CODATA Recommended Values of the Fundamental Physical Constants—2006

Quantity	Symbol	Value	Unit	Relative standard uncertainty 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 $1/\mu_0 c^2$	ϵ_0	$8.854\ 187\ 817\ldots\times10^{-12}$	F m^{-1}	(exact)
characteristic impedance of vacuum $\sqrt{\mu_0/\epsilon_0}=\mu_0 c$	Z_0	376.730 313 461 . . .	Ω	(exact)
Newtonian constant of gravitation	G	$6.674\ 28(67)\times10^{-11}$	m^3 kg^{-1} s^{-2}	1.0×10^{-4}
	$G/\hbar c$	$6.708\ 81(67)\times10^{-39}$	(GeV/c^2)$^{-2}$	1.0×10^{-4}
Planck constant	h	$6.626\ 068\ 96(33)\times10^{-34}$	J s	5.0×10^{-8}
in eV s		$4.135\ 667\ 33(10)\times10^{-15}$	eV s	2.5×10^{-8}
$h/2\pi$	$\hbar$	$1.054\ 571\ 628(53)\times10^{-34}$	J s	5.0×10^{-8}
in eV s		$6.582\ 118\ 99(16)\times10^{-16}$	eV s	2.5×10^{-8}
$\hbar c$ in MeV fm		197.326 9631(49)	MeV fm	2.5×10^{-8}
Planck mass $(\hbar c/G)^{1/2}$	m_P	$2.176\ 44(11)\times10^{-8}$	kg	5.0×10^{-5}
energy equivalent in GeV	$m_P c^2$	$1.220\ 892(61)\times10^{19}$	GeV	5.0×10^{-5}
Planck temperature $(\hbar c^5/G)^{1/2}/k$	T_P	$1.416\ 785(71)\times10^{32}$	K	5.0×10^{-5}
Planck length $\hbar/m_P c=(\hbar G/c^3)^{1/2}$	l_P	$1.616\ 252(81)\times10^{-35}$	m	5.0×10^{-5}
Planck time $l_P/c=(\hbar G/c^5)^{1/2}$	t_P	$5.391\ 24(27)\times10^{-44}$	s	5.0×10^{-5}
ELECTROMAGNETIC				
elementary charge	e	$1.602\ 176\ 487(40)\times10^{-19}$	C	2.5×10^{-8}
	e/h	$2.417\ 989\ 454(60)\times10^{14}$	A J^{-1}	2.5×10^{-8}
magnetic flux quantum $h/2e$	Φ_0	$2.067\ 833\ 667(52)\times10^{-15}$	Wb	2.5×10^{-8}
conductance quantum $2e^2/h$	G_0	$7.748\ 091\ 7004(53)\times10^{-5}$	S	6.8×10^{-10}
inverse of conductance quantum	G_0^{-1}	12 906.403 7787(88)	Ω	6.8×10^{-10}
Josephson constant[a] $2e/h$	K_J	$483\ 597.891(12)\times10^{9}$	Hz V^{-1}	2.5×10^{-8}
von Klitzing constant[b] $h/e^2=\mu_0 c/2\alpha$	R_K	25 812.807 557(18)	Ω	6.8×10^{-10}
Bohr magneton $e\hbar/2m_e$	μ_B	$927.400\ 915(23)\times10^{-26}$	J T^{-1}	2.5×10^{-8}
in eV T^{-1}		$5.788\ 381\ 7555(79)\times10^{-5}$	eV T^{-1}	1.4×10^{-9}
	μ_B/h	$13.996\ 246\ 04(35)\times10^{9}$	Hz T^{-1}	2.5×10^{-8}
	μ_B/hc	46.686 4515(12)	m^{-1} T^{-1}	2.5×10^{-8}
	μ_B/k	0.671 7131(12)	K T^{-1}	1.7×10^{-6}
nuclear magneton $e\hbar/2m_p$	μ_N	$5.050\ 783\ 24(13)\times10^{-27}$	J T^{-1}	2.5×10^{-8}
in eV T^{-1}		$3.152\ 451\ 2326(45)\times10^{-8}$	eV T^{-1}	1.4×10^{-9}
