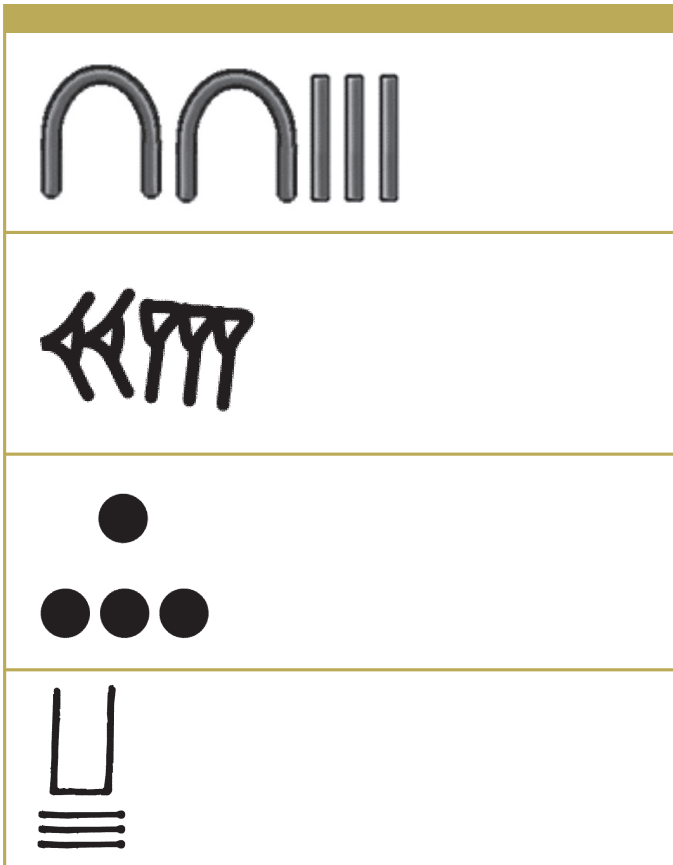


Ancient History Math Mystery



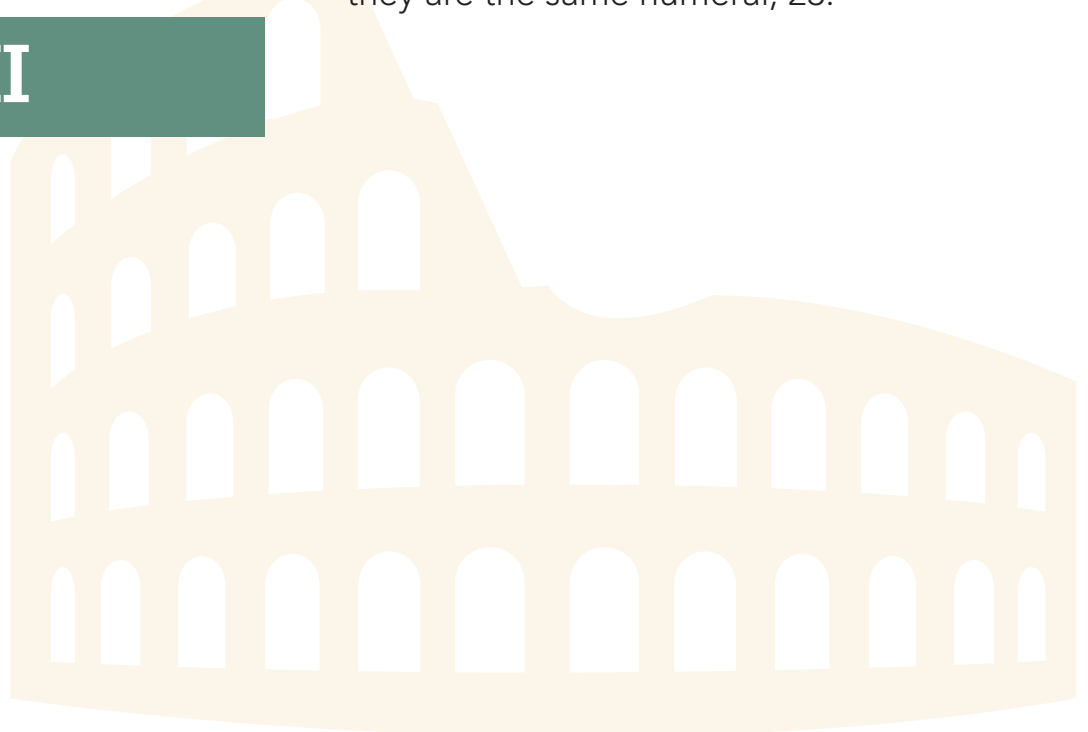
XXIII



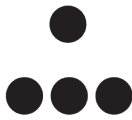
Here we have an ancient history mystery. Look at the symbols in the box to the left. Can you make a deduction about what they are or what they mean? Here is a clue. They all say the exact same thing. Do you have any theories?

When you make a deduction you use what you know to help you discover what you don't know. Is there anything familiar in the box to the left? Do you recognize any of the symbols?

No guesses yet? Well, how about another clue? Take a look at the next box. Does this symbol help you determine the meaning of any of the others? Are you getting warmer?

How about one more clue? This one should cinch the deal. The clue is 23. Eureka! The symbols in these boxes are all numerals; in fact, they are the same numeral, 23.



	Egyptian for 23
	Babylonian for 23
XXIII	Roman for 23
	Maya for 23
	Shang Oracle Bone for 23

Now that you know that all of these symbols stand for the numeral 23, examine them more carefully.

- What do they have in common?
- How are they different?
- Can you deduce which symbols stand for ones, tens, and twenties?
- How is our numeral for 23 different from all the others?

Types of Numeral Systems

There are essentially two types of numeral systems. One is called the unary system. A **unary system** is a type of numeral system that uses something like tally marks. Each number is represented by different amounts of symbols.

Another type of numeral system is called positional. A **positional system** uses place value to show the value of numerals. The Hindu-Arabic system is the positional decimal system that we use.

VOCABULARY



- 1) unary system
- 2) positional system
- 3) cuneiform
- 4) sexigesimal
- 5) vigesimal

ANCIENT EGYPTIANS

The ancient Egyptians used a unary system. Take a look at how they would have written the numeral 7.



When they got to the numeral 10, they had another symbol.



So, in ancient Egyptian the numeral 17 looks like this.

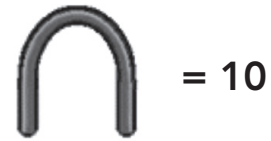


And the numeral 27 looks like this.



The ancient Egyptian system was a base 10 system. It has different symbols for powers of ten. This system was workable for smaller numbers, but it didn't work so well with large numbers. If the ancient Egyptians wanted to write the numeral 5,978,947, they'd have to use forty-nine symbols. Whew!

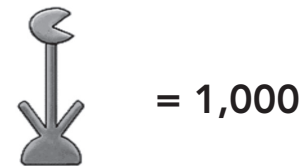
Ancient Egyptian Numeral System



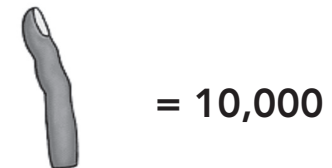
= 10



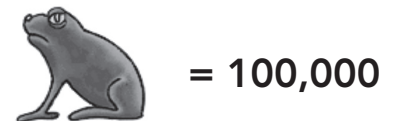
= 100



= 1,000



= 10,000



= 100,000



= 1,000,000

Roman Numerals

$$\text{I} = 1$$

$$\text{V} = 5$$

$$\text{X} = 10$$

$$\text{L} = 50$$

$$\text{C} = 100$$

$$\text{D} = 500$$

$$\text{M} = 1,000$$

Roman Numerals
5,000 & Greater

$$\overline{\text{V}} = 5,000$$

$$\overline{\text{X}} = 10,000$$

$$\overline{\text{L}} = 50,000$$

$$\overline{\text{C}} = 100,000$$

$$\overline{\text{D}} = 500,000$$

$$\overline{\text{M}} = 1,000,000$$

THE ROMANS

The Romans also had a unary system, but it was a little bit different from the Egyptian type. Roman numerals use a system of addition and subtraction to create numerals so you need to be pretty good at mental math to figure out the value of the numerals expressed. For example:

- **IV** is the numeral 4: $\text{V} - \text{I} = \text{IV}$
 $5 - 1 = 4$
- **VI** is the numeral 6: $\text{V} + \text{I} = \text{VI}$
 $5 + 1 = 6$

Here are few more examples:

- **XXXIII** is the numeral 33: $\text{X} + \text{X} + \text{X} + \text{I} + \text{I} + \text{I} = \text{XXXIII}$
 $10 + 10 + 10 + 1 + 1 + 1 = 33$
- **XL** is the numeral for 40: $\text{L} - \text{X} = \text{XL}$
 $50 - 10 = 40$

Roman numerals could get kind of tricky the greater the number became.

