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FUNDAMENTAL PHYSICAL CONSTANTS

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The numbers in parentheses are the standard-deviation uncertainties in the last digits of the quoted value, computed on the basis of internal consistency.

Quantity	Symbol	Value	Error (ppm)	Units: SI	Units: cgs
Velocity of light	c	2.9979250(10)	0.33	10^8 m sec^{-1}	10^{10} cm sec^{-1}
Fine-structure constant, $[\mu_0 c^2/4\pi](e^2/\hbar c)$	α α^{-1}	7.297351(11) 137.03602(21)	1.5 1.5	10^{-3}	10^{-3}
Electron charge	e	1.6021917(70) 4.803250(21)	4.4 4.4	10^{-19} C	10^{-20} emu 10^{-10} esu
Planck's constant	h $\hbar = h/2\pi$	6.626196(50) 1.0545919(80)	7.6 7.6	10^{-34} J · sec 10^{-34} J · sec	10^{-27} erg · sec 10^{-27} erg · sec
Avogadro's number	N	6.022169(40)	6.6	10^{26} kmole^{-1}	10^{23} mole^{-1}
Atomic mass unit	amu	1.660531(11)	6.6	10^{-27} kg	10^{-24} g
Electron rest mass	m_e m_e^*	9.109558(54) 5.485930(34)	6.0 6.2	10^{-31} kg 10^{-4} amu	10^{-28} g 10^{-4} amu
Proton rest mass	M_p M_p^*	1.672614(11) 1.00727661(8)	6.6 0.08	10^{-27} kg amu	10^{-24} g amu
Neutron rest mass	M_n M_n^*	1.674920(11) 1.00866520(10)	6.6 0.10	10^{-27} kg amu	10^{-24} g amu
Ratio of proton mass to electron mass	M_p/m_e	1836.109(11)	6.2		
Electron charge to mass ratio	e/m_e	1.7588028(54) 5.272759(16)	3.1 3.1	10^{11} C kg^{-1}	10^7 emu g^{-1} 10^{17} esu g^{-1}
Magnetic flux quantum, $[c]^{-1}(hc/2e)$	Φ_0 h/e	2.0678538(69) 4.135708(14) 1.3795234(46)	3.3 3.3 3.3	10^{-15} T · m^2 10^{-15} J · sec C^{-1}	10^{-7} G · cm^2 10^{-7} erg · sec emu^{-1} 10^{-17} erg · sec esu^{-1}
Quantum of circulation	$h/2m_e$ h/m_e	3.636947(11) 7.273894(22)	3.1 3.1	10^{-4} J · sec kg^{-1} 10^{-4} J · sec kg^{-1}	erg · sec g^{-1} erg · sec g^{-1}
Faraday constant, Ne	F	9.648670(54) 2.892599(16)	5.5 5.5	10^7 C kmole^{-1}	10^3 emu mole^{-1} 10^{14} esu mole^{-1}
Rydberg constant, $[\mu_0 c^2/4\pi]^2(m_e e^4/4\pi\hbar^3 c)$	R_∞	1.09737312(11)	0.10	10^7 m^{-1}	10^5 cm^{-1}
Bohr radius, $[\mu_0 c^2/4\pi]^{-1}(\hbar^2/m_e e^2) = \alpha/4\pi R_\infty$	a_0	5.2917715(81)	1.5	10^{-11} m	10^{-9} cm
Classical electron radius $[\mu_0 c^2/4\pi](e^2/m_e c^2) = \alpha^3/4\pi R_\infty$	r_0	2.817939(13)	4.6	10^{-15} m	10^{-13} cm
Electron magnetic moment in Bohr magnetons	μ_e/μ_B	1.0011596389(31)	0.0031		
Bohr magneton, $[c](e\hbar/2m_e c)$	μ_B	9.274096(65)	7.0	10^{-24} J T^{-1}	10^{-21} erg G^{-1}
Electron magnetic moment	μ_e	9.284851(65)	7.0	10^{-24} J T^{-1}	10^{-21} erg G^{-1}
Gyromagnetic ratio of protons in H_2O	γ_p' $\gamma_p'/2\pi$	2.6751270(82) 4.257597(13)	3.1 3.1	10^8 rad sec^{-1} · T^{-1} 10^7 Hz T^{-1}	10^4 rad sec^{-1} · G^{-1} 10^3 Hz G^{-1}
γ_p' corrected for diamagnetism of H_2O	γ_p $\gamma_p/2\pi$	2.6751965(82) 4.257707(13)	3.1 3.1	10^8 rad sec^{-1} · T^{-1} 10^7 Hz T^{-1}	10^4 rad sec^{-1} · G^{-1} 10^3 Hz G^{-1}
Magnetic moment of protons in H_2O in Bohr magnetons	μ_p'/μ_B	1.52099312(10)	0.066	10^{-3}	10^{-3}
Proton magnetic moment in Bohr magnetons	μ_p/μ_B	1.52103264(46)	0.30	10^{-3}	10^{-3}
Proton magnetic moment	μ_p	1.4106203(99)	7.0	10^{-26} J T^{-1}	10^{-23} erg G^{-1}
Magnetic moment of protons in H_2O in nuclear magnetons	μ_p'/μ_n	2.792709(17)	6.2		
μ_p'/μ_n corrected for diamagnetism of H_2O	μ_p/μ_n	2.792782(17)	6.2		
Nuclear magneton, $[c](e\hbar/2M_p c)$	μ_n	5.050951(50)	10	10^{-27} J T^{-1}	10^{-24} erg G^{-1}
Compton wavelength of the electron, $h/m_e c$	λ_C $\lambda_C/2\pi$	2.4263096(74) 3.861592(12)	3.1 3.1	10^{-12} m 10^{-13} m	10^{-10} cm 10^{-11} cm
Compton wavelength of the proton, $h/M_p c$	$\lambda_{C,p}$ $\lambda_{C,p}/2\pi$	1.3214409(90) 2.103139(14)	6.8 6.8	10^{-15} m 10^{-16} m	10^{-13} cm 10^{-14} cm
Compton wavelength of the neutron, $h/M_n c$	$\lambda_{C,n}$ $\lambda_{C,n}/2\pi$	1.3196217(90) 2.100243(14)	6.8 6.8	10^{-15} m 10^{-16} m	10^{-13} cm 10^{-14} cm
Gas constant	R_0	8.31434(35)	42	10^3 J kmole^{-1} · K^{-1}	10^7 erg mole^{-1} · K^{-1}
Boltzman's constant, R_0/N	k	1.380622(59)	43	10^{-23} J K^{-1}	10^{-16} erg K^{-1}
Stefan-Boltzman constant, $\pi^2 k^4/60\hbar^3 c^2$	σ	5.66961(96)	170	10^{-8} W m^{-2} K^{4}	10^{-5} erg sec^{-1} · cm^{-2} · K^{-4}
First radiation constant, $8\pi hc$	c_1	4.992579(38)	7.6	10^{-24} J · m	10^{-15} erg · cm
Second radiation constant, hc/k	c_2	1.438833(61)	43	10^{-2} m · K	cm · K
Gravitational constant	G	6.6732(31)	460	10^{-11} N · m^2 kg^{-2}	10^{-8} dyn · cm^2 g^{-2}
kx-unit-to-angstrom conversion factor, $\Lambda = \lambda(Å)/\lambda(kxu)$; $\lambda(CuK\alpha_1) \equiv$ 1.537400 kxu	Λ	1.0020764(53)	5.3		
Å*-to-angstrom conversion factor, $\Lambda = \lambda(Å)/\lambda(Å^*)$; $\lambda(WK\alpha_1) \equiv$ 0.2090100 Å*	Λ^*	1.0000197(56)	5.6		

