CODATA Recommended Values of the Fundamental Physical Constants: 2014*

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This document gives the 2014 self-consistent set of values of the constants and conversion factors of physics and chemistry recommended by the Committee on Data for Science and Technology (CODATA). These values are based on a least-squares adjustment that takes into account all data available up to 31 December 2014. The recommended values may also be found at physics.nist.gov/constants.

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TABLE I An abbreviated list of the CODATA recommended values of the fundamental constants of physics and chemistry based on the 2014 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
speed of light in vacuum	c, c_0	$299\,792\,458$	$\mathrm{m\ s^{-1}}$	exact
magnetic constant	μ_0	$4\pi \times 10^{-7}$	$\mathrm{N\ A^{-2}}$	
		$= 12.566\,370\,614... \times 10^{-7}$	$\mathrm{N\ A^{-2}}$	exact
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854\,187\,817... \times 10^{-12}$	$\mathrm{F\ m^{-1}}$	exact
Newtonian constant of gravitation	G	$6.674\,08(31) \times 10^{-11}$	$\mathrm{m^3\ kg^{-1}\ s^{-2}}$	4.7×10^{-5}
Planck constant	h	$6.626\,070\,040(81) \times 10^{-34}$	J s	1.2×10^{-8}
$h/2\pi$	$\hbar$	$1.054\,571\,800(13) \times 10^{-34}$	J s	1.2×10^{-8}
elementary charge	e	$1.602\,176\,6208(98) \times 10^{-19}$	C	6.1×10^{-9}
magnetic flux quantum $h/2e$	Φ_0	$2.067\,833\,831(13) \times 10^{-15}$	Wb	6.1×10^{-9}
conductance quantum $2e^2/h$	G_0	$7.748\,091\,7310(18) \times 10^{-5}$	S	2.3×10^{-10}
electron mass	m_e	$9.109\,383\,56(11) \times 10^{-31}$	kg	1.2×10^{-8}
proton mass	m_p	$1.672\,621\,898(21) \times 10^{-27}$	kg	1.2×10^{-8}
proton-electron mass ratio	$m_\mathrm{p}/m_\mathrm{e}$	$1836.152\,673\,89(17)$		9.5×10^{-11}
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\,352\,5664(17) \times 10^{-3}$		2.3×10^{-10}
inverse fine-structure constant	α^{-1}	$137.035\,999\,139(31)$		2.3×10^{-10}
Rydberg constant $\alpha^2 m_\mathrm{e} c/2h$	R_∞	$10\,973\,731.568\,508(65)$	$\mathrm{m^{-1}}$	5.9×10^{-12}
Avogadro constant	N_A, L	$6.022\,140\,857(74) \times 10^{23}$	$\mathrm{mol^{-1}}$	1.2×10^{-8}
Faraday constant $N_\mathrm{A} e$	F	$96\,485.332\,89(59)$	$\mathrm{C\ mol^{-1}}$	6.2×10^{-9}
molar gas constant	R	$8.314\,4598(48)$	$\mathrm{J\ mol^{-1}\ K^{-1}}$	5.7×10^{-7}
Boltzmann constant R/N_A	k	$1.380\,648\,52(79) \times 10^{-23}$	$\mathrm{J\ K^{-1}}$	5.7×10^{-7}
Stefan-Boltzmann constant $(\pi^2/60)k^4/\hbar^3 c^2$	σ	$5.670\,367(13) \times 10^{-8}$	$\mathrm{W\ m^{-2}\ K^{-4}}$	2.3×10^{-6}
		Non-SI units accepted for use with the SI		
electron volt (e/C) J	eV	$1.602\,176\,6208(98) \times 10^{-19}$	J	6.1×10^{-9}
(unified) atomic mass unit $\frac{1}{12}m(^{12}\mathrm{C})$	u	$1.660\,539\,040(20) \times 10^{-27}$	kg	1.2×10^{-8}

