

**Group 2, the alkaline earth metals**

Specification reference	Checklist questions	
3.2.2	Can you explain the trends in atomic radius, first ionisation energy and melting point of the elements Mg–Ba?	<input type="checkbox"/>
3.2.2	Can you explain the trends in atomic radius and first ionisation energy?	<input type="checkbox"/>
3.2.2	Can you explain the melting point of the elements in terms of their structure and bonding?	<input type="checkbox"/>
3.2.2	Can you describe reactions of the elements Mg–Ba with water?	<input type="checkbox"/>
3.2.2	Can you describe the use of magnesium in the extraction of titanium from $\text{TiCl}_4$ ?	<input type="checkbox"/>
3.2.2	Can you explain the relative solubilities of the hydroxides of the elements Mg–Ba in water?	<input type="checkbox"/>
3.2.2	Can you explain how $\text{Mg}(\text{OH})_2$ is sparingly soluble?	<input type="checkbox"/>
3.2.2	Can you describe the use of $\text{Mg}(\text{OH})_2$ in medicine and of $\text{Ca}(\text{OH})_2$ in agriculture?	<input type="checkbox"/>
3.2.2	Can you describe the use of $\text{CaO}$ or $\text{CaCO}_3$ to remove $\text{SO}_2$ from flue gases?	<input type="checkbox"/>
3.2.2	Can you explain how $\text{BaSO}_4$ is insoluble?	<input type="checkbox"/>
3.2.2	Can you describe the use of acidified $\text{BaCl}_2$ solution to test for sulfate ions?	<input type="checkbox"/>
3.2.2	Can you describe the use of $\text{BaSO}_4$ in medicine?	<input type="checkbox"/>

## Group 7, the halogens

Specification reference	Checklist questions	
3.2.3.1	Can you describe trends in electronegativity and boiling point of the halogens?	<input type="checkbox"/>
3.2.3.1	Can you explain the trend in electronegativity?	<input type="checkbox"/>
3.2.3.1	Can you explain the trend in the boiling point of the elements in terms of their structure and bonding?	<input type="checkbox"/>
3.2.3.1	Can you describe the trend in oxidising ability of the halogens down the group, including displacement reactions of halide ions in aqueous solution?	<input type="checkbox"/>
3.2.3.1	Can you describe the trend in reducing ability of the halide ions, including the reactions of solid sodium halides with concentrated sulfuric acid?	<input type="checkbox"/>
3.2.3.1	Can you describe the use of acidified silver nitrate solution to identify and distinguish between halide ions?	<input type="checkbox"/>
3.2.3.1	Can you describe the trend in solubility of the silver halides in ammonia?	<input type="checkbox"/>
3.2.3.1	Can you explain why silver nitrate solution is used to identify halide ions?	<input type="checkbox"/>
3.2.3.1	Can you explain why the silver nitrate solution is acidified?	<input type="checkbox"/>
3.2.3.1	Can you explain why ammonia solution is added?	<input type="checkbox"/>
3.2.3.2	Can you describe the reaction of chlorine with water to form chloride ions and chlorate(I) ions?	<input type="checkbox"/>
3.2.3.2	Can you describe the reaction of chlorine with water to form chloride ions and oxygen?	<input type="checkbox"/>