*Note that the unified atomic mass scale $^{12}C \equiv 12$ has been used throughout, that amu = atomic mass unit, C = coulomb, G = gauss, Hz = hertz = cycles/sec, J = joule, K = kelvin (degrees kelvin), T = tesla (10^4 G), V = volt, and W = watt. In cases where formulas for constants are given (e.g., R_∞), the relations are written as the product of two factors. The second factor, in parentheses, is the expression to be used when all quantities are expressed in cgs units, with the electron charge in electrostatic units. The first factor, in brackets, is to be included only if all quantities are expressed in SI units. We remind the reader that with the exception of the auxiliary constants which have been taken to be exact, the uncertainties of these constants are correlated, and therefore the general law of error propagation must be used in calculating additional quantities requiring two or more of these constants.

Energy Conversion Factors

Quantity	Value	Unit	Error (ppm)
1 kg	5.609538(24)	10^{29} MeV	4.4
1 amu	931.4812(52)	MeV	5.5
Electron mass	0.5110041(16)	MeV	3.1
Proton mass	938.2592(52)	MeV	5.5
Neutron mass	939.5527(52)	MeV	5.5
1 electron volt	1.6021917(70)	10^{-19} J 10^{-12} erg	4.4
	2.4179659(81)	10^{14} Hz	3.3
	8.065465 (27)	10^5 m^{-1} 10^3 cm^{-1}	3.3
	1.160485(49)	10^4 K	42
Energy-wavelength conversion	1.2398541(41)	10^{-6} eV · m 10^{-4} eV · cm	3.3
Rydberg constant, R_∞	2.179914(17)	10^{-18} J 10^{-11} erg	7.6
	13.605826(45)	eV	3.3
	3.2898423(11)	10^{15} Hz	0.35
	1.578936(67)	10^5 K	43
Bohr magneton, μ_B	5.788381(18)	10^{-5} eV T^{-1}	3.1
	1.3996108(43)	10^{10} Hz T^{-1}	3.1
	46.68598(14)	m^{-1} · T^{-1} 10^{-2} cm^{-1} · T^{-1}	3.1
	0.671733(29)	K T^{-1}	43
Nuclear magneton, μ_n	3.152526(21)	10^{-8} eV T^{-1}	6.8
	7.622700(42)	10^6 Hz T^{-1}	5.5
	2.542659(14)	10^{-2} m^{-1} · T^{-1} 10^{-4} cm^{-1} · T^{-1}	5.5
	3.65846(16)	10^{-4} K T^{-1}	43
Gas constant, R_0	8.20562(35)	10^{-2} m^3 · atm kmole^{-1} · K^{-1}	42
Standard volume of ideal gas, V_0	22.4136	m^3 kmole^{-1}	

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