TABLE XXIII. An abbreviated list of the CODATA recommended values of the fundamental constants of physics and chemistry based on the 1998 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
speed of light in vacuum	c, c_0	299 792 458	$m\,s^{-1}$	(exact)
magnetic constant	μ_0	$4\pi\times10^{-7}$	$N\,A^{-2}$	
		$=12.566\,370\,614\ldots\times10^{-7}$	$N\,A^{-2}$	(exact)
electric constant $1/\mu_0c^2$	ϵ_0	$8.854\,187\,817\ldots\times10^{-12}$	$F\,m^{-1}$	(exact)
Newtonian constant of gravitation	G	$6.673(10)\times10^{-11}$	$m^3\,kg^{-1}\,s^{-2}$	1.5×10^{-3}
Planck constant	h	$6.626\,068\,76(52)\times10^{-34}$	J s	7.8×10^{-8}
$h/2\pi$	$\hbar$	$1.054\,571\,596(82)\times10^{-34}$	J s	7.8×10^{-8}
elementary charge	e	$1.602\,176\,462(63)\times10^{-19}$	C	3.9×10^{-8}
magnetic flux quantum $h/2e$	Φ_0	$2.067\,833\,636(81)\times10^{-15}$	Wb	3.9×10^{-8}
conductance quantum $2e^2/h$	G_0	$7.748\,091\,696(28)\times10^{-5}$	S	3.7×10^{-9}
electron mass	m_e	$9.109\,381\,88(72)\times10^{-31}$	kg	7.9×10^{-8}
proton mass	m_p	$1.672\,621\,58(13)\times10^{-27}$	kg	7.9×10^{-8}
proton-electron mass ratio	m_p/m_e	1 836.152 6675(39)		2.1×10^{-9}
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\,352\,533(27)\times10^{-3}$		3.7×10^{-9}
inverse fine-structure constant	α^{-1}	137.035 999 76(50)		3.7×10^{-9}
Rydberg constant $\alpha^2m_ec/2h$	R_∞	10 973 731.568 549(83)	m^{-1}	7.6×10^{-12}
Avogadro constant	N_A, L	$6.022\,141\,99(47)\times10^{23}$	mol^{-1}	7.9×10^{-8}
Faraday constant N_Ae	F	96 485.3415(39)	$C\,mol^{-1}$	4.0×10^{-8}
molar gas constant	R	8.314 472(15)	$J\,mol^{-1}\,K^{-1}$	1.7×10^{-6}
Boltzmann constant R/N_A	k	$1.380\,6503(24)\times10^{-23}$	$J\,K^{-1}$	1.7×10^{-6}
Stefan–Boltzmann constant $(\pi^2/60)k^4/\hbar^3c^2$	σ	$5.670\,400(40)\times10^{-8}$	$W\,m^{-2}\,K^{-4}$	7.0×10^{-6}
Non-SI units accepted for use with the SI				
electron volt: (e/C) J	eV	$1.602\,176\,462(63)\times10^{-19}$	J	3.9×10^{-8}
(unified) atomic mass unit				
$1\ u=m_u=\frac{1}{12}m(^{12}C)$ $=10^{-3}\,kg\,mol^{-1}/N_A$	u	$1.660\,538\,73(13)\times10^{-27}$	kg	7.9×10^{-8}

ment 1 of Table XXII. The direct result of this adjustment is best estimated values in the least-squares sense of the 57 adjusted constants given in Tables XVII.A.1 and XIX.B.1 together with their variances and covariances. All of the 1998 recommended values and their uncertainties are obtained from these 57 constants and, as appropriate: (i) those constants that have defined values such as c and μ_0; (ii) the value of G adopted in Sec III.Q; and (iii) values of m_τ, G_F, and $\sin^2\theta_W$ given in Sec. III.S. How this is done is described in Sec. V.B, which immediately follows the tables of recommended values given in Sec. V.A.

A. Tables of values

The 1998 CODATA recommended values of the basic constants and conversion factors of physics and chemistry, including the values of related quantities, are given in Tables XXIII to XXX. Table XXIII is a highly abbreviated list containing the values of the constants and conversion factors most commonly used. Table XXIV is a much more extensive list of values categorized as follows: UNIVERSAL; ELECTROMAGNETIC; ATOMIC AND NUCLEAR; and PHYSICOCHEMICAL. The ATOMIC AND NUCLEAR category is subdivided into ten subcategories: General; Electroweak; Electron, e^-; Muon, μ^-; Tau, τ^-; Proton, p; Neutron, n; Deuteron, d; Helion, h; and Alpha particle, α. Table XXV gives the variances, covariances, and correlation coefficients of a selected group of constants. (Application of the covariance matrix is discussed in Appendix F.) Table XXVI gives the internationally adopted values of various quantities; Table XXVII lists the values of a number of x-ray-related quantities; Table XXVIII lists the values of various non-SI units; and Tables XXIX and XXX give the values of various energy equivalents.