**Alkanes**

Specification reference	Checklist questions	
3.3.2.1	Can you describe alkanes as saturated hydrocarbons?	<input type="checkbox"/>
3.3.2.1	Can you explain that petroleum is a mixture consisting mainly of alkane hydrocarbons that can be separated by fractional distillation?	<input type="checkbox"/>
3.3.2.2	Can you describe how cracking involves breaking C–C bonds in alkanes?	<input type="checkbox"/>
3.3.2.2	Can you describe how thermal cracking takes place at high pressure and high temperature and produces a high percentage of alkenes?	<input type="checkbox"/>
3.3.2.2	Can you describe how catalytic cracking takes place at a slight pressure, high temperature and in the presence of a zeolite catalyst and is used mainly to produce motor fuels and aromatic hydrocarbons?	<input type="checkbox"/>
3.3.2.2	Can you explain the economic reasons for cracking alkanes?	<input type="checkbox"/>
3.3.2.3	Can you explain how alkanes are used as fuels?	<input type="checkbox"/>
3.3.2.3	Can you explain that combustion of alkanes and other organic compounds can be complete or incomplete?	<input type="checkbox"/>
3.3.2.3	Can you describe how the internal combustion engine produces a number of pollutants including NO <sub>x</sub> , CO, carbon, and unburned hydrocarbons?	<input type="checkbox"/>
3.3.2.3	Can you describe how gaseous pollutants from internal combustion engines can be removed using catalytic converters?	<input type="checkbox"/>
3.3.2.3	Can you describe how the combustion of hydrocarbons containing sulfur leads to sulfur dioxide that causes air pollution?	<input type="checkbox"/>
3.3.2.3	Can you explain why sulfur dioxide can be removed from flue gases using calcium oxide or calcium carbonate?	<input type="checkbox"/>

## Halogenoalkanes

Specification reference	Checklist questions	
3.3.3.1	Can you explain how halogenoalkanes contain polar bonds?	<input type="checkbox"/>
3.3.3.1	Can you explain how halogenoalkanes undergo substitution reactions with the nucleophiles $\text{OH}^-$ , $\text{CN}^-$ and $\text{NH}_3$ ?	<input type="checkbox"/>
3.3.3.1	Can you outline the nucleophilic substitution mechanisms of these reactions?	<input type="checkbox"/>
3.3.3.1	Can you explain why the carbon–halogen bond enthalpy influences the rate of reaction?	<input type="checkbox"/>
3.3.3.2	Can you describe the concurrent substitution and elimination reactions of a halogenoalkane (for example, 2-bromopropane with potassium hydroxide)?	<input type="checkbox"/>
3.3.3.2	Can you explain the role of the reagent as both nucleophile and base?	<input type="checkbox"/>
3.3.3.2	Can you outline the mechanisms of the concurrent substitution and elimination reactions of a halogenoalkane?	<input type="checkbox"/>
3.3.3.3	Can you explain that ozone, formed naturally in the upper atmosphere, is beneficial because it absorbs ultraviolet radiation?	<input type="checkbox"/>
3.3.3.3	Can you describe how chlorine atoms are formed in the upper atmosphere when ultraviolet radiation causes C–Cl bonds in chlorofluorocarbons (CFCs) to break?	<input type="checkbox"/>
3.3.3.3	Can you describe how chlorine atoms catalyse the decomposition of ozone and contribute to the hole in the ozone layer?	<input type="checkbox"/>
3.3.3.3	Can you explain that results of research by different groups in the scientific community provided evidence for legislation to ban the use of CFCs as solvents and refrigerants?	<input type="checkbox"/>

**Alkenes**

Specification reference	Checklist questions	
3.3.4.1	Can you explain that alkenes are unsaturated hydrocarbons?	<input type="checkbox"/>
3.3.4.1	Can you describe how bonding in alkenes involves a double covalent bond, a centre of high electron density?	<input type="checkbox"/>
3.3.4.2	Can you explain that electrophilic addition reactions of alkenes with HBr, H <sub>2</sub> SO <sub>4</sub> , and Br <sub>2</sub> ?	<input type="checkbox"/>
3.3.4.2	Can you describe the use of bromine to test for unsaturation?	<input type="checkbox"/>
3.3.4.2	Can you describe the formation of major and minor products in addition reactions of unsymmetrical alkenes?	<input type="checkbox"/>
3.3.4.2	Can you outline the mechanisms for these reactions?	<input type="checkbox"/>
3.3.4.2	Can you explain the formation of major and minor products by reference to the relative stabilities of primary, secondary and tertiary carbocation intermediates?	<input type="checkbox"/>

