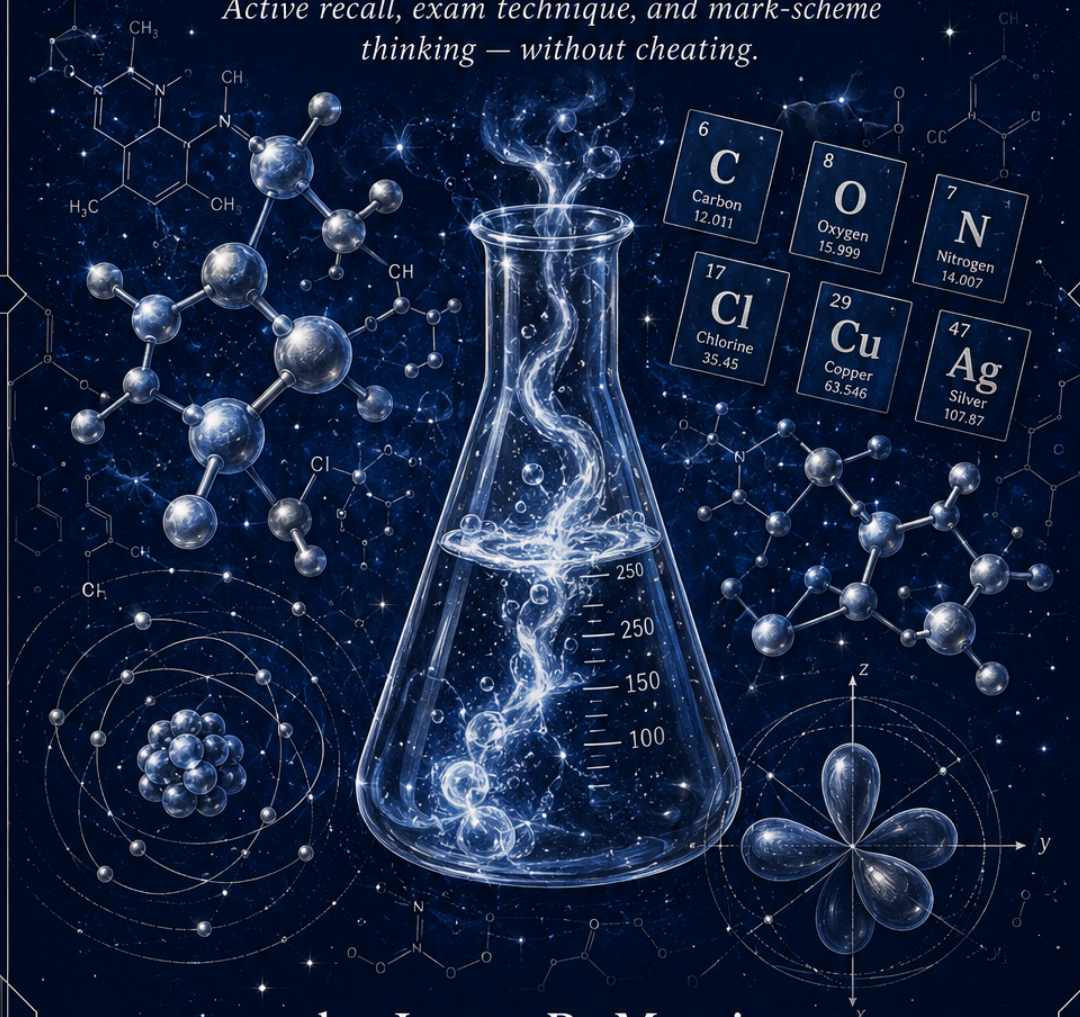


# A-LEVEL CHEMISTRY 100 AI PROMPTS

for Smarter Revision *and* Exam Prep

*Active recall, exam technique, and mark-scheme  
thinking — without cheating.*



by James R. Martin

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ISBN: [TO BE ASSIGNED]

First published 2026

## How to Use This Book

For a long time, high-quality tutoring has been a major contributor to elite academic achievement. Used well, AI can now act as a powerful tutor that most students and parents could not previously afford.

This book is a **starting point**, not a rulebook. Each prompt is designed to help you revise, test your understanding, and think more clearly — not to give perfect answers. You are encouraged to **adapt, improve, and remix** these prompts.

You are learning how to think carefully about the questions you ask — a skill that will matter far beyond these exams.

## **Note on Exam Boards and Syllabi**

This book is designed to support A-Level Chemistry students across all major UK exam boards, including AQA, Edexcel (Pearson), OCR A (Chemistry A), and OCR B (Chemistry B, Salters). The 100 prompts cover the core content that appears across every specification, ensuring that whichever board you are studying, the vast majority of material will be directly relevant to your course.

While the specifications differ in how they sequence topics and in some of the contexts they use, the fundamental chemistry at A-Level is remarkably consistent. Atomic structure, bonding, energetics, kinetics, equilibria, organic chemistry, and analytical techniques are examined by every board at a comparable depth. This book addresses all of these areas thoroughly.

Where exam boards diverge, such as OCR B's context-led approach or Edexcel's treatment of certain inorganic topics, the prompts have been written broadly enough to remain useful. A small number of prompts may cover material that sits slightly outside your specific specification, but engaging with this content will only deepen your understanding and strengthen your exam performance.

The prompts incorporate the styles of questioning used across A-Level Chemistry papers, including multi-step calculations, extended response questions, practical-based scenarios, and synoptic questions that draw together knowledge from multiple topics. Command words such as 'explain', 'evaluate', 'justify', and 'deduce' are used throughout, reflecting genuine exam expectations.

You should always cross-reference with your own specification and use your textbook or specification checklist to confirm which topics you need. This book is a powerful revision companion, but your specification document remains the definitive guide to what you will be examined on.

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# Section 1

## Atomic Structure and Bonding

Atomic structure and bonding underpin the entire A-Level Chemistry course. A thorough understanding of electron configurations, ionisation energies, and the nature of chemical bonds is essential before you can tackle more advanced topics such as reaction mechanisms, transition metal chemistry, or spectroscopic analysis.

At A-Level, you are expected to go well beyond the simple models of the atom and bonding that you encountered at GCSE. You need to understand sub-shells and orbitals, explain trends in ionisation energy using nuclear charge and shielding, interpret mass spectra, and predict molecular shapes using electron pair repulsion theory. Electronegativity and intermolecular forces must be understood quantitatively, not just qualitatively.

The prompts in this section will test your ability to recall key definitions, apply bonding models to unfamiliar molecules, and evaluate why certain substances have the physical properties they do. Mastering this material will give you a secure foundation for every other section of the course.

### **Prompt 1: Electron Configuration Fundamentals**

#### **Copy this prompt into your AI tool:**

*Quiz me on electron configurations for elements and ions up to krypton. Include at least two transition metal ions and ask me to explain any irregularities such as chromium or copper. After each answer, tell me if I'm right and correct any mistakes.*

**What this helps you practise:**

Writing electron configurations using sub-shell notation and explaining exceptions

**How to use it well:**

Work through these without a periodic table first, then check which ones you need to look up. Focus on the reasoning behind exceptions, not just memorising them.

**Prompt 2: Sub-shells and Orbitals**

**Copy this prompt into your AI tool:**

*Test me on the shapes, orientations, and maximum electron capacities of s, p, and d orbitals. Ask me to sketch or describe the spatial arrangement of p orbitals and explain how electrons fill orbitals according to the Aufbau principle, Hund's rule, and the Pauli exclusion principle.*

**What this helps you practise:**

Describing orbital shapes and applying electron-filling rules

**How to use it well:**

If you can confidently explain all three filling rules with examples, you have a strong grasp. Revisit any rule you struggle to articulate clearly.

**Prompt 3: Ionisation Energy Trends**

**Copy this prompt into your AI tool:**

*Give me an A-Level style question where I must explain the trend in first ionisation energies across Period 3 and down Group 2. Require me to use the terms nuclear charge, shielding, and sub-shell in my answers. Mark my response against a six-mark scheme.*

**What this helps you practise:**

Explaining ionisation energy trends using atomic structure concepts

### **How to use it well:**

Pay close attention to the mark scheme. Examiners want precise use of terminology and clear logical links between factors and the trend observed.

### **Prompt 4: Successive Ionisation Energies**

#### **Copy this prompt into your AI tool:**

*Present me with a set of successive ionisation energy data for an unknown element and ask me to identify which group the element belongs to. Then ask me to explain the large jumps in the data in terms of electron shells and sub-shells.*

#### **What this helps you practise:**

Interpreting successive ionisation energy data to deduce electronic structure

#### **How to use it well:**

Practise spotting where the big jumps occur and counting how many electrons are removed before each jump. This tells you the group number directly.

### **Prompt 5: Mass Spectrometry of Elements**

#### **Copy this prompt into your AI tool:**

*Ask me to calculate the relative atomic mass of an element from mass spectrum data you provide. Include isotopic masses and percentage abundances. Then give me a second dataset and ask me to work backwards to find a missing abundance.*

#### **What this helps you practise:**

Calculating relative atomic mass from mass spectrometry data

#### **How to use it well:**

Show all working in your calculations. Examiners award method marks even if your final answer has a rounding error, so practise setting out each step clearly.

### **Prompt 6: Ionic and Covalent Bonding**

**Copy this prompt into your AI tool:**

*Test me on the differences between ionic and covalent bonding. Give me five substances and ask me to identify the bonding type, draw dot-and-cross diagrams, and explain how the bonding model accounts for each substance's melting point and electrical conductivity.*

**What this helps you practise:**

Distinguishing bonding types and linking them to physical properties

**How to use it well:**

Focus on the explanations of properties, not just identifying the bond type. A-Level questions almost always require you to connect structure to behaviour.

