



| AQA Chemistry | Working towards expected outcomes | Working at expected outcomes | Working beyond expected outcomes |
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| | Your child is not yet making the expected progress within this course. | Your child is achieving the expected progress for this point within the course. | Your child is exceeding the expected progress. |
| Y13 Autumn Term 1&2 Carboxylic acids & derivatives Equilibrium constant K_p | <p>Students working towards expected outcomes in Year 13 can:</p> <p><i>Students are beginning to grasp foundational ideas but require support to apply them confidently.</i></p> <ul style="list-style-type: none">Identify structures of carboxylic acids, esters, acyl chlorides, and related compounds.Describe basic reactions: esterification, ester hydrolysis, soap and biodiesel production.States simple properties and uses of esters.Recognise acylating agents react with water, alcohols, ammonia, and amines. | <p>Students working at expected in Year 13 can:</p> <p><i>Students can apply their knowledge and skills to solve standard problems and interpret familiar data.</i></p> <ul style="list-style-type: none">Explain esterification and hydrolysis, including conditions and products.Describe soap and biodiesel synthesis with correct reactants and processes.Performs key practical's: ester prep/purification, aspirin synthesis.Outline nucleophilic addition-elimination mechanisms with common nucleophiles.Compare industrial use of acylating agents (e.g. ethanoic anhydride vs ethanoyl chloride). | <p>Students working beyond expected in Year 13 can:</p> <p><i>Students demonstrate a deeper understanding and can apply their knowledge in unfamiliar or more complex contexts.</i></p> <ul style="list-style-type: none">Predict and explain products of acylation reactions using mechanisms.Evaluate synthesis routes in terms of efficiency, sustainability, and purity.Interprets experimental data (boiling/melting points) to assess compound identity and purity.Design and critiques organic synthesis and purification procedures. |



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| Aromatic chemistry | <ul style="list-style-type: none">• Identify qualitative shifts in equilibrium with changes in temperature and pressure.• Identify the planar structure of benzene and its bond lengths as intermediate between single and double bonds.• State that benzene is more stable than cyclohexa-1,3,5-triene due to electron delocalisation.• Recognise that benzene undergoes substitution, not addition, reactions.• Name nitration and acylation as electrophilic substitution reactions. | <ul style="list-style-type: none">• Predict the effect of temperature changes on the value of K_p (increase, decrease, or no change).• Use enthalpy of hydrogenation data to explain benzene's extra stability compared to theoretical alternatives.• Explain why substitution is favoured over addition due to preservation of aromatic stability.• Describe the mechanism of electrophilic substitution for nitration, including formation of the nitronium ion.• Outline the mechanism of Friedel-Crafts acylation using $AlCl_3$ as a catalyst.• Link nitration and acylation reactions to their synthetic importance (e.g. explosives, pharmaceuticals). | <ul style="list-style-type: none">• Justify significant figures and precision limits based on data uncertainty and calculation stages.• Compare reactivity of benzene to other unsaturated compounds using energy and stability arguments.• Justify the conditions needed for specific electrophilic substitutions and predicts outcomes of these reactions.• Analyse mechanisms using electron movement to explain reactivity and regioselectivity in substitution.• Apply understanding of electrophilic substitution to suggest or design synthetic pathways involving aromatic compounds. |
| Acids & Bases | <ul style="list-style-type: none">• Define acids as proton donors and bases as proton acceptors.• State that acid-base equilibria involve proton transfer.• Identify the pH scale as a measure of $[H^+]$ on a logarithmic scale.• Recall and uses the formulae: $pH = -\log_{10}[H^+]$ $K_w = [H^+][OH^-]$ $pK_a = -\log_{10}K_a$• Recognise that weak acids/bases only partially dissociate in water. | <ul style="list-style-type: none">• Convert $[H^+]$ to pH and vice versa; calculates pH for strong acids and strong bases.• Construct K_a expressions and calculates pH of weak acid solutions from K_a and concentration.• Convert between K_a and pK_a and applies correct units and significant figures.• Sketch and explains typical pH curves for titrations involving combinations of strong and weak monoprotic acids and bases. | <ul style="list-style-type: none">• Justify the shape and inflection points of pH curves using equilibria and reaction stoichiometry.• Explain temperature effects on K_w and how it influences pH.• Apply K_a concepts to experimental design (e.g. calculating K_a from pH at half-neutralisation).• Design or evaluates buffer systems for real-world applications (e.g. biological, industrial) with reasoning.• Critically evaluates pH and buffer calculations in terms of assumptions and limitations (e.g. approximation of $[HA] \approx$ initial concentration). |



