Year 12 A level Chemistry		
Autumn Term 14 weeks	**Spring Term** 14 weeks	**Summer Term** 14 weeks
Module 1 – Development of practical skills in chemistry will be tested at each point where the practical is applicable.	**Module 1 – Development of practical skills in chemistry will be tested at each point where the practical is applicable.**	**Module 1 – Development of practical skills in chemistry will be tested at each point where the practical is applicable.**

Skills

Apply chemical principles to new contexts. Carry out unstructured calculations involving several steps
Link appropriate facts from different areas of the specification
Carry out more complicated redox titration calculations
Have a good knowledge of key words and definitions and use them appropriately n written answers

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Module 4: Core organic chemistry

- Basic concepts
- Hydrocarbons
- Alcohols and haloalkanes
- Organic synthesis
- Analytical techniques (IR and MS)

Module 2: Foundations in chemistry

- Atoms, compounds, molecules and equations
- Amount of substance
- Acid–base and redox reactions
- Electrons, bonding and structure

Module 3: Periodic table and energy

- The periodic table and periodicity
- Group 2 and the halogens
- Qualitative analysis
- Enthalpy changes
- Reaction rates and equilibrium (qualitative)

Describe the periodic table in terms of: atomic number, periods, periodicity and groups

Define isotope	Describe the periodic table in terms of: atomic number, periods, periodicity and groups	Describe the trend in electron configuration across periods 2 and 3
Describe atomic structure in terms of protons, electrons, neutrons for atoms and ions given the atomic number, mass number and ionic charge	Describe the trend in electron configuration across periods 2 and 3	Describe the classification of elements into s, p and d-blocks
Explain the terms relative isotopic and relative atomic mass, based on the mass of a 12C atom	Describe the classification of elements into s, p and d-blocks	Define first ionisation energy
Use of mass spectrometry in: the determination of relative isotopic masses and relative abundances of its isotopes	Define first ionisation energy	Explain the trend in first ionisation energies across Periods 2 and 3 and down a group (attraction, nuclear charge and atomic radius)
Use of mass spectrometry in: calculation of the relative atomic mass from the relative abundances of its isotopes	Explain the trend in first ionisation energies across Periods 2 and 3 and down a group (attraction, nuclear charge and atomic radius)	Predict from successive ionisation energies, the number of electrons in each shell of an atom and the group of an element
Use of the terms relative molecular mass (Mr) and relative formula mass and their calculation from relative atomic masses	Predict from successive ionisation energies, the number of electrons in each shell of an atom and the group of an element	Explain metallic bonding in terms of electrostatic attraction between cations and delocalised electrons
Write the formulae of ionic compounds from ionic charges including: prediction of ionic charge from the position in the periodic table	Explain metallic bonding in terms of electrostatic attraction between cations and delocalised electrons	Explain giant lattice structures e.g. metals
Write the formulae of ionic compounds from ionic charges including: recall of the names and formulae for the following ions: NO_3^-, CO_3^{2-}, SO_4^{2-}, OH^-, NH_4^+, Zn^{2+} and Ag^+	Explain giant lattice structures e.g. metals	Explain the solid covalent lattices of carbon and silicon
Construction of balanced equations (including ionic), with state symbols, for familiar and unfamiliar reactions	Explain the solid covalent lattices of carbon and silicon	Explain the physical properties of giant metallic and giant covalent lattices
Explanation and use of the terms: amount of substance, mole, Avogadro constant, molar mass, molar gas volume	Explain the physical properties of giant metallic and giant covalent lattices	Explain the variation in melting points across Periods 2 and 3
Use of the terms empirical formula and molecular formula	Explain the variation in melting points across Periods 2 and 3	Describe the outer shell s2 electron configuration and the loss of these electrons in redox reactions to form 2+ ions