All of the values given in Tables XXIII to XXX are available on the Web pages of the Fundamental Constants Data Center of the NIST Physics Laboratory at physics.nist.gov/constants. This electronic version of the 1998 CODATA recommended values of the constants also includes a much more extensive correlation coefficient matrix. Indeed, the correlation coefficient of any two constants listed in the tables is accessible on the Web site, as well as the automatic conversion of the value of an energy-related quantity expressed in one unit to the corresponding value expressed in another unit (in essence, an automated version of Tables XXIX and XXX).

TABLE XXIV. The CODATA recommended values of the fundamental constants of physics and chemistry based on the 1998 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
		UNIVERSAL		
speed of light in vacuum	c, c_0	299 792 458	$m\,s^{-1}$	(exact)
magnetic constant	μ_0	$4\pi\times10^{-7}$	$N\,A^{-2}$	
		$=12.566\,370\,614\ldots\times10^{-7}$	$N\,A^{-2}$	(exact)
electric constant $1/\mu_0c^2$	ϵ_0	$8.854\,187\,817\ldots\times10^{-12}$	$F\,m^{-1}$	(exact)
characteristic impedance of vacuum $\sqrt{\mu_0/\epsilon_0}=\mu_0c$	Z_0	376.730 313 461 ...	Ω	(exact)
Newtonian constant of gravitation	G	$6.673(10)\times10^{-11}$	$m^3\ kg^{-1}\,s^{-2}$	1.5×10^{-3}
	$G/\hbar c$	$6.707(10)\times10^{-39}$	$(GeV/c^2)^{-2}$	1.5×10^{-3}
Planck constant	h	$6.626\,068\,76(52)\times10^{-34}$	J s	7.8×10^{-8}
in eV s		$4.135\,667\,27(16)\times10^{-15}$	eV s	3.9×10^{-8}
$h/2\pi$	$\hbar$	$1.054\,571\,596(82)\times10^{-34}$	J s	7.8×10^{-8}
in eV s		$6.582\,118\,89(26)\times10^{-16}$	eV s	3.9×10^{-8}
Planck mass $(\hbar c/G)^{1/2}$	m_P	$2.1767(16)\times10^{-8}$	kg	7.5×10^{-4}
Planck length $\hbar/m_Pc=(\hbar G/c^3)^{1/2}$	l_P	$1.6160(12)\times10^{-35}$	m	7.5×10^{-4}
Planck time $l_P/c=(\hbar G/c^5)^{1/2}$	t_P	$5.3906(40)\times10^{-44}$	s	7.5×10^{-4}
		ELECTROMAGNETIC		
elementary charge	e	$1.602\,176\,462(63)\times10^{-19}$	C	3.9×10^{-8}
	e/h	$2.417\,989\,491(95)\times10^{14}$	$A\,J^{-1}$	3.9×10^{-8}
magnetic flux quantum $h/2e$	Φ_0	$2.067\,833\,636(81)\times10^{-15}$	Wb	3.9×10^{-8}
conductance quantum $2e^2/h$	G_0	$7.748\,091\,696(28)\times10^{-5}$	S	3.7×10^{-9}
inverse of conductance quantum	G_0^{-1}	12 906.403 786(47)	Ω	3.7×10^{-9}
Josephson constant[a] $2e/h$	K_J	$483\,597.898(19)\times10^9$	$Hz\,V^{-1}$	3.9×10^{-8}
von Klitzing constant[b] $h/e^2=\mu_0c/2\alpha$	R_K	25 812.807 572(95)	Ω	3.7×10^{-9}
Bohr magneton $e\hbar/2m_e$	μ_B	$927.400\,899(37)\times10^{-26}$	$J\,T^{-1}$	4.0×10^{-8}
in $eV\,T^{-1}$		$5.788\,381\,749(43)\times10^{-5}$	$eV\,T^{-1}$	7.3×10^{-9}
	μ_B/h	$13.996\,246\,24(56)\times10^9$	$Hz\,T^{-1}$	4.0×10^{-8}
	μ_B/hc	46.686 4521(19)	$m^{-1}\,T^{-1}$	4.0×10^{-8}
	μ_B/k	0.671 7131(12)	$K\,T^{-1}$	1.7×10^{-6}
nuclear magneton $e\hbar/2m_p$	μ_N	$5.050\,783\,17(20)\times10^{-27}$	$J\,T^{-1}$	4.0×10^{-8}
in $eV\,T^{-1}$		$3.152\,451\,238(24)\times10^{-8}$	$eV\,T^{-1}$	7.6×10^{-9}
	μ_N/h	7.622 593 96(31)	$MHz\,T^{-1}$	4.0×10^{-8}
	μ_N/hc	$2.542\,623\,66(10)\times10^{-2}$	$m^{-1}\,T^{-1}$	4.0×10^{-8}
	μ_N/k	$3.658\,2638(64)\times10^{-4}$	$K\,T^{-1}$	1.7×10^{-6}
		ATOMIC AND NUCLEAR		
		General		
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\,352\,533(27)\times10^{-3}$		3.7×10^{-9}
inverse fine-structure constant	α^{-1}	137.035 999 76(50)		3.7×10^{-9}
Rydberg constant $\alpha^2m_ec/2h$	R_∞	10 973 731.568 549(83)	m^{-1}	7.6×10^{-12}
	$R_\infty c$	$3.289\,841\,960\,368(25)\times10^{15}$	Hz	7.6×10^{-12}
	$R_\infty hc$	$2.179\,871\,90(17)\times10^{-18}$	J	7.8×10^{-8}
$R_\infty hc$ in eV		13.605 691 72(53)	eV	3.9×10^{-8}
Bohr radius $\alpha/4\pi R_\infty=4\pi\epsilon_0\hbar^2/m_ee^2$	a_0	$0.529\,177\,2083(19)\times10^{-10}$	m	3.7×10^{-9}
Hartree energy $e^2/4\pi\epsilon_0a_0=2R_\infty hc$ $=\alpha^2m_ec^2$	E_h	$4.359\,743\,81(34)\times10^{-18}$	J	7.8×10^{-8}
in eV		27.211 3834(11)	eV	3.9×10^{-8}
quantum of circulation	$h/2m_e$	$3.636\,947\,516(27)\times10^{-4}$	$m^2\,s^{-1}$	7.3×10^{-9}
	h/m_e	$7.273\,895\,032(53)\times10^{-4}$	$m^2\,s^{-1}$	7.3×10^{-9}

