A Short History of Zero

How could the world operate without the concept of zero? It functions as a placeholder to correctly state an amount. Is it 75, 750, 75,000, 750,000? Could you tell without the zeroes? And if you accidentally erased one zero, would that make a big difference?

The number system (Arabic) that we use today came from India. An Indian named Brahmagupta was the first to use zero in arithmetic operations. This happened about 650 AD. Brahmagupta's writings along with spices and other items were carried by Arabian traders to other parts of the world.

The zero reached Baghdad (today in Iraq) by 773 AD and Middle Eastern mathematicians would base their number systems on the Indian system. In the 800s AD, Mohammed ibn-Musa al-Khowarizimi was the first to work on equations that would equal zero. He called the zero, "sifr," which means empty. And by 879 AD the zero was written as "0."

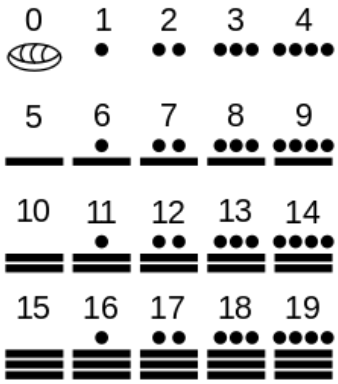
It would take a few centuries before the concept of zero would spread to Europe. In 1202 AD, an Italian mathematician named Fibonacci began to influence Italian merchants and German bankers to use the zero. These businessmen came to realize that using zero would show if their accounts were balanced.

The next European to promote the use of zero was Frenchman, Rene Descartes who used 0,0 as the graph coordinates for X and Y axes in the middle of the 1600s. Then British mathematician, Isaac Newton, and German mathematician, Gottfried Leibniz, made further advances in the last of the 1600s. They used zero in a kind of mathematics called calculus. Without calculus, we would not have physics and engineering.

So if zero is a placeholder, how did other civilizations not use zero but could still calculate numbers? One example comes from China. In early China, a space would be left vacant to show that nothing was there. In this picture of Chinese counting rods, the empty space is used to represent zero.

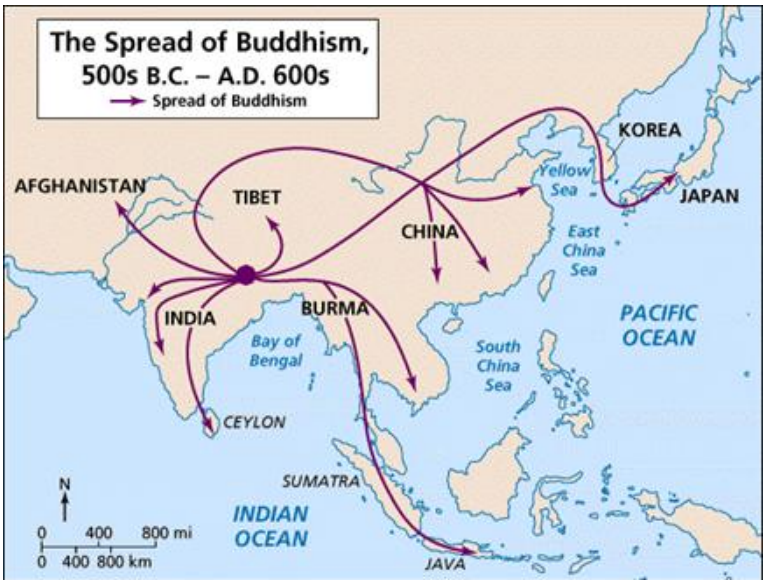
It is also known that the Mayan civilization (mostly in modern day Mexico and Guatemala) used a zero as well. Artifacts from 36 BC show the Mayans could add numbers up to hundreds of millions. It appears that even though the Maya used the zero, later civilizations in that area did not use it. Therefore, the idea did not spread.

