$3 + ? = 12$ $x - 7 = 4$ $? + 8 = 17$

The History of

Number Systems

Place Value

Gabriel Esmay

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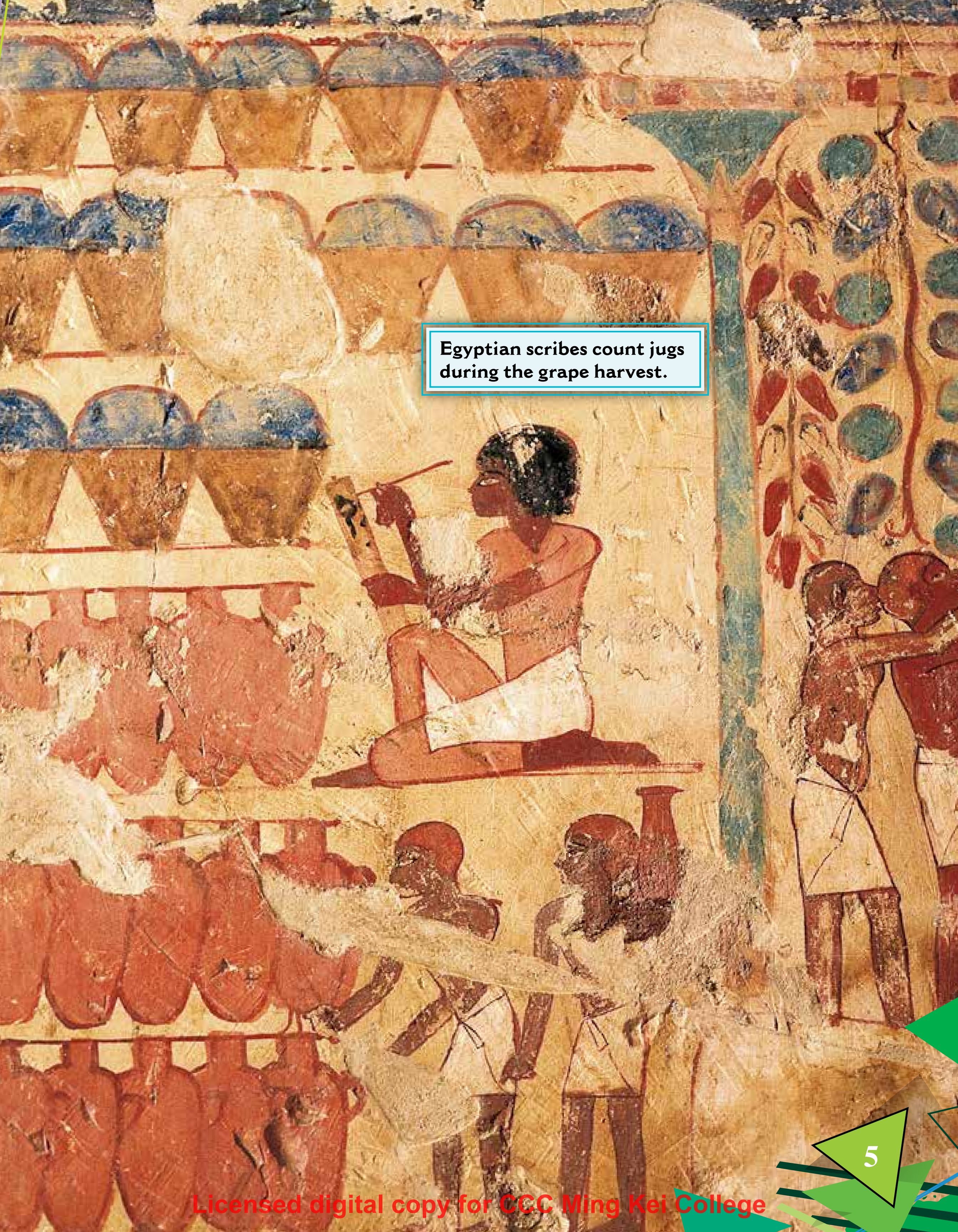
Table of Content

Timeless Need

For as long as humans have walked the earth, they have needed to show numbers. Farmers count **crops** and animals. People track time. Merchants track goods. Builders measure structures. So, people of the past created **number systems**.

Early cultures were very creative. People used pictures, letters, knots, dots, and bars. These symbols stood for numbers. They were carved in stone and clay. They were written on early forms of paper. They were even tied into string. These **ancient** number systems may not look the same as the modern number system. But keep looking. You may just see some things you recognize!

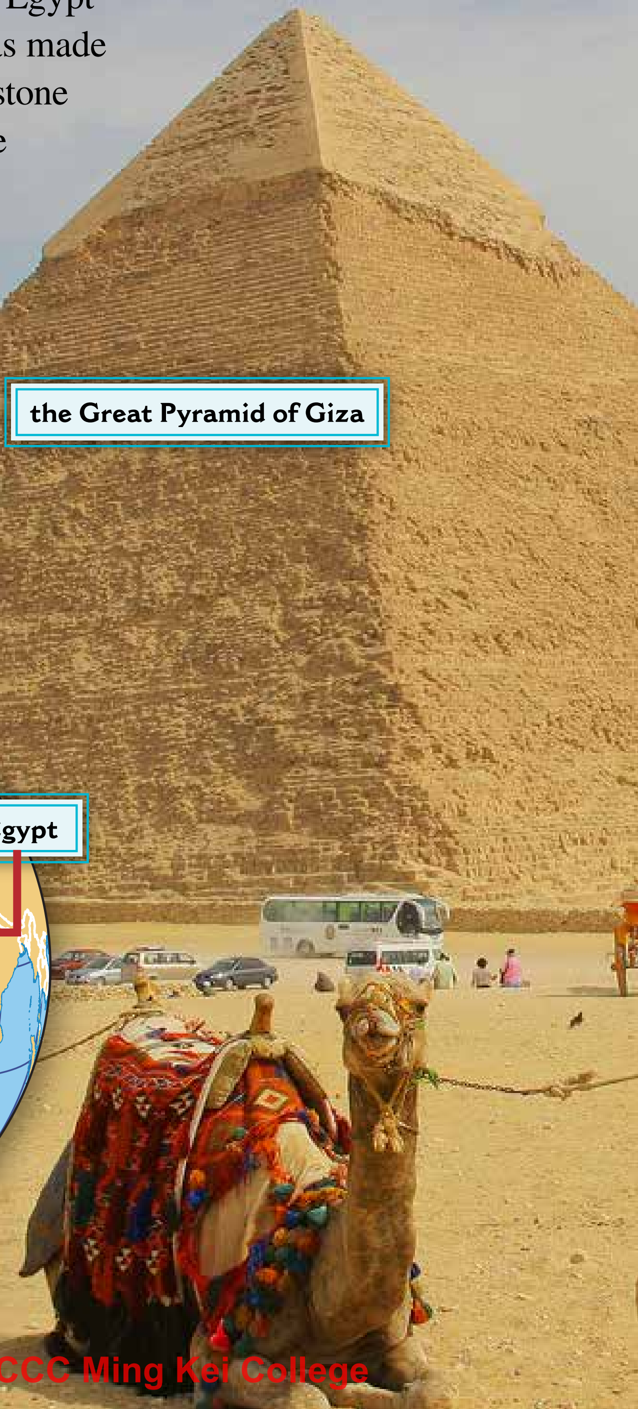
geometry problems carved into a clay tablet from Babylon



Egyptian scribes count jugs during the grape harvest.

