

U. S. DEPARTMENT OF COMMERCE National Bureau of Standards

FUNDAMENTAL PHYSICAL CONSTANTS

These constants were compiled by E. R. Cohen and B. N. Taylor under the auspices of the CODATA Task Group on Fundamental Constants, officially adopted by CODATA, and published in J. Phys. Chem. Ref. Data, Vol. 2, No. 4 p. 663 (1973), CODATA Bulletin No. 11 (Dec. 1973), and DIMENSIONS/NBS (Jan. 1974).

Quantity	Symbol	Num. value	Uncert.*	Units (SI)
Speed of light in vacuum	c	299792458	1.2	$\text{m}\cdot\text{s}^{-1}$
Permeability of vacuum	μ_0	12.5663706144		$10^{-7} \text{H}\cdot\text{m}^{-1}$
Permittivity of vacuum, $1/\mu_0 c^2$	ϵ_0	8.854187818	71	$10^{-12} \text{F}\cdot\text{m}^{-1}$
Fine-structure constant	α	7.2973506	60	10^{-3}
$[\mu_0 c^2 / 4\pi] (e^2 / hc)$	α^{-1}	137.03604	11	
Elementary charge	e	1.6021892	46	10^{-19}C
Planck constant	h	6.626176	36	$10^{-34} \text{J}\cdot\text{s}$
$h/2\pi$	\hbar	1.0545887	57	$10^{-34} \text{J}\cdot\text{s}$
Avogadro constant	N_A	6.022045	31	10^{23}mol^{-1}
Atomic mass unit**	u	1.6605655	86	10^{-27}kg
Electron rest mass	m_e	9.109534	47	10^{-31}kg
Proton rest mass	m_p	1.6726485	86	10^{-27}kg
Proton to electron mass ratio	m_p/m_e	1836.15152	70	
Neutron rest mass	m_n	1.6749543	86	10^{-27}kg
Elementary charge to mass ratio	e/m_e	1.7588047	49	$10^{11} \text{C}\cdot\text{kg}^{-1}$
Magnetic flux quantum, $h/2e$	Φ_0	2.0678506	54	10^{-15}Wb
Josephson freq.-voltage ratio	$2e/h$	4.835989	13	$10^{14} \text{Hz}\cdot\text{V}^{-1}$
Quantum of circulation	$h/2m_e$	3.6369455	60	$10^{-4} \text{J}\cdot\text{s}\cdot\text{kg}^{-1}$
Faraday constant, $N_A e$	F	9.648456	27	$10^4 \text{C}\cdot\text{mol}^{-1}$
Rydberg constant, $\alpha^2/2\lambda_C$	R_∞	1.097373177	83	10^7m^{-1}
Bohr radius, $a_0/4\pi R_\infty$	a_0	5.2917706	44	10^{-11}m
Classical electron radius, $\alpha\lambda_C$	r_e	2.8179380	70	10^{-15}m
Thomson cross section	σ_e	0.6652448	33	10^{-28}m^2
Free electron g-factor, μ_e/μ_B	$g_e/2$	1.0011596567	35	
Free muon g-factor	$g_\mu/2$	1.00116616	31	
Bohr magneton, $eh/2m_e$	μ_B	9.274078	36	$10^{-24} \text{J}\cdot\text{T}^{-1}$
Electron magnetic moment	μ_e	9.284832	36	$10^{-24} \text{J}\cdot\text{T}^{-1}$
Proton gyromagnetic ratio, H_2O	γ_p^0	2.6751301	75	$10^6 \text{s}^{-1}\cdot\text{T}^{-1}$
corrected for diamagnetism	γ_p	2.6751987	75	$10^6 \text{s}^{-1}\cdot\text{T}^{-1}$
Proton magnetic moment	μ_p	1.4106171	55	$10^{-26} \text{J}\cdot\text{T}^{-1}$
in Bohr magnetons	μ_p/μ_B	1.521032209	16	10^{-1}
in nuclear magnetons	μ_p/μ_N	2.7928456	11	
in H_2O in Bohr magnetons	μ_p^0/μ_B	1.52099322	10	10^{-1}
in H_2O in nuclear magnetons	μ_p^0/μ_N	2.7927740	11	
Electron-proton mag. mom. ratio	μ_e/μ_p	658.2106880	66	
Nuclear magneton, $eh/2m_p$	μ_N	5.050824	20	$10^{-27} \text{J}\cdot\text{T}^{-1}$
Compton wavelength:				
electron, $h/m_e c = \alpha^2/2R_\infty$	λ_C	2.4263089	40	10^{-12}m
proton, $h/m_p c$	$\lambda_{C,p}$	1.3214099	22	10^{-15}m
neutron, $h/m_n c$	$\lambda_{C,n}$	1.3195909	22	10^{-15}m
Muon-proton mag. mom. ratio	μ_μ/μ_p	3.1833402	72	