Amines

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| <p>Amines</p> | <ul style="list-style-type: none">• Identify amines as weak bases and nucleophiles.• Recognise that primary aliphatic amines are made from halogenoalkanes or by reducing nitriles.• State that aromatic amines are produced by reducing nitro compounds and used in dye manufacture.• Recognise that amines react with halogenoalkanes and acyl chlorides. | <ul style="list-style-type: none">• Use pH curves to choose a suitable indicator.• Explain how buffer solutions resist changes in pH when small amounts of acid or base are added.• Calculate the pH of acidic buffer solutions using appropriate expressions.• Explain differences in base strength between ammonia, aliphatic, and aromatic amines using lone pair availability.• Describe the preparation of primary, secondary, tertiary amines and quaternary ammonium salts via nucleophilic substitution.• Outline mechanisms of nucleophilic substitution between halogenoalkanes and ammonia/amines.• Outline mechanisms of nucleophilic addition–elimination between ammonia/primary amines and acyl chlorides.• Describes the role of quaternary ammonium salts as cationic surfactants. | <ul style="list-style-type: none">• Predict and explains reaction outcomes and product types in multistep syntheses involving amines.• Justify trends in base strength using electronic effects and resonance in molecular structures.• Analyses nucleophilic mechanisms in detail, including the role of lone pairs and leaving groups.• Apply knowledge of amine reactions to synthetic design involving functional group transformations and acylation pathways. |
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| <p>Spring Term 1</p> <p>Thermodynamics</p> | <ul style="list-style-type: none">• Define lattice enthalpy as either formation or dissociation of an ionic solid.• Identify key enthalpy terms: formation, ionisation energy, atomisation, bond enthalpy, and electron affinity.• Recognise that Born–Haber cycles show enthalpy changes for forming ionic compounds.• Define enthalpy of hydration and solution.• State that negative Gibbs free energy (ΔG) indicates a feasible reaction.• Recognise that entropy (ΔS) relates to disorder in a system. | <ul style="list-style-type: none">• Construct Born–Haber cycles to calculate lattice enthalpy or other enthalpy values using provided data.• Calculate enthalpy of solution from lattice enthalpy and hydration enthalpies using an energy cycle.• Compare calculated lattice enthalpies (using a perfect ionic model) with experimental values to identify covalent character.• Calculate entropy changes using standard entropy data.• Use $\Delta G = \Delta H - T\Delta S$ to determine feasibility of a reaction.• Determine the temperature at which a reaction becomes feasible by rearranging and using $\Delta G = 0$. | <ul style="list-style-type: none">• Evaluate ionic versus covalent character in compounds based on discrepancies in lattice enthalpy.• Design or critique Born–Haber cycles, identifying missing data and suggesting experimental routes.• Interpret how changes in ΔH and ΔS influence feasibility across a temperature range.• Apply thermodynamic principles to physical and chemical processes (e.g. melting, dissolving, spontaneous reactions).• Justify predictions of feasibility based on full thermodynamic reasoning, including sign and magnitude of ΔS and ΔH. |
| <p>Electrode potentials</p> | <ul style="list-style-type: none">• Identify standard conditions for measuring electrode potentials.• Recognise the role of the standard hydrogen electrode as a reference.• Follow the IUPAC convention for writing half-equations and cell representations.• List standard electrode potentials (E^\ominus) in order to form a basic electrochemical series. | <ul style="list-style-type: none">• Write conventional cell notation accurately.• Use E^\ominus values to predict the direction of redox reactions and identify oxidising/reducing agents.• Calculate the standard EMF of a cell from two E^\ominus values.• Explain how E^\ominus values relate to the feasibility of a redox reaction. | <ul style="list-style-type: none">• Plan and evaluate experiments to measure EMF and investigate how changing conditions affect it.• Assess the benefits and limitations of electrochemical and fuel cells in commercial and environmental contexts.• Explain differences in performance and reversibility between different types of cells (e.g. lithium-ion vs hydrogen fuel cell) using detailed electrode reactions and redox concepts. |