**Prompt 7: Shapes of Molecules and Ions**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner. Give me six molecules or ions, including at least one with an expanded octet and one with lone pairs, and ask me to predict the shape and bond angle of each using VSEPR theory. Correct any errors in my reasoning.*

**What this helps you practise:**

Predicting molecular geometry using electron pair repulsion theory

**How to use it well:**

Always count bonding pairs and lone pairs separately. Remember that lone pairs repel more strongly than bonding pairs, which reduces bond angles from the ideal values.

**Prompt 8: Electronegativity and Bond Polarity**

**Copy this prompt into your AI tool:**

*Test me on electronegativity and bond polarity at A-Level Chemistry standard. Ask me to define electronegativity, explain the Pauling scale, and*

*predict the polarity of bonds between different pairs of atoms. Give me molecules and ask me to identify polar bonds and determine whether the overall molecule is polar or non-polar, considering molecular shape and symmetry. After each answer, check my reasoning and correct any errors. Present one question at a time.*

**What this helps you practise:**

Applying electronegativity to determine bond and molecular polarity

**How to use it well:**

Remember that a molecule can contain polar bonds but be non-polar overall if the dipoles cancel due to symmetry. Sketch the dipole arrows to check.

**Prompt 9: Metallic Bonding and Properties**

**Copy this prompt into your AI tool:**

*Set me a challenge: explain why metals are good conductors of electricity and heat, why they are malleable, and why transition metals generally have higher melting points than Group 1 metals. Require me to reference delocalised electrons and the lattice structure in every answer.*

**What this helps you practise:**

Explaining metallic properties in terms of the metallic bonding model

**How to use it well:**

Keep your explanations precise. Avoid vague statements like 'strong bonds' without specifying what type of bonding and what structural feature creates the strength.

**Prompt 10: Intermolecular Forces**

**Copy this prompt into your AI tool:**

*Quiz me on the three types of intermolecular force: London dispersion forces, permanent dipole-dipole interactions, and hydrogen bonding. For each, ask*

*me to explain how it arises, give an example molecule, and predict boiling point trends for a series of related compounds.*

**What this helps you practise:**

Identifying and comparing intermolecular forces in different substances

**How to use it well:**

Practise ranking compounds by boiling point and justifying each ranking. This is a very common A-Level question style that tests whether you truly understand the relative strengths.

**Prompt 11: Bonding and Properties Synoptic Challenge**

**Copy this prompt into your AI tool:**

*Give me an A-Level style six-mark extended response question that asks me to compare and contrast the structure and bonding in sodium chloride, diamond, graphite, and ice. Require me to explain the physical properties of each in terms of its bonding and structure. Mark my answer using a level-of-response mark scheme.*

**What this helps you practise:**

Comparing bonding models across different substance types in extended writing

**How to use it well:**

Extended response questions reward structured, logical writing. Plan your answer before you start writing, and ensure every property you mention is explicitly linked to a bonding or structural feature.

## Section 2

### Amount of Substance and Energetics

The concept of amount of substance is the quantitative backbone of chemistry. At A-Level, mole calculations become significantly more demanding, requiring you to handle titrations, gas volumes, atom economies, and multi-step stoichiometric problems with confidence and precision.

Energetics at A-Level extends far beyond simple enthalpy change calculations. You must be able to construct and interpret Born-Haber cycles, apply Hess's law to unfamiliar reactions, calculate entropy changes, and determine whether a reaction is feasible using Gibbs free energy. These topics require both mathematical fluency and a deep conceptual understanding of why energy changes occur.

The prompts in this section will push you through increasingly complex quantitative and conceptual challenges. Start with the recall-based prompts to ensure your definitions and formulae are secure, then work through the application and analysis prompts that mirror the style of real A-Level exam questions.

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#### **Prompt 12: Mole Calculations Core Skills**

##### **Copy this prompt into your AI tool:**

*Quiz me on core mole calculations at A-Level Chemistry standard. Give me a range of problems including calculating moles from mass and molar mass, using Avogadro's constant, determining moles from gas volumes at standard conditions, and finding concentrations from solution volumes. Include multi-step calculations such as reacting mass problems and limiting reagent questions. After*

*each answer, check my working and units carefully.  
Present one question at a time and wait for my  
response.*

**What this helps you practise:**

Performing fundamental mole calculations across  
different measurement types

**How to use it well:**

Always write the formula you are using before  
substituting numbers. This habit prevents errors and  
ensures you pick up method marks in exams.

**Prompt 13: Empirical and Molecular Formulae**

**Copy this prompt into your AI tool:**

*Give me three sets of combustion analysis or  
percentage composition data and ask me to  
determine the empirical formula and, where a  
relative molecular mass is given, the molecular  
formula. Vary the difficulty and include one with a  
hydrated salt.*

**What this helps you practise:**

Deriving empirical and molecular formulae from  
experimental data

**How to use it well:**

Set these out as a table with element, mass, moles,  
and ratio columns. A clear, systematic layout  
dramatically reduces errors in these multi-step  
calculations.

**Prompt 14: Titration Calculations**

**Copy this prompt into your AI tool:**

*Present me with two titration scenarios, one acid-  
base and one involving a back titration or a redox  
titration. Provide the experimental data and ask me  
to calculate the unknown concentration or mass.  
Check my use of the mole ratio from the balanced  
equation.*

**What this helps you practise:**

Applying titration data to determine unknown concentrations

**How to use it well:**

The most common mistake in titration calculations is using the wrong mole ratio. Always write out the balanced equation and explicitly state the ratio before calculating.

**Prompt 15: Enthalpy Changes and Definitions**

**Copy this prompt into your AI tool:**

*Test me on enthalpy changes and their definitions at A-Level Chemistry standard. Ask me to define standard enthalpy of formation, combustion, neutralisation, and atomisation, including standard conditions. Give me thermochemical equations and ask me to identify the type of enthalpy change and calculate enthalpy values using Hess's law. After each answer, check whether I use correct sign conventions and state symbols. Present one question at a time and wait for my response.*

**What this helps you practise:**

Recalling precise definitions of standard enthalpy terms

**How to use it well:**

Definitions must be exact at A-Level. Forgetting to mention standard conditions, one mole, or the correct state symbols will lose you marks. Drill these until they are automatic.

**Prompt 16: Hess's Law Calculations**

**Copy this prompt into your AI tool:**

*Give me an A-Level style Hess's law problem using either enthalpies of formation or enthalpies of combustion. Ask me to draw the energy cycle, write the equation, and calculate the enthalpy change for*

*the target reaction. Then give me a second problem using bond enthalpies.*

**What this helps you practise:**

Constructing Hess's law energy cycles and performing enthalpy calculations

**How to use it well:**

Draw the cycle before doing any arithmetic. Getting the direction of the arrows right is the key step; the calculation itself is straightforward once the cycle is correct.

**Prompt 17: Born-Haber Cycles**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner. Give me the relevant enthalpy data for an ionic compound and ask me to construct a complete Born-Haber cycle, label every step, and calculate the lattice enthalpy. Then ask me to explain why the calculated value might differ from the theoretical value.*

**What this helps you practise:**

Constructing Born-Haber cycles and interpreting lattice enthalpy values

**How to use it well:**

Learn the order of steps in the cycle as a sequence: atomisation, ionisation, electron affinity, then lattice enthalpy. Practise with both Group 1 and Group 2 compounds.

**Prompt 18: Entropy and Feasibility**

**Copy this prompt into your AI tool:**

*Ask me to define entropy and predict the sign of the entropy change for five different reactions, including dissolution, gas-producing reactions, and precipitation. Then give me numerical data and ask me to calculate the total entropy change for a reaction.*

**What this helps you practise:**

Predicting and calculating entropy changes for chemical reactions

**How to use it well:**

Think about the number of moles of gas on each side of the equation as your first check. An increase in gas moles almost always means a positive entropy change.

**Prompt 19: Gibbs Free Energy**

**Copy this prompt into your AI tool:**

*Test me on the Gibbs free energy equation. Give me three scenarios with different combinations of enthalpy and entropy values and ask me to calculate the Gibbs free energy change and determine feasibility. Include one where I must find the temperature at which a reaction becomes feasible.*

**What this helps you practise:**

Calculating Gibbs free energy and determining reaction feasibility

**How to use it well:**

Remember to convert entropy values to kilojoules before substituting into the equation. This unit conversion error is extremely common and costs students marks every year.

**Prompt 20: Atom Economy and Percentage Yield**

**Copy this prompt into your AI tool:**

*Give me two reaction scenarios and ask me to calculate both the atom economy and the percentage yield. Then ask me to explain why a reaction might have high atom economy but low percentage yield, and discuss the green chemistry implications.*

**What this helps you practise:**

Calculating and interpreting atom economy and percentage yield

### **How to use it well:**

Be clear about the difference: atom economy is theoretical and based on the equation, while percentage yield is experimental. Examiners test whether you understand this distinction.

### **Prompt 21: Ideal Gas Equation**

#### **Copy this prompt into your AI tool:**

*Set me a challenge: give me three problems requiring the ideal gas equation  $pV = nRT$ , where each problem requires rearranging for a different variable. Include one where I must convert units before substituting. Check that I use the correct value of R and consistent units throughout.*

#### **What this helps you practise:**

Applying the ideal gas equation with correct unit conversions

#### **How to use it well:**

Write out all unit conversions before substituting into the equation. Convert temperature to kelvin, pressure to pascals, and volume to cubic metres to match the standard value of R.