Egypt

The Great Pyramid has stood in Egypt for over four thousand years. It was made from more than two million large stone blocks. It is the only wonder of the ancient world that is still standing. Of course, no modern tools were used. But the builders were not alone. They had math and number systems to help.



the Great Pyramid of Giza

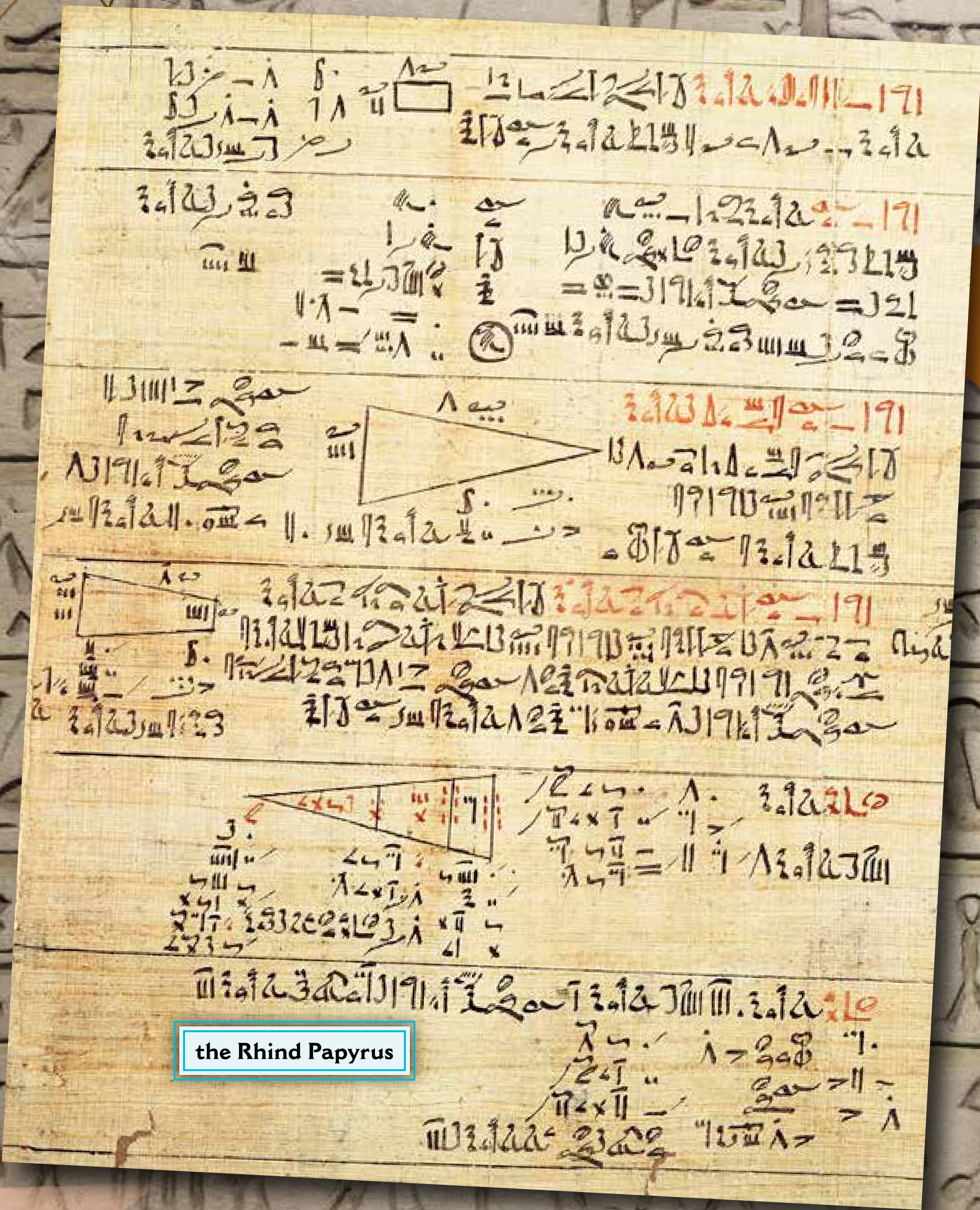

Egyptian glyphs

Egyptian symbols do not look the same as numerals today. They were **glyphs**, or pictures, that were carved into stone. They stood for words and numbers.

Just like today, 10 was a key number. Glyphs were carved many times to show larger numbers. To show the number 30, the glyph for 10 was carved three times. If 10 glyphs were needed, a different glyph was used. This way, the number did not take as long to carve.

LET'S EXPLORE MATH

The Great Pyramid of Giza was originally about 481 feet tall. In time, parts of the pyramid have worn away. It is now about 455 feet tall. How can you use place value to tell that 455 feet is less than 481 feet?



the Rhind Papyrus

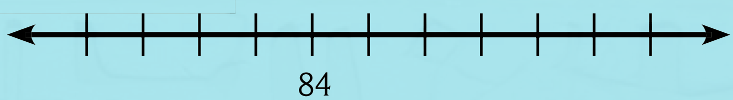
Later, Egyptians started writing on **papyrus**. It was an early paper made out of plants. Over time, the look of some glyphs changed. And, more glyphs were added. The system did not use **place value**. So, symbols could be written in any order. But still, Egyptians used the symbols to do math. They could add and subtract. They could even multiply and divide.

Egyptians could write math problems, too. They wrote the Rhind Papyrus around 1550 BC. It was a very early math text. Many of the problems in the text are about triangles. Others ask how many loaves of bread can be baked. Some ask how many bricks should be used to build a ramp. These problems helped Egyptians in their daily lives. But, there is one thing that was not found on it—a zero! Egyptians had no symbol for zero.

LET'S EXPLORE MATH

The Rhind Papyrus has 84 math problems. Use the number line to answer the questions.