Calculations of empirical and molecular formulae from composition by mass or percentage compositions by mass and relative formula mass	Describe the outer shell s2 electron configuration and the loss of these electrons in redox reactions to form 2+ ions	Describe the relative reactivities of the Group 2 elements shown by their reactions with oxygen, water and dilute acids
	Describe the relative reactivities of the Group 2 elements shown by their reactions with oxygen, water and dilute acids	Trend in reactivity in terms of the first and second ionisation energies of Group 2 elements down the group
	Trend in reactivity in terms of the first and second ionisation energies of Group 2 elements down the group	The action of water on Group 2 oxides and the approximate pH of any resulting solution
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Understand the terms anhydrous, hydrated and water of crystallisation	Uses of Group 2 compounds as bases, including equations, e.g. Ca(OH)2 in agriculture and Mg(OH)2 and CaCO3 as antacids	Uses of Group 2 compounds as bases, including equations, e.g. Ca(OH)2 in agriculture and Mg(OH)2 and CaCO3 as antacids
Calculation of the formula of a hydrated salt from percentage composition, mass composition or experimental results	Explain the trend in boiling points of Cl2, Br2 and I2 in terms of induced dipole-dipole interactions	Explain the trend in boiling points of Cl2, Br2 and I2 in terms of induced dipole-dipole interactions
Mole calculations involving: mass, gas volume, solution concentration and volume	The outer shell s2p5 electron configuration of halogens and the gaining of one electron in many redox reactions to form 1- ions	The outer shell s2p5 electron configuration of halogens and the gaining of one electron in many redox reactions to form 1- ions
Calculations involving the ideal gas equation: $pV = nRT$	Trend in reactivity of the halogens, illustrated by the reaction with other halide ions	Trend in reactivity of the halogens, illustrated by the reaction with other halide ions
Use of stoichiometric relationships in calculations	Explanation of this trend in terms of attraction, atomic radius and electron shielding	Explanation of this trend in terms of attraction, atomic radius and electron shielding
Calculations to determine the percentage yield of a reaction or related quantities	Explanation of the term disproportionation illustrated by: water purification, formation of bleach and reactions analogous to these	Explanation of the term disproportionation illustrated by: water purification, formation of bleach and reactions analogous to these
Calculations to determine the atom economy of a reaction	The benefits and associated risks of chlorine use in water treatment	The benefits and associated risks of chlorine use in water treatment
Knowledge of techniques and procedures required during experiments requiring the measurement of mass, volumes of solutions and gas volumes	The precipitation reactions, including ionic equations, of the aqueous anions Cl-, Br- and I- with aqueous silver ions followed by aqueous ammonia	The precipitation reactions, including ionic equations, of the aqueous anions Cl-, Br- and I- with aqueous silver ions followed by aqueous ammonia
Benefits for sustainability of developing chemical processes with a high atom economy	Qualitative analysis of ions on a test-tube scale, processes and techniques needed to identify the specified ions in an unknown compound	Qualitative analysis of ions on a test-tube scale, processes and techniques needed to identify the specified ions in an unknown compound
Know the formulae of the common acids and alkalis	3.2 Physical chemistry	3.2 Physical chemistry
Explain acids release H+ ions in aqueous solutions and alkalis release OH- ions in aqueous solutions	Explain some chemical reactions are accompanied by enthalpy changes that are exothermic or endothermic	Explain some chemical reactions are accompanied by enthalpy changes that are exothermic or endothermic
Explain qualitatively strong and weak acids in terms of dissociation	Construct energy profile diagrams to show the difference in the enthalpy of reactants compare with products	Construct energy profile diagrams to show the difference in the enthalpy of reactants compare with products
Understand neutralisation in terms of ions to form water and salts	Explain qualitatively the term activation energy including the use of enthalpy profile diagrams	
Techniques and procedures used when preparing a standard solution of required concentration and carrying out an acid-base titration		
Structured and non-structured titration calculations, based on experimental results for familiar and unfamiliar acids and bases		

