

MATHEMATICS • CLASS 9

CHAPTER 3

The World of Numbers

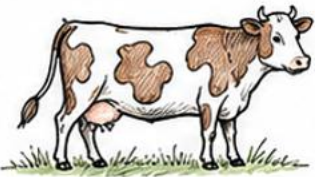
CHAPTER NOTES



FROM COUNTING TO NATURAL NUMBERS

WHY COUNT?

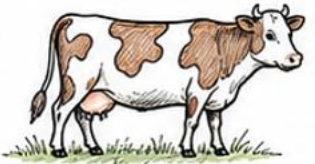
- People needed to track animals, food, trade and time.
- **ONE-TO-ONE CORRESPONDENCE:**
match one object to one counter.



one cow
leaving



one pebble
placed
in a pot



one cow
returning



one pebble
removed

An empty pot meant every cow returned.

- **NATURAL NUMBERS** are the counting numbers.

$$\mathbb{N} = \{1, 2, 3, 4, \dots\}$$

LEBOMBO BONE



- about 35,000 years old
- 29 deliberate notches
- possibly used to track a lunar or menstrual cycle

ISHANGO BONE



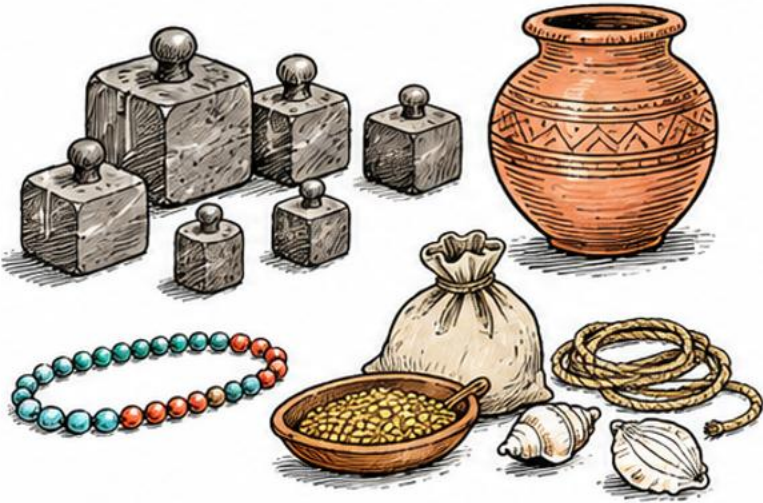
11, 13, 17, 19

- about 20,000 BCE
- three columns of grouped tallies
- one column contains the prime numbers 11, 13, 17 and 19
- another pattern suggests doubling

★ Numbers began as practical matching and tallying, then became abstract ideas.

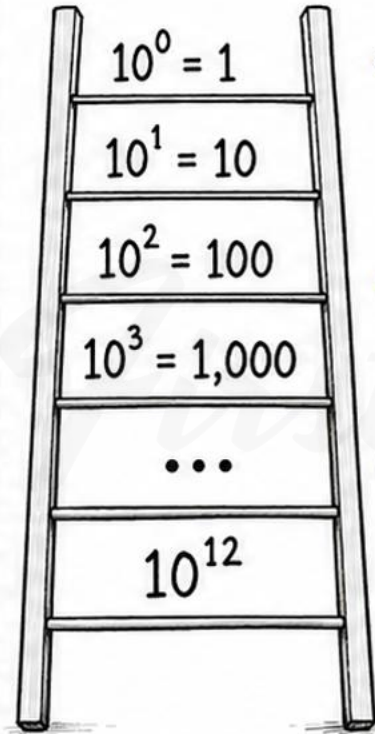
INDIAN NUMBER TRADITION: PLACE VALUE & LARGE NUMBERS

1. TRADE & MEASUREMENT



- Lothal and Harappa used standardised weights and measures.
- Trade needed reliable counting, comparison and accounting.

2. POWERS OF TEN



- Vedic texts named very large powers of 10.
- The chapter gives 10^{12} as parārdha.
- The Lalitavistara tradition names numbers up to 10^{53} , called tallakṣhaṇa.

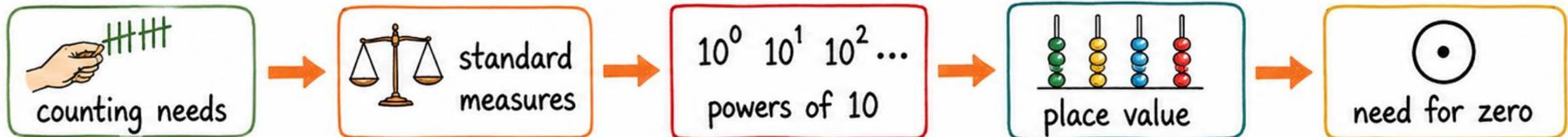
3. PLACE VALUE

4,582

Thousands	Hundreds	Tens	Ones
4	5	8	2

$$4,582 = 4 \times 10^3 + 5 \times 10^2 + 8 \times 10^1 + 2 \times 10^0$$

- A digit's value depends on its position.
- Writing quantities with powers of 10 prepared the way for the place-value system and zero.