	μ_N/h	7.622 593 84(19)	MHz T^{-1}	2.5×10^{-8}
	μ_N/hc	$2.542\ 623\ 616(64)\times10^{-2}$	m^{-1} T^{-1}	2.5×10^{-8}
	μ_N/k	$3.658\ 2637(64)\times10^{-4}$	K T^{-1}	1.7×10^{-6}
ATOMIC AND NUCLEAR				
General				
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\ 352\ 5376(50)\times10^{-3}$		6.8×10^{-10}
inverse fine-structure constant	α^{-1}	137.035 999 679(94)		6.8×10^{-10}
Rydberg constant $\alpha^2 m_e c/2h$	R_∞	10 973 731.568 527(73)	m^{-1}	6.6×10^{-12}
	$R_\infty c$	$3.289\ 841\ 960\ 361(22)\times10^{15}$	Hz	6.6×10^{-12}
	$R_\infty hc$	$2.179\ 871\ 97(11)\times10^{-18}$	J	5.0×10^{-8}
$R_\infty hc$ in eV		13.605 691 93(34)	eV	2.5×10^{-8}
Bohr radius $\alpha/4\pi R_\infty=4\pi\epsilon_0\hbar^2/m_e e^2$	a_0	$0.529\ 177\ 208\ 59(36)\times10^{-10}$	m	6.8×10^{-10}
Hartree energy $e^2/4\pi\epsilon_0 a_0=2R_\infty hc=\alpha^2 m_e c^2$	E_h	$4.359\ 743\ 94(22)\times10^{-18}$	J	5.0×10^{-8}
in eV		27.211 383 86(68)	eV	2.5×10^{-8}
quantum of circulation	$h/2m_e$	$3.636\ 947\ 5199(50)\times10^{-4}$	m^2 s^{-1}	1.4×10^{-9}
	h/m_e	$7.273\ 895\ 040(10)\times10^{-4}$	m^2 s^{-1}	1.4×10^{-9}
Electroweak				
Fermi coupling constant[c]	$G_F/(\hbar c)^3$	$1.166\ 37(1)\times10^{-5}$	GeV^{-2}	8.6×10^{-6}
weak mixing angle[d] θ_W (on-shell scheme)				
$\sin^2\theta_W=s_W^2\equiv1-(m_W/m_Z)^2$	$\sin^2\theta_W$	0.222 55(56)		2.5×10^{-3}
Electron, e^-				
electron mass	m_e	$9.109\ 382\ 15(45)\times10^{-31}$	kg	5.0×10^{-8}
in u, $m_e=A_r(e)$ u (electron rel. atomic mass times u)		$5.485\ 799\ 0943(23)\times10^{-4}$	u	4.2×10^{-10}
energy equivalent	$m_e c^2$	$8.187\ 104\ 38(41)\times10^{-14}$	J	5.0×10^{-8}
in MeV		0.510 998 910(13)	MeV	2.5×10^{-8}
electron–muon mass ratio	m_e/m_μ	$4.836\ 331\ 71(12)\times10^{-3}$		2.5×10^{-8}
electron–tau mass ratio	m_e/m_τ	$2.875\ 64(47)\times10^{-4}$		1.6×10^{-4}
electron–proton mass ratio	m_e/m_p	$5.446\ 170\ 2177(24)\times10^{-4}$		4.3×10^{-10}
electron–neutron mass ratio	m_e/m_n	$5.438\ 673\ 4459(33)\times10^{-4}$		6.0×10^{-10}
electron–deuteron mass ratio	m_e/m_d	$2.724\ 437\ 1093(12)\times10^{-4}$		4.3×10^{-10}
electron to alpha particle mass ratio	m_e/m_α	$1.370\ 933\ 555\ 70(58)\times10^{-4}$		4.2×10^{-10}
electron charge to mass quotient	$-e/m_e$	$-1.758\ 820\ 150(44)\times10^{11}$	C kg^{-1}	2.5×10^{-8}
electron molar mass $N_A m_e$	$M(e), M_e$	$5.485\ 799\ 0943(23)\times10^{-7}$	kg mol^{-1}	4.2×10^{-10}

