CODATA Recommended Values of the Fundamental Physical Constants: 2014*

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(Dated: July 30, 2015)

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. $u_{\rm r}$
speed of light in vacuum	c, c_0	299 792 458	$\mathrm{m~s}^{-1}$	exact
magnetic constant	μ_0	$4\pi \times 10^{-7}$	$N A^{-2}$	
	F =0	$= 12.566370614\times10^{-7}$	$N A^{-2}$	exact
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854187817\times10^{-12}$	$\mathrm{F}~\mathrm{m}^{-1}$	exact
Newtonian constant of gravitation	G	$6.67408(31) \times 10^{-11}$	$m^3 kg^{-1} s^{-2}$	4.7×10^{-5}
Planck constant	h	$6.626070040(81)\times10^{-34}$	Js	1.2×10^{-8}
$h/2\pi$	\hbar	$1.054571800(13)\times10^{-34}$	J s	1.2×10^{-8}
elementary charge	e	$1.6021766208(98)\times10^{-19}$	С	6.1×10^{-9}
magnetic flux quantum $h/2e$	Φ_0	$2.067833831(13)\times10^{-15}$	Wb	6.1×10^{-9}
conductance quantum $2e^2/h$	G_0	$7.7480917310(18) \times 10^{-5}$	S	2.3×10^{-10}
electron mass	$m_{ m e}$	$9.10938356(11) \times 10^{-31}$	kg	1.2×10^{-8}
proton mass	$m_{ m p}$	$1.672621898(21) \times 10^{-27}$	kg	1.2×10^{-8}
proton-electron mass ratio	$m_{ m p}/m_{ m e}$	1836.152 673 89(17)		9.5×10^{-11}
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.2973525664(17) \times 10^{-3}$		2.3×10^{-10}
inverse fine-structure constant	$lpha^{-1}$	137.035 999 139(31)		2.3×10^{-10}
Rydberg constant $\alpha^2 m_{\rm e} c/2h$	R_{∞}	10973731.568508(65)	m^{-1}	5.9×10^{-12}
Avogadro constant	$N_{ m A}, L$	$6.022140857(74)\times10^{23}$	mol^{-1}	1.2×10^{-8}
Faraday constant $N_{\rm A}e$	F	96485.33289(59)	$\mathrm{C} \; \mathrm{mol}^{-1}$	6.2×10^{-9}
molar gas constant	R	8.314 4598(48)	$\mathrm{J} \; \mathrm{mol}^{-1} \; \mathrm{K}^{-1}$	5.7×10^{-7}
Boltzmann constant $R/N_{\rm A}$	k	$1.38064852(79) \times 10^{-23}$	$\rm J~K^{-1}$	5.7×10^{-7}
Stefan-Boltzmann constant				
$(\pi^2/60)k^4/\hbar^3c^2$	σ	$5.670367(13)\times10^{-8}$	${ m W} { m m}^{-2} { m K}^{-4}$	2.3×10^{-6}
No	on-SI units ac	ccepted for use with the SI		
electron volt (e/C) J	${ m eV}$	$1.6021766208(98)\times10^{-19}$	J	6.1×10^{-9}
(unified) atomic mass unit $\frac{1}{12}m(^{12}C)$	u	$1.660539040(20)\times10^{-27}$	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. $u_{\rm r}$
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speed of light in vacuum	c, c_0	299 792 458	${\rm m~s}^{-1}$	exact
magnetic constant	μ_0	$4\pi \times 10^{-7}$	$\stackrel{ ext{III S}}{ ext{N A}^{-2}}$	exact
magnetic constant	μ_0	$= 12.566370614 \times 10^{-7}$	$^{ m N}$ $^{ m A^{-2}}$	exact
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854187817\times10^{-12}$	$\mathrm{F}~\mathrm{m}^{-1}$	exact
characteristic impedance of vacuum $\mu_0 c$	Z_0	376.730 313 461	Ω	exact
Newtonian constant of gravitation	$\overset{=}{G}$	$6.67408(31)\times10^{-11}$	$m^3 kg^{-1} s^{-2}$	
2.4	$G/\hbar c$	$6.70861(31) \times 10^{-39}$	$(\text{GeV}/c^2)^{-2}$	4.7×10^{-5}
Planck constant	$h^{'}$	$6.626070040(81)\times10^{-34}$	Js	1.2×10^{-8}
		$4.135667662(25) \times 10^{-15}$	eV s	6.1×10^{-9}
$h/2\pi$	\hbar	$1.054571800(13) \times 10^{-34}$	Jѕ	1.2×10^{-8}
,		$6.582119514(40)\times10^{-16}$	eV s	6.1×10^{-9}
	$\hbar c$	197.326 9788(12)	MeV fm	6.1×10^{-9}
Planck mass $(\hbar c/G)^{1/2}$	$m_{ m P}$	$2.176470(51)\times10^{-8}$	kg	2.3×10^{-5}
energy equivalent	$m_{ m P}c^2$	$1.220910(29)\times10^{19}$	$\widetilde{\mathrm{GeV}}$	2.3×10^{-5}
Planck temperature $(\hbar c^5/G)^{1/2}/k$	$T_{ m P}$	$1.416808(33)\times10^{32}$	K	2.3×10^{-5}
Planck length $\hbar/m_{\rm P}c = (\hbar G/c^3)^{1/2}$	$l_{ m P}$	$1.616229(38)\times10^{-35}$	m	2.3×10^{-5}
Planck time $l_{\rm P}/c = (\hbar G/c^5)^{1/2}$	$t_{ m P}$	$5.39116(13)\times10^{-44}$	s	2.3×10^{-5}
- / (/ /	FI ECTROI	MAGNETIC		
elementary charge	e	$1.6021766208(98)\times10^{-19}$	\mathbf{C}	6.1×10^{-9}
cicinentary charge	e/h	$2.417989262(15)\times 10^{14}$	$A J^{-1}$	6.1×10^{-9}
magnetic flux quantum $h/2e$	Φ_0	$2.067833831(13) \times 10^{-15}$	Wb	6.1×10^{-9}
conductance quantum $2e^2/h$	G_0	$7.7480917310(18) \times 10^{-5}$	S	2.3×10^{-10}
inverse of conductance quantum	G_0^{-1}	12906.4037278(29)	$\overset{\circ}{\Omega}$	2.3×10^{-10}
Josephson constant $\frac{1}{2}e/h$	$K_{ m J}$	$483597.8525(30) \times 10^9$	$\mathrm{Hz}\;\mathrm{V}^{-1}$	6.1×10^{-9}
von Klitzing constant ² $h/e^2 = \mu_0 c/2\alpha$	$R_{ m K}$	25 812.807 4555(59)	Ω	2.3×10^{-10}
Bohr magneton $e\hbar/2m_{\rm e}$	$\mu_{ m B}$	$927.4009994(57) \times 10^{-26}$	$ m J~T^{-1}$	6.2×10^{-9}
	d-P	$5.7883818012(26) \times 10^{-5}$	${ m eV}~{ m T}^{-1}$	4.5×10^{-10}
	$\mu_{ m B}/h$	$13.996245042(86) \times 10^9$	$\mathrm{Hz}\;\mathrm{T}^{-1}$	6.2×10^{-9}
	$\mu_{ m B}/hc$	46.686 448 14(29)	${\rm m}^{-1} {\rm T}^{-1}$	6.2×10^{-9}
	$\mu_{ m B}/k$	0.67171405(39)	${ m K}~{ m T}^{-1}$	5.7×10^{-7}
nuclear magneton $e\hbar/2m_{\rm p}$	$\mu_{ m N}$	$5.050783699(31) \times 10^{-27}$	$\rm J~T^{-1}$	6.2×10^{-9}
, ,	•	$3.1524512550(15) \times 10^{-8}$	$eV T^{-1}$	4.6×10^{-10}
	$\mu_{ m N}/h$	7.622593285(47)	$ m MHz~T^{-1}$	6.2×10^{-9}
	$\mu_{ m N}/hc$	$2.542623432(16) \times 10^{-2}$	${ m m}^{-1} { m T}^{-1}$	6.2×10^{-9}
	$\mu_{ m N}/k$	$3.658\ 2690(21) \times 10^{-4}$	${ m K}~{ m T}^{-1}$	5.7×10^{-7}
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	Gen			
fine-structure constant $e^2/4\pi\epsilon_0\hbar c$	α	$7.2973525664(17) \times 10^{-3}$		2.3×10^{-10}
inverse fine-structure constant	α^{-1}	137.035 999 139(31)		2.3×10^{-10}
Rydberg constant $\alpha^2 m_e c/2h$	R_{∞}	10 973 731.568 508(65)	m^{-1}	5.9×10^{-12}
<i>y y</i>	$R_{\infty}c$	$3.289841960355(19)\times 10^{15}$	$_{ m Hz}$	5.9×10^{-12}
	$R_{\infty}hc$	$2.179872325(27)\times10^{-18}$	J	1.2×10^{-8}
		13.605693009(84)	${ m eV}$	6.1×10^{-9}
Bohr radius $\alpha/4\pi R_{\infty} = 4\pi\epsilon_0 \hbar^2/m_e e^2$	a_0	$0.52917721067(12)\times10^{-10}$	m	2.3×10^{-10}
Hartree energy $e^2/4\pi\epsilon_0 a_0 = 2R_{\infty}hc = \alpha^2 m_e c^2$	$E_{ m h}$	$4.359744650(54) \times 10^{-18}$	J	1.2×10^{-8}
50 , 1 0		27.21138602(17)	${ m eV}$	6.1×10^{-9}
quantum of circulation	$h/2m_{ m e}$	$3.6369475486(17) \times 10^{-4}$	$\mathrm{m^2~s^{-1}}$	4.5×10^{-10}
-	$h^{'}\!/m_{ m e}$	$7.2738950972(33)\times10^{-4}$	$\mathrm{m^2~s^{-1}}$	4.5×10^{-10}
	,	roweak		