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| <p>Polymers</p> | <ul style="list-style-type: none">• State that condensation polymers form from dicarboxylic acids with diols, diamines, or from amino acids.• Recognise names of common condensation polymers (e.g. nylon, Kevlar, Terylene).• Identify types of monomers involved in forming polyesters and polyamides.• Describe that polyalkenes are non-biodegradable, while polyesters and polyamides are biodegradable.• Give a basic reason for the biodegradability of polyesters and polyamides. | <ul style="list-style-type: none">• Identify the half-equations and net equations in both non-rechargeable and rechargeable cells using given data.• Describe the electrode reactions in lithium and alkaline hydrogen–oxygen fuel cells.• Explain how electron flow in cells produces a current. • Draw the repeating unit of a polyester or polyamide from given monomer structures.• Draw the repeating unit from a section of a polymer chain.• Deduce and draw the monomer(s) from a section of a condensation polymer.• Explain the formation of ester and amide linkages in condensation polymers.• Describe and explain intermolecular forces (e.g. hydrogen bonding) in condensation polymers.• Explain why polyesters and polyamides can be hydrolysed, but polyalkenes cannot.• Describe environmental impact of polymer disposal, including recycling and biodegradability.• Describe the formation of nylon 6,6 and name its monomers. | <ul style="list-style-type: none">• Compare and contrast structures and properties of condensation polymers (e.g. Kevlar, nylon 6,6, Terylene).• Analyse sections of unfamiliar polymers and deduce monomers and linkages.• Evaluate disposal methods (incineration, landfill, recycling) based on polymer structure and environmental impact.• Explain in detail how hydrolysis breaks down condensation polymers and why this doesn't occur in polyalkenes. |
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| Amino acids, proteins & DNA | <ul style="list-style-type: none">• Recognise amino acids as molecules with both acidic ($-\text{COOH}$) and basic ($-\text{NH}_2$) groups.• Identify zwitterions as a special form of amino acids.• State that proteins are made of amino acids linked by peptide bonds.• Recognise enzymes as protein-based biological catalysts.• Recall the basic structure of DNA: sugar-phosphate backbone and four nitrogenous bases.• Recognise that cisplatin is used as an anticancer drug. | <ul style="list-style-type: none">• Draw amino acids as zwitterions and as ions in acidic and alkaline solutions.• Draw peptides formed from up to three amino acids.• Draw the amino acids formed by hydrolysis of a peptide.• Identify primary, secondary (α-helix, β-pleated sheet), and tertiary structures of proteins in diagrams.• Explain how hydrogen bonding and sulfur-sulfur (disulfide) bonds stabilise protein structures.• Explain how enzymes catalyse reactions via a stereospecific active site.• Explain how DNA strands are held together by hydrogen bonds between complementary base pairs.• Describe the structure of nucleotides, including phosphate, deoxyribose, and bases.• Explain how cisplatin binds to DNA and prevents replication. | <ul style="list-style-type: none">• Predict the structure of zwitterions and ion forms of unfamiliar amino acids under different pH conditions.• Analyse protein structure diagrams and evaluate the role of different types of bonding.• Justify the use of chromatography techniques in separating and identifying amino acids, including choice of solvent and detection method.• Evaluate the effect of amino acid sequence on protein structure and enzyme function.• Explain the role of stereospecificity in drug design and enzyme-substrate interactions.• Evaluate the societal and ethical considerations of using drugs like cisplatin, balancing benefits and side effects. |
| Organic synthesis | <ul style="list-style-type: none">• Recognise that organic synthesis can involve multiple steps.• Identify that chemists aim to reduce environmental impact by improving processes. | <ul style="list-style-type: none">• Explain why solvent-free and non-hazardous starting materials are preferred.• Explain the benefits of designing synthesis with fewer steps and high percentage atom economy.• Use known reactions from the specification to devise a synthesis pathway of up to four steps for a target organic compound.• Justify chosen reagents and conditions in each step of a synthetic route. | <ul style="list-style-type: none">• Evaluate different synthetic routes in terms of atom economy, yield, safety, and environmental impact.• Optimise a multi-step synthesis by selecting the most efficient sequence based on available reagents and mechanisms.• Modify given synthetic routes to reduce waste, avoid hazardous reagents, or increase overall efficiency.• Justify decisions in synthetic design using green chemistry principles. |