1. Between which two tens does 84 fall?
2. Which ten is 84 closer to?



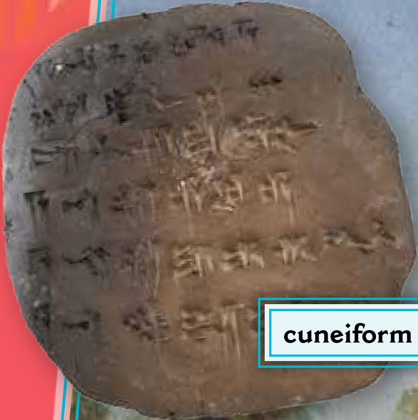
Babylon

Around 2000 BC, a great city was emerging. Babylon was known for its size, beauty, power, and wealth. It is said to have had stunning gardens perched high off the ground. But so far, no one has found these gardens. What has been found is Babylon's number system.

The number system was based on groups of 60. History experts have many thoughts about why they might have picked 60. But no one knows for sure.

The number symbols were wedge shaped, called **cuneiform** (kyoo-NEE-uh-form). They were carved in wet clay tablets with a **stylus**. The wet clay was not easy to work with, and they could not draw curved lines in any of the symbols. The wet clay was then dried in the sun. Many of these tablets are still around.

The ancient city of Babylon was southwest of modern-day Baghdad in Iraq.



cuneiform

Hanging Gardens of Babylon

LET'S EXPLORE MATH

Many legends have been written about the Hanging Gardens of Babylon.

1. If the gardens did exist, they probably would have been built around 605 BC. What is this year rounded to the nearest hundred?
2. The Babylonian priest Berossus wrote about the gardens around 280 BC. What is this year rounded to the nearest hundred?

Babylon's number system used only two symbols. But, many numbers could still be formed. As in Egypt, symbols were carved to write numbers, and there was still no symbol for zero. But, there was one big difference between the systems. The order of the symbols in Babylon's system mattered a lot.

To keep track of the order, symbols were placed in columns. This told the value of the symbol. It was the first time place value had been used. This changed the way people viewed numbers. The modern number system is based on groups of 10, not 60. But it still uses place value. We can thank Babylon for that!

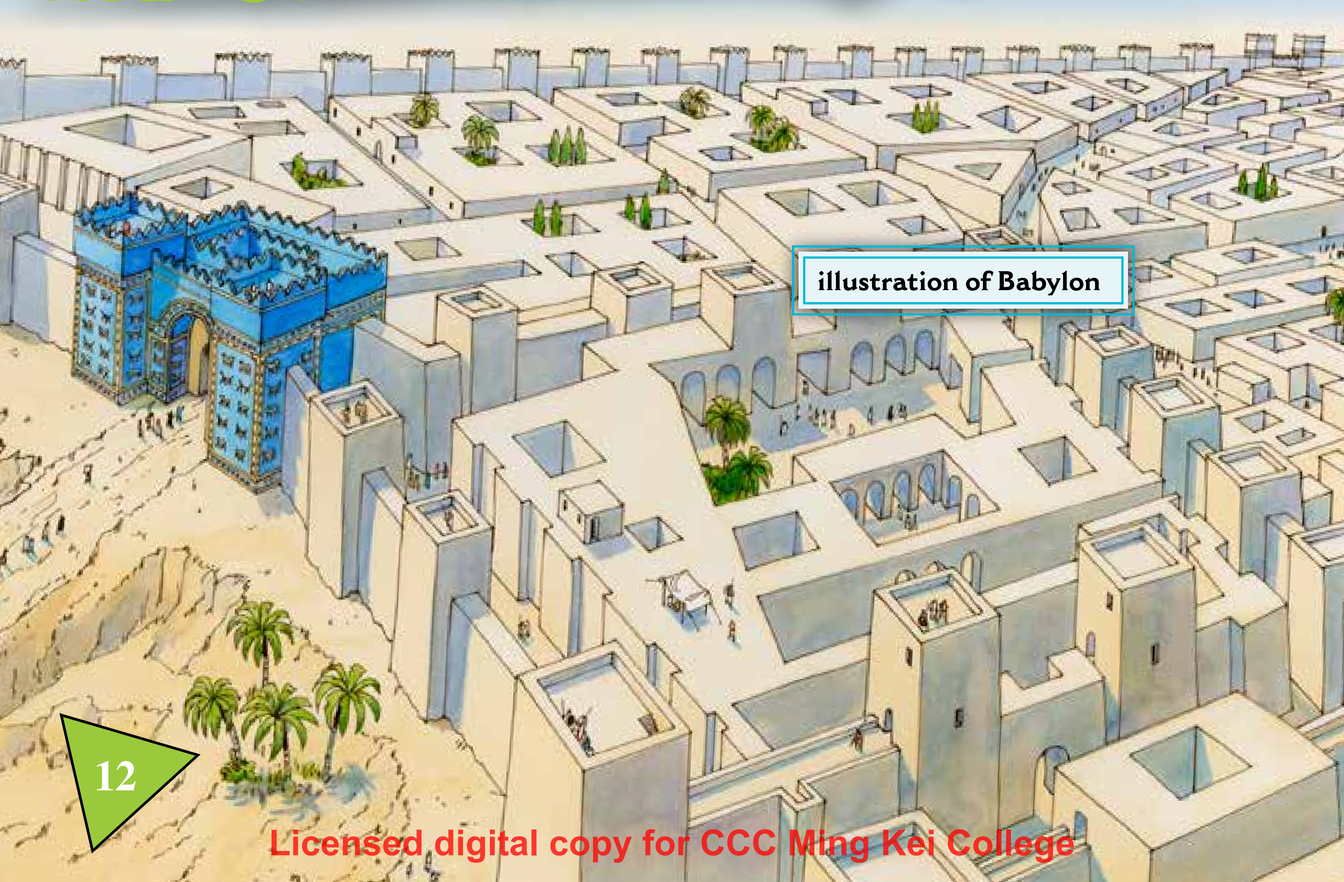
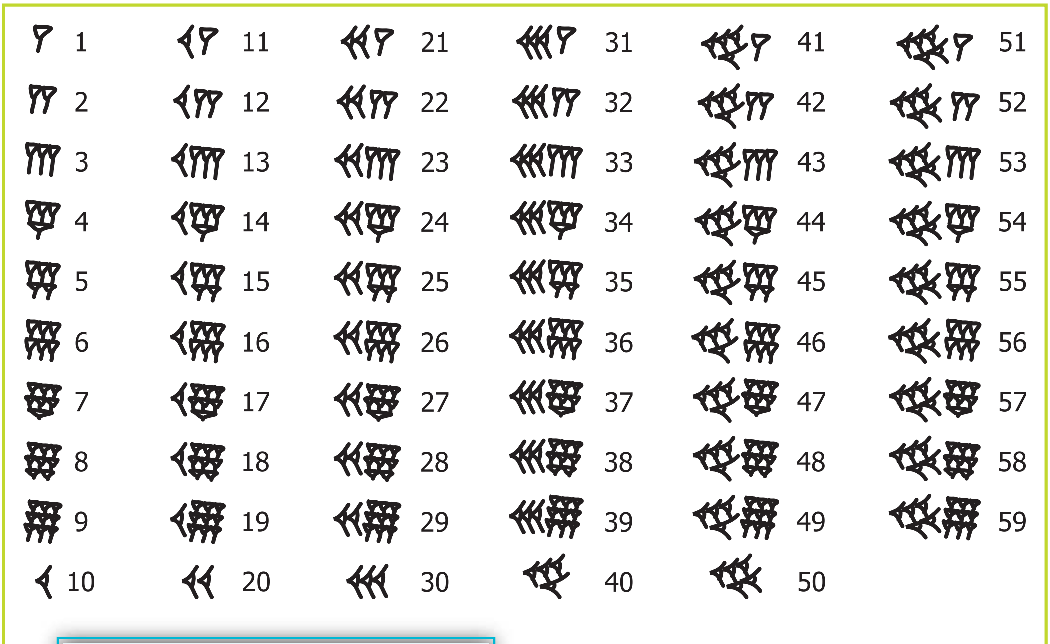


