AS and A Level Chemistry

TWO YEAR (LINEAR A LEVEL) SCHEME OF WORK

Pearson Edexcel GCE Chemistry

Scheme of Work – Two Year (Linear A Level) Chemistry

This is an example and may be adapted.

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
1 **Structure of Atoms and the Periodic Table**	GCSE: Atomic Structure and Periodic Table	Know the structure of an atom in terms of electrons, protons and neutrons.	Carry out research to produce a timeline of events in the development of our current understanding of the structure of the atom. Build a model to represent Geiger and Muller's experiment to confirm most of an atom is empty space.	Topic 1: 1–7	
		Know the relative mass and relative charge of protons, neutrons and electrons. Know what is meant by the terms 'atomic (proton) number' and 'mass number'.	Annotate a Periodic Table with key information, showing how to determine numbers of sub-atomic particles.		
		Be able to determine the number of each type of sub-atomic particle in an atom, molecule or ion from the atomic (proton) number and mass number. Understand the term 'isotopes'.	'Build an atom' simulation.		http://tinyurl.com/buildanatomsim
		Be able to define the terms 'relative isotopic mass' and 'relative atomic mass', based on the ^{12}C scale.	Students play a 'spot the difference' game with cards showing all the key definitions.		

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		Understand the terms ‘relative molecular mass’ and ‘relative formula mass’, including calculating these values from relative atomic masses.	Design a spreadsheet to calculate relative molecular mass / relative formula mass from relative atomic masses.		

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2 **Mass Spectrometry and the Formation of Ions** **Electron Orbitals**	GCSE Atomic Structure and Periodic Table	Be able to analyse and interpret data from mass spectrometry to calculate relative atomic mass from relative abundance of isotopes and vice versa. Be able to predict the mass spectra for diatomic molecules, including chlorine. Understand how mass spectrometry can be used to determine the relative molecular mass of a molecule.		Topic 1: 8–19	
		Be able to define the terms 'first ionisation energy' and 'successive ionisation energies'.	Carry out 'True and False' quiz based on misconceptions about Ionisation Energy – use findings to construct definitions and peer assess compared to accepted definition.		http://tinyurl.com/IE-Misconceptions
		Understand reasons for the general increase in first ionisation energy across a period. Understand reasons for the decrease in first ionisation energy down a group.	Plot a graph of IE across a period and / or down a group and use these to help explain the quantum model for electron configurations.		
		Understand how ideas about electronic configuration developed from: i. the fact that successive ionisation energies provide evidence for the existence of quantum shells and the group to which the element belongs ii. the fact that the first ionisation energy of successive elements provides evidence for electron sub-shells. Know the number of electrons that can fill the first four quantum shells. Know that an orbital is a region within an atom that can hold up to two electrons with opposite spins.	Plot graphs of the successive ionisation energies of a selection of atoms and use these to predict the group to which the element belongs.		

		Know the shape of an *s*-orbital and a *p*-orbital. Know the number of electrons that occupy *s*-, *p*- and *d*-sub-shells.	Make models of *s*- and *p*- orbitals.		

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3 **Electronic Configuration and Periodicity**	GCSE: Periodic Table Week 2: Electron Orbitals	Be able to predict the electronic configurations, using 1s notation and electrons-in-boxes notation, of: i. atoms, given the atomic number, *Z*, up to *Z* = 36 ii. ions, given the atomic number, *Z*, and the ionic charge, for *s* and *p*-block ions only, up to *Z* = 36. Know that elements can be classified as *s*-, *p*- and *d*-block elements. Understand that electronic configuration determines the chemical properties of an element. Understand periodicity in terms of a repeating pattern across different periods. Understand reasons for the trends in the following properties of the elements from Periods 2 and 3 of the periodic table: i. the melting and boiling temperatures of the elements, based on given data, in terms of structure and bonding ii. ionisation energy based on given data or recall of the plots of ionisation energy versus atomic number. Be able to illustrate periodicity using data, including electronic configurations, atomic radii, melting and boiling temperatures and first ionisation energies.	Carry out a 'Whiteboard' or Pupil Response Unit Quiz on electronic configurations, using both '$1s^2$ etc.' and 'electrons in boxes' models. Students can self-assess using online quiz. Carry out Periodic Table Card Game based on formulae of oxides of elements. Plot melting and boiling temperatures of the elements in Periods 2 and 3. Annotate the graphs to explain trends in terms of structure. Provide students with images showing trends in Period 2 for atomic radii and ask them to predict the trend in Period 3.	Topic 1: 20–25	http://tinyurl.com/electronquiz http://www.tes.co.uk/teaching-resource/Periodic-table-card-game-differentiated-6301845/