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| NMR spectroscopy | <ul style="list-style-type: none">• Recognise that scientists use a range of analytical techniques to determine molecular structures.• Identify NMR spectroscopy as a method to investigate the position of hydrogen and carbon atoms in a molecule.• Recall that ^{13}C NMR produces simpler spectra than ^1H NMR.• Recognise that the δ (delta) scale is used to measure chemical shift.• Identify tetramethylsilane (TMS) as a standard in NMR. | <ul style="list-style-type: none">• Explain why TMS is used as a standard reference in NMR• Use ^1H and ^{13}C NMR spectra with chemical shift data to suggest possible structures or part-structures of molecules.• Use integration data from ^1H NMR spectra to determine the relative number of protons in different environments.• Apply the n+1 rule to predict splitting patterns (doublet, triplet, quartet) in aliphatic compounds.• Identify chemical environments from NMR data using the Chemistry Data Booklet.• Recognise the use of deuterated solvents or CCl_4 in obtaining ^1H NMR spectra. | <ul style="list-style-type: none">• Analyse complex ^1H and ^{13}C NMR spectra to deduce full molecular or fragment structures.• Evaluate possible molecular structures based on overlapping chemical shift, integration, and splitting pattern data.• Justify how spin-spin coupling patterns and chemical shifts correlate with molecular structure and environment.• Interpret experimental NMR data in context with other analytical techniques to confirm or refine a structural proposal. |
| Chromatography | <ul style="list-style-type: none">• Recognise chromatography as a technique to separate and identify components in a mixture.• Identify the key types of chromatography: TLC, column chromatography, and gas chromatography.• Recall that substances separate based on differences in their interactions with the stationary and mobile phases. | <ul style="list-style-type: none">• Describe how substances move in TLC, CC, and GC depending on solubility in the mobile phase and retention by the stationary phase.• Calculate R_f values from a chromatogram.• Compare retention times (GC) and R_f values (TLC) with known standards to identify substances.• Describe the role of GC in separating volatile compounds.• Explain how mass spectrometry can be used alongside gas chromatography to analyse separated components. | <ul style="list-style-type: none">• Evaluate the effectiveness of different types of chromatography for various mixtures based on compound properties.• Interpret chromatographic data to deduce the identity and relative abundance of components in complex samples.• Justify the use of specific stationary and mobile phases in relation to compound polarity and volatility.• Assess the advantages of using GC-MS in identifying trace components in mixtures with high precision. |



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| <p>Spring Term 2</p> <p>Transition metals Reactions of ions in aqueous solution</p> | <ul style="list-style-type: none">• Recognise properties of transition metals: coloured ions, variable oxidation states, complex formation, catalysis.• Define ligand, complex, and co-ordination number.• Identify basic ligand substitution and complex shapes.• Recall that colour arises from d-d electron transitions.• Recognise types of catalysts (heterogeneous/homogeneous).• Observe colour and precipitation changes in test-tube reactions. | <ul style="list-style-type: none">• Explain ligand substitution and co-ordination changes.• Describe chelate effect using enthalpy and entropy.• Draw and identify cis-trans and optical isomers.• Use $\Delta E = hv = hc/\lambda$ to explain colour changes.• Use colorimetry to determine ion concentration.• Carry out and calculate redox titrations.• Write catalytic cycle equations (e.g. V_2O_5, Fe^{2+}, Mn^{2+}).• Compare acidity of $[M(H_2O)_6]^{3+}$ vs $[M(H_2O)_6]^{2+}$.• Predict outcomes of test-tube reactions with OH^-, NH_3, CO_3^{2-}. | <ul style="list-style-type: none">• Predict ligand exchange outcomes based on structure and stability.• Analyse the chelate effect in detail with entropy/enthalpy.• Explain changes in colour from ligand/oxidation state/geometry.• Interpret colorimetry data using calibration curves.• Evaluate redox potential changes (pH, ligands, state).• Explain catalyst mechanisms with intermediates.• Assess effects of catalyst poisoning and economic impact.• Identify unknown ions through detailed qualitative analysis. |
| <p>Period 3 elements and their oxides</p> | <ul style="list-style-type: none">• Recall reactions of Na and Mg with water.• Recognise oxides formed by Na, Mg, Al, Si, P, and S (e.g. Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10}, SO_2, SO_3).• Describe trends in melting points of oxides Na-S.• State the pH of solutions formed when oxides react with water.• Identify acids and anions formed when P_4O_{10}, SO_2, and SO_3 react with water. | <ul style="list-style-type: none">• Explain melting point trends of Na-S oxides by linking to structure and bonding type.• Explain how oxide bonding type affects reactivity with water.• Write balanced equations for reactions of Na-S oxides with water, acids, and bases. | <ul style="list-style-type: none">• Analyse how changes in bonding (ionic, covalent, giant covalent) influence oxide properties and reactivity.• Predict outcomes of reactions between oxides and various acids/bases beyond those listed.• Correlate trends in oxide melting points and reactivity with periodic properties of Na-S elements. |