APPENDIX B. PHYSICAL CONSTANTS[1,2,3]

Quantity	Symbol, equation	Value	Uncert. (ppm)
speed of light in vacuum[4]	c	$2.997\ 924\ 58\times10^{10}$ cm s^{-1}	0
Planck constant	h	$6.626\ 075\ 5(40)\times10^{-27}$ erg s	0.60
Planck constant, reduced	$\hbar = h/2\pi$	$1.054\ 572\ 66(63)\times10^{-27}$ erg s	0.60
		$= 6.582\ 122\ 0(20)\times10^{-22}$ MeV s	0.30
electron charge magnitude	e	$4.803\ 206\ 8(15)\times10^{-10}$ esu	0.30
		$= 1.602\ 177\ 33(49)\times10^{-19}$ coulomb	0.30
conversion constant	$\hbar c$	197.327 053(59) MeV fm	0.30
conversion constant	$(\hbar c)^2$	0.389 379 66(23) GeV^2 mbarn	0.59
electron mass	m_e	0.510 999 06(15) $MeV/c^2 = 9.109\ 389\ 7(54)\times10^{-28}$ g	0.30, 0.59
proton mass	m_p	938.272 31(28) $MeV/c^2 = 1.672\ 623\ 1(10)\times10^{-24}$ g	0.30, 0.59
neutron mass	m_n	939.565 63(28) $MeV/c^2 = 1.674\ 928\ 6(10)\times10^{-24}$ g	0.30, 0.59
		= 1.008 664 904(14) amu	0.014
deuteron mass	m_d	1875.613 39(57) MeV/c^2	0.30
atomic mass unit (amu)	(mass C^{12} atom)/12 = (1 g)/N_A	931.494 32(28) $MeV/c^2 = 1.660\ 540\ 2(10)\times10^{-24}$ g	0.30, 0.59
electron charge to mass ratio	e/m_e	$5.272\ 808\ 6(16)\times10^{17}$ esu g^{-1}	0.30
		$= 1.758\ 819\ 62(53)\times10^{8}$ coulomb g^{-1}	0.30
quantum of magnetic flux	h/e	$4.135\ 669\ 2(12)\times10^{-15}$ joule s $coulomb^{-1}$	0.30
Josephson frequency-voltage ratio	$2e/h$	$4.835\ 976\ 7(14)\times10^{14}$ cycles s^{-1} v^{-1}	0.30
Faraday constant	F	$9.648\ 530\ 9(29)\times10^{4}$ coulomb mol^{-1}	0.30
fine-structure constant	$\alpha = e^2/\hbar c$	1/137.035 989 5(61)	0.045
classical electron radius	$r_e = e^2/m_e c^2$	2.817 940 92(38) fm	0.13
electron Compton wavelength	$\lambda_e = \hbar/m_e c = r_e\,\alpha^{-1}$	$3.861\ 593\ 23(35)\times10^{-11}$ cm	0.089
proton Compton wavelength	$\lambda_p = \hbar/m_p c$	$2.103\ 089\ 37(19)\times10^{-14}$ cm	0.089
neutron Compton wavelength	$\lambda_n = \hbar/m_n c$	$2.100\ 194\ 45(19)\times10^{-14}$ cm	0.089
Bohr radius ($m_{nucleus} = \infty$)	$\alpha_\infty = \hbar^2/m_e e^2 = r_e\,\alpha^{-2}$	$0.529\ 177\ 249(24)\times10^{-8}$ cm	0.045
Rydberg energy	$hcR_\infty = m_e e^4/2\hbar^2 = m_e c^2\alpha^2/2$	13.605 698 1(40) eV	0.30
Thomson cross section	$\sigma_T = 8\pi r_e^{\,2}/3$	0.665 246 16(18) barn	0.27
Bohr magneton	$\mu_B = e\hbar/2m_e c$	$5.788\ 382\ 63(52)\times10^{-15}$ MeV $gauss^{-1}$	0.089
nuclear magneton	$\mu_N = e\hbar/2m_p c$	$3.152\ 451\ 66(28)\times10^{-18}$ MeV $gauss^{-1}$	0.089
electron cyclotron frequency/field	$\omega_{cycl}^{e}/B = e/m_e c$	$1.758\ 819\ 62(53)\times10^{7}$ radian s^{-1} $gauss^{-1}$	0.30
proton cyclotron frequency/field	$\omega_{cycl}^{p}/B = e/m_p c$	$9.578\ 830\ 9(29)\times10^{3}$ radian s^{-1} $gauss^{-1}$	0.30
gravitational constant	G_N	$6.672\ 59(85)\times10^{-8}$ $cm^3 g^{-1}$ s^{-2}	128
grav. acceleration, sea level, 45° lat.	g	980.665 cm s^{-2}	0
Fermi coupling constant	$G_F/(\hbar c)^3$	$1.166\ 39(2)\times10^{-5}$ GeV^{-2}	20
Avogadro number	N_A	$6.022\ 136\ 7(36)\times10^{23}$ mol^{-1}	0.59
molar gas constant, ideal gas at STP	R	$8.314\ 510(70)\times10^{7}$ erg mol^{-1} K^{-1}	8.4
Boltzmann constant	k	$1.380\ 658(12)\times10^{-16}$ erg K^{-1}	8.5
		$= 8.617\ 385(73)\times10^{-5}$ eV K^{-1}	8.4
molar volume, ideal gas at STP	$N_A k(273.15\ K)/(\text{atmosphere})$	22 414.10(19) cm^3 mol^{-1}	8.4
Stefan-Boltzmann constant	$\sigma = \pi^2 k^4/60\hbar^3 c^2$	$5.670\ 51(19)\times10^{-5}$ erg s^{-1} cm^{-2} K^{-4}	34
first radiation constant	$2\pi hc^2$	$3.741\ 774\ 9(22)\times10^{-5}$ erg cm^2 s^{-1}	0.60
second radiation constant	hc/k	1.438 769(12) cm K	8.4