### **Prompt 22: Multi-Step Quantitative Problem**

#### **Copy this prompt into your AI tool:**

*Give me an A-Level style multi-step calculation that combines at least three quantitative skills: for example, using titration data to find a concentration, then calculating the enthalpy change, and finally determining the percentage uncertainty. Walk me through the mark scheme after I attempt it.*

#### **What this helps you practise:**

Integrating multiple quantitative techniques in extended calculations

#### **How to use it well:**

These questions carry high marks in exams. Practise breaking them into clear stages and labelling each

stage. If you get stuck partway, use a sensible assumed value so you can still attempt later parts.

## Section 3

### Kinetics and Equilibria

Kinetics and equilibria are central to understanding how and why chemical reactions proceed. At A-Level, you move beyond simple collision theory into quantitative treatment of rates, including rate equations, orders of reaction, and the Arrhenius equation.

Equilibrium at A-Level demands mathematical confidence. You must be able to calculate equilibrium constants  $K_c$  and  $K_p$ , interpret their values, and predict how changes in conditions affect the position of equilibrium. The treatment of acids and bases extends to pH calculations for strong and weak acids, buffer solutions, and titration curves.

This section tests your ability to handle both the quantitative and conceptual aspects of these topics. The prompts progress from recalling definitions and simple calculations to analysing experimental data, interpreting graphs, and evaluating industrial applications of equilibrium principles.

#### **Prompt 23: Rate Equations and Orders**

##### **Copy this prompt into your AI tool:**

*Test me on rate equations. Give me experimental data for a reaction showing initial concentrations and initial rates, and ask me to determine the order with respect to each reactant and write the overall rate equation. Then ask me to calculate the rate constant and state its units.*

##### **What this helps you practise:**

Determining reaction orders and rate constants from experimental data

### **How to use it well:**

Look for experiments where only one concentration changes while others remain constant. This allows you to isolate the effect of each reactant and determine its order directly.

### **Prompt 24: Concentration-Time and Rate-Time Graphs**

#### **Copy this prompt into your AI tool:**

*Quiz me on concentration-time and rate-time graphs in A-Level Chemistry. Give me graphs showing reactant concentration or reaction rate against time and ask me to identify the reaction order from the shape, determine initial rates, find half-lives, and explain how the graphs change with temperature or catalyst addition. After each answer, check my graph interpretation and reasoning. Present one question at a time and wait for my response before giving feedback.*

#### **What this helps you practise:**

Interpreting rate graphs to determine reaction order

#### **How to use it well:**

Remember that only first-order reactions have a constant half-life. If you can measure two successive half-lives from a graph and they are equal, the reaction is first-order.

### **Prompt 25: The Arrhenius Equation**

#### **Copy this prompt into your AI tool:**

*Quiz me on the Arrhenius equation  $k = Ae^{(-E_a/RT)}$ . Ask me to define each term, then give me data for two temperatures and rate constants and ask me to calculate the activation energy. Finally, ask me to explain the physical meaning of the equation in terms of the Boltzmann distribution.*

**What this helps you practise:**

Applying the Arrhenius equation to calculate activation energy

**How to use it well:**

Practise the logarithmic form of the equation for calculations. Drawing the Boltzmann distribution helps you explain why higher temperature increases the fraction of molecules exceeding the activation energy.

**Prompt 26: Equilibrium Constants  $K_c$**

**Copy this prompt into your AI tool:**

*Give me an A-Level style problem where I must write the  $K_c$  expression for a given equilibrium, use an ICE table to determine equilibrium concentrations, and calculate the value of  $K_c$ . Include a problem where I must work backwards from a given  $K_c$  to find an unknown equilibrium concentration.*

**What this helps you practise:**

Writing  $K_c$  expressions and performing equilibrium calculations

**How to use it well:**

Set up ICE tables (Initial, Change, Equilibrium) systematically every time. Even when the algebra feels simple, the table prevents sign errors and missed stoichiometric coefficients.

**Prompt 27: Equilibrium Constants  $K_p$**

**Copy this prompt into your AI tool:**

*Ask me to calculate  $K_p$  for a gaseous equilibrium. Provide total pressure and mole data, and require me to calculate mole fractions, partial pressures, and then  $K_p$ . Include a follow-up asking me to explain the relationship between  $K_p$  and  $K_c$ .*

**What this helps you practise:**

Calculating  $K_p$  from mole fractions and partial pressures

**How to use it well:**

Work in a logical sequence: moles to mole fractions to partial pressures to  $K_p$ . Keep extra decimal places during intermediate steps and round only at the end.

**Prompt 28: Le Chatelier's Principle Applied**

**Copy this prompt into your AI tool:**

*Give me an industrial equilibrium such as the Haber process or Contact process. Ask me to predict and explain the effect of changing temperature, pressure, and concentration on the position of equilibrium and on the value of  $K$ . Then ask me to evaluate the compromise conditions used industrially.*

**What this helps you practise:**

Applying Le Chatelier's principle to industrial equilibria

**How to use it well:**

A very common error is saying that  $K$  changes with pressure or concentration. Only temperature changes  $K$ . Practise stating this explicitly in your answers.

**Prompt 29: Strong and Weak Acid pH Calculations**

**Copy this prompt into your AI tool:**

*Test me on pH calculations. Give me the concentration of a strong acid, a strong base, a weak acid (with its  $K_a$ ), and ask me to calculate the pH of each. Include one problem where I must calculate the pH of a diluted strong acid. Check my use of logarithms throughout.*

**What this helps you practise:**

Calculating pH for strong acids, strong bases, and weak acids

**How to use it well:**

For weak acids, write out the  $K_a$  expression and the

assumptions you are making. Examiners award marks for showing the assumption that dissociation is negligible compared to the initial concentration.

### **Prompt 30: Buffer Solutions**

#### **Copy this prompt into your AI tool:**

*You are an A-Level examiner. Ask me to explain how a buffer solution works, including the equilibrium and the role of the conjugate acid-base pair. Then give me data to calculate the pH of a buffer, and ask me to explain what happens when a small amount of acid or base is added.*

#### **What this helps you practise:**

Explaining buffer action and calculating buffer pH

#### **How to use it well:**

Learn to explain buffer action in two parts: what happens when acid is added, and what happens when base is added. Each part must reference the equilibrium shifting and the species that reacts.

### **Prompt 31: Titration Curves and Indicators**

#### **Copy this prompt into your AI tool:**

*Ask me to sketch and label titration curves for strong acid-strong base, weak acid-strong base, strong acid-weak base, and weak acid-weak base titrations. For each, ask me to identify the equivalence point pH, explain why it is above or below 7, and choose an appropriate indicator.*

#### **What this helps you practise:**

Drawing and interpreting titration curves for different acid-base combinations

#### **How to use it well:**

The key to getting these right is knowing that the equivalence point pH depends on the salt formed. A salt of a weak acid and strong base will have a pH above 7 at equivalence.

### **Prompt 32: $K_a$ , $K_b$ , and $K_w$ Relationships**

#### **Copy this prompt into your AI tool:**

*Quiz me on the relationship between  $K_a$ ,  $K_b$ , and  $K_w$ . Ask me to calculate the pH of a solution of a salt of a weak acid and a strong base. Then ask me to explain what happens to  $K_w$  and the pH of pure water as temperature increases, and why water remains neutral.*

#### **What this helps you practise:**

Linking  $K_a$ ,  $K_b$ , and  $K_w$  in acid-base equilibrium calculations

#### **How to use it well:**

Understanding why pure water at higher temperatures has a lower pH but is still neutral is a conceptual question that distinguishes top-grade students. Make sure you can explain it clearly.

### **Prompt 33: Kinetics and Equilibria Synoptic Problem**

#### **Copy this prompt into your AI tool:**

*Give me an A-Level style synoptic question that links kinetics and equilibria. For example, ask me to explain why a catalyst does not change the position of equilibrium but speeds up the attainment of equilibrium, using energy profile diagrams and the concept of equal effect on forward and reverse rates.*

#### **What this helps you practise:**

Connecting kinetics concepts with equilibrium principles in extended reasoning

#### **How to use it well:**

Draw the energy profile diagram with and without the catalyst. The visual makes it much easier to explain why both forward and reverse activation energies are lowered by the same amount.

## Section 4

### Redox and Electrochemistry

Redox chemistry pervades the entire A-Level course, from rusting and combustion to electrode potentials and electrochemical cells. A secure understanding of oxidation states, half-equations, and electron transfer is essential for tackling both inorganic and physical chemistry topics.

At A-Level, electrochemistry becomes quantitative. You must be able to use standard electrode potentials to predict the feasibility of reactions, construct electrochemical cell diagrams, and calculate cell EMFs. You should also understand the limitations of thermodynamic predictions and why some feasible reactions do not occur in practice.

The prompts in this section build from foundational oxidation state assignments through to complex half-equation balancing and electrode potential analysis. The later prompts challenge you to evaluate feasibility arguments and apply electrochemistry to real-world contexts such as fuel cells and batteries.

