# AQA · GCSE · Chemistry

**Syllabus Checklist · 大纲自查表**

Tick one box per statement: ☐ not yet ☐ nearly ☐ confident. 每条打一个勾：尚未掌握 / 快会了 / 有把握。

## 1. Atomic structure and the periodic table 原子结构与元素周期表

### 1.1 Atoms, elements, compounds and mixtures (4.1.1.1–4.1.1.4) 原子、元素、化合物与混合物 (4.1.1.1–4.1.1.4)

- ☐☐☐ Distinguish atoms, elements, compounds and mixtures, with symbols and formulae.
- ☐☐☐ Describe the five physical separation methods and choose one for a given mixture.
- ☐☐☐ Recount the development of the model of the atom from sphere to neutron.
- ☐☐☐ Use proton, neutron and electron charges and masses, atomic and mass numbers, isotopes and relative atomic mass.
- ☐☐☐ Write electronic structures for the first twenty elements.

### 1.2 The periodic table (4.1.2.1–4.1.2.3) 元素周期表（4.1.2.1–4.1.2.3）

- ☐☐☐ Relate group and period to outer-shell electrons and atomic number.
- ☐☐☐ Describe the development of the periodic table, including Mendeleev's gaps and the isotope explanation.
- ☐☐☐ Distinguish metals from non-metals by position and properties.
- ☐☐☐ State and explain the trends in Groups 0, 1 and 7, including displacement.

### 1.3 Transition metals – chemistry only (4.1.3) 过渡金属 – 仅限化学（4.1.3）

- ☐☐☐ Compare transition elements with Group 1 in melting point, density, strength, hardness and reactivity.
- ☐☐☐ Describe ions with different charges, coloured compounds and catalysis, with named examples.

## 2. Bonding, structure and the properties of matter 键合、物质结构与性质

### 2.1 Ionic, covalent and metallic bonding (4.2.1.1–4.2.1.5) 离子键、共价键和金属键（4.2.1.1–4.2.1.5）

- ☐☐☐ Explain the three bond types in terms of electrons and electrostatic forces.
- ☐☐☐ Draw dot and cross diagrams for electron transfer and for the eight named molecules.
- ☐☐☐ Deducie ion charges and empirical formulae from group numbers and lattice models; state model limitations.

### 2.2 Bonding, structure and properties (4.2.2.1–4.2.2.7) 键合、结构与性质（4.2.2.1–4.2.2.7）

- ☐☐☐ Link states of matter and state symbols to particle theory, with (HT) its limitations.
- ☐☐☐ Explain the melting points and conductivity of ionic compounds, small molecules, polymers and metals.
- ☐☐☐ Explain why alloys are harder than pure metals.

### 2.3 Structure and bonding of carbon (4.2.3.1–4.2.3.3) 碳的结构与键合（4.2.3.1–4.2.3.3）

- ☐☐☐ Explain diamond's properties from its four-bond giant structure.
- ☐☐☐ Explain graphite's properties from three bonds, layers and delocalised electrons.

☐☐☐ Describe graphene and fullerenes, including carbon nanotubes and their uses.

**2.4 Bulk and surface properties incl. nanoparticles – chemistry only (4.2.4)** 宏观与表面性质，包括纳米粒子 — 仅限化学（4.2.4）

☐☐☐ Compare nanoparticle, fine and coarse particle size ranges.
☐☐☐ Apply the surface-area-to-volume factor-of-10 rule to cubes.
☐☐☐ Explain why nanoparticles differ from bulk materials, their uses and the concerns.

## 3. Quantitative chemistry 定量化学

**3.1 Measurements, conservation of mass and equations (4.3.1.1–4.3.1.3)** 测量、质量守恒与方程式（4.3.1.1–4.3.1.3）

☐☐☐ Balance symbol equations and use conservation of mass.
☐☐☐ Calculate relative formula masses and percentage by mass of an element.
☐☐☐ Explain apparent mass changes when a gas is involved.
☐☐☐ Estimate uncertainty as the range of repeat measurements about the mean.

**3.2 Moles – amount of substance and reacting masses (4.3.2)** 物质的量 — 摩尔及反应质量（4.3.2）

☐☐☐ Use the mole, the Avogadro constant and moles = mass / Mr.
☐☐☐ Calculate reacting masses from balanced equations.
☐☐☐ Balance equations from reacting masses.
☐☐☐ Explain and use the limiting reactant.
☐☐☐ Calculate concentrations in g/dm3 and, with mol/dm3, mass-volume relations.

**3.3 Yield and atom economy – chemistry only, HT (4.3.3)** 产率与原子经济性 — 仅限化学，高阶（4.3.3）

☐☐☐ Give the three reasons yield is below 100 percent.
☐☐☐ Calculate percentage yield, and (HT) the theoretical mass first.
☐☐☐ Calculate atom economy and explain its importance.

