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Importance of the number 0 and names for the number 0 in English

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Annotatsiya: Maqolada 0 raqimining etimologiyasi, osiyodan yevropaga kirib kelishi, matematika va matematikadan boshqa fanlarga, yil jadvalida nol raqamining ahamiyati haqida fikr yuritiladi.

Kalit so'zlar: ṣifr, matematik termin, kalkulyator, rim, arab raqamlari, elementar algebra

Annotation: The article discusses the etymology of the number 0, its entry from Asia to Europe, the importance of the number zero in the table of the year, from mathematics and non-mathematics to other disciplines.
Keywords: ṣifr, mathematical term, calculator, Roman, Arabic numerals, elementary algebra

Аннотация: В статье обсуждается этимология числа 0, его проникновение из Азии в Европу, важность числа ноль в таблице года, от математики и нематематики до других дисциплин.

Ключевые слова: ifr, математический термин, калькулятор, римские, арабские цифры, элементарная алгебра.

The word zero came into the English language via French zéro from Italian zero, Italian contraction of Venetian zevero form of Italian zefiro via ṣafira or ṣifr.In pre-Islamic time the word ṣifr had the meaning "empty". Sifr evolved to mean zero when it was used to translate śūnya Sanskrit from India. The first known English use of zero was in 1598.[1]Depending on the context, there may be different words used for the number zero. For the simple notion of lacking, the words nothing and none are often used. Sometimes, the words nought, naught and aughtare used. Several sports have specific words for a score of zero, such as love in tennis and duck in cricket; nil is used for many sports in British English. It is often called oh in the context of telephone numbers. Slang words for zero include zip, zilch, nada, and scratch. Duck egg and goose egg are also slang for zero.[2]

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The earliest use of zero in the calculation of the Julian Easter occurred before AD 311, at the first entry in a table of epacts as preserved in an Ethiopic document for the years AD 311 to 369, using a Ge'ez word for "none" (English translation is "0" elsewhere) alongside Ge'ez numerals (based on Greek numerals), which was translated from an equivalent table published by the Church of Alexandria in Medieval Greek.[3] This use was repeated in AD 525 in an equivalent table, that was translated via the Latin nulla or "none" by Dionysius Exiguus, alongside Roman numerals.[4] When division produced zero as a remainder, nihil, meaning "nothing", was used. These medieval zeros were used by all future medieval calculators of Easter. The initial "N" was used as a zero symbol in a table of Roman numerals by Bede—or his colleagues around AD 725.

India

Pingala (c. 3rd/2nd century BC), a Sanskrit prosody scholar, used binary numbers in the form of short and long syllables (the latter equal in length to two short syllables), a notation similar to Morse code. Pingala used the Sanskrit word śūnya explicitly to refer to zero.The concept of zero as a written digit in the **decimal** place value notation was developed in India, presumably as early as during the Gupta period (c. 5th century), with the oldest unambiguous evidence dating to the 7th century.A symbol for zero, a large dot likely to be the precursor of the still-current hollow symbol, is used throughout the Bakhshali manuscript, a practical manual on arithmetic for merchants. In 2017, three samples from the manuscript were shown by radiocarbon dating to come from three different centuries: from AD 224–383, AD 680–779, and AD 885–993, making it South Asia's oldest recorded use of the zero symbol. It is not known how the birch bark fragments from different centuries forming the manuscript came to be packaged together.

The Lokavibhāga, a Jain text on cosmology surviving in a medieval Sanskrit translation of the Prakrit original, which is internally dated to AD 458 (Saka era 380), uses a decimal place-value system, including a zero. In this text, śūnya ("void, empty") is also used to refer to zero.

The Aryabhatiya (c. 500), states sthānāt sthānaṁ daśaguṇaṁ syāt "from place to place each is ten times the preceding."

Rules governing the use of zero appeared in Brahmagupta's Brahmasputha Siddhanta (7th century), which states the sum of zero with itself as zero, and incorrectly division by zero as:

A positive or negative number when divided by zero is a fraction with the zero as denominator. Zero divided by a negative or positive number is either zero or

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is expressed as a fraction with zero as numerator and the finite quantity as denominator. Zero divided by zero is zero.