 $^{^{1}}$ 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. $u_{\rm r}$
Fermi coupling constant ³	$G_{\rm F}/(\hbar c)^3$	$1.1663787(6) \times 10^{-5}$	${ m GeV^{-2}}$	5.1×10^{-7}
weak mixing angle ⁴ $\theta_{\rm W}$ (on-shell scheme)	, , ,	, ,		
$\sin^2 \theta_{\rm W} = s_{\rm W}^2 \equiv 1 - (m_{\rm W}/m_{\rm Z})^2$	$\sin^2 \theta_{ m W}$	0.2223(21)		9.5×10^{-3}
	Electro	n. e		
electron mass	$m_{ m e}$	$9.10938356(11) \times 10^{-31}$	kg	1.2×10^{-8}
order on made	7706	$5.48579909070(16) \times 10^{-4}$	u	2.9×10^{-11}
energy equivalent	$m_{ m e}c^2$	$8.18710565(10)\times10^{-14}$	J	1.2×10^{-8}
G. 1	C	0.5109989461(31)	MeV	6.2×10^{-9}
electron-muon mass ratio	$m_{ m e}/m_{ m \mu}$	$4.83633170(11)\times10^{-3}$		2.2×10^{-8}
electron-tau mass ratio	$m_{ m e}/m_{ m au}$	$2.87592(26)\times10^{-4}$		9.0×10^{-5}
electron-proton mass ratio	$m_{ m e}/m_{ m p}$	$5.44617021352(52)\times10^{-4}$		9.5×10^{-11}
electron-neutron mass ratio	$m_{ m e}/m_{ m n}$	$5.4386734428(27) \times 10^{-4}$		4.9×10^{-10}
electron-deuteron mass ratio	$m_{ m e}/m_{ m d}$	$2.724437107484(96)\times10^{-4}$		3.5×10^{-11}
electron-triton mass ratio	$m_{ m e}/m_{ m t}$	$1.819200062203(84)\times10^{-4}$		4.6×10^{-11}
electron-helion mass ratio	$m_{ m e}/m_{ m h}$	$1.819543074854(88) \times 10^{-4}$		4.9×10^{-11}
electron to alpha particle mass ratio	$m_{ m e}/m_{ m lpha}$	$1.370933554798(45)\times10^{-4}$		3.3×10^{-11}
electron charge to mass quotient	$-e/m_{ m e}$	$-1.758820024(11)\times10^{11}$	$\rm C~kg^{-1}$	6.2×10^{-9}
electron molar mass $N_{\rm A}m_{\rm e}$	$M(\mathrm{e}), M_\mathrm{e}$	$5.48579909070(16) \times 10^{-7}$	$kg \text{ mol}^{-1}$	2.9×10^{-11}
Compton wavelength $h/m_{\rm e}c$	$\lambda_{ m C}$	$2.4263102367(11)\times10^{-12}$	m	4.5×10^{-10}
$\lambda_{\rm C}/2\pi = \alpha a_0 = \alpha^2/4\pi R_{\infty}$	$\lambda_{ m C}$	$386.159\ 267\ 64(18) \times 10^{-15}$	m	4.5×10^{-10}
classical electron radius $\alpha^2 a_0$	$r_{ m e}$	$2.8179403227(19)\times10^{-15}$	m	6.8×10^{-10}
Thomson cross section $(8\pi/3)r_{\rm e}^2$	$\sigma_{ m e}$	$0.66524587158(91)\times10^{-28}$	m^2	1.4×10^{-9}
electron magnetic moment	$\mu_{ m e}$	$-928.4764620(57)\times10^{-26}$	$\rm J~T^{-1}$	6.2×10^{-9}
to Bohr magneton ratio	$\mu_{ m e}/\mu_{ m B}$	-1.00115965218091(26)		2.6×10^{-13}
to nuclear magneton ratio	$\mu_{ m e}/\mu_{ m N}$	-1838.28197234(17)		9.5×10^{-11}
electron magnetic moment		1.170.070.100.01(00) 10-3		2.2 10-10
anomaly $ \mu_{\rm e} /\mu_{\rm B}-1$	$a_{ m e}$	$1.15965218091(26) \times 10^{-3}$		2.3×10^{-10}
electron g -factor $-2(1+a_e)$	$g_{ m e}$	-2.00231930436182(52)		2.6×10^{-13}
electron-muon magnetic moment ratio	$\mu_{ m e}/\mu_{ m \mu}$	206.766 9880(46)		2.2×10^{-8}
electron-proton magnetic moment ratio	$\mu_{ m e}/\mu_{ m p}$	-658.2106866(20)		3.0×10^{-9}
electron to shielded proton magnetic	/ /	CEO 007 F071 (70)		1 1 10=8
moment ratio (H ₂ O, sphere, 25 °C)	$\mu_{ m e}/\mu_{ m p}'$	-658.2275971(72)		1.1×10^{-8}
electron-neutron magnetic moment ratio	$\mu_{ m e}/\mu_{ m n}$	960.920 50(23)		2.4×10^{-7}
electron-deuteron magnetic moment ratio	$\mu_{ m e}/\mu_{ m d}$	-2143.923499(12)		5.5×10^{-9}
electron to shielded helion magnetic	$\mu_{ m e}/\mu_{ m h}'$	864.058 257(10)		1.2×10^{-8}
moment ratio (gas, sphere, 25 °C)		$1.760859644(11) \times 10^{11}$	$s^{-1} T^{-1}$	6.2×10^{-9}
electron gyromagnetic ratio $2 \mu_{\rm e} /\hbar$	$\gamma_{ m e}$	28024.95164(17)	$^{ m S}$ $^{ m I}$ $^{ m MHz}$ ${ m T}^{-1}$	6.2×10^{-9}
	$\gamma_{ m e}/2\pi$, ,	MIIZ I	0.2×10
	Muon			0
muon mass	$m_{ m \mu}$	$1.883531594(48) \times 10^{-28}$	kg	2.5×10^{-8}
	0	0.1134289257(25)	u	2.2×10^{-8}
energy equivalent	$m_{ m \mu}c^2$	$1.692833774(43)\times 10^{-11}$	J	2.5×10^{-8}
		105.6583745(24)	MeV	2.3×10^{-8}
muon-electron mass ratio	$m_{ m \mu}/m_{ m e}$	206.768 2826(46)		2.2×10^{-8}
muon-tau mass ratio	$m_{ m \mu}/m_{ m au}$	$5.94649(54) \times 10^{-2}$		9.0×10^{-5}
muon-proton mass ratio	$m_{ m \mu}/m_{ m p}$	0.1126095262(25)		2.2×10^{-8}
muon-neutron mass ratio	$m_{ m \mu}/m_{ m n}$	0.112 454 5167(25)	1	2.2×10^{-8}
muon molar mass $N_{\rm A} m_{\rm \mu}$	$M(\mu), M_{\mu}$	$0.1134289257(25) \times 10^{-3}$	$kg \text{ mol}^{-1}$	2.2×10^{-8}
muon Compton wavelength $h/m_{\mu}c$	$\lambda_{\mathrm{C},\mu}$	$11.73444111(26) \times 10^{-15}$	m	2.2×10^{-8}
$\lambda_{\mathrm{C},\mu}/2\pi$	$\lambda_{\mathrm{C},\mu}$	$1.867594308(42)\times10^{-15}$	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 $m_{\rm W}/m_{\rm Z}$ recommended by the Particle Data Group (Olive et al., 2014). The value for $\sin^2\theta_{\rm W}$ they recommend, which is based on a particular variant of the modified minimal subtraction ($\overline{\rm MS}$) scheme, is $\sin^2 \hat{\theta}_{\text{W}}(M_{\text{Z}}) = 0.231 \, 26(5).$

