The Mayan Numeral System

Journey to Ancient Mesoamerica — 300–900 AD

★ ANSWER KEY — TEACHER COPY ★

Part 1: Time Travel Challenge

Fill-in-the-blank — accept reasonable variations

1. The Maya lived in **Mesoamerica / Mexico and Guatemala**
2. Folded books called **codices (codex)**, made from bark
3. Numbers were written **vertically**
4. First to invent a symbol for **zero**

Part 2: Meet the Three Symbols

Students describe the symbols — accept drawings or written descriptions

5. 4 → **4 dots (no bars)**
6. 8 → **1 bar on bottom + 3 dots on top**
7. 13 → **2 bars on bottom + 3 dots on top**
8. 19 → **3 bars on bottom + 4 dots on top**

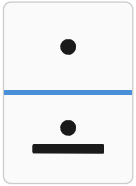
> **Teacher note — Part 2:** Verify that students understand dots sit ON TOP of bars, never below. The number 8 is the key diagnostic: a student who writes three bars and one dot likely has the orientation backwards. The full 0–19 reference grid in the student worksheet shows the correct layout for every number.

Part 3: The Place-Value System

Part 3 is a reading / concept section with no fill-in blanks. The worked examples below are for teacher reference.

Worked examples — for teacher reference:

Example 1 — 26



20s place (top): 1 dot = 1 × 20 = 20

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

20 + 6 = 26 ✓

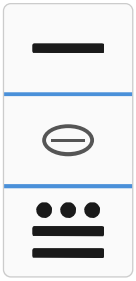
Example 2 — 118

20s place (top): 1 bar = 5 × 20 = **100**

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

100 + 18 = 118 ✓

Example 3 — 2,013



400s place (top): 1 bar = 5 × 400 = **2,000**

20s place (middle): shell = 0 × 20 = **0**

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

2,000 + 0 + 13 = 2,013 ✓

Part 4: Mayan → Our Numbers

Reading Mayan → base-10:

9. 20s: 2 dots | 1s: 1 bar + 3 dots → (**2** × 20) + (**8**) = **40** + **8** = **48** *[1 bar + 3 dots = 5+3 = 8]*

10. 20s: 1 bar + 1 dot | 1s: shell → (**6** × 20) + 0 = **120** *[1 bar + 1 dot = 5+1 = 6 twenties]*

11. 400s: 1 dot | 20s: shell | 1s: 2 dots → (**1** × 400) + 0 + **2** = **402**

12. 400s: 1 dot | 20s: 3 dots | 1s: 2 bars + 1 dot → (**1** × 400) + (**3** × 20) + **11** = **471** *[2 bars + 1 dot = 10+1 = 11]*

Converting our numbers to Mayan notation:

13. 45 → 20s: **2 dots** | 1s: **1 bar** *(45 ÷ 20 = 2 r 5; 5 = one bar)*

14. 380 → 400s: **shell (0)** | 20s: **3 bars + 4 dots (= 19)** | 1s: **shell (0)** *(380 ÷ 400 = 0; 380 ÷ 20 = 19 r 0)*

15. 2,045 → 400s: **1 bar (= 5)** | 20s: **2 dots** | 1s: **1 bar** *(2045 ÷ 400 = 5 r 45; 45 ÷ 20 = 2 r 5; 5 = one bar)*

> **Teacher note — Q14:** 380 is a great diagnostic. Because 380 < 400, the 400s place gets a shell. Students must still write the shell — omitting it would make the number unreadable. The 20s place holds 19 (= 3 bars + 4 dots, the maximum), and the 1s place also gets a shell.

Part 5: The Zero Hero

16. Without the shell in the 20s place, the reader would see only two places and likely interpret it as **213** (= 1 bar in the 20s place × 20, plus 2 bars + 3 dots in the 1s). *Accept any answer that identifies the ambiguity caused by the missing zero.*

17. Babylonians used **spacing** (blank space). Maya used a **shell symbol**.

18. *Open-ended — look for:* In a vertical system, a missing place could cause all the places above it to collapse down, making an entirely different number. A visible shell guarantees the reader knows a place exists but is empty.

Part 6: Why Base-20?

19. *Open-ended — look for:* 10 fingers + 10 toes = 20 body parts to count on, making 20 a natural grouping size. Accept any answer connecting body counting to base selection.

20. Max two-place value: **399** *(19 × 20 + 19 = 380 + 19 = 399)*

Part 7: The Living Legacy

21. Solar calendar: **365** days

22. Sacred calendar: **260** days

23. Observations made by the **Maya** over **1,000–2,000** years ago. *(Accept any reasonable number of years consistent with 300–900 AD.)*

Part 8: System Comparison

Completed comparison table:

Feature	Our Base-10 System	Mayan Base-20 (answers)
Base number	10	**20**
Core symbols	0–9 (ten symbols)	**Dot, Bar, Shell (3 symbols)**
Has zero?	Yes	**Yes (shell symbol)**
Place-value system?	Yes	**Yes**
Direction places grow	Left to right	**Bottom to top**
Max value in one place	9 (then carry)	**19 (then carry)**
Main strength	Easy (10 fingers)	**Fingers & toes (20); only 3 symbols needed**

Part 9: Challenge Problems

Worked solutions:

Q24 — 14 + 9 = ?

14 + 9 = **23**

23 ÷ 20 = 1 remainder 3

Mayan: 20s place = **1 dot** | 1s place = **3 dots**

(No bars needed in either place for this answer)

Q25 — 17 + 16 = ?

17 + 16 = **33**

33 ÷ 20 = 1 remainder 13

Mayan: 20s place = **1 dot** | 1s place = **2 bars + 3 dots** (= 10+3 = 13)

Q26 — top = 1 bar | middle = shell | bottom = 2 bars + 3 dots

400s place (top): 1 bar = 5 × 400 = **2,000**

20s place (middle): shell = 0 × 20 = **0**

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

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

(This is the same as Example 3 on the worksheet — intentional! Students who decoded Example 3 correctly should recognize it.)

Part 10: Reflection

Open-ended — grade on quality of reasoning, not specific content

Q27 — What surprised you most?

Strong answers may mention: only 3 symbols needed; numbers grow upward instead of sideways; zero existed 1,500+ years ago in the Americas; how large numbers can be represented with simple dots and bars.

Q28 — Bottom-to-top vs. left-to-right:

Similar: both are place-value systems; both carry when a place is full; both use zero as a placeholder.
Different: direction of reading; Maya uses only 3 symbols vs. our 10; Maya places carry at 20, ours at 10; within each Maya place, dots stack above bars (a second layer of additive notation).

Q29 — Question for a Mayan astronomer:

Any thoughtful question accepted. Look for curiosity about: how they tracked planets without telescopes, why they chose base-20, how they discovered the 365-day year, what zero meant to them conceptually.