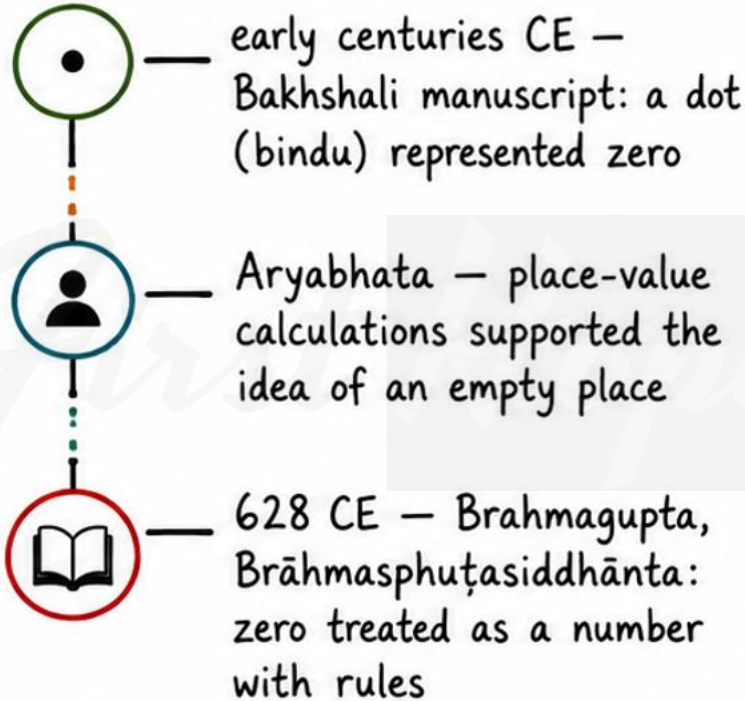


THE REVOLUTION OF ZERO (ŚHŪNYA)

PLACEHOLDER → NUMBER

- Babylonian and Mayan systems used placeholders for an empty position.
- A placeholder marks absence in a numeral; an operational number follows arithmetic rules.
- Śhūnya means zero; śhūnyatā expresses emptiness or 'zerness' in Indian philosophical traditions.
- This idea later entered mathematics through Indian scholarship.

KEY STEPS



BRAHMAGUPTA'S ZERO RULES

$$\Rightarrow a - a = 0 \quad 7 - 7 = 0$$

$$\Rightarrow a + 0 = a \quad 9 + 0 = 9$$

$$\Rightarrow a - 0 = a \quad 9 - 0 = 9$$

$$\Rightarrow a \times 0 = 0 \quad 9 \times 0 = 0$$

Zero is both a place-holder in numerals and a number used in arithmetic.

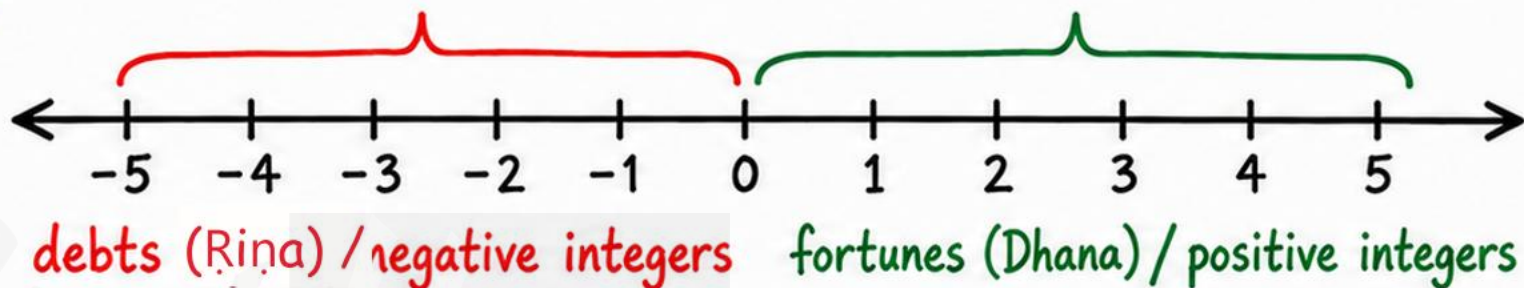
52 $\Rightarrow$ versus $\Leftarrow$ 502

holds the tens place

INTEGERS: FORTUNES, DEBTS & SIGN RULES

- Positive numbers can represent fortunes or assets: Dhana.
- Negative numbers can represent debts: Riṇa.
- Zero separates positive and negative integers.

$$\mathbb{Z} = \{ \dots, -3, -2, -1, 0, 1, 2, 3, \dots \}$$



RULES & EXAMPLES

- ① fortune + fortune = fortune
- ② debt + debt = debt
- ③ number - 0 = same number
- ④ debt × fortune = debt
- ⑤ debt × debt = fortune

$$5 + 4 = 9$$

$$(-5) + (-4) = -9$$

$$7 - 0 = 7; \quad -6 - 0 = -6$$

$$(-3) \times 4 = -12$$

$$(-3) \times (-4) = 12$$

$(+) \times (+)$	$= +$
$(+) \times (-)$	$= -$
$(-) \times (+)$	$= -$
$(-) \times (-)$	$= +$



Integer = negative whole number, zero, or positive whole number.



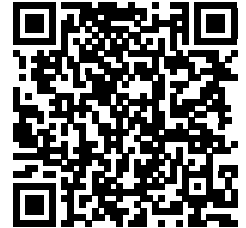


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