The shape of nothing

Why a symbol for nothing was one of the hardest ideas mathematics ever had to accept.

A Zero seems the simplest idea, yet it was among the last great mathematical ideas to arrive, and many sophisticated civilisations counted, traded and built without it. The difficulty was never in the symbol but in the thought behind it: treating nothing as something. Two distinct ideas hide inside the single word. One is a placeholder that holds an empty column so that a number keeps its shape; the other is a number in its own right, one that can be added, subtracted and multiplied like any other. The first is a convenience. The second changed mathematics.

B In a system where a digit's value depends on its position, you need some way to show an empty position, or 25 and 205 look the same. Early positional systems felt this pressure. Babylonian scribes, writing in base sixty on clay, eventually used a pair of slanted wedges to mark a gap between digits. But they used it only in the middle of a number, never at the end, so a reader still had to judge from context whether a figure meant sixty or one. The mark was a piece of punctuation, not yet a number.

C On the other side of the world, the Maya arrived independently at a symbol for zero, often drawn as a shell, and used it with great precision in their calendar. It was a true placeholder within a working positional system, but it stayed bound to the counting of days and did not travel beyond their culture. History records more than one invention of zero. What mattered in the end was not the first appearance of the symbol but where the idea could spread, and what it was allowed to do.

D The decisive step was taken in India. By the middle of the first millennium, Indian mathematicians were using a dot, and later a small circle, as a placeholder in a decimal system, and they went further than anyone before them: they treated zero as a number that could be reasoned about. In the seventh century the mathematician Brahmagupta set down rules for calculating with it and with negative numbers, stating that a number added to zero is unchanged and that a number subtracted from itself leaves zero. Some questions defeated him, in particular what happens when a number is divided by zero, a problem that would trouble mathematicians for a thousand years. But the essential move had been made. Nothing had become a number.

E From India the system passed into the mathematics of the medieval Islamic world, where scholars refined it and carried it widely. The word for the concept, meaning empty, was rendered into Arabic as sifr, and it is from this single root that both cipher and, by a longer road, zero descend. With the numerals came methods of calculation on paper that were faster and clearer than working with counters or an abacus, and the reputation of the new arithmetic began to travel ahead of it into Europe.

F Europe did not welcome the newcomer at once. Roman numerals had served record-keeping for centuries and had no need of a zero, and the merchants who actually reckoned sums often did so on a counting board, where an empty line needs no symbol. When the Italian mathematician Leonardo of Pisa, later known as Fibonacci, set out the new numerals in a widely read book in the early thirteenth century, he won an audience but also resistance. Some authorities distrusted the figures precisely because they were easy to write and, they feared, easy to alter, since a stray stroke could turn one numeral into another, and for a time certain cities restricted their use in official accounts. Only slowly, helped by printing and by the sheer convenience of the method for trade, did the numerals and their zero become ordinary.

G The reward for accepting zero was out of all proportion to the difficulty of the idea. As a placeholder it made a compact notation possible, so that any number, however large, could be written with ten signs. As a number it opened the way to algebra, to coordinates measured from an origin, and in time to the calculus, which depends on quantities shrinking towards zero without ever quite reaching it. The logic of modern computing, built on just two symbols, needs zero as much as it needs one. The hard part, in the end, was never the calculation. It was the willingness to give nothing a name and to treat it as something real.

ANSWER THE QUESTIONS

Questions 1–5 · True / False / Not Given

Do the following statements agree with the information in the passage? Write True, False, or Not Given.

1 Some advanced civilisations counted and traded without using a zero.

2 The Babylonians used their placeholder mark at the end of a number as well as in the middle.

3 The Maya developed their zero without borrowing it from another culture.

4 Brahmagupta's rules were accepted across India within his lifetime.

5 European merchants immediately preferred the new numerals to their counting boards.

Questions 6–9 · Multiple choice

Choose the correct answer, A, B, C or D.

6 According to paragraph A, what are the two different ideas contained in the word 'zero'?

- **A** A symbol and the sound that names it
- **B** A placeholder for an empty position, and a number that can be calculated with
- **C** A positive number and its negative
- **D** A Babylonian wedge and a Maya shell

7 Why did the Babylonian mark still leave room for confusion?

- **A** It was written in base ten
- **B** It was easily mistaken for the symbol for sixty
- **C** It was used only in the middle of a number, never at the end
- **D** Scribes frequently forgot to include it

8 What does paragraph D say Brahmagupta could not resolve?

- **A** How to add a negative number to a positive one
- **B** How to write zero as a circle rather than a dot
- **C** How to carry his ideas beyond India
- **D** What happens when a number is divided by zero

9 According to paragraph F, why did some European authorities distrust the new numerals?

- **A** They were more expensive to print than Roman numerals
- **B** They were thought to be easy to alter or forge
- **C** They could not represent very large numbers
- **D** They had been banned by the Church

Questions 10–11 · Sentence completion

Complete each sentence using no more than two words from the passage.

10 The Sanskrit word behind the concept meant , and was rendered into Arabic as sifr.

11 Fibonacci set out the new numerals in a widely read in the early thirteenth century.

Questions 12–14 · Matching information

The passage has seven paragraphs, A–G. Which paragraph contains the following information? Choose the correct letter.

12 a description of resistance to the new numerals in Europe

13 an example of a zero used accurately within a calendar

14 the naming origin of the words cipher and zero

ANSWER KEY

1. TRUE
2. FALSE
3. TRUE
4. NOT GIVEN
5. FALSE
6. B
7. C
8. D
9. B
10. empty
11. book
12. F
13. C
14. E