of his Alexandria-to Syene 'grapefruit' section."

Why did he need to know the measure of angle AED?

7) How did Eratosthenes know that angle ABC would be equal to angle AED?

8) How do you think he measured angle AED?



9) What does he need now in order to figure out the circumference?

10) Once he has that piece of information what will he do with it?

*“There was a problem. The problem was camels! Camels were the main manner of transport in the desert, and Eratosthenes had planned to measure the distance between the two cities by calculating how long it took camels to get from one city to another. He thought camels would be perfect. But he forgot that they are ornery, stubborn, and have minds of their own....No matter how hard Eratosthenes tried, he could not record travel times for camels that were accurate enough for his mathematical equations....He asked the king if could borrow the services of his best bematists—surveyors trained to walk with equal steps....It was then easy to estimate that the distance between Alexandria and Syene was five thousand stades. A stade was supposed to equal the length of a Greek stadium. The stade that Eratosthenes used was 515 feet, or just under one-tenth of a mile.”*

11) Show how Eratosthenes figured out the circumference of the earth. Redraw the picture above to help show your thinking.

(Eratosthenes came within 200 miles of the measurement taken in this century)

12) Problem solve to figure out the missing information below. Show all work!

