2022 CODATA RECOMMENDED VALUES OF THE FUNDAMENTAL CONSTANTS OF PHYSICS AND CHEMISTRY **NIST SP 959** (May 2024)

An extensive constants list is available at physics.nist.gov/constants.

Quantity	Symbol	Numerical value	Unit
*^{133}Cs hyperfine transition frequency	$\Delta\nu_{\mathrm{Cs}}$	9 192 631 770	Hz
*speed of light in vacuum	c	299 792 458	$\mathrm{m\,s^{-1}}$
*Planck constant	h	$6.626\,070\,15 \times 10^{-34}$	$\mathrm{J\,Hz^{-1}}$
	$\hbar$	$1.054\,571\,817\ldots \times 10^{-34}$	J s
*elementary charge	e	$1.602\,176\,634 \times 10^{-19}$	C
*Avogadro constant	N_{A}	$6.022\,140\,76 \times 10^{23}$	$\mathrm{mol^{-1}}$
*Boltzmann constant	k	$1.380\,649 \times 10^{-23}$	$\mathrm{J\,K^{-1}}$
*luminous efficacy	K_{cd}	683	$\mathrm{lm\,W^{-1}}$
electron volt (e/C) J	eV	$1.602\,176\,634 \times 10^{-19}$	J
Josephson constant $2e/h$	K_{J}	$483\,597.848\,4\ldots \times 10^{9}$	$\mathrm{Hz\,V^{-1}}$
von Klitzing constant $2\pi\hbar/e^2$	R_{K}	$25\,812.807\,45\ldots$	Ω
molar gas constant $N_{\mathrm{A}}k$	R	$8.314\,462\,618\ldots$	$\mathrm{J\,mol^{-1}\,K^{-1}}$
Stefan-Boltzmann const. $\pi^2k^4/(60\hbar^3c^2)$	σ	$5.670\,374\,419\ldots \times 10^{-8}$	$\mathrm{W\,m^{-2}\,K^{-4}}$

*Defining constants of the International System of Units (SI).

Quantity	Symbol	Numerical value	Unit
(unified) atomic mass unit $\frac{1}{12}m(^{12}\mathrm{C})$	u	$1.660\,539\,068\,92(52) \times 10^{-27}$	kg
Newtonian constant of gravitation	G	$6.674\,30(15) \times 10^{-11}$	$\mathrm{m^3\,kg^{-1}\,s^{-2}}$
fine-structure constant $e^2/(4\pi\epsilon_0\hbar c)$	α	$7.297\,352\,5643(11) \times 10^{-3}$	
inverse fine-structure constant	α^{-1}	$137.035\,999\,177(21)$	
Rydberg frequency $\alpha^2 m_\mathrm{e} c^2/(2h)$	cR_∞	$3.289\,841\,960\,2500(36) \times 10^{15}$	Hz
vac. magnetic permeability $4\pi\alpha\hbar/(e^2 c)$	μ_0	$1.256\,637\,061\,27(20) \times 10^{-6}$	$\mathrm{N\,A^{-2}}$
vac. electric permittivity $1/(\mu_0 c^2)$	ϵ_0	$8.854\,187\,8188(14) \times 10^{-12}$	$\mathrm{F\,m^{-1}}$
electron mass	m_e	$9.109\,383\,7139(28) \times 10^{-31}$	kg
proton mass	m_p	$1.672\,621\,925\,95(52) \times 10^{-27}$	kg
proton-electron mass ratio	$m_\mathrm{p}/m_\mathrm{e}$	$1836.152\,673\,426(32)$	
reduced Compton wavelength $\hbar/(m_\mathrm{e} c)$	$\lambda\!\!\!^{-}_\mathrm{C}$	$3.861\,592\,6744(12) \times 10^{-13}$	m
Bohr radius $\hbar/(\alpha m_\mathrm{e} c)$	a_0	$5.291\,772\,105\,44(82) \times 10^{-11}$	m
Bohr magneton $e\hbar/(2m_\mathrm{e})$	μ_B	$9.274\,010\,0657(29) \times 10^{-24}$	$\mathrm{J\,T^{-1}}$

The number in parentheses is the one-sigma ($1\,\sigma$) uncertainty in the last two digits of the given value.