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Compton wavelength $h/m_e c$	λ_C	$2.426\ 310\ 2175(33)\times10^{-12}$	m	1.4×10^{-9}
$\lambda_C/2\pi=\alpha a_0=\alpha^2/4\pi R_\infty$	$\bar{\lambda}_C$	$386.159\ 264\ 59(53)\times10^{-15}$	m	1.4×10^{-9}
classical electron radius $\alpha^2 a_0$	r_e	$2.817\ 940\ 2894(58)\times10^{-15}$	m	2.1×10^{-9}
Thomson cross section $(8\pi/3)\,r_e^2$	σ_e	$0.665\ 245\ 8558(27)\times10^{-28}$	m^2	4.1×10^{-9}
electron magnetic moment	μ_e	$-928.476\ 377(23)\times10^{-26}$	$J\ T^{-1}$	2.5×10^{-8}
to Bohr magneton ratio	μ_e/μ_B	$-1.001\ 159\ 652\ 181\ 11(74)$		7.4×10^{-13}
to nuclear magneton ratio	μ_e/μ_N	$-1838.281\ 970\ 92(80)$		4.3×10^{-10}
electron magnetic moment anomaly $\lvert\mu_e\rvert/\mu_B-1$	a_e	$1.159\ 652\ 181\ 11(74)\times10^{-3}$		6.4×10^{-10}
electron g-factor $-2(1+a_e)$	g_e	$-2.002\ 319\ 304\ 3622(15)$		7.4×10^{-13}
electron–muon magnetic moment ratio	μ_e/μ_μ	$206.766\ 9877(52)$		2.5×10^{-8}
electron–proton magnetic moment ratio	μ_e/μ_p	$-658.210\ 6848(54)$		8.1×10^{-9}
electron to shielded proton magnetic moment ratio (H_2O, sphere, 25 °C)	μ_e/μ'_p	$-658.227\ 5971(72)$		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	$-2143.923\ 498(18)$		8.4×10^{-9}
electron to shielded helion magnetic moment ratio (gas, sphere, 25 °C)	μ_e/μ'_h	$864.058\ 257(10)$		1.2×10^{-8}
electron gyromagnetic ratio $2\lvert\mu_e\rvert/\hbar$	γ_e	$1.760\ 859\ 770(44)\times10^{11}$	$s^{-1}\ T^{-1}$	2.5×10^{-8}
	$\gamma_e/2\pi$	$28\ 024.953\ 64(70)$	$MHz\ T^{-1}$	2.5×10^{-8}
		Muon, $\mu-$		
muon mass	m_μ	$1.883\ 531\ 30(11)\times10^{-28}$	kg	5.6×10^{-8}
in u, $m_\mu=A_r(\mu)$ u (muon rel. atomic mass times u)		$0.113\ 428\ 9256(29)$	u	2.5×10^{-8}
energy equivalent	$m_\mu c^2$	$1.692\ 833\ 510(95)\times10^{-11}$	J	5.6×10^{-8}
in MeV		$105.658\ 3668(38)$	MeV	3.6×10^{-8}
muon–electron mass ratio	m_μ/m_e	$206.768\ 2823(52)$		2.5×10^{-8}
muon–tau mass ratio	m_μ/m_τ	$5.945\ 92(97)\times10^{-2}$		1.6×10^{-4}
muon–proton mass ratio	m_μ/m_p	$0.112\ 609\ 5261(29)$		2.5×10^{-8}
muon–neutron mass ratio	m_μ/m_n	$0.112\ 454\ 5167(29)$		2.5×10^{-8}
muon molar mass $N_A m_\mu$	$M(\mu)$, M_μ	$0.113\ 428\ 9256(29)\times10^{-3}$	$kg\ mol^{-1}$	2.5×10^{-8}
muon Compton wavelength $h/m_\mu c$	$\lambda_{C,\mu}$	$11.734\ 441\ 04(30)\times10^{-15}$	m	2.5×10^{-8}
