Chemistry

Stoichiometry

grams
⇕
mole ⟺ molecule ⟺ atoms
⇕
Liters

Intermolecular Forces

Van der Waals
- London = dispersion
- dipole-dipole
- hydrogen bond
- ion-ion

Atom

Thompson's: Electrons are distributed in a positive charged medium like "raising in pudding"
Rutherford: mass is found in the positively charged nucleus and electrons move around it.
Bohr: Electrons move in orbits. Electrons can absorb or emit energy
Quantum Mechanic: Rather than orbits electrons are more likely to be found in some regions

GASES

STP : 0^{O} C and 1 atm
Ideal gas law : $PV = nRT$
Charles law : $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Boyle's Law : $P_1V_1 = P_2V_2$
Combined Law $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Molecular Speed $\mu = \sqrt{\frac{3RT}{MW}}$
Graham's effusion $\alpha \frac{1}{MW}$
Ideal gas
- Have no volume
- Have no mass
- Random motion
- Elastic collisions
- No interaction with particles

Quantum numbers

Principal, n = size: 1,2,3,…
Orbital angular, l = shape: 0,1,2 .. n-1
Magnetic, m_l = -l,..0..l
Magnetic spin, m_s = ±½

Solutions

$$\text{Molarity} = \frac{\text{moles}}{\text{volume}}$$

$$\text{molality} = \frac{\text{moles}}{\text{Kg solvent}}$$

Boiling pt / Freezing pt

$\Delta T = i \cdot m \cdot K_{b/f}$
$K_{b\ (\text{for water})}$ = 0.51 ºK Kg/mol
$K_{f\ (\text{for water})}$ = 1.86 ºK Kg/mol

Acids - Bases

pH = -log[H^+]
pOH = -log[OH^-]
pH + *pOH* = 14
[H^+] = 10^{-pH}
[OH-] = 10^{-pOH}
[H+] [OH-] = Kw = 1×10^{-14}
$M_aV_a = M_bV_b$
Buffer $pH = pKa + \log\frac{[A^-]}{[HA]}$

Periodic Trends

Ionization Energy → + ↑
Electronegativity
Atomic mass

Metallic character + ← ↓ +
Atomic size

THERMODYNAMICS

Temperature: measure of average K.E. of system
Heat: transfer of thermal E.
Heat Capacity, ***C*****:** energy to raise 1 gram by 1 degree
Heat Energy, ***Q*****:** $Q = C\Delta T$
Conduction: through physical contact
Convection: hot fluid or gas rises through cooler fluid
Radiation: no medium needed for transfer, ex. electromagnetic wave

Calculating Heat or Energy

$Q = m \cdot C \cdot \Delta T$
$Q = m \cdot \Delta H_{vap\ /\ fus}$
$\Delta U = \text{heat}_{\text{supplied/lost}} + \text{work}$
$W = P \cdot \Delta V$

Electron configuration

Pauli exclusion:
Less than 2 e^- per orbital
Hund's rule: fill empty orbitals before pairing
Paramagnetic: unpaired e^- & attracted into magnetic field
Diamagnetic: all e- paired & repelled by magnetic field

Bonds

Ionic	**covalent**
Unequal sharing of e^-	Equal sharing of e^-
metal & non-metal	non-metal & non-metal
Electrolyte	Non-electrolyte
High melting	low melting
High boiling	Low boiling
Brittle	soft

Metals	**Non-metals**
High melting	Low melting
Malleable/moldable	Non-malleable
Ductile/flexible	Non-ductile
Conductor	Non-conductor
Shiny/luster	Dull

Solubility Rules

Soluble compounds

Group I and ammonium (NH_4^+)

Cl^-, Br^-, I^- , **except** Ag^+, Hg_2^{2+}, Pb^{2+}

Nitrates (NO_3^-), acetates($CH_3CO_2^-$)
Chlorates(ClO_3^-), perchlorates(ClO_4^-)

Sulfates (SO42-), **except**
Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Hg_2^{2+}, Ag^{2+}

Insoluble compounds

Carbonates (CO_3^{2-}), chromates (CrO_4^{2-}), oxalates ($C_2O_4^{2-}$), Phosphates (PO_4^{3-}),
except group I and NH_4^+

