Appendix: The cm^{-1} unit

For the uninitiated, the spectroscopist's habit of using the unit cm^{-1} for both frequency and energy is often confusing. The cm^{-1} (pronounced as 'reciprocal centimeter') is formally the unit for the quantity $\bar{\nu}$, called *wave number* (i.e. the inverse of a wavelength). However, it is often used as a unit for frequency (i.e. the frequency of light in vacuum that corresponds to that wave number), for angular frequency, or for energy (i.e. the energy of a photon at that wave number). Table 8.2 provides the appropriate conversion formulas; Table 8.3 provides some fundamental constants in cm^{-1} units.

Table 8.2. Converting $\bar{\nu}$ expressed in cm^{-1} to other quantities. The symbolic conversion factors assume SI units.

Desired quantity	Conversion (numeric)	(symbolic)
Energy (J)	$1.9865 \times 10^{-23} \times \bar{\nu}$	$100hc\bar{\nu}$
Energy (eV)	$123.99 \times 10^{-6} \times \bar{\nu}$	$100hc\bar{\nu}/e$
Energy (J mol^{-1})	11.963	$100hcN_A$
Frequency ν (Hz)	$29.978 \times 10^{9} \times \bar{\nu}$	$100c\bar{\nu}$
Frequency ω (rad s^{-1})	$0.18836 \times 10^{12} \times \bar{\nu}$	$200\pi c\bar{\nu}$
Characteristic time $t = 1/\omega$ (s)	$5.3091 \times 10^{-12}/\bar{\nu}$	$1/200\pi c\bar{\nu}$
Wavelength (nm)	$10^{7}/\bar{\nu}$	$10^{7}/\bar{\nu}$
Wavelength (μm)	$10^{4}/\bar{\nu}$	$10^{4}/\bar{\nu}$

Table 8.3. Fundamental constants in spectroscopic units. The symbolic expressions assume SI units.

Fundamental constant		Value (numeric)	(symbolic)
Boltzmann's constant	k_B	0.69503 $cm^{-1}K^{-1}$	k_B / 100 hc
Planck's constant (in $h\nu$)	h	1	1
Planck's constant (in $\hbar\omega$)	$\hbar$	1	1