[1]E.R. Cohen and B.N. Taylor, *Rev. Mod. Phys.* **59**, 1121 (1987).

[2]B.N. Taylor and E.R. Cohen, *J. Res. Natl. Inst. Stand. Technol.* **95**, 497 (1990).

[3]E.R. Cohen and B.N. Taylor, *Phys. Today*, **46**(8) Part 2, BG9 (1993).

[4]Defined at the Conférence Générale des Poids et Mesures, October, 1983.

Physical Constants (continued)

Useful constants and conversion factors	
π= 3.141 592 653 589 793 238	1 coulomb = 2.997 924 58$\times 10^{9}$ esu
e = 2.718 281 828 459 045 235	1 tesla = 10^{4} gauss
γ = 0.577 215 664 901 532 861	1 atm. = 1.013 25$\times 10^{6}$ dyne/cm^{2}
1 in = 2.54 cm	0° C = 273.15 K
1 Å = 10^{-8} cm	1 sidereal year = 3.155 814 98$\times 10^{7}$ s
1 fm = 10^{-13} cm	1 tropical year 3.155 692 52$\times 10^{7}$ s
1 barn = 10^{-24} cm^{2}	1 light year = 9.460 528$\times 10^{17}$ cm
1 newton = 10^{5} dyne	1 parsec = 3.261 633 light year
1 joule = 10^{7} erg	1 astro. unit = 1.495 978 706 6(2)$\times 10^{13}$ cm
1 eV = 1.602 177 33(49)$\times 10^{-12}$ erg	1 curie = 3.7$\times 10^{10}$ disintegration /s
1 eV/c^{2} = 1.782 662 70(54)$\times 10^{-33}$ g	1 rad = 100 erg/ g of tissue
1 cal = 4.184 joule	1 roentgen = 1 esu/ 0.001293 g of air