Scheme of work – A level Chemistry

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4 **Inorganic Reactions, Equations and Yields**	GCSE Chemical Formulae and Equations GCSE: Reacting Masses	Be able to write balanced full and ionic equations, including state symbols, for chemical reactions. Be able to relate ionic and full equations, with state symbols, to observations from simple test tube reactions, to include: i. displacement reactions ii. reactions of acids iii. precipitation reactions.	Look at a selection of solubility data for a range of salts and work as a group to propose a set of solubility rules. Use the accepted solubility rules to peer assess. Carry out a selection of displacement, precipitation and acid reactions, using mini whiteboards to write equations.	Topic 5: 6, 14–16	
		Be able to calculate percentage yields and percentage atom economies using chemical equations and experimental results. Understand risks and hazards in practical procedures and suggest appropriate precautions where necessary.	Prepare a sample of a salt and compare predicted to actual yield, considering any potential loss of product. Examples could include copper(II) sulfate or ammonium iron(II) sulfate.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
5 **Amount of Substance**		Know that the mole (mol) is the unit for amount of a substance.	Carry out experiments to determine the molar ratio in a reaction e.g. iron and sulfuric acid.	Topic 5: 1–5	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		Be able to use the Avogadro constant, *L*, in calculations. Know that the molar mass of a substance is the mass per mole of the substance in g mol^{-1}.	View video on Mole and Avogadro as part of 'Flip Learning' preparation, then use scaffolded worksheets to check understanding.		http://www.youtube.com/watch?v=AsqEkF7hcII

		Know what is meant by the terms ‘empirical formula’ and ‘molecular formula’. Be able to calculate empirical and molecular formulae from experimental data.	Carry out experiments to confirm the empirical formula of a compound (e.g. magnesium oxide). Carry out experiments to determine the number of water molecules in a hydrated salt (e.g. hydrated copper(II) sulfate).		http://tinyurl.com/formulaofanoxide

Scheme of work – A level Chemistry

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6 **Calculating Amounts in Reactions Using Moles**	GCSE Reacting Masses and Volumes	Be able to calculate amounts of substances (in mol) in reactions involving mass and volume of gas. Be able to calculate reacting masses from chemical equations, and vice versa, using the concepts of amount of substance and molar mass. Be able to calculate reacting volumes of gases from chemical equations, and vice versa, using the concepts of amount of substance. Be able to calculate reacting volumes of gases from chemical equations, and vice versa, using the concepts of molar volume of gases. ● CORE PRACTICAL 1: Measure the molar volume of a gas	Carry out experiments to investigate thermal decomposition of carbonates (e.g. 'Carbonate rocks!' – RSC). Assess progress of students using AfL sheet from RSC.	Topic 5: 7–10	http://tinyurl.com/carbonaterocks http://www.rsc.org/education/teachers/resources/aflchem/resources/36/index.htm
7 **Calculating Concentration and Carrying Out Titrations**	Week 6: Calculating Amounts of Substance	Be able to calculate solution concentrations, in mol dm^{-3} and g dm^{-3}, for simple acid-base titrations using a range of acids, alkalis and indicators. Be able to: i. calculate measurement uncertainties and measurement errors in experimental results ii. comment on sources of error in experimental procedures. Understand how to minimise the percentage error and percentage uncertainty in experiments involving measurements. ● CORE PRACTICAL 2: Prepare a standard solution from a solid acid ● CORE PRACTICAL 3: Find the concentration of a solution of hydrochloric acid	Carry of preparation of a standard solution e.g. potassium hydrogen phthalate. Determine the solubility of a weak base by titration with standard acid. Compare experimental value to accepted value.	Topic 5: 11–13	Advanced Practical Chemistry ISBN: 978-0-7195-7507-5 Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
8 **Ionic and Covalent Bonding**	GCSE: Ionic and Covalent Bonding	Know that ionic bonding is the strong electrostatic attraction between oppositely charged ions. Understand the effects that ionic radius and ionic charge have on the strength of ionic bonding.	Produce models of ionic lattices (e.g. caesium chloride) using toothpicks and marshmallows.	Topic 2A: 1–9	The Mole Magazine (RSC) – July 2014
		Understand the formation of ions in terms of electron loss or gain. Be able to draw electronic configuration diagrams of cations and anions using dot-and-cross diagrams. Understand reasons for the trends in ionic radii down a group and for a set of isoelectronic ions.	Study dot-and-cross diagram of a known compound (e.g. sodium chloride) and use it to predict the dot-and-cross diagram for less familiar compounds (e.g. potassium fluoride).		
		Understand that the physical properties of ionic compounds and the migration of ions provide evidence for the existence of ions.	Carry out experiment to look for evidence of ion migration.		
		Know that a covalent bond is the strong electrostatic attraction between two nuclei and the shared pair of electrons between them. Be able to draw dot-and-cross diagrams to show electrons in simple covalent molecules, including those with multiple bonds and dative covalent (coordinate) bonds.	Produce a series of cards showing the dot-and-cross diagrams for the chlorides of period 2 (not LiCl). Self-assess and keep for later work on shapes of molecules.		
		Understand the relationship between bond lengths and bond strengths for covalent bonds.	Collect bond length and strength data for a series of covalent bonds. Collate data on spreadsheet and use graph function to look for relationship between length and strength.		

