



**International Center  
for Leadership  
in Education**



**Gold Seal Lesson:**

Copernicus Education Gateway

<b>Author(s):</b> Michael Lucky Voiselle			<b>Lesson Title:</b> HOW LARGE IS THE EARTH?			
<b>Grade Span</b>			<b>ICLE Application Model</b>			
<b>K-4</b>	<b>5-8</b>	<b>9-12</b> X	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b> X

**Instructional Focus:**

**Writing**

Students write for a variety of purposes and audiences with sophistication and complexity appropriate to the grade level.

**Algebraic Concepts and Relationships**

Students use algebraic methods to investigate, model, and interpret patterns and functions involving numbers, shapes, data, and graphs in a problem-solving situation. Students evaluate and communicate the reasoning used in solving these problems.

**Measurement**

Students use a variety of tools and techniques of measurement in a problem-solving situation. Students communicate the reasoning used in solving these problems.

**Science as Inquiry**

Students demonstrate knowledge and skills necessary to perform scientific inquiry.

**Habits of Mind**

Students develop habits of mind including curiosity, open-mindedness and persistence.

**Performance Task**

Your task is to work in groups of 2 or 3 to recreate Eratosthenes' experiment used over 2000 years ago to find the circumference of the earth by finding the circumference of an earth globe, basketball, or volleyball. You will need 2 small dowels (bamboo teriyaki sticks will do) approximately 8 cm long, 2 suction cups or clay to attach rods to globe, (caution: the rods must be attached to align straight to the center of the globe you are using), a protractor to measure the proper angle, string and centimeter ruler to measure the distance between your dowels attached to the globe and a light source such as the sun or a bright projector lamp if it is a cloudy day. You also need some way to place the globe on the floor or ground without it rolling around.

Consult attached diagram and use your ingenuity to make the necessary measurements to predict the diameter of your globe. (Note to the teacher: place a string around the globe and measure the length of the string along a meter stick to find the actual circumference).

After the measurements are made and recorded in a neatly organized chart, and you have used the algebraic formula to determine the circumference, consult your teacher for the actual circumference of your globe. Find your percent of error by subtracting the actual measurement from your calculated one. Then divide the actual value into this little subtraction and multiply by 100%. This is your relative error. Record it in your chart. If you came up with a negative sign simply discard it. A relative error simply means how far off the true value you are. You could be off to the right or left or up and down.

You are to include a detailed diagram of the experiment with your measurements in proper places. You must show your calculations and how you arrived at the final value both numerically and units of measurement. (centimeters, degrees, etc.)

You are to include a conclusion paper with this experiment. The paper should be will organized and free from spelling and grammatical errors. The paper must include your procedure used to find the circumference of your globe stating any problems you experienced and how you solved them. You must also include a story of Eratosthenes and how he used places on the real earth to find its' circumference. (He was less than 5% off. That is fantastic for his day and time with limited equipment and guess work!) You may use any resources to discover his methods such as encyclopedias, textbooks, the internet, and do not forget your partners.

Eratosthenes made two rash assumptions for his time period 2000 years ago. Your conclusion paper should include these two assumptions within the context.

### ICLE Essential Skills

Apply in writing the rules and conventions of grammar, usage, punctuation, paragraphing and spelling. (ela1)
Gather information from a variety of sources, including electronic sources, and summarize, analyze, and evaluate its use for a report. (ela3)
Present information in well-organized fashion that will be clear to the target audience. (ela11)
Understand the characteristics of <b>parallel, perpendicular, and intersecting lines</b> . (m2)
Understand <b>basic algebraic properties</b> (i.e., commutative: $ab = ba$ ; associative: $ab(c) = a(bc)$ ; and distributive: $a(b+c) = (ab)+(ac)$ ). (m3)
Understand the characteristics and terminology of <b>angles</b> , e.g., degree measure, classification of angles by measure (acute, right, obtuse, and straight), supplementary and complementary angles, and vertical angles. (m4)
Plan and apply real or hypothetical models and constructions to facilitate investigation and learning and the solution to practical problems. (Not Ranked s115)
Understand the impact upon society and the environment of scientific and technological discoveries and the contributions of scientists. Understand how society may accept or reject scientific discoveries based upon need or refusal to change. (Not Ranked s116)
Know the metric system and the units of metric measure and convert metric units to English units. (s4)
Exhibit good data management skills by collecting, organizing, and graphing data (s19)
Know how to determine percent error wherever applicable. (s92)

### Scoring Guide:

RATE EACH CRITERIA: 3=Excellent, 2=Satisfactory, 1=Unsatisfactory, 0=Does not attempt

CRITERIA	SCORE
Experimental procedure and group cooperation	_____
Algebra skills in rearranging the formulas and Showing all work in arriving at the results	_____
Accuracy of results: 5%=3, 8%=2, 12%=1, 0=>12	_____
Eratosthenes' experiment included in the paper	_____
Eratosthenes' two assumptions included in paper	_____
Neatness and accuracy of diagrams	_____
Grammatical and spelling errors in paper: 2errors=3, 5errors=2, 8errors=1, 0=>8errors	_____

**Keywords**

English Language Arts	Mathematics	Science
Reading Research	Algebra Algebraic Operations Measurement Data Collection Data Organization	Earth Science Earth Scientific Inquiry Model
Writing Technical Writing Laboratory Reports	Geometry Angles	Life Science
Communications	Statistics	Chemistry
Literature	Calculus	Physics
Other	Trigonometry	Other History of Science
	Other	

If you have a Picture, Chart, or Graph that has special formatting, please identify the name of the file(s) in box below. Also attach a copy of the file(s) with this disk.

Picture, Chart, or Graph file name(s):

Assumption # 1 by Eratosthenes:  
The sun's rays are parallel coming to earth.

Assumption # 2 by Eratosthenes:  
The earth is round.

Measure angle a in °

Measure distance d in cm.

Angle a = angle a' due to parallel lines

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Use this formula to calculate the circumference:

$$\frac{D}{d} = \frac{A}{a}$$

D = Circumference around globe in cm. (unknown)  
d = measured distance between dowels in cm.  
A = Angle of a full circle = 360°  
a = Measured angle in °