# 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

$\Delta H^\circ_{rxn} = \sum \Delta H^\circ_f(\text{products}) - \sum \Delta H^\circ_f(\text{reactants})$ $\Delta H^\circ_f$ 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 $\Delta H$.*

*Bond enthalpy route:* $\Delta H = \sum(\textit{bonds broken}) - \sum(\textit{bonds formed})$. *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

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

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

$\mathrm{pH} = \mathrm{p}K_a + \log \dfrac{[\mathrm{A}^-]}{[\mathrm{HA}]}$ buffer only; at the half-equivalence point $\mathrm{pH} = \mathrm{p}K_a$ 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.*