TABLE II: (Continued).

				Relative std.
Quantity	Symbol	Numerical value	Unit	uncert. $u_{\rm r}$
muon magnetic moment	$\mu_{ extsf{\mu}}$	$-4.49044826(10) \times 10^{-26}$	$\rm J~T^{-1}$	2.3×10^{-8}
to Bohr magneton ratio	$\mu_{ m \mu}/\mu_{ m B}$	$-4.84197048(11)\times10^{-3}$		2.2×10^{-8}
to nuclear magneton ratio	$\mu_{ m \mu}/\mu_{ m N}$	-8.89059705(20)		2.2×10^{-8}
muon magnetic moment anomaly				_
$ \mu_{\mu} /(e\hbar/2m_{\mu})-1$	a_{μ}	$1.16592089(63)\times10^{-3}$		5.4×10^{-7}
muon g-factor $-2(1+a_{\mu})$	$g_{ m \mu}$	-2.0023318418(13)		6.3×10^{-10}
muon-proton magnetic moment ratio	$\mu_{ m \mu}/\mu_{ m p}$	-3.183345142(71)		2.2×10^{-8}
	Tau,			
tau mass ⁵	$m_{ au}$	$3.16747(29) \times 10^{-27}$	kg	9.0×10^{-5}
		1.90749(17)	\mathbf{u}	9.0×10^{-5}
energy equivalent	$m_{ au}c^2$	$2.84678(26) \times 10^{-10}$	J	9.0×10^{-5}
		1776.82(16)	MeV	9.0×10^{-5}
tau-electron mass ratio	$m_{ au}/m_{ m e}$	3477.15(31)		9.0×10^{-5}
tau-muon mass ratio	$m_{ au}/m_{ extsf{\mu}}$	16.8167(15)		9.0×10^{-5}
tau-proton mass ratio	$m_{ au}/m_{ m p}$	1.89372(17)		9.0×10^{-5}
tau-neutron mass ratio	$m_{ au}/m_{ m n}$	$1.891\ 11(17)$		9.0×10^{-5}
tau molar mass $N_{\rm A} m_{ au}$	$M(au), M_ au$	$1.90749(17) \times 10^{-3}$	$kg \text{ mol}^{-1}$	9.0×10^{-5}
tau Compton wavelength $h/m_{\tau}c$	$\lambda_{\mathrm{C}, au}$	$0.697787(63) \times 10^{-15}$	m	9.0×10^{-5}
$\lambda_{ m C, au}/2\pi$	$\lambda_{\mathrm{C},\tau}$	$0.111056(10)\times10^{-15}$	m	9.0×10^{-5}
	Proto	n, p		
proton mass	$m_{ m p}$	$1.672621898(21) \times 10^{-27}$	kg	1.2×10^{-8}
	•	1.007276466879(91)	u	9.0×10^{-11}
energy equivalent	$m_{ m p}c^2$	$1.503277593(18) \times 10^{-10}$	J	1.2×10^{-8}
	1	938.272 0813(58)	MeV	6.2×10^{-9}
proton-electron mass ratio	$m_{ m p}/m_{ m e}$	1836.152 673 89(17)		9.5×10^{-11}
proton-muon mass ratio	$m_{ m p}/m_{ m \mu}$	8.880 243 38(20)		2.2×10^{-8}
proton-tau mass ratio	$m_{ m p}/m_{ m au}$	0.528 063(48)		9.0×10^{-5}
proton-neutron mass ratio	$m_{ m p}/m_{ m n}$	0.998 623 478 44(51)		5.1×10^{-10}
proton charge to mass quotient	$e/m_{ m p}$	$9.578833226(59)\times10^7$	$\rm C~kg^{-1}$	6.2×10^{-9}
proton molar mass $N_{\rm A}m_{\rm p}$	$M(p), M_p$	$1.007276466879(91)\times10^{-3}$	$kg \text{ mol}^{-1}$	9.0×10^{-11}
proton Compton wavelength $h/m_{\rm p}c$	$\lambda_{ ext{C,p}}$	$1.32140985396(61) \times 10^{-15}$	m	4.6×10^{-10}
$\lambda_{ m C,p}/2\pi$	$\lambda_{ m C,p}$	$0.210308910109(97)\times10^{-15}$	m	4.6×10^{-10}
proton rms charge radius	$r_{ m p}$	$0.8751(61) \times 10^{-15}$	m	7.0×10^{-3}
proton magnetic moment	$\mu_{ m p}$	$1.4106067873(97)\times10^{-26}$	$\rm J~T^{-1}$	6.9×10^{-9}
to Bohr magneton ratio	$\mu_{ m P}/\mu_{ m B}$	$1.5210322053(46)\times10^{-3}$		3.0×10^{-9}
to nuclear magneton ratio	$\mu_{ m p}/\mu_{ m N}$	2.7928473508(85)		3.0×10^{-9}
proton g-factor $2\mu_{\rm p}/\mu_{\rm N}$	$g_{ m p}$	5.585694702(17)		3.0×10^{-9}
proton-neutron magnetic moment ratio	$\mu_{ m p}/\mu_{ m n}$	-1.45989805(34)		2.4×10^{-7}
shielded proton magnetic moment	$\mu_{ m p}'$	$1.410570547(18) \times 10^{-26}$	$\rm J~T^{-1}$	1.3×10^{-8}
$(H_2O, \text{ sphere, } 25 ^{\circ}C)$				
to Bohr magneton ratio	$\mu_{ m p}'/\mu_{ m B}$	$1.520993128(17)\times10^{-3}$		1.1×10^{-8}
to nuclear magneton ratio	$\mu_{ m p}'/\mu_{ m N}$	2.792775600(30)		1.1×10^{-8}
proton magnetic shielding correction				
$1 - \mu'_{\rm p}/\mu_{\rm p}$ (H ₂ O, sphere, 25 °C)	$\sigma_{ m p}'$	$25.691(11) \times 10^{-6}$		4.4×10^{-4}
proton gyromagnetic ratio $2\mu_{\rm p}/\hbar$	$\gamma_{ m p}$	$2.675221900(18)\times10^8$	$s^{-1} T^{-1}$	6.9×10^{-9}
	$\gamma_{ ext{p}}/2\pi$	42.57747892(29)	$ m MHz~T^{-1}$	6.9×10^{-9}
shielded proton gyromagnetic ratio	,	0	1 1	0
$2\mu_{\rm p}'/\hbar$ (H ₂ O, sphere, 25 °C)	$\gamma_{ m p}'$	$2.675153171(33)\times10^8$	$s^{-1} T^{-1}$	1.3×10^{-8}
	$\gamma_{ m p}'/2\pi$	42.57638507(53)	$ m MHz~T^{-1}$	1.3×10^{-8}
	Neutro	on, n		
neutron mass	$m_{ m n}$	$1.674927471(21)\times10^{-27}$	kg	1.2×10^{-8}
		1.00866491588(49)	\mathbf{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. $u_{\rm r}$
energy equivalent	$m_{\rm n}c^2$	$1.505349739(19) \times 10^{-10}$	J	1.2×10^{-8}
		939.565 4133(58)	MeV	6.2×10^{-9}
neutron-electron mass ratio	$m_{ m n}/m_{ m e}$	1838.683 661 58(90)		4.9×10^{-10}
neutron-muon mass ratio	$m_{ m n}/m_{ m \mu}$	8.892 484 08(20)		2.2×10^{-8}