TABLE II: The CODATA recommended values of the fundamental constants of physics and chemistry based on the 2014 adjustment.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_{\rm r}$
		UNIVERSAL		
speed of light in vacuum	c, c_0	299 792 458	m s^{-1}	exact
magnetic constant	μ_0	$4\pi \times 10^{-7}$	N A^{-2}	
		$= 12.566\,370\,614... \times 10^{-7}$	N A^{-2}	exact
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854\,187\,817... \times 10^{-12}$	F m^{-1}	exact
characteristic impedance of vacuum $\mu_0 c$	Z_0	376.730 313 461...	Ω	exact
Newtonian constant of gravitation	G	$6.674\,08(31) \times 10^{-11}$	m^3 kg^{-1} s^{-2}	4.7×10^{-5}
	$G/\hbar c$	$6.708\,61(31) \times 10^{-39}$	(GeV/c^2)$^{-2}$	4.7×10^{-5}
Planck constant	h	$6.626\,070\,040(81) \times 10^{-34}$	J s	1.2×10^{-8}
		$4.135\,667\,662(25) \times 10^{-15}$	eV s	6.1×10^{-9}
$h/2\pi$	$\hbar$	$1.054\,571\,800(13) \times 10^{-34}$	J s	1.2×10^{-8}
		$6.582\,119\,514(40) \times 10^{-16}$	eV s	6.1×10^{-9}
	$\hbar c$	197.326 9788(12)	MeV fm	6.1×10^{-9}
Planck mass $(\hbar c/G)^{1/2}$	$m_{\rm P}$	$2.176\,470(51) \times 10^{-8}$	kg	2.3×10^{-5}
energy equivalent	$m_{\rm P} c^2$	$1.220\,910(29) \times 10^{19}$	GeV	2.3×10^{-5}
Planck temperature $(\hbar c^5/G)^{1/2}/k$	$T_{\rm P}$	$1.416\,808(33) \times 10^{32}$	K	2.3×10^{-5}
Planck length $\hbar/m_{\rm P}c = (\hbar G/c^3)^{1/2}$	$l_{\rm P}$	$1.616\,229(38) \times 10^{-35}$	m	2.3×10^{-5}
Planck time $l_{\rm P}/c = (\hbar G/c^5)^{1/2}$	$t_{\rm P}$	$5.391\,16(13) \times 10^{-44}$	s	2.3×10^{-5}
		ELECTROMAGNETIC		
elementary charge	e	$1.602\,176\,6208(98) \times 10^{-19}$	C	6.1×10^{-9}
	e/h	$2.417\,989\,262(15) \times 10^{14}$	A J^{-1}	6.1×10^{-9}
magnetic flux quantum $h/2e$	Φ_0	$2.067\,833\,831(13) \times 10^{-15}$	Wb	6.1×10^{-9}
conductance quantum $2e^2/h$	G_0	$7.748\,091\,7310(18) \times 10^{-5}$	S	2.3×10^{-10}
inverse of conductance quantum	G_0^{-1}	12 906.403 7278(29)	Ω	2.3×10^{-10}
Josephson constant[1] $2e/h$	$K_{\rm J}$	$483\,597.8525(30) \times 10^{9}$	Hz V^{-1}	6.1×10^{-9}
von Klitzing constant[2] $h/e^2 = \mu_0 c/2\alpha$	$R_{\rm K}$	25 812.807 4555(59)	Ω	2.3×10^{-10}
Bohr magneton $e\hbar/2m_{\rm e}$	$\mu_{\rm B}$	$927.400\,9994(57) \times 10^{-26}$	J T^{-1}	6.2×10^{-9}
		$5.788\,381\,8012(26) \times 10^{-5}$	eV T^{-1}	4.5×10^{-10}
	$\mu_{\rm B}/h$	$13.996\,245\,042(86) \times 10^{9}$	Hz T^{-1}	6.2×10^{-9}
	$\mu_{\rm B}/hc$	46.686 448 14(29)	m^{-1} T^{-1}	6.2×10^{-9}
	$\mu_{\rm B}/k$	0.671 714 05(39)	K T^{-1}	5.7×10^{-7}
nuclear magneton $e\hbar/2m_{\rm p}$	$\mu_{\rm N}$	$5.050\,783\,699(31) \times 10^{-27}$	J T^{-1}	6.2×10^{-9}
		$3.152\,451\,2550(15) \times 10^{-8}$	eV T^{-1}	4.6×10^{-10}
	$\mu_{\rm N}/h$	7.622 593 285(47)	MHz T^{-1}	6.2×10^{-9}
	$\mu_{\rm N}/hc$	$2.542\,623\,432(16) \times 10^{-2}$	m^{-1} T^{-1}	6.2×10^{-9}
	$\mu_{\rm N}/k$	$3.658\,2690(21) \times 10^{-4}$	K T^{-1}	5.7×10^{-7}
		ATOMIC AND NUCLEAR		
		General		
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.297\,352\,5664(17) \times 10^{-3}$		2.3×10^{-10}
inverse fine-structure constant	α^{-1}	137.035 999 139(31)		2.3×10^{-10}
Rydberg constant $\alpha^2 m_{\rm e} c/2h$	R_∞	10 973 731.568 508(65)	m^{-1}	5.9×10^{-12}
	$R_\infty c$	$3.289\,841\,960\,355(19) \times 10^{15}$	Hz	5.9×10^{-12}
	$R_\infty hc$	$2.179\,872\,325(27) \times 10^{-18}$	J	1.2×10^{-8}
		13.605 693 009(84)	eV	6.1×10^{-9}
Bohr radius $\alpha/4\pi R_\infty = 4\pi\epsilon_0\hbar^2/m_{\rm e}e^2$	a_0	$0.529\,177\,210\,67(12) \times 10^{-10}$	m	2.3×10^{-10}
Hartree energy $e^2/4\pi\epsilon_0 a_0 = 2R_\infty hc = \alpha^2 m_{\rm e}c^2$	$E_{\rm h}$	$4.359\,744\,650(54) \times 10^{-18}$	J	1.2×10^{-8}
		27.211 386 02(17)	eV	6.1×10^{-9}
quantum of circulation	$h/2m_{\rm e}$	$3.636\,947\,5486(17) \times 10^{-4}$	m^2 s^{-1}	4.5×10^{-10}
	$h/m_{\rm e}$	$7.273\,895\,0972(33) \times 10^{-4}$	m^2 s^{-1}	4.5×10^{-10}
		Electroweak		

[1] See Table IV for the conventional value adopted internationally for realizing representations of the volt using the Josephson effect.
[2] See Table IV for the conventional value adopted internationally for realizing representations of the ohm using the quantum Hall effect.