$\lambda_{C,\mu}/2\pi$	$\bar{\lambda}_{C,\mu}$	$1.867\ 594\ 295(47)\times10^{-15}$	m	2.5×10^{-8}
muon magnetic moment	μ_μ	$-4.490\ 447\ 86(16)\times10^{-26}$	$J\ T^{-1}$	3.6×10^{-8}
to Bohr magneton ratio	μ_μ/μ_B	$-4.841\ 970\ 49(12)\times10^{-3}$		2.5×10^{-8}
to nuclear magneton ratio	μ_μ/μ_N	$-8.890\ 597\ 05(23)$		2.5×10^{-8}
muon magnetic moment anomaly $\lvert\mu_\mu\rvert/(e\hbar/2m_\mu)-1$	a_μ	$1.165\ 920\ 69(60)\times10^{-3}$		5.2×10^{-7}
muon g-factor $-2(1+a_\mu)$	g_μ	$-2.002\ 331\ 8414(12)$		6.0×10^{-10}
muon–proton magnetic moment ratio	μ_μ/μ_p	$-3.183\ 345\ 137(85)$		2.7×10^{-8}
		Tau, $\tau-$		
tau mass[e]	m_τ	$3.167\ 77(52)\times10^{-27}$	kg	1.6×10^{-4}
in u, $m_\tau=A_r(\tau)$ u (tau rel. atomic mass times u)		$1.907\ 68(31)$	u	1.6×10^{-4}
energy equivalent	$m_\tau c^2$	$2.847\ 05(46)\times10^{-10}$	J	1.6×10^{-4}
in MeV		$1776.99(29)$	MeV	1.6×10^{-4}
tau–electron mass ratio	m_τ/m_e	$3477.48(57)$		1.6×10^{-4}
tau–muon mass ratio	m_τ/m_μ	$16.8183(27)$		1.6×10^{-4}
tau–proton mass ratio	m_τ/m_p	$1.893\ 90(31)$		1.6×10^{-4}
tau–neutron mass ratio	m_τ/m_n	$1.891\ 29(31)$		1.6×10^{-4}
tau molar mass $N_A m_\tau$	$M(\tau)$, M_τ	$1.907\ 68(31)\times10^{-3}$	$kg\ mol^{-1}$	1.6×10^{-4}
tau Compton wavelength $h/m_\tau c$	$\lambda_{C,\tau}$	$0.697\ 72(11)\times10^{-15}$	m	1.6×10^{-4}
$\lambda_{C,\tau}/2\pi$	$\bar{\lambda}_{C,\tau}$	$0.111\ 046(18)\times10^{-15}$	m	1.6×10^{-4}
		Proton, p		
proton mass	m_p	$1.672\ 621\ 637(83)\times10^{-27}$	kg	5.0×10^{-8}
in u, $m_p=A_r(p)$ u (proton rel. atomic mass times u)		$1.007\ 276\ 466\ 77(10)$	u	1.0×10^{-10}
energy equivalent	$m_p c^2$	$1.503\ 277\ 359(75)\times10^{-10}$	J	5.0×10^{-8}
in MeV		$938.272\ 013(23)$	MeV	2.5×10^{-8}
proton–electron mass ratio	m_p/m_e	$1836.152\ 672\ 47(80)$		4.3×10^{-10}
proton–muon mass ratio	m_p/m_μ	$8.880\ 243\ 39(23)$		2.5×10^{-8}
proton–tau mass ratio	m_p/m_τ	$0.528\ 012(86)$		1.6×10^{-4}
proton–neutron mass ratio	m_p/m_n	$0.998\ 623\ 478\ 24(46)$		4.6×10^{-10}
proton charge to mass quotient	e/m_p	$9.578\ 833\ 92(24)\times10^{7}$	$C\ kg^{-1}$	2.5×10^{-8}
proton molar mass $N_A m_p$	$M(p)$, M_p	$1.007\ 276\ 466\ 77(10)\times10^{-3}$	$kg\ mol^{-1}$	1.0×10^{-10}
proton Compton wavelength $h/m_p c$	$\lambda_{C,p}$	$1.321\ 409\ 8446(19)\times10^{-15}$	m	1.4×10^{-9}
$\lambda_{C,p}/2\pi$	$\bar{\lambda}_{C,p}$	$0.210\ 308\ 908\ 61(30)\times10^{-15}$	m	1.4×10^{-9}