TABLE XXIV (*Continued*).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
		Electroweak		
Fermi coupling constant[c]	$G_F/(\hbar c)^3$	$1.166\,39(1)\times10^{-5}$	GeV^{-2}	8.6×10^{-6}
weak mixing angle[d] θ_W (on-shell scheme) $\sin^2\theta_W=s_W^2\equiv1-(m_W/m_Z)^2$	$\sin^2\theta_W$	0.2224(19)		8.7×10^{-3}
		Electron, e^-		
electron mass	m_e	$9.109\,381\,88(72)\times10^{-31}$	kg	7.9×10^{-8}
in u, $m_e=A_r(e)$ u (electron relative atomic mass times u)		$5.485\,799\,110(12)\times10^{-4}$	u	2.1×10^{-9}
energy equivalent	m_ec^2	$8.187\,104\,14(64)\times10^{-14}$	J	7.9×10^{-8}
in MeV		0.510 998 902(21)	MeV	4.0×10^{-8}
electron–muon mass ratio	m_e/m_μ	$4.836\,332\,10(15)\times10^{-3}$		3.0×10^{-8}
electron–tau mass ratio	m_e/m_τ	$2.875\,55(47)\times10^{-4}$		1.6×10^{-4}
electron–proton mass ratio	m_e/m_p	$5.446\,170\,232(12)\times10^{-4}$		2.1×10^{-9}
electron–neutron mass ratio	m_e/m_n	$5.438\,673\,462(12)\times10^{-4}$		2.2×10^{-9}
electron–deuteron mass ratio	m_e/m_d	$2.724\,437\,1170(58)\times10^{-4}$		2.1×10^{-9}
electron to alpha particle mass ratio	m_e/m_α	$1.370\,933\,5611(29)\times10^{-4}$		2.1×10^{-9}
electron charge to mass quotient	$-e/m_e$	$-1.758\,820\,174(71)\times10^{11}$	$C\,kg^{-1}$	4.0×10^{-8}
electron molar mass N_Am_e	$M(e),M_e$	$5.485\,799\,110(12)\times10^{-7}$	$kg\,mol^{-1}$	2.1×10^{-9}
Compton wavelength h/m_ec	λ_C	$2.426\,310\,215(18)\times10^{-12}$	m	7.3×10^{-9}
$\lambda_C/2\pi=\alpha a_0=\alpha^2/4\pi R_\infty$	$\lambda\!\!\!^{-}_C$	$386.159\,2642(28)\times10^{-15}$	m	7.3×10^{-9}
classical electron radius α^2a_0	r_e	$2.817\,940\,285(31)\times10^{-15}$	m	1.1×10^{-8}
Thomson cross section $(8\pi/3)r_e^2$	σ_e	$0.665\,245\,854(15)\times10^{-28}$	m^2	2.2×10^{-8}
electron magnetic moment	μ_e	$-928.476\,362(37)\times10^{-26}$	$J\,T^{-1}$	4.0×10^{-8}
to Bohr magneton ratio	μ_e/μ_B	$-1.001\,159\,652\,1869(41)$		4.1×10^{-12}
to nuclear magneton ratio	μ_e/μ_N	$-1\,838.281\,9660(39)$		2.1×10^{-9}
electron magnetic moment anomaly $\lvert\mu_e\rvert/\mu_B-1$	a_e	$1.159\,652\,1869(41)\times10^{-3}$		3.5×10^{-9}
electron g-factor $-2(1+a_e)$	g_e	$-2.002\,319\,304\,3737(82)$		4.1×10^{-12}
electron–muon magnetic moment ratio	μ_e/μ_μ	206.766 9720(63)		3.0×10^{-8}
electron–proton magnetic moment ratio	μ_e/μ_p	− 658.210 6875(66)		1.0×10^{-8}
electron to shielded proton magnetic moment ratio (H_2O, sphere, 25 °C)	μ_e/μ_p'	− 658.227 5954(71)		1.1×10^{-8}
electron–neutron magnetic moment ratio	μ_e/μ_n	960.920 50(23)		2.4×10^{-7}
electron–deuteron magnetic moment ratio	μ_e/μ_d	−2 143.923 498(23)		1.1×10^{-8}
electron to shielded helion[e] magnetic moment ratio (gas, sphere, 25 °C)	μ_e/μ_h'	864.058 255(10)		1.2×10^{-8}
electron gyromagnetic ratio $2\lvert\mu_e\rvert/\hbar$	γ_e	$1.760\,859\,794(71)\times10^{11}$	$s^{-1}\,T^{-1}$	4.0×10^{-8}
	$\gamma_e/2\pi$	28 024.9540(11)	$MHz\,T^{-1}$	4.0×10^{-8}
		Muon, μ^-		
muon mass	m_μ	$1.883\,531\,09(16)\times10^{-28}$	kg	8.4×10^{-8}
in u, $m_\mu=A_r(\mu)$ u (muon relative atomic mass times u)		0.113 428 9168(34)	u	3.0×10^{-8}
energy equivalent	$m_\mu c^2$	$1.692\,833\,32(14)\times10^{-11}$	J	8.4×10^{-8}
in MeV		105.658 3568(52)	MeV	4.9×10^{-8}
muon–electron mass ratio	m_μ/m_e	206.768 2657(63)		3.0×10^{-8}