- **MDCCCLXXXVIII** is the numeral 1,888:
 $1000 + 500 + 100 + 100 + 100 + 50 + 10 + 10 + 10 + 5 + 1 + 1 + 1 = 1,888$

The Romans did not always agree on how to write numerals greater than 4,999. Often, a horizontal line over the top of a numeral meant that you multiplied that number by one thousand. Read this large Roman numeral and then write it in expanded form using Arabic numerals.


CMXXIVLXXXVII


Expanded Form: _____

BABYLONIANS

The Babylonians lived about 5,000 years ago in an area known as Mesopotamia. Archaeologists believe that they developed one of the first written numeral systems. The Babylonians had a numeral system that was a combination of a unary and a positional system.

The Babylonian system of writing is called **cuneiform**, which means *wedge-shaped* in Latin. If you examine the Babylonian number system, you can see that the numerals resemble tiny wedges.

In cuneiform the numeral 7 looks like this: 

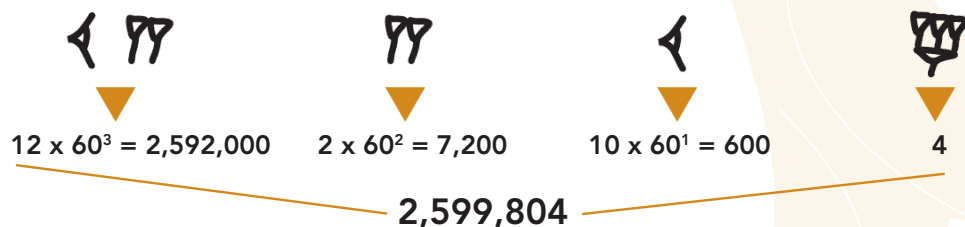
And the numeral 27 looks like this: 

This works for numerals up to 59. But take a look at the cuneiform numeral for 60 in the box in the upper right. It looks just like the cuneiform numeral for 1, doesn't it?

When the Babylonians wanted to show numerals above 60, they made sure to leave a space between the 60s and the ones to avoid confusion. It still can be a little confusing!

$$\text{𐎶} \text{ 𐎶𐎶𐎶} = 63$$

The Babylonian system is base 60, or **sexagesimal**. Take a look at how their place value system worked.



Try to determine the value of the cuneiform numerals in the place value chart below. Write your answers using our numerals in the column labeled Numeral.

Cuneiform Place Value				
216,000s (60^3)	3,600s (60^2)	60s (60^1)	1s	Numeral
	𐎶𐎶 𐎶𐎶	𐎶 𐎶	𐎶𐎶 𐎶𐎶𐎶	
𐎶𐎶 𐎶𐎶	𐎶		𐎶𐎶	

Babylonian Numeral System

$$\text{𐎶} = 1$$

$$\text{𐎵} = 10$$

$$\text{𐎶} = 60$$

THE MAYA

The Maya, who lived in an area known as Mesoamerica, had a vigesimal system that was both unary and positional. **Vigesimal** means base 20. The Maya were also the inventors of the numeral zero. It wasn't that other civilizations didn't understand the concept of zero, they just didn't create a numeral for it!

Maya Numerals 0-19

0	1	2	3	4
	•	••	•••	••••
5	6	7	8	9
	• 	•• 	••• 	••••
10	11	12	13	14
	• 	•• 	••• 	••••
15	16	17	18	19
	• 	•• 	••• 	••••

horizontal
orientation

stacked
horizontal
orientation

The Maya numeral system is a series of dots and bars for numerals 1-19. The numerals 1-5 are written horizontally in one row. Numerals 5 through 19 also use dots and bars, but the ones are stacked on top of the fives.

Once the Maya got to the numeral 20, they stacked them vertically and used powers of twenty to show their value. For example, this numeral is 5,125.

$$\begin{array}{rcl}
 \begin{array}{c} \bullet \bullet \\ \hline \hline \end{array} & = 400 \times 12 & = 4,800 \\
 \begin{array}{c} \bullet \\ \hline \hline \hline \end{array} & = 20 \times 16 & = 320 \\
 + \begin{array}{c} \hline \hline \hline \end{array} & = 5 & = 5 \\
 \hline & & 5,125
 \end{array}$$

Maya Place Value

8,000s (20 ³)		••
400s (20 ²)	•	
20s (20 ¹)	•	•••
1s		••
Numeral		

Try to determine the value of the Maya numerals in this place value chart. Record your answers in the row labeled "Numeral."

THINK INSIDE OF THE BOX

How can you compare the cuneiform numeral for 60, and the Maya numeral for 20?

SHANG ORACLE BONE NUMERALS

Shang oracle bones were used in the religious practice of divination by the ancient Chinese over 3,500 years ago. The numerals were etched into the bones themselves. This system was unary.



Shang Oracle Bone Fragment

Shang Oracle Bone Numerals

1	2	3	4	5	6	7	8	9	10	11	12	13
—	=	≡	≡	⌘	↗	+)(3		—	—	≡
20	30	40	50	80	88							
⊏	⊐	⊑	⌘)()(
100	162	200	500	600	656							
⊕	⊕	⊕	⌘	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕
1,000	2,000	3,000	4,000									
⌘	⌘	⌘	⌘									

Write 3,213 using Shang oracle bone numerals.

HINDU-ARABIC NUMERAL SYSTEM

The number system that we use is called the Hindu-Arabic numeral system. It is a positional decimal (base10) system. This system was developed in India about 2,000 years ago. It spread all across Europe by the time of the Renaissance. Before that, people living in Europe used Roman numerals.

This numeral system is very simple and easy to use. With only nine symbols and a zero, you can create literally trillions of numerals. A numeral's value depends entirely upon its position. Take a look at this number:

2,222,222,222,222

You know that the first 2 in this numeral is worth 2 trillion, while the last is worth only 2 ones. This is the strength of a purely positional system. Can you imagine how this numeral would look in ancient Egyptian, Maya, or cuneiform! Choose a seven digit Hindu-Arabic numeral, for example 6, 273,485. In the space below, write this numeral in one of the other number systems you have learned about. Swap papers with a classmate to see if they can read your number.

DID YOU KNOW?



The base 10, or decimal system evolved because people counted on their fingers.

page 4 answer

The expanded form of **CMXXIVLXXXVII** is:

$$900,000 + 20,000 + 4,000 + 80 + 7$$

page 5 answers

Cuneiform Place Value				
216,000s (60^3)	3,600s (60^2)	60s (60^1)	1s	Numeral
	𐎶 𐎶 𐎶	𐎶 𐎶	𐎶 𐎶 𐎶	79,883
𐎶 𐎶 𐎶	𐎶		𐎶	5,184,000

page 6 answers

Maya Place Value		
8,000s (20^3)		• •
400s (20^2)	•	• =
20s (20^1)	•	• • •
1s	• • • •	• •
Numeral	429	20,462

page 7 answer

Write 3,213 using Shang oracle bone numerals.