Maya Counting System



A Definition of Cultural Diffusion

Cultural diffusion is the spread of ideas, styles, religions, languages, and other characteristics from one place to another. An example would be the spread of Buddhism. Look at the map below.



www.amyglenn.com

From the examples given in the reading (India, China, Maya), which civilization had its concept of zero spread from its source?

Sources:
"Maya Civilization." Wikipedia. Retrieved July 2013 from http://en.wikipedia.org/wiki/Maya_civilization

O'Connor, JJ and EF Robertson. A history of zero. Retrieved July 2013 from http://www-history.mcs.st-and.ac.uk/HistTopics/Zero.html

Wallin, Nils-Bertil. How was the zero discovered? YaleGlobal. 19 November 2002. Retrieved July 2013 from http://yaleglobal.yale.edu/about/zero.jsp

"Zero." Wikipedia. Retrieved July 2013 from http://en.wikipedia.org/wiki/0_%28number%29

A Short History of Zero
Map Assignment

Name_____

Background: You have read about the earliest use of zero in history and how it spread to other parts of the world. Now you will be creating a map to show the **diffusion** of the number zero. Only include locations where it diffused, not locations where it may have been invented but did not spread.

Task: First, plan out the information that will be included on your map by completing the following:

Innovator (if known)	When (time)	Location (where)

Next, place the information on your map.
Finally, be sure to consider the important elements of a map. Did you include . . .

A. date you created your map
B. orientation – a compass rose
C. title appropriate for the information on your map
D. author (you and original cartographer)
E. legend and symbols to explain the information on your map
F. add arrows (and a symbol in the legend for the arrow) to show the diffusion of zero.

Points will be assigned in the following way:

Components	Points
Correct placement of zero usage	2
Indicated the innovator of zero usage	2
Correct timeframe for zero usage	2
Correctly showed diffusion route	2
Map elements – date, orientation, title, author, legend	5
Readability of map	2
Total Possible Points	15

Map Scoring Guide **Name of Student**_____

Components	Points	Comments
Correct placement of zero usage	2	
Indicated the innovator of zero usage	2	
Correct timeframe for zero usage	2	
Correctly showed diffusion route	2	
Map elements – date, orientation, title, author, legend	5	
Readability of map	2	
Total Possible Points	15	

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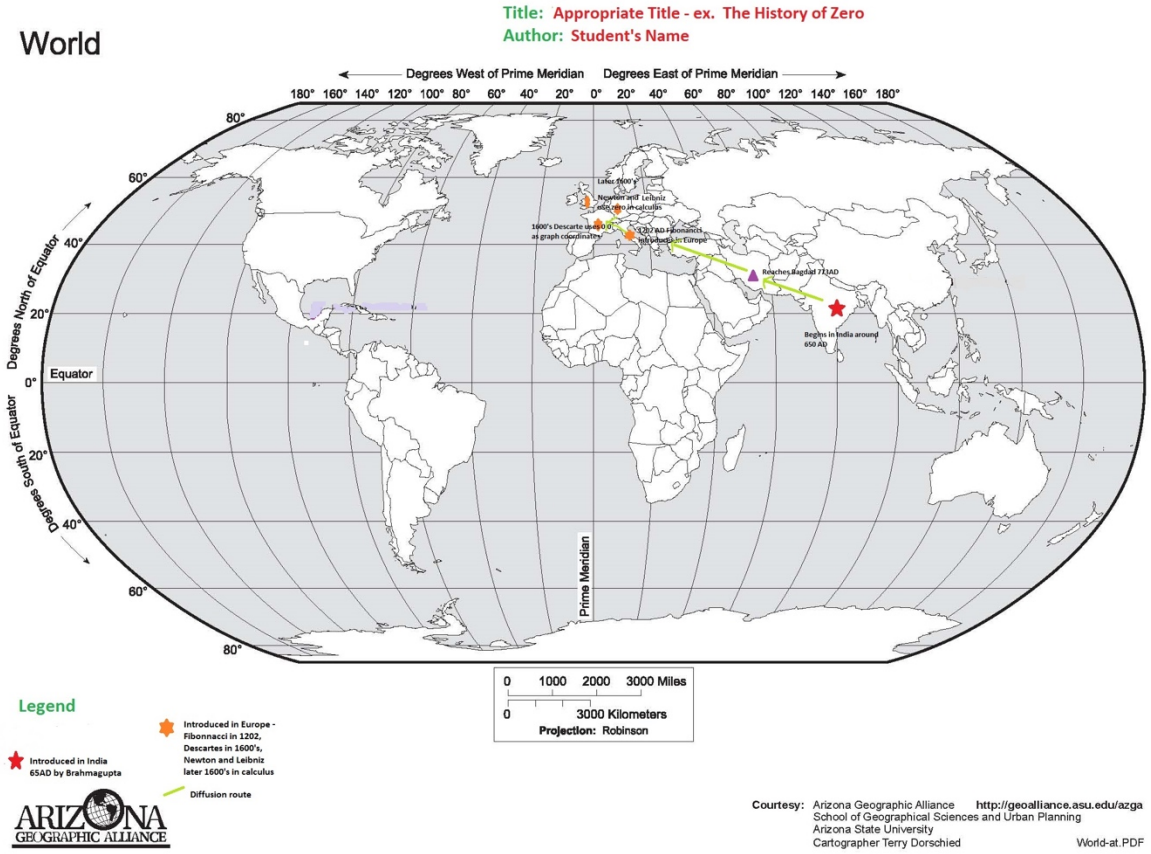
Map Assignment Answer Key