Rules for assigning and calculating oxidation number for atoms in elements, compounds and ions	Explanation and use of the terms: standard conditions, standard states; enthalpy change of reaction, formation, combustion and neutralisation	Explain qualitatively the term activation energy including the use of enthalpy profile diagrams
Write formulae using oxidation numbers	Determination of enthalpy changes including the relationship: $q = mc\Delta T$	Explanation and use of the terms: standard conditions, standard states; enthalpy change of reaction, formation, combustion and neutralisation
Use Roman numerals to indicate the magnitude of the oxidation number where applicable	Explanation of the term average bond enthalpy	
Explain oxidation and reduction in terms of electron transfer and changes in oxidation number	Explanation of exothermic and endothermic reactions in terms of enthalpy changes associated with making and breaking bonds	Determination of enthalpy changes including the relationship: $q = mc\Delta T$
		Explanation of the term average bond enthalpy
Full equations (not ionic) for the redox reactions of metals with acids to form salts	Use of average bond enthalpies to calculate enthalpy changes and related quantities	Explanation of exothermic and endothermic reactions in terms of enthalpy changes associated with making and breaking bonds
Interpretation of redox reactions to make predictions in terms of oxidation numbers and electron loss/ gain	Use Hess' law to determine indirectly: an enthalpy change of reaction from enthalpy changes of combustion	
2.2 Electrons, bonding and structure		Use of average bond enthalpies to calculate enthalpy changes and related quantities
Know the number of electrons that can fill the first four shells	Use Hess' law to determine indirectly: an enthalpy change of reaction from enthalpy changes of formation	Use Hess' law to determine indirectly: an enthalpy change of reaction from enthalpy changes of combustion
Define atom orbitals as: regions around the nucleus that can hold up to two electrons, with opposite spins	Use Hess' law to determine indirectly: from unfamiliar enthalpy cycles	Use Hess' law to determine indirectly: an enthalpy change of reaction from enthalpy changes of formation
Know the shapes of s and p orbitals; the number of orbitals making up s, p and d sub-shells and the number of electrons that can fill these shells	Techniques and procedures used to determine enthalpy changes directly and indirectly	Use Hess' law to determine indirectly: from unfamiliar enthalpy cycles
Know how to fill these orbitals	The effect of concentration, including pressure of gases, on the rate of reaction	Techniques and procedures used to determine enthalpy changes directly and indirectly
Deduce the electron configuration of atoms given their atomic number (up to Z=36)	Calculation of reaction rate from the gradients of graphs measuring how a physical quantity changes with time	The effect of concentration, including pressure of gases, on the rate of reaction
Deduce the electron configuration of ions given the atomic number and ionic charge; limited to s and p-blocks (up to Z=36)	Explain the role of a catalyst (reaction rate, not used up in overall reaction, activation energy)	Calculation of reaction rate from the gradients of graphs measuring how a physical quantity changes with time
Define ionic bonding and use dot and cross diagrams	Explain the terms homogeneous and heterogeneous catalysts	Explain the role of a catalyst (reaction rate, not used up in overall reaction, activation energy)
Explain the solid structures of giant ionic lattices	Explain the economic importance and benefits of catalysts	
Explain the effect of structure and bonding on the physical properties of ionic compounds (melting and boiling points, electrical conductivity)		