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proton rms charge radius	R_p	$0.8768(69)\times10^{-15}$	m	7.8×10^{-3}
proton magnetic moment	μ_p	$1.410\,606\,662(37)\times10^{-26}$	J T^{-1}	2.6×10^{-8}
to Bohr magneton ratio	μ_p/μ_B	$1.521\,032\,209(12)\times10^{-3}$		8.1×10^{-9}
to nuclear magneton ratio	μ_p/μ_N	2.792 847 356(23)		8.2×10^{-9}
proton g-factor $2\mu_p/\mu_N$	g_p	5.585 694 713(46)		8.2×10^{-9}
proton–neutron magnetic moment ratio	μ_p/μ_n	−1.459 898 06(34)		2.4×10^{-7}
shielded proton magnetic moment (H_2O, sphere, 25 °C)	μ'_p	$1.410\,570\,419(38)\times10^{-26}$	J T^{-1}	2.7×10^{-8}
to Bohr magneton ratio	μ'_p/μ_B	$1.520\,993\,128(17)\times10^{-3}$		1.1×10^{-8}
to nuclear magneton ratio	μ'_p/μ_N	2.792 775 598(30)		1.1×10^{-8}
proton magnetic shielding correction $1-\mu'_p/\mu_p$ (H_2O, sphere, 25 °C)	σ'_p	$25.694(14)\times10^{-6}$		5.3×10^{-4}
proton gyromagnetic ratio $2\mu_p/\hbar$	γ_p	$2.675\,222\,099(70)\times10^{8}$	s^{-1} T^{-1}	2.6×10^{-8}
	$\gamma_p/2\pi$	42.577 4821(11)	MHz T^{-1}	2.6×10^{-8}
shielded proton gyromagnetic ratio $2\mu'_p/\hbar$ (H_2O, sphere, 25 °C)	γ'_p	$2.675\,153\,362(73)\times10^{8}$	s^{-1} T^{-1}	2.7×10^{-8}
	$\gamma'_p/2\pi$	42.576 3881(12)	MHz T^{-1}	2.7×10^{-8}
Neutron, n				
neutron mass	m_n	$1.674\,927\,211(84)\times10^{-27}$	kg	5.0×10^{-8}
in u, $m_n = A_r(n)$ u (neutron rel. atomic mass times u)		1.008 664 915 97(43)	u	4.3×10^{-10}
energy equivalent	m_nc^2	$1.505\,349\,505(75)\times10^{-10}$	J	5.0×10^{-8}
in MeV		939.565 346(23)	MeV	2.5×10^{-8}
neutron–electron mass ratio	m_n/m_e	1838.683 6605(11)		6.0×10^{-10}
neutron–muon mass ratio	m_n/m_μ	8.892 484 09(23)		2.5×10^{-8}
neutron–tau mass ratio	m_n/m_τ	0.528 740(86)		1.6×10^{-4}
neutron–proton mass ratio	m_n/m_p	1.001 378 419 18(46)		4.6×10^{-10}
neutron molar mass N_Am_n	M(n), M_n	$1.008\,664\,915\,97(43)\times10^{-3}$	kg mol^{-1}	4.3×10^{-10}
neutron Compton wavelength h/m_nc	$\lambda_{C,n}$	$1.319\,590\,8951(20)\times10^{-15}$	m	1.5×10^{-9}
$\lambda_{C,n}/2\pi$	$\bar{\lambda}_{C,n}$	$0.210\,019\,413\,82(31)\times10^{-15}$	m	1.5×10^{-9}
neutron magnetic moment	μ_n	$-0.966\,236\,41(23)\times10^{-26}$	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 73(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	$1.832\,471\,85(43)\times10^{8}$	s^{-1} T^{-1}	2.4×10^{-7}
	$\gamma_n/2\pi$	29.164 6954(69)	MHz T^{-1}	2.4×10^{-7}
Deuteron, d				
deuteron mass	m_d	$3.343\,583\,20(17)\times10^{-27}$	kg	5.0×10^{-8}
in u, $m_d = A_r(d)$ u (deuteron rel. atomic mass times u)		2.013 553 212 724(78)	u	3.9×10^{-11}
energy equivalent	m_dc^2	$3.005\,062\,72(15)\times10^{-10}$	J	5.0×10^{-8}
in MeV		1875.612 793(47)	MeV	2.5×10^{-8}
deuteron–electron mass ratio	m_d/m_e	3670.482 9654(16)		4.3×10^{-10}
deuteron–proton mass ratio	m_d/m_p	1.999 007 501 08(22)		1.1×10^{-10}
deuteron molar mass N_Am_d	M(d), M_d	$2.013\,553\,212\,724(78)\times10^{-3}$	kg mol^{-1}	3.9×10^{-11}
deuteron rms charge radius	R_d	$2.1402(28)\times10^{-15}$	m	1.3×10^{-3}
deuteron magnetic moment	μ_d	$0.433\,073\,465(11)\times10^{-26}$	J T^{-1}	2.6×10^{-8}
to Bohr magneton ratio	μ_d/μ_B	$0.466\,975\,4556(39)\times10^{-3}$		8.4×10^{-9}
to nuclear magneton ratio	μ_d/μ_N	0.857 438 2308(72)		8.4×10^{-9}
deuteron g-factor μ_d/μ_N	g_d	0.857 438 2308(72)		8.4×10^{-9}
deuteron–electron magnetic moment ratio	μ_d/μ_e	$-4.664\,345\,537(39)\times10^{-4}$		8.4×10^{-9}
deuteron–proton magnetic moment ratio	μ_d/μ_p	0.307 012 2070(24)		7.7×10^{-9}
deuteron–neutron magnetic moment ratio	μ_d/μ_n	−0.448 206 52(11)		2.4×10^{-7}
Triton, t				
triton mass	m_t	$5.007\,355\,88(25)\times10^{-27}$	kg	5.0×10^{-8}
in u, $m_t = A_r(t)$ u (triton rel. atomic mass times u)		3.015 500 7134(25)	u	8.3×10^{-10}
energy equivalent	m_tc^2	$4.500\,387\,03(22)\times10^{-10}$	J	5.0×10^{-8}
in MeV		2808.920 906(70)	MeV	2.5×10^{-8}
triton–electron mass ratio	m_t/m_e	5496.921 5269(51)		9.3×10^{-10}
triton–proton mass ratio	m_t/m_p	2.993 717 0309(25)		8.4×10^{-10}
triton molar mass N_Am_t	M(t), M_t	$3.015\,500\,7134(25)\times10^{-3}$	kg mol^{-1}	8.3×10^{-10}