DIRECTIONS

Read each problem carefully and then convert according to the instructions. Make sure to leave spaces between numerals where required.

1. Convert **MMMMDLXXIII** to a Hindu-Arabic numeral.

Answer: _____

2. Convert 576 to a Roman numeral.

Answer: _____

3. Convert **CCXCIII** to a Maya numeral.

Answer: _____

4. Convert  to a Roman numeral.

Answer: _____

5. Convert  to a Hindu-Arabic numeral.

Answer: _____

6. Convert ●●● to a Shang oracle bone numeral.



Answer: _____

7. Convert 25,734 to ancient Egyptian.

Answer: _____

8. Convert 252,003 to cuneiform.

Answer: _____

9. Convert **XCVIII** to a Maya numeral.

Answer: _____

10. Write 2,012 in Maya, cuneiform, ancient Egyptian and Shang oracle bone numerals.

Maya: _____

Cuneiform: _____

Ancient Egyptian: _____

Shang Oracle Bone: _____

BONUS BRAIN TEASER!

Add the following numbers:

	=	
	=	
	=	
	=	
	=	
	=	
	=	
	+	
Answer: _____		



DIRECTIONS

Read each problem carefully and then convert according to the instructions. Make sure to leave spaces between numerals where required.

1. Convert **MMMMDLXXIII** to a Hindu-Arabic numeral.

Answer: 4,573

2. Convert 576 to a Roman numeral.

Answer: DLXXVI

3. Convert **CCXCIII** to a Maya numeral.



Answer: _____

4. Convert  to a Roman numeral.

Answer: DCCCXXVI

5. Convert  to a Hindu-Arabic numeral.

Answer: 72,604

6. Convert $\bullet\bullet\bullet$ to a Shang oracle bone numeral.



Answer: _____

7. Convert 25,734 to ancient Egyptian.

Answer:

8. Convert 252,003 to cuneiform.

Answer:

9. Convert **XCVIII** to a Maya numeral.



Answer: _____

10. Write 2,012 in Maya, cuneiform, ancient Egyptian and Shang oracle bone numerals.



Maya: _____






Cuneiform:

Ancient Egyptian:

Shang Oracle Bone:

BONUS BRAIN TEASER!

Add the following numbers:

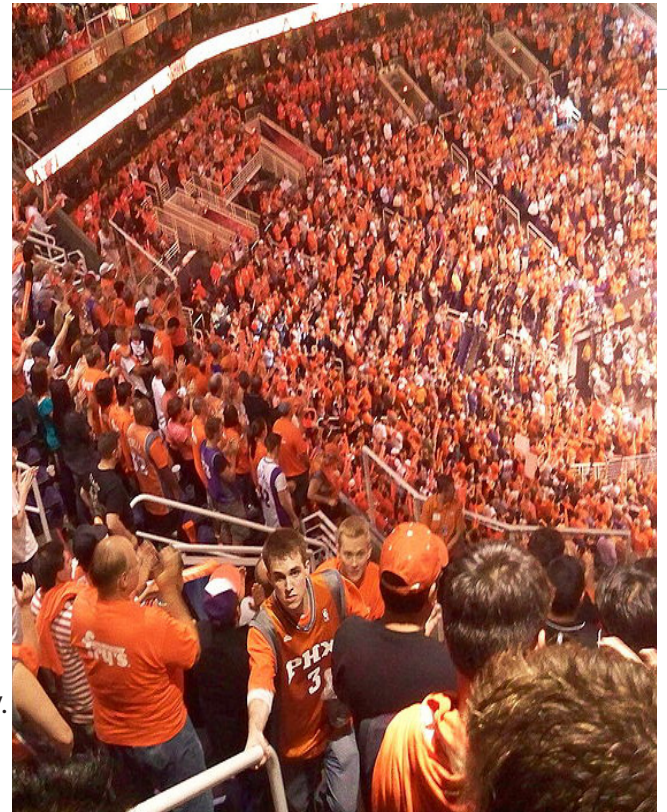
	=	4,605
	=	224
	=	40,507
	=	7,202
	=	3,246
		+
Answer:		<u>55,784</u>



PLAY BALL!

What is your favorite spectator sport? Is it football, baseball, or basketball? Which team do you cheer for the strongest and the loudest? Do you root for the Pittsburgh Steelers, the Philadelphia Phillies, or the Miami Heat?

Spectator sports, or sports that you watch, are incredibly popular in the United States. Last year, over 73 million people attended baseball games, and the Super Bowl had a television audience of 111 million! Now that's a lot of hot dogs! But football, baseball and basketball are relatively new sports, invented in the 19th century. Have you ever wondered who people cheered for 3,000 years ago? How about these guys!



THE BEGINNING OF TEAM SPORTS

The ancient Greeks may have had their Olympics, and the Romans their gladiators, but when it comes to team sports, nobody beat the Maya.

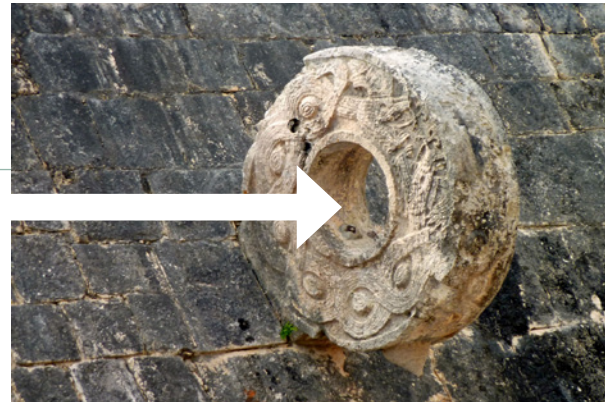
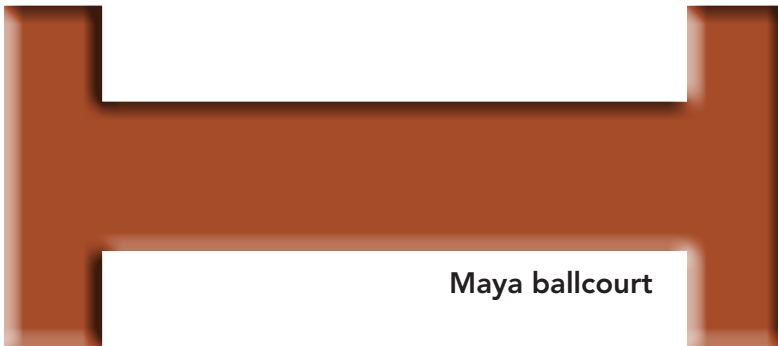
The first sport played by teams with a hard rubber ball was invented in Mesoamerica, probably by the Olmec. The game was played by many civilizations in this region, and evolved over time. Archaeologists aren't entirely sure what the Maya called their version of the game, but they do know that it was a little bit like volleyball and a little bit like basketball.



Clay Model of Maya ballgame, 250 CE

HOW TO PLAY MAYA BALL

The Maya played ball on a field that was shaped like the capital letter **I**.



Maya Hoop



Basketball Hoop

The ball, made out of rubber, was about the size of a volleyball and weighed between 6 to 10 pounds. Players would play on teams of two to four. Each team passed the ball back and forth between themselves and members of the opposing team. They were only allowed to hit the ball with their legs, arms and hips. Hitting with the hands was not permitted.



On either side of the I-shaped court, stone hoops were attached to either an inclined or vertical wall. Maya ball players shot the ball through these hoops in order to score points. This was extremely difficult to do. The hoops were not oriented as our basketball hoops are, and remember, no hands! Centuries ago, a visitor from Spain who watched a Maya ballgame had this to say: "A man, throwing it by hand at close range, could not put it in once in one hundred tries, nor in two hundred."

MORE

Watch a more modern version of the Maya ballgame called Pok-A-Tok here!
<http://www.youtube.com/watch?v=jKvQjgC9slY&feature=related>

Great ballcourt at Chichen Itza, about 1000 CE



stone hoop



Yokes made of wicker and fabric were tied around the waist to protect the abdomen. Stone yokes like these were ceremonial. This stone yoke dates from 800 CE.