neutron-tau mass ratio	$m_{ m n}/m_{ m au}$	0.528 790(48)		9.0×10^{-5}
neutron-proton mass ratio	$m_{ m n}/m_{ m p}$	1.001 378 418 98(51)		5.1×10^{-10}
neutron-proton mass difference	$m_{ m n}-m_{ m p}$	$2.30557377(85)\times10^{-30}$	kg	3.7×10^{-7}
F	п	0.001 388 449 00(51)	u	3.7×10^{-7}
energy equivalent	$(m_{\rm n} - m_{\rm p})c^2$	$2.07214637(76)\times10^{-13}$	J	3.7×10^{-7}
OV I	(" P/	1.29333205(48)	MeV	3.7×10^{-7}
neutron molar mass $N_{\rm A} m_{\rm n}$	$M(\mathrm{n}), M_{\mathrm{n}}$	$1.00866491588(49)\times10^{-3}$	$kg \text{ mol}^{-1}$	4.9×10^{-10}
neutron Compton wavelength $h/m_{\rm n}c$	$\lambda_{ m C,n}$	$1.31959090481(88)\times10^{-15}$	m	6.7×10^{-10}
$\lambda_{ m C,n}/2\pi$	$\lambda_{\mathrm{C,n}}$	$0.21001941536(14)\times10^{-15}$	m	6.7×10^{-10}
neutron magnetic moment	$\mu_{ m n}$	$-0.96623650(23)\times10^{-26}$	$\rm J~T^{-1}$	2.4×10^{-7}
to Bohr magneton ratio	$\mu_{ m n}/\mu_{ m B}$	$-1.04187563(25)\times10^{-3}$		2.4×10^{-7}
to nuclear magneton ratio	$\mu_{ m n}/\mu_{ m N}$	-1.91304273(45)		2.4×10^{-7}
neutron g-factor $2\mu_{\rm n}/\mu_{\rm N}$	$g_{ m n}$	-3.82608545(90)		2.4×10^{-7}
neutron-electron magnetic moment ratio	$\mu_{ m n}/\mu_{ m e}$	$1.04066882(25)\times10^{-3}$		2.4×10^{-7}
neutron-proton magnetic moment ratio	$\mu_{ m n}/\mu_{ m p}$	-0.68497934(16)		2.4×10^{-7}
neutron to shielded proton magnetic	F-11/ F-P	0.00 = 0.00 0 = (= 0)		
moment ratio (H ₂ O, sphere, 25 °C)	$\mu_{ m n}/\mu_{ m p}'$	-0.68499694(16)		2.4×10^{-7}
neutron gyromagnetic ratio $2 \mu_n /\hbar$	$\gamma_{ m n}$	$1.83247172(43) \times 10^{8}$	$s^{-1} T^{-1}$	2.4×10^{-7}
induction Systema Succession 2 pin / 10	$\gamma_{ m n}^{ m n}/2\pi$	29.164 6933(69)	$ m MHz~T^{-1}$	2.4×10^{-7}
	•	, ,		
1	Deuteron		1	1.0 × 10=8
deuteron mass	$m_{ m d}$	$3.343583719(41) \times 10^{-27}$	kg	1.2×10^{-8}
. 1	2	2.013553212745(40)	u	2.0×10^{-11}
energy equivalent	$m_{ m d}c^2$	$3.005063183(37)\times10^{-10}$	J	1.2×10^{-8}
1	/	1875.612 928(12)	MeV	$6.2 \times 10^{-9} \\ 3.5 \times 10^{-11}$
deuteron-electron mass ratio	$m_{ m d}/m_{ m e}$	3670.482 967 85(13)		9.3×10^{-11}
deuteron-proton mass ratio	$m_{\rm d}/m_{\rm p}$	1.99900750087(19)	$kg \text{ mol}^{-1}$	9.3×10 2.0×10^{-11}
deuteron molar mass $N_{\rm A}m_{\rm d}$	$M(\mathrm{d}), M_{\mathrm{d}}$	$2.013553212745(40) \times 10^{-3}$	_	
deuteron rms charge radius	$r_{ m d}$	$2.1413(25) \times 10^{-15}$	$_{ m J}^{ m m}$	1.2×10^{-3}
deuteron magnetic moment	$\mu_{ m d}$	$0.4330735040(36) \times 10^{-26}$	J T	8.3×10^{-9}
to Bohr magneton ratio	$\mu_{ m d}/\mu_{ m B}$	$0.4669754554(26) \times 10^{-3}$		5.5×10^{-9}
to nuclear magneton ratio	$\mu_{ m d}/\mu_{ m N}$	0.857 438 2311(48)		5.5×10^{-9}
deuteron g-factor $\mu_{\rm d}/\mu_{ m N}$	$g_{ m d}$,	0.857 438 2311(48)		5.5×10^{-9}
deuteron-electron magnetic moment ratio	$\mu_{ m d}/\mu_{ m e}$	$-4.664345535(26) \times 10^{-4}$		5.5×10^{-9}
deuteron-proton magnetic moment ratio	$\mu_{ m d}/\mu_{ m p}$	0.307 012 2077(15)		5.0×10^{-9}
deuteron-neutron magnetic moment ratio	$\mu_{ m d}/\mu_{ m n}$	-0.44820652(11)		2.4×10^{-7}
	Triton,			
triton mass	$m_{ m t}$	$5.007356665(62) \times 10^{-27}$	kg	1.2×10^{-8}
		3.01550071632(11)	u	3.6×10^{-11}
energy equivalent	$m_{ m t}c^2$	$4.500387735(55)\times10^{-10}$	J	1.2×10^{-8}
		2808.921 112(17)	MeV	6.2×10^{-9}
triton-electron mass ratio	$m_{ m t}/m_{ m e}$	$5496.921\ 535\ 88(26)$		4.6×10^{-11}
triton-proton mass ratio	$m_{ m t}/m_{ m p}$	2.99371703348(22)		7.5×10^{-11}
triton molar mass $N_{ m A} m_{ m t}$	$M({ m t}), M_{ m t}$	$3.01550071632(11)\times10^{-3}$	${\rm kg~mol^{-1}}$	3.6×10^{-11}
triton magnetic moment	$\mu_{ m t}$	$1.504609503(12)\times10^{-26}$	$\rm J~T^{-1}$	7.8×10^{-9}
to Bohr magneton ratio	$\mu_{ m t}/\mu_{ m B}$	$1.6223936616(76) \times 10^{-3}$		4.7×10^{-9}
to nuclear magneton ratio	$\mu_{ m t}/\mu_{ m N}$	2.978 962 460(14)		4.7×10^{-9}
triton g-factor $2\mu_{\rm t}/\mu_{\rm N}$	$g_{ m t}$	5.957924920(28)		4.7×10^{-9}
	Helion,	h		
helion mass	$m_{ m h}$	$5.006412700(62) \times 10^{-27}$	kg	1.2×10^{-8}
11000	,,,,,,	3.01493224673(12)	u u	3.9×10^{-11}
energy equivalent	$m_{ m h}c^2$	$4.499539341(55) \times 10^{-10}$	J	1.2×10^{-8}
onorgy equivation	none.	2808.391586(17)	${ m MeV}$	6.2×10^{-9}
helion-electron mass ratio	$m_{ m h}/m_{ m e}$	5495.885 279 22(27)	1110 4	4.9×10^{-11}

