CODATA RECOMMENDED VALUES OF THE FUNDAMENTAL PHYSICAL CONSTANTS: 2014

NIST SP 961 (Sept/2015) Values from: P. J. Mohr, D. B. Newell, and B. N. Taylor, arXiv:1507.07956

A more extensive listing of constants is available in the above reference and on the NIST Physics Laboratory Web site physics.nist.gov/constants.

The number in parentheses is the one-standard-deviation uncertainty in the last two digits of the given value.

Quantity	Symbol	Numerical value	Unit
speed of light in vacuum	c, c_0	299 792 458 (exact)	m s^{-1}
magnetic constant	μ_0	$4\pi \times 10^{-7}$ (exact)	N A^{-2}
		$= 12.566\,370\,614... \times 10^{-7}$	N A^{-2}
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854\,187\,817... \times 10^{-12}$	F m^{-1}
Newtonian constant of gravitation	G	$6.674\,08(31) \times 10^{-11}$	m^3 kg^{-1} s^{-2}
Planck constant	h	$6.626\,070\,040(81) \times 10^{-34}$	J s
in eV s		$4.135\,667\,662(25) \times 10^{-15}$	eV s
$h/2\pi$	$\hbar$	$1.054\,571\,800(13) \times 10^{-34}$	J s
in eV s		$6.582\,119\,514(40) \times 10^{-16}$	eV s
elementary charge	e	$1.602\,176\,6208(98) \times 10^{-19}$	C
magnetic flux quantum $h/2e$	Φ_0	$2.067\,833\,831(13) \times 10^{-15}$	Wb
Josephson constant $2e/h$	K_J	$483\,597.8525(30) \times 10^{9}$	Hz V^{-1}
von Klitzing constant $h/e^2 = \mu_0 c/2\alpha$	R_K	25 812.807 4555(59)	Ω
Bohr magneton $e\hbar/2m_e$	μ_B	$927.400\,9994(57) \times 10^{-26}$	J T^{-1}
in eV T^{-1}		$5.788\,381\,8012(26) \times 10^{-5}$	eV T^{-1}
nuclear magneton $e\hbar/2m_p$	μ_N	$5.050\,783\,699(31) \times 10^{-27}$	J T^{-1}
in eV T^{-1}		$3.152\,451\,2550(15) \times 10^{-8}$	eV T^{-1}
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\,352\,5664(17) \times 10^{-3}$	
inverse fine-structure constant	α^{-1}	137.035 999 139(31)	
Rydberg constant $\alpha^2 m_e c/2h$	R_∞	10 973 731.568 508(65)	m^{-1}
	$R_\infty c$	$3.289\,841\,960\,355(19) \times 10^{15}$	Hz
energy equivalent in eV	$R_\infty hc$	13.605 693 009(84)	eV
Bohr radius $\alpha/4\pi R_\infty = 4\pi\epsilon_0\hbar^2/m_e e^2$	a_0	$0.529\,177\,210\,67(12) \times 10^{-10}$	m
Hartree energy $e^2/4\pi\epsilon_0 a_0 = 2R_\infty hc = \alpha^2 m_e c^2$	E_h	$4.359\,744\,650(54) \times 10^{-18}$	J
in eV		27.211 386 02(17)	eV
electron mass	m_e	$9.109\,383\,56(11) \times 10^{-31}$	kg
in u		$5.485\,799\,090\,70(16) \times 10^{-4}$	u
energy equivalent in MeV	$m_e c^2$	0.510 998 9461(31)	MeV
electron-muon mass ratio	m_e/m_μ	$4.836\,331\,70(11) \times 10^{-3}$	
electron-proton mass ratio	m_e/m_p	$5.446\,170\,213\,52(52) \times 10^{-4}$	
electron charge to mass quotient	$-e/m_e$	$-1.758\,820\,024(11) \times 10^{11}$	C kg^{-1}
Compton wavelength $h/m_e c$	λ_C	$2.426\,310\,2367(11) \times 10^{-12}$	m
$\lambda_C/2\pi = \alpha a_0 = \alpha^2/4\pi R_\infty$	$\bar{\lambda}_C$	$386.159\,267\,64(18) \times 10^{-15}$	m
classical electron radius $\alpha^2 a_0$	r_e	$2.817\,940\,3227(19) \times 10^{-15}$	m
Thomson cross section $(8\pi/3)r_e^2$	σ_e	$0.665\,245\,871\,58(91) \times 10^{-28}$	m^2
electron magnetic moment	μ_e	$-928.476\,4620(57) \times 10^{-26}$	J T^{-1}
to Bohr magneton ratio	μ_e/μ_B	$-1.001\,159\,652\,180\,91(26)$	
to nuclear magneton ratio	μ_e/μ_N	$-1838.281\,972\,34(17)$	
electron magnetic moment anomaly $\lvert\mu_e\rvert/\mu_B - 1$	a_e	$1.159\,652\,180\,91(26) \times 10^{-3}$	
electron g-factor $-2(1 + a_e)$	g_e	$-2.002\,319\,304\,361\,82(52)$	
electron-proton magnetic moment ratio	μ_e/μ_p	$-658.210\,6866(20)$	
muon mass in u	m_μ	0.113 428 9257(25)	u
energy equivalent in MeV	$m_\mu c^2$	105.658 3745(24)	MeV
muon-electron mass ratio	m_μ/m_e	206.768 2826(46)	
muon magnetic moment	μ_μ	$-4.490\,448\,26(10) \times 10^{-26}$	J T^{-1}
to Bohr magneton ratio	μ_μ/μ_B	$-4.841\,970\,48(11) \times 10^{-3}$	
to nuclear magneton ratio	μ_μ/μ_N	$-8.890\,597\,05(20)$	
muon magnetic moment anomaly			
$\lvert\mu_\mu\rvert/(e\hbar/2m_\mu) - 1$	a_μ	$1.165\,920\,89(63) \times 10^{-3}$	

