A-Level Chemistry

Revision Sheet · 考前速记

Learn these by heart before the exam. 考试前把这些内容背熟。

Atoms, moles and formulae

$n = \dfrac{m}{M}$ moles = mass ÷ molar mass 摩尔

$n = \dfrac{N}{N_A}, \quad N_A = 6.02 \times 10^{23}$ 阿伏伽德罗常数

$n = cV, \quad c = \dfrac{n}{V}$ c in mol/dm^3, V in dm^3 浓度

$pV = nRT$ ideal gas; $R = 8.31$ J/(mol K), T in kelvin

Empirical vs molecular formula 实验式与分子式: empirical = simplest whole-number ratio of atoms; molecular = actual number in one molecule

Percentage yield = (actual ÷ theoretical) × 100%; atom economy = (mass of desired product ÷ total mass) × 100%.

Bonding and structure

Ionic, covalent, metallic 化学键: ionic = transfer of electrons (giant lattice); covalent = shared pair; metallic = lattice of ions in a sea of delocalised electrons

Electronegativity 电负性: the power of an atom to attract a bonding pair; increases across a period, decreases down a group

Shapes (VSEPR): 2 pairs linear 180°, 3 trigonal 120°, 4 tetrahedral 109.5°, 6 octahedral 90°; lone pairs reduce the angle by ~2.5° each.

Intermolecular forces (weak → strong): London (induced dipole) < permanent dipole < hydrogen bonding –set boiling points.

Energetics and equilibria

$q = mc\Delta T$ heat change; then $\Delta H = -\dfrac{q}{n}$

$\Delta H = \Sigma\Delta H_f(\text{products}) - \Sigma\Delta H_f(\text{reactants})$ Hess's law; also = Σbonds broken − Σbonds made 焓变

$\Delta G = \Delta H - T\Delta S$ feasible when $\Delta G < 0$ 吉布斯自由能

$K_c = \dfrac{[C]^c[D]^d}{[A]^a[B]^b}$ 平衡常数

Le Chatelier's principle 勒沙特列原理: a system at equilibrium shifts to oppose a change in concentration, pressure or temperature

A catalyst speeds both directions equally: it does not move the equilibrium position, only reaches it faster.

Kinetics, acids and redox

Activation energy 活化能: the minimum energy colliding particles need to react; a catalyst provides a route with lower E_a

Rate rises with concentration, pressure, surface area, temperature and a catalyst (more frequent / more energetic collisions).

$\text{pH} = -\log_{10}[\text{H}^+], \quad K_w = [\text{H}^+][\text{OH}^-] = 10^{-14}$ pH 值

$K_a = \dfrac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}, \quad \text{p}K_a = -\log_{10} K_a$ weak acid; smaller $\text{p}K_a$ = stronger acid

Oxidation and reduction 氧化与还原: OIL RIG – Oxidation Is Loss of electrons, Reduction Is Gain; the oxidising agent is itself reduced

Balance redox by combining half-equations so the electrons cancel.

Organic chemistry

Homologous series 同系物: a family with the same general formula and functional group, differing by CH_2; similar reactions, gradual trend in properties

Alkanes → free-radical substitution (UV); alkenes → electrophilic addition; halogenoalkanes → nucleophilic substitution.

Oxidation ladder: primary alcohol → aldehyde → carboxylic acid; secondary alcohol → ketone.

Isomerism 同分异构: structural (same formula, different connectivity) and stereoisomerism –cis/trans (E/Z) and optical (mirror-image) forms

Test: bromine water decolourises with a C=C double bond; 2,4-DNPH gives an orange precipitate with a carbonyl.

Analysis

Mass spectrometry 质谱: the molecular ion peak gives M_r; fragment peaks reveal parts of the structure

IR: a broad O-H (~3200-3550), sharp C=O (~1700 cm^{-1}) identify functional groups.

NMR: the number of peaks = chemical environments; the ratio of areas = the ratio of H atoms.