NOVA

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Hindu–Arabic Numerals and Algebra | Zero to Infinity

What is the Hindu–Arabic numeral system?

The set of 10 numerals—0, 1, 2, 3, 4, 5, 6, 7, 8, 9—that you have used all your life make up the Hindu–Arabic system, which is also known as the *decimal system,* or *base-10 system*. It is a *place value* (or *positional*) system, meaning that the value of a numeral depends on its position. The values increase by powers of ten. For example, in the number 3,456, "6" is in the ones place, while "3" is in the thousands place; the value of each numeral is its value multiplied by the value of the place—the "3" in the number represents 3,000.

algebra–a part of mathematics that represents problems or situations using mathematical equations consisting of numbers, letters or symbols, and operations (addition, subtraction, multiplication, division), and basic rules to solve them

Who was al-Khwārizmī and why was he important?

Muhammad ibn Mūsā al-Khwārizmī (~780–850 CE) was a Persian mathematician at the "House of Wisdom" (also known as the Grand Library of Baghdad). The House of Wisdom was an intellectual center during the Golden Age of the Islamic Empire, where scholars gathered to study, research, exchange ideas, and translate scientific and other works that came from other places. The scholars played an important role in compiling and building upon existing knowledge. Al-Khwārizmī's key works include the following:

- In about 830 CE, al-Khwārizmī wrote a book (in Arabic) on algebra titled *Al-Kitāb al-mukhtaṣar fī ḥisāb al-jabr waʾl-muqābala* ("The Compendious Book on Calculation by Completion and Balancing" in English). In the book, al-Khwārizmī described how to solve different types of equations by moving a negative number from one side of an equation to the other side and changing its sign (*al-jabr,* or "completion") and subtracting the same quantity from both sides of the equation (*al-muqābala,* or "balancing").
- In a book on arithmetic, written in about 825 CE, al-Khwārizmī explains the Hindu–Arabic numbers and how to perform addition, subtraction, multiplication, division, doubling, and halving and how to calculate with fractions. The original Arabic version of this book is lost, but it was translated into Latin in the 12th century. Multiple Latin versions exist. One of the oldest and most complete is preserved at the Hispanic Society of America in New York (as seen in the video).

Al-Khwārizmī's work had a great impact. It helped spread awareness of the Hindu–Arabic numeral system to the Western world in the 12th century and promote its use. Eventually, the number system was accepted and became the primary numeral system used worldwide. Al-Khwārizmī's work also established the concepts of algebra, which are used across the fields of science, mathematics, and technology. The modern term *algebra* comes from *al-jabr* in the title of al-Khwārizmi's book. The word *algorithm* also derives from al-Khwārizmi, whose Latinized name is *Algoritmi.* An algorithm is a set of step-by-step rules used for performing calculations. A

computer relies on algorithms to solve a problem or complete a task. Thus, with computers managing many aspects of daily life, it can be said that much of the modern world runs on algorithms.

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