TABLE II: *(Continued).*

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
Fermi coupling constant[3]	$G_F/(\hbar c)^3$	$1.166\,3787(6) \times 10^{-5}$	GeV^{-2}	5.1×10^{-7}
weak mixing angle[4] θ_W (on-shell scheme)				
$\sin^2\theta_W = s_W^2 \equiv 1 - (m_W/m_Z)^2$	$\sin^2\theta_W$	$0.2223(21)$		9.5×10^{-3}
		Electron, e^-		
electron mass	m_e	$9.109\,383\,56(11) \times 10^{-31}$	kg	1.2×10^{-8}
		$5.485\,799\,090\,70(16) \times 10^{-4}$	u	2.9×10^{-11}
energy equivalent	$m_e c^2$	$8.187\,105\,65(10) \times 10^{-14}$	J	1.2×10^{-8}
		$0.510\,998\,9461(31)$	MeV	6.2×10^{-9}
electron-muon mass ratio	m_e/m_μ	$4.836\,331\,70(11) \times 10^{-3}$		2.2×10^{-8}
electron-tau mass ratio	m_e/m_τ	$2.875\,92(26) \times 10^{-4}$		9.0×10^{-5}
electron-proton mass ratio	m_e/m_p	$5.446\,170\,213\,52(52) \times 10^{-4}$		9.5×10^{-11}
electron-neutron mass ratio	m_e/m_n	$5.438\,673\,4428(27) \times 10^{-4}$		4.9×10^{-10}
electron-deuteron mass ratio	m_e/m_d	$2.724\,437\,107\,484(96) \times 10^{-4}$		3.5×10^{-11}
electron-triton mass ratio	m_e/m_t	$1.819\,200\,062\,203(84) \times 10^{-4}$		4.6×10^{-11}
electron-helion mass ratio	m_e/m_h	$1.819\,543\,074\,854(88) \times 10^{-4}$		4.9×10^{-11}
electron to alpha particle mass ratio	m_e/m_α	$1.370\,933\,554\,798(45) \times 10^{-4}$		3.3×10^{-11}
electron charge to mass quotient	$-e/m_e$	$-1.758\,820\,024(11) \times 10^{11}$	$\mathrm{C\,kg^{-1}}$	6.2×10^{-9}
electron molar mass $N_A m_e$	$M(e), M_e$	$5.485\,799\,090\,70(16) \times 10^{-7}$	$\mathrm{kg\,mol^{-1}}$	2.9×10^{-11}
Compton wavelength $h/m_e c$	λ_C	$2.426\,310\,2367(11) \times 10^{-12}$	m	4.5×10^{-10}
$\lambda_C/2\pi = \alpha a_0 = \alpha^2/4\pi R_\infty$	$\lambda\!\!\!^{-}_C$	$386.159\,267\,64(18) \times 10^{-15}$	m	4.5×10^{-10}
classical electron radius $\alpha^2 a_0$	r_e	$2.817\,940\,3227(19) \times 10^{-15}$	m	6.8×10^{-10}
Thomson cross section $(8\pi/3)r_e^2$	σ_e	$0.665\,245\,871\,58(91) \times 10^{-28}$	$\mathrm{m^2}$	1.4×10^{-9}
electron magnetic moment	μ_e	$-928.476\,4620(57) \times 10^{-26}$	$\mathrm{J\,T^{-1}}$	6.2×10^{-9}
to Bohr magneton ratio	μ_e/μ_B	$-1.001\,159\,652\,180\,91(26)$		2.6×10^{-13}
to nuclear magneton ratio	μ_e/μ_N	$-1838.281\,972\,34(17)$		9.5×10^{-11}
electron magnetic moment anomaly $\lvert\mu_e\rvert/\mu_B - 1$	a_e	$1.159\,652\,180\,91(26) \times 10^{-3}$		2.3×10^{-10}
electron g-factor $-2(1 + a_e)$	g_e	$-2.002\,319\,304\,361\,82(52)$		2.6×10^{-13}
electron-muon magnetic moment ratio	μ_e/μ_μ	$206.766\,9880(46)$		2.2×10^{-8}
electron-proton magnetic moment ratio	μ_e/μ_p	$-658.210\,6866(20)$		3.0×10^{-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	$-2143.923\,499(12)$		5.5×10^{-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	$1.760\,859\,644(11) \times 10^{11}$	$\mathrm{s^{-1}\,T^{-1}}$	6.2×10^{-9}
	$\gamma_e/2\pi$	$28\,024.951\,64(17)$	$\mathrm{MHz\,T^{-1}}$	6.2×10^{-9}
		Muon, μ^-		
muon mass	m_μ	$1.883\,531\,594(48) \times 10^{-28}$	kg	2.5×10^{-8}
		$0.113\,428\,9257(25)$	u	2.2×10^{-8}
energy equivalent	$m_\mu c^2$	$1.692\,833\,774(43) \times 10^{-11}$	J	2.5×10^{-8}
		$105.658\,3745(24)$	MeV	2.3×10^{-8}
muon-electron mass ratio	m_μ/m_e	$206.768\,2826(46)$		2.2×10^{-8}
muon-tau mass ratio	m_μ/m_τ	$5.946\,49(54) \times 10^{-2}$		9.0×10^{-5}
muon-proton mass ratio	m_μ/m_p	$0.112\,609\,5262(25)$		2.2×10^{-8}
muon-neutron mass ratio	m_μ/m_n	$0.112\,454\,5167(25)$		2.2×10^{-8}
muon molar mass $N_A m_\mu$	$M(\mu), M_\mu$	$0.113\,428\,9257(25) \times 10^{-3}$	$\mathrm{kg\,mol^{-1}}$	2.2×10^{-8}
muon Compton wavelength $h/m_\mu c$	$\lambda_{C,\mu}$	$11.734\,441\,11(26) \times 10^{-15}$	m	2.2×10^{-8}
$\lambda_{C,\mu}/2\pi$	$\lambda\!\!\!^{-}_{C,\mu}$	$1.867\,594\,308(42) \times 10^{-15}$	m	2.2×10^{-8}

[3] Value recommended by the Particle Data Group (Olive *et al.*, 2014).

[4] Based on the ratio of the masses of the W and Z bosons m_W/m_Z recommended by the Particle Data Group (Olive *et al.*, 2014). The value for $\sin^2\theta_W$ they recommend, which is based on a particular variant of the modified minimal subtraction ($\overline{\mathrm{MS}}$) scheme, is $\sin^2\hat{\theta}_W(M_Z) = 0.231\,26(5)$.

TABLE II: *(Continued).*

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
muon magnetic moment	μ_μ	$-4.490\,448\,26(10) \times 10^{-26}$	J T^{-1}	2.3×10^{-8}
to Bohr magneton ratio	μ_μ/μ_B	$-4.841\,970\,48(11) \times 10^{-3}$		2.2×10^{-8}
to nuclear magneton ratio	μ_μ/μ_N	$-8.890\,597\,05(20)$		2.2×10^{-8}
muon magnetic moment anomaly				
$\lvert\mu_\mu\rvert/(e\hbar/2m_\mu) - 1$	a_μ	$1.165\,920\,89(63) \times 10^{-3}$		5.4×10^{-7}
muon g-factor $-2(1 + a_\mu)$	g_μ	$-2.002\,331\,8418(13)$		6.3×10^{-10}
muon-proton magnetic moment ratio	μ_μ/μ_p	$-3.183\,345\,142(71)$		2.2×10^{-8}
		Tau, τ^-		
tau mass[5]	m_τ	$3.167\,47(29) \times 10^{-27}$	kg	9.0×10^{-5}
		$1.907\,49(17)$	u	9.0×10^{-5}
energy equivalent	$m_\tau c^2$	$2.846\,78(26) \times 10^{-10}$	J	9.0×10^{-5}
		$1776.82(16)$	MeV	9.0×10^{-5}
tau-electron mass ratio	m_τ/m_e	$3477.15(31)$		9.0×10^{-5}
tau-muon mass ratio	m_τ/m_μ	$16.8167(15)$		9.0×10^{-5}
tau-proton mass ratio	m_τ/m_p	$1.893\,72(17)$		9.0×10^{-5}
tau-neutron mass ratio	m_τ/m_n	$1.891\,11(17)$		9.0×10^{-5}
tau molar mass $N_A m_\tau$	$M(\tau), M_\tau$	$1.907\,49(17) \times 10^{-3}$	kg mol^{-1}	9.0×10^{-5}
tau Compton wavelength $h/m_\tau c$	$\lambda_{C,\tau}$	$0.697\,787(63) \times 10^{-15}$	m	9.0×10^{-5}
$\lambda_{C,\tau}/2\pi$	$\bar{\lambda}_{C,\tau}$	$0.111\,056(10) \times 10^{-15}$	m	9.0×10^{-5}
		Proton, p		
proton mass	m_p	$1.672\,621\,898(21) \times 10^{-27}$	kg	1.2×10^{-8}
		$1.007\,276\,466\,879(91)$	u	9.0×10^{-11}
energy equivalent	$m_p c^2$	$1.503\,277\,593(18) \times 10^{-10}$	J	1.2×10^{-8}
		$938.272\,0813(58)$	MeV	6.2×10^{-9}
proton-electron mass ratio	m_p/m_e	$1836.152\,673\,89(17)$		9.5×10^{-11}
proton-muon mass ratio	m_p/m_μ	$8.880\,243\,38(20)$		2.2×10^{-8}
proton-tau mass ratio	m_p/m_τ	$0.528\,063(48)$		9.0×10^{-5}
proton-neutron mass ratio	m_p/m_n	$0.998\,623\,478\,44(51)$		5.1×10^{-10}
proton charge to mass quotient	e/m_p	$9.578\,833\,226(59) \times 10^{7}$	C kg^{-1}	6.2×10^{-9}
proton molar mass $N_A m_p$	$M(p)$, M_p	$1.007\,276\,466\,879(91) \times 10^{-3}$	kg mol^{-1}	9.0×10^{-11}
proton Compton wavelength $h/m_p c$	$\lambda_{C,p}$	$1.321\,409\,853\,96(61) \times 10^{-15}$	m	4.6×10^{-10}
$\lambda_{C,p}/2\pi$	$\bar{\lambda}_{C,p}$	$0.210\,308\,910\,109(97) \times 10^{-15}$	m	4.6×10^{-10}
proton rms charge radius	r_p	$0.8751(61) \times 10^{-15}$	m	7.0×10^{-3}
proton magnetic moment	μ_p	$1.410\,606\,7873(97) \times 10^{-26}$	J T^{-1}	6.9×10^{-9}
to Bohr magneton ratio	μ_p/μ_B	$1.521\,032\,2053(46) \times 10^{-3}$		3.0×10^{-9}
to nuclear magneton ratio	μ_p/μ_N	$2.792\,847\,3508(85)$		3.0×10^{-9}
proton g-factor $2\mu_p/\mu_N$	g_p	$5.585\,694\,702(17)$		3.0×10^{-9}
proton-neutron magnetic moment ratio	μ_p/μ_n	$-1.459\,898\,05(34)$		2.4×10^{-7}
shielded proton magnetic moment	μ'_p	$1.410\,570\,547(18) \times 10^{-26}$	J T^{-1}	1.3×10^{-8}
(H_2O, sphere, 25 °C)				
to Bohr magneton ratio	μ'_p/μ_B	$1.520\,993\,128(17) \times 10^{-3}$		1.1×10^{-8}
to nuclear magneton ratio	μ'_p/μ_N	$2.792\,775\,600(30)$		1.1×10^{-8}
proton magnetic shielding correction				
$1 - \mu'_p/\mu_p$ (H_2O, sphere, 25 °C)	σ'_p	$25.691(11) \times 10^{-6}$		4.4×10^{-4}
proton gyromagnetic ratio $2\mu_p/\hbar$	γ_p	$2.675\,221\,900(18) \times 10^{8}$	s^{-1} T^{-1}	6.9×10^{-9}
	$\gamma_p/2\pi$	$42.577\,478\,92(29)$	MHz T^{-1}	6.9×10^{-9}
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}	1.3×10^{-8}
	$\gamma'_p/2\pi$	$42.576\,385\,07(53)$	MHz T^{-1}	1.3×10^{-8}
		Neutron, n		
neutron mass	m_n	$1.674\,927\,471(21) \times 10^{-27}$	kg	1.2×10^{-8}
		$1.008\,664\,915\,88(49)$	u	4.9×10^{-10}

