The Mayan Numeral System

Journey to Ancient Mesoamerica — 300–900 AD

Name: _____ Date: _____

Part 1: Time Travel Challenge

Imagine…

You've traveled to ancient Mesoamerica — the jungles of present-day Mexico and Guatemala — sometime between 300 and 900 AD. You are visiting a Maya city. The priests are watching the stars and keeping track of time with incredible precision. But there are no Arabic numerals and no paper as you know it. How do the Maya write their numbers?

Fill in the blanks about the Maya and their writing:

1. The Maya lived in the region we now call _____ in Central America.
2. Instead of paper, the Maya wrote in folded books called _____, made from bark.
3. Maya numbers were written _____ — places stack from bottom to top rather than left to right.
4. The Maya were among the first civilizations in the world to invent a symbol for _____ .

Part 2: Meet the Three Symbols

The Maya only needed **THREE symbols** to write any number from 0 to 19 — and any larger number using their place-value system.

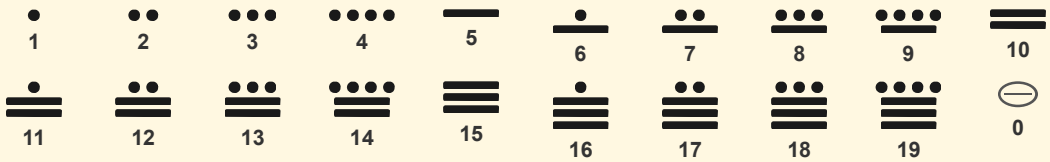
The Three Mayan Number Symbols

DOT
= 1 (one unit)

BAR
= 5 (five units)

SHELL
= 0 (empty place)

All numbers 0–19 — dots always sit ON TOP of bars:



Rule: dots always sit ON TOP of bars • Max 4 dots and 3 bars per place • 19 is the largest single-place value

Practice: describe what dots and bars you would draw for each number:

5. 4 → _____ *(no bars; how many dots?)*

6. 8 → _____ *(one bar on bottom; dots on top)*

7. 13 → _____ *(two bars; three dots above)*

8. 19 → _____ *(three bars; four dots above — the maximum!)*

Part 3: The Place-Value System — Bottom to Top!

The Big Idea: Places Stack Upward!

In our system, the *ones* place is on the right and place values grow to the *left* (ones → tens → hundreds). The Maya did the same thing vertically: the **ones place is always at the bottom**, and place values grow **upward**. A thin blue line separates each place, just like a column divider turned on its side.

Place values — bottom to top:

▲ **400s place** ($20^2 = 400$)

▲ **20s place** ($20^1 = 20$)

★ **1s place** ← **always start here**

Compare to our system:

Our **1s** place = Maya **1s** place (bottom)

Our **10s** place = Maya **20s** place (above)

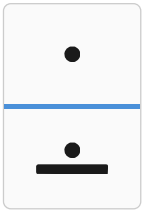
Our **100s** place = Maya **400s** place (20^2)

Our **1,000s** place = Maya **8,000s** place (20^3)

Key difference: we go left→right; Maya go bottom→top.

Worked Examples — each blue line separates one place from the next:

Example 1 — 26 (two places)

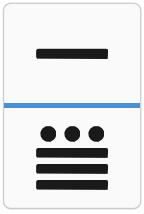


20s (top): 1 dot = 1 × 20 = 20

1s (bottom): 1 bar + 1 dot = 5+1 = 6

Total: 20 + 6 = 26

Example 2 — 118 (two places)

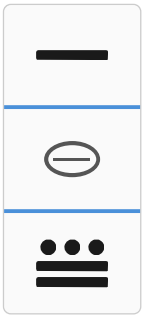


20s (top): 1 bar = 5 × 20 = 100

1s (bottom): 3 bars + 3 dots = 15+3 = 18

Total: 100 + 18 = 118

Example 3 — 2,013 (three places)



400s (top): 1 bar = 5 × 400 = 2,000

20s (middle): shell = 0 × 20 = 0

1s (bottom): 2 bars + 3 dots = 10+3 = 13

Total: 2,000 + 0 + 13 = 2,013

Part 4: Mayan → Our Numbers

Read each Mayan number from bottom to top and calculate the value:

9. 20s place: 2 dots | 1s place: 1 bar + 3 dots
→ (_____ × 20) + (_____) = _____ + _____ = _____