Quantity	Symbol	Numerical value	Unit
muon g-factor $-2(1 + a_\mu)$	g_μ	$-2.002\,331\,8418(13)$	
muon-proton magnetic moment ratio	μ_μ/μ_p	$-3.183\,345\,142(71)$	
proton mass	m_p	$1.672\,621\,898(21) \times 10^{-27}$	kg
in u		1.007 276 466 879(91)	u
energy equivalent in MeV	$m_p c^2$	938.272 0813(58)	MeV
proton-electron mass ratio	m_p/m_e	1836.152 673 89(17)	
proton magnetic moment	μ_p	$1.410\,606\,7873(97) \times 10^{-26}$	J T^{-1}
to nuclear magneton ratio	μ_p/μ_N	2.792 847 3508(85)	
proton magnetic shielding correction $1 - \mu'_p/\mu_p$ (H_2O, sphere, 25 °C)	σ'_p	$25.691(11) \times 10^{-6}$	
proton gyromagnetic ratio $2\mu_p/\hbar$	γ_p	$2.675\,221\,900(18) \times 10^{8}$	s^{-1} T^{-1}
	$\gamma_p/2\pi$	42.577 478 92(29)	MHz T^{-1}
shielded proton gyromagnetic ratio $2\mu'_p/\hbar$ (H_2O, sphere, 25 °C)	γ'_p	$2.675\,153\,171(33) \times 10^{8}$	s^{-1} T^{-1}
	$\gamma'_p/2\pi$	42.576 385 07(53)	MHz T^{-1}
neutron mass in u	m_n	1.008 664 915 88(49)	u
energy equivalent in MeV	$m_n c^2$	939.565 4133(58)	MeV
neutron-proton mass ratio	m_n/m_p	1.001 378 418 98(51)	
neutron magnetic moment	μ_n	$-0.966\,236\,50(23) \times 10^{-26}$	J T^{-1}
to nuclear magneton ratio	μ_n/μ_N	$-1.913\,042\,73(45)$	
deuteron mass in u	m_d	2.013 553 212 745(40)	u
energy equivalent in MeV	$m_d c^2$	1875.612 928(12)	MeV
deuteron-proton mass ratio	m_d/m_p	1.999 007 500 87(19)	
deuteron magnetic moment	μ_d	$0.433\,073\,5040(36) \times 10^{-26}$	J T^{-1}
to nuclear magneton ratio	μ_d/μ_N	0.857 438 2311(48)	
helion (^{3}He nucleus) mass in u	m_h	3.014 932 246 73(12)	u
energy equivalent in MeV	$m_h c^2$	2808.391 586(17)	MeV
shielded helion magnetic moment (gas, sphere, 25 °C)	μ'_h	$-1.074\,553\,080(14) \times 10^{-26}$	J T^{-1}
to Bohr magneton ratio	μ'_h/μ_B	$-1.158\,671\,471(14) \times 10^{-3}$	
to nuclear magneton ratio	μ'_h/μ_N	$-2.127\,497\,720(25)$	
alpha particle mass in u	m_α	4.001 506 179 127(63)	u
energy equivalent in MeV	$m_\alpha c^2$	3727.379 378(23)	MeV
Avogadro constant	N_A, L	$6.022\,140\,857(74) \times 10^{23}$	mol^{-1}
atomic mass constant $\frac{1}{12}m(^{12}C) = 1$ u	m_u	$1.660\,539\,040(20) \times 10^{-27}$	kg
energy equivalent in MeV	$m_u c^2$	931.494 0954(57)	MeV
Faraday constant $N_A e$	F	96 485.332 89(59)	C mol^{-1}
molar gas constant	R	8.314 4598(48)	J mol^{-1} K^{-1}
Boltzmann constant R/N_A	k	$1.380\,648\,52(79) \times 10^{-23}$	J K^{-1}
in eV K^{-1}		$8.617\,3303(50) \times 10^{-5}$	eV K^{-1}
molar volume of ideal gas RT/p ($T = 273.15$ K, $p = 101.325$ kPa)	V_m	$22.413\,962(13) \times 10^{-3}$	m^3 mol^{-1}
Stefan-Boltzmann constant $\pi^2 k^4/60\hbar^3 c^2$	σ	$5.670\,367(13) \times 10^{-8}$	W m^{-2} K^{-4}
first radiation constant $2\pi hc^2$	c_1	$3.741\,771\,790(46) \times 10^{-16}$	W m^2
second radiation constant hc/k	c_2	$1.438\,777\,36(83) \times 10^{-2}$	m K
Wien displacement law constant			
$b = \lambda_{max} T = c_2/4.965\,114\,231...$	b	$2.897\,7729(17) \times 10^{-3}$	m K
Cu x unit: $\lambda(\mathrm{Cu\,K}\alpha_1)/1\,537.400$	xu(Cu Kα_1)	$1.002\,076\,97(28) \times 10^{-13}$	m
Mo x unit: $\lambda(\mathrm{Mo\,K}\alpha_1)/707.831$	xu(Mo Kα_1)	$1.002\,099\,52(53) \times 10^{-13}$	m

