

Periodic table (atomic number, symbol, relative atomic mass)																				2			
1 H 1.01																			2 He 4.00				
3 Li 6.94	4 Be 9.01																	5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31																	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80						
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29						
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)						
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (269)	109 Mt (278)	110 Ds (281)	111 Rg (281)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (288)	116 Lv (293)	117 Ts (294)	118 Og (294)						
			58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97							
			90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)							

Equations

Speed, frequency and wavelength of light

$$c = f\lambda$$

Energy of a photon

$$E = hf$$

Amount from mass

$$n = \frac{m}{M}$$

Amount from concentration

$$n = CV$$

Ideal gas equation

$$PV = nRT$$

Combined gas law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Heat change

$$Q = mc\Delta T$$

Atom economy

$$\frac{\% \text{ atom economy} = \frac{\text{molar mass of desired product}}{\text{molar mass of all reactants}} \times 100}{\text{Enthalpy change from enthalpies of formation}}$$
$$\Delta H^\ominus = \sum (\Delta H_f^\ominus \text{ products}) - \sum (\Delta H_f^\ominus \text{ reactants})$$

Enthalpy change from enthalpies of combustion

$$\Delta H^\ominus = \sum (\Delta H_c^\ominus \text{ reactants}) - \sum (\Delta H_c^\ominus \text{ products})$$

Gibbs energy change

$$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$$

Gibbs energy and reaction quotient

$$\Delta G = \Delta G^\ominus + RT \ln Q$$

Gibbs energy and equilibrium constant

$$\Delta G^\ominus = -RT \ln K$$

Gibbs energy and cell potential

$$\Delta G^\ominus = -nFE^\ominus$$

Arrhenius equation

$$k = Ae^{\frac{-E_a}{RT}}$$

Arrhenius equation (logarithmic form)

$$\ln k = \frac{-E_a}{RT} + \ln A$$

pH

$$\text{pH} = -\log_{10}[\text{H}_3\text{O}^+] \text{ or } \text{pH} = -\log_{10}[\text{H}^+]$$

Ionic product of water

$$K_w = [\text{H}^+][\text{OH}^-]$$

pOH

$$\text{pOH} = -\log_{10}[\text{OH}^-]$$

Physical constants

Elementary charge

$$e = 1.602177 \times 10^{-19} \text{ C}$$

Electron rest mass

$$m_e = 9.109384 \times 10^{-31} \text{ kg}$$

Proton rest mass

$$m_p = 1.672622 \times 10^{-27} \text{ kg}$$

Neutron rest mass

$$m_n = 1.674927 \times 10^{-27} \text{ kg}$$

Speed of light in vacuum

$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$

Planck constant

$$h = 6.63 \times 10^{-34} \text{ J s}$$

Avogadro constant

$$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$$

Gas constant

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

Molar volume of an ideal gas at STP

$$V_m = 22.7 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1} = 22.7 \text{ dm}^3 \text{ mol}^{-1}$$

Specific heat capacity of water

$$c_w = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1} = 4.18 \text{ J g}^{-1} \text{ K}^{-1}$$

Ionic product constant for water at 298.15 K

$$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$$

Faraday constant

$$F = 9.65 \times 10^4 \text{ C mol}^{-1}$$

Conversions and standard conditions

Temperature (K) = temperature (°C) + 273.15

$$1 \text{ dm}^3 = 1 \text{ litre} = 1 \times 10^{-3} \text{ m}^3 = 1 \times 10^3 \text{ cm}^3$$