**Alcohols**

Specification reference	Checklist questions	
3.3.5.1	Can you describe how alcohols are produced industrially by hydration of alkenes in the presence of an acid catalyst.	<input type="checkbox"/>
3.3.5.1	Can you describe how ethanol is produced by the reaction of ethene and steam using a phosphoric acid catalyst?	<input type="checkbox"/>
3.3.5.1	Can you describe how ethanol is produced industrially by fermentation of glucose? The conditions for this process.	<input type="checkbox"/>
3.3.5.1	Can you explain the conditions for the industrial production of ethanol?	<input type="checkbox"/>
3.3.5.1	Can you describe how ethanol produced industrially by fermentation is separated by fractional distillation and can then be used as a biofuel?	<input type="checkbox"/>
3.3.5.1	Can you explain the economic and environmental advantages and disadvantages of fermentation compared with the industrial production from ethene?	<input type="checkbox"/>
3.3.5.1	Can you explain the meaning of the term biofuel?	<input type="checkbox"/>
3.3.5.2	Can you explain how alcohols are classified as primary, secondary and tertiary?	<input type="checkbox"/>
3.3.5.2	Can you explain that primary alcohols can be oxidised to aldehydes which can be further oxidised to carboxylic acids?	<input type="checkbox"/>
3.3.5.2	Can you explain that secondary alcohols can be oxidised to ketones?	<input type="checkbox"/>
3.3.5.2	Can you explain that tertiary alcohols are not easily oxidised?	<input type="checkbox"/>
3.3.5.2	Can you describe acidified potassium dichromate(VI) as a suitable oxidising agent?	<input type="checkbox"/>

**Organic analysis**

Specification reference	Checklist questions	
3.3.6.1	Can you describe the reactions of functional groups listed in the specification?	<input type="checkbox"/>
3.3.6.1	Can you identify the functional groups using reactions in the specification?	<input type="checkbox"/>
3.3.6	Have you carried out practical tests for alcohol, aldehyde, alkene, and carboxylic acid?	<input type="checkbox"/>
3.3.6.2	Can you explain how mass spectrometry can be used to determine the molecular formula of a compound?	<input type="checkbox"/>
3.3.6.2	Can you use precise atomic masses and the precise molecular mass to determine the molecular form?	<input type="checkbox"/>
3.3.6.3	Can you explain how bonds in a molecule absorb infrared radiation at characteristic wavenumbers?	<input type="checkbox"/>
3.3.6.3	Can you describe how 'fingerprinting' allows identification of a molecule by comparison of spectra?	<input type="checkbox"/>
3.3.6.3	Can you use infrared spectra and the Chemistry Data Booklet to identify particular bonds, and therefore functional groups, and also to identify impurities?	<input type="checkbox"/>

**Atomic structure**

Specification reference	Checklist questions	
3.1.1.1	Can you explain that knowledge and understanding of atomic structure has evolved over time?	<input type="checkbox"/>
3.1.1.1	Can you describe how protons, neutrons, and electrons have relative charge and relative mass?	<input type="checkbox"/>
3.1.1.1	Can you describe that an atom consists of a nucleus, with protons and neutrons that are surrounded by electrons?	<input type="checkbox"/>
3.1.1.2	Can you identify $A$ as mass number and $Z$ as atomic (proton) number?	<input type="checkbox"/>
3.1.1.2	Can you determine the number of fundamental particles in atoms and ions using mass number, atomic number, and charge?	<input type="checkbox"/>
3.1.1.2	Can you explain the existence of isotopes?	<input type="checkbox"/>
3.1.1.2	Can you explain the principles of a simple time of flight (TOF) mass spectrometer?	<input type="checkbox"/>
3.1.1.2	Can you explain that the mass spectrometer gives accurate information about relative isotopic mass and the relative abundance of isotopes?	<input type="checkbox"/>
3.1.1.2	Can you describe how mass spectrometry can be used to identify elements?	<input type="checkbox"/>
3.1.1.2	Can you describe how mass spectrometry can be used to determine relative molecular mass?	<input type="checkbox"/>
3.1.1.2	Can you interpret simple mass spectra of elements?	<input type="checkbox"/>
3.1.1.2	Can you calculate relative atomic mass from isotopic abundance?	<input type="checkbox"/>