A Short History of Zero
Writing Assignment

Name_____ Date_____Period_____

In the space below, write a paragraph (1) defining cultural diffusion and (2) using zero as your example. Use the reading and your map for help.

The Zero and Cultural Diffusion

Cultural diffusion is when one idea, language, _____ or other characteristic _____ from one place to another. A good example of cultural diffusion is the use of zero. The number system that we use today came from _____. About 650 AD, an Indian named _____ was the first to use _____. Arabian traders carried his writings to _____.

By 773 AD the idea of zero reached _____. By 879 AD the zero was written as _____. Then in 1202 AD, the use of zero would reach Italian _____ and German bankers. Then the zero would spread to France and Descartes would use 0,0 as _____ coordinates. Then in the 1600s, mathematicians would use the zero in a kind of mathematics called _____.

The fact that the zero was used in India and then spread to other parts of the world shows it is a good example of _____ _____.

A Short History of Zero
Writing Assignment Answer Key

Name_____ Date_____Period_____

In the space below, write a paragraph (1) defining cultural diffusion and (2) using zero as your example. Use the reading and your map for help.

The Zero and Cultural Diffusion

Cultural diffusion is when one idea, language, ___religion_____ or other characteristic _____**spreads**_____ from one place to another. A good example of cultural diffusion is the use of zero. The number system that we use today came from ____**India**_____. About 650 AD, an Indian named __**Brahmagupta**_____ was the first to use __**zero**_____. Arabian traders carried his writings to _____**other parts of the world**____.

By 773 AD the idea of zero reached ____**Baghdad**_____. By 879 AD the zero was written as ____**0**____. Then in 1202 AD, the use of zero would reach Italian ____**merchants**_____ and German bankers. Then the zero would spread to France and Descartes would use 0,0 as __**graph**_____ coordinates. Then in the 1600s, mathematicians would use the zero in a kind of mathematics called _____**calculus**_____.

The fact that the zero was used in India and then spread to other parts of the world shows it is a good example of ___**cultural**_____ **diffusion**_____.

Answers will vary on the Writing Assignment where the students use computers to find their own examples.

A Short History of Zero
Writing Assignment

Name_____ Date_____Period_____

In the space below, write a paragraph describing the cultural diffusion of a modern-day object. Use examples from your research and create a map to support your argument that this object has experienced cultural diffusion.

Go to http://www.youtube.com/watch?v=wb4Npexda4A to learn about Aryabhata's Influence (father of the Hindu Arabic number system).