Define covalent bonding	Techniques and procedures used to investigate reaction rates	Explain the terms homogeneous and heterogeneous catalysts
Construct dot and cross diagrams to describe: single, double and dative covalent bonding	Qualitative explanation of the Boltzmann distribution and its relationship with activation energy	Explain the economic importance and benefits of catalysts
Define and use the term average bond enthalpy	Explanation of the impact of temperature changes on the Boltzmann distribution	Techniques and procedures used to investigate reaction rates
Know the shapes of and bond angles in molecules and ions up to six electron pairs surrounding the central atom	Explanation of the impact of catalytic behaviour on the Boltzmann distribution	Qualitative explanation of the Boltzmann distribution and its relationship with activation energy
Use electron pair repulsion to explain these shapes of molecules and ions: linear, non-linear, trigonal planar, pyramidal, tetrahedral, octahedral	Explanation of dynamic equilibrium	Explanation of the impact of temperature changes on the Boltzmann distribution
Define electronegativity	Le Chatelier's principle to deduce qualitatively the effect of a change in temperature, pressure or concentration on the position of equilibrium	Explanation of the impact of catalytic behaviour on the Boltzmann distribution
Explain polar bond and permanent dipole within molecules containing covalently-bonded atoms with different electronegativities	Explanation of how catalysts affect equilibrium	Explanation of dynamic equilibrium
Explain a polar molecule and overall dipole in terms of permanent dipole(s) and molecular shape	Techniques and procedures used to investigate changes to the position of equilibrium (temperature and pressure)	Le Chatelier's principle to deduce qualitatively the effect of a change in temperature, pressure or concentration on the position of equilibrium
Define intermolecular forces based on dipoles	Explain the importance of compromise between chemical equilibrium and reaction rate	Explanation of how catalysts affect equilibrium
Define hydrogen bonding	Calculations of the equilibrium constant Kc, from provided equilibrium concentrations and the creation of expressions for Kc	Techniques and procedures used to investigate changes to the position of equilibrium (temperature and pressure)
Explain the anomalous properties of water resulting from hydrogen bonding (density, melting and boiling points)	Estimation of the position of equilibrium from the magnitude of Kc	Explain the importance of compromise between chemical equilibrium and reaction rate
Explanation of the solid structures of simple molecular lattices		Calculations of the equilibrium constant Kc, from provided equilibrium concentrations and the creation of expressions for Kc
Explanation of the structure and bonding on the physical properties of covalent compounds with simple molecular structures		Estimation of the position of equilibrium from the magnitude of Kc

Assessments

1. Assessments: Module 4 part 1 exam

Assessments	**Assessments**	2. End of module 4 exam
1. Induction exam 2. Module 2 part 1 exam 3. End of module 2 exam	1. Mock PPE examinations 2. Module 3 part 1 exam 3. End of module 3 exam	

Year 13 A level Chemistry		
Autumn Term 14 weeks	**Spring Term** 14 weeks	**Summer Term** 14 weeks
Module 5: Physical chemistry and transition elements • Reaction rates and equilibrium (quantitative) • pH and buffers • Enthalpy, entropy and free energy • Redox and electrode potentials • Transition elements **Assessments** 1. Module 5 part 1 exam 2. End of module 5 exam	*Module 6: Organic chemistry and analysis* • Aromatic compounds • Carbonyl compounds • Carboxylic acids and esters • Nitrogen compounds • Polymers • Organic synthesis • Chromatography and spectroscopy (NMR) **Assessments** 1. Mock PPE examinations 2. Module 6 part 1 exam 3. End of module 6 exam	<u>**Complete walking talking mocks consistently to apply knowledge**</u>

Explain and use the terms: rate of reaction, order, overall order, rate constant, half-life, rate-determining step
Deduction of orders from experimental data
Deduction of a rate equation from orders of the form: rate = k[A]m[B]n
Calculate rate constant k, and related quantities, from a rate equation including determining units
Deduce the order with respect to a reactant from the shape of a concentration-time graph
Calculate the reaction rate from the gradient of a concentration-time graph
Find the constant half-life from a concentration-time graph of a first order reaction
Determine the rate constant, k, for a first order reaction from the constant half life

6.1.1 Aromatic compounds
Comparison of the Kekulé model of benzene and the subsequent delocalised models
Experimental evidence for delocalised, rather than Kekulé model
Use of IUPAC rules of nomenclature for systematically naming substituted aromatic compounds
Understanding of electrophilic substitution of aromatic compounds with concentrated nitric acid
Understanding of electrophilic substitution of aromatic compounds with a halogen