[5] 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 (Olive *et al.*, 2014).

TABLE II: *(Continued).*

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
energy equivalent	$m_n c^2$	$1.505\,349\,739(19) \times 10^{-10}$	J	1.2×10^{-8}
		$939.565\,4133(58)$	MeV	6.2×10^{-9}
neutron-electron mass ratio	m_n/m_e	$1838.683\,661\,58(90)$		4.9×10^{-10}
neutron-muon mass ratio	m_n/m_μ	$8.892\,484\,08(20)$		2.2×10^{-8}
neutron-tau mass ratio	m_n/m_τ	$0.528\,790(48)$		9.0×10^{-5}
neutron-proton mass ratio	m_n/m_p	$1.001\,378\,418\,98(51)$		5.1×10^{-10}
neutron-proton mass difference	$m_n - m_p$	$2.305\,573\,77(85) \times 10^{-30}$	kg	3.7×10^{-7}
		$0.001\,388\,449\,00(51)$	u	3.7×10^{-7}
energy equivalent	$(m_n - m_p)c^2$	$2.072\,146\,37(76) \times 10^{-13}$	J	3.7×10^{-7}
		$1.293\,332\,05(48)$	MeV	3.7×10^{-7}
neutron molar mass $N_A m_n$	$M(n), M_n$	$1.008\,664\,915\,88(49) \times 10^{-3}$	kg mol^{-1}	4.9×10^{-10}
neutron Compton wavelength $h/m_n c$	$\lambda_{C,n}$	$1.319\,590\,904\,81(88) \times 10^{-15}$	m	6.7×10^{-10}
$\lambda_{C,n}/2\pi$	$\bar{\lambda}_{C,n}$	$0.210\,019\,415\,36(14) \times 10^{-15}$	m	6.7×10^{-10}
neutron magnetic moment	μ_n	$-0.966\,236\,50(23) \times 10^{-26}$	J T^{-1}	2.4×10^{-7}
to Bohr magneton ratio	μ_n/μ_B	$-1.041\,875\,63(25) \times 10^{-3}$		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	$1.040\,668\,82(25) \times 10^{-3}$		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	$1.832\,471\,72(43) \times 10^{8}$	s^{-1} T^{-1}	2.4×10^{-7}
	$\gamma_n/2\pi$	$29.164\,6933(69)$	MHz T^{-1}	2.4×10^{-7}
		Deuteron, d		
deuteron mass	m_d	$3.343\,583\,719(41) \times 10^{-27}$	kg	1.2×10^{-8}
		$2.013\,553\,212\,745(40)$	u	2.0×10^{-11}
energy equivalent	$m_d c^2$	$3.005\,063\,183(37) \times 10^{-10}$	J	1.2×10^{-8}
		$1875.612\,928(12)$	MeV	6.2×10^{-9}
deuteron-electron mass ratio	m_d/m_e	$3670.482\,967\,85(13)$		3.5×10^{-11}
deuteron-proton mass ratio	m_d/m_p	$1.999\,007\,500\,87(19)$		9.3×10^{-11}
deuteron molar mass $N_A m_d$	$M(d), M_d$	$2.013\,553\,212\,745(40) \times 10^{-3}$	kg mol^{-1}	2.0×10^{-11}
deuteron rms charge radius	r_d	$2.1413(25) \times 10^{-15}$	m	1.2×10^{-3}
deuteron magnetic moment	μ_d	$0.433\,073\,5040(36) \times 10^{-26}$	J T^{-1}	8.3×10^{-9}
to Bohr magneton ratio	μ_d/μ_B	$0.466\,975\,4554(26) \times 10^{-3}$		5.5×10^{-9}
to nuclear magneton ratio	μ_d/μ_N	$0.857\,438\,2311(48)$		5.5×10^{-9}
deuteron g-factor μ_d/μ_N	g_d	$0.857\,438\,2311(48)$		5.5×10^{-9}
deuteron-electron magnetic moment ratio	μ_d/μ_e	$-4.664\,345\,535(26) \times 10^{-4}$		5.5×10^{-9}
deuteron-proton magnetic moment ratio	μ_d/μ_p	$0.307\,012\,2077(15)$		5.0×10^{-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	$5.007\,356\,665(62) \times 10^{-27}$	kg	1.2×10^{-8}
		$3.015\,500\,716\,32(11)$	u	3.6×10^{-11}
energy equivalent	$m_t c^2$	$4.500\,387\,735(55) \times 10^{-10}$	J	1.2×10^{-8}
		$2808.921\,112(17)$	MeV	6.2×10^{-9}
triton-electron mass ratio	m_t/m_e	$5496.921\,535\,88(26)$		4.6×10^{-11}
triton-proton mass ratio	m_t/m_p	$2.993\,717\,033\,48(22)$		7.5×10^{-11}
triton molar mass $N_A m_t$	$M(t), M_t$	$3.015\,500\,716\,32(11) \times 10^{-3}$	kg mol^{-1}	3.6×10^{-11}
triton magnetic moment	μ_t	$1.504\,609\,503(12) \times 10^{-26}$	J T^{-1}	7.8×10^{-9}
to Bohr magneton ratio	μ_t/μ_B	$1.622\,393\,6616(76) \times 10^{-3}$		4.7×10^{-9}
to nuclear magneton ratio	μ_t/μ_N	$2.978\,962\,460(14)$		4.7×10^{-9}
triton g-factor $2\mu_t/\mu_N$	g_t	$5.957\,924\,920(28)$		4.7×10^{-9}
		Helion, h		
helion mass	m_h	$5.006\,412\,700(62) \times 10^{-27}$	kg	1.2×10^{-8}
		$3.014\,932\,246\,73(12)$	u	3.9×10^{-11}
energy equivalent	$m_h c^2$	$4.499\,539\,341(55) \times 10^{-10}$	J	1.2×10^{-8}
		$2808.391\,586(17)$	MeV	6.2×10^{-9}
helion-electron mass ratio	m_h/m_e	$5495.885\,279\,22(27)$		4.9×10^{-11}

