

*X-Ray Data Booklet Table 5-1. Physical constants.*

Quantity	Symbol, equation	Value	Uncert. (ppb)
speed of light	$c$ (see note *)	$2.997\,924\,58 \times 10^8 \text{ m s}^{-1}$ ( $10^{10} \text{ cm s}^{-1}$ )	exact
Planck constant	$h$	$6.626\,068\,76(52) \times 10^{-34} \text{ J s}$ ( $10^{-27} \text{ erg s}$ )	78
Planck constant, reduced	$\hbar = h/2\pi$	$1.054\,571\,596(82) \times 10^{-34} \text{ J s} = 6.582\,118\,89(26) \times 10^{-22} \text{ MeV s}$	78, 39
electron charge magnitude	$e$	$4.803\,204\,20(19) \times 10^{-10} \text{ esu} = 1.602\,176\,462(63) \times 10^{-19} \text{ C}$	39, 59
conversion constant	$\hbar c$	$197.326\,960\,1(78) \text{ MeV fm}$ (= eV nm)	39
electron mass	$m_e$	$0.510\,998\,902(21) \text{ MeV}/c^2 = 9.109\,381\,88(72) \times 10^{-31} \text{ kg}$	40, 79
proton mass	$m_p$	$938.271\,998(38) \text{ MeV}/c^2 = 1.672\,621\,58(13) \times 10^{-27} \text{ kg}$ $= 1.007\,276\,466\,88(13) \text{ u} = 1836.152\,667\,5(39) m_e$	40, 79 0.13, 2.1
deuteron mass	$m_d$	$1875.612\,762(75) \text{ MeV}/c^2$	40
unified atomic mass unit (u)	(mass $^{12}\text{C}$ atom)/12 = (1 g)/( $N_A$ mol)	$931.494\,013(37) \text{ MeV}/c^2 = 1.660\,538\,73(13) \times 10^{-27} \text{ kg}$	40, 79
permittivity of free space	$\epsilon_0 = 1/(\mu_0 c^2)$	$8.854\,187\,817\dots \times 10^{-12} \text{ F m}^{-1}$	exact
permeability of free space	$\mu_0$	$4\pi \times 10^{-7} \text{ N A}^{-2} = 12.566\,370\,614\dots \times 10^{-7} \text{ N A}^{-2}$	exact
fine-structure constant	$\alpha = e^2/4\pi\epsilon_0\hbar c$	$1/137.035\,999\,76(50)$	3.7
classical electron radius	$r_e = e^2/4\pi\epsilon_0 m_e c^2$	$2.817\,940\,285(31) \times 10^{-15} \text{ m}$	11
Bohr radius ( $m_{\text{nucleus}} = \infty$ )	$a_0 = 4\pi\epsilon_0\hbar^2/m_e e^2 = r_e \alpha^{-2}$	$0.529\,177\,208\,3(19) \times 10^{-10} \text{ m}$ ( $10^{-8} \text{ cm}$ )	3.7
Rydberg energy	$hcR_{\infty} = m_e e^4/2(4\pi\epsilon_0)^2 \hbar^2$ $= m_e c^2 \alpha^2/2$	$13.605\,691\,72(53) \text{ eV}$	39
Thomson cross section	$\sigma_T = 8\pi r_e^2/3$	$0.665\,245\,854(15) \text{ barn}$ ( $10^{-28} \text{ m}^2$ )	22
Bohr magneton	$\mu_B = e\hbar/2m_e$	$5.788\,381\,749(43) \times 10^{-11} \text{ MeV T}^{-1}$	7.3
nuclear magneton	$\mu_N = e\hbar/2m_p$	$3.152\,451\,238(24) \times 10^{-14} \text{ MeV T}^{-1}$	7.6
electron cyclotron freq./field	$\omega_{\text{cycl}}^e/B = e/m_e$	$1.758\,820\,174(71) \times 10^{11} \text{ rad s}^{-1} \text{ T}^{-1}$	40
proton cyclotron freq./field	$\omega_{\text{cycl}}^p/B = e/m_p$	$9.578\,834\,08(38) \times 10^7 \text{ rad s}^{-1} \text{ T}^{-1}$	40

*Table 5-1. Physical constants(continued).*

Quantity	Symbol, equation	Value	Uncert. (ppb)
Avogadro constant	$N_A$	$6.022\,141\,99(47)\times 10^{23}\text{ mol}^{-1}$	79
Boltzman constant	$k$	$1.380\,650\,3(24)\times 10^{-23}\text{ J K}^{-1} = 8.617\,342(15)\times 10^{-5}\text{ eV K}^{-1}$	1700
molar volume, ideal gas at STP	$N_A k (273.15\text{ K})/(101\,325\text{ Pa})$	$22.413\,996(39)\times 10^{-3}\text{ m}^3\text{ mol}^{-1}$	1700
$p = 3.141\,592\,653\,589\,793\,238$		$e = 2.718\,281\,828\,459\,045\,235$	$g = 0.577\,215\,664\,901\,532\,861$
The meter is the length of the path traveled by light in vacuum during a time interval of 1/299 792 458 of a second.			
1 in. = 2.54 cm	1 newton = $10^5$ dyne	$1\text{ eV}/c^2 = 1.782\,662\times 10^{-33}\text{ g}$	1 coulomb = $2.997\,924\,58\times 10^9\text{ esu}$
1 Å = $10^{-8}$ cm	1 joule = $10^7$ erg	$hc/(1\text{ eV}) = 1.239\,842\text{ }\mu\text{m}$	1 tesla = $10^4$ gauss
1 fm = $10^{-13}$ cm	1 cal = 4.184 joule	$1\text{ eV}/h = 2.417\,989\times 10^{14}\text{ Hz}$	1 atm = $1.013\,25\times 10^6\text{ dyne/cm}^2$
1 barn = $10^{-24}\text{ cm}^2$	1 eV = $1.602\,176\,5\times 10^{-12}\text{ erg}$	$1\text{ eV}/k = 11\,604.5\text{ K}$	0°C = 273.15 K