These *hachas* may have been used to mark off sections of the ballcourt. They date from 250-900 CE.

HOW THE MAYA MADE RUBBER

The creations and inventions of a culture or civilization depend on the natural resources that are available. The ancient Egyptians made paper from the papyrus plant which grew along the banks of the Nile. The Etruscans were experts at working with bronze because their land was rich in metals; and the Maya had access to the abundance of the rain forest because they lived in the midst of it.

The rubber tree grows naturally in the jungles of Mesoamerica. The Maya, and other Mesoamerican civilizations like the Olmec and Aztec, figured out how to use the sap, or latex, from the rubber tree to fashion the balls that were used during their games. Can you imagine, even today, playing a game with a ball that is not made of some kind of rubber?

Maya Rubber Recipe

- > Cut a vertical channel in the trunk of the rubber tree.
- > Cut diagonal channels along the vertical channel.
- > Collect the latex from the tree.
- > Cut a long piece of Morning Glory vine.
- > Crush the vine so you can extract the juice.
- > Mix the juice from the vine with the latex from the tree. This makes the rubber bouncy.
- > Form it into a ball.



Rubber Tree



Man cutting the channels for the rubber to drain from the tree.

DID YOU KNOW?

The Olmecs were the first civilization to make and use rubber.







WINNERS AND LOSERS

The Maya ballgame was much more than just entertainment. It was a religious ritual that symbolized the constant battle between good and evil. The Maya believed that in order to keep the gods happy and the harvest plentiful, they had to sacrifice a healthy human being. This is why you didn’t want to be the loser in a Maya ballgame. If you lost, it could mean that you would be killed to appease the gods.



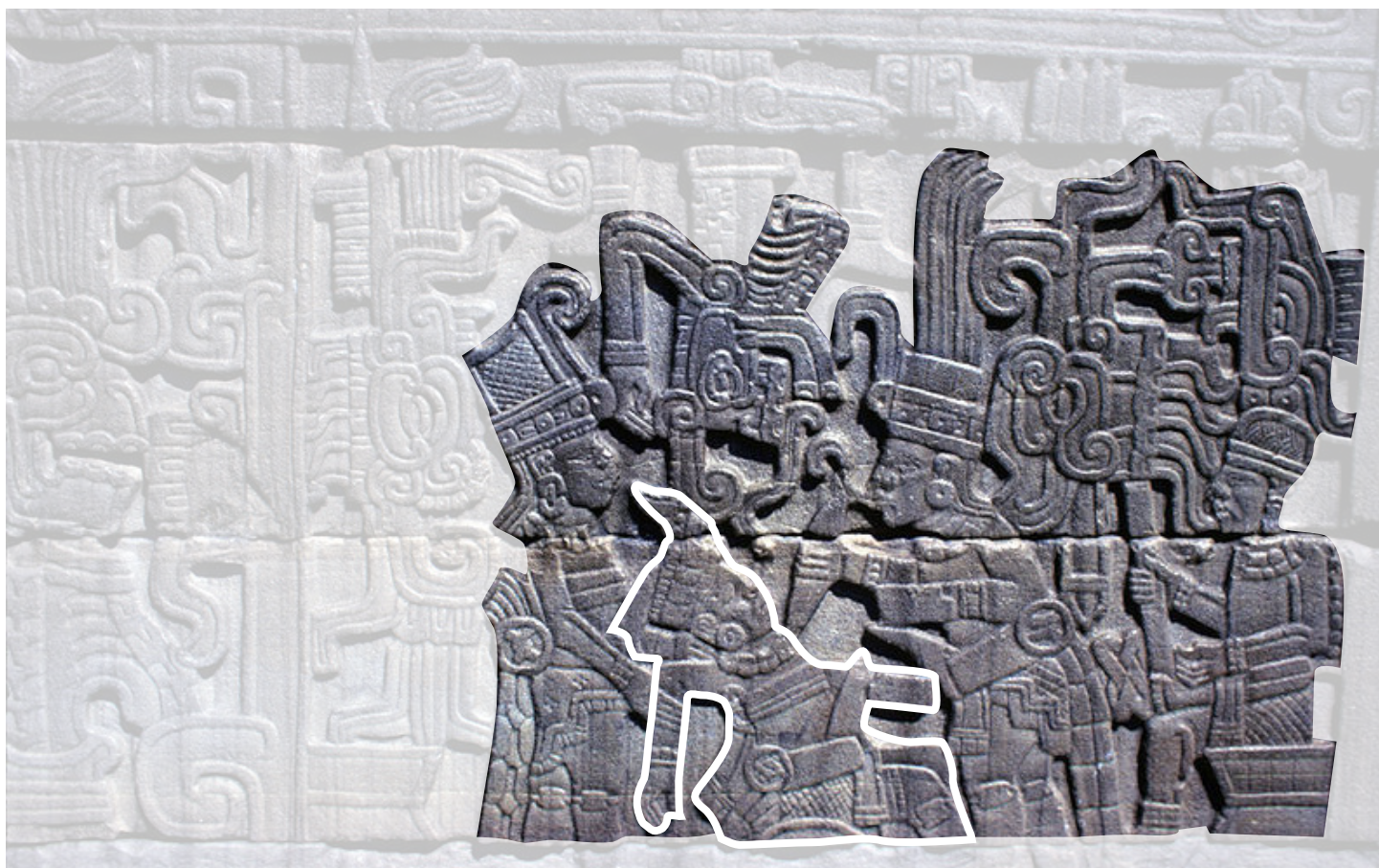
These *palmas* would have been worn on the yoke and used as a striking surface for the ball. The *palmas* date from 800 CE. Some archaeologists think that the *palmas* worn during play would have been made of wood and that these were ceremonial.



TYPES OF SPORTS BALLS		
Ball		Weight
baseball		5 ounces
football		15 ounces
basketball		22 ounces
tennis ball		2 ounces
soccer ball		14 ounces
golf ball		1.62 ounces
Maya ball		6-10 pounds 96-160 ounces

DID YOU KNOW?

A Maya ball is 19 times heavier than a baseball!



Stone relief from ballcourt at El Tajin, around 400 CE. This relief depicts a scene of human sacrifice.

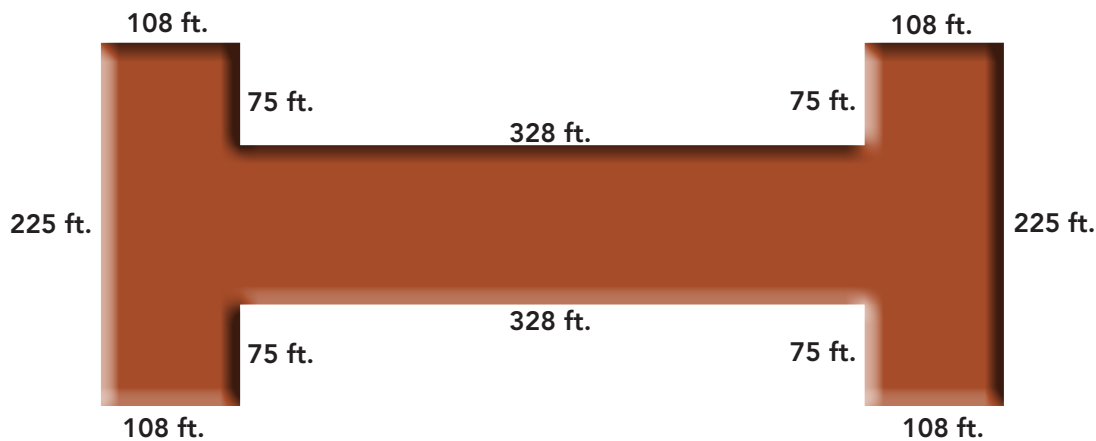


The stone relief above is from the ballcourt at Chichen Itza. It dates from about 1000 CE. Can you guess who lost the ballgame? This pottery model to the right is of a Maya ball player. He is wearing the protective yoke and knee pads. It dates from about 200-400 CE.