TABLE XXIV (*Continued*).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
muon–tau mass ratio	m_μ/m_τ	$5.945\,72(97)\times10^{-2}$		1.6×10^{-4}
muon–proton mass ratio	m_μ/m_p	0.112 609 5173(34)		3.0×10^{-8}
muon–neutron mass ratio	m_μ/m_n	0.112 454 5079(34)		3.0×10^{-8}
muon molar mass $N_A m_\mu$	$M(\mu), M_\mu$	$0.113\,428\,9168(34)\times10^{-3}$	kg mol^{-1}	3.0×10^{-8}
muon Compton wavelength $h/m_\mu c$	$\lambda_{C,\mu}$	$11.734\,441\,97(35)\times10^{-15}$	m	2.9×10^{-8}
$\lambda_{C,\mu}/2\pi$	$\lambda\!\!\!^{-}_{C,\mu}$	$1.867\,594\,444(55)\times10^{-15}$	m	2.9×10^{-8}
muon magnetic moment	μ_μ	$-4.490\,448\,13(22)\times10^{-26}$	J T^{-1}	4.9×10^{-8}
to Bohr magneton ratio	μ_μ/μ_B	$-4.841\,970\,85(15)\times10^{-3}$		3.0×10^{-8}
to nuclear magneton ratio	μ_μ/μ_N	−8.890 597 70(27)		3.0×10^{-8}
muon magnetic moment anomaly $\lvert\mu_\mu\rvert/(e\hbar/2m_\mu)-1$	a_μ	$1.165\,916\,02(64)\times10^{-3}$		5.5×10^{-7}
muon g-factor $-2(1+a_\mu)$	g_μ	−2.002 331 8320(13)		6.4×10^{-10}
muon–proton magnetic moment ratio	μ_μ/μ_p	−3.183 345 39(10)		3.2×10^{-8}
		Tau, τ^-		
tau mass[f]	m_τ	$3.167\,88(52)\times10^{-27}$	kg	1.6×10^{-4}
in u, $m_\tau = A_r(\tau)$ u (tau relative atomic mass times u)		1.907 74(31)	u	1.6×10^{-4}
energy equivalent	$m_\tau c^2$	$2.847\,15(46)\times10^{-10}$	J	1.6×10^{-4}
in MeV		1 777.05(29)	MeV	1.6×10^{-4}
tau–electron mass ratio	m_τ/m_e	3 477.60(57)		1.6×10^{-4}
tau–muon mass ratio	m_τ/m_μ	16.8188(27)		1.6×10^{-4}
tau–proton mass ratio	m_τ/m_p	1.893 96(31)		1.6×10^{-4}
tau–neutron mass ratio	m_τ/m_n	1.891 35(31)		1.6×10^{-4}
tau–molar mass $N_A m_\tau$	$M(\tau), M_\tau$	$1.907\,74(31)\times10^{-3}$	kg mol^{-1}	1.6×10^{-4}
tau Compton wavelength $h/m_\tau c$	$\lambda_{C,\tau}$	$0.697\,70(11)\times10^{-15}$	m	1.6×10^{-4}
$\lambda_{C,\tau}/2\pi$	$\lambda\!\!\!^{-}_{C,\tau}$	$0.111\,042(18)\times10^{-15}$	m	1.6×10^{-4}
		Proton, p		
proton mass	m_p	$1.672\,621\,58(13)\times10^{-27}$	kg	7.9×10^{-8}
in u, $m_p = A_r(p)$ u (proton relative atomic mass times u)		1.007 276 466 88(13)	u	1.3×10^{-10}
energy equivalent	$m_p c^2$	$1.503\,277\,31(12)\times10^{-10}$	J	7.9×10^{-8}
in MeV		938.271 998(38)	MeV	4.0×10^{-8}
proton–electron mass ratio	m_p/m_e	1 836.152 6675(39)		2.1×10^{-9}
proton–muon mass ratio	m_p/m_μ	8.880 244 08(27)		3.0×10^{-8}
proton–tau mass ratio	m_p/m_τ	0.527 994(86)		1.6×10^{-4}
proton–neutron mass ratio	m_p/m_n	0.998 623 478 55(58)		5.8×10^{-10}
proton charge to mass quotient	e/m_p	$9.578\,834\,08(38)\times10^{7}$	C kg^{-1}	4.0×10^{-8}
proton molar mass $N_A m_p$	$M(p), M_p$	$1.007\,276\,466\,88(13)\times10^{-3}$	kg mol^{-1}	1.3×10^{-10}
proton Compton wavelength $h/m_p c$	$\lambda_{C,p}$	$1.321\,409\,847(10)\times10^{-15}$	m	7.6×10^{-9}
$\lambda_{C,p}/2\pi$	$\lambda\!\!\!^{-}_{C,p}$	$0.210\,308\,9089(16)\times10^{-15}$	m	7.6×10^{-9}
proton magnetic moment	μ_p	$1.410\,606\,633(58)\times10^{-26}$	J T^{-1}	4.1×10^{-8}
to Bohr magneton ratio	μ_p/μ_B	$1.521\,032\,203(15)\times10^{-3}$		1.0×10^{-8}
to nuclear magneton ratio	μ_p/μ_N	2.792 847 337(29)		1.0×10^{-8}
proton g-factor $2\mu_p/\mu_N$	g_p	5.585 694 675(57)		1.0×10^{-8}
proton–neutron magnetic moment ratio	μ_p/μ_n	−1.459 898 05(34)		2.4×10^{-7}
shielded proton magnetic moment (H_2O, sphere, 25 °C)	μ'_p	$1.410\,570\,399(59)\times10^{-26}$	J T^{-1}	4.2×10^{-8}
to Bohr magneton ratio	μ'_p/μ_B	$1.520\,993\,132(16)\times10^{-3}$		1.1×10^{-8}
to nuclear magneton ratio	μ'_p/μ_N	2.792 775 597(31)		1.1×10^{-8}