TABLE II: *(Continued)*.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
helion-proton mass ratio	m_h/m_p	2.993 152 670 46(29)		9.6×10^{-11}
helion molar mass $N_A m_h$	$M(h), M_h$	$3.014\,932\,246\,73(12) \times 10^{-3}$	kg mol^{-1}	3.9×10^{-11}
helion magnetic moment	μ_h	$-1.074\,617\,522(14) \times 10^{-26}$	J T^{-1}	1.3×10^{-8}
to Bohr magneton ratio	μ_h/μ_B	$-1.158\,740\,958(14) \times 10^{-3}$		1.2×10^{-8}
to nuclear magneton ratio	μ_h/μ_N	$-2.127\,625\,308(25)$		1.2×10^{-8}
helion g-factor $2\mu_h/\mu_N$	g_h	$-4.255\,250\,616(50)$		1.2×10^{-8}
shielded helion magnetic moment (gas, sphere, 25 °C)	μ'_h	$-1.074\,553\,080(14) \times 10^{-26}$	J T^{-1}	1.3×10^{-8}
to Bohr magneton ratio	μ'_h/μ_B	$-1.158\,671\,471(14) \times 10^{-3}$		1.2×10^{-8}
to nuclear magneton ratio	μ'_h/μ_N	$-2.127\,497\,720(25)$		1.2×10^{-8}
shielded helion to proton magnetic moment ratio (gas, sphere, 25 °C)	μ'_h/μ_p	$-0.761\,766\,5603(92)$		1.2×10^{-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	$2.037\,894\,585(27) \times 10^{8}$	s^{-1} T^{-1}	1.3×10^{-8}
	$\gamma'_h/2\pi$	32.434 099 66(43)	MHz T^{-1}	1.3×10^{-8}
	Alpha particle, α			
alpha particle mass	m_α	$6.644\,657\,230(82) \times 10^{-27}$	kg	1.2×10^{-8}
		4.001 506 179 127(63)	u	1.6×10^{-11}
energy equivalent	$m_\alpha c^2$	$5.971\,920\,097(73) \times 10^{-10}$	J	1.2×10^{-8}
		3727.379 378(23)	MeV	6.2×10^{-9}
alpha particle to electron mass ratio	m_α/m_e	7294.299 541 36(24)		3.3×10^{-11}
alpha particle to proton mass ratio	m_α/m_p	3.972 599 689 07(36)		9.2×10^{-11}
alpha particle molar mass $N_A m_\alpha$	$M(\alpha), M_\alpha$	$4.001\,506\,179\,127(63) \times 10^{-3}$	kg mol^{-1}	1.6×10^{-11}
	PHYSICOCHEMICAL			
Avogadro constant	N_A, L	$6.022\,140\,857(74) \times 10^{23}$	mol^{-1}	1.2×10^{-8}
atomic mass constant $m_u = \frac{1}{12}m(^{12}C) = 1$ u	m_u	$1.660\,539\,040(20) \times 10^{-27}$	kg	1.2×10^{-8}
energy equivalent	$m_u c^2$	$1.492\,418\,062(18) \times 10^{-10}$	J	1.2×10^{-8}
		931.494 0954(57)	MeV	6.2×10^{-9}
Faraday constant[6] $N_A e$	F	96 485.332 89(59)	C mol^{-1}	6.2×10^{-9}
molar Planck constant	$N_A h$	$3.990\,312\,7110(18) \times 10^{-10}$	J s mol^{-1}	4.5×10^{-10}
	$N_A hc$	0.119 626 565 582(54)	J m mol^{-1}	4.5×10^{-10}
molar gas constant	R	8.314 4598(48)	J mol^{-1} K^{-1}	5.7×10^{-7}
Boltzmann constant R/N_A	k	$1.380\,648\,52(79) \times 10^{-23}$	J K^{-1}	5.7×10^{-7}
		$8.617\,3303(50) \times 10^{-5}$	eV K^{-1}	5.7×10^{-7}
	k/h	$2.083\,6612(12) \times 10^{10}$	Hz K^{-1}	5.7×10^{-7}
	k/hc	69.503 457(40)	m^{-1} K^{-1}	5.7×10^{-7}
molar volume of ideal gas RT/p $T = 273.15$ K, $p = 100$ kPa	V_m	$22.710\,947(13) \times 10^{-3}$	m^3 mol^{-1}	5.7×10^{-7}
Loschmidt constant N_A/V_m	n_0	$2.651\,6467(15) \times 10^{25}$	m^{-3}	5.7×10^{-7}
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}	5.7×10^{-7}
Loschmidt constant N_A/V_m	n_0	$2.686\,7811(15) \times 10^{25}$	m^{-3}	5.7×10^{-7}
Sackur-Tetrode (absolute entropy) constant[7] $\frac{5}{2} + \ln[(2\pi m_u k T_1/h^2)^{3/2} k T_1/p_0]$				
$T_1 = 1$ K, $p_0 = 100$ kPa	S_0/R	$-1.151\,7084(14)$		1.2×10^{-6}
$T_1 = 1$ K, $p_0 = 101.325$ kPa		$-1.164\,8714(14)$		1.2×10^{-6}
Stefan-Boltzmann constant				

[6] The numerical value of F to be used in coulometric chemical measurements is 96 485.3251(12) [1.2×10^{-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 IV.