illustration of Babylon



Babylonian number system

The Roman Empire

Have you ever seen clocks with letters instead of numbers? Or, have you ever noticed letters after the name of an event? Odds are, you saw Roman numerals.

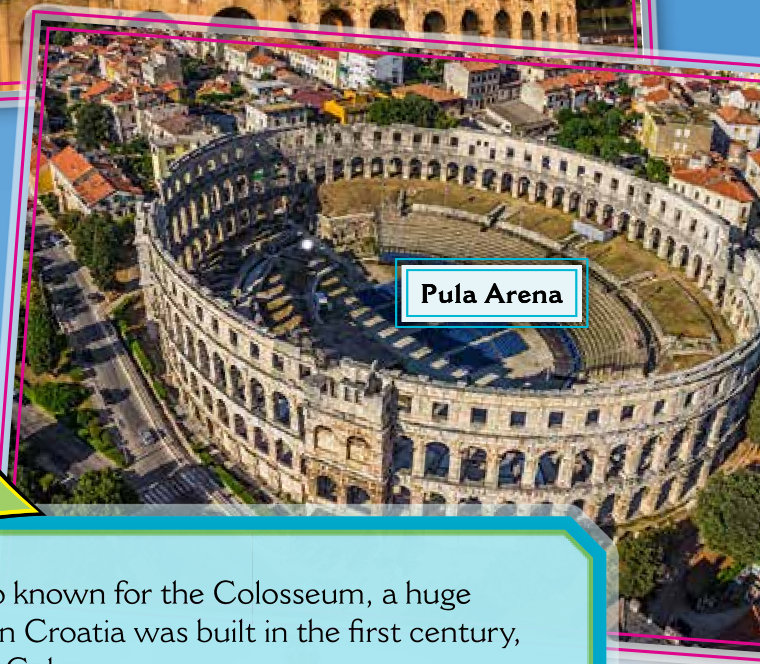
The Roman Empire was known for its size and strength. Romans led the way in trade. They knew they needed a way to keep track of their goods. So, they made a system for writing numbers around 850 BC. It would be the main system of Europe for nearly two thousand years.

The Romans used seven **digits**. The digits looked like letters. And they were written from left to right. Depending on the order, they would add or subtract the values of the letters.

Roman numerals are sometimes still used today. But, there is no symbol for zero. And there is no easy way to write large numbers. So, other systems have been more widely used.

Roman numerals on a clockface

ruins of the Roman Colosseum

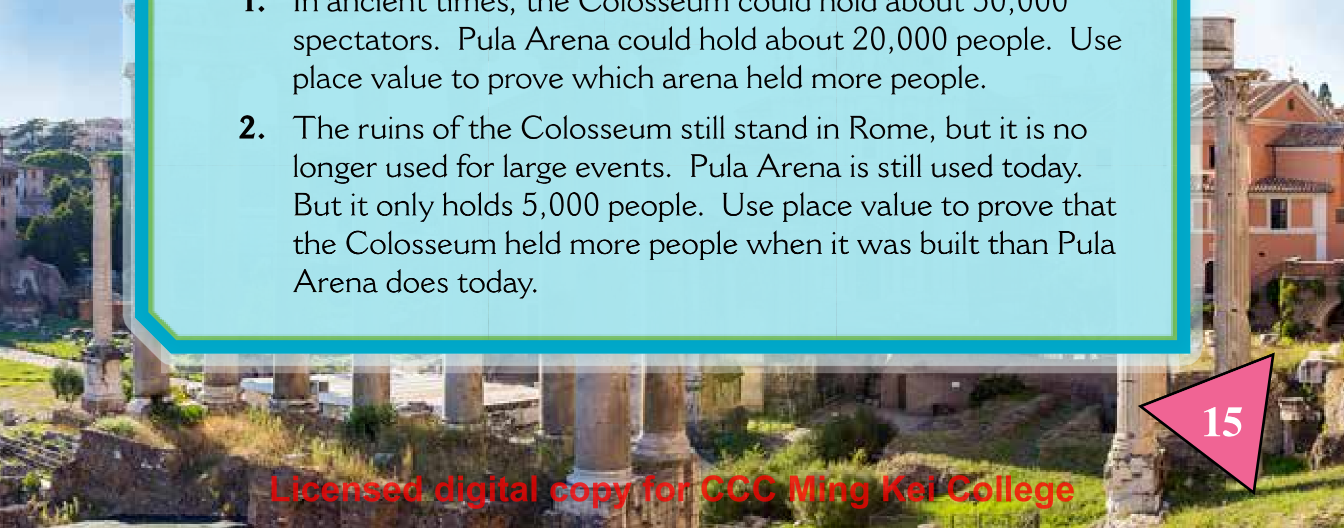


Pula Arena

LET'S EXPLORE MATH

The Roman Empire was also known for the Colosseum, a huge outdoor arena. Pula Arena in Croatia was built in the first century, around the same time as the Colosseum.

1. In ancient times, the Colosseum could hold about 50,000 spectators. Pula Arena could hold about 20,000 people. Use place value to prove which arena held more people.
2. The ruins of the Colosseum still stand in Rome, but it is no longer used for large events. Pula Arena is still used today. But it only holds 5,000 people. Use place value to prove that the Colosseum held more people when it was built than Pula Arena does today.