TABLE XXIV (*Continued*).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
proton magnetic shielding correction $1-\mu'_p/\mu_p$ (H_2O, sphere, 25 °C)	σ'_p	$25.687(15)\times10^{-6}$		5.7×10^{-4}
proton gyromagnetic ratio $2\mu_p/\hbar$	γ_p	$2.675\,222\,12(11)\times10^{8}$	$s^{-1}\,T^{-1}$	4.1×10^{-8}
	$\gamma_p/2\pi$	42.577 4825(18)	$MHz\,T^{-1}$	4.1×10^{-8}
shielded proton gyromagnetic ratio $2\mu'_p/\hbar$ (H_2O, sphere, 25 °C)	γ'_p	$2.675\,153\,41(11)\times10^{8}$	$s^{-1}\,T^{-1}$	4.2×10^{-8}
	$\gamma'_p/2\pi$	42.576 3888(18)	$MHz\,T^{-1}$	4.2×10^{-8}
		Neutron, n		
neutron mass	m_n	$1.674\,927\,16(13)\times10^{-27}$	kg	7.9×10^{-8}
in u, $m_n=A_r(n)$ u (neutron relative atomic mass times u)		1.008 664 915 78(55)	u	5.4×10^{-10}
energy equivalent	m_nc^2	$1.505\,349\,46(12)\times10^{-10}$	J	7.9×10^{-8}
in MeV		939.565 330(38)	MeV	4.0×10^{-8}
neutron–electron mass ratio	m_n/m_e	1 838.683 6550(40)		2.2×10^{-9}
neutron–muon mass ratio	m_n/m_μ	8.892 484 78(27)		3.0×10^{-8}
neutron–tau mass ratio	m_n/m_τ	0.528 722(86)		1.6×10^{-4}
neutron–proton mass ratio	m_n/m_p	1.001 378 418 87(58)		5.8×10^{-10}
neutron molar mass N_Am_n	$M(n), M_n$	$1.008\,664\,915\,78(55)\times10^{-3}$	$kg\,mol^{-1}$	5.4×10^{-10}
neutron Compton wavelength h/m_nc	$\lambda_{C,n}$	$1.319\,590\,898(10)\times10^{-15}$	m	7.6×10^{-9}
$\lambda_{C,n}/2\pi$	$\lambda\!\!\!^{-}_{C,n}$	$0.210\,019\,4142(16)\times10^{-15}$	m	7.6×10^{-9}
neutron magnetic moment	μ_n	$-0.966\,236\,40(23)\times10^{-26}$	$J\,T^{-1}$	2.4×10^{-7}
to Bohr magneton ratio	μ_n/μ_B	$-1.041\,875\,63(25)\times10^{-3}$		2.4×10^{-7}
to nuclear magneton ratio	μ_n/μ_N	−1.913 042 72(45)		2.4×10^{-7}
neutron g-factor $2\mu_n/\mu_N$	g_n	−3.826 085 45(90)		2.4×10^{-7}
neutron–electron magnetic moment ratio	μ_n/μ_e	$1.040\,668\,82(25)\times10^{-3}$		2.4×10^{-7}
neutron–proton magnetic moment ratio	μ_n/μ_p	−0.684 979 34(16)		2.4×10^{-7}
neutron to shielded proton magnetic moment ratio (H_2O, sphere, 25 °C)	μ_n/μ'_p	−0.684 996 94(16)		2.4×10^{-7}
neutron gyromagnetic ratio $2\lvert\mu_n\rvert/\hbar$	γ_n	$1.832\,471\,88(44)\times10^{8}$	$s^{-1}\,T^{-1}$	2.4×10^{-7}
	$\gamma_n/2\pi$	29.164 6958(70)	$MHz\,T^{-1}$	2.4×10^{-7}
		Deuteron, d		
deuteron mass	m_d	$3.343\,583\,09(26)\times10^{-27}$	kg	7.9×10^{-8}
in u, $m_d=A_r(d)$ u (deuteron relative atomic mass times u)		2.013 553 212 71(35)	u	1.7×10^{-10}
energy equivalent	m_dc^2	$3.005\,062\,62(24)\times10^{-10}$	J	7.9×10^{-8}
in MeV		1 875.612 762(75)	MeV	4.0×10^{-8}
deuteron–electron mass ratio	m_d/m_e	3 670.482 9550(78)		2.1×10^{-9}
deuteron–proton mass ratio	m_d/m_p	1.999 007 500 83(41)		2.0×10^{-10}
deuteron molar mass N_Am_d	$M(d), M_d$	$2.013\,553\,212\,71(35)\times10^{-3}$	$kg\,mol^{-1}$	1.7×10^{-10}
deuteron magnetic moment	μ_d	$0.433\,073\,457(18)\times10^{-26}$	$J\,T^{-1}$	4.2×10^{-8}
to Bohr magneton ratio	μ_d/μ_B	$0.466\,975\,4556(50)\times10^{-3}$		1.1×10^{-8}
to nuclear magneton ratio	μ_d/μ_N	0.857 438 2284(94)		1.1×10^{-8}
deuteron–electron magnetic moment ratio	μ_d/μ_e	$-4.664\,345\,537(50)\times10^{-4}$		1.1×10^{-8}
deuteron–proton magnetic moment ratio	μ_d/μ_p	0.307 012 2083(45)		1.5×10^{-8}

