3.3 Defining constants and base units

The defining constant of wavelength(R_∞) and the base unit of length	($m_u = 10^6_{(12)}\Omega_1/R_\infty$ $= 27.21028842$cm $= 38999.753$km$/(4 \times 12^7_{(10)})$)
The defining constant of speed(c_0) and the base unit of time	($s_u = 10^8_{(12)} m_u/c_0 = 390.2675219$ms)
The defining constant of action($\hbar$) and the base unit of energy	($J_u = 10^{26}_{(12)}\hbar/s_u = 64.1433465$mJ)
The defining constant of entropy(k_B) and the base unit of temperature	($K_u = 10^{-18}_{(12)} J_u/k_B = 1.211831$K)

Derived units that have no characteristic symbol (examples)

area	(m_u^2	=	740.39980cm^2		)
volume	(m_u^3	=	20.146492dm^3		)
speed	(m_u/s_u	=	0.697221442m/s	= 2.50999719km/h	)
frequency	(Ω_1/s_u	=	2.562344915Hz	= 30.748139Hz/12	)
molar concentration	mol_u/m_u^3	=	6.552393mol/dm^3		)

The dimensions of the base units were selected by the process that is described at the beginning of this section. Next, it is necessary to select the defining constants from among the fundamental physical constants. From the definition of the Universal Unit System, the use of 'the speed of light in a vacuum', 'the quantum of action', and 'the Boltzman constant' is already settled. Although one more fundamental physical constant is needed for the definition of the remaining four base units, which are not natural units, that constant is selected from among 'the Rydberg constant', 'the atomic mass unit', 'the Bohr radius', and 'half the value of the Planck length'.

While 'the atomic mass unit' is by all means a desirable defining constant for the field of chemistry, there are many unsettled requirements, such as which chemical element to base it on and whether to select a particular nuclear species or to use an average of elements. Because any value within a certain range can be selected, this constant is not suitable as a defining constant of the Universal System of Units Standard.

The constant 'half the value of the Planck length' has a relative error of close to 1% with respect to the other three candidates and also has the practical problem of insufficient measurement accuracy for the constant.

'The Rydberg constant' and 'the Bohr radius' do not involve the vagueness of 'the atomic mass unit'. In addition, because these constants are deeply involved with the electron, they have the advantage that the fundamental physical constants that are closely related to the electron (charge, mass, the classical electron radius, and the Bohr magneton) as well as the Josephson constant, K_J, (of the Josephson effect) which is used in the standard representation of voltage, and the von Klitzing constant R_K (of the quantum hole effect), which is used in the standard representation of electrical resistance, can all be represented accurately if the fine structure constant can be strictly determined.

Using 'the Rydberg constant' for a defining constant, puts the derived unit of mass in the range (about equal to the mean mass of nucleons in the aluminum nucleus) where it can be used as 'the atomic mass unit' without modification. That cannot be said for 'the Bohr radius'. Also, 'the Rydberg constant' is related to optical measurements and is the only of the fundamental physical constants that are not dimensionless quantities that has a reproducible accuracy of more than 10 decimal places, and so is the most practical for use as a defining constant. Therefore, 'the Rydberg constant' was finally selected as the fourth defining constant. The base units comprise the base units just defined and the following base