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triton magnetic moment	μ_t	$1.504\,609\,361(42)\times10^{-26}$	$J\,T^{-1}$	2.8×10^{-8}
to Bohr magneton ratio	μ_t/μ_B	$1.622\,393\,657(21)\times10^{-3}$		1.3×10^{-8}
to nuclear magneton ratio	μ_t/μ_N	$2.978\,962\,448(38)$		1.3×10^{-8}
triton g-factor $2\mu_t/\mu_N$	g_t	$5.957\,924\,896(76)$		1.3×10^{-8}
triton–electron magnetic moment ratio	μ_t/μ_e	$-1.620\,514\,423(21)\times10^{-3}$		1.3×10^{-8}
triton–proton magnetic moment ratio	μ_t/μ_p	$1.066\,639\,908(10)$		9.8×10^{-9}
triton–neutron magnetic moment ratio	μ_t/μ_n	$-1.557\,185\,53(37)$		2.4×10^{-7}
Helion, h				
helion mass[f]	m_h	$5.006\,411\,92(25)\times10^{-27}$	kg	5.0×10^{-8}
in u, $m_h = A_r(\mathrm{h})$ u (helion rel. atomic mass times u)		$3.014\,932\,2473(26)$	u	8.6×10^{-10}
energy equivalent	m_hc^2	$4.499\,538\,64(22)\times10^{-10}$	J	5.0×10^{-8}
in MeV		$2808.391\,383(70)$	MeV	2.5×10^{-8}
helion–electron mass ratio	m_h/m_e	$5495.885\,2765(52)$		9.5×10^{-10}
helion–proton mass ratio	m_h/m_p	$2.993\,152\,6713(26)$		8.7×10^{-10}
helion molar mass N_Am_h	$M(\mathrm{h})$, M_h	$3.014\,932\,2473(26)\times10^{-3}$	$kg\,mol^{-1}$	8.6×10^{-10}
shielded helion magnetic moment (gas, sphere, 25 °C)	μ'_h	$-1.074\,552\,982(30)\times10^{-26}$	$J\,T^{-1}$	2.8×10^{-8}
to Bohr magneton ratio	μ'_h/μ_B	$-1.158\,671\,471(14)\times10^{-3}$		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	$-0.761\,766\,558(11)$		1.4×10^{-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	$2.037\,894\,730(56)\times10^{8}$	$s^{-1}\,T^{-1}$	2.8×10^{-8}
	$\gamma'_h/2\pi$	$32.434\,101\,98(90)$	$MHz\,T^{-1}$	2.8×10^{-8}
Alpha particle, α				
alpha particle mass	m_α	$6.644\,656\,20(33)\times10^{-27}$	kg	5.0×10^{-8}
in u, $m_\alpha = A_r(\alpha)$ u (alpha particle rel. atomic mass times u)		$4.001\,506\,179\,127(62)$	u	1.5×10^{-11}
energy equivalent	$m_\alpha c^2$	$5.971\,919\,17(30)\times10^{-10}$	J	5.0×10^{-8}
in MeV		$3727.379\,109(93)$	MeV	2.5×10^{-8}
alpha particle to electron mass ratio	m_α/m_e	$7294.299\,5365(31)$		4.2×10^{-10}
alpha particle to proton mass ratio	m_α/m_p	$3.972\,599\,689\,51(41)$		1.0×10^{-10}
alpha particle molar mass N_Am_α	$M(\alpha)$, M_α	$4.001\,506\,179\,127(62)\times10^{-3}$	$kg\,mol^{-1}$	1.5×10^{-11}
PHYSICOCHEMICAL				
Avogadro constant	N_A, L	$6.022\,141\,79(30)\times10^{23}$	mol^{-1}	5.0×10^{-8}
atomic mass constant $m_u = \frac{1}{12}m(^{12}\mathrm{C}) = 1\ \mathrm{u} = 10^{-3}\ \mathrm{kg\,mol^{-1}}/N_A$	m_u	$1.660\,538\,782(83)\times10^{-27}$	kg	5.0×10^{-8}
energy equivalent	m_uc^2	$1.492\,417\,830(74)\times10^{-10}$	J	5.0×10^{-8}
in MeV		$931.494\,028(23)$	MeV	2.5×10^{-8}
Faraday constant[g] N_Ae	F	$96\,485.3399(24)$	$C\,mol^{-1}$	2.5×10^{-8}
molar Planck constant	N_Ah	$3.990\,312\,6821(57)\times10^{-10}$	$J\,s\,mol^{-1}$	1.4×10^{-9}
	N_Ahc	$0.119\,626\,564\,72(17)$	$J\,m\,mol^{-1}$	1.4×10^{-9}
molar gas constant	R	$8.314\,472(15)$	$J\,mol^{-1}\,K^{-1}$	1.7×10^{-6}
Boltzmann constant R/N_A	k	$1.380\,6504(24)\times10^{-23}$	$J\,K^{-1}$	1.7×10^{-6}
in $eV\,K^{-1}$		$8.617\,343(15)\times10^{-5}$	$eV\,K^{-1}$	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}
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	$2.686\,7774(47)\times10^{25}$	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] $\frac{5}{2}+\ln[(2\pi m_ukT_1/h^2)^{3/2}kT_1/p_0]$				
$T_1=1$ K, $p_0=100$ kPa	S_0/R	$-1.151\,7047(44)$		3.8×10^{-6}
$T_1=1$ K, $p_0=101.325$ kPa		$-1.164\,8677(44)$		3.8×10^{-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	$3.741\,771\,18(19)\times10^{-16}$	$W\,m^2$	5.0×10^{-8}
first radiation constant for spectral radiance $2hc^2$	c_{1L}	$1.191\,042\,759(59)\times10^{-16}$	$W\,m^2\,sr^{-1}$	5.0×10^{-8}
second radiation constant hc/k	c_2	$1.438\,7752(25)\times10^{-2}$	m K	1.7×10^{-6}
Wien displacement law constants				
$b=\lambda_{max}T=c_2/4.965\,114\,231\ldots$	b	$2.897\,7685(51)\times10^{-3}$	m K	1.7×10^{-6}
$b'=\nu_{max}/T=2.821\,439\,372\ldots c/c_2$	b'	$5.878\,933(10)\times10^{10}$	$Hz\,K^{-1}$	1.7×10^{-6}