#### **Prompt 34: Oxidation States**

**Copy this prompt into your AI tool:**

*Test me on oxidation states at A-Level Chemistry standard. Give me a range of compounds and polyatomic ions and ask me to assign oxidation states to each atom. Include transition metal compounds, oxyanions, and molecules where the rules need careful application. Then give me equations and ask me to identify which species is oxidised and which is reduced by tracking oxidation state changes. After each answer, check my*

*assignments and correct any errors. Present one question at a time.*

**What this helps you practise:**

Assigning oxidation states in complex compounds and polyatomic ions

**How to use it well:**

Always apply the rules in order: free elements are zero, then use the known oxidation states of common elements to work out the unknown. Practise with unfamiliar species to build confidence.

**Prompt 35: Writing Half-Equations**

**Copy this prompt into your AI tool:**

*Ask me to write balanced half-equations for five different redox processes, including at least one in acidic solution and one in alkaline solution. Require me to balance atoms, then oxygen using water, then hydrogen using  $H^+$  ions, and finally charge using electrons.*

**What this helps you practise:**

Balancing half-equations systematically in acidic and alkaline conditions

**How to use it well:**

Follow the four-step method every time: balance the element being oxidised or reduced, then oxygen, then hydrogen, then charge. This systematic approach prevents errors.

**Prompt 36: Combining Half-Equations**

**Copy this prompt into your AI tool:**

*Give me pairs of half-equations and ask me to combine them into full balanced redox equations. Include one pair where the electron numbers do not initially match and must be multiplied. Check my final equation balances for atoms and charge.*

**What this helps you practise:**

Constructing complete redox equations from half-equation pairs

**How to use it well:**

The number of electrons lost in oxidation must equal the number gained in reduction. If they do not match, multiply one or both half-equations before combining.

**Prompt 37: Identifying Oxidising and Reducing Agents**

**Copy this prompt into your AI tool:**

*Present me with four complete redox reactions and ask me to identify the oxidising agent and reducing agent in each. Then ask me to explain why a particular species acts as a good oxidising agent, using its electron configuration or position in the reactivity series.*

**What this helps you practise:**

Identifying and explaining the roles of oxidising and reducing agents

**How to use it well:**

Remember: the oxidising agent is reduced and the reducing agent is oxidised. This can feel counterintuitive, so practise stating which species gains and which loses electrons.

**Prompt 38: Standard Electrode Potentials**

**Copy this prompt into your AI tool:**

*Test me on standard electrode potentials. Give me a table of  $E^\ominus$  values and ask me to use them to predict which reactions are feasible. Include one example where the reaction is thermodynamically feasible but kinetically hindered, and ask me to explain why.*

**What this helps you practise:**

Using standard electrode potentials to predict reaction feasibility

**How to use it well:**

The more positive the overall cell EMF, the more feasible the reaction. But always mention that a positive EMF means thermodynamic feasibility, not that the reaction will necessarily occur at an observable rate.

**Prompt 39: Electrochemical Cells**

**Copy this prompt into your AI tool:**

*Ask me to draw a labelled diagram of an electrochemical cell, including the salt bridge, electrodes, and direction of electron flow. Then give me electrode potential data and ask me to calculate the cell EMF and write the overall cell reaction.*

**What this helps you practise:**

Constructing electrochemical cell diagrams and calculating EMF values

**How to use it well:**

Remember the convention: the more negative electrode is the anode (oxidation occurs here) and the more positive electrode is the cathode (reduction occurs here). Electrons flow from anode to cathode.

**Prompt 40: Cell Notation and Conventions**

**Copy this prompt into your AI tool:**

*Give me an A-Level style question asking me to write cell diagrams using conventional notation for three different electrochemical cells. Ask me to explain each component of the notation, including the salt bridge, phase boundaries, and the convention for which half-cell is written on the left.*

**What this helps you practise:**

Writing and interpreting electrochemical cell notation

### **How to use it well:**

Learn the convention that the left-hand half-cell is the one being oxidised. Practise converting between cell diagrams and written descriptions of cells.

### **Prompt 41: Redox Titrations**

#### **Copy this prompt into your AI tool:**

*Quiz me on redox titrations at A-Level Chemistry standard. Present me with titration scenarios involving potassium manganate(VII) or potassium dichromate(VI) and ask me to write balanced half-equations and the overall ionic equation. Then give me quantitative data and ask me to calculate unknown concentrations or masses from the titration results. After each answer, check my balancing and calculations. Present one problem at a time and wait for my response.*

#### **What this helps you practise:**

Performing redox titration calculations with half-equation balancing

#### **How to use it well:**

In manganate(VII) titrations, the end point is the first permanent pink colour. In iodine-thiosulfate titrations, starch indicator is added near the end point. Know these practical details for exam questions.

### **Prompt 42: Fuel Cells and Batteries**

#### **Copy this prompt into your AI tool:**

*Test me on fuel cells and batteries at A-Level Chemistry standard. Ask me to explain how a hydrogen fuel cell works, including the electrode reactions in acidic and alkaline conditions. Then ask me to compare fuel cells with rechargeable and non-rechargeable batteries in terms of efficiency, environmental impact, and practicality. Give me calculation problems involving energy output. After*

*each answer, check my electrode equations and reasoning. Present one question at a time.*

**What this helps you practise:**

Explaining fuel cell operation and evaluating energy storage technologies

**How to use it well:**

This topic frequently appears as an extended response or evaluative question. Prepare a balanced argument covering efficiency, practicality, environmental impact, and cost.

**Prompt 43: Disproportionation Reactions**

**Copy this prompt into your AI tool:**

*Set me a challenge: give me two examples of disproportionation reactions and ask me to identify the element that is simultaneously oxidised and reduced. Ask me to assign oxidation states, write half-equations for each process, and explain what makes these reactions distinctive.*

**What this helps you practise:**

Identifying and analysing disproportionation as a special type of redox reaction

**How to use it well:**

The key feature of disproportionation is that the same element in a single oxidation state is both oxidised and reduced. Chlorine in alkali and copper(I) compounds are classic examples.

**Prompt 44: Electrode Potential Feasibility Evaluation**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner setting a six-mark question. Ask me to evaluate the statement: 'A positive cell EMF means a reaction will always occur.' Require me to discuss thermodynamic versus kinetic feasibility, the effect of non-standard*

*conditions, and limitations of electrode potential data.*

**What this helps you practise:**

Evaluating the limitations of electrode potential predictions

**How to use it well:**

This is a classic evaluative question. Structure your answer around three limitations: kinetic barriers, non-standard conditions, and the assumption of reversibility. Each point earns marks independently.

## Section 5

### Periodicity and Inorganic Chemistry

Inorganic chemistry at A-Level builds on your understanding of atomic structure and bonding to explain the characteristic properties of elements and their compounds across periods and down groups. You are expected to know the chemistry of Period 3, Group 2, Group 7, and the transition metals in considerable detail.

Transition metal chemistry is a major topic at A-Level, encompassing variable oxidation states, complex ion formation, colour, catalysis, and precipitation reactions. You need to be able to explain the colours of complex ions using d-orbital splitting, predict products of ligand exchange reactions, and write equations for the formation and reactions of complexes.

The prompts in this section cover both the descriptive chemistry that you must know and the explanatory frameworks that allow you to rationalise observations. Being able to link observations to underlying theory is what separates competent answers from excellent ones at A-Level.

#### **Prompt 45: Period 3 Oxides and Chlorides**

##### **Copy this prompt into your AI tool:**

*Test me on the reactions of Period 3 oxides and chlorides with water. For each compound from Na<sub>2</sub>O to P<sub>4</sub>O<sub>10</sub> and NaCl to SiCl<sub>4</sub>, ask me to write the equation, predict whether the solution formed is acidic or basic, and explain the trend in terms of bonding character.*

##### **What this helps you practise:**

Describing and explaining the reactions of Period 3 compounds with water

### **How to use it well:**

Learn the equations and the pH of the resulting solutions. The trend from basic to acidic oxides and from ionic to covalent chlorides is the key pattern that examiners test.

### **Prompt 46: Group 2 Reactions and Trends**

#### **Copy this prompt into your AI tool:**

*Quiz me on the reactions of Group 2 elements with water and oxygen, and the thermal stability of their carbonates and nitrates. Ask me to write equations and explain the trends down the group in terms of ionic radius, charge density, and polarising power.*

#### **What this helps you practise:**

Explaining Group 2 reactivity and thermal stability trends

#### **How to use it well:**

Polarising power is the crucial concept here. Smaller, more highly charged cations polarise anions more effectively, destabilising the carbonate. Make sure you can explain this mechanism clearly.

### **Prompt 47: Group 7 Properties and Reactions**

#### **Copy this prompt into your AI tool:**

*Give me an A-Level style question on Group 7 chemistry. Cover the trend in boiling points, the displacement reactions of halogens, and the reactions of halide ions with concentrated sulfuric acid. Ask me to write ionic equations and explain observations for each halide.*

#### **What this helps you practise:**

Describing halogen displacement reactions and halide ion reducing power

#### **How to use it well:**

The reactions of halide ions with concentrated sulfuric acid are a favourite exam topic. Learn the

observations (gas colour, smell) and the equations for chloride, bromide, and iodide separately.

### **Prompt 48: Tests for Halide Ions**

#### **Copy this prompt into your AI tool:**

*Ask me to describe the test for halide ions using silver nitrate solution and dilute nitric acid. Require me to state the observations for chloride, bromide, and iodide, write the ionic equations, and explain how to confirm the identity using ammonia solution.*

#### **What this helps you practise:**

Identifying halide ions through qualitative analytical tests

#### **How to use it well:**

The ammonia solubility test is the distinguishing step: AgCl dissolves in dilute ammonia, AgBr dissolves in concentrated ammonia, and AgI is insoluble in both. Memorise this pattern.

