SCIENTIFIC NOTATION

Scientific notation (also referred to as **scientific form** or **standard index form**, or **standard form** in the UK) is a way of expressing numbers that are too big or too small to be conveniently written in decimal form. It is commonly used by scientists, mathematicians and engineers, in part because it can simplify certain arithmetic operations. On scientific calculators it is usually known as "SCI" display mode.

Decimal notation	Scientific notation
2	2×10^{0}
300	3×10^{2}
4321.768	4.321768×10^{3}
−53000	-5.3×10^{4}
6720000000	6.72×10^{9}
0.2	2×10^{-1}
987	9.87×10^{2}
0.00000000751	7.51×10^{-9}

In scientific notation, all numbers are written in the form

$$m \times 10^{n}$$

(*m* times ten raised to the power of *n*), where the exponent *n* is an integer, and the coefficient *m* is any real number. The integer *n* is called the order of magnitude and the real number *m* is called the *significand* or *mantissa*.[1] However, the term "mantissa" may cause confusion because it is the name of the fractional part of the common logarithm. If the number is negative then a minus sign precedes *m* (as in ordinary decimal notation). In normalized notation, the exponent is chosen so that the absolute value (modulus) of the significand *m* is at least 1 but less than 10.

Decimal floating point is a computer arithmetic system closely related to scientific notation.

Normalized notation

Any given real number can be written in the form $m \times 10^n$ in many ways: for example, 350 can be written as 3.5×10^2 or 35×10^1 or 350×10^0.

In *normalized* scientific notation (called "standard form" in the UK), the exponent *n* is chosen so that the absolute value of *m* remains at least one but less than ten ($1 \leq |m| < 10$). Thus 350 is written as 3.5×10^2. This form allows easy comparison of numbers, as the exponent *n* gives the number's order of magnitude. It is the form that is required when using tables of common logarithms. In normalized notation, the exponent *n* is negative for a number with absolute value between 0 and 1 (e.g. 0.5 is written as 5×10^{-1}). The 10 and exponent are often omitted when the exponent is 0.

Normalized scientific form is the typical form of expression of large numbers in many fields, unless an unnormalized form, such as engineering notation, is desired. Normalized scientific notation is often called **exponential notation**—although the latter term is more general and also applies when *m* is not restricted to the range 1 to 10 (as in engineering notation for instance) and to bases other than 10 (for example, 3.15×2^{20}).

Order of magnitude

Scientific notation also enables simpler order-of-magnitude comparisons. A proton's mass is 0.00000000000000000000000016726 kg. If written as 1.6726×10^{-27} kg, it is easier to compare this mass with that of an electron, given below. The order of magnitude of the ratio of the masses can be obtained by comparing the exponents instead of the more error-prone task of counting the leading zeros. In this case, −27 is larger than −31 and therefore the proton is roughly four orders of magnitude (10,000 times) more massive than the electron.

Scientific notation also avoids misunderstandings due to regional differences in certain quantifiers, such as *billion*, which might indicate either 10^9 or 10^{12}.

In physics and astrophysics, the number of orders of magnitude between two numbers is sometimes referred to as "dex", a contraction of "decimal exponent" (see f.e. Chemical abundance ratios). For instance, if two numbers are within 1 dex of each other, then the ratio of the larger to the smaller number is less than 10. Fractional values can be used, so if within 0.5 dex, the ratio is less than $10^{0.5}$, and so on.

Further examples of scientific notation

- An electron's mass is about 0.000000000000000000000000000000910938356 kg.[22] In scientific notation, this is written 9.10938356×10^{-31} kg (in SI units).
- The Earth's mass is about 5972400000000000000000000 kg.[23] In scientific notation, this is written 5.9724×10^{24} kg.
- The Earth's circumference is approximately 40000000 m.[24] In scientific notation, this is 4×10^{7} m. In engineering notation, this is written 40×10^{6} m. In SI writing style, this may be written 40 Mm (*40 megametres*).
- An inch is defined as *exactly* 25.4 mm. Quoting a value of 25.400 mm shows that the value is correct to the nearest micrometre. An approximated value with only two significant digits would be 2.5×10^{1} mm instead. As there is no limit to the number of significant digits, the length of an inch could, if required, be written as (say) $2.54000000000\times10^{1}$ mm instead.

Converting numbers

Converting a number in these cases means to either convert the number into scientific notation form, convert it back into decimal form or to change the exponent part of the equation. None of these alter the actual number, only how it's expressed.

Decimal to scientific

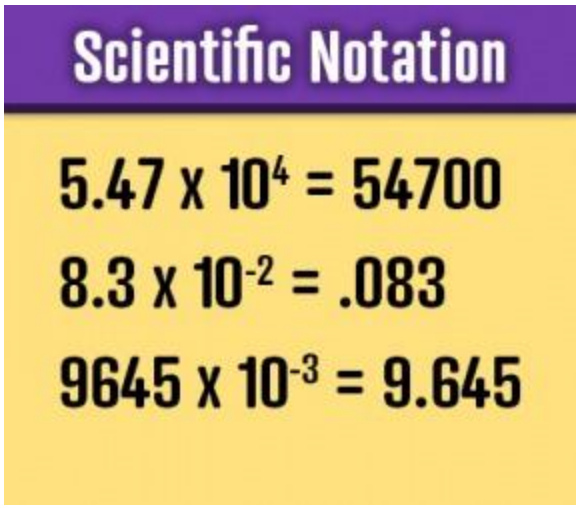
First, move the decimal separator point sufficient places, *n*, to put the number's value within a desired range, between 1 and 10 for normalized notation. If the decimal was moved to the left, append $\times 10^{n}$; to the right, $\times 10^{-n}$. To represent the number 1,230,400 in normalized scientific notation, the decimal separator would be moved 6 digits to the left and $\times 10^{6}$ appended, resulting in 1.2304×10^{6}. The number −0.0040321 would have its decimal separator shifted 3 digits to the right instead of the left and yield -4.0321×10^{-3} as a result.

Scientific to decimal

Converting a number from scientific notation to decimal notation, first remove the $\times 10^{n}$ on the end, then shift the decimal separator *n* digits to the right (positive *n*) or left (negative *n*). The number 1.2304×10^{6} would have its decimal separator shifted 6 digits to the right and become 1,230,400, while -4.0321×10^{-3} would have its decimal separator moved 3 digits to the left and be −0.0040321.

Scientific notation is a mathematical expression used to represent a decimal number between 1 and 10 multiplied by ten, so you can write large numbers using less digits.

An example of scientific notation is when you write 4 x 10^3 for 4,000.



a mathematical expression used to represent any decimal number as a number between one and ten raised to a specific power of ten (Ex.: 4.1 × 10 for 4.1, 4.1 × 10 for 41, 4.1 × 10 for 410, 4.1 × 10 for 0.41, 4.1 × 10 for 0.041): often used for approximate computations with very large or small numbers

A method of expressing numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. The scientific notation for 10,492, for example, is 1.0492×10^4.