TABLE XXIV (*Continued*).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
deuteron–neutron magnetic moment ratio	μ_d/μ_n	−0.448 206 52(11)		2.4×10^{-7}
		Helion, h		
helion mass[e]	m_h	$5.006\,411\,74(39)\times10^{-27}$	kg	7.9×10^{-8}
in u, $m_h=A_r(h)$ u (helion relative atomic mass times u)		3.014 932 234 69(86)	u	2.8×10^{-10}
energy equivalent	m_hc^2	$4.499\,538\,48(35)\times10^{-10}$	J	7.9×10^{-8}
in MeV		2 808.391 32(11)	MeV	4.0×10^{-8}
helion–electron mass ratio	m_h/m_e	5 495.885 238(12)		2.1×10^{-9}
helion–proton mass ratio	m_h/m_p	2.993 152 658 50(93)		3.1×10^{-10}
helion molar mass N_Am_h	$M(h),M_h$	$3.014\,932\,234\,69(86)\times10^{-3}$	kg mol^{-1}	2.8×10^{-10}
shielded helion magnetic moment (gas, sphere, 25 °C)	μ_h'	$-1.074\,552\,967(45)\times10^{-26}$	J T^{-1}	4.2×10^{-8}
to Bohr magneton ratio	μ_h'/μ_B	$-1.158\,671\,474(14)\times10^{-3}$		1.2×10^{-8}
to nuclear magneton ratio	μ_h'/μ_N	−2.127 497 718(25)		1.2×10^{-8}
shielded helion to proton magnetic moment ratio (gas, sphere, 25 °C)	μ_h'/μ_p	−0.761 766 563(12)		1.5×10^{-8}
shielded helion to shielded proton magnetic moment ratio (gas/H_2O, spheres, 25 °C)	μ_h'/μ_p'	−0.761 786 1313(33)		4.3×10^{-9}
shielded helion gyromagnetic ratio $2\lvert\mu_h'\rvert/\hbar$ (gas, sphere, 25 °C)	γ_h'	$2.037\,894\,764(85)\times10^{8}$	s^{-1} T^{-1}	4.2×10^{-8}
	$\gamma_h'/2\pi$	32.434 1025(14)	MHz T^{-1}	4.2×10^{-8}
		Alpha particle, α		
alpha particle mass	m_α	$6.644\,655\,98(52)\times10^{-27}$	kg	7.9×10^{-8}
in u, $m_\alpha=A_r(\alpha)$ u (alpha particle relative atomic mass times u)		4.001 506 1747(10)	u	2.5×10^{-10}
energy equivalent	$m_\alpha c^2$	$5.971\,918\,97(47)\times10^{-10}$	J	7.9×10^{-8}
in MeV		3 727.379 04(15)	MeV	4.0×10^{-8}
alpha particle to electron mass ratio	m_α/m_e	7 294.299 508(16)		2.1×10^{-9}
alpha particle to proton mass ratio	m_α/m_p	3.972 599 6846(11)		2.8×10^{-10}
alpha particle molar mass N_Am_α	$M(\alpha),M_\alpha$	$4.001\,506\,1747(10)\times10^{-3}$	kg mol^{-1}	2.5×10^{-10}
		PHYSICOCHEMICAL		
Avogadro constant	N_A,L	$6.022\,141\,99(47)\times10^{23}$	mol^{-1}	7.9×10^{-8}
atomic mass constant $m_u=\frac{1}{12}m(^{12}C)=1\,u=10^{-3}$ kg mol$^{-1}/N_A$	m_u	$1.660\,538\,73(13)\times10^{-27}$	kg	7.9×10^{-8}
energy equivalent	m_uc^2	$1.492\,417\,78(12)\times10^{-10}$	J	7.9×10^{-8}
in MeV		931.494 013(37)	MeV	4.0×10^{-8}
Faraday constant[g] N_Ae	F	96 485.3415(39)	C mol^{-1}	4.0×10^{-8}
molar Planck constant	N_Ah	$3.990\,312\,689(30)\times10^{-10}$	J s mol^{-1}	7.6×10^{-9}
	N_Ahc	0.119 626 564 92(91)	J m mol^{-1}	7.6×10^{-9}
molar gas constant	R	8.314 472(15)	J mol^{-1} K^{-1}	1.7×10^{-6}
Boltzmann constant R/N_A	k	$1.380\,6503(24)\times10^{-23}$	J K^{-1}	1.7×10^{-6}
in eV K^{-1}		$8.617\,342(15)\times10^{-5}$	eV K^{-1}	1.7×10^{-6}
	k/h	$2.083\,6644(36)\times10^{10}$	Hz K^{-1}	1.7×10^{-6}
	k/hc	69.503 56(12)	m^{-1} K^{-1}	1.7×10^{-6}

