PFS 27-10 4/7/14 _____

Eratosthenes!

Eratosthenes was born in North Africa about 276 BCE. From the age of thirty he lived in Alexandria, Egypt, where he served as librarian of the great Library of Alexandria. Eratosthenes was interested in many things: poetry, math, astronomy, geography, music theory, etc. He is one of my heroes! Here are two reasons why.

I. The Sieve of Eratosthenes

Eratosthenes found a way to find "all" prime numbers without factoring any numbers or doing any division! His method is called a sieve, and it's something like a pencil and paper computer program. Here's how to make one:

On a sheet of graph paper write numbers in order using six columns. Go as far as you can! Your sieve will start like this:

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

Put a triangle around the number 1; it's special—it's a unit. From now on, the next number you see that's not crossed out is the next prime, automatically! So 2 must be the first prime number. Circle it! Now all the other multiples of 2 can't be prime, so cross them all out by drawing a line down three columns. Continue. The next number you see is 3, so it's the next prime! Circle it! Cross out all the other multiples of 3. What's the next number that's not crossed out? It's 5! Circle it! Cross out all the other multiples of 5. And so on.

1) What number did your sieve go to? What prime numbers did you find? What did you notice?

2) Do modern mathematicians still use sieves to find prime numbers?

3) What is a "lucky number"?

4) Please help Bob! Here's what he told his friend Ann: "Well, how did you like that math homework last night? Find out if 211 is prime! That's way too much work so I just used a calculator. I divided 211 by 2, and got 105.5, so I knew 2 wasn't a factor. Then I divided 211 by 3, and got 70.33333…, so I knew 3 wasn't a factor. Then I divided 211 by 4 and got 52.75, so I knew 4 wasn't a factor. I kept at it till I divided 211 by 210 and got 1.00476…, so I knew 210 wasn't a factor. And that proved it! 211 is prime! It only took me an hour!" "Silly you," said Ann. "I did the same assignment in less that two minutes, and I didn't need no stinkin' calculator!" Help Bob learn a better way!

II. The Circumference of the Earth

Eratosthenes measured the circumference of the earth without leaving his backyard! His measurement was quite accurate! How was he able to do this? Here are some things he knew:

a) He knew a basic fact about geometry. You can know it too. Draw two parallel lines on lined paper, and a third slanting line that intersects the other two lines. Use a protractor to measure all eight angles. What do you notice?

b) He knew that the sun's rays are not parallel—they all meet in the center of the sun. But he also knew that the sun is *very* far away, and that the earth is small compared to the sun, so that the sun's rays that hit the earth can be considered parallel.

c) He had heard that in the southern Egyptian town of Syene (modern Aswan) at noon on the summer solstice, the sun was directly overhead.

d) He knew Syene was about 500 miles south of his home in Alexandria.

e) When Eratosthenes set up a vertical pole in his backyard on the summer solstice, he noticed the sun was *not* overhead where he lived. The shadow showed that the sun was about 7 degrees, or a fiftieth of a circle, away from vertical.

5) Explain how Eratosthenes did it! Use carefully made drawings and diagrams to support your written explanation.

6) What measurement would Eratosthenes get, based on the numbers in this POW? What is the correct circumference of the earth?

7) Why do you think people like Eratosthenes already thought of the earth as a sphere? What evidence would thay have had?

Postcript

Ancient Alexandria was a pretty amazing place. One of the most important books in the history of the human race, Euclid's *Elements*, was written there. The *Septuagint,* the first translation of the Hebrew bible into Greek, was made there as well. Appolonius Rhodius wrote the *Argonautica* there—the fabulous story of Jason and the Argonauts. What do you think made it a place where so much progress was made in literature, math, science, geography, etc.? Are there lessons we can learn from Alexandria?

8) Have fun!