Chemistry — HSC Reference Sheet

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Constants & Data

Avogadro's constant
$N_A = 6.022 \times 10^{23}$ mol⁻¹

Universal gas constant
$R = 8.314$ J mol⁻¹ K⁻¹

Molar volume of an ideal gas at STP (0 °C, 100 kPa)
$V_m = 22.71$ L mol⁻¹

Molar volume of an ideal gas at 25 °C, 100 kPa
$V_m = 24.79$ L mol⁻¹

Ionic product of water
$K_w = 1.0 \times 10^{-14}$ mol² L⁻²

Specific heat capacity of water
$c = 4.18$ J g⁻¹ K⁻¹

Faraday constant
$F = 96\,485$ C mol⁻¹

Mole & Stoichiometry

Moles from mass

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

Moles from number of particles

$$n = \frac{N}{N_A}$$

Moles from volume (solutions)

$$n = cV$$

Gases

Ideal gas law

$$PV = nRT$$

Molar volume (gas volume)

$$V = nV_m$$

Solutions & Concentration

Molar concentration

$$c = \frac{n}{V}$$

Dilution formula

$$c_1V_1 = c_2V_2$$

Parts per million (mass/mass)

$$\text{ppm} = \frac{m_{\text{solute}}}{m_{\text{solution}}} \times 10^6$$

Energetics & Calorimetry

Heat transferred (calorimetry)

$$q = mc\Delta T$$

Molar enthalpy of reaction

$$\Delta H = -\frac{q}{n}$$

Hess's Law

$$\Delta H_{\text{rxn}} = \sum \Delta H_{\text{products}} - \sum \Delta H_{\text{reactants}}$$

Equilibrium & Acids/Bases

Equilibrium constant expression

$$K_{eq} = \frac{[\text{C}]^c[\text{D}]^d}{[\text{A}]^a[\text{B}]^b}$$

Reaction quotient

$$Q = \frac{[\text{C}]^c[\text{D}]^d}{[\text{A}]^a[\text{B}]^b}$$

pH definition

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

pOH and the water relationship

$$\text{pH} + \text{pOH} = 14$$

Ionic product of water

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$$

Acid dissociation constant

$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

pKa

$$\text{p}K_a = -\log_{10} K_a$$

Electrochemistry

Charge transferred in electrolysis

$$Q = It$$

Moles of electrons (Faraday's law)

$$n_e = \frac{Q}{F}$$

Mass deposited in electrolysis

$$m = nM$$

Standard Electrode Potentials

Standard reduction potentials (electrochemical series)

Reduction half-equation	E° (V)
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2.87
$Ag^+ + e^- \rightleftharpoons Ag$	+0.80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
$2H^+ + 2e^- \rightleftharpoons H_2$	0.00
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	-0.13
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	-0.44
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	-0.76
$Al^{3+} + 3e^- \rightleftharpoons Al$	-1.66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	-2.37
$Na^+ + e^- \rightleftharpoons Na$	-2.71
$Li^+ + e^- \rightleftharpoons Li$	-3.04

Spectroscopy (Module 8)

Infrared absorption data

Bond	Wavenumber (cm^{-1})	Intensity
O–H	3230–3550	strong, broad
N–H	3300–3500	medium
C–H	2850–3000	medium
O–H (acid)	2500–3000	very broad
C≡N	2220–2260	sharp
C=O	1680–1750	strong
C=C	1620–1680	medium
C–O	1000–1300	strong

^{1}H NMR chemical shift data

Type of proton	Chemical shift δ (ppm)
R–CH$_3$, R–CH$_2$–R (alkyl)	0.9–1.8
C–H next to C=O / aromatic	2.0–3.0
C–H next to O / halogen	3.3–4.5
Alkene C=C–H	4.5–6.5
Aromatic H	6.5–8.0
Aldehyde –CHO	9.0–10.0
Carboxylic acid –COOH	10.0–12.0

^{13}C NMR chemical shift data

Type of carbon	Chemical shift δ (ppm)
Alkyl C (C–C)	5–40
C–N	40–60
C–O	50–90
C=C / aromatic C	100–150
C=O (ester/acid)	160–185
C=O (aldehyde/ketone)	190–220

UV-visible spectroscopy

$$A = \varepsilon c l$$

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