

Mathematical Symbols

I INTRODUCTION

Mathematical Symbols, various signs and abbreviations used in mathematics to indicate entities, relations, or operations.

II HISTORY

The origin and development of mathematical symbols are not entirely clear. For the *probable* origin of the remarkable digits 1 through 9, see Numerals. The origin of zero is unknown, because no authentic record exists of its history before AD 400. The extension of the decimal position system below unity is attributed to the Dutch mathematician Simon Stevin, who called tenths, hundredths, and thousandths *primes*, *sekondes*, and *terzes* and circled digits to denote the orders; thus, 4.628 was written as

4 ④ ⑥ ① 2 ② 8 ③ . A point was used to set off the decimal part of a number as early as 1492, and later a bar was also used. In the *Exempelbüchlein* of 1530 by the German mathematician Christoff Rudolf, a problem in compound interest is solved, and some use is made of the decimal fraction. The German astronomer Johannes Kepler used the comma to set off the decimal orders, and the Swiss mathematician Justus Byrgius used the decimal fraction in such forms as 3.2.

Although the early Egyptians had symbols for addition and equality, and the Greeks, Hindus, and Arabs had symbols for equality and the unknown quantity, from earliest times mathematical processes were cumbersome because proper symbols of operation were lacking. The expressions for such processes were either written out in full or denoted by word abbreviations. The later Greeks, the Hindus, and the German-born mathematician Nemorarius Jordanus indicated addition by juxtaposition; the Italians usually denoted it by the letter *P* or *p* with a line drawn through it, but their symbols were not uniform. Some mathematicians used *p*, some *e*, and the mathematician Niccolò Tartaglia commonly expressed the operation by \emptyset . German and English algebraists introduced the sign $+$, but spoke of it as *signum additorum* and first used it only to indicate excess. The Greek mathematician Diophantus indicated subtraction by the symbol \nearrow . The Hindus used a dot, and the Italian algebraists denoted it by *M* or *m* with a line drawn through the letter. The German and English algebraists were the first to use the present symbol and described it as *Signum subtractorum*. The symbols $+$ and $-$ were first shown in 1489 by the German Johann Widman.

The English mathematician William Oughtred first used the symbol \times for "times". The German mathematician Gottfried Wilhelm Leibniz used a point to indicate multiplication, and in 1637 the French mathematician René Descartes used juxtaposition. In 1688 Leibniz employed the sign \cap to denote multiplication and \cup to denote division. The Hindus wrote the divisor under the dividend. Leibniz used the familiar form $a:b$. Descartes made popular the notation a^n for involution; the English mathematician John Wallis defined the negative exponent and first used the symbol (∞) for infinity.

The symbol of equality, $=$, was originated by the English mathematician Robert Recorde, and the symbols $>$ and $<$ for "greater than" and "less than" originated with Thomas Harriot, also an Englishman. The French mathematician François Viète introduced various symbols of aggregation. The

symbols of differentiation, dx , and integration, \int , as used in calculus, originated with Leibniz as did the symbol \sim for similarity, as used in geometry. The Swiss mathematician Leonhard Euler was largely responsible for the symbols \emptyset , f , F , as used in the theory of functions.

III THE HIERARCHY OF NUMBERS

The hierarchy of numbers is the following: million, billion, trillion, quadrillion, quintillion, sextillion, septillion, octillion, nonillion, decillion, undecillion, duodecillion, tredecillion, quat(t)uordecillion, quindecillion, sexdecillion, septendecillion, octodecillion, novemdecillion, vigintillion.

In the French and American system of notation, each number after a million is a thousand times the preceding number; in the English and German system, each number is a million times the preceding, though the French and American system is becoming used as a standard. A vigintillion is written as a 1 followed by 63 zeros in the French and American system; by 120 zeros in England and Germany.

Decimals are written in the form 1.23 in the United States, 1·23 in Great Britain, and 1,23 in continental Europe. In standard scientific notation, a number such as 0.000000123 is written as 1.23×10^{-7} .

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