

## The International System of Units

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[The International System of Units \(SI\) on the BIPM website:](#)

The definition of the SI units is established in terms of a set of seven defining constants. The complete system of units can be derived from the fixed values of these defining constants, expressed in the units of the SI. These seven defining constants are the most fundamental feature of the definition of the entire system of units.

The seven defining constants of the SI and the seven corresponding units they define:

Defining constant	Symbol	Numerical value	Unit
hyperfine transition frequency of Cs	$\Delta\nu_{\text{Cs}}$	9 192 631 770	Hz
speed of light in vacuum	$c$	299 792 458	$\text{m s}^{-1}$
Planck constant	$h$	$6.626\,070\,15 \times 10^{-34}$	J s
elementary charge	$e$	$1.602\,176\,634 \times 10^{-19}$	C
Boltzmann constant	$k$	$1.380\,649 \times 10^{-23}$	$\text{J K}^{-1}$
Avogadro constant	$N_{\text{A}}$	$6.022\,140\,76 \times 10^{23}$	$\text{mol}^{-1}$
luminous efficacy	$K_{\text{cd}}$	683	$\text{lm W}^{-1}$

These particular constants were chosen after having been identified as being the best choice, taking into account the previous definition of the SI, which was based on seven base units, and progress in science.

The definitions below specify the exact numerical value of each constant when its value is expressed in the corresponding SI unit. By fixing the exact numerical value the unit becomes defined, since the product of the *numerical value* and the *unit* has to equal the *value* of the constant, which is postulated to be invariant. The seven constants are chosen in such a way that any unit of the SI can be written either through a defining constant itself or through products or quotients of defining

constants.

The International System of Units, the SI, is the system of units in which

- the unperturbed ground state hyperfine transition frequency of the caesium 133 atom  $\Delta\nu_{\text{Cs}}$  is 9 192 631 770 Hz,
- the speed of light in vacuum  $c$  is 299 792 458 m/s,
- the Planck constant  $h$  is  $6.626\,070\,15 \times 10^{-34}$  J s,
- the elementary charge  $e$  is  $1.602\,176\,634 \times 10^{-19}$  C,
- the Boltzmann constant  $k$  is  $1.380\,649 \times 10^{-23}$  J/K,
- the Avogadro constant  $N_{\text{A}}$  is  $6.022\,140\,76 \times 10^{23}$  mol<sup>-1</sup>,
- the luminous efficacy of monochromatic radiation of frequency  $540 \times 10^{12}$  Hz,  $K_{\text{cd}}$ , is 683 lm/W.

where the hertz, joule, coulomb, lumen, and watt, with unit symbols Hz, J, C, lm, and W, respectively, are related to the units second, metre, kilogram, ampere, kelvin, mole, and candela, with unit symbols s, m, kg, A, K, mol, and cd, respectively, according to  $\text{Hz} = \text{s}^{-1}$ ,  $\text{J} = \text{kg m}^2 \text{s}^{-2}$ ,  $\text{C} = \text{A s}$ ,  $\text{lm} = \text{cd m}^2 \text{m}^{-2} = \text{cd sr}$ , and  $\text{W} = \text{kg m}^2 \text{s}^{-3}$ .

The seven constants are chosen in such a way that any unit of the SI can be written either through a defining constant itself or through products or quotients of defining constants.

The numerical values of the seven defining constants have no uncertainty.