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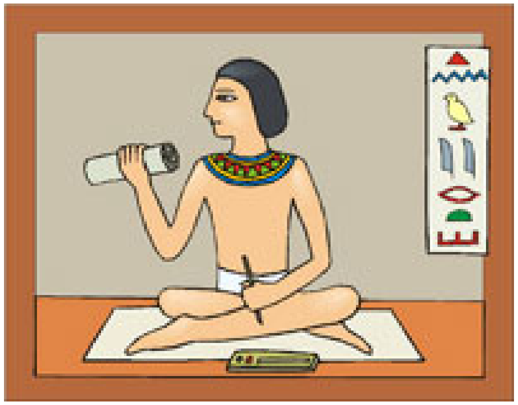
Ahmes and Angles - Egyptian Mathematics

By Colleen Messina



In the 1850s, a man named Mr. Rhind bought an amazing papyrus manuscript. A scribe named Ahmes, the Moonborn, wrote the manuscript in 1575 B.C., and it contains most of what we now know about Egyptian mathematics. The manuscript describes the Egyptian number system, the Egyptian use of fractions to divide rations of bread and beer among the workers, and geometric calculations. The Rhind Papyrus hangs in the British Museum in London, and it is one of the oldest mathematical documents in the world. Although it is hard to pinpoint exact dates for ancient cultures, the Egyptians' civilization thrived from about 4000 B.C. to 500 B.C., and they made many strides in the development of mathematics.

Mathematics had come a long way since the hunters and gatherers first figured out the lunar cycle. The Egyptians developed a system of writing called hieroglyphics that used pictures to represent words and numbers, but they still had no zero in their numerical system. A papyrus leaf represented the number 1; bent-over papyrus leaf represented 10; a coiled rope represented 100; and the sacred lotus flower represented 1,000 (Egyptians believed that a god who appeared from a lotus created the world). Animals represented the larger Egyptian numbers; a snake represented 10,000, and a tadpole was the symbol for 100,000. A figure of a scribe represented the number 1 million, so the scribes were pleased! Repeating the symbols created larger numbers. For example, three coiled ropes meant 300.

Scribes like Ahmes learned to read and write, but many Egyptian children did not attend school. If the future scribes complained about school, they had to listen to a list of the problems that faced other professions. Metalworkers supposedly choked on smoke from the furnaces, and weavers had cramped places to work. School was challenging and the teachers were strict, but the young people had some fun learning about numbers through games. They learned how to use numbers for practical things, such as counting household goods, organizing soldiers in the army, and keeping track of taxes. They also learned calculations to help with farming.

Farming was one of the most important jobs in ancient Egypt because farmers had to produce food for everyone. Egyptian farmers needed a more precise calendar. At first, they still used the lunar calendar to plan their farming, but since this calendar had only 360 days (12 cycles of 30 days,) they had to add days to remain in harmony with the seasons. The Egyptians replaced their lunar calendar with the first solar calendar in approximately 2772 B.C. This calendar was 365 days long, the actual time it takes the earth to orbit the sun. Across the globe, in Central America, the Mayan civilization also developed a solar calendar.

Egyptian farmers had other challenges that led to better methods of measurement. Each year the Nile River flooded, leaving behind a stretch of fertile land where the Egyptians grew their crops of barley and emmer wheat. Therefore, each year the boundaries of the fields had to be accurately redrawn. Egyptian surveyors or "rope stretchers" used lengths of ropes with equally spaced knots tied in them to measure land boundaries. When two fields bordered one another, the rope stretchers had to measure a right angle to form the corners of the fields. The establishment of boundaries was also important because the area of the land determined the amount of taxes, and the scribes kept the accounts for taxation.

After much trial and error, the surveyors eventually discovered that if one segment of the rope had three spaces between the knots, a second segment had four spaces between the knots, and the last segment had five spaces between the knots, a right triangle was easy to make. This right triangle with its right angle made measuring fields easy, and it was also useful when farmers were digging irrigation ditches. Since water was so important in the dry land of Egypt, the irrigation ditches had to have level bottoms and walls at right angles so that the water flowed easily in the right direction. The concept of a right angle might sound simple to us, but it was an important moment in mathematics. Later, a Greek mathematician named Pythagoras developed an important theorem about the right triangle.