**3.4 Concentrations of solutions (4.3.4)** 溶液浓度（4.3.4）

☐☐☐ Relate moles, mass, volume and concentration in mol/dm3.
☐☐☐ Calculate an unknown concentration from titration volumes and the equation ratio.

**3.5 Volumes of gases – chemistry only, HT (4.3.5)** 气体体积 — 仅限化学，高阶（4.3.5）

☐☐☐ State that equal gas volumes contain equal moles at the same temperature and pressure.
☐☐☐ Use the equation ratio to relate gas volumes in reactions.

## 4. Chemical changes 化学变化

**4.1 Reactivity of metals and displacement (4.4.1.1–4.4.1.3)** 金属的反应活性与置换反应（4.4.1.1–4.4.1.3）

☐☐☐ Recall the reactivity series order including carbon and hydrogen, with water and acid reactions.
☐☐☐ Explain reactivity as the tendency to form positive ions and deduce order from results.
☐☐☐ Relate extraction method to reactivity: carbon reduction vs electrolysis.

☐☐☐ (HT) Use OIL RIG to write ionic equations for displacement and redox.

### 4.2 Reactions of acids and making salts (4.4.2.1–4.4.2.6) 酸的反应与盐的制备（4.4.2.1–4.4.2.6）

☐☐☐ Predict acid-metal and acid-base products, naming salts from acid and base.

☐☐☐ Describe RP1 salt preparation from an insoluble oxide or carbonate.

☐☐☐ Use the pH scale, universal indicator and pH probe; write the neutralisation ionic equation.

☐☐☐ (Chem) Describe titration method (RP2) and (HT) strong vs weak acids with the factor-of-10 pH rule.

### 4.3 Electrolysis (4.4.3.1–4.4.3.3) 电解（4.4.3.1–4.4.3.3）

☐☐☐ Describe electrolytes, electrode attraction and discharge.

☐☐☐ Predict products for molten binary compounds and aqueous solutions.

☐☐☐ Explain aluminium extraction: cryolite mixture and anode replacement.

☐☐☐ (HT) Write balanced half-equations at both electrodes.

## 5. Energy changes 能量变化

### 5.1 Exothermic and endothermic reactions (4.5.1.1–4.5.1.3) 放热与吸热反应（4.5.1.1–4.5.1.3）

☐☐☐ Define exothermic and endothermic from temperature change, with examples and uses.

☐☐☐ Draw and interpret reaction profiles with activation energy and overall energy change.

☐☐☐ (HT) Calculate overall energy change from bond energies and explain the difference between the two reaction types.

### 5.2 Chemical cells and fuel cells – chemistry only (4.5.2) 化学电池与燃料电池 — 仅限化学（4.5.2）

☐☐☐ Explain how cells produce electricity and what the voltage depends on.

☐☐☐ Compare non-rechargeable and rechargeable cells.

☐☐☐ Describe hydrogen fuel cells and (HT) their electrode half-equations, evaluating them against rechargeable cells.

## 6. The rate and extent of chemical change 化学反应的速率与限度

### 6.1 Rate of reaction (4.6.1.1–4.6.1.5) 反应速率（4.6.1.1–4.6.1.5）

☐☐☐ Calculate mean rates in g/s, cm3/s and (HT) mol/s, and read product-time graphs with tangents.

☐☐☐ Recall the five factors affecting rate and investigate concentration (RP5).

☐☐☐ Explain each factor with collision theory and activation energy.

☐☐☐ Describe catalysts and their effect on the reaction profile, including enzymes.

### 6.2 Reversible reactions and dynamic equilibrium (4.6.2.1–4.6.2.3) 可逆反应与动态平衡（4.6.2.1–4.6.2.3）

☐☐☐ Represent reversible reactions and their opposite energy changes.

☐☐☐ Define dynamic equilibrium in a closed system.

☐☐☐ (HT) Predict the effect of concentration, pressure and temperature changes with Le Chatelier's principle, and the catalyst's null effect.

## 7. Organic chemistry 有机化学

**7.1 Crude oil, fuels and feedstock (4.7.1.1–4.7.1.3)** 原油、燃料与原料（4.7.1.1–4.7.1.3）

- ☐☐☐ Describe crude oil's origin and composition; name and formulate the first four alkanes.
- ☐☐☐ Explain fractional distillation and match fraction properties to uses.
- ☐☐☐ Relate molecule size to boiling point, viscosity and flammability.
- ☐☐☐ Describe cracking conditions and products, balance cracking equations and use the bromine-water test.

**7.2 Reactions of alkenes and alcohols – chemistry only (4.7.2.1–4.7.2.3)** 烯烃与醇的反应 — 仅限化学（4.7.2.1–4.7.2.3）

- ☐☐☐ Recognise alkenes CnH2n as unsaturated and describe their addition reactions.
- ☐☐☐ Describe the four reactions and uses of the first four alcohols, with fermentation conditions.
- ☐☐☐ Describe the reactions of the first four carboxylic acids, including ester formation, and (HT) weak-acid ionisation.