Answer each question below. Explain how you got your answers.

1. Calculate the perimeter of this Maya ballcourt.



Answer (P): _____

2. Using the ballcourt above, calculate the area.

Answer (A): _____

3. Calculate the radius of the stone hoop at Chichen Itza.

Answer (R): _____



4. Using the stone hoop to the right, calculate the area.

Answer (A): _____

5. Using the stone hoop to the right, calculate the circumference.

Answer (C): _____

6. One point is scored each time a Maya player puts the ball through the hoop. If the probability of a Maya player shooting the ball through the hoop is 1 in 100, then how many times does he have to shoot the ball to make 6 points?

Answer: _____

Use the table on page 5 to answer questions 7-10.

7. If a Maya rubber ball weighs 6 pounds, than how much heavier is it than a soccer ball? Round to the nearest 10.

Answer: _____

8. If a Maya rubber ball weights 8 pounds, how many ounces is that?

Answer: _____

9. What is the average weight, in ounces, of all of the balls listed in the table?
(Note: Maya ball weights 6 pounds.)

Answer: _____

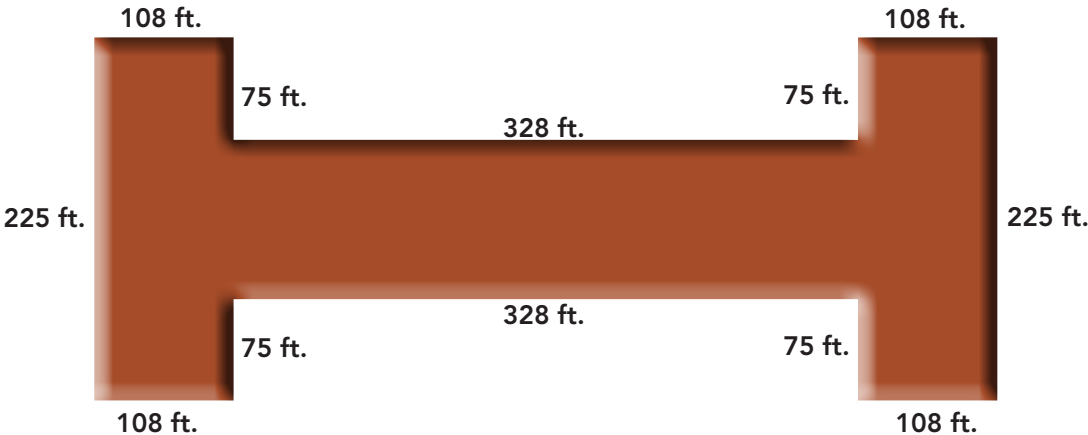
10. What is the median weight of the balls listed on the table?
(Note: Maya ball weighs 6 pounds.)

Answer _____



Answer each question below. Explain how you got your answers.

1. Calculate the perimeter of this Maya ballcourt.



Answer (P): 1,838 ft.

2. Using the ballcourt above, calculate the area.

Answer (A): 73,200 ft.²

3. Calculate the radius of the stone hoop at Chichen Itza.

Answer (R): 17.5 in.

4. Using the stone hoop to the right, calculate the area.

Answer (A): 961.63 in.²

5. Using the stone hoop to the right, calculate the circumference.

Answer (C): 109.9 in.



6. One point is scored each time a Maya player puts the ball through the hoop. If the probability of a Maya player shooting the ball through the hoop is 1 in 100, then how many times does he have to shoot the ball to make 6 points?

Answer: 600

Use the table on page 5 to answer questions 7-10.

7. If a Maya rubber ball weighs 6 pounds, than how much heavier is it than a soccer ball? Round to the nearest 10.

Answer: 7 times heavier

8. If a Maya rubber ball weights 8 pounds, how many ounces is that?

Answer: 128 oz.

9. What is the average weight, in ounces, of all of the balls listed in the table? (Note: Maya ball weights 6 pounds.)

Answer: 22.23 oz.

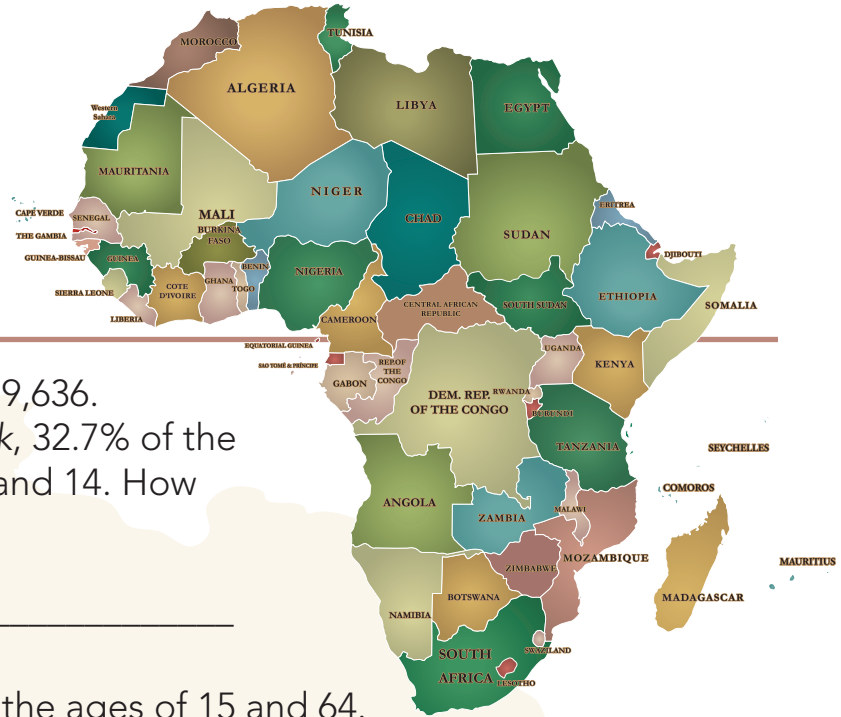
10. What is the median weight of the balls listed on the table? (Note: Maya ball weighs 6 pounds.)

Answer 14 oz.



Africa by Numbers

Use what you know about percents, decimals, and fractions to study the demography of some African countries.



1. In 2011, Egypt's population was 82,079,636. According to the *CIA World Factbook*, 32.7% of the population is between the ages of 0 and 14. How many people is that?

ANSWER: _____

2. 51,541,868 of Egyptians are between the ages of 15 and 64. What percentage of the population is that?

ANSWER: _____

3. 43.4% of Egyptians live in cities. How many people is that? How do you write 43.4% as a fraction? Reduce to lowest terms.

ANSWER: _____

4. If 90% of the Egyptian population is Muslim, and 9% are Coptic, then what percentage of the population is Christian?

ANSWER: _____

5. Based on a population of around 82 million, if Egypt's population growth rate is 1.96% annually, about how many new Egyptians are born each year?

ANSWER: _____

6. In 2011, Nigeria's population was 155,215,573. The Yoruba people account for 21% of the population. How many people is that?

ANSWER: _____

7. 40% of the Nigerian population practices Christianity. Write 40% as a fraction. Reduce to lowest terms.

ANSWER: _____

8. Based on a population of 155,215,573, if 85,368,565 of Nigerians are between the ages of 15 and 64, about what percentage of the population do they represent?

ANSWER: _____

9. The Igbo people account for 18% of the population of Nigeria. What is the approximate number of people? Write 18% as a decimal.

ANSWER: _____

10. Based on a population of around 155 million, if Nigeria's rate of urbanization grows by an annual rate of 3.5%, about how many Nigerians will move to cities each year?

ANSWER: _____

11. The population of Ghana is 24,791,073. 892,478 people are over the age of 65. What percentage of the population do they represent?

