Eratosthenes and Earth’s Circumference

More than 2000 years ago, a man named Eratosthenes made a surprisingly accurate estimation of earth’s circumference. He did this by using some simple geometric relationships. In this activity, you will use Eratosthenes’ method to determine the circumference of a circle.

Procedure:

Part A: Finding a Circle’s Circumference

1. Locate the coordinate of (0,0) or, (the center of the circle). Label it point *C*.

2. Use a protractor to draw a straight line in any direction from point *C* to the edge of the square border. Label the point where the straight line intersects the circle point *A*.

The line connecting points *A* and *C* is called line *AC*.

3. Place the protractor along line *AC* so that its center is on point *C*. Mark off an angle between 15° and 50°. Record this angle in Table 1.

4. Complete the angle by drawing a straight line from point *C* through the point you have marked off with the protractor to the edge of the square border. Label the point where this straight line intersects the circle point *B*. The line connecting points *B* and *C* is called line *BC.*

5. Set the flexible metric ruler on edge and bend it to follow the circumference of the circle. Use the curved ruler to measure, to the nearest tenth of a centimeter, the length of the circle from point *A* to point *B* (arc *AB*). Record the value in Table 1.

6. Measure the length from point *C* to point *A*, to the nearest tenth of a centimeter. Record this value in Table 1. Line *AC*  is the radius of the circle.

7. Answer Questions 1 and 2 under Analysis and Conclusions.

Part B: Finding Earth’s Circumference

1. Eratosthenes used careful observations of the sun’s rays to find earth’s circumference. The figure below shows the sun’s rays striking two locations at Earth’s surface, *E* and *F*. At point *E*, the sun is straight overhead and strikes the surface at a 90° angle. At point *F*, the sun’s rays strike the surface at angle *GFH*. Measure angle *GFH*. Record the angle in Table 2.

2. Because the sun is far away, Eratosthenes considered its rays to be parallel. Based on geometric principles, this parallelism means that the angle IFH equals the angle between E and F at Earth’s center. To find IFH, subtract GFH from IFG. Note that angle IFG is a right angle (90°).

3. Using the curved ruler technique from Part A, measure the distance, to the nearest tenth of a centimeter, from point E to F along the segment of Earth’s surface shown. Record the arc length in your copy of Table 2.

4. Use the scale 1 centimeter = 1800 kilometers to convert the length of arc EF to kilometers. Record this value in Table 2.

5. Answer Questions 3 and 4 under Analysis and Conclusions.

Analysis and Conclusions

1. The length of arc AB has the same relationship to the circumference of the circle as the angle used has to the whole circle (360°). Use the equation to find the circumference of the circle.

2. Using the standard formula C =2πr (C=circumference, r=radius), determine the circumference of your circle again. (Use π=3.14.)

3. Calculate Earth’s circumference using the equation provided.

4. Earth’s actual circumference is approximately 40,000 km. determine the percentage by which your answer differs from Earth’s actual circumference using the equation provided.