Deduce the order with respect to a reactant from a rate-concentration graph	Understanding of electrophilic substitution of aromatic compounds with a haloalkane or acyl chloride
Determine the rate constant for a first order reaction from the gradient of a rate-concentration graph	Understanding of mechanism of electrophilic substitution in arenes for nitration and halogenation
Describe techniques and procedures used to investigate reaction rates by the initial rates method, including calorimetry	Explanation of the relative resistance to bromination of benzene compared with alkenes
Predict a rate equation consistent with the rate-determining step of a multi-step reaction	Interpretation of unfamiliar electrophilic substitution reactions of aromatic compounds
Predict possible steps in a reaction mechanism for the rate equation and the balanced equation for a multistep reaction	Understanding of the weak acidity of phenols
	Understanding of the electrophilic substitution reactions of phenol with bromine and dilute nitic acid
Qualitative explanation of the affect of temperature change on the rate of a reaction and the rate constant	Explanation of the relative ease of electrophilic substitution of phenol compared to benzene
Use the Arrhenius equation to find the exponential relationship between the rate constant and temperature	Explantion of the 2- and 4-directing effect of electron donating groups in electrophilic substituion of aromatic compounds
Use the Arrhenius equation to determine Ea and A graphically	Understanding of 3-directing effect of electron withdrawing groups in electrophilic substituion of aromatic compounds
5.1.2 How Far?	
Use the terms mole fraction and partial pressue	Prediction of substitution products of aromatic compouinds
Calculate quantities at equilibrium	6.1.2 Carbonyl compounds
Describe techniques and procedures used to determine quantities present at equilibrium	Understand oxidation of aldehydes using $Cr_2O_7^{2-}$/H^+ to form carboxylic acids
Use expressions for Kc and Kp for homogeneous and heterogeneous equilibria	Understand nucleophilic addition reactions of carbonyl compounds with $NaBH_4$ and HCN
Calculate Kc and Kp including the determination of units	Describe the mechanism of nucleophilic addition reactions of aldehydes and ketones with $NaBH_4$ and HCN
Describe the qualitative effect on equilibrium constants of changing temperature for exothermic and endothermic reactions	Describe the use of 2,4-dinitrophenolhydrazine to detect the presence of a carbonyl group
Describe the constancy of equilibrium constants with changes in concentration, pressure or the presence of a catalyst	Describe the use of 2,4-dinitrophenolhydrazine to identify a carbonyl compound from the melting point of the derivative
Explanation of how an equilibrium constant controls the position of equilibium on	Describe the use of Tollens' reagent to detect the presence of an aldehyde group