Sulfides (S^{2-}),
except group I and II and NH_4^+

Hydroxides (OH^-) and oxides (O^{2-}),
except group I and II

Activity Series

Li, K, Ba, Ca, Na, Mg, Al, Zn, Cr, Fe, Cd, Co,Ni, Sn, Pb, H_2, Cu, Hg, Ag, Au

Nuclear chem

Alpha : ${}^{4}_{2}He$ proton : ${}^{1}_{1}p$

neutron : ${}^{1}_{0}n$ beta : ${}^{0}_{-1}e$

positron : ${}^{0}_{1}e$ gamma : ${}^{0}_{0}\gamma$

Beta: n → p + e^-
Positron: p → n + e^+
Electron capture: p + e^- → n

Electromagnetic Energy

$\lambda = \frac{c}{v} = \frac{h}{mv}$
$E = hv$
$v = R(\frac{1}{n_1^2} - \frac{1}{n_2^2})$
$E = h \cdot R(\frac{1}{n_1^2} - \frac{1}{n_2^2})$

Spontaneity

$\Delta G = \Delta H - T\Delta S$
$\Delta G_r = -RT \ln K$
$\Delta G_r = -nFE$
$\ln K = \frac{nFE}{RT}$

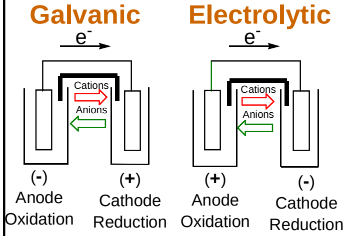
ΔG < 0 (spontaneous)
ΔH (exothermic)

$W = I \cdot t \cdot \Delta E$

Nerst Eq

$E = E^o - \frac{RT}{nF}\ln Q$
$\Delta G_r = \Delta G^o + RT \ln Q$

Galvanic Electrolytic



$E = E_{cathode} - E_{anode}$

Electrolysis q = I·t
gm → mol → mol e^- → C

Integrated Rate Laws

Zero: [Conc.] Vs time
First: Ln [conc] vs time
Second: 1/[conc] vs time

Half-live: $\ln(\frac{[A]_o}{[A]_t}) = kt$

Chemistry

PHYSICAL CONSTANTS

Avogadro's number	N_A	6.022×10^{23} particles
Coulomb's constant	k	8.988×10^{9} N·m²/C²
Planck's constant	h	6.63×10^{-34} J·s
Ideal gas constant	R	0.0821 atm·L/(mol·K)
		8.314 J/(mol·K)
		1.987 cal/mol-K
Atomic mass unit		1.6606×10^{-27} Kg
Mass of electron		9.11×10^{-31} Kg
Mass of proton		1.6726×10^{-27} Kg
mass of neutron		1.6750×10^{-27} Kg
Boltzmann	K	1.38066×10^{-23} J/K
Faraday	F	9.64853×10^{4} C/mol e^-
Rydberg	R	3.28984×10^{15} Hz
Speed of light	C	2.99792×10^{8} m/s
Specific heat (water)	C	1 cal/(g °C) = 4.18 J/(g °C)
Heat of enthalpy (water)	ΔH_{vap}	2260 J/g
Heat of fusion (water)	ΔH_{fus}	334 J/g

CONVERSION FACTORS

1 m = 39.37 in = 3.281 ft = 1.094 yd
1 m = 10^{15} f m = 10^{10} Å = 10^{9} nm
1 mi = 5280 ft = 1.609 km
1 in = 2.540 cm
1 L = 10^{3} cm³ = 2.113 pints = 1.057 qt = 0.264 gal
1 qt = 4 pt = 0.25 gal
1 atm = 1.013×10^{5} N/m² = 101.3 kPa = 760 mm Hg
1 atm = 14.70 lb/in² = 29.92 in Hg
1J = 107 ergs = 0.7373 ft-lb = 1 Kg·m/sec² = 1C·V
1 cal = 4.184 J
1 eV = 1.602×10^{-19} J
1 Kg = 2.205 lb = 35.274 oz
1 lb = 16 oz = 453.59 g
1 ft = 12 in
1 yd = 3 ft
1 lb = 16 oz
1 Ton = 2,000 lbs
1 amp = 1 C/s

1 m = 10 dm
1 m = 100 cm
1 m = 1,000 mm
1 m = 10^{6} μm
1 m = 10^{9} nm
1 km = 1,000 m