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

TABLE II: *(Continued).*

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
$(\pi^2/60)k^4/\hbar^3c^2$	σ	$5.670\,367(13) \times 10^{-8}$	W m^{-2} K^{-4}	2.3×10^{-6}
first radiation constant $2\pi hc^2$	c_1	$3.741\,771\,790(46) \times 10^{-16}$	W m^2	1.2×10^{-8}
first radiation constant for spectral radiance $2hc^2$	$c_{1\mathrm{L}}$	$1.191\,042\,953(15) \times 10^{-16}$	W m^2 sr^{-1}	1.2×10^{-8}
second radiation constant hc/k	c_2	$1.438\,777\,36(83) \times 10^{-2}$	m K	5.7×10^{-7}
Wien displacement law constants				
$b = \lambda_{\max}T = c_2/4.965\,114\,231...$	b	$2.897\,7729(17) \times 10^{-3}$	m K	5.7×10^{-7}
$b' = \nu_{\max}/T = 2.821\,439\,372...\,c/c_2$	b'	$5.878\,9238(34) \times 10^{10}$	Hz K^{-1}	5.7×10^{-7}

References

Olive, K. A., *et al.*, and Particle Data Center, 2014, Chin. Phys. C **38**, 090001.

TABLE III The variances, covariances, and correlation coefficients of the values of a selected group of constants based on the 2014 CODATA adjustment. The numbers in bold above the main diagonal are 10^{16} times the numerical values of the relative covariances; the numbers in bold on the main diagonal are 10^{16} times the numerical values of the relative variances; and the numbers in italics below the main diagonal are the correlation coefficients.[1]

	α	h	e	m_e	N_A	m_e/m_μ	F
α	**0.0005**	**0.0005**	**0.0005**	**−0.0005**	**0.0005**	**−0.0010**	**0.0010**
h	*0.0176*	**1.5096**	**0.7550**	**1.5086**	**−1.5086**	**−0.0010**	**−0.7536**
e	*0.0361*	*0.9998*	**0.3778**	**0.7540**	**−0.7540**	**−0.0010**	**−0.3763**
m_e	*−0.0193*	*0.9993*	*0.9985*	**1.5097**	**−1.5097**	**0.0011**	**−0.7556**
N_A	*0.0193*	*−0.9993*	*−0.9985*	*−1.0000*	**1.5097**	**−0.0011**	**0.7557**
m_e/m_μ	*−0.0202*	*−0.0004*	*−0.0007*	*0.0004*	*−0.0004*	**4.9471**	**−0.0021**
F	*0.0745*	*−0.9957*	*−0.9939*	*−0.9985*	*0.9985*	*−0.0015*	**0.3794**

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

TABLE IV Internationally adopted values of various quantities.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
relative atomic mass[1] of ^{12}C	$A_r(^{12}C)$	12		exact
molar mass constant	M_u	1×10^{-3}	kg mol^{-1}	exact
molar mass of ^{12}C	$M(^{12}C)$	12×10^{-3}	kg mol^{-1}	exact
conventional value of Josephson constant[2]	K_{J-90}	483 597.9	GHz V^{-1}	exact
conventional value of von Klitzing constant[3]	R_{K-90}	25 812.807	Ω	exact
standard-state pressure		100	kPa	exact
standard atmosphere		101.325	kPa	exact

[1] 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 $m_u = m(^{12}C)/12 = M_u/N_A = 1$ 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 $M(X) = A_r(X)M_u$.

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

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

TABLE V Values of some x-ray-related quantities based on the 2014 CODATA adjustment of the values of the constants.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
Cu x unit: $\lambda(\text{CuK}\alpha_1)/1\,537.400$	xu(CuKα_1)	$1.002\,076\,97(28) \times 10^{-13}$	m	2.8×10^{-7}
Mo x unit: $\lambda(\text{MoK}\alpha_1)/707.831$	xu(MoKα_1)	$1.002\,099\,52(53) \times 10^{-13}$	m	5.3×10^{-7}
ångstrom star: $\lambda(\text{WK}\alpha_1)/0.209\,010\,0$	Å*	$1.000\,014\,95(90) \times 10^{-10}$	m	9.0×10^{-7}
lattice parameter[1] of Si (in vacuum, 22.5 °C)	a	$543.102\,0504(89) \times 10^{-12}$	m	1.6×10^{-8}
{220} lattice spacing of Si $a/\sqrt{8}$ (in vacuum, 22.5 °C)	d_{220}	$192.015\,5714(32) \times 10^{-12}$	m	1.6×10^{-8}
molar volume of Si $M(\text{Si})/\rho(\text{Si}) = N_A a^3/8$ (in vacuum, 22.5 °C)	V_m(Si)	$12.058\,832\,14(61) \times 10^{-6}$	m^3 mol^{-1}	5.1×10^{-8}

[1] This is the lattice parameter (unit cell edge length) of an ideal single crystal of naturally occurring Si free of impurities and imperfections, and is deduced from measurements on extremely pure and nearly perfect single crystals of Si by correcting for the effects of impurities.

TABLE VI The values in SI units of some non-SI units based on the 2014 CODATA adjustment of the values of the constants.