Is Zero Nada?

Centuries ago, the zero symbol was invented in India. The Arabs, who were great travelers, introduced it to other parts of the world, along with the Indo-Arabic numbers system we use today.

	Write number in words	Omit "0"	Write number in words	**N, H, U**
670	Six hundred seventy	67	Sixty-seven	**N**
6.70				
0.67				
607				
06.7				
.067				
067				
.670				
67.0				

N = Zero is Necessary **H** = Zero is helpful, but not necessary
U = Zero is not necessary and not helpful

Use 9, 2, 0, 0 to write two numbers in which

1. Both zeros are necessary:
2. One zero is necessary, the other is helpful:
3. One zero is necessary and the other is unnecessary:

Why is there no zero in the Roman numeral number system?

Adapted from: Zaslavsky, Claudia. *Multicultural Mathematics*. Portland: J. Weston Walch, 1993. 0-8251-2181-7.

Is Zero Nada? Answer Key

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	Write number in words	Omit "0"	Write number in words	**N, H, U**
670	Six hundred seventy	67	Sixty-seven	**N**
6.70	Six and seven tenths	6.7	Six and seven tenths	U
0.67	Sixty-seven hundredths	.67	Sixty-seven hundredths	H
607	Six hundred seven	67	Sixty-seven	N
06.7	Six and seven tenths	6.7	Six and seven tenths	U
.067	Sixty-seven thousandths	.67	Sixty-seven hundredths	N
067	Sixty-seven	67	Sixty-seven	U
.670	Sixty-seven hundredths	.67	Sixty-seven hundredths	U,H
67.0	Sixty-seven and zero tenths	67	Sixty-seven	U

N = Zero is Necessary **H** = Zero is helpful, but not necessary
U = Zero is not necessary and not helpful

Use 9, 2, 0, 0 to write two numbers in which

1. Both zeros are necessary: ex. 902, 90, 20, .02, .902
2. One zero is necessary, the other is helpful: ex. 0.02, 90.20
3. One zero is necessary and the other is unnecessary: ex. 02.90

Why is there no zero in the Roman numeral number system? Because in Roman numerals the numbers are formed by adding together – for example X + X = XX to form 20

Indus Inch*

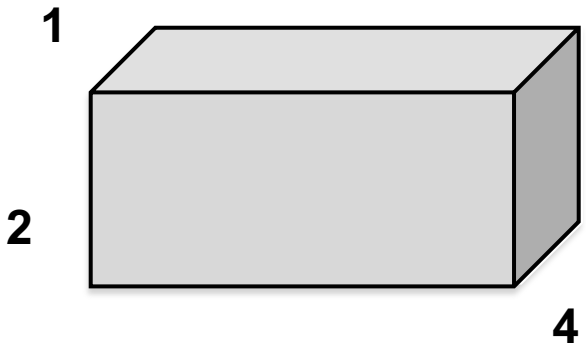
Name_____

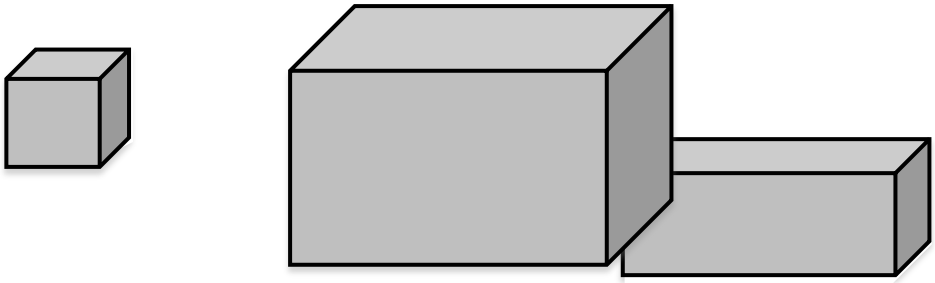
The Indian civilization began near the Indus River area. The two ancient cities of Mohenjo-Daro and Harappa (now located in modern day Pakistan) with their drainage systems, network of roads, granaries (place to store grain), water tanks, canals, and houses prove that craftsmen knew and understood the use and value of accurate mathematics.