TABLE XXIV (*Continued*).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
molar volume of ideal gas RT/p				
$T=273.15$ K, $p=101.325$ kPa	V_m	$22.413\,996(39)\times10^{-3}$	$m^3\,mol^{-1}$	1.7×10^{-6}
Loschmidt constant N_A/V_m	n_0	$2.686\,7775(47)\times10^{25}$	m^{-3}	1.7×10^{-6}
$T=273.15$ K, $p=100$ kPa	V_m	$22.710\,981(40)\times10^{-3}$	$m^3\,mol^{-1}$	1.7×10^{-6}
Sackur-Tetrode constant (absolute entropy constant)[h] $\frac{5}{2}+\ln[(2\pi m_u kT_1/h^2)^{3/2}kT_1/p_0]$				
$T_1=1$ K, $p_0=100$ kPa	S_0/R	$-1.151\,7048(44)$		3.8×10^{-6}
$T_1=1$ K, $p_0=101.325$ kPa		$-1.164\,8678(44)$		3.7×10^{-6}
Stefan-Boltzmann constant $(\pi^2/60)k^4/\hbar^3c^2$	σ	$5.670\,400(40)\times10^{-8}$	$W\,m^{-2}\,K^{-4}$	7.0×10^{-6}
first radiation constant $2\pi hc^2$	c_1	$3.741\,771\,07(29)\times10^{-16}$	$W\,m^2$	7.8×10^{-8}
first radiation constant for spectral radiance $2hc^2$	c_{1L}	$1.191\,042\,722(93)\times10^{-16}$	$W\,m^2\,sr^{-1}$	7.8×10^{-8}
second radiation constant hc/k	c_2	$1.438\,7752(25)\times10^{-2}$	m K	1.7×10^{-6}
Wien displacement law constant $b=\lambda_{max}T=c_2/4.965\,114\,231\ldots$	b	$2.897\,7686(51)\times10^{-3}$	m K	1.7×10^{-6}