TABLE II: (Continued).

-				Relative std.
Quantity	Symbol	Numerical value	Unit	uncert. $u_{\rm r}$
helion-proton mass ratio	$m_{ m h}/m_{ m p}$	2.99315267046(29)		9.6×10^{-11}
helion molar mass $N_{\rm A} m_{\rm h}$	$M(\mathrm{h}), M_{\mathrm{h}}$	$3.01493224673(12)\times10^{-3}$	$kg \text{ mol}^{-1}$	3.9×10^{-11}
helion magnetic moment	$\mu_{ m h}$	$-1.074617522(14) \times 10^{-26}$	$\bar{\mathrm{J}} \mathrm{T}^{-1}$	1.3×10^{-8}
to Bohr magneton ratio	$\mu_{ m h}/\mu_{ m B}$	$-1.158740958(14) \times 10^{-3}$		1.2×10^{-8}
to nuclear magneton ratio	$\mu_{ m h}/\mu_{ m N}$	-2.127625308(25)		1.2×10^{-8}
helion g-factor $2\mu_{\rm h}/\mu_{\rm N}$	$g_{ m h}$	-4.255250616(50)		1.2×10^{-8}
shielded helion magnetic moment	$\mu'_{ m h}$	$-1.074553080(14)\times10^{-26}$	$\rm J~T^{-1}$	1.3×10^{-8}
(gas, sphere, 25 $^{\circ}$ C)		,	v –	
to Bohr magneton ratio	$\mu_{ m h}^\prime/\mu_{ m B}$	$-1.158671471(14) \times 10^{-3}$		1.2×10^{-8}
to nuclear magneton ratio	$\mu_{ m h}'/\mu_{ m N}$	-2.127497720(25)		1.2×10^{-8}
shielded helion to proton magnetic				•
moment ratio (gas, sphere, 25 $^{\circ}$ C) shielded helion to shielded proton magnetic	$\mu_{ m h}'/\mu_{ m p}$	-0.7617665603(92)		1.2×10^{-8}
moment ratio (gas/H ₂ O, spheres, 25 °C) shielded helion gyromagnetic ratio	$\mu_{ m h}'/\mu_{ m p}'$	-0.7617861313(33)		4.3×10^{-9}
$2 \mu'_{\rm h} /\hbar$ (gas, sphere, 25 °C)	$\gamma_{ m h}'$	$2.037894585(27)\times10^8$	$s^{-1} T^{-1}$	1.3×10^{-8}
$2 \mu_h /\hbar$ (See, spirote, 20 °C)	$\gamma_{\rm h}^{\prime h}/2\pi$	32.434 099 66(43)	$ m MHz~T^{-1}$	1.3×10^{-8}
		* *	WIIIZ I	1.9 × 10
alala a antiala arras	Alpha par	6.644 657 230(82) \times 10 ⁻²⁷	1	1.0 10=8
alpha particle mass	$m_{oldsymbol{lpha}}$		kg	1.2×10^{-8}
	9	4.001 506 179 127(63)	u	1.6×10^{-11}
energy equivalent	$m_{\mathbf{\alpha}}c^2$	$5.971920097(73) \times 10^{-10}$	J	1.2×10^{-8}
		3727.379 378(23)	MeV	6.2×10^{-9}
alpha particle to electron mass ratio	$m_{f lpha}/m_{ m e}$	7294.29954136(24)		3.3×10^{-11}
alpha particle to proton mass ratio	$m_{f lpha}/m_{ m p}$	3.972 599 689 07(36)		9.2×10^{-11}
alpha particle molar mass $N_{\rm A} m_{\alpha}$	$M(\alpha), M_{\alpha}$	$4.001506179127(63)\times10^{-3}$	$kg \text{ mol}^{-1}$	1.6×10^{-11}
	PHYSICOCI	HEMICAL		
Avogadro constant	$N_{ m A}, L$	$6.022140857(74)\times10^{23}$	mol^{-1}	1.2×10^{-8}
atomic mass constant	,	,		
$m_{\rm u} = \frac{1}{12} m(^{12}{\rm C}) = 1 \text{ u}$	$m_{ m u}$	$1.660539040(20)\times10^{-27}$	kg	1.2×10^{-8}
energy equivalent	$m_{ m u}c^2$	$1.492418062(18) \times 10^{-10}$	J	1.2×10^{-8}
		931.494 0954(57)	MeV	6.2×10^{-9}
Faraday constant ⁶ $N_{\rm A}e$	F	96 485.332 89(59)	$C \text{ mol}^{-1}$	6.2×10^{-9}
molar Planck constant	$N_{ m A}h$	$3.9903127110(18) \times 10^{-10}$	$J \text{ s mol}^{-1}$	4.5×10^{-10}
	$N_{ m A}hc$	0.119 626 565 582(54)	$J \text{ m mol}^{-1}$	4.5×10^{-10}
molar gas constant	R	8.314 4598(48)	$J \text{ mol}^{-1} \text{ K}^{-1}$	
Boltzmann constant $R/N_{\rm A}$	$\stackrel{1}{k}$	$1.38064852(79) \times 10^{-23}$	$ m J~K^{-1}$	5.7×10^{-7}
Dolezmann constant 1t/1vA	N	$8.6173303(50) \times 10^{-5}$	$eV K^{-1}$	5.7×10^{-7}
	k/h	$2.0836612(12) \times 10^{10}$	$\mathrm{Hz}\ \mathrm{K}^{-1}$	5.7×10^{-7}
	- 1		${\rm m}^{-1}~{\rm K}^{-1}$. 7
molar volume of ideal mas PT/n	k/hc	69.503 457(40)	ш к	5.7×10^{-7}
molar volume of ideal gas RT/p	T/	$99.710.047(12) \times 10^{-3}$	$\mathrm{m}^3 \ \mathrm{mol}^{-1}$	F 7 × 10-7