Streets met at nearly perfect right angles. Bricks were fired that had dimension ratios--thickness: width: length (1:2:4), which made it possible to construct strongly bonded walls. In Mohenjo-Daro, archeologists found an artifact that is now referred to as the Mohenjo-Daro ruler. This "ruler" has divisions that measure lengths of 1.32 inches. The subdivisions have a maximum error of 0.005.

If		Then
1 Indus inch	=	1.32 inches
2 Indus inches	=	
3 Indus inches	=	
4 Indus inches	=	
5 Indus inches	=	
7 Indus inches	=	
8 Indus inches	=	

If the ratio of this brick is (1:2:4), what are the ratios of the other bricks?





Based on "Using the Indus Inch" by Myra Faye Turner found in *Calliope* January 2008 Volume 18 Number 5

Indus Inch* Answer Key

Name_____

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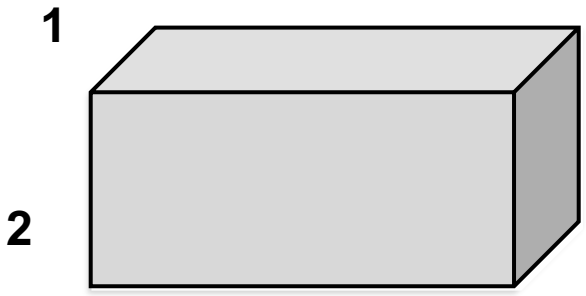
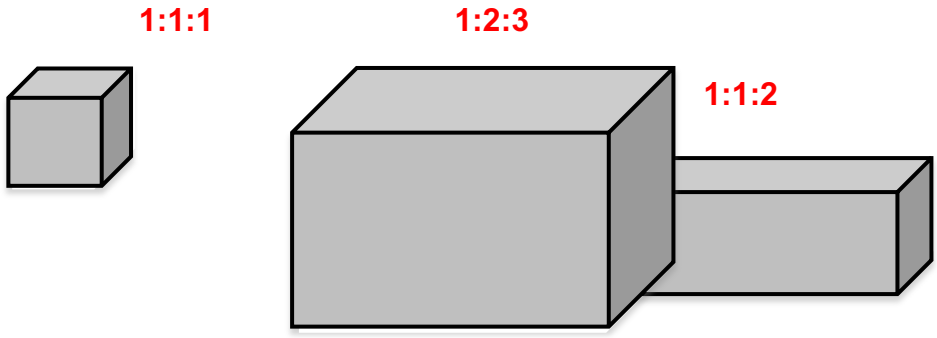
If		Then
1 Indus inch	=	1.32 inches
2 Indus inches	=	2.64 inches
3 Indus inches	=	3.96 inches
4 Indus inches	=	5.28 inches
5 Indus inches	=	6.6 inches
7 Indus inches	=	9.24 inches
8 Indus inches	=	10.56 inches

If the ratio of this brick is (1:2:4), what are the ratios of the other bricks?





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Tower of Brahma

Adapted from San Diego Math Tutor http://www.sdmath.com/hanoi.html

There is an old legend that says the Tower of Brahma is located at the "center of the world" in Benares, India. In the beginning, there were three diamond spires in the temple. One of them had 64 golden disks. It was arranged by the gods to move one disk each minute, day and night. When all the disks had been moved so that they are all on one of the other spires, the gods decreed that the world would vanish, with a thunderclap.

The rules for moving the disks were:

Only one disk may be moved at a time.
No disk can be placed on a smaller one.
Must be done in the fewest number of moves.

This puzzle is sometimes referred to as the "Towers of Hanoi." Go to: http://www.sdmath.com/hanoi.html to learn more about the legend and the math and to play the game online.