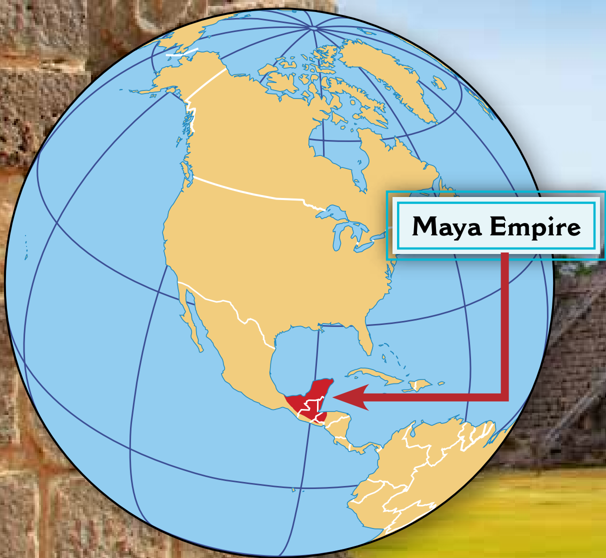
The Americas

Not all number systems started in Europe, Africa, or Asia. Groups in the Americas had their own systems, too.

The Maya Empire

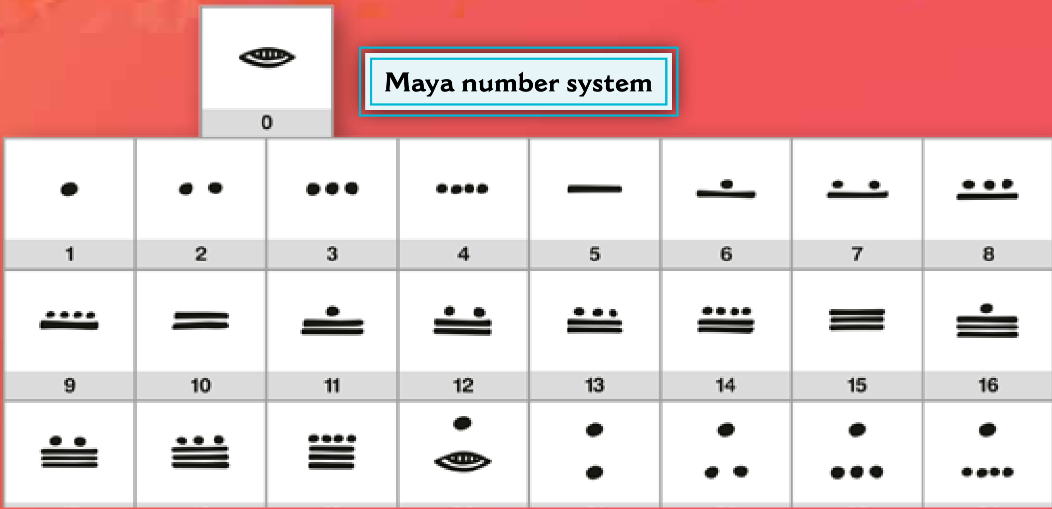
The Maya of North and Central America were a large group. Their culture peaked from AD 250 to AD 900. But people first moved to that area four thousand years ago.

El Castillo pyramid in Mexico was built by the Maya around AD 1000.



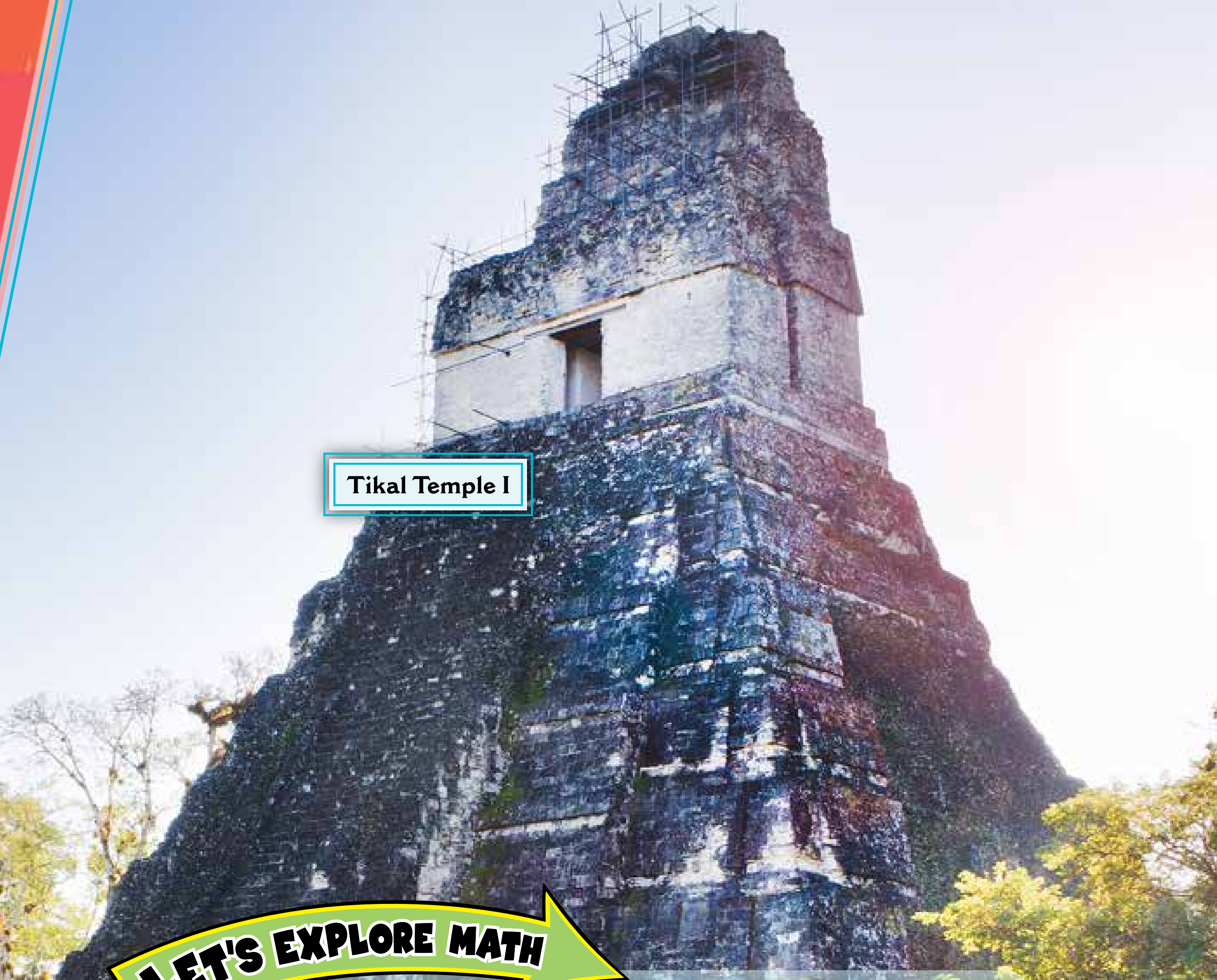
The Maya were known for being an advanced people. Math was vital to them. Some of their art even shows people with number scrolls. The Maya built huge structures. They studied the skies and stars. They even built a wheel that kept track of days and years. They also bought, sold, and traded goods. So, they needed a number system. They had to be able to write and use numbers in daily life.