changing concentration, pressure and temperature	Describe the use of Tollens' reagent to distinguish between aldehydes and ketones, with explanation
Application of above principles for Kc, Kp to other equilibrium constants	**6.1.3 Carboxylic acids and esters**
5.1.3 Acids, bases and buffers	Explantion of the water solubility of carboxylic acids in terms of hydrogen bonding
Define an Brønsted- lowry acid and base in terms of protons	Description of the reactions of carboxylic acids with metals and bases
Use the term conjugate acid-base pairs	Understanding of esterification of carboxylic acids with alcohols in the presence of an acid catalyst
Use the terms monobasic, dibasic and tribasic	Understanding of esterification of acid anhydrides with alcohols
Describe the role of H+ in the reaction of acids with metals and bases using ionic equations	Understanding of hydrolysis of esters in hot aqueous acid to form carboxylic acids and alcohols
Use the acid dissociation constant Ka for the extent of acid dissociation	Understanding of hydrolysis of esters in hot aqueous alkali to form carboxylate salts and alcohols
Describe the relationship between Ka and pKa	Understanding of the formation of acyl chlorides from carboxylic acids using SOCl2
Use the expressions for pH as: pH = -log[H+] ; [H+] = 10 -pH	Use of acyl chlorides in synthessis in formation of esters, carboxylic acids and primary and secondary amides
Use of the expression for the ionic product of water Kw	**6.2 Nitrogen compounds, polymers and synthesis**
Calculations of pH for: strong monobasic acids and stong bases (using Kw)	**6.2.1 Amines**
Calculations of pH, Ka or related quantities for a weak monobasic acis using approximations	Explain basicity of amines in terms of protons and reactions with dilute acids
Describe the limitations of using approximations to Ka related calculations for 'stronger' weak acids	Understand the preparation of aliphatic amines by substitution of haloalkanes with excess ethanolic ammonia and amines
Define the term buffer	Understand the preparation of aromatic amines by reduction of nitroarenes using tin and concetrated hydrochloric acid
Describe the formation of a buffer from a weak acid and salt of the weak acid	**6.2.2 Amino acids, amides and chirality**
Describe the formation of a buffer from excess of weak acid and a strong alkali	State the general formula for an α-amino acids as RCH(NH2)COOH
Explanation of the role of a conjugate acid-base pair in an acid buffer solution	Understand the reactions of the carboxylic acid group with alkalis and in the formation of esters
Calculation of the pH of a buffer solution from the Ka value of a weak acid and the equilibrium concentrations	

Explanation of the control of blood pH by the carbonic acid- hydrogencarbonate buffer system	Understand the reaction of the amine group with acids
Use of pH titration curves for combinations of stong and weak acid	Describe the structures of primary and secondary amides
Describe the techniques and procedures used when measuring pH with a pH meter	Understanding of optical isomerism
	Identification of chiral centres in a molecule of any organic compound

5.2 Energy

5.2.1 Lattice enthalpy

Explanation of the term lattice energy and its use as a measure of the strength of ionic bonding in a giant ionic lattice	
Use of lattice enthalpy of a simple ionic solid and relevant energy terms for the construction of Born-Haber cycles	
Use of lattice enthalpy of a simple ionic solid and relevant energy terms for related calculations	
Explanation and use of the term enthalpy change of solution	
Explanation and use of the term enthalpy change of hydration	
Use of the enthalpy change of solution and energy terms for the construction of enthalpy cycles	
Use of the enthalpy change of solution and energy terms for related calculations	
Qualitative explanation of the effect of ionic charge and ionic radius on lattice enthalpy and enthalpy change of hydration	

5.2.2 Enthalpy and entropy

Explanation of term entropy	
Explantion of the difference in magnitude of the entropy system of solids, liquids and gases	
Explantion of the difference in magnitude of the entropy system for a reaction with a change in number of gaseous molecules	

6.2.3 Polyesters and polyamides

Understanding of condensation polymerisation to form polyesters and polyamides	
Understanding of the acid and base hydrolysis of ester groups in polyesters and amide groups in polyamides	
Prediction form addition and condensation reactions of: the repeat unit, monomer required, type of polymerisation	

6.2.4 Carbon-carbon bond formation

Describe the use of C-C bond formation in synthesis to increase the length of a carbon chain	
Understand the formation of C-C=N by reaction of haloalkanes with CN- and ethanol, including mechanism	
Understand the formation of C-C=N by reaction of carbonyl compounds with HCN, including mechanism	
Understand the reaction of nitriles by reduction and acid hydrolysis	
Understand the formation of substituted aromatic C-C by alkylation and acylation (Friedel-Crafts reaction)	

6.2.5 Organic synthesis

Describe techniques and procedures used for the preparation and purification of organic solids	
Describe the synthetic routes for an organic molecule containing several functional groups	
Describe the multistage synthetic routes for the preparation of organic compounds	