[a]See Table XXVI for the conventional value adopted internationally for realizing representations of the volt using the Josephson effect.

[b]See Table XXVI for the conventional value adopted internationally for realizing representations of the ohm using the quantum Hall effect.

[c]Value recommended by the Particle Data Group (Caso *et al.*, 1998).

[d]Based on the ratio of the masses of the W and Z bosons m_W/m_Z recommended by the Particle Data Group (Caso *et al.*, 1998). The value for $\sin^2\theta_W$ they recommend, which is based on a particular variant of the modified minimal subtraction ($\overline{MS}$) scheme, is $\sin^2\hat{\theta}_W(M_Z)=0.231\,24(24)$.

[e]The helion, symbol h, is the nucleus of the ^{3}He atom.

[f]This and all other values involving m_τ are based on the value of $m_\tau c^2$ in MeV recommended by the Particle Data Group (Caso *et al.*, 1998), but with a standard uncertainty of 0.29 MeV rather than the quoted uncertainty of -0.26 MeV, $+0.29$ MeV.

[g]The numerical value of F to be used in coulometric chemical measurements is 96 485.3432(76) [7.9×10^{-8}] when the relevant current is measured in terms of representations of the volt and ohm based on the Josephson and quantum Hall effects and the internationally adopted conventional values of the Josephson and von Klitzing constants K_{J-90} and R_{K-90} given in Table XXVI.

[h]The entropy of an ideal monoatomic gas of relative atomic mass A_r is given by $S=S_0+\frac{3}{2}R\ln A_r-R\ln(p/p_0)+\frac{5}{2}R\ln(T/K)$.

TABLE XXV. The variances, covariances, and correlation coefficients of the values of a selected group of constants based on the 1998 CODATA adjustment. The numbers in boldface above the main diagonal are 10^{16} times the values of the relative covariances; the numbers in boldface on the main diagonal are 10^{16} times the values of the relative variances; and the numbers in italics below the main diagonal are the correlation coefficients.[a]

	α	h	e	m_e	N_A	m_e/m_μ	F
α	**0.135**	**0.005**	**0.070**	**−0.265**	**0.264**	**−0.259**	**0.334**
h	*0.002*	**61.129**	**30.567**	**61.119**	**−61.119**	**−0.009**	**−30.552**
e	*0.049*	*0.999*	**15.318**	**30.427**	**−30.428**	**−0.134**	**−15.109**
m_e	*−0.092*	*0.996*	*0.990*	**61.648**	**−61.647**	**0.509**	**−31.220**
N_A	*0.092*	*−0.995*	*−0.990*	*−1.000*	**61.691**	**−0.508**	**31.263**
m_e/m_μ	*−0.233*	*0.000*	*−0.011*	*0.021*	*−0.021*	**9.189**	**−0.642**
F	*0.226*	*−0.972*	*−0.960*	*−0.989*	*0.990*	*−0.053*	**16.154**

[a]The relative covariance $u_r(x_i, x_j)$ is defined according to $u_r(x_i, x_j)=u(x_i, x_j)/(x_i x_j)$, where $u(x_i, x_j)$ is the covariance of x_i and x_j; the relative variance $u_r^2(x_i)$ is defined according to $u_r^2(x_i)=u^2(x_i)/x_i^2=u_r(x_i, x_i)=u(x_i, x_i)/x_i^2$, where $u^2(x_i)$ is the variance of x_i; and the correlation coefficient is defined according to $r(x_i, x_j)=u(x_i, x_j)/[u(x_i)u(x_j)]=u_r(x_i, x_j)/[u_r(x_i)u_r(x_j)]$.