## Bonding

Specification reference	Checklist questions	
3.1.3.1	Can you describe how ionic bonding involves electrostatic attraction between oppositely charged ions in a lattice?	<input type="checkbox"/>
3.1.3.1	Do you know the formulas of compound ions, for example sulfate, hydroxide, nitrate, carbonate, and ammonium?	<input type="checkbox"/>
3.1.3.1	Can you predict the charge on a simple ion using the position of the element in the Periodic Table?	<input type="checkbox"/>
3.1.3.1	Can you construct formulas for ionic compounds?	<input type="checkbox"/>
3.1.3.2	Can you describe how a single covalent bond contains a shared pair of electrons?	<input type="checkbox"/>
3.1.3.2	Can you describe how multiple bonds contain multiple pairs of electrons?	<input type="checkbox"/>
3.1.3.2	Can you describe how a co-ordinate (dative covalent) bond contains a shared pair of electrons with both electrons supplied by one atom?	<input type="checkbox"/>
3.1.3.2	Can you represent a covalent bond using a line?	<input type="checkbox"/>
3.1.3.2	Can you represent a co-ordinate bond using an arrow?	<input type="checkbox"/>
3.1.3.3	Can you explain that metallic bonding involves attraction between delocalised electrons and positive ions arranged in a lattice?	<input type="checkbox"/>
3.1.3.4	Can you identify and describe the four types of crystal structure – ionic, metallic, macromolecular (giant covalent) and molecular?	<input type="checkbox"/>
3.1.3.4	Can you identify and describe structures of the following crystals as examples of ionic, metallic, macromolecular and molecular crystal structure – diamond, graphite, ice, iodine, magnesium, sodium chloride?	<input type="checkbox"/>

## Energetics

Specification reference	Checklist questions	
3.1.4.1	Can you explain that reactions can be endothermic or exothermic?	<input type="checkbox"/>
3.1.4.1	Can you explain that enthalpy change ( $\Delta H$ ) is the heat energy change measured under conditions of constant pressure?	<input type="checkbox"/>
3.1.4.1	Can you explain that standard enthalpy changes refer to standard conditions, i.e. 100 kPa and a stated temperature (for example, $\Delta H_{298}$ )?	<input type="checkbox"/>
3.1.4.1	Can you define standard enthalpy of combustion ( $\Delta_c H$ )?	<input type="checkbox"/>
3.1.4.1	Can you define standard enthalpy of formation ( $\Delta_f H$ )?	<input type="checkbox"/>
3.1.4.2	Can you explain that heat change, $q$ , in a reaction is given by the equation $q = mc\Delta T$ where $m$ is the mass of the substance that has a temperature change $\Delta T$ and a specific heat capacity $c$ ?	<input type="checkbox"/>
3.1.4.2	Can you use the equation $q = mc\Delta T$ to calculate the molar enthalpy change for a reaction?	<input type="checkbox"/>
3.1.4.2	Can you use the equation $q = mc\Delta T$ in related calculations?	<input type="checkbox"/>
3.1.4	Have you carried out a practical activity to measure an enthalpy change?	<input type="checkbox"/>
3.1.4.3	Can you explain Hess's law?	<input type="checkbox"/>
3.1.4.3	Can you use Hess's law to perform calculations, including calculation of enthalpy changes for reactions from enthalpies of combustion or from enthalpies of formation?	<input type="checkbox"/>
3.1.4.4	Can you describe mean bond enthalpy?	<input type="checkbox"/>