History of the Hindu–Arabic numeral system

The Arabic-language inheritance of science was largely Greek, followed by Hindu influences. In 773, at Al-Mansur's behest, translations were made of many ancient treatises including Greek, Roman, Indian, and others.

In AD 813, astronomical tables were prepared by a Persian mathematician, Muḥammad ibn Mūsā al-Khwārizmī, using Hindu numerals; and about 825, he published a book synthesizing Greek and Hindu knowledge and also contained his own contribution to mathematics including an explanation of the use of zero. This book was later translated into Latin in the 12th century under the title Algoritmi de numero Indorum. This title means "al-Khwarizmi on the Numerals of the Indians". The word "Algoritmi" was the translator's Latinization of Al-Khwarizmi's name, and the word "Algorithm" or "Algorism" started to acquire a meaning of any arithmetic based on decimals.

Muhammad ibn Ahmad al-Khwarizmi, in 976, stated that if no number appears in the place of tens in a calculation, a little circle should be used "to keep the rows". This circle was called ṣifr.

Transmission to Europe

The Hindu–Arabic numeral system (base 10) reached Europe in the 11th century, via Al-Andalus through Spanish Muslims, the Moors, together with knowledge of astronomy and instruments like the astrolabe, first imported by Gerbert of Aurillac. For this reason, the numerals came to be known in Europe as "Arabic numerals". The Italian mathematician Fibonacci or Leonardo of Pisa was instrumental in bringing the system into European mathematics in 1202, stating:

After my father's appointment by his homeland as state official in the customs house of Bugia for the Pisan merchants who thronged to it, he took charge; and in view of its future usefulness and convenience, had me in my boyhood come to him and there wanted me to devote myself to and be instructed in the study of calculation for some days. There, following my introduction, as a consequence of marvelous instruction in the art, to the nine digits of the Hindus, the knowledge of the art very much appealed to me before all others, and for it I realized that all its aspects were studied in Egypt, Syria, Greece, Sicily, and Provence, with their varying methods; and at these places thereafter, while on business. I pursued my study in depth and learned the give-and-take of disputation. But all this even, and the algorism, as well as the art of Pythagoras,

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I considered as almost a mistake in respect to the method of the Hindus (Modus Indorum). Therefore, embracing more stringently that method of the Hindus, and taking stricter pains in its study, while adding certain things from my own understanding and inserting also certain things from the niceties of Euclid's geometric art. I have striven to compose this book in its entirety as understandably as I could, dividing it into fifteen chapters. Almost everything which I have introduced I have displayed with exact proof, in order that those further seeking this knowledge, with its pre-eminent method, might be instructed, and further, in order that the Latin people might not be discovered to be without it, as they have been up to now. If I have perchance omitted anything more or less proper or necessary, I beg indulgence, since there is no one who is blameless and utterly provident in all things. The nine Indian figures are: 9 8 7 6 5 4 3 2 1. With these nine figures, and with the sign 0 ... any number may be written.

Here Leonardo of Pisa uses the phrase "sign 0", indicating it is like a sign to do operations like addition or multiplication. From the 13th century, manuals on calculation (adding, multiplying, extracting roots, etc.) became common in Europe where they were called algorismus after the Persian mathematician al-Khwārizmī. The most popular was written by Johannes de Sacrobosco, about 1235 and was one of the earliest scientific books to be printed in 1488. Until the late 15th century, Hindu–Arabic numerals seem to have predominated among mathematicians, while merchants preferred to use the Roman numerals. In the 16th century, they became commonly used in Europe.

0 is the integer immediately preceding 1. Zero is an even number[61] because it is divisible by 2 with no remainder. 0 is neither positive nor negative. Many definitions include 0 as a natural number, in which case it is the only natural number that is not positive. Zero is a number which quantifies a count or an amount of null size. In most cultures, 0 was identified before the idea of negative things (i.e., quantities less than zero) was accepted.

As a value or a number, zero is not the same as the digit zero, used in numeral systems with positional notation. Successive positions of digits have higher weights, so the digit zero is used inside a numeral to skip a position and give appropriate weights to the preceding and following digits. A zero digit is not always necessary in a positional number system (e.g., the number 02). In some instances, a leading zero may be used to distinguish a number.