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
		Non-SI units accepted for use with the SI		
electron volt: (e/C) J	eV	$1.602\,176\,6208(98) \times 10^{-19}$	J	6.1×10^{-9}
(unified) atomic mass unit: $\frac{1}{12}m(^{12}\mathrm{C})$	u	$1.660\,539\,040(20) \times 10^{-27}$	kg	1.2×10^{-8}
		Natural units (n.u.)		
n.u. of velocity	c, c_0	$299\,792\,458$	m s^{-1}	exact
n.u. of action: $h/2\pi$	$\hbar$	$1.054\,571\,800(13) \times 10^{-34}$	J s	1.2×10^{-8}
		$6.582\,119\,514(40) \times 10^{-16}$	eV s	6.1×10^{-9}
	$\hbar c$	$197.326\,9788(12)$	MeV fm	6.1×10^{-9}
n.u. of mass	m_e	$9.109\,383\,56(11) \times 10^{-31}$	kg	1.2×10^{-8}
n.u. of energy	$m_\mathrm{e}c^2$	$8.187\,105\,65(10) \times 10^{-14}$	J	1.2×10^{-8}
		$0.510\,998\,9461(31)$	MeV	6.2×10^{-9}
n.u. of momentum	$m_\mathrm{e}c$	$2.730\,924\,488(34) \times 10^{-22}$	kg m s^{-1}	1.2×10^{-8}
		$0.510\,998\,9461(31)$	MeV/c	6.2×10^{-9}
n.u. of length: $\hbar/m_\mathrm{e}c$	$\lambda\!\!\!^{-}_\mathrm{C}$	$386.159\,267\,64(18) \times 10^{-15}$	m	4.5×10^{-10}
n.u. of time	$\hbar/m_\mathrm{e}c^2$	$1.288\,088\,667\,12(58) \times 10^{-21}$	s	4.5×10^{-10}
		Atomic units (a.u.)		
a.u. of charge	e	$1.602\,176\,6208(98) \times 10^{-19}$	C	6.1×10^{-9}
a.u. of mass	m_e	$9.109\,383\,56(11) \times 10^{-31}$	kg	1.2×10^{-8}
a.u. of action: $h/2\pi$	$\hbar$	$1.054\,571\,800(13) \times 10^{-34}$	J s	1.2×10^{-8}
a.u. of length: Bohr radius (bohr) $\alpha/4\pi R_\infty$	a_0	$0.529\,177\,210\,67(12) \times 10^{-10}$	m	2.3×10^{-10}
a.u. of energy: Hartree energy (hartree) $e^2/4\pi\epsilon_0 a_0 = 2R_\infty hc = \alpha^2 m_\mathrm{e}c^2$	E_h	$4.359\,744\,650(54) \times 10^{-18}$	J	1.2×10^{-8}
a.u. of time	$\hbar/E_\mathrm{h}$	$2.418\,884\,326\,509(14) \times 10^{-17}$	s	5.9×10^{-12}
a.u. of force	E_h/a_0	$8.238\,723\,36(10) \times 10^{-8}$	N	1.2×10^{-8}
a.u. of velocity: αc	$a_0E_\mathrm{h}/\hbar$	$2.187\,691\,262\,77(50) \times 10^{6}$	m s^{-1}	2.3×10^{-10}
a.u. of momentum	$\hbar/a_0$	$1.992\,851\,882(24) \times 10^{-24}$	kg m s^{-1}	1.2×10^{-8}
a.u. of current	$eE_\mathrm{h}/\hbar$	$6.623\,618\,183(41) \times 10^{-3}$	A	6.1×10^{-9}
a.u. of charge density	e/a_0^3	$1.081\,202\,3770(67) \times 10^{12}$	C m^{-3}	6.2×10^{-9}
a.u. of electric potential	E_h/e	$27.211\,386\,02(17)$	V	6.1×10^{-9}
a.u. of electric field	E_h/ea_0	$5.142\,206\,707(32) \times 10^{11}$	V m^{-1}	6.1×10^{-9}
a.u. of electric field gradient	E_h/ea_0^2	$9.717\,362\,356(60) \times 10^{21}$	V m^{-2}	6.2×10^{-9}
a.u. of electric dipole moment	ea_0	$8.478\,353\,552(52) \times 10^{-30}$	C m	6.2×10^{-9}
a.u. of electric quadrupole moment	ea_0^2	$4.486\,551\,484(28) \times 10^{-40}$	C m^2	6.2×10^{-9}
a.u. of electric polarizability	$e^2a_0^2/E_\mathrm{h}$	$1.648\,777\,2731(11) \times 10^{-41}$	C^2 m^2 J^{-1}	6.8×10^{-10}
a.u. of 1st hyperpolarizability	$e^3a_0^3/E_\mathrm{h}^2$	$3.206\,361\,329(20) \times 10^{-53}$	C^3 m^3 J^{-2}	6.2×10^{-9}
a.u. of 2nd hyperpolarizability	$e^4a_0^4/E_\mathrm{h}^3$	$6.235\,380\,085(77) \times 10^{-65}$	C^4 m^4 J^{-3}	1.2×10^{-8}
a.u. of magnetic flux density	$\hbar/ea_0^2$	$2.350\,517\,550(14) \times 10^{5}$	T	6.2×10^{-9}
a.u. of magnetic dipole moment: $2\mu_\mathrm{B}$	$\hbar e/m_\mathrm{e}$	$1.854\,801\,999(11) \times 10^{-23}$	J T^{-1}	6.2×10^{-9}
a.u. of magnetizability	$e^2a_0^2/m_\mathrm{e}$	$7.891\,036\,5886(90) \times 10^{-29}$	J T^{-2}	1.1×10^{-9}
a.u. of permittivity: $10^7/c^2$	e^2/a_0E_h	$1.112\,650\,056\ldots \times 10^{-10}$	F m^{-1}	exact

TABLE VII The values of some energy equivalents derived from the relations $E = mc^2 = hc/\lambda = h\nu = kT$, and based on the 2010 CODATA adjustment of the values of the constants; 1 eV = (e/C) J, 1 u = $m_\mathrm{u} = \frac{1}{12}m(^{12}\mathrm{C}) = 10^{-3}$ kg mol$^{-1}/N_\mathrm{A}$, and $E_\mathrm{h} = 2R_\infty hc = \alpha^2 m_\mathrm{e} c^2$ is the Hartree energy (hartree).