Maya Calendar



Maya number system

The Maya number system was based on groups of 20. Experts believe that the Maya may have used 20 because it was as high as they could count on their fingers and toes. Whatever the reason, there were only three symbols in the Maya system. A dot stood for one. A bar stood for five. And a symbol that looks like a shell stood for zero. This was a big deal! The Maya were the first to grasp the concept of zero. They also knew how important it is for zero to have a symbol. It makes writing large numbers easier. Zero finally had a spot in the place value system! Whether or not a zero is in the number, Maya numbers are read from the bottom up. The symbols are stacked on top of each other. Each level has a certain place value.



LET'S EXPLORE MATH

Many of the large structures built by the Maya were used for religious ceremonies. Some of the ruins still stand today. Listed below are the approximate heights of these Maya structures. Write the heights in order from least to greatest:

Nohoch Mul: 42 m
El Castillo: 30 m
La Danta: 70 m
Tikal Temple I: 47 m

The Inca Empire

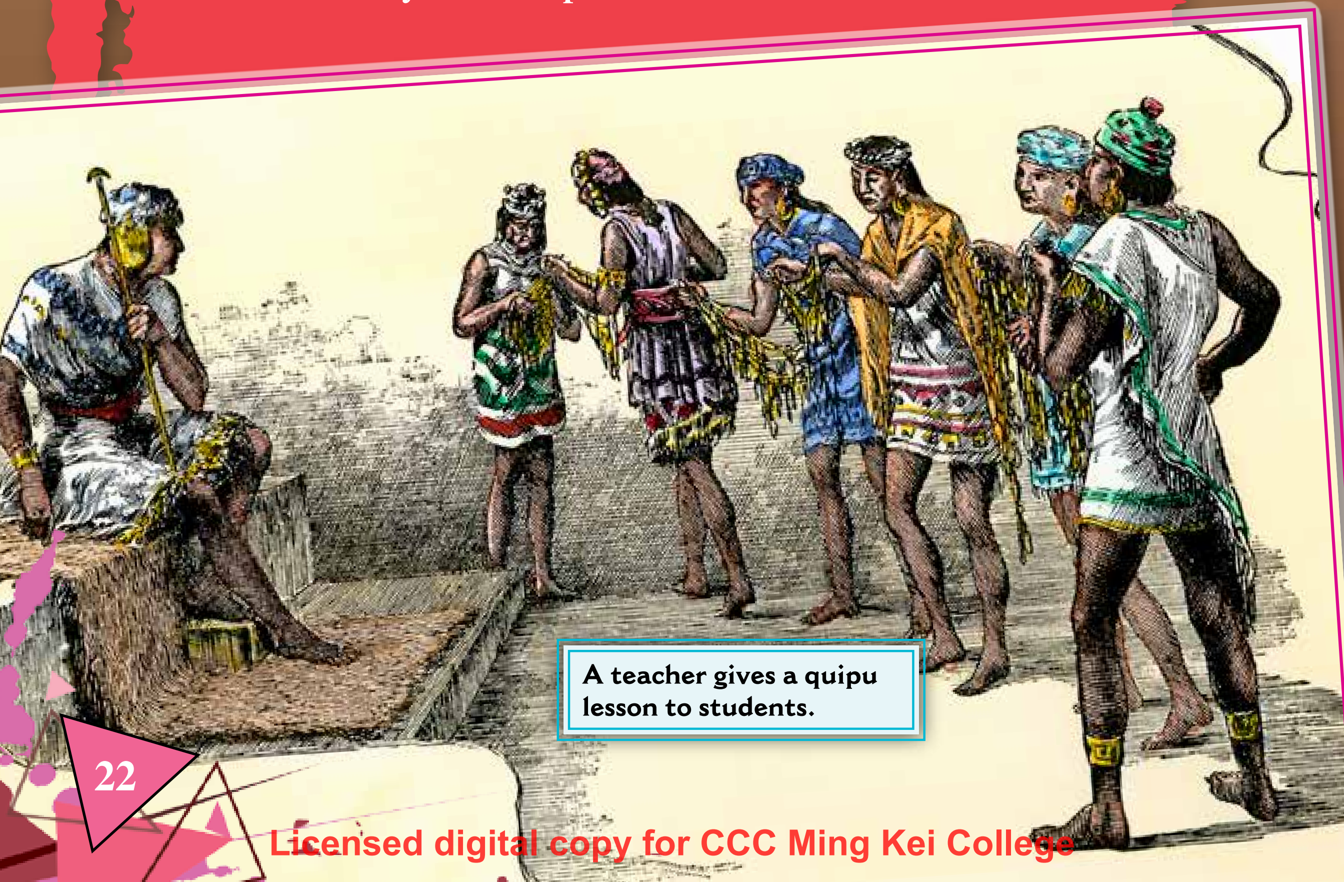
The Inca Empire rose to power in South America about AD 1450. The empire was huge! It covered 300,000 square miles (780,000 square kilometers) of land. And, at its peak, its population was around 12 million people.

The Inca spoke 20 languages. But, they did not have a written language. That meant they could not write numbers. But they still had to find a way to keep track of numbers.

So, the Inca tied knots on string. The group of knotted strings was called a **quipu** (KEE-poo). This was a way to record numbers without writing. It could not help them solve math problems. But it was still very important to the Inca. In fact, there was a job called the "keeper of the knots." People with this job worked for the king.

The quipu system was based on groups of 10. And, the concept of place value was used. Recording a larger number meant tying more knots. The Inca did not have a symbol, or special knot, for zero. But, they did leave blank spaces where zeros would go.

There were many things to track when using a quipu. First, the Inca had to know how to read the numbers from the knots. Second, only one number was shown on each string. A quipu could have many strings on it. So, they had to know what each number stood for. To help with this, different-color strings were used. Colors had different meanings. Certain colors stood for the number of animals, such as cows or sheep. Some colors were symbols of war. Others were symbols of peace.



