# A-Level Chemistry

Formula Sheet · 公式表

*A Data Booklet is supplied, and it is generous: constants, standard electrode potentials, the periodic table, infrared and NMR data. What it never contains is a single relationship between quantities – every equation below has to be recalled.* 考卷附数据册，但不含任何计算公式，以下全部需要背诵。

## Supplied in the Data Booklet – look it up, do not memorise

Physical constants: the Avogadro constant, the gas constant $R$, the Faraday constant, the molar volume of a gas, the ionic product of water, and the speed of light.

Standard electrode potentials for every half-equation you will meet, with the half-equations written out.

The periodic table with relative atomic masses, ionic radii, electronegativities and first ionisation energies.

Characteristic infrared absorptions, proton and carbon-13 NMR chemical-shift ranges, and typical bond energies and lengths.

## Amount of substance – must be recalled

**Moles from mass** 物质的量 — $n = m/M$, where $M$ is the molar mass in g mol$^{-1}$

**Moles from concentration** 由浓度求物质的量 — $n = cV$, with $V$ in cubic decimetres. A volume in cm$^3$ must be divided by 1000 first, and this is the most common slip in the whole subject.

**Moles of a gas** 气体的物质的量 — $n = V/24.0$ dm$^3$ at room conditions, or from $pV = nRT$ with $p$ in Pa, $V$ in m$^3$ and $T$ in K

**Percentage yield and atom economy** 产率与原子经济性 — yield = actual ÷ theoretical ×100; atom economy = mass of desired product ÷ total mass of products ×100. They measure different things and are examined together to see whether you know that.

## Energetics, kinetics and equilibrium

**Enthalpy change of a solution** 溶液的焓变 — $q = mc\Delta T$, where $m$ is the mass of the SOLUTION, not the solute, and $c = 4.18$ J g$^{-1}$K$^{-1}$. Then $\Delta H = -q/n$, with the sign flipped and per mole.

**Hess"s law** 盖斯定律 — $\Delta H_r = \sum \Delta H_f(\text{products}) - \sum \Delta H_f(\text{reactants})$, and from combustion data the subtraction runs the other way.

**Gibbs free energy** 吉布斯自由能 — $\Delta G = \Delta H - T\Delta S$, with $\Delta S$ converted from J to kJ before subtracting. A reaction is feasible when $\Delta G$ is negative.

**Entropy change** 熵变 — $\Delta S = \sum S(\text{products}) - \sum S(\text{reactants})$, using absolute entropies, which are never zero except for a perfect crystal at 0 K.

**Rate equation** 速率方程 — rate $= k[\text{A}]^m[\text{B}]^n$. Orders come only from experiment, never from the stoichiometric equation, and the units of $k$ change with the overall order.

**Equilibrium constants** 平衡常数 — $K_c$ from concentrations, $K_p$ from partial pressures, each raised to the power of its coefficient, products over reactants. Pure solids and liquids are omitted.

**Arrhenius** 阿伦尼乌斯方程 — $\ln k = -E_a/RT + \ln A$: a plot of $\ln k$ against $1/T$ is a straight line of gradient $-E_a/R$.



## Acids, bases and electrochemistry

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

**Weak acid dissociation** 弱酸电离 — $K_a = [\text{H}^+]^2/[\text{HA}]$ under the usual approximations, and $\text{p}K_a = -\log_{10} K_a$

**Ionic product of water** 水的离子积 — $K_w = [\text{H}^+][\text{OH}^-] = 1.00 \times 10^{-14}$ at 298 K – the route to the pH of an alkali

**Buffer** 缓冲溶液 — $[\text{H}^+] = K_a \times [\text{acid}]/[\text{salt}]$, so a buffer's pH depends on the ratio, which is why dilution barely changes it.

**Solubility product** 溶度积 — For $\text{A}_x\text{B}_y$, $K_{sp} = [\text{A}]^x[\text{B}]^y$. Precipitation occurs when the ionic product exceeds $K_{sp}$.

**Cell potential and electrolysis** 电池电动势与电解 — $E^{\ominus}_{\text{cell}} = E^{\ominus}(\text{reduced}) - E^{\ominus}(\text{oxidised})$; in electrolysis, charge $Q = It$ and moles of electrons $= Q/F$.

## Where the marks actually go

Show the mole calculation as a chain: given quantity to moles, moles to moles by the equation ratio, moles to the answer. Each arrow is a mark, and a final answer alone collects one of three.

Significant figures follow the least precise datum, usually three. An answer copied from the display with nine digits is penalised once per paper – but only once, so do not panic about it mid-paper.

Units are part of the answer for $k$, for concentration and for enthalpy. Deriving the units of a rate constant from the rate equation is a routine exam task, not an afterthought.