Elementary algebra

The number 0 is the smallest non-negative integer. The natural number following 0 is 1 and no natural number precedes 0. The number 0 may

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or may not be considered a natural number, but it is an integer, and hence a rational number and a real number (as well as an algebraic number and a complex number).

The number 0 is neither positive nor negative, and is usually displayed as the central number in a number line. It is neither a prime number nor a composite number. It cannot be prime because it has an infinite number of factors, and cannot be composite because it cannot be expressed as a product of prime numbers (as 0 must always be one of the factors). Zero is, however, even (i.e. a multiple of 2, as well as being a multiple of any other integer, rational, or real number).

The following are some basic (elementary) rules for dealing with the number 0. These rules apply for any real or complex number x, unless otherwise stated.

- Addition: $x + 0 = 0 + x = x$. That is, 0 is an identity element (or neutral element) with respect to addition.
- Subtraction: $x - 0 = x$ and $0 - x = -x$.
- Multiplication: $x \cdot 0 = 0 \cdot x = 0$.
- Division: $0/x = 0$, for nonzero x. But $x/0$ is undefined, because 0 has no multiplicative inverse (no real number multiplied by 0 produces 1), a consequence of the previous rule.
- Exponentiation: $x^0 = x/x = 1$, except that the case $x = 0$ may be left undefined in some contexts. For all positive real x, $0^x = 0$.

The expression $0/0$, which may be obtained in an attempt to determine the limit of an expression of the form $f(x)/g(x)$ as a result of applying the lim operator independently to both operands of the fraction, is a so-called "indeterminate form". That does not simply mean that the limit sought is necessarily undefined; rather, it means that the limit of $f(x)/g(x)$, if it exists, must be found by another method, such as l'Hôpital's rule.

The sum of 0 numbers (the empty sum) is 0, and the product of 0 numbers (the empty product) is 1. The factorial 0! evaluates to 1, as a special case of the empty product.

Other branches of mathematics

- In set theory, 0 is the cardinality of the empty set: if one does not have any apples, then one has 0 apples. In fact, in certain axiomatic developments of mathematics from set theory, 0 is defined to be the empty set. When this is done, the empty set is the von Neumann cardinal assignment for a set with

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no elements, which is the empty set. The cardinality function, applied to the empty set, returns the empty set as a value, thereby assigning it 0 elements.

- Also in set theory, 0 is the lowest ordinal number, corresponding to the empty set viewed as a well-ordered set.
- In propositional logic, 0 may be used to denote the truth value false.
- In abstract algebra, 0 is commonly used to denote a zero element, which is a neutral element for addition (if defined on the structure under consideration) and an absorbing element for multiplication (if defined).
- In lattice theory, 0 may denote the bottom element of a bounded lattice.
- In category theory, 0 is sometimes used to denote an initial object of a category.
- In recursion theory, 0 can be used to denote the Turing degree of the partial computable functions.

Related mathematical terms

- A zero of a function f is a point x in the domain of the function such that f(x) = 0. When there are finitely many zeros these are called the roots of the function. This is related to zeros of a holomorphic function.
- The **zero function** (or zero map) on a domain D is the constant function with 0 as its only possible output value, i.e., the function f defined by f(x) = 0 for all x in D. The zero function is the only function that is both even and odd. A particular zero function is a zero morphism in category theory; e.g., a zero map is the identity in the additive group of functions. The determinant on non-invertible square matrices is a zero map.
- Several branches of mathematics have zero elements, which generalize either the property $0 + x = x$, or the property $0 \cdot x = 0$, or both.

Physics

The value zero plays a special role for many physical quantities. For some quantities, the zero level is naturally distinguished from all other levels, whereas for others it is more or less arbitrarily chosen. For example, for an absolute temperature (as measured in kelvins), zero is the lowest possible value (negative temperatures are defined, but negative-temperature systems are not actually colder). This is in contrast to for example temperatures on the Celsius scale, where zero is arbitrarily defined to be at the freezing point of water. Measuring sound intensity in decibels or phons, the zero level is arbitrarily set at a reference value—for example, at a value for the threshold of hearing. In physics, the zero-point energy is the lowest possible energy that a quantum

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mechanical physical system may possess and is the energy of the ground state of the system.