Scheme of work – A level Chemistry

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9 **Types of Structure**	GCSE Metallic Bonding GCSE: Properties and structures Week 8: Bonding	Know that metallic bonding is the strong electrostatic attraction between metal ions and the sea of delocalised electrons. Know that giant lattices are present in: i. ionic solids (giant ionic lattices)	Research atomic radii of metallic elements and compare to melting point. Use metallic bonding model to explain any trends.	Topic 2A: 22 Topic 2B: 23–25	
		ii. covalently bonded solids, such as diamond, graphite and silicon (IV) oxide (giant covalent lattices)	Carry out experiments to compare physical properties of a range of structures (e.g. ion migration, allotropes of sulfur).		Advanced Practical Chemistry ISBN: 978-0-7195-7507-5
		iii. solid metals (giant metallic lattices).	Research and explain trends in melting temperatures of metals using metallic bonding model.		http://tinyurl.com/structuresandproperties
		Know that the structure of covalently bonded substances such as iodine, I_2, and ice, H_2O, is simple molecular. Know the different structures formed by carbon atoms, including graphite, diamond and graphene.	Small groups peer teach each other the structure & properties of a range of structures. Using the RSC Elements Top Trumps as a model, groups design a compounds version based on structures and properties.		 http://tinyurl.com/elementstoptrumps

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Electro-negativity, Bond Polarity and Intermolecular Forces</td><td>Week 8: Bonding

Week 9: Simple molecular structures</td><td>Know that electronegativity is the ability of an atom to attract the bonding electrons in a covalent bond.
Know that ionic and covalent bonding are the extremes of a continuum of bonding type and that electronegativity differences lead to bond polarity in bonds and molecules.

Understand the difference between polar bonds and polar molecules and be able to predict whether or not a given molecule is likely to be polar.
Understand the nature of intermolecular forces resulting from the following interactions:
i. London forces (instantaneous dipole – induced dipole)
ii. permanent dipoles
iii. hydrogen bonds.

Understand the interactions in molecules, such as H_2O, liquid NH_3 and liquid HF, which give rise to hydrogen bonding.
Understand the following anomalous properties of water resulting from hydrogen bonding:
i. its relatively high melting temperature and boiling temperature
ii. the density of ice compared to that of water.
Be able to predict the presence of hydrogen bonding in simple molecules.
Understand, in terms of intermolecular forces, the trends in boiling temperatures of the hydrogen halides, HF to HI.</td><td>Card sort task to order elements in terms of electronegativity and /or bonds in terms of polarity.

Test predictions by experiment – effect of electrostatic field on a stream of liquid.

Compare boiling temperatures of unbranched hydrocarbons to introduce concept of London Forces.

Consider hydrogen bonding in a range of molecules and assess understanding using observations and deductions from practical work (e.g. 'What are Hydrogen Bonds and where are they found?' – RSC).
Whiteboard / PRU Quiz.
Plot data and annotate graph to explain trends in boiling temperature of hydrogen halides.</td><td>Topic 2A: 13–19, 20 iv</td><td>Nuffield Advanced Chemistry: 4th edition
ISBN: 0-582-32835-7

http://tinyurl.com/whatraehydrogenbonds</td></tr>
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11 **Formation of Solutions** **Predicting Structure** **VSEPR**	Week 10: Intermolecular Forces Week 8: Bonding Week :9 Structures	Understand factors that influence the choice of solvents, including: i. water, to dissolve some ionic compounds, in terms of the hydration of the ions	Carry out experiments to compare solubility of sulfates and carbonates.	Topic 2A: 10–11, 21 i, iii, iv Topic 2B: 26–27	http://tinyurl.com/solubility-group1-Group2-compo
		iii. water, as a poor solvent for some compounds, in terms of inability to form hydrogen bonds. iv. non-aqueous solvents, for compounds that have similar intermolecular forces to those in the solvent.	Carry out experiments to compare solubility of some alcohols in water.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		Be able to predict the type of structure and bonding present in a substance from numerical data and/or other information. Be able to predict the physical properties of a substance, including melting and boiling temperature, electrical conductivity and solubility in water, in terms of: i. the types of particle present (atoms, molecules, ions, electrons) ii. the structure of the substance iii. the type of bonding and the presence of intermolecular forces, where relevant.	Compare bonding and intermolecular forces in a range of molecules (e.g. ‘Spot the Bonding’ – RSC).		http://tinyurl.com/spot-the-bonding
		Understand that the shape of a simple molecule or ion is determined by the repulsion between the electron pairs that surround a central atom.	Students are given cards / models showing the shapes of a variety of molecules. They then draw a dot-and-cross diagram for each molecule and produce a summary that links number of electron pairs to shape. Self-assess against VSEPR rules.		

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		Understand reasons for the shapes of, and bond angles in, simple molecules and ions with up to six outer pairs of electrons (any combination of bonding pairs and lone pairs). Be able to predict the shapes of, and bond angles in simple molecules and ions using electron pair repulsion theory.	Balloon modelling of shapes.		http://tinyurl.com/balloonmodels
12 **Redox Reactions**	GCSE: Oxidation and Reduction Week 4: Writing Equations	Know what is meant by the term 'oxidation number'. Be able to calculate the oxidation number of atoms in elements, compounds and ions. Understand oxidation and reduction in terms of electron transfer and changes in