### **Prompt 49: Transition Metal Properties**

#### **Copy this prompt into your AI tool:**

*Quiz me on the properties of transition metals at A-Level Chemistry standard. Ask me to explain why transition metals form coloured compounds, exhibit variable oxidation states, and act as catalysts. Test whether I can relate these properties to the partially filled d-orbitals. Give me specific examples of transition metal ions and ask me to predict their oxidation states and explain their catalytic roles. After each answer, check my reasoning. Present one question at a time.*

#### **What this helps you practise:**

Explaining the characteristic properties of transition metals

#### **How to use it well:**

The definition of a transition metal is very specific: it must form at least one stable ion with a partially

filled d sub-shell. Zinc is not a transition metal by this definition. Know why.

### **Prompt 50: Complex Ions and Ligands**

**Copy this prompt into your AI tool:**

*Quiz me on complex ion chemistry. Give me several complex ions and ask me to identify the central metal ion, its oxidation state, the coordination number, and the type of ligand (monodentate, bidentate, or multidentate). Include examples with water, ammonia, chloride, and EDTA.*

**What this helps you practise:**

Analysing the composition and geometry of transition metal complex ions

**How to use it well:**

Link coordination number to shape: 6 gives octahedral, 4 gives tetrahedral or square planar. Practise drawing three-dimensional representations showing the spatial arrangement of ligands.

### **Prompt 51: Ligand Exchange Reactions**

**Copy this prompt into your AI tool:**

*Test me on ligand exchange reactions at A-Level Chemistry standard. Present scenarios involving substitution of ligands around a transition metal ion and ask me to write equations, predict colour changes, and explain changes in coordination number. Include examples such as the addition of ammonia or chloride ions to aqueous copper(II) or cobalt(II) ions. After each answer, check my equations and colour predictions. Present one question at a time and wait for my response.*

**What this helps you practise:**

Predicting and explaining ligand substitution reactions and colour changes

**How to use it well:**

When bidentate or multidentate ligands replace

monodentate ligands, the entropy change is favourable because more free particles are released. This drives the chelate effect.

### **Prompt 52: Colour in Transition Metal Compounds**

#### **Copy this prompt into your AI tool:**

*You are an A-Level examiner. Ask me to explain why transition metal complex ions are coloured, using the concept of d-orbital splitting. Then ask me to explain why some complexes change colour when ligands are exchanged, and why some d-block compounds are colourless.*

#### **What this helps you practise:**

Explaining the origin of colour in transition metal complexes using d-orbital theory

#### **How to use it well:**

The explanation must include: ligands cause d-orbital splitting, light of specific frequencies is absorbed for d-d transitions, and the complementary colour is observed. A colourless complex has either empty or full d orbitals.

### **Prompt 53: Transition Metals as Catalysts**

#### **Copy this prompt into your AI tool:**

*Ask me to explain why transition metals and their compounds are effective catalysts, using examples of both homogeneous and heterogeneous catalysis. Require me to name the catalyst, the reaction it catalyses, and the mechanism by which it works, including any intermediate oxidation states.*

#### **What this helps you practise:**

Explaining homogeneous and heterogeneous catalytic mechanisms

#### **How to use it well:**

For homogeneous catalysis, the key idea is that the catalyst changes oxidation state during the reaction,

forming intermediates, then is regenerated. Iron ions in the reaction of persulfate with iodide is a classic example.

### **Prompt 54: Precipitation and Sodium Hydroxide Tests**

#### **Copy this prompt into your AI tool:**

*Give me a set of transition metal ion solutions and ask me to predict the observations when sodium hydroxide solution is added dropwise until in excess. Include  $Fe^{2+}$ ,  $Fe^{3+}$ ,  $Cu^{2+}$ , and  $Cr^{3+}$ . Ask me to write ionic equations and explain any colour changes in excess NaOH.*

#### **What this helps you practise:**

Predicting precipitate formation and amphoteric behaviour of metal hydroxides

#### **How to use it well:**

Learn the colours of each precipitate and whether it dissolves in excess NaOH. Chromium(III) hydroxide is amphoteric and dissolves to give a green solution.

This is a commonly tested distinction.

### **Prompt 55: Inorganic Chemistry Synoptic Challenge**

#### **Copy this prompt into your AI tool:**

*Set me a challenge: give me an unknown transition metal compound and a series of experimental observations (colour, precipitate tests, flame tests, reactions with acid). Ask me to use these observations systematically to identify the metal ion and the anion present, explaining my reasoning at each step.*

#### **What this helps you practise:**

Applying qualitative analysis techniques to identify unknown inorganic compounds

#### **How to use it well:**

Approach this like a detective: eliminate possibilities

systematically based on each observation. This mirrors the style of synoptic inorganic questions that require you to draw on knowledge from multiple topics.

## Section 6

### Organic Chemistry – Foundations

Organic chemistry at A-Level requires you to understand not just the reactions of functional groups, but the mechanisms by which those reactions occur. Nucleophilic substitution, electrophilic addition, and free radical substitution are fundamental mechanisms that you must be able to draw using curly arrow notation.

The foundational organic topics cover alkanes, alkenes, halogenoalkanes, and alcohols. For each functional group, you need to know the characteristic reactions, the conditions required, the products formed, and the underlying mechanism. You should also be able to classify reactions by type and explain why certain reagents react with certain functional groups.

The prompts in this section ensure you can recall the core reactions confidently, apply curly arrow mechanisms to explain how bonds break and form, and begin to think about how different functional groups can be interconverted. This lays the groundwork for the more advanced organic chemistry and synthesis planning in the next section.

#### **Prompt 56: Naming and Drawing Organic Compounds**

**Copy this prompt into your AI tool:**

*Test me on IUPAC nomenclature. Give me structural or displayed formulae of eight organic compounds spanning alkanes, alkenes, halogenoalkanes, and alcohols, and ask me to name them. Then give me four names and ask me to draw the structures. Include branched chains and positional isomers.*

**What this helps you practise:**

Applying IUPAC nomenclature rules to name and draw organic compounds

**How to use it well:**

Naming questions appear throughout the exam, not just in organic sections. If you consistently get names wrong, it undermines your answers across multiple questions. Drill this until it is automatic.

**Prompt 57: Types of Isomerism**

**Copy this prompt into your AI tool:**

*Quiz me on structural isomerism and stereoisomerism. Give me a molecular formula and ask me to draw all the structural isomers, then give me molecules that exhibit E/Z stereoisomerism and ask me to draw and name both isomers using Cahn-Ingold-Prelog priority rules.*

**What this helps you practise:**

Identifying and drawing structural isomers and E/Z stereoisomers

**How to use it well:**

For structural isomers, work systematically: draw the longest chain first, then all possible branching positions, then change the functional group position. For E/Z, always assign priorities before deciding the configuration.

**Prompt 58: Alkane Reactions and Free Radical Substitution**

**Copy this prompt into your AI tool:**

*Ask me to outline the free radical substitution mechanism for the reaction of methane with chlorine. Require me to show initiation, propagation, and termination steps with correct use of curly arrows and radical notation. Then ask me to explain why a mixture of products is formed.*

**What this helps you practise:**

Drawing the free radical substitution mechanism with correct notation

**How to use it well:**

Use single-headed (fish-hook) curly arrows for radical mechanisms, not the double-headed arrows used in ionic mechanisms. This is a common error that costs marks.

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**Prompt 59: Alkene Addition Reactions**

**Copy this prompt into your AI tool:**

*Quiz me on alkene addition reactions at A-Level Chemistry standard. Test whether I can describe and explain the mechanisms of electrophilic addition reactions of alkenes with hydrogen bromide, bromine, sulfuric acid, and hydrogen. Include the concept of Markovnikov's rule and ask me to predict major products. Give me specific alkenes and ask me to draw the mechanism showing curly arrows and intermediates. After each answer, check my mechanism. Present one question at a time.*

**What this helps you practise:**

Recalling the addition reactions of alkenes with appropriate conditions

**How to use it well:**

Create a summary table of alkene reactions with columns for reagent, conditions, product, and reaction type. This format makes revision efficient and highlights any gaps.

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**Prompt 60: Electrophilic Addition Mechanism**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner. Ask me to draw the mechanism for the electrophilic addition of HBr to propene. Require correct curly arrows showing the movement of electron pairs, the formation of the carbocation intermediate, and the attack of the*

*nucleophile. Then ask me to explain Markovnikov's rule.*

**What this helps you practise:**

Drawing electrophilic addition mechanisms with correct curly arrow notation

**How to use it well:**

Every curly arrow must start from a bond or lone pair and end at an atom or between two atoms. Examiners check this precisely. Practise until your arrow placement is exact.

**Prompt 61: Halogenoalkane Reactions**

**Copy this prompt into your AI tool:**

*Test me on halogenoalkane reactions at A-Level Chemistry standard. Give me halogenoalkanes and ask me to predict the products and classify the reaction type for nucleophilic substitution with hydroxide ions, cyanide ions, and ammonia, as well as elimination reactions. Ask me to draw mechanisms showing curly arrows and explain how the type of halogenoalkane affects the mechanism. After each answer, check my mechanisms and products. Present one question at a time.*

**What this helps you practise:**

Recalling nucleophilic substitution reactions of halogenoalkanes

**How to use it well:**

The three key nucleophiles (OH<sup>-</sup>, CN<sup>-</sup>, NH<sub>3</sub>) each produce a different functional group. Cyanide extends the carbon chain by one carbon, which is important for synthesis questions.