Make your own puzzle by following the directions on this link: http://www.lawrencehallofscience.org/java/tower/towerprintout.html

2^2 = 2 x 2 = **4** **2^3** = 2 x 2 x 2= **8** **2^4** = 2 x 2 x 2 x 2 = **16** **2^5**= 2 x 2 x 2 x 2 x 2 = **32**

The minimum number of moves for:

2 disks is 3	1 + 2 = 3	= 4 – 1	= 2^2 - 1
3 disks is 7.	1 + 2 + 4 = 7	= 8 – 1	= 2^3 - 1
4 disks is 15	1 + 2 + 4 + 8 = 15	= 16 – 1	= 2^4 - 1

5 disks is ____1 + 2 + 4 + 8 + 16 = _____ = 32 - _____ = 2^5 - 1

6 disks is ____1 + 2 + 4 + 8 + 16 + 32 =_____ =_____ = _____

7 disks is_____1 + 2 + 4 + 8 + 16 + 32 + 64 = _____= _____ = _____

For any number of disks (n) the number of moves is **2^n-1**

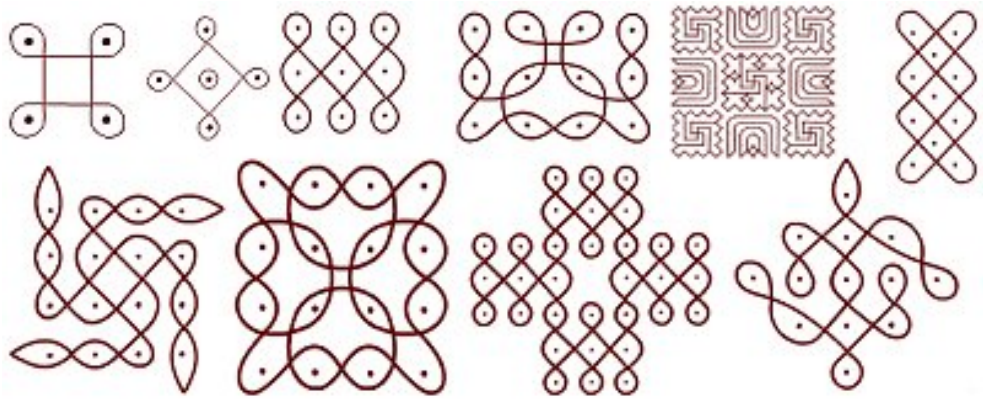
Information and images: http://www.historyforkids.org/learn/india/religion/buddhism.htm, http://www.historyforkids.org/learn/india/history/mauryan.htm and http://www.indiastudies.org

Kolams

http://www.youtube.com/watch?v=kbQcGdyT86M&list=LPhQ6TDsKgVcA&feature=plcp

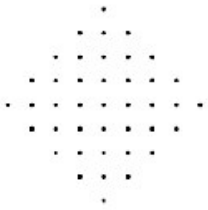
Describe these Kolams using these terms:

- **Pulli** is the Tamil (Southern India) word for dot.
- **Varisai** means row.
- **Ner** means straight or in line.
- **Idai** and **nadu** mean centered or in between.