**7.3 Synthetic and naturally occurring polymers (4.7.3.1–4.7.3.2)** 合成及天然聚合物（4.7.3.1–4.7.3.2）

- ☐☐☐ Draw addition polymers from alkene monomers and relate repeating units back to monomers.
- ☐☐☐ (HT) Explain condensation polymerisation with functional groups, polyester and polypeptide examples.
- ☐☐☐ Name DNA's structure and the monomers of proteins, starch and cellulose.

## 8. Chemical analysis 化学分析

**8.1 Purity, formulations and chromatography (4.8.1.1–4.8.1.3)** 纯度、配方与色谱法（4.8.1.1–4.8.1.3）

- ☐☐☐ Distinguish pure substances from mixtures using melting and boiling point data.
- ☐☐☐ Identify formulations and explain their purpose.
- ☐☐☐ Explain paper chromatography, calculate Rf values and interpret chromatograms.

**8.2 Identification of common gases (4.8.2)** 常见气体的鉴定（4.8.2）

- ☐☐☐ Describe the tests and positive results for hydrogen, oxygen, carbon dioxide and chlorine.

**8.3 Identification of ions – chemistry only (4.8.3.1–4.8.3.2)** 离子的鉴定 — 仅限化学（4.8.3.1–4.8.3.2）

- ☐☐☐ Give flame-test colours for Li, Na, K, Ca and Cu, noting masking in mixtures.
- ☐☐☐ Identify metal ions with sodium hydroxide solution, including the aluminium excess test.
- ☐☐☐ Test for carbonates, halides and sulfates with reagents and precipitate colours.
- ☐☐☐ (HT) Describe flame emission spectroscopy and its advantages.

## 9. Chemistry of the atmosphere 大气化学

**9.1 Evolution of the Earth's atmosphere (4.9.1.1–4.9.1.2)** 地球大气层的演化（4.9.1.1–4.9.1.2）

- ☐☐☐ Describe the evidence for and composition of the early atmosphere.
- ☐☐☐ Explain how oceans, carbonates and photosynthesis changed the atmosphere to today's proportions.

**9.2 Greenhouse gases and global climate change (4.9.2.1–4.9.2.3)** 温室气体与全球气候变化 (4.9.2.1–4.9.2.3)

- ☐☐☐ Name the greenhouse gases and explain the mechanism in terms of wavelength.
- ☐☐☐ Relate human activities to rising gas levels and interpret given climate data.
- ☐☐☐ Describe consequences of global climate change and the basis of scientific consensus.

**9.3 Atmospheric pollutants and their sources (4.9.3.1–4.9.3.2)** 大气污染物及其来源（4.9.3.1–4.9.3.2）

- ☐☐☐ Link complete and incomplete combustion to the products CO2, water, CO and particulates, with effects.
- ☐☐☐ Explain the formation and effects of sulfur dioxide and oxides of nitrogen, including acid rain and its reduction.

## 10. Using resources 资源利用

**10.1 Resources and potable water (4.10.1.1–4.10.1.3)** 资源与饮用水（4.10.1.1–4.10.1.3）

- ☐☐☐ Distinguish finite from renewable resources and define sustainable development.
- ☐☐☐ Distinguish potable from pure water and describe UK treatment; compare with desalination.
- ☐☐☐ Describe sewage treatment in order, and compare ease of obtaining potable water from waste, ground and salt water.
- ☐☐☐ (HT) Describe phytomining and bioleaching for low-grade copper ores.

**10.2 Life cycle assessment and recycling (4.10.2.1–4.10.2.2)** 生命周期评估与回收利用 (4.10.2.1–4.10.2.2)

- ☐☐☐ List the four LCA stages and explain why LCAs are not purely objective.
- ☐☐☐ Evaluate reduce, reuse and recycling for given materials, with reasons.

**10.3 Using materials – corrosion and alloys, chemistry only (4.10.3.1–4.10.3.2)** 材料的应用 — 腐蚀与合金，仅限化学（4.10.3.1–4.10.3.2）

- ☐☐☐ Describe corrosion and its prevention, including sacrificial zinc.
- ☐☐☐ Recall named alloys with compositions and uses, and interpret alloy data.
- ☐☐☐ Compare glasses, clay ceramics, polymers and composites, including thermosoftening vs thermosetting.

**10.4 The Haber process and NPK fertilisers – chemistry only (4.10.4.1–4.10.4.2)** 哈伯法与氮磷钾化肥 — 仅限化学（4.10.4.1–4.10.4.2）

- ☐☐☐ State the raw material sources and conditions of the Haber process.
- ☐☐☐ Describe the separation and recycling of ammonia and unreacted gases.
- ☐☐☐ (HT) Apply equilibrium principles to explain the compromise conditions.
- ☐☐☐ Name the NPK compounds and how they are produced, evaluating fertiliser manufacture.