Unfortunately, some of the land that the surveyors measured

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could not form a perfect square or rectangular. The surveyors realized that if they could find the area of a triangle, they could measure any field. The Egyptians figured out that the area of any triangle was the length of the base multiplied by its height divided by two. The method of using triangles to calculate areas, called triangulation, has been used by surveyors ever since.

In addition to triangles, the Egyptians also figured out the geometry of circles. Ahmes, the scribe, was the first person to record the important mathematical ratio called *pi*. He said that the area of the circle is nearly three and one-seventh times as great as the area of a square drawn on its radius. The Egyptian value of *pi* was 3.16, which is less than one percent off the true value of 3.14. No one knows why the Egyptians calculated this value, except to perhaps measure land and buildings more precisely. The value of *pi* is the only topic from ancient mathematics that is still used in modern mathematical research.

The value of *pi* is also significant in the dimensions of the pyramids, the most memorable accomplishment of the Egyptians. In the Great Pyramid at Giza, the ratio of the length of one side to its height is approximately the value of *pi* divided by two. This pyramid is almost 450 feet high. The sides once were white with polished limestone and the gold-tipped capstone caught the rays of the sun. Archaeologists have discovered more than eighty pyramids of different sizes and shapes in Egypt, and the earliest one goes back to 2650 B.C.

No one is certain how the Egyptians laid over 2,000,000 stone blocks, each weighing 2.75 tons, to build the Great Pyramid, but we do know that the Egyptians' understanding of geometry was vital for this monument. With their understanding of right angles, they laid out correct direction lines, and they figured out a north-south line by observing shadows, so all pyramids' bases face exactly north, south, east, and west. The architects of the pyramids also had to draw plans, level the edges of stone blocks, and place them squarely in the right position. Although the builders left no precise records, we can be sure that they used geometry to do this. The Rhind Papyrus also mentioned calculations for the volume of rectangles, triangles, and pyramids.

The Egyptians made progress in many areas of mathematics and geometry, and built some of the greatest monuments in the world, but they also had a sense of humor. Ahmes, the scribe, had one joke in his ponderous mathematical text. He theoretically calculated how much grain could be saved if forty-nine cats ate 343 mice!

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Questions

_____ 1. What was the significance of the Rhind Papyrus? Check the true statements.

A. It hangs in the Metropolitan Museum in New York City.
B. It contains most of what we now know about Egyptian mathematics.
C. It describes the problems of certain ancient professions.
D. It is one of the oldest mathematical documents in the world.

_____ 2. What was the symbol for the number 1 million in the Egyptian numerical system?

A. a lotus
B. a snake
C. a papyrus leaf
D. a scribe

_____ 3. Which statements about the Egyptian calendar are true? Check all that apply.

A. It was written in stone.
B. It was based on the sun.
C. It had 365 days.
D. The Pharaoh sold calendars as a fundraiser to build the pyramids.

_____ 4. What kind of angle did the Egyptian surveyors use to construct land boundaries?

A. acute
B. obtuse
C. right
D. isosceles

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______ 5. What was another name for an Egyptian surveyor?

A. field boundary finder
B. rope puller
C. rope stretcher
D. twine dragger

______ 6. How much did each stone block for the Great Pyramid weigh?

A. 27.5 lbs.
B. 27.5 tons
C. 2.75 lbs.
D. 2.75 tons

______ 7. How close was the Egyptian value of *pi* to the true value?

A. between 2% and 5% off
B. between 6% and 10% off
C. way off
D. less than 1% off

______ 8. What process or value is relevant to modern mathematical research?

A. the number of bricks used to build the Great Pyramid
B. the process of triangulation
C. the value of *pi*
D. the process used to build the Great Pyramid

Write a short description of how Ahmes might have figured out the number of mice that could be eaten by forty-nine cats.

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There are many theories about how the pyramids were built. How do you think the Egyptians moved and positioned the heavy blocks to build the pyramids?

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