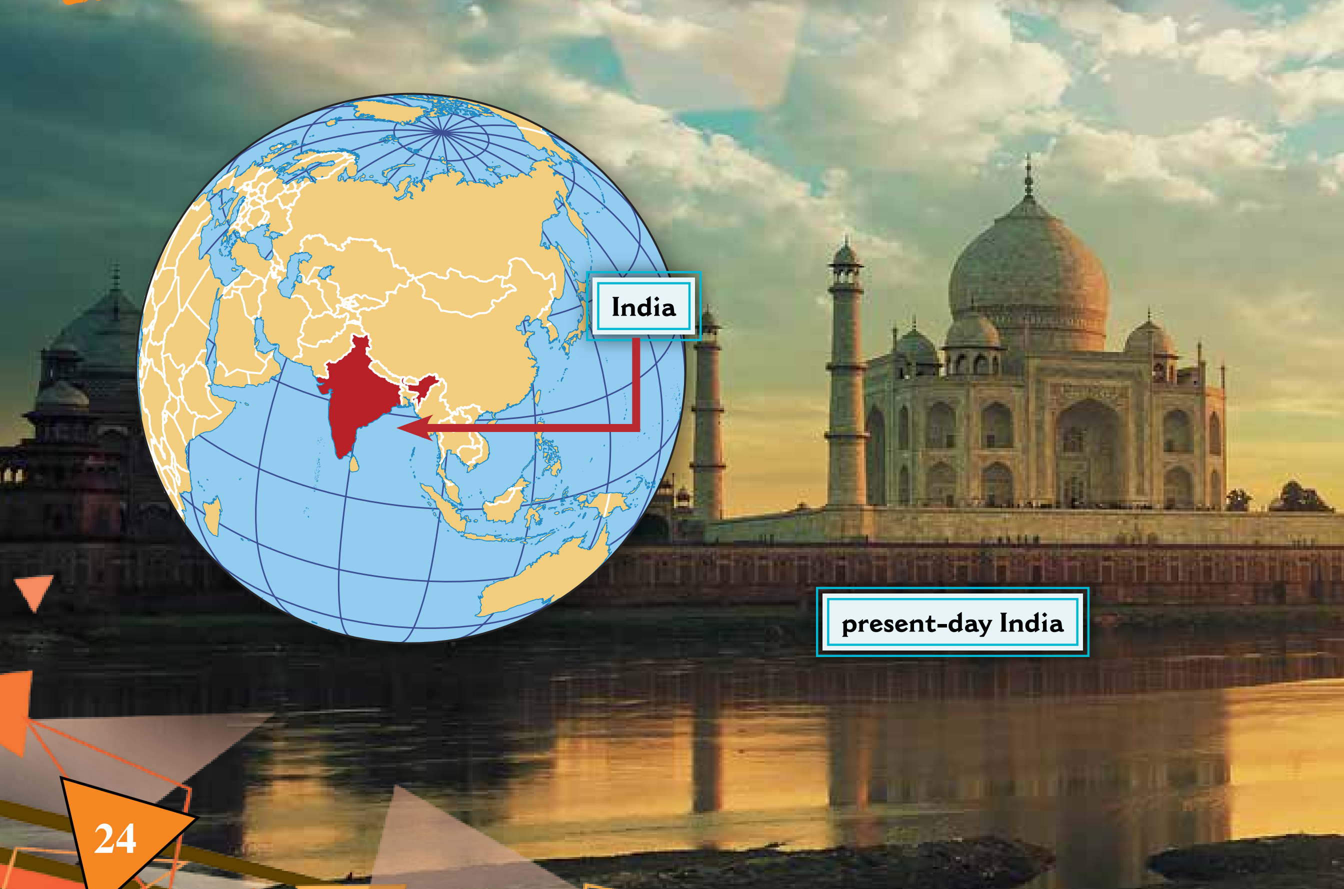
A teacher gives a quipu lesson to students.


quipu

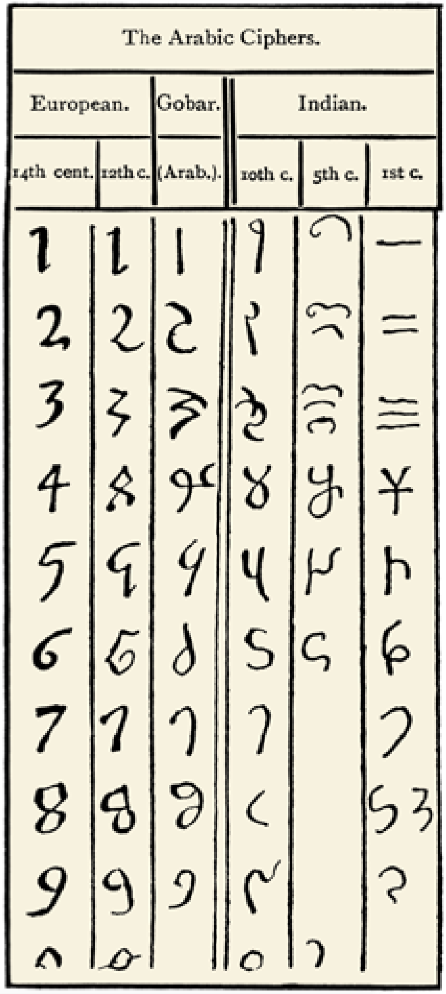
Modern Beginnings

The modern number system is made possible by nothing. Well, it is made possible by the concept and symbol for nothing—zero. It uses place value. And zero can be used to show a place with no value.

This system was formed in India around AD 650. But, it was the Arabs who first brought it to Europe. Before that, people counted on their fingers and toes. And they used letters as numbers.



The Hindu-Arabic system changed all of this. It is based on groups of 10. The digits range from 0 to 9, like the digits used now. But, they did not look the same back then. The symbols were more **intricate**. They took longer to write. Over time, they got simpler to make writing faster. They were easier to use in other ways, too. By using digits and groups of 10, all numbers, small and large, can be written more quickly. Soon, people saw how helpful this system could be.



This table shows the development of written numbers from the first century to the fourteenth century.

Future of Number Systems

Ancient groups of people needed to express numbers. So, they made symbols that worked for them. We owe much to the people of the past. Place value, symbols, and zero paved the way for how we use numbers today. And number systems are still changing.

Computers use a number system that is based on groups of 2, not 10. The **binary** system has just two digits: 0 and 1. Computers use it to store data and solve problems. So, no matter what a user types, computers change it all to 0s and 1s.

Number systems have changed before. Will they change again? Many people now believe that we should use groups of 12, not 10. But one thing is clear. However numbers are written or shown, we will always need them.

Problem Solving

At a site near Giza, Egypt, there are three huge pyramids named after kings Khafre, Khufu, and Menkaure. Along with the pyramids, there is a structure, the Great Sphinx, which has the body of a lion and the head of a human.

By now, some of the structures at Giza have lost a bit of their height due to **erosion**. Use the information in the table to compare the heights of these famous structures as they stand today.