[a] See the "Adopted values" table for the conventional value adopted internationally for realizing representations of the volt using the Josephson effect.
[b] See the "Adopted values" table for the conventional value adopted internationally for realizing representations of the ohm using the quantum Hall effect.

continued

[c] Value recommended by the Particle Data Group (Yao et al., *J. Phys. G* **33**, 1, 2006).
[d] Based on the ratio of the masses of the W and Z bosons m_W/m_Z recommended by the Particle Data Group (Yao et al., *J. Phys. G* **33**, 1, 2006). 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 $\sin^2\hat{\theta}_W(M_Z)=0.231\,22(15)$.
[e] 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 (Yao et al., *J. Phys. G* **33**, 1, 2006), but with a standard uncertainty of 0.29 MeV rather than the quoted uncertainty of −0.26 MeV, +0.29 MeV.
[f] The helion, symbol h, is the nucleus of the ^{3}He atom.
[g] The numerical value of F to be used in coulometric chemical measurements is 96 485.3401(48) [5.0×10^{-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 the "Adopted values" table.
[h] The entropy of an ideal monoatomic gas of relative atomic mass A_r is given by $S=S_0+\frac{3}{2}R\ln A_r-R\ln(p/p_0)+\frac{5}{2}R\ln(T/\mathrm{K})$.

Internationally Adopted Values of Various Quantities

Quantity	Symbol	Value	Unit	Relative standard uncertainty u_r
relative atomic mass[a] of ^{12}C	$A_r(^{12}\mathrm{C})$	12		(exact)
molar mass constant	M_u	1×10^{-3}	kg mol^{-1}	(exact)
molar mass of ^{12}C	$M(^{12}\mathrm{C})$	12×10^{-3}	kg mol^{-1}	(exact)
conventional value of Josephson constant[b]	K_{J-90}	483 597.9	GHz V^{-1}	(exact)
conventional value of von Klitzing constant[c]	R_{K-90}	25 812.807	Ω	(exact)
standard atmosphere		101 325	Pa	(exact)

[a] The relative atomic mass $A_r(X)$ of particle X with mass $m(X)$ is defined by $A_r(X) = m(X)/m_u$, where $m_u = m(^{12}\mathrm{C})/12 = M_u/N_A = 1$ u is the atomic mass constant, M_u is the molar mass constant, N_A is the Avogadro constant, and u is the unified atomic mass unit. Thus the mass of particle X is $m(X) = A_r(X)$ u and the molar mass of X is $M(X) = A_r(X)M_u$.

[b] This is the value adopted internationally for realizing representations of the volt using the Josephson effect.

[c] This is the value adopted internationally for realizing representations of the ohm using the quantum Hall effect.

CODATA Recommended Values of Energy Equivalents—2006

	Relevant unit			
	J	**kg**	**m^{-1}**	**Hz**
1 J	(1 J) = 1 J	(1 J)/c^2 = 1.112 650 056 . . . $\times 10^{-17}$ kg	(1 J)/hc = 5.034 117 47(25) $\times 10^{24}$ m^{-1}	(1 J)/h = 1.509 190 450(75) $\times 10^{33}$ Hz
1 kg	(1 kg)c^2 = 8.987 551 787 . . . $\times 10^{16}$ J	(1 kg) = 1 kg	(1 kg)c/h = 4.524 439 15(23) $\times 10^{41}$ m^{-1}	(1 kg)c^2/h = 1.356 392 733(68) $\times 10^{50}$ Hz
1 m^{-1}	(1 m^{-1})hc = 1.986 445 501(99) $\times 10^{-25}$ J	(1 m^{-1})h/c = 2.210 218 70(11) $\times 10^{-42}$ kg	(1 m^{-1}) = 1 m^{-1}	(1 m^{-1})c = 299 792 458 Hz
1 Hz	(1 Hz)h = 6.626 068 96(33) $\times 10^{-34}$ J	(1 Hz)h/c^2 = 7.372 496 00(37) $\times 10^{-51}$ kg	(1 Hz)/c = 3.335 640 951 . . . $\times 10^{-9}$ m^{-1}	(1 Hz) = 1 Hz
1 K	(1 K)k = 1.380 6504(24) $\times 10^{-23}$ J	(1 K)k/c^2 = 1.536 1807(27) $\times 10^{-40}$ kg	(1 K)k/hc = 69.503 56(12) m^{-1}	(1 K)k/h = 2.083 6644(36) $\times 10^{10}$ Hz
1 eV	(1 eV) = 1.602 176 487(40) $\times 10^{-19}$ J	(1 eV)/c^2 = 1.782 661 758(44) $\times 10^{-36}$ kg	(1 eV)/hc = 8.065 544 65(20) $\times 10^{5}$ m^{-1}	(1 eV)/h = 2.417 989 454(60) $\times 10^{14}$ Hz
1 u	(1 u)c^2 = 1.492 417 830(74) $\times 10^{-10}$ J	(1 u) = 1.660 538 782(83) $\times 10^{-27}$ kg	(1 u)c/h = 7.513 006 671(11) $\times 10^{14}$ m^{-1}	(1 u)c^2/h = 2.252 342 7369(32) $\times 10^{23}$ Hz
1 E_h	(1 E_h) = 4.359 743 94(22) $\times 10^{-18}$ J	(1 E_h)/c^2 = 4.850 869 34(24) $\times 10^{-35}$ kg	(1 E_h)/hc = 2.194 746 313 705(15) $\times 10^{7}$ m^{-1}	(1 E_h)/h = 6.579 683 920 722(44) $\times 10^{15}$ Hz