Chemistry

Zero has been proposed as the atomic number of the theoretical element tetraneutron. It has been shown that a cluster of four neutrons may be stable enough to be considered an atom in its own right. This would create an element with no protons and no charge on its nucleus.

As early as 1926, Andreas von Antropoff coined the term neutronium for a conjectured form of matter made up of neutrons with no protons, which he placed as the chemical element of atomic number zero at the head of his new version of the periodic table. It was subsequently placed as a noble gas in the middle of several spiral representations of the periodic system for classifying the chemical elements.

Computer science

The most common practice throughout human history has been to start counting at one, and this is the practice in early classic computer programming languages such as Fortran and COBOL. However, in the late 1950s LISP introduced zero-based numbering for arrays while Algol 58 introduced completely flexible basing for array subscripts (allowing any positive, negative, or zero integer as base for array subscripts), and most subsequent programming languages adopted one or other of these positions. For example, the elements of an array are numbered starting from 0 in C, so that for an array of n items the sequence of array indices runs from 0 to n−1. This permits an array element's location to be calculated by adding the index directly to address of the array, whereas 1-based languages precalculate the array's base address to be the position one element before the first.

There can be confusion between 0- and 1-based indexing, for example Java's JDBC indexes parameters from 1 although Java itself uses 0-based indexing.

In databases, it is possible for a field not to have a value. It is then said to have a null value. For numeric fields it is not the value zero. For text fields this is not blank nor the empty string. The presence of null values leads to three-valued logic. No longer is a condition either true or false, but it can be undetermined. Any computation including a null value delivers a null result.

A null pointer is a pointer in a computer program that does not point to any object or function. In C, the integer constant 0 is converted into the null pointer

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at compile time when it appears in a pointer context, and so 0 is a standard way to refer to the null pointer in code. However, the internal representation of the null pointer may be any bit pattern (possibly different values for different data types).

In mathematics −0 = +0 = 0; both −0 and +0 represent exactly the same number, i.e., there is no "positive zero" or "negative zero" distinct from zero. However, in some computer hardware signed number representations, zero has two distinct representations, a positive one grouped with the positive numbers and a negative one grouped with the negatives; this kind of dual representation is known as signed zero, with the latter form sometimes called negative zero. These representations include the signed magnitude and one's complement binary integer representations (but not the two's complement binary form used in most modern computers), and most floating point number representations

In binary, 0 represents the value for "off", which means no electricity flow.

Zero is the value of false in many programming languages.

Other fields

- In telephony, pressing 0 is often used for dialling out of a company network or to a different city or region, and 00 is used for dialling abroad. In some countries, dialling 0 places a call for operator assistance.
- DVDs that can be played in any region are sometimes referred to as being "region 0"
- Roulette wheels usually feature a "0" space (and sometimes also a "00" space), whose presence is ignored when calculating payoffs (thereby allowing the house to win in the long run).
- In Formula One, if the reigning World Champion no longer competes in Formula One in the year following their victory in the title race, 0 is given to one of the drivers of the team that the reigning champion won the title with. This happened in 1993 and 1994, with Damon Hill driving car 0, due to the reigning World Champion (Nigel Mansell and Alain Prost respectively) not competing in the championship.
- On the U.S. Interstate Highway System, in most states exits are numbered based on the nearest milepost from the highway's western or southern terminus within that state. Several that are less than half a mile (800 m) from state boundaries in that direction are numbered as Exit 0.

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A slashed zero can be used to distinguish the number from the letter. The digit 0 with a dot in the center seems to have originated as an option on IBM 3270 displays and has continued with some modern computer typefaces such as Andalé Mono, and in some airline reservation systems. One variation uses a short vertical bar instead of the dot. Some fonts designed for use with computers made one of the capital-O–digit-0 pair more rounded and the other more angular (closer to a rectangle). A further distinction is made in falsification-hindering typeface as used on German car number plates by slitting open the digit 0 on the upper right side. Sometimes the digit 0 is used either exclusively, or not at all, to avoid confusion altogether.

Year label

In the BC calendar era, the year 1 BC is the first year before AD 1; there is not a year zero. By contrast, in astronomical year numbering, the year 1 BC is numbered 0, the year 2 BC is numbered −1, and so forth.

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