**Prompt 62: Nucleophilic Substitution Mechanisms**

**Copy this prompt into your AI tool:**

*Ask me to draw the mechanism for nucleophilic substitution of a primary halogenoalkane with*

*hydroxide ions (SN2). Then ask me to draw the SN1 mechanism for a tertiary halogenoalkane. Require me to explain why primary halogenoalkanes undergo SN2 and tertiary undergo SN1.*

**What this helps you practise:**

Drawing SN1 and SN2 mechanisms and explaining the factors that determine the pathway

**How to use it well:**

The key factors are steric hindrance (primary versus tertiary) and carbocation stability. Practise explaining both mechanisms and why each substrate favours its particular pathway.

**Prompt 63: Elimination versus Substitution**

**Copy this prompt into your AI tool:**

*Quiz me on elimination versus substitution in organic chemistry at A-Level standard. Give me specific halogenoalkane reactions and ask me to predict whether elimination or nucleophilic substitution will dominate, based on the type of halogenoalkane (primary, secondary, tertiary), the reagent used, and the reaction conditions such as solvent and temperature. After each answer, check my prediction and reasoning. Present one question at a time and wait for my response.*

**What this helps you practise:**

Predicting competition between elimination and substitution pathways

**How to use it well:**

Strong bases and high temperatures favour elimination. Weaker nucleophiles and lower temperatures favour substitution. The substrate type also matters: tertiary halogenoalkanes favour elimination.

**Prompt 64: Alcohol Reactions and Classifications**

**Copy this prompt into your AI tool:**

*Quiz me on alcohol chemistry. Ask me to classify alcohols as primary, secondary, or tertiary, then test me on reactions including oxidation (with acidified dichromate), dehydration, and esterification. For oxidation, ask me to distinguish the products for each class of alcohol.*

**What this helps you practise:**

Classifying alcohols and predicting their oxidation products

**How to use it well:**

Primary alcohols can be oxidised to aldehydes (distillation) or carboxylic acids (reflux). Secondary alcohols give ketones. Tertiary alcohols resist oxidation. This distinction is tested frequently.

**Prompt 65: Testing for Functional Groups**

**Copy this prompt into your AI tool:**

*Give me five unknown organic compounds and ask me to describe the chemical tests I would use to distinguish between them. Include tests for alkenes, alcohols, aldehydes, ketones, and halogenoalkanes. Require me to state the reagent, conditions, positive result observation, and the equation.*

**What this helps you practise:**

Designing and interpreting chemical tests to identify organic functional groups

**How to use it well:**

For each test, know the reagent, what you add, the observation for a positive result, and what it tells you. Tollens' reagent and Fehling's solution distinguish aldehydes from ketones.

**Prompt 66: Organic Reaction Pathways**

**Copy this prompt into your AI tool:**

*Set me a challenge: give me a starting molecule and a target molecule, and ask me to plan a two-step*

*synthesis route. I must state the reagents, conditions, and intermediate for each step. Include a conversion that requires changing the functional group and extending or modifying the carbon chain.*

**What this helps you practise:**

Planning multi-step organic synthesis routes with correct reagents and conditions

**How to use it well:**

Work backwards from the target molecule. Identify the functional group in the product and think about which reaction produces it. Then identify a suitable starting material or intermediate.

**Prompt 67: Combustion and Environmental Impact**

**Copy this prompt into your AI tool:**

*Test me on combustion reactions and their environmental impact at A-Level Chemistry standard. Ask me to write balanced equations for complete and incomplete combustion of hydrocarbons and explain the products formed. Then quiz me on the environmental consequences, including carbon dioxide and climate change, carbon monoxide toxicity, sulfur dioxide and acid rain, and particulate formation. After each answer, check my equations and environmental explanations. Present one question at a time.*

**What this helps you practise:**

Explaining combustion reactions and evaluating their environmental significance

**How to use it well:**

This topic blends chemistry with environmental awareness. Be prepared to discuss both the chemistry and the broader implications, as extended response questions in this area often require evaluation.

## Section 7

### Organic Chemistry – Advanced

Advanced organic chemistry at A-Level introduces carbonyl compounds, carboxylic acids and their derivatives, amines, amino acids, and polymers. You need to know the characteristic reactions of each functional group and understand how they connect in longer synthetic pathways.

Optical isomerism becomes important at this level, and you must be able to identify chiral centres, draw enantiomers, and explain how they interact with plane-polarised light. The concept of chirality links to biological molecules such as amino acids and pharmaceutical compounds.

This section challenges you to apply your mechanistic understanding to new functional groups, plan multi-step syntheses, and evaluate the suitability of different synthetic routes. The later prompts push towards the kind of synoptic thinking required for the highest grades at A-Level.

#### **Prompt 68: Carbonyl Compound Reactions**

##### **Copy this prompt into your AI tool:**

*Test me on the reactions of aldehydes and ketones.*

*Ask me to predict the products of nucleophilic addition with HCN, and the products of reduction with NaBH<sub>4</sub>. Then ask me how to distinguish between an aldehyde and a ketone using chemical tests.*

##### **What this helps you practise:**

Recalling nucleophilic addition reactions of carbonyl compounds

##### **How to use it well:**

The nucleophilic addition of HCN is mechanistically

important. Practise drawing the mechanism with correct curly arrows showing the nucleophilic attack on the electrophilic carbon.

**Prompt 69: Nucleophilic Addition Mechanism**

**Copy this prompt into your AI tool:**

*Ask me to draw the mechanism for the nucleophilic addition of cyanide ions to a carbonyl compound.*

*Require correct curly arrows, identification of the nucleophile and electrophilic centre, and labelling of the intermediate. Then ask me why cyanide addition is synthetically useful.*

**What this helps you practise:**

Drawing nucleophilic addition mechanisms for carbonyl chemistry

**How to use it well:**

Cyanide addition creates a new C-C bond and introduces a nitrile group that can be hydrolysed to a carboxylic acid. This is important for synthesis route questions.

**Prompt 70: Carboxylic Acids and Esters**

**Copy this prompt into your AI tool:**

*Quiz me on carboxylic acid reactions. Include esterification with an alcohol, reaction with bases and carbonates, and reduction with  $\text{LiAlH}_4$ . Then ask me to draw the structure of a specific ester given an acid and an alcohol, and to name it.*

**What this helps you practise:**

Predicting products and writing equations for carboxylic acid reactions

**How to use it well:**

Esterification is a reversible reaction requiring an acid catalyst. In exams, always state the catalyst (concentrated sulfuric acid) and the condition (reflux) for full marks.

### **Prompt 71: Acyl Chlorides and Acid Anhydrides**

#### **Copy this prompt into your AI tool:**

*Give me an A-Level style question on the reactions of acyl chlorides and acid anhydrides with water, alcohols, and amines. Ask me to write equations for each reaction, identify the type of reaction, and explain why acyl chlorides are more reactive than carboxylic acids.*

#### **What this helps you practise:**

Comparing the reactivity and reactions of acyl chlorides and acid anhydrides

#### **How to use it well:**

These reactions all involve nucleophilic addition-elimination. Learn the pattern: the nucleophile attacks the carbonyl carbon, and HCl or a carboxylic acid is eliminated.

### **Prompt 72: Amines: Preparation and Reactions**

#### **Copy this prompt into your AI tool:**

*Test me on the preparation of amines from halogenoalkanes and from the reduction of nitriles. Then ask me to explain the basicity of amines, compare the basicity of primary aliphatic amines, aromatic amines, and ammonia, and explain the differences using inductive and delocalisation effects.*

#### **What this helps you practise:**

Explaining amine basicity and preparation methods

#### **How to use it well:**

The basicity comparison is a classic A-Level question. Aliphatic amines are more basic than ammonia because of the positive inductive effect of alkyl groups. Aromatic amines are less basic because the lone pair is delocalised into the ring.

### **Prompt 73: Amino Acids and Proteins**

#### **Copy this prompt into your AI tool:**

*Quiz me on amino acid chemistry. Ask me to draw the general structure, explain zwitterion formation, predict the behaviour of amino acids at different pH values, and describe how amino acids form peptide bonds. Include a question about gel electrophoresis and isoelectric points.*

**What this helps you practise:**

Understanding amino acid structure, zwitterion behaviour, and peptide bond formation

**How to use it well:**

Draw the amino acid at low pH (fully protonated), at the isoelectric point (zwitterion), and at high pH (fully deprotonated). This shows examiners you understand the acid-base chemistry involved.

**Prompt 74: Optical Isomerism**

**Copy this prompt into your AI tool:**

*Present me with five organic molecules and ask me to identify which contain a chiral centre. For those that do, ask me to draw both enantiomers, explain how they interact with plane-polarised light, and describe what a racemic mixture is and how it can be formed.*

**What this helps you practise:**

Identifying chiral centres and drawing enantiomers

**How to use it well:**

A chiral centre is a carbon bonded to four different groups. Practise spotting these in larger molecules and in reaction products. Nucleophilic addition to a carbonyl compound creates a new chiral centre.

**Prompt 75: Condensation Polymers**

**Copy this prompt into your AI tool:**

*Quiz me on condensation polymers at A-Level Chemistry standard. Ask me to explain how condensation polymerisation differs from addition polymerisation, identify the monomers needed to*

*form polyesters and polyamides, and draw repeating units showing the linkage formed. Include questions on the hydrolysis of condensation polymers and the environmental implications. After each answer, check my structural drawings and reasoning. Present one question at a time and wait for my response.*

**What this helps you practise:**

Drawing condensation polymer repeating units and comparing polymer types

**How to use it well:**

To draw the repeating unit, identify where the ester or amide bond forms and what small molecule is eliminated. Practise with different monomer combinations until you can do this confidently.