6.3 Analysis

Calculation of the entropy change of a system ΔS and related quantities	6.3.1 Chromatography and qualitative analysis
Explanation on the feasibility of a process based on TΔS and ΔH	Interpretation of one-way TLC chromatograms in terms of Rf values
Explanation, and related calculations for free energy ΔG	Interpretation of gas chromatograms in terms of retention rates and the amounts and proportions of the components
Explantion of process feasibility in terms of ΔG	Qualitative analysis of organic functional groups on a test tube scale: alkenes by bromine
Limitations of predictions made by ΔG about feasibility in terms of kinetics	Qualitative analysis of organic functional groups on a test tube scale: Halogenoalkanes by aqueous silver nitrate in ethanol
5.2.3 Redox and electrode potentials	Qualitative analysis of organic functional groups on a test tube scale: Phenols by weak acidity but no reaction with CO_3^{2-}
Explanation and use of the terms oxidising agent and reducing agent	Qualitative analysis of organic functional groups on a test tube scale: Carbonyl compounds by reaction with 2,4-DNP
Construction of redox equations using half-equations and oxidation numbers	Qualitative analysis of organic functional groups on a test tube scale: Aldehydes by reaction with Tollens' reagent
Interpretation and prediction of reactions involving electron transfer	Qualitative analysis of organic functional groups on a test tube scale: Primary and secondary alcohols and aldehydes by reaction with acidified dichromate
Describe techniques and procedures used when carrying out redox titrations	
Use of structured and non-structured titration calculations, based on experimental results of redox titrations	Qualitative analysis of organic functional groups on a test tube scale: Carboxylic acids by reaction with CO_3^{2-}
Use of the term standard electrode (redox) potential including its measurement	6.3.2 Spectroscopy
Describe techniques and procedures used for the measurement of cell potentials	Analyse carbon-13 NMR spectrum of an organic molecule to make predictions
Calculation of standard cell potential by combining two standard electrode potentials	Analyse high resolution proton NMR spectrum of an organic molecule to make predictions
Prediction of feasibility of a reaction and limitations using standard electrode potentials	Predict the carbon-13 or proton NMR spectrum for a given molecule
Application of principles of electrode potentials to modern storage cells	Explain the use of tetramethylsilane, TMS, as the standard for chemical shift measurements
Explanation of a fuel cell in terms of oxygen	Explain the need for deuterated solvents when running an NMR spectrum
5.3 Transition elements	
5.3.1 Transition elements	
Electron configuration of atoms and ions of the d-block elements of period 4, given atomic number and charge	

Know the elements Ti- Cu as transition elements	Identify O-H and N-H protons by proton exchange using D2O	
Illustration using at least two transition elements of: the existence of more than 1 oxidation state	Deduce the structures of organic compounds from different analytical data	
Illustration using at least two transition elements of: the formation of coloured ions		
Illustration using at least two transition elements of: the catalystic behaviour of elements and compounds		
Explanation of the term ligand in terms of coordinate bonding, including bidentate ligands		
Use of terms complex ion and coordination number		
Examples of complexes with six-fold coordination with an octohedral shape		
Examples of complexes with four-fold coordination with either a planar or tetrahedral shape		
Types of stereoisomerism shown by complexes including those associated with bidentate and multidentate ligands		
Use of cis-platin as an anticancer drug and its action		
Ligand substitution reactions and the accompanying colour changes		
Explanation of the biochemical importance of iron in haemoglobin, including ligand substitutuion		
Precipitaion reactions, including ionic equations and colour changes for transition element ions with sodium hydroxide and ammonia		
Complex formation with sodium hydroxide(aq) and ammonia(aq)		
Redox reactions and colour changes for interconversions between Fe2+ and Fe3+		

Redox reactions and colour changes for interconversions between Cr3+ and Cr2O72-		
Redox reactions and colour changes for reduction of Cu2+ to Cu+ and disproportionation		
Interpretation and prediction of unfamiliar reactions including ligand substitution, precipitation and redox		
5.3.2 Qualitative analysis		
Qualitative analysis of ions on a test tube scale		