ANSWER: _____

12. 74% of the population of Ghana lives in rural areas. Write 74% as both a fraction and as a decimal.

ANSWER: _____

13. The total population of Mali is 14,159,904. The Songhai people comprise 6% of the total population. How many people are Songhai?

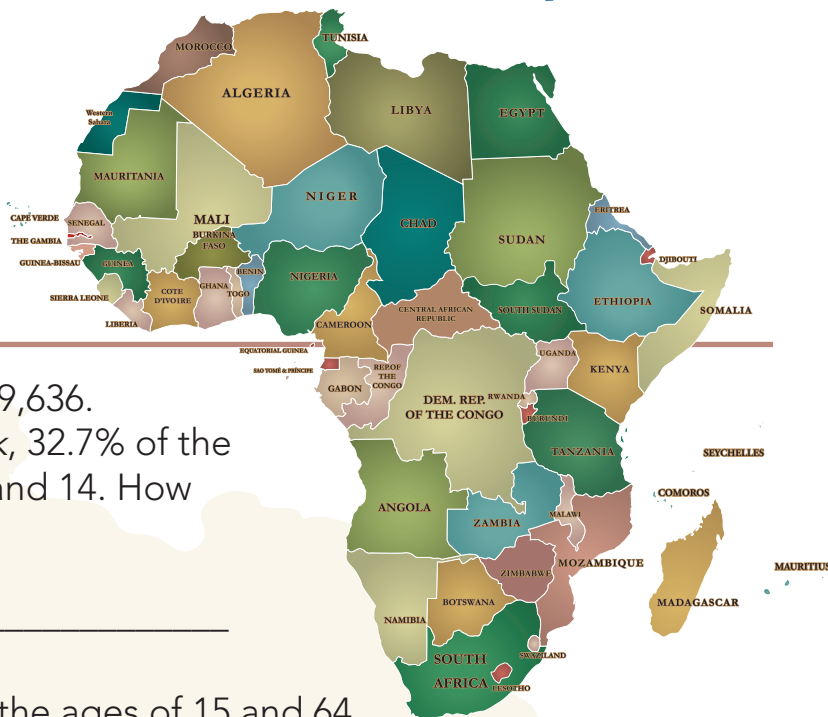
ANSWER: _____

14. 11.49% of the total population of Mali (14,159,904) lives in the capital city of Bamako. About how many people live in Bamako? Round your answer to the nearest thousand.

ANSWER: _____

Africa by Numbers

Use what you know about percents, decimals, and fractions to study the demography of some African countries.



1. In 2011, Egypt's population was 82,079,636. According to the *CIA World Factbook*, 32.7% of the population is between the ages of 0 and 14. How many people is that?

ANSWER: 26,840,040

2. 51,541,868 of Egyptians are between the ages of 15 and 64. What percentage of the population is that?

ANSWER: 62.79%

3. 43.4% of Egyptians live in cities. How many people is that? How do you write 43.4% as a fraction? Reduce to lowest terms.

ANSWER: 35,622,562 $434/1000 = 217/500$

4. If 90% of the Egyptian population is Muslim, and 9% are Coptic, then what percentage of the population is Christian?

ANSWER: 1%

5. Based on a population of around 82 million, if Egypt's population growth rate is 1.96% annually, about how many new Egyptians are born each year?

ANSWER: 1,607,200

6. In 2011, Nigeria's population was 155,215,573. The Yoruba people account for 21% of the population. How many people is that?

ANSWER: 32,595,270

7. 40% of the Nigerian population practices Christianity. Write 40% as a fraction. Reduce to lowest terms.

ANSWER: $40/100 = 2/5$

8. Based on a population of 155,215,573, if 85,368,565 of Nigerians are between the ages of 15 and 64, about what percentage of the population do they represent?

ANSWER: 55%

9. The Igbo people account for 18% of the population of Nigeria. What is the approximate number of people? Write 18% as a decimal.

ANSWER: 27,938,803 0.18

10. Based on a population of around 155 million, if Nigeria's rate of urbanization grows by an annual rate of 3.5%, about how many Nigerians will move to cities each year?

ANSWER: 5,425,000

11. The population of Ghana is 24,791,073. 892,478 people are over the age of 65. What percentage of the population do they represent?

ANSWER: 3.6%

12. 74% of the population of Ghana lives in rural areas. Write 74% as both a fraction and as a decimal.

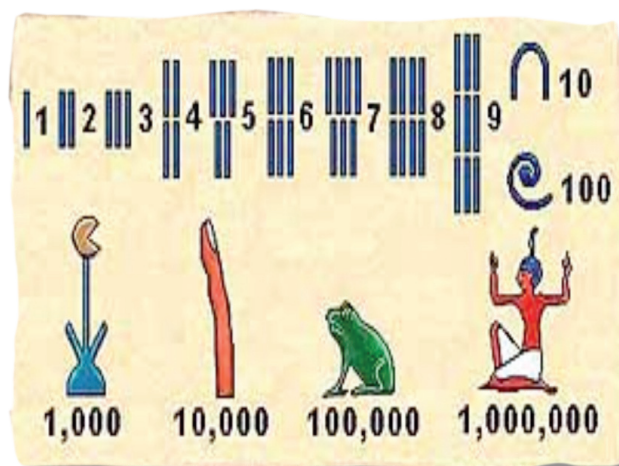
ANSWER: $74/100 = 37/50$ 0.74

13. The total population of Mali is 14,159,904. The Songhai people comprise 6% of the total population. How many people are Songhai?

ANSWER: 849,594

14. 11.49% of the total population of Mali (14,159,904) lives in the capital city of Bamako. About how many people live in Bamako? Round your answer to the nearest thousand.

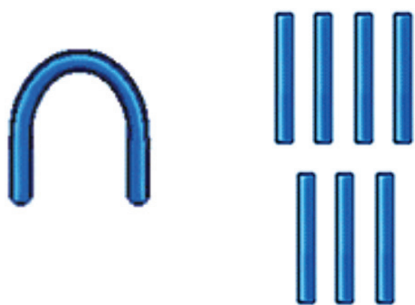
ANSWER: 1,627,000





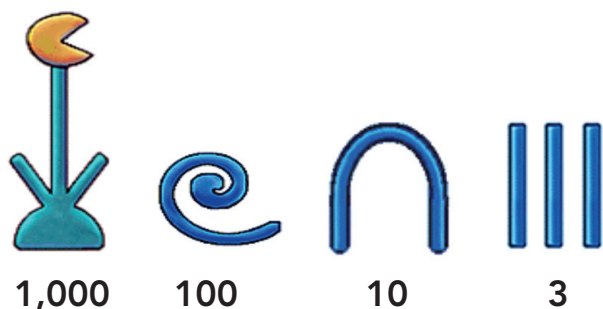
The ancient Egyptians had hieroglyphs to represent letter sounds, whole words, parts of words, and even complex ideas. They also had symbols to represent numerals.

The ancient Egyptians had to be pretty good at math too! Think of all those pyramids, tombs, sphinxes, massive statues, and palaces that they were famous for building. You can't make any of that stuff without mathematics. You also need math to trade goods and measure the land for planting crops.

Look at the symbols above to see how the ancient Egyptians wrote their numerals. Take a guess at what the numeral below and on the left is. **Hint! Read the numeral from left to right. The larger numbers always come first.**



Let's work it out! The  stands for **10** and the  stands for the numeral **7**. So **10** plus **7** equals **17**. **The number is 17!**



Let's try another one. Use the chart on this page to help you figure out the number to the left:

Look at each symbol carefully. What amount does each one represent? Look at the value of each symbol underneath of it to help you read this numeral. **The numeral is 1,113.**

Just as our numerals have names, so do ancient Egyptian numerals. For example, when we talk about the numeral 1,000 we say the words *one thousand*. Study the symbols to learn what to call the numerals of the ancient Egyptians.



One (1) is a stroke.