	Relevant unit			
	J	kg	m^{-1}	Hz
1 J	(1 J) = 1 J	$(1\ \mathrm{J})/c^2$ = $1.112\,650\,056\ldots \times 10^{-17}$ kg	$(1\ \mathrm{J})/hc$ = $5.034\,116\,651(62) \times 10^{24}\ \mathrm{m}^{-1}$	$(1\ \mathrm{J})/h$ = $1.509\,190\,205(19) \times 10^{33}$ Hz
1 kg	$(1\ \mathrm{kg})c^2$ = $8.987\,551\,787\ldots \times 10^{16}$ J	(1 kg) = 1 kg	$(1\ \mathrm{kg})c/h$ = $4.524\,438\,411(56) \times 10^{41}\ \mathrm{m}^{-1}$	$(1\ \mathrm{kg})c^2/h$ = $1.356\,392\,512(17) \times 10^{50}$ Hz
$1\ \mathrm{m}^{-1}$	$(1\ \mathrm{m}^{-1})hc$ = $1.986\,445\,824(24) \times 10^{-25}$ J	$(1\ \mathrm{m}^{-1})h/c$ = $2.210\,219\,057(27) \times 10^{-42}$ kg	$(1\ \mathrm{m}^{-1})$ = $1\ \mathrm{m}^{-1}$	$(1\ \mathrm{m}^{-1})c$ = 299 792 458 Hz
1 Hz	$(1\ \mathrm{Hz})h$ = $6.626\,070\,040(81) \times 10^{-34}$ J	$(1\ \mathrm{Hz})h/c^2$ = $7.372\,497\,201(91) \times 10^{-51}$ kg	$(1\ \mathrm{Hz})/c$ = $3.335\,640\,951\ldots \times 10^{-9}\ \mathrm{m}^{-1}$	(1 Hz) = 1 Hz
1 K	$(1\ \mathrm{K})k$ = $1.380\,648\,52(79) \times 10^{-23}$ J	$(1\ \mathrm{K})k/c^2$ = $1.536\,178\,65(88) \times 10^{-40}$ kg	$(1\ \mathrm{K})k/hc$ = $69.503\,457(40)\ \mathrm{m}^{-1}$	$(1\ \mathrm{K})k/h$ = $2.083\,6612(12) \times 10^{10}$ Hz
1 eV	(1 eV) = $1.602\,176\,6208(98) \times 10^{-19}$ J	$(1\ \mathrm{eV})/c^2$ = $1.782\,661\,907(11) \times 10^{-36}$ kg	$(1\ \mathrm{eV})/hc$ = $8.065\,544\,005(50) \times 10^{5}\ \mathrm{m}^{-1}$	$(1\ \mathrm{eV})/h$ = $2.417\,989\,262(15) \times 10^{14}$ Hz
1 u	$(1\ \mathrm{u})c^2$ = $1.492\,418\,062(18) \times 10^{-10}$ J	(1 u) = $1.660\,539\,040(20) \times 10^{-27}$ kg	$(1\ \mathrm{u})c/h$ = $7.513\,006\,6166(34) \times 10^{14}\ \mathrm{m}^{-1}$	$(1\ \mathrm{u})c^2/h$ = $2.252\,342\,7206(10) \times 10^{23}$ Hz
1 E_h	$(1\ E_\mathrm{h})$ = $4.359\,744\,650(54) \times 10^{-18}$ J	$(1\ E_\mathrm{h})/c^2$ = $4.850\,870\,129(60) \times 10^{-35}$ kg	$(1\ E_\mathrm{h})/hc$ = $2.194\,746\,313\,702(13) \times 10^{7}\ \mathrm{m}^{-1}$	$(1\ E_\mathrm{h})/h$ = $6.579\,683\,920\,711(39) \times 10^{15}$ Hz

TABLE VIII The values of some energy equivalents derived from the relations $E = mc^2 = hc/\lambda = h\nu = kT$, and based on the 2010 CODATA adjustment of the values of the constants; 1 eV = (e/C) J, 1 u = $m_\mathrm{u} = \frac{1}{12}m(^{12}\mathrm{C}) = 10^{-3}$ kg mol$^{-1}/N_\mathrm{A}$, and $E_\mathrm{h} = 2R_\infty hc = \alpha^2 m_\mathrm{e} c^2$ is the Hartree energy (hartree).

	Relevant unit			
	K	eV	u	E_h
1 J	$(1\ \mathrm{J})/k$ = $7.242\,9731(42) \times 10^{22}$ K	(1 J) = $6.241\,509\,126(38) \times 10^{18}$ eV	$(1\ \mathrm{J})/c^2$ = $6.700\,535\,363(82) \times 10^{9}$ u	(1 J) = $2.293\,712\,317(28) \times 10^{17}\ E_\mathrm{h}$
1 kg	$(1\ \mathrm{kg})c^2/k$ = $6.509\,6595(37) \times 10^{39}$ K	$(1\ \mathrm{kg})c^2$ = $5.609\,588\,650(34) \times 10^{35}$ eV	(1 kg) = $6.022\,140\,857(74) \times 10^{26}$ u	$(1\ \mathrm{kg})c^2$ = $2.061\,485\,823(25) \times 10^{34}\ E_\mathrm{h}$
$1\ \mathrm{m}^{-1}$	$(1\ \mathrm{m}^{-1})hc/k$ = $1.438\,777\,36(83) \times 10^{-2}$ K	$(1\ \mathrm{m}^{-1})hc$ = $1.239\,841\,9739(76) \times 10^{-6}$ eV	$(1\ \mathrm{m}^{-1})h/c$ = $1.331\,025\,049\,00(61) \times 10^{-15}$ u	$(1\ \mathrm{m}^{-1})hc$ = $4.556\,335\,252\,767(27) \times 10^{-8}\ E_\mathrm{h}$
1 Hz	$(1\ \mathrm{Hz})h/k$ = $4.799\,2447(28) \times 10^{-11}$ K	$(1\ \mathrm{Hz})h$ = $4.135\,667\,662(25) \times 10^{-15}$ eV	$(1\ \mathrm{Hz})h/c^2$ = $4.439\,821\,6616(20) \times 10^{-24}$ u	$(1\ \mathrm{Hz})h$ = $1.519\,829\,846\,0088(90) \times 10^{-16}\ E_\mathrm{h}$
1 K	(1 K) = 1 K	$(1\ \mathrm{K})k$ = $8.617\,3303(50) \times 10^{-5}$ eV	$(1\ \mathrm{K})k/c^2$ = $9.251\,0842(53) \times 10^{-14}$ u	$(1\ \mathrm{K})k$ = $3.166\,8105(18) \times 10^{-6}\ E_\mathrm{h}$
1 eV	$(1\ \mathrm{eV})/k$ = $1.160\,452\,21(67) \times 10^{4}$ K	(1 eV) = 1 eV	$(1\ \mathrm{eV})/c^2$ = $1.073\,544\,1105(66) \times 10^{-9}$ u	(1 eV) = $3.674\,932\,248(23) \times 10^{-2}\ E_\mathrm{h}$
1 u	$(1\ \mathrm{u})c^2/k$ = $1.080\,954\,38(62) \times 10^{13}$ K	$(1\ \mathrm{u})c^2$ = $931.494\,0954(57) \times 10^{6}$ eV	(1 u) = 1 u	$(1\ \mathrm{u})c^2$ = $3.423\,177\,6902(16) \times 10^{7}\ E_\mathrm{h}$
1 E_h	$(1\ E_\mathrm{h})/k$ = $3.157\,7513(18) \times 10^{5}$ K	$(1\ E_\mathrm{h})$ = $27.211\,386\,02(17)$ eV	$(1\ E_\mathrm{h})/c^2$ = $2.921\,262\,3197(13) \times 10^{-8}$ u	$(1\ E_\mathrm{h})$ = $1\ E_\mathrm{h}$