T = 273.15 K, p = 100 kPa	$V_{ m m}$	$22.710947(13) \times 10^{-3}$	m^{-3}	5.7×10^{-7}
Loschmidt constant $N_{\rm A}/V_{\rm m}$	n_0	$2.6516467(15)\times10^{25}$	m °	5.7×10^{-7}
molar volume of ideal gas RT/p	17	00.419.060(12) 10=3	$\mathrm{m}^3 \ \mathrm{mol}^{-1}$	F 7 10-7
T = 273.15 K, p = 101.325 kPa	$V_{ m m}$	$22.413962(13) \times 10^{-3}$		5.7×10^{-7}
Loschmidt constant $N_{\rm A}/V_{\rm m}$	n_0	$2.6867811(15)\times10^{25}$	m^{-3}	5.7×10^{-7}
Sackur-Tetrode (absolute entropy) constant ⁷				
$\frac{5}{2} + \ln[(2\pi m_{\rm u}kT_1/h^2)^{3/2}kT_1/p_0]$	a 15	1 171 700 1/3 ()		1.0 1.0=6
$T_1 = 1 \text{ K}, p_0 = 100 \text{ kPa}$	S_0/R	-1.1517084(14)		1.2×10^{-6}
$T_1 = 1 \text{ K}, p_0 = 101.325 \text{ kPa}$		-1.1648714(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) $[1.2 \times 10^{-8}]$ 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 $K_{\rm J-90}$ and $R_{\rm K-90}$ given in Table IV.

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

TABLE II: (Continued).

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. $u_{\rm r}$
$(\pi^2/60)k^4/\hbar^3c^2$	σ	$5.670367(13)\times10^{-8}$	${ m W} { m m}^{-2} { m K}^{-4}$	
first radiation constant $2\pi hc^2$	c_1	$3.741771790(46) \times 10^{-16}$	$W m^2$	1.2×10^{-8}
first radiation constant for spectral radiance 2	$c^2 c_{1L}$	$1.191042953(15) \times 10^{-16}$	$\mathrm{W}~\mathrm{m}^2~\mathrm{sr}^{-1}$	1.2×10^{-8}
second radiation constant hc/k	c_2	$1.43877736(83)\times 10^{-2}$	m K	5.7×10^{-7}
Wien displacement law constants				
$b = \lambda_{\text{max}} T = c_2 / 4.965 114 231$	b	$2.8977729(17) \times 10^{-3}$	m K	5.7×10^{-7}
$b' = \nu_{\text{max}}/T = 2.821439372c/c_2$	b'	$5.8789238(34)\times10^{10}$	$\mathrm{Hz}\;\mathrm{K}^{-1}$	5.7×10^{-7}

References

Olive, K. A., $\ et\ al.,$ and Particle Data Center, 2014, Chin. Phys. C ${\bf 38},\,090001.$

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	$m_{ m e}$	$N_{ m A}$	$m_{ m e}/m_{\mu}$	\overline{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
$m_{ m e}$	-0.0193	0.9993	0.9985	1.5097	-1.5097	0.0011	-0.7556
$N_{ m A}$	0.0193	-0.9993	-0.9985	-1.0000	1.5097	-0.0011	0.7557
$m_{ m e}/m_{\mu}$	-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

The relative covariance is $u_{\rm r}(x_i,x_j)=u(x_i,x_j)/(x_ix_j)$, where $u(x_i,x_j)$ is the covariance of x_i and x_j ; the relative variance is $u_{\rm r}^2(x_i)=u_{\rm r}(x_i,x_i)$: 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. $u_{\rm r}$
relative atomic mass ¹ of ¹² C molar mass constant molar mass of ¹² C conventional value of Josephson constant ² conventional value of von Klitzing constant ³ standard-state pressure standard atmosphere	$A_{\rm r}(^{12}{ m C})$ $M_{ m u}$ $M(^{12}{ m C})$ $K_{ m J-90}$ $R_{ m K-90}$	$ 12 1 \times 10^{-3} 12 \times 10^{-3} 483 597.9 25 812.807 100 101.325$	$kg \ mol^{-1}$ $kg \ mol^{-1}$ $GHz \ V^{-1}$ Ω kPa kPa	exact exact exact exact exact exact exact

The relative atomic mass $A_{\rm r}(X)$ of particle X with mass m(X) is defined by $A_{\rm r}(X) = m(X)/m_{\rm u}$, where $m_{\rm u} = m(^{12}{\rm C})/12 = M_{\rm u}/N_{\rm A} = 1$ u is the atomic mass constant, $M_{\rm u}$ is the molar mass constant, $N_{\rm A}$ is the Avogadro constant, and u is the unified atomic mass unit. Thus the mass of particle X is $m(X) = A_{\rm r}(X)$ u and the molar mass of X is $M(X) = A_{\rm r}(X)M_{\rm u}$.