Quantity	Symbol	Num. value	Uncert.*	Units (SI)
Muon magnetic moment	μ_μ	4.490474	18	$10^{-26} \text{ J}\cdot\text{T}^{-1}$
Muon to electron mass ratio	m_μ/m_e	206.76865	47	
Muon rest mass	m_μ	1.883566	11	10^{-28} kg
Molar volume, ideal gas, s.t.p.	V_m	22.41383	70	$10^{-3} \text{ m}^3\cdot\text{mol}^{-1}$
Molar gas constant	R	8.31441	26	$\text{J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
Boltzmann constant, R/N_A	k	1.380662	44	$10^{-23} \text{ J}\cdot\text{K}^{-1}$
Stefan-Boltzmann constant	σ	5.67032	71	$10^{-8} \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-4}$
First radiation constant, $2\pi hc^2$	c_1	3.741832	20	$10^{-16} \text{ W}\cdot\text{m}^2$
Second radiation constant, hc/k	c_2	1.438786	45	$10^{-2} \text{ m}\cdot\text{K}$
Gravitational constant	G	6.6720	41	$10^{-11} \text{ m}^3\cdot\text{s}^{-2}\cdot\text{kg}^{-1}$
Ratio, kx-unit to angstrom, $\lambda(\text{CuK}\alpha_1)=1.537400 \text{ kxu}$	A	1.0020772	54	

ENERGY CONVERSION FACTORS AND EQUIVALENTS

Quantity	Num. value	Uncertainty*	Units
1 kilogram (kgc^2)	5.609545	16	10^{28} MeV
1 Atomic mass unit (uc^2)	931.5016	26	MeV
1 Electron mass ($m_e c^2$)	0.5110034	14	MeV
1 Muon mass ($m_\mu c^2$)	105.65948	35	MeV
1 Proton mass ($m_p c^2$)	938.2796	27	MeV
1 Neutron mass ($m_n c^2$)	939.5731	27	MeV

1 electron volt	1.6021892	46	10^{-19} J
1 eV/h	2.4179696	63	10^{14} Hz
1 eV/hc	8.065479	21	10^8 m^{-1}
1 eV/k	1.160450	36	10^8 K
Voltage-wavelength conv., hc	1.2398520	32	$10^{-6} \text{ eV}\cdot\text{m}$
Rydberg constant $R_\infty hc$	2.179907	12	10^{-18} J
	13.605804	36	eV
$R_\infty c$	3.28984200	25	10^{15} Hz
$R_\infty hc/k$	1.578885	49	10^8 K
Bohr magneton μ_B	5.7883785	95	$10^{-8} \text{ eV}\cdot\text{T}^{-1}$
μ_B/h	1.3996123	39	$10^{10} \text{ Hz}\cdot\text{T}^{-1}$
μ_B/hc	46.58604	13	$\text{m}^{-1}\cdot\text{T}^{-1}$
μ_B/k	0.671712	21	$\text{K}\cdot\text{T}^{-1}$
Nuclear magneton μ_N	3.1524515	53	$10^{-8} \text{ eV}\cdot\text{T}^{-1}$
μ_N/h	7.622532	22	$10^8 \text{ Hz}\cdot\text{T}^{-1}$
μ_N/hc	2.5426030	72	$10^{-2} \text{ m}^{-1}\cdot\text{T}^{-1}$
μ_N/k	3.65826	12	$10^{-4} \text{ K}\cdot\text{T}^{-1}$

*Uncertainty (1 std. dev.) applies to last digits of preceding column; μ_0 is exactly $4\pi \times 10^{-7} \text{ H}\cdot\text{m}^{-1}$. For some entries, energies are given in non-SI units. For values in SI units, see revised reprint of the January 1974 DIMENSIONS/NBS article.
** $10^{-3} \text{ kg}\cdot\text{mol}^{-1}\cdot N_A^{-1}$

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