STP conditions

273.15 K and 100 kPa

SATP conditions

298.15 K and 100 kPa

Acid-base indicators

Standard reduction potentials at 298.15 K

Oxidized species	Reduced species	E° / V
Ca ²⁺ (aq) + 2e [−]	Ca(s)	−2.87
Na ⁺ (aq) + e [−]	Na(s)	−2.71
Mg ²⁺ (aq) + 2e [−]	Mg(s)	−2.37
Al ³⁺ (aq) + 3e [−]	Al(s)	−1.66
Mn ²⁺ (aq) + 2e [−]	Mn(s)	−1.18
H ₂ O(l) + e [−]	½H ₂ (g) + OH [−] (aq)	−0.83
Zn ²⁺ (aq) + 2e [−]	Zn(s)	−0.76
Fe ²⁺ (aq) + 2e [−]	Fe(s)	−0.45
Ni ²⁺ (aq) + 2e [−]	Ni(s)	−0.26
Sn ²⁺ (aq) + 2e [−]	Sn(s)	−0.14
Pb ²⁺ (aq) + 2e [−]	Pb(s)	−0.13
H ⁺ (aq) + e [−]	½H ₂ (g)	0.00
Cu ²⁺ (aq) + e [−]	Cu ⁺ (aq)	+0.15
SO ₄ ^{2−} (aq) + 4H ⁺ (aq)	H ₂ SO ₃ (aq) + H ₂ O(l)	+0.17
Cu ²⁺ (aq) + 2e [−]	Cu(s)	+0.34
½O ₂ (g) + H ₂ O(l) + 2e [−]	2OH [−] (aq)	+0.40
Cu ⁺ (aq) + e [−]	Cu(s)	+0.52
½I ₂ (s) + e [−]	I [−] (aq)	+0.54
Fe ³⁺ (aq) + e [−]	Fe ²⁺ (aq)	+0.77
Ag ⁺ (aq) + e [−]	Ag(s)	+0.80
½Br ₂ (l) + e [−]	Br [−] (aq)	+1.09
½O ₂ (g) + 2H ⁺ (aq) + 2e [−]	H ₂ O(l)	+1.23
Cr ₂ O ₇ ^{2−} (aq) + 14H ⁺ (aq) + 6e [−]	2Cr ³⁺ (aq) + 7H ₂ O(l)	+1.36
½Cl ₂ (g) + e [−]	Cl [−] (aq)	+1.36
MnO ₄ [−] (aq) + 8H ⁺ (aq) + 5e [−]	Mn ²⁺ (aq) + 4H ₂ O(l)	+1.51
½F ₂ (g) + e [−]	F [−] (aq)	+2.87

Infrared data: Characteristic ranges for infrared absorption due to stretching vibrations in organic molecules

Bond	Types of organic molecules	Wavenumber / cm ^{−1}	Intensity
C—I	iodoalkanes	490–620	strong
C—Br	bromoalkanes	500–600	strong
C—Cl	chloroalkanes	600–800	strong
C—F	fluoroalkanes	1000–1400	strong
C—O	alcohols, esters, ethers	1050–1410	strong
C=C	alkenes	1620–1680	medium-weak; multiple bands
C=O	aldehydes, ketones, carboxylic acids and esters	1700–1750	strong
C≡C	alkynes	2100–2260	variable

Bond	Types of organic molecules	Wavenumber / cm ^{−1}	Intensity
O—H	carboxylic acids (with hydrogen bonding)	2500–3000	strong, very broad
C—H	alkanes, alkenes, arenes	2850–3090	strong
O—H	alcohols and phenols (with hydrogen bonding)	3200–3600	strong, broad
N—H	primary amines	3300–3500	medium; two bands

'H NMR data: Typical proton chemical shift values (δ) relative to tetramethylsilane (TMS)

Type of proton	Chemical shift / ppm
—CH ₃	0.9–1.0
—CH ₂ —R	1.3–1.4
—CHR ₂	1.5
RO—C(=O)—CH ₂ —	2.0–2.5
R—C(=O)—CH ₂ —	2.2–2.7
—C ₆ H ₄ —CH ₃ (CH ₃ on a benzene ring)	2.5–3.5
—C≡C—H	1.8–3.1
—CH ₂ —Hal	3.5–4.4
R—O—CH ₂ —	3.3–3.7
R—C(=O)—O—CH ₂ —	3.7–4.8
R—C(=O)—O—H	9.0–13.0
R—O—H	1.0–6.0
—CH=CH ₂	4.5–6.0
—C ₆ H ₄ —OH (OH on a benzene ring)	4.0–12.0
—C ₆ H ₄ —H (H on a benzene ring)	6.9–9.0
R—C(=O)—H	9.4–10.0

Uncertainties

$$y = a \pm b \Rightarrow \Delta y = \Delta a + \Delta b$$
$$y = \frac{ab}{c} \Rightarrow \frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b} + \frac{\Delta c}{c}$$
$$y = a^n \Rightarrow \frac{\Delta y}{y} = \left| n \frac{\Delta a}{a} \right|$$

Bond enthalpies, combustion data and mass-spec fragments: see the annotated sheet or the full booklet.