10. 20s place: 1 bar + 1 dot | 1s place: shell
→ (_____ × 20) + 0 = _____

11. 400s place: 1 dot | 20s place: shell | 1s place: 2 dots
→ (_____ × 400) + 0 + _____ = _____

12. 400s place: 1 dot | 20s place: 3 dots | 1s place: 2 bars + 1 dot
→ (_____ × 400) + (_____ × 20) + _____ = _____

Convert our numbers into Mayan notation. Write how many dots/bars in each place:

13. 45 → 20s: _____ | 1s: _____ *(Hint: 45 ÷ 20 = 2 remainder 5)*

14. 380 → 400s: _____ | 20s: _____ | 1s: _____ *(How many 400s? Then 20s? Then 1s?)*

15. Now try 2,045 → 400s: _____ | 20s: _____ | 1s: _____

Part 5: The Zero Hero

Think About It…

The Maya independently invented ZERO. Without zero as a place-holder, you cannot tell whether a place is empty or simply missing. Look at Example 3: the shell in the 20s place is the only thing that separates 2,013 from 213. The shell made the whole vertical system work.

16. In Example 3 above, what would a reader think the number was if the scribe forgot the shell in the middle place? _____

17. The Babylonians used _____ to show an empty place. The Maya used a _____.

18. Why is zero especially important in a vertical place-value system?
_____

Part 6: Why Base-20?

Our number system is **base-10** (10 fingers). The Maya counted on **fingers AND toes** — 20 digits total — giving them base-20 (vigesimal).

Place	Our Base-10	Mayan Base-20	Note
1st (bottom)	1s (10^0)	1s (20^0)	Same starting point
2nd	10s (10^1)	20s (20^1)	Carry at 10 vs. at 20
3rd	100s (10^2)	400s (20^2)	10^2=100 vs 20^2=400
4th	1,000s (10^3)	8,000s (20^3)	Place values grow fast!

Factors of 10: 1, 2, 5, 10 — only 4 factors	**Factors of 20:** 1, 2, 4, 5, 10, 20 — 6 factors (easier fractions!)

19. Why did counting on fingers AND toes naturally lead to a base-20 system?

_____

20. Using just the 1s and 20s places, the highest number you can write is _____. *(Hint: max in each place is 19)*

Part 7: The Living Legacy

You Use Mayan Math Every Day!

The Maya calendar was one of the most accurate ever created. **Note for the curious:** the priests used a slightly modified base-20 for their Long Count calendar — in that system the 3rd place is 360 (not 400) because a year has roughly 360 days. But the everyday counting system was pure base-20 with the place values shown above.

21. The Maya solar calendar had _____ days in a year — almost identical to ours.

22. The Maya also used a sacred calendar of _____ days for religious purposes.

23. When you use a 365-day calendar, you are building on observations made by the _____ over _____ years ago!

Part 8: System Comparison

Complete this comparison table:

Feature	Our Base-10 System	Mayan Base-20
Base number	10	
Core symbols	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	Dot ( ) Bar ( ) Shell ( )
Has zero?	Yes	
Place-value system?	Yes	
Direction places grow	Left to right	
Max value in one place	9 (then carry)	
Main strength	Easy (10 fingers)	

Part 9: Challenge Problems

Mayan Addition

Work place by place, starting at the bottom. When dots in a place reach 5, trade them for one bar. When a place's total reaches 20, carry one dot up to the next place.

24. 14 + 9 = _____ → Mayan: 20s place _____ | 1s place _____ *(Hint: 23 = 1×20 + 3)*

25. 17 + 16 = _____ → Mayan: 20s place _____ | 1s place _____

26. A Maya astronomer's tablet shows three places: top = 1 bar | middle = shell | bottom = 2 bars + 3 dots. What is the number? _____ *(Show your work)*

Part 10: Reflection

27. What surprised you most about the Mayan number system?

28. How is reading Mayan numbers (bottom to top) similar to and different from reading our numbers (left to right)?

29. If you could ask a Mayan astronomer one question, what would it be?

Key Takeaway

Ancient mathematicians were brilliant problem-solvers!
The Maya invented zero and built a *vertical* place-value system using only three symbols: a dot (1), a bar (5), and a shell (0). Within each place, dots stack on top of bars. For numbers 20 and above, places stack upward — ones at the bottom, twenties above, four-hundreds above that. Their mathematics powered one of the most accurate calendars ever created.