Ten (10) is a hobbles for cattle.



One hundred (100) is a coil of rope.



One thousand (1,000) is a lotus plant.



Ten thousand (10,000) is a finger.



One hundred thousand (100,000) is a frog.



One million (1,000,000) is an Egyptian god.

Problem Solving

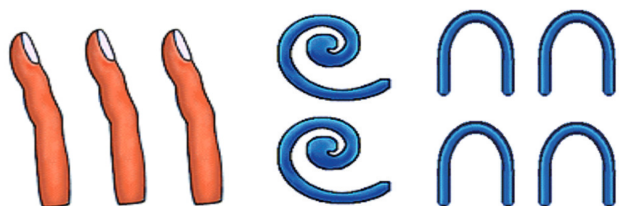
Now that you know all of the symbols for ancient Egyptian numerals, try a little ancient Egyptian numeral translation. See if you can read the following numerals. Write the numeral in standard form in the spaces provided.



Write your answer here. _____



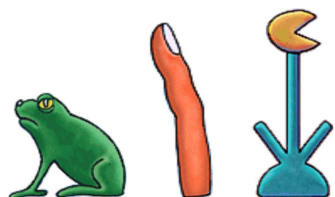
Write your answer here. _____



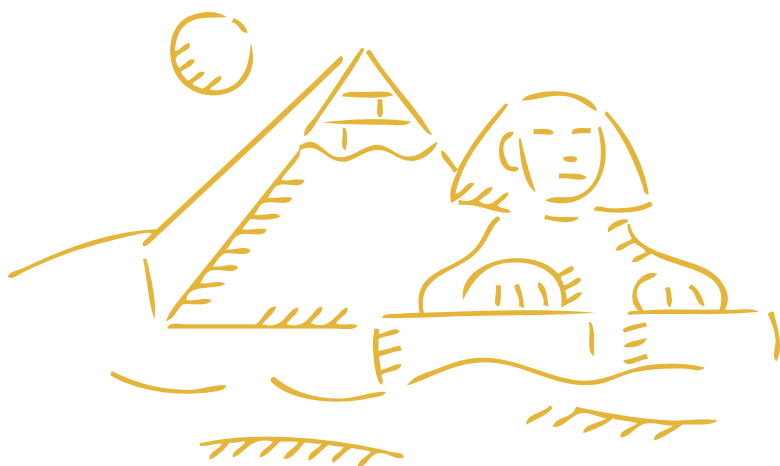
Write your answer here. _____



Write your answer here. _____



Write your answer here. _____

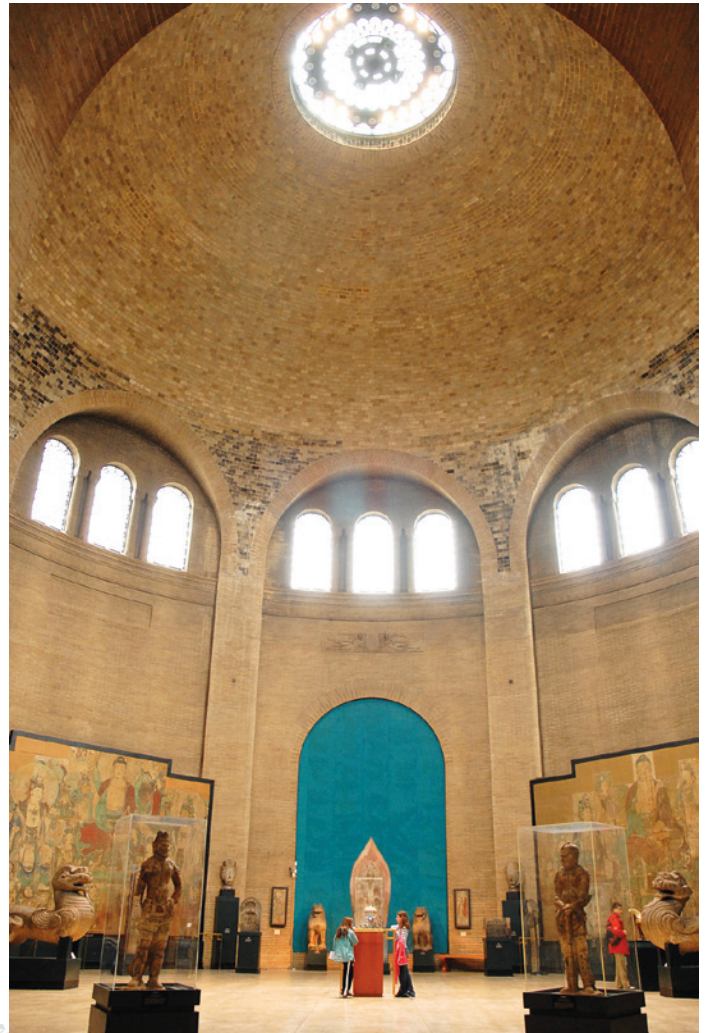


The Chinese Rotunda at the Penn Museum has one of the world's largest, unsupported masonry domes. That means there are no steel or supporting trusses within the dome to hold it up. The weight of the dome is carried by the eight arches that encircle the rotunda, and by the natural forces of compression, tension, gravity, and the normal force.

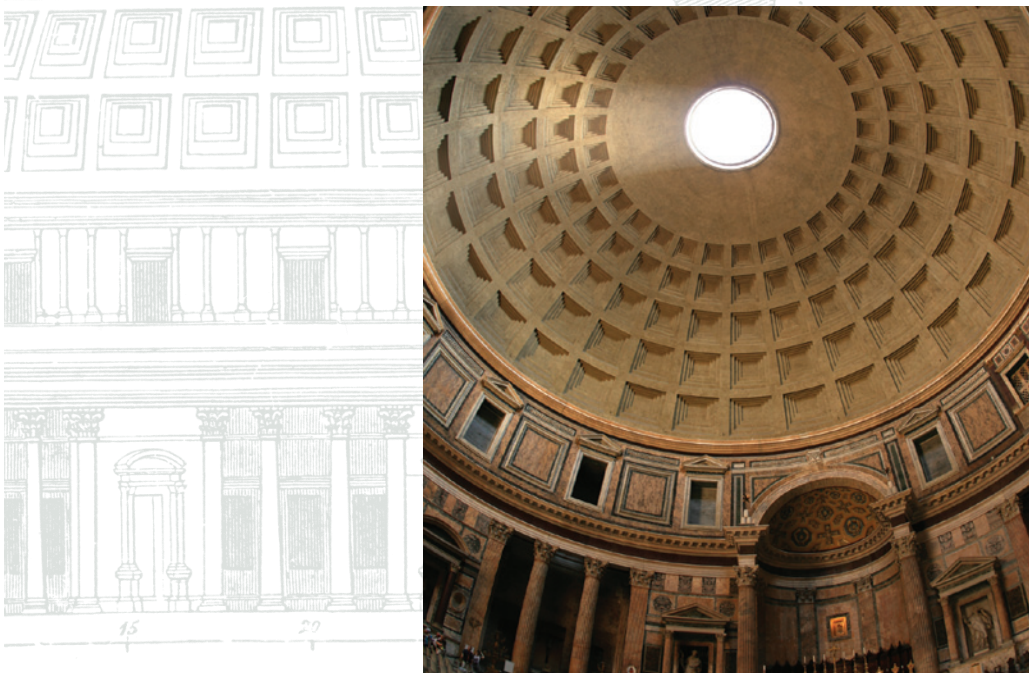
The design of the Museum's dome was based on the design of a much older and larger dome called the Pantheon, an ancient Roman temple.

Look carefully at the apex of both of these domes. The **apex** is the highest point of the dome. The opening located at the apex is called an **oculus**. Oculus means eye in Latin.

The oculus is not only a way to bring light into a domed structure, but it also *lightens* the weight of the roof.



Above, the Chinese Rotunda at the Penn Museum. Left, interior of the Pantheon.