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. $u_{\rm r}$
Cu x unit: $\lambda(\text{CuK}\alpha_1)/1537.400$ Mo x unit: $\lambda(\text{MoK}\alpha_1)/707.831$ ångstrom star: $\lambda(\text{WK}\alpha_1)/0.2090100$ lattice parameter ¹ of Si (in vacuum, 22.5 °C) {220} lattice spacing of Si $a/\sqrt{8}$ (in vacuum, 22.5 °C) molar volume of Si $M(\text{Si})/\rho(\text{Si}) = N_{\text{A}}a^3/8$ (in vacuum, 22.5 °C)		$\begin{array}{c} 1.00207697(28)\times10^{-13}\\ 1.00209952(53)\times10^{-13}\\ 1.00001495(90)\times10^{-10}\\ 543.1020504(89)\times10^{-12}\\ 192.0155714(32)\times10^{-12}\\ 12.05883214(61)\times10^{-6} \end{array}$	m m m	2.8×10^{-7} 5.3×10^{-7} 9.0×10^{-7} 1.6×10^{-8} 1.6×10^{-8} 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.

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.

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

Quantity	Symbol	Numerical value	Unit	Relative std.
Quantity	- V		Omt	uncert. $u_{\rm r}$
		ecepted for use with the SI		0
electron volt: (e/C) J	eV	$1.6021766208(98)\times10^{-19}$	J	6.1×10^{-9}
(unified) atomic mass unit: $\frac{1}{12}m(^{12}C)$	u	$1.660539040(20)\times10^{-27}$	kg	1.2×10^{-8}
	Nati	ural units (n.u.)		
n.u. of velocity	c, c_0	299 792 458	${\rm m~s^{-1}}$	exact
n.u. of action: $h/2\pi$	\hbar	$1.054571800(13)\times10^{-34}$	J s	1.2×10^{-8}
n.u. of action. 11/210	16	$6.582119514(40)\times10^{-16}$	eV s	6.1×10^{-9}
	$\hbar c$	$197.326\ 9788(12)$	MeV fm	6.1×10^{-9}
n.u. of mass	$m_{ m e}$	$9.10938356(11) \times 10^{-31}$	kg	1.2×10^{-8}
n.u. of energy	$m_{ m e}c^2$	$8.18710565(10)\times10^{-14}$	J	1.2×10^{-8} 1.2×10^{-8}
ii.u. or energy	mec	0.5109989461(31)	${ m MeV}$	6.2×10^{-9}
n.u. of momentum	$m_{ m e}c$	$2.730924488(34)\times10^{-22}$	$kg m s^{-1}$	1.2×10^{-8}
ii.u. or momentum	mec	0.5109989461(31)	MeV/c	6.2×10^{-9}
n.u. of length: $\hbar/m_{\rm e}c$	$\lambda_{ m C}$	$386.159\ 267\ 64(18) \times 10^{-15}$	m	4.5×10^{-10}
n.u. of time	$\hbar/m_{ m e}c^2$	$1.28808866712(58)\times10^{-21}$	S S	4.5×10^{-10} 4.5×10^{-10}
n.u. of time	n/mec	1.200 000 007 12(00) × 10	5	4.0 × 10
	Ator	mic units (a.u.)		
a.u. of charge	e	$1.6021766208(98)\times10^{-19}$	С	6.1×10^{-9}
a.u. of mass	$m_{ m e}$	$9.10938356(11)\times10^{-31}$	kg	1.2×10^{-8}
a.u. of action: $h/2\pi$	\hbar	$1.054571800(13)\times10^{-34}$	Js	1.2×10^{-8}
a.u. of length: Bohr radius (bohr)				
$lpha/4\pi R_{\infty}$	a_0	$0.52917721067(12)\times10^{-10}$	m	2.3×10^{-10}
a.u. of energy: Hartree energy (hartree)				
$e^2/4\pi\epsilon_0 a_0 = 2R_\infty hc = \alpha^2 m_e c^2$	$E_{ m h}$	$4.359744650(54) \times 10^{-18}$	J	1.2×10^{-8}
a.u. of time	$\hbar/E_{ m h}$	$2.418884326509(14)\times10^{-17}$	\mathbf{s}	5.9×10^{-12}
a.u. of force	$E_{ m h}/a_0$	$8.23872336(10) \times 10^{-8}$	N	1.2×10^{-8}
a.u. of velocity: αc	$a_0 E_{ m h}/\hbar$	$2.18769126277(50) \times 10^{6}$	$\mathrm{m}~\mathrm{s}^{-1}$	2.3×10^{-10}
a.u. of momentum	\hbar/a_0	$1.992851882(24) \times 10^{-24}$	${\rm kg~m~s^{-1}}$	1.2×10^{-8}
a.u. of current	$eE_{ m h}/\hbar$	$6.623618183(41) \times 10^{-3}$	A	6.1×10^{-9}
a.u. of charge density	e/a_{0}^{3}	$1.081\ 202\ 3770(67) \times 10^{12}$	${ m C~m^{-3}}$	6.2×10^{-9}
a.u. of electric potential	$E_{ m h}/e$	27.211 386 02(17)	V	6.1×10^{-9}
a.u. of electric field	$E_{ m h}/ea_0$	$5.142206707(32)\times10^{11}$	${ m V~m^{-1}}$	6.1×10^{-9}
a.u. of electric field gradient	$E_{ m h}/ea_0^2$	$9.717362356(60) \times 10^{21}$	${ m V~m^{-2}}$	6.2×10^{-9}
a.u. of electric dipole moment	$egin{array}{c} ea_0 \ ea_0^2 \end{array}$	$8.478353552(52) \times 10^{-30}$	Ст	6.2×10^{-9}
a.u. of electric quadrupole moment	ea_0^2	$4.486551484(28)\times10^{-40}$	$C m^2$	6.2×10^{-9}
a.u. of electric polarizability	$e^2 a_0^2 / E_{\rm h}$ $e^3 a_0^3 / E_{\rm h}^2$	$1.6487772731(11) \times 10^{-41}$	$C^2 m^2 J^{-1}$	6.8×10^{-10}
a.u. of 1 st hyperpolarizability	$e^{3}a_{0}^{3}/E_{ m h}^{2}$	$3.206361329(20)\times10^{-53}$	$C^3 \text{ m}^3 \text{ J}^{-2}$	6.2×10^{-9}
a.u. of 2 nd hyperpolarizability	$e^4 a_0^4 / E_{\rm h}^3$	$6.235380085(77)\times10^{-65}$	$\mathrm{C^4~m^4~J^{-3}}$	1.2×10^{-8}
a.u. of magnetic flux density	\hbar/ea_0^2	$2.350517550(14)\times10^{5}$	T	6.2×10^{-9}
a.u. of magnetic dipole moment: $2\mu_{\rm B}$	$\hbar e/m_{ m e}$	$1.854801999(11)\times10^{-23}$	$ m J~T^{-1}$	6.2×10^{-9}
a.u. of magnetizability	$e^2a_0^2/m_{ m e}$	$7.8910365886(90) \times 10^{-29}$	$\rm J~T^{-2}$	1.1×10^{-9}
a.u. of permittivity: $10^7/c^2$	$e^2/a_0E_{ m h}$	$1.112650056\times10^{-10}$	$\mathrm{F}~\mathrm{m}^{-1}$	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 = $m_{\rm u} = \frac{1}{12}m(^{12}C) = 10^{-3}$ kg mol⁻¹/ $N_{\rm A}$, and $E_{\rm h} = 2R_{\infty}hc = \alpha^2 m_{\rm e}c^2$ is the Hartree energy (hartree).