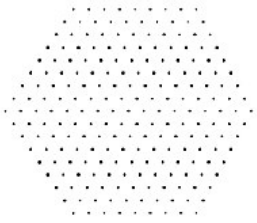


1-9

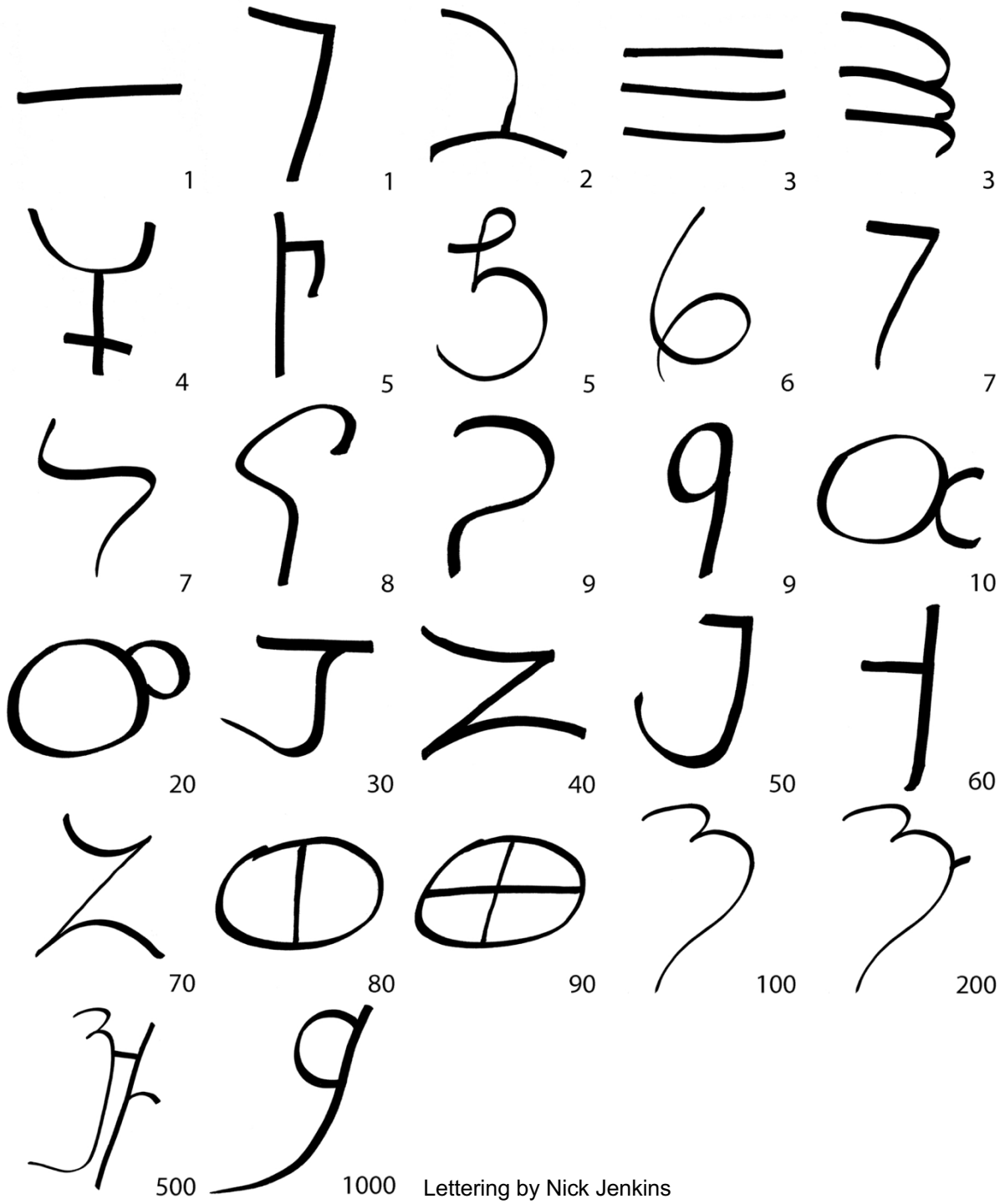
http://www.indian-heritage.org/alangaram/kolams/kolams.htm