- 1) apex
- 2) oculus
- 3) diameter
- 4) radius
- 5) circumference
- 6) area

VOCABULARY

Diameter, Radius, Circumference, and Area of Circles

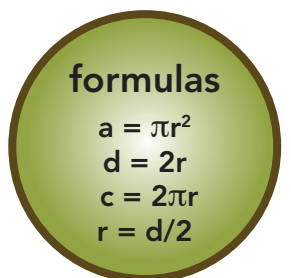
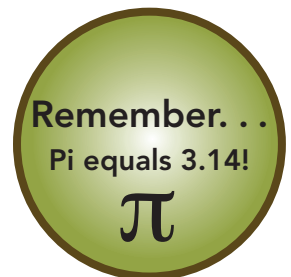
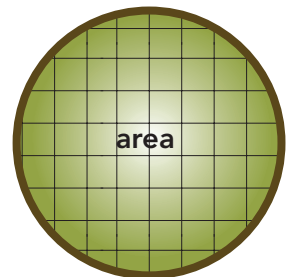
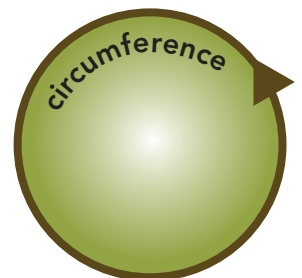
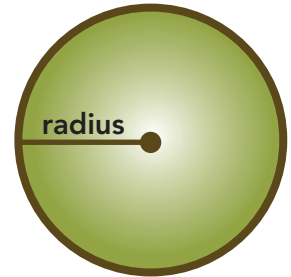
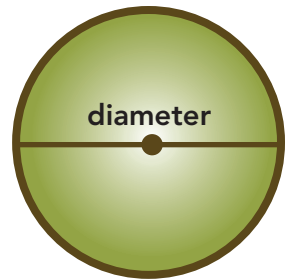
Diameter, radius, circumference and area are different ways in which to measure circles. If you know one of these measurements, then you can figure out the others.

The **diameter** is the distance across a circle through its center point. If you know the diameter of a circle, then you can calculate the radius, the circumference, and the area of a circle.

The **radius** of a circle is the distance from its center to any point along its edge. It's easy to find the center of the Chinese Rotunda. Just look for the 49-pound crystal ball!

The **circumference** of a circle is the distance around it. It is the circle's perimeter.

The **area** of a circle is the number of square units it would take to fill the circle.

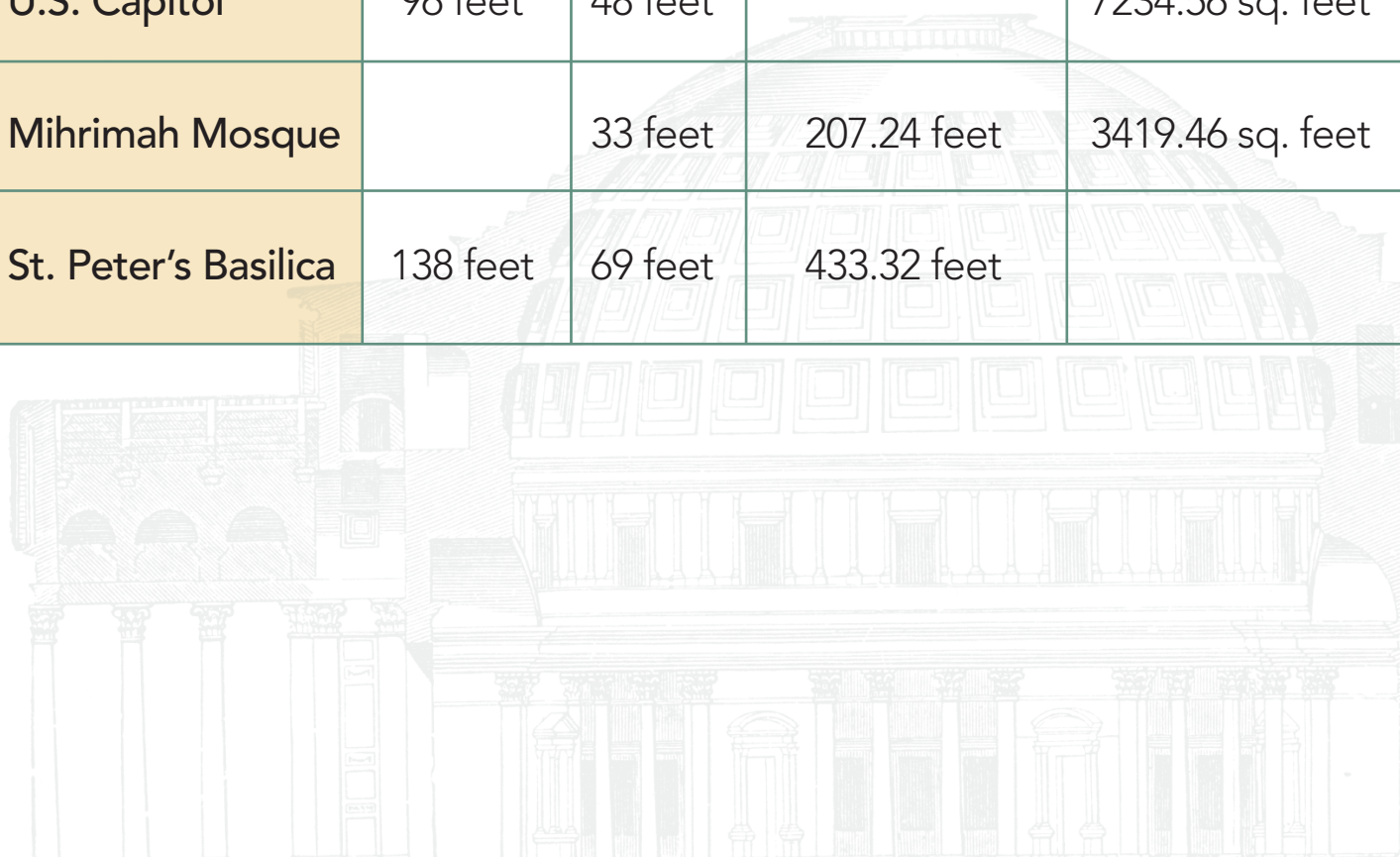


Dome of the Capitol Building.

Famous Domes of the World

Look at the chart on the next page. It has a list of eight of the world's most famous domes and information about their size. Use the correct formulas for finding diameter, radius, circumference and area to calculate the missing measurements.

Dome	Diameter	Radius	Circumference	Area
Chinese Rotunda	90 feet	45 feet	282.6 feet	
The Pantheon		71 feet	445.88 feet	15828.74 sq. feet
Astrodome	710 feet	355 feet		395718.5 sq. feet
Georgia Dome		420 feet	2637.6 feet	553,896 sq. feet
Hagia Sophia	102 feet			8167.14 sq. feet
U.S. Capitol	96 feet	48 feet		7234.56 sq. feet
Mihrimah Mosque		33 feet	207.24 feet	3419.46 sq. feet
St. Peter's Basilica	138 feet	69 feet	433.32 feet	



Math of Domes – Answer Key

Dome	Diameter	Radius	Circumference	Area
Chinese Rotunda	90 feet	45 feet	282.6 feet	6358.5 sq. feet
The Pantheon	142 feet	71 feet	445.88 feet	15828.74 sq. feet
Astrodome	710 feet	355 feet	2229.4 feet	395718.5 sq. feet
Georgia Dome	840 feet	420 feet	2637.6 feet	553,896 sq. feet
Hagia Sophia	102 feet	51 feet	320.28 feet	8167.14 sq. feet
U.S. Capitol	96 feet	48 feet	301.44 feet	7234.56 sq. feet
Mihrimah Mosque	66 feet	33 feet	207.24 feet	3419.46 sq. feet
St. Peter's Basilica	138 feet	69 feet	433.32 feet	14949.54 sq. feet