

Selected Physical Constants<sup>1</sup>

Symbol	Quantity	SI value and unit name	Gaussian value and unit name	Relative uncertainty
$c$	speed of light in free space	$2.99792458 \times 10^8$ m/s	$2.99792458 \times 10^{10}$ cm/s	0 (value defined)
$G$	gravitation constant	$6.6743 \times 10^{-11}$ $\text{m}^3/\text{kg}\cdot\text{s}^2$	$6.6743 \times 10^{-8}$ $\text{cm}^3/\text{g}\cdot\text{s}^2$	$\sim 10^{-4}$
$\hbar$	Plank constant	$1.0545716 \times 10^{-34}$ J·s	$1.0545716 \times 10^{-27}$ erg·s	$\sim 5 \times 10^{-8}$
$e$	elementary electric charge	$1.6021764 \times 10^{-19}$ C	$4.803204 \times 10^{-10}$ statcoulomb	$\sim 3 \times 10^{-8}$
$m_e$	electron's rest mass	$0.9109382 \times 10^{-30}$ kg	$0.9109382 \times 10^{-27}$ g	$\sim 5 \times 10^{-8}$
$m_p$	proton's rest mass	$1.6726216 \times 10^{-27}$ kg	$1.6726216 \times 10^{-24}$ g	$\sim 5 \times 10^{-8}$
$\mu_0$	magnetic constant	$4\pi \times 10^{-7}$ N/A <sup>2</sup>	-	0 (value defined)
$\epsilon_0$	electric constant	$8.854187817 \times 10^{-12}$ F/m	-	0 (defined as $1/\mu_0 c^2$ )
$k_B$	Boltzmann constant	$1.380650 \times 10^{-23}$ J/K	$1.380650 \times 10^{-16}$ erg/K	$\sim 2 \times 10^{-6}$

## Remarks:

1. The exact value of  $c$  was defined by an international convention in 1983, in order to extend the official definition of a second (as “the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom”) to that of a meter. The selected values are back-compatible with the legacy definitions of the meter (initially, as the a 1/40,000,000-th part of the Earth equator's length) and the second (for a long time, as 1/(24×60×60)-th part of the Earth rotation period), within the experimental errors of these measures.

2.  $\epsilon_0$  and  $\mu_0$  are not really the fundamental constants; rather they define the SI unit system.

3. The Boltzmann constant can be called the “fundamental constant” only with reservations, because its only role is to comply with the independent definition of a kelvin (as a temperature unit in which the triple point of water is exactly 273.15 K). If temperature is expressed in energy units  $k_B T$  (as is done in this lecture course), this constant disappears.

4. Dimensionless “fine structure” constant:

$$\alpha \equiv \begin{cases} e^2 / 4\pi\epsilon_0\hbar c & \text{in SI units} \\ e^2 / \hbar c & \text{in Gaussian units} \end{cases} \approx 7.29735253 \times 10^{-3} \approx \frac{1}{137}.$$

<sup>1</sup> Adapted from the most recent (2006) NIST list, available online at <http://physics.nist.gov/cuu/Constants/>. (See also a nice article *Physical Constant* in *Wikipedia*.)