The values of some energy equivalents derived from the relations $E = mc^2 = hc/\lambda = h\nu = kT$, and based on the 2006 CODATA adjustment of the values of the constants; 1 eV = (e/C) J, 1 u = $m_u = \frac{1}{12} m(^{12}\mathrm{C}) = 10^{-3}$ kg mol$^{-1}/N_A$, and $E_h = 2R_\infty hc = \alpha^2 m_e c^2$ is the Hartree energy (hartree).

CODATA Recommended Values of Energy Equivalents—2006

	Relevant unit			
	K	**eV**	**u**	**E_h**
1 J	(1 J)/k = 7.242 963(13) $\times 10^{22}$ K	(1 J) = 6.241 509 65(16) $\times 10^{18}$ eV	(1 J)/c^2 = 6.700 536 41(33) $\times 10^{9}$ u	(1 J) = 2.293 712 69(11) $\times 10^{17}$ E_h
1 kg	(1 kg)c^2/k = 6.509 651(11) $\times 10^{39}$ K	(1 kg)c^2 = 5.609 589 12(14) $\times 10^{35}$ eV	(1 kg) = 6.022 141 79(30) $\times 10^{26}$ u	(1 kg)c^2 = 2.061 486 16(10) $\times 10^{34}$ E_h
1 m^{-1}	(1 m^{-1})hc/k = 1.438 7752(25) $\times 10^{-2}$ K	(1 m^{-1})hc = 1.239 841 875(31) $\times 10^{-6}$ eV	(1 m^{-1})h/c = 1.331 025 0394(19) $\times 10^{-15}$ u	(1 m^{-1})hc = 4.556 335 252 760(30) $\times 10^{-8}$ E_h
1 Hz	(1 Hz)h/k = 4.799 2374(84) $\times 10^{-11}$ K	(1 Hz)h = 4.135 667 33(10) $\times 10^{-15}$ eV	(1 Hz)h/c^2 = 4.439 821 6294(64) $\times 10^{-24}$ u	(1 Hz)h = 1.519 829 846 006(10) $\times 10^{-16}$ E_h
1 K	(1 K) = 1 K	(1 K)k = 8.617 343(15) $\times 10^{-5}$ eV	(1 K)k/c^2 = 9.251 098(16) $\times 10^{-14}$ u	(1 K)k = 3.166 8153(55) $\times 10^{-6}$ E_h
1 eV	(1 eV)/k = 1.160 4505(20) $\times 10^{4}$ K	(1 eV) = 1 eV	(1 eV)/c^2 = 1.073 544 188(27) $\times 10^{-9}$ u	(1 eV) = 3.674 932 540(92) $\times 10^{-2}$ E_h
1 u	(1 u)c^2/k = 1.080 9527(19) $\times 10^{13}$ K	(1 u)c^2 = 931.494 028(23) $\times 10^{6}$ eV	(1 u) = 1 u	(1 u)c^2 = 3.423 177 7149(49) $\times 10^{7}$ E_h
1 E_h	(1 E_h)/k = 3.157 7465(55) $\times 10^{5}$ K	(1 E_h) = 27.211 383 86(68) eV	(1 E_h)/c^2 = 2.921 262 2986(42) $\times 10^{-8}$ u	(1 E_h) = 1 E_h

The values of some energy equivalents derived from the relations $E = mc^2 = hc/\lambda = h\nu = kT$, and based on the 2006 CODATA adjustment of the values of the constants; 1 eV = (e/C) J, 1 u = $m_u = \frac{1}{12} m(^{12}\mathrm{C}) = 10^{-3}$ kg mol$^{-1}/N_A$, and $E_h = 2R_\infty hc = \alpha^2 m_e c^2$ is the Hartree energy (hartree).