AP Chemistry

Revision Sheet · 考前速记

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

Atomic Structure and Properties

$n = \dfrac{m}{M}, \quad N = nN_A, \quad N_A = 6.022 \times 10^{23}$ 物质的量与阿伏伽德罗常数

$\%\text{ by mass} = \dfrac{\text{mass of element}}{\text{molar mass}} \times 100\%$ empirical formula: masses to moles, divide by the smallest, scale to whole numbers 质量分数

$E_{\text{photon}} = h\nu = \dfrac{hc}{\lambda}, \quad c = \lambda\nu$ 光子能量

PES: peak height is the NUMBER of electrons; binding energy rises with nuclear attraction. Read the 1s peak far left.

Coulomb's law explains all periodic trends: Z_{eff} up and r down means stronger attraction.

Across a period: radius falls, ionisation energy rises. Down a group: radius rises, ionisation energy falls.

Compound Structure and Properties

Lewis: count valence electrons, form bonds, complete octets, place any leftover on the central atom. Check formal charge.

$\text{formal charge} = V - N - \frac{1}{2}B$ the best structure keeps formal charges nearest zero 形式电荷

VSEPR: 2 domains linear, 3 trigonal planar, 4 tetrahedral, 5 trigonal bipyramidal, 6 octahedral. Lone pairs squeeze the angles.

Polar molecule needs polar bonds AND asymmetry. CO_2 is nonpolar; H_2O is polar.

IMF strength: ionic > hydrogen bonding > dipole-dipole > London. London rises with more electrons.

Sigma is head-on, pi is side-on. A double bond is 1 sigma + 1 pi; a triple is 1 sigma + 2 pi.

Properties of Substances and Mixtures

$PV = nRT, \quad R = 0.08206\ \text{L atm mol}^{-1}\text{K}^{-1}$ 理想气体定律

$P_{\text{total}} = \sum P_i, \quad P_i = \chi_i P_{\text{total}}$ 道尔顿分压定律

$M = \dfrac{n_{\text{solute}}}{V_{\text{solution}}}, \quad M_1V_1 = M_2V_2$ 浓度与稀释

Real gases deviate at HIGH pressure and LOW temperature: molecules have volume and they attract.

$A = \varepsilon bc$ absorbance is proportional to concentration 比尔-朗伯定律

Chemical Reactions

Limiting reactant: convert BOTH to moles of product; the smaller answer wins. Percent yield $= \frac{actual}{theoretical} \times 100\%$.

Net ionic equation: cancel the spectator ions. Show states.

Oxidation is loss of electrons (number rises); reduction is gain. Balance half-equations with H^+/H_2O in acid.

Titration: at equivalence, moles of acid equal moles of base times the stoichiometric ratio.

Kinetics

$\text{rate} = k[A]^m[B]^n$ orders come from EXPERIMENT, never from the balanced equation 速率方程

$\ln[A]_t = -kt + \ln[A]_0, \quad t_{1/2} = \dfrac{0.693}{k}$ 一级反应

$\dfrac{1}{[A]_t} = kt + \dfrac{1}{[A]_0}$ 二级反应

Linear plot identifies the order: $[A]$ vs t zero order; $\ln[A]$ vs t first; $1/[A]$ vs t second.

The slow step is rate-determining; the rate law must match it. A catalyst lowers E_a and is regenerated.

$k = Ae^{-E_a/RT}$ 阿伦尼乌斯方程

Thermochemistry

$q = mc\Delta T, \quad q_{\text{sys}} = -q_{\text{surr}}$ 量热

$\Delta H^\circ_{rxn} = \sum \Delta H^\circ_f(\text{products}) - \sum \Delta H^\circ_f(\text{reactants})$ ΔH°_f of an element in its standard state is 0 生成焓法

Hess's law: reverse a step and flip the sign; multiply a step and multiply ΔH.

Bond enthalpy route: $\Delta H = \sum(\text{bonds broken}) - \sum(\text{bonds formed})$. Breaking costs energy.

Exothermic $\Delta H < 0$ (heat out); endothermic $\Delta H > 0$.

Equilibrium

$K_c = \dfrac{[\text{C}]^c[\text{D}]^d}{[\text{A}]^a[\text{B}]^b}$ omit pure solids and liquids 平衡常数

$Q < K$ shifts right; $Q > K$ shifts left; $Q = K$ is at equilibrium.

Le Chatelier: the system opposes the change. Adding heat shifts an endothermic reaction right. An inert gas at constant V does NOTHING.

ICE table: Initial, Change, Equilibrium. If K is very small, approximate x as negligible, then check it is under 5%.

$K_{sp} = [\text{A}^+]^a[\text{B}^-]^b$ a common ion lowers solubility 溶度积

Acids and Bases

$\text{pH} = -\log[\text{H}^+], \quad \text{pOH} = -\log[\text{OH}^-], \quad \text{pH} + \text{pOH} = 14$ pH 与 pOH

$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}, \quad K_aK_b = K_w$ 水的离子积

$\text{pH} = \text{p}K_a + \log\dfrac{[\text{A}^-]}{[\text{HA}]}$ buffer only; at the half-equivalence point $\text{pH} = \text{p}K_a$ 亨德森-哈塞尔巴尔赫方程

Strong acid or base dissociates completely, so $[H^+]$ equals the concentration. Weak needs an ICE table with K_a.

Titration curve: buffer region flattest at half-equivalence; equivalence is the STEEPEST point (pH 7 only for strong-strong).

Thermodynamics and Electrochemistry

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ $\Delta G < 0$ means thermodynamically favourable 吉布斯自由能

$\Delta G^\circ = -RT\ln K = -nFE^\circ$ $F = 96485$ C/mol 自由能、K 与电动势

Entropy rises: solid to liquid to gas, more particles, higher temperature, mixing.

$\Delta H < 0, \Delta S > 0$ always favourable; both positive needs HIGH T; both negative needs LOW T.

Galvanic cell: oxidation at the ANODE (negative), reduction at the CATHODE. $E^\circ_{cell} = E^\circ_{cat} - E^\circ_{an} > 0$.

$q = It, \quad n_{e^-} = \dfrac{It}{F}$ 电解定量计算

Exam technique

Justify with particles: say what the atoms, ions or molecules are doing, not just which way the number moved.

Every answer needs units and the right significant figures. Show the setup, not just the calculator result.

'Explain in terms of Coulomb's law / IMF / Le Chatelier' means name the principle AND apply it to this substance.