**Prompt 76: Organic Synthesis Route Planning**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner. Give me a target molecule and ask me to plan a complete synthesis route from a simple starting material in no more than four steps. I must state the reagent, conditions, and product for each step. Then ask me to justify my choice of route over an alternative.*

**What this helps you practise:**

Designing and justifying multi-step organic synthesis pathways

**How to use it well:**

Build a mental map of functional group interconversions. The key transformations to know are: halogenoalkane to alcohol, alcohol to aldehyde/ketone/carboxylic acid, halogenoalkane to nitrile to carboxylic acid, and halogenoalkane to amine.

**Prompt 77: Reaction Mechanisms Summary Challenge**

**Copy this prompt into your AI tool:**

*Set me a challenge: give me five reactions and ask me to classify each mechanism as free radical substitution, electrophilic addition, nucleophilic substitution, or nucleophilic addition. For two of them, ask me to draw the complete mechanism with curly arrows. Mix reactions from across all organic topics.*

**What this helps you practise:**

Classifying and drawing organic reaction mechanisms across multiple functional groups

**How to use it well:**

Being able to classify mechanisms quickly is a valuable exam skill. The type of mechanism is determined by the functional group present and the nature of the attacking species.

**Prompt 78: Evaluating Organic Synthesis in Context**

**Copy this prompt into your AI tool:**

*Give me an A-Level style evaluative question about organic synthesis in industry. Ask me to compare two possible synthetic routes to the same product, considering yield, atom economy, waste products, safety, cost of reagents, and environmental impact. Require a justified conclusion.*

**What this helps you practise:**

Evaluating and comparing organic synthesis routes using multiple criteria

**How to use it well:**

Evaluative questions require balanced arguments. Discuss at least three factors, explain how they trade off against each other, and reach a conclusion that acknowledges the complexity of the decision.

## Section 8

### Analytical Chemistry

Analytical chemistry at A-Level equips you with the tools to determine the structure of unknown organic compounds. Mass spectrometry, infrared spectroscopy, and nuclear magnetic resonance spectroscopy each provide different information, and the skill lies in combining data from multiple techniques to deduce a molecular structure.

Mass spectrometry reveals molecular mass and fragmentation patterns. Infrared spectroscopy identifies functional groups through characteristic absorption frequencies. Proton and carbon-13 NMR spectroscopy reveal the chemical environment and connectivity of atoms within the molecule. Chromatography separates mixtures and can provide evidence of purity.

The prompts in this section progress from interpreting individual spectra to combining multiple analytical datasets to solve structural puzzles. This combined approach mirrors the style of A-Level exam questions, which frequently present data from two or three techniques and ask you to work out the structure.

#### **Prompt 79: Mass Spectrometry of Organic Compounds**

**Copy this prompt into your AI tool:**

*Test me on interpreting mass spectra. Give me a molecular ion peak and a fragmentation pattern, and ask me to determine the molecular formula and suggest structures for the major fragment ions. Include a spectrum where the M+1 or M+2 peak provides useful information.*

**What this helps you practise:**

Interpreting molecular ion peaks and fragmentation patterns in mass spectra

**How to use it well:**

Learn the common fragment losses: 15 (CH<sub>3</sub>), 17 (OH), 29 (CHO or C<sub>2</sub>H<sub>5</sub>), 45 (OC<sub>2</sub>H<sub>5</sub>). When you see a gap between peaks, check if it matches one of these common losses.

**Prompt 80: Infrared Spectroscopy Interpretation**

**Copy this prompt into your AI tool:**

*Give me three IR spectra (described as wavenumber and absorption data) and ask me to identify the functional groups present using the characteristic absorption ranges. Then ask me to match each spectrum to one of four possible compounds, explaining my reasoning.*

**What this helps you practise:**

Identifying functional groups from infrared absorption data

**How to use it well:**

You do not need to memorise every wavenumber. Focus on the key absorptions: broad O-H (alcohol or carboxylic acid), sharp C=O (carbonyl), and N-H (amine or amide). A data sheet is provided in the exam.

**Prompt 81: Proton NMR: Chemical Shift and Integration**

**Copy this prompt into your AI tool:**

*Quiz me on proton NMR. Give me a molecular formula and a proton NMR spectrum with chemical shift values, integration ratios, and splitting patterns. Ask me to determine the number of hydrogen environments, the type of hydrogen in*

*each environment, and propose a structure consistent with the data.*

**What this helps you practise:**

Interpreting chemical shift, integration, and splitting in proton NMR spectra

**How to use it well:**

Work systematically: molecular formula gives you the degree of unsaturation, integration gives the ratio of protons, chemical shift tells you the environment, and splitting tells you adjacent protons.

**Prompt 82: NMR Splitting Patterns**

**Copy this prompt into your AI tool:**

*Ask me to predict the splitting pattern for each set of equivalent protons in three given molecules.*

*Require me to use the  $n+1$  rule and explain why each signal appears as a singlet, doublet, triplet, or quartet. Then give me splitting data and ask me to work backwards to the structure.*

**What this helps you practise:**

Applying the  $n+1$  rule to predict and interpret NMR splitting patterns

**How to use it well:**

Draw the molecule and identify each distinct proton environment. Count the protons on adjacent carbons to determine the splitting. Practise both predicting and interpreting until you are equally confident in both directions.

**Prompt 83: Carbon-13 NMR**

**Copy this prompt into your AI tool:**

*Present me with carbon-13 NMR data showing the number of peaks and their chemical shifts for three compounds. Ask me to determine the number of carbon environments in each and match the spectra*

*to possible structures. Explain how symmetry reduces the number of peaks.*

**What this helps you practise:**

Interpreting carbon-13 NMR spectra to determine carbon environments

**How to use it well:**

The number of peaks equals the number of distinct carbon environments. Symmetrical molecules have fewer peaks than you might expect. Always look for symmetry elements before counting environments.

**Prompt 84: D2O Shake in NMR**

**Copy this prompt into your AI tool:**

*Ask me to explain what happens during a D2O shake in proton NMR and why certain peaks disappear.*

*Give me an NMR spectrum before and after a D2O shake and ask me to identify which functional group was responsible for the peak that vanished.*

**What this helps you practise:**

Using the D2O shake technique to identify exchangeable protons in NMR

**How to use it well:**

O-H and N-H protons are exchangeable and disappear after a D2O shake. This is a quick diagnostic tool that often appears in combined analytical questions.

**Prompt 85: Chromatography Techniques**

**Copy this prompt into your AI tool:**

*Test me on chromatography techniques at A-Level Chemistry standard. Ask me to explain the principles of thin-layer chromatography, column chromatography, and gas chromatography, including the roles of the stationary and mobile phases. Give me Rf value data and retention time data and ask me to interpret them to identify substances. After each answer, check my understanding of separation*

*principles and calculations. Present one question at a time and wait for my response.*

**What this helps you practise:**

Explaining chromatographic separation principles and interpreting results

**How to use it well:**

For TLC, practise calculating and comparing R<sub>f</sub> values. For GC, understand that the area under each peak is proportional to the amount of that component. GC-MS questions often require you to interpret both the chromatogram and the mass spectrum.

**Prompt 86: Combined Analytical Techniques — Basic**

**Copy this prompt into your AI tool:**

*Give me a molecular formula and data from IR and proton NMR spectroscopy. Ask me to use all the data together to determine the structure of the unknown compound. Walk through the problem one technique at a time and check my reasoning at each stage.*

**What this helps you practise:**

Combining IR and NMR data to deduce organic molecular structures

**How to use it well:**

Start with the molecular formula to calculate the degree of unsaturation. Then use IR to identify functional groups. Finally, use NMR to determine the connectivity. This order ensures you narrow down possibilities efficiently.

**Prompt 87: Combined Analytical Techniques — Advanced**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner. Give me a challenging structure determination problem with data from*

*mass spectrometry, IR, proton NMR (including splitting), and carbon-13 NMR. Ask me to deduce the structure, draw it, and justify my answer using evidence from each technique.*

**What this helps you practise:**

Solving complex structural problems using all four analytical techniques

**How to use it well:**

These questions are worth many marks in exams.

Practise writing justifications that explicitly reference the data: 'The peak at 1715 cm<sup>-1</sup> in the IR indicates a C=O group' is far better than 'The IR shows a carbonyl.'

**Prompt 88: Evaluating Analytical Methods**

**Copy this prompt into your AI tool:**

*Set me a challenge: ask me to evaluate which analytical technique or combination of techniques would be most suitable for solving three different practical problems. Examples might include confirming the identity of a synthesis product, checking the purity of a pharmaceutical compound, or distinguishing between two structural isomers.*

**What this helps you practise:**

Selecting and justifying appropriate analytical techniques for different scenarios

**How to use it well:**

Think about what information each technique provides and match it to the question being asked.

NMR is best for connectivity, IR for functional groups, mass spec for molecular mass, and chromatography for purity.