17 reduce to 9



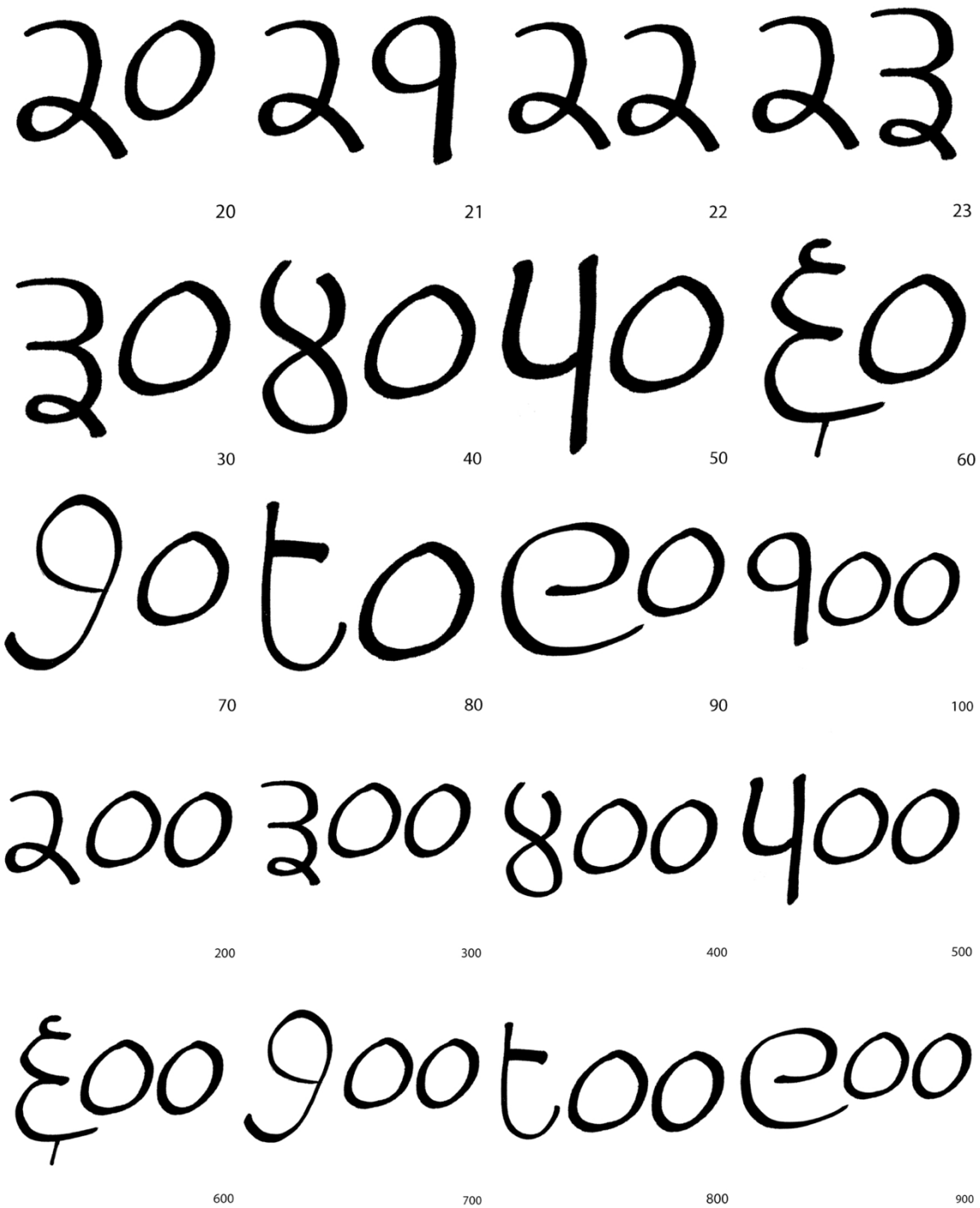
Brahmi Writing 200 BCE



Lettering by Nick Jenkins

Brahmi, a written form of Sanskrit, was read from left to right. In time a zero would be added and all number symbols except 0 through 9 were eliminated. Every possible number could be written in this place value number system. This system is used throughout the world today.

Sanskrit Writing c. 1000 AD



Lettering by Nick Jenkins Adapted from: Fisher, Leonard Everett. *Number Art Thirteen 123s From Around the World*.

When the Aryans invaded the subcontinent they became the highest caste of Indian society, the Brahmins. To protect their rule, they denied education to everyone not Brahmin. Sanskrit was the written language of Indian scholars and priest. Most Indian literature was written in Sanskrit. Sanskrit numbers came from the ancient Brahmi numbers.