**Kinetics**

Specification reference	Checklist questions	
3.1.5.1	Can you explain that reactions can only occur when collisions with sufficient energy take place between particles energy?	<input type="checkbox"/>
3.1.5.1	Can you define the term activation energy?	<input type="checkbox"/>
3.1.5.1	Can you explain why most collisions do not lead to a reaction?	<input type="checkbox"/>
3.1.5.2	Can you explain the Maxwell–Boltzmann distribution of molecular energies in gases?	<input type="checkbox"/>
3.1.5.2	Can you draw and interpret distribution curves for different temperatures?	<input type="checkbox"/>
3.1.5.3	Can you define the term rate of reaction?	<input type="checkbox"/>
3.1.5.3	Can you explain the qualitative effect of temperature changes on the rate of reaction?	<input type="checkbox"/>
3.1.5.3	Can you use the Maxwell–Boltzmann distribution to explain why a small temperature increase can lead to a large increase in rate?	<input type="checkbox"/>
3.1.5	Have you carried out a practical to investigate how the rate of a reaction changes with temperature?	<input type="checkbox"/>
3.1.5.4	Can you describe the qualitative effect of changes in concentration on collision frequency?	<input type="checkbox"/>
3.1.5.4	Can you describe the qualitative effect of a change in the pressure of a gas on collision frequency?	<input type="checkbox"/>
3.1.5.4	Can you explain how a change in concentration or a change in pressure influences the rate of a reaction?	<input type="checkbox"/>

**Equilibria**

Specification reference	Checklist questions	
3.1.6	Can you explain that many chemical reactions are reversible?	<input type="checkbox"/>
3.1.6	Can you explain that, in a reversible reaction at equilibrium, forward and reverse reactions proceed at equal rates?	<input type="checkbox"/>
3.1.6	Can you explain that, in a reversible reaction at equilibrium, the concentrations of reactants and products remain constant?	<input type="checkbox"/>
3.1.6	Can you explain that, in a reversible reaction at equilibrium, the equilibrium constant $K_c$ is deduced from the equation for a reversible reaction?	<input type="checkbox"/>
3.1.6	Can you describe Le Chatelier's principle?	<input type="checkbox"/>
3.1.6	Can you explain that Le Chatelier's principle can be used to predict the effects of changes in temperature, pressure and concentration on the position of equilibrium in homogeneous reactions?	<input type="checkbox"/>
3.1.6	Can you explain that a catalyst does not affect the position of equilibrium?	<input type="checkbox"/>
3.1.6	Can you use Le Chatelier's principle to predict qualitatively the effect of changes in temperature, pressure and concentration on the position of equilibrium?	<input type="checkbox"/>
3.1.6	Can you explain why, for a reversible reaction used in an industrial process, a compromise temperature and pressure may be used?	<input type="checkbox"/>

**Oxidation, reduction, and redox reactions**

Specification reference	Checklist questions	
3.1.7	Can you explain that oxidation is the process of electron loss and oxidising agents are electron acceptors?	<input type="checkbox"/>
3.1.7	Can you explain that reduction is the process of electron gain and reducing agents are electron donors?	<input type="checkbox"/>
3.1.7	Can you recall and use the rules for assigning oxidation states?	<input type="checkbox"/>
3.1.7	Can you work out the oxidation state of an element in a compound or ion from the formula?	<input type="checkbox"/>
3.1.7	Can you write half-equations identifying the oxidation and reduction processes in redox reactions?	<input type="checkbox"/>
3.1.7	Can you combine half-equations to give an overall redox equation?	<input type="checkbox"/>

**Periodicity**

Specification reference	Checklist questions	
3.2.1.1	Can you explain that an element is classified as s, p, d or f block according to its position in the Periodic Table, which is determined by its proton number?	<input type="checkbox"/>
3.2.1.2	Can you explain the reasons for periodic trends in terms of the structure of and bonding in the elements?	<input type="checkbox"/>
3.2.1.2	Can you explain periodic trends in atomic radius and first ionisation energy?	<input type="checkbox"/>
3.2.1.2	Can you explain the melting point of the elements in terms of their structure and bonding?	<input type="checkbox"/>