**Prompt 89: Degree of Unsaturation**

**Copy this prompt into your AI tool:**

*Give me an A-Level style question where I must calculate the degree of unsaturation (index of*

*hydrogen deficiency) from a molecular formula, and use this to narrow down possible structures before analysing spectral data. Include compounds with rings, double bonds, and aromatic systems.*

**What this helps you practise:**

Calculating and applying degree of unsaturation in structural analysis

**How to use it well:**

A degree of unsaturation of 4 strongly suggests a benzene ring. Combine this with spectral data to confirm. This calculation should always be your first step in any structure determination problem.

## Section 9

### Practical Skills and Synoptic Chemistry

Practical chemistry is assessed throughout A-Level, and you must be familiar with the required practicals specified by your exam board. Beyond knowing the procedures, you need to understand the theory behind each practical, how to process results, and how to evaluate sources of error and uncertainty.

Synoptic questions draw together knowledge from multiple areas of the specification and require you to make connections between topics. These questions are a significant feature of A-Level papers and are often where the most challenging marks lie. Being able to link kinetics with equilibria, or organic reactions with analytical techniques, demonstrates the depth of understanding that examiners reward.

The prompts in this section cover practical techniques, data analysis, error calculations, and multi-topic problem solving. Working through these will prepare you for the practical endorsement assessment and for the synoptic questions that appear on all A-Level Chemistry papers.

#### **Prompt 90: Required Practical: Enthalpy of Neutralisation**

**Copy this prompt into your AI tool:**

*Test me on the enthalpy of neutralisation practical.*

*Ask me to describe the method, state the measurements I would take, explain how to calculate the enthalpy change from the temperature data using  $q = mc\Delta T$ , and identify the main sources of error and how they could be minimised.*

**What this helps you practise:**

Describing and evaluating the enthalpy of neutralisation experiment

**How to use it well:**

Focus on explaining why heat loss to the surroundings is a systematic error and how using a polystyrene cup or extrapolation technique reduces it. These details earn marks in practical questions.

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**Prompt 91: Required Practical: Rates of Reaction**

**Copy this prompt into your AI tool:**

*Ask me to describe a method for investigating how concentration affects rate of reaction, including how to measure the rate. Then give me a set of results and ask me to plot an appropriate graph, determine the order, and calculate the rate constant.*

**What this helps you practise:**

Designing and interpreting a rate of reaction experiment

**How to use it well:**

Continuous monitoring methods (gas collection, colorimetry) give richer data than clock reactions. Know the advantages and disadvantages of each method for exam discussions.

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**Prompt 92: Required Practical: Titration Technique**

**Copy this prompt into your AI tool:**

*Quiz me on titration technique. Ask me to describe how to prepare a standard solution, how to perform a titration with correct use of a burette and pipette, and how to determine the concordant titre. Include a question about why the first titre is usually a rough value.*

**What this helps you practise:**

Describing correct titration procedure and standard solution preparation

**How to use it well:**

Examiners test precise vocabulary: 'concordant results', 'rough titre', 'standard solution'. Use these terms correctly and describe each step in the order you would perform it.

**Prompt 93: Apparatus and Technique Selection**

**Copy this prompt into your AI tool:**

*Present me with three different practical scenarios and ask me to choose the most appropriate apparatus and technique for each. Include reflux, distillation, and filtration under reduced pressure. Ask me to explain why each apparatus is chosen and draw a labelled diagram of one setup.*

**What this helps you practise:**

Selecting and justifying apparatus choices for different practical procedures

**How to use it well:**

Reflux is used when you want to heat a reaction mixture for a long time without losing volatile reactants or products. Distillation is used when you want to collect a volatile product. Know when to use each.

**Prompt 94: Percentage Error and Uncertainty**

**Copy this prompt into your AI tool:**

*Give me an A-Level style question on experimental uncertainty. Provide measurements from a burette, balance, and thermometer, and ask me to calculate the absolute and percentage uncertainty for each. Then ask me to determine the overall percentage uncertainty in a calculated value.*

**What this helps you practise:**

Calculating and combining experimental uncertainties

**How to use it well:**

The resolution of each instrument determines the minimum uncertainty. For a burette, the uncertainty is plus or minus 0.05 cm<sup>3</sup> per reading, and you take two readings per titre. Practise combining these correctly.

**Prompt 95: Processing and Presenting Data**

**Copy this prompt into your AI tool:**

*Ask me to process raw experimental data into a results table, calculate appropriate derived quantities, and choose the correct type of graph to plot. Provide messy raw data and ask me to identify anomalous results, calculate a mean, and explain my decisions.*

**What this helps you practise:**

Processing raw experimental data and identifying anomalous results

**How to use it well:**

Always show your working when processing data. If you exclude an anomalous result, state which value you excluded and give a brief reason. This demonstrates good scientific practice.

**Prompt 96: Multi-Step Calculation Problem**

**Copy this prompt into your AI tool:**

*Set me a challenge: give me a multi-step calculation that links at least three different topic areas. For example, use titration data to find the concentration of an acid, then calculate the enthalpy change of neutralisation, and then determine the percentage error. Provide realistic data and a clear mark scheme.*

**What this helps you practise:**

Performing extended calculations that integrate multiple chemistry topics

**How to use it well:**

These questions test your ability to use the output of one calculation as the input for the next. Label each stage clearly and carry enough significant figures through your working to avoid rounding errors.

**Prompt 97: Synoptic: Linking Organic and Inorganic**

**Copy this prompt into your AI tool:**

*Give me an A-Level style synoptic question that links organic and inorganic chemistry. For example, ask me to explain how transition metal catalysts are used in organic reactions, or how electrode potentials can predict whether a redox reaction will oxidise an organic compound.*

**What this helps you practise:**

Making connections between organic and inorganic chemistry topics

**How to use it well:**

Synoptic questions reward students who see chemistry as an interconnected subject rather than isolated topics. Practise identifying links between topics whenever you revise a new area.

**Prompt 98: Synoptic: Linking Physical and Organic**

**Copy this prompt into your AI tool:**

*You are an A-Level examiner. Set me a synoptic question that requires me to use concepts from kinetics, thermodynamics, and organic chemistry together. For example, ask me to discuss why a particular organic reaction has a high activation energy but is thermodynamically feasible, and what*

*conditions would be needed to make it occur at a useful rate.*

**What this helps you practise:**

Integrating physical chemistry concepts with organic reaction understanding

**How to use it well:**

Think about every organic reaction in terms of both thermodynamics (is it energetically favourable?) and kinetics (how fast does it go?). This dual perspective is exactly what synoptic questions demand.

**Prompt 99: Command Words and Exam Technique**

**Copy this prompt into your AI tool:**

*Test me on A-Level Chemistry command words. Give me the command words 'state', 'describe', 'explain', 'suggest', 'evaluate', 'justify', and 'deduce'. Ask me to define what each requires in an answer and give me a practice question for each one, then mark my responses against examiner expectations.*

**What this helps you practise:**

Interpreting A-Level command words and responding at the appropriate depth

**How to use it well:**

The difference between 'describe' and 'explain' is crucial. 'Describe' requires you to state what happens, while 'explain' requires you to state what happens and why, using scientific reasoning.

**Prompt 100: Full Paper Synoptic Challenge**

**Copy this prompt into your AI tool:**

*Give me an A-Level style synoptic question worth ten or more marks that draws together at least four different topic areas. It should require extended writing, calculations, and the application of chemical principles to an unfamiliar context. After I attempt*

*it, provide detailed feedback against a level-of-response mark scheme.*

**What this helps you practise:**

Tackling high-mark synoptic questions under exam-like conditions

**How to use it well:**

Time yourself when attempting this. In a real exam, you have roughly one minute per mark. If a question is worth ten marks, spend no more than twelve minutes on it. Practise allocating time as well as knowledge.

## **Final Closing Note**

You have now worked through 100 prompts designed to help you think more clearly, revise more effectively, and prepare more confidently for your GCSE.

Remember: the goal was never to rely on AI for answers. The goal was to use it as a tool to test, challenge, and strengthen your own understanding.

The strongest students are not those who avoid difficulty, but those who engage with it deliberately. Each mistake you identified, each explanation you improved, and each gap you filled has strengthened your thinking.

As you continue your studies, aim to depend less on prompts and more on your own judgement. AI can support you — but your reasoning, clarity, and persistence are what earn marks.

Approach your exams calmly. Think carefully. Write clearly.

You are more prepared than you think.

## Using AI Beyond This Book

The prompts in this book are starting points, not final forms.

As you grow more confident, begin modifying them:

- Add constraints (for example, “limit to three key points”).
- Increase difficulty gradually.
- Ask the AI to challenge your reasoning.
- Request alternative explanations.
- Ask it to critique your thinking rather than provide answers.

The most powerful use of AI is not asking it to tell you things — it is asking it to test and refine your thinking.

In the future, those who understand how to use tools intelligently will have an advantage. Treat AI as a tutor, not a shortcut. The skill of asking better questions will continue to matter long after your exams are over.

## **About the Author**

James R. Martin holds an MSci in Physics from the University of Bristol and a PGCE with a Physics focus from the University of Oxford. He has over a decade of experience teaching and tutoring students aged 11–18 across a range of subjects, including Physics, Biology, Chemistry, Mathematics, Economics, and Electronics.

He has worked with multiple syllabi, including GCSE, A-Level, KS3, and the International Baccalaureate Diploma Programme (IBDP), supporting students of varying abilities to develop clarity, confidence, and exam success.

His work focuses on effective revision strategies, independent thinking, and the responsible use of artificial intelligence as a tool to strengthen — not replace — understanding.

## **Other Titles in This Series**

The *100 AI Prompts for Smarter Revision* series supports students across GCSE, A-Level, and IB DP subjects.

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