	Relevant unit					
	J	kg	m^{-1}	$_{ m Hz}$		
1 J	(1 J) = 1 J	$(1 \text{ J})/c^2 = 1.112650056 \times 10^{-17} \text{ kg}$	(1 J)/hc = 5.034 116 651(62) × 10 ²⁴ m ⁻¹	$(1 \text{ J})/h = 1.509 190 205(19) \times 10^{33} \text{ Hz}$		
1 kg	$(1 \text{ kg})c^2 = 8.987551787 \times 10^{16} \text{ J}$	(1 kg) = 1 kg	$(1 \text{ kg})c/h = 4.524438411(56) \times 10^{41} \text{ m}^{-1}$	$(1 \text{ kg})c^2/h = 1.356392512(17) \times 10^{50} \text{ Hz}$		
1 m^{-1}	$(1 \text{ m}^{-1})hc = 1.986445824(24) \times 10^{-25} \text{ J}$	$(1 \text{ m}^{-1})h/c =$ 2.210 219 057(27) × 10 ⁻⁴² kg	$(1 \text{ m}^{-1}) = 1 \text{ m}^{-1}$	$(1 \text{ m}^{-1})c = 299792458 \text{ Hz}$		
1 Hz	$(1 \text{ Hz})h = 6.626070040(81) \times 10^{-34} \text{ J}$	$(1 \text{ Hz})h/c^2 = 7.372497201(91) \times 10^{-51} \text{ kg}$	$(1 \text{ Hz})/c =$ 3.335 640 951 $\times 10^{-9} \text{ m}^{-1}$	(1 Hz) = 1 Hz		
1 K	$(1 \text{ K})k = 1.38064852(79) \times 10^{-23} \text{ J}$	$(1 \text{ K})k/c^2 = 1.53617865(88) \times 10^{-40} \text{ kg}$	$(1 \text{ K})k/hc = 69.503457(40) \text{ m}^{-1}$	$(1 \text{ K})k/h = 2.0836612(12) \times 10^{10} \text{ Hz}$		
1 eV	$(1 \text{ eV}) = 1.6021766208(98) \times 10^{-19} \text{ J}$	$(1 \text{ eV})/c^2 = 1.782661907(11) \times 10^{-36} \text{ kg}$	$(1 \text{ eV})/hc = 8.065544005(50) \times 10^5 \text{ m}^{-1}$	$(1 \text{ eV})/h = 2.417989262(15) \times 10^{14} \text{ Hz}$		
1 u	$(1 \text{ u})c^2 = 1.492418062(18) \times 10^{-10} \text{ J}$	$(1 \text{ u}) = 1.660539040(20) \times 10^{-27} \text{ kg}$	$(1 \text{ u})c/h = 7.5130066166(34) \times 10^{14} \text{ m}^{-1}$	$(1 \text{ u})c^2/h = 2.2523427206(10) \times 10^{23} \text{ Hz}$		
$1~E_{ m h}$	$(1 E_{\rm h}) = 4.359744650(54) \times 10^{-18} \text{ J}$	$(1 E_{\rm h})/c^2 = 4.850870129(60) \times 10^{-35} \text{ kg}$	$(1 E_{\rm h})/hc = 2.194746313702(13) \times 10^7 {\rm m}^{-1}$	$(1 E_{\rm h})/h = 6.579 683 920 711(39) \times 10^{15} \text{ Hz}$		

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 = $m_{\rm u} = \frac{1}{12}m(^{12}C) = 10^{-3}$ kg mol⁻¹/ $N_{\rm A}$, and $E_{\rm h} = 2R_{\infty}hc = \alpha^2 m_{\rm e}c^2$ is the Hartree energy (hartree).

Relevant unit				
	K	eV	u	$E_{ m h}$
1 J	$(1 \text{ J})/k = 7.2429731(42) \times 10^{22} \text{ K}$	$(1 \text{ J}) = 6.241509126(38) \times 10^{18} \text{ eV}$	$(1 \text{ J})/c^2 =$ $6.700535363(82) \times 10^9 \text{ u}$	$(1 \text{ J}) = 2.293712317(28) \times 10^{17} E_{\text{h}}$
1 kg	$(1 \text{ kg})c^2/k = 6.5096595(37) \times 10^{39} \text{ K}$	$(1 \text{ kg})c^2 = 5.609588650(34) \times 10^{35} \text{ eV}$	$(1 \text{ kg}) = 6.022140857(74) \times 10^{26} \text{ u}$	$(1 \text{ kg})c^2 = 2.061 485 823(25) \times 10^{34} E_h$
$1~\mathrm{m}^{-1}$	$(1 \text{ m}^{-1})hc/k = 1.43877736(83) \times 10^{-2} \text{ K}$	$(1 \text{ m}^{-1})hc = 1.2398419739(76) \times 10^{-6} \text{ eV}$	$(1 \text{ m}^{-1})h/c = 1.33102504900(61) \times 10^{-15} \text{ u}$	$(1 \text{ m}^{-1})hc = 4.556335252767(27) \times 10^{-8} E_{\text{h}}$
1 Hz	$(1 \text{ Hz})h/k = 4.7992447(28) \times 10^{-11} \text{ K}$	$(1 \text{ Hz})h = 4.135667662(25) \times 10^{-15} \text{ eV}$	$(1 \text{ Hz})h/c^2 = 4.4398216616(20) \times 10^{-24} \text{ u}$	$(1 \text{ Hz})h = 1.5198298460088(90) \times 10^{-16} E_{\text{h}}$
1 K	(1 K) = 1 K	$(1 \text{ K})k = 8.6173303(50) \times 10^{-5} \text{ eV}$	$(1 \text{ K})k/c^2 =$ $9.2510842(53) \times 10^{-14} \text{ u}$	$(1 \text{ K})k = 3.1668105(18) \times 10^{-6} E_{\text{h}}$
1 eV	$(1 \text{ eV})/k = 1.16045221(67) \times 10^4 \text{ K}$	(1 eV) = 1 eV	$(1 \text{ eV})/c^2 = 1.0735441105(66) \times 10^{-9} \text{ u}$	$(1 \text{ eV}) = 3.674932248(23) \times 10^{-2} E_{\text{h}}$
1 u	$(1 \text{ u})c^2/k = 1.08095438(62) \times 10^{13} \text{ K}$	$(1 \text{ u})c^2 =$ $931.4940954(57) \times 10^6 \text{ eV}$	(1 u) = 1 u	$(1 \text{ u})c^2 = 3.4231776902(16) \times 10^7 E_h$
$1~E_{ m h}$	$(1 E_{\rm h})/k =$ 3.1577513(18) × 10 ⁵ K	$(1 E_{\rm h}) = 27.21138602(17) \text{ eV}$	$(1 E_{\rm h})/c^2 =$ 2.921 262 3197(13) × 10 ⁻⁸ u	$(1 E_{ m h}) = 1 E_{ m h}$