Energy equivalents

$(1\ \mathrm{m}^{-1})c = 299\,792\,458$ Hz	$(1\ \mathrm{Hz})h/k = 4.799\,2447(28) \times 10^{-11}$ K	$(1\ \mathrm{J}) = 6.241\,509\,126(38) \times 10^{18}$ eV	$(1\ \mathrm{eV})/c^2 = 1.073\,544\,1105(66) \times 10^{-9}$ u
$(1\ \mathrm{m}^{-1})hc/k = 1.438\,777\,36(83) \times 10^{-2}$ K	$(1\ \mathrm{Hz})h = 4.135\,667\,662(25) \times 10^{-15}$ eV	$(1\ \mathrm{eV}) = 1.602\,176\,6208(98) \times 10^{-19}$ J	$(1\ \mathrm{kg}) = 6.022\,140\,857(74) \times 10^{26}$ u
$(1\ \mathrm{m}^{-1})hc = 1.239\,841\,9739(76) \times 10^{-6}$ eV	$(1\ \mathrm{K})k/hc = 69.503\,457(40)$ m^{-1}	$(1\ \mathrm{eV})/hc = 8.065\,544\,005(50) \times 10^{5}$ m^{-1}	$(1\ \mathrm{u}) = 1.660\,539\,040(20) \times 10^{-27}$ kg
$(1\ \mathrm{m}^{-1})h/c = 1.331\,025\,049\,00(61) \times 10^{-15}$ u	$(1\ \mathrm{K})k/h = 2.083\,6612(12) \times 10^{10}$ Hz	$(1\ \mathrm{eV})/h = 2.417\,989\,262(15) \times 10^{14}$ Hz	$(1\ \mathrm{u})c/h = 7.513\,006\,6166(34) \times 10^{14}$ m^{-1}
$(1\ \mathrm{Hz})/c = 3.335\,640\,951 \ldots \times 10^{-9}$ m^{-1}	$(1\ \mathrm{K})k = 8.617\,3303(50) \times 10^{-5}$ eV	$(1\ \mathrm{eV})/k = 1.160\,452\,21(67) \times 10^{4}$ K	$(1\ \mathrm{u})c^2 = 931.494\,0954(57) \times 10^{6}$ eV

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