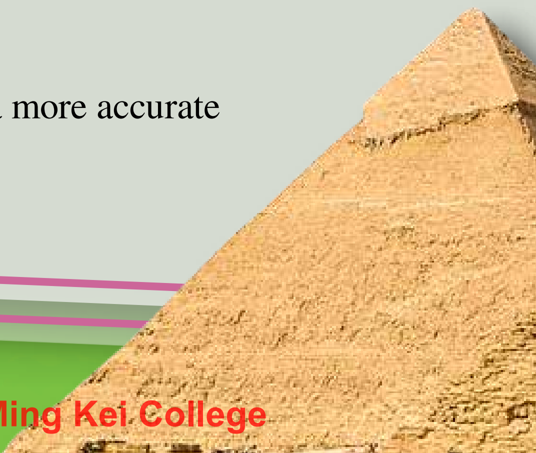
1. Use > or < to compare the heights:
a. Khufu Pyramid ________ Khafre Pyramid
b. Menkaure Pyramid ________ Khafre Pyramid
c. Menkaure Pyramid ________ Great Sphinx

2. Write the heights of the structures in order from greatest to least.

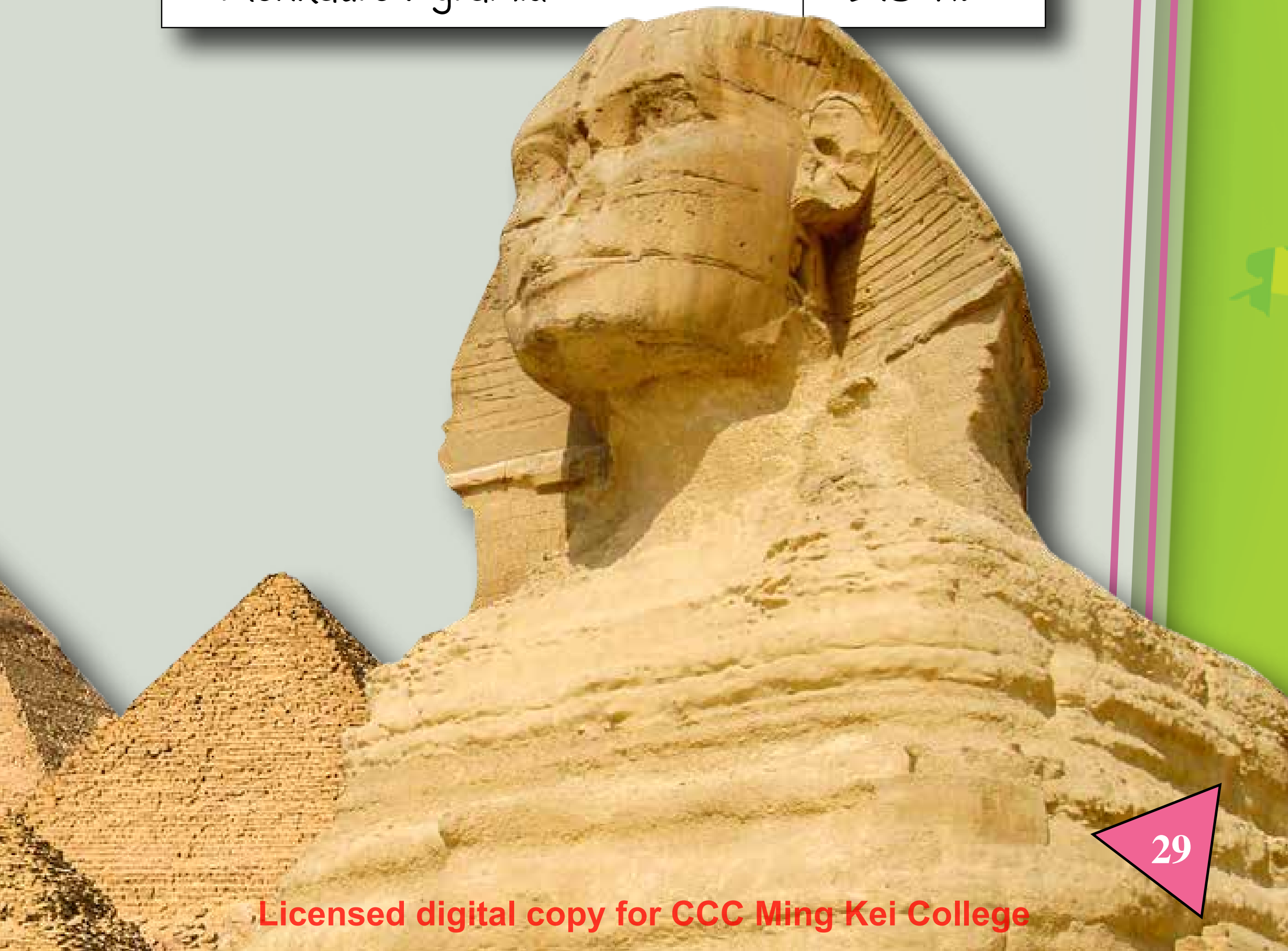
3. What is the height of each structure when rounded to the nearest ten?

4. What is the height of each structure when rounded to the nearest hundred?

5. Which set of rounded heights gives a more accurate estimate? Why do you think so?



Structure	Height
Great Sphinx	66 ft.
Khafre Pyramid	448 ft.
Khufu Pyramid (Great Pyramid)	455 ft.
Menkaure Pyramid	215 ft.



Glossary

ancient—belonging to a time long ago

binary—relating to two parts

crops—plants grown by farmers

cuneiform—writing systems that have individual shapes made from wedges

digits—written symbols for any numbers

erosion—movement of weathered rock and sediment

glyphs—written characters that look like pictures

intricate—having many complex steps or parts

number systems—methods for expressing numbers

papyrus—a tall plant that grows in Egypt and can be made into paper

place value—the value assigned to a digit based on its position in a number

quipu—ancient Incan method of recording information by tying knots in different-color threads

stylus—a tool that was used for writing on clay tablets

Index

Answer Key

Let's Explore Math

page 7:

Each height has 4 hundreds. But, 5 tens is less than 8 tens. So, 455 ft. must be less than 481 ft.

page 9:

1. Between 8 tens and 9 tens, or 80 and 90
2. 8 tens, or 80

page 11:

1. 600 BC
2. 300 BC

page 15:

1. The Colosseum held 5 ten-thousands and Pula Arena held 2 ten-thousands. So, the Colosseum held more people.
2. The Colosseum held 5 ten-thousands. Pula Arena now holds only 5 thousands.

page 19:

30 m, 42 m, 47 m, 70 m

Problem Solving

1. a. >
   b. <
   c. >
2. 455 ft.; 448 ft.; 215 ft.; 66 ft.
3. 70 ft.; 450 ft.; 460 ft.; 220 ft.
4. 100 ft.; 400 ft.; 500 ft.; 200 ft.
5. The set that has been rounded to the nearest ten would give a more accurate estimate. When rounded to the nearest hundred, the estimates are farther away from the actual number.

Math Talk

1. What is the difference between a rounded number and an exact number?
2. What does a digit's position in a number tell about its value?
3. How is 10 used to organize the modern number system?
4. How can you use place value to compare two numbers?
5. One ancient number system never used any writing. Why do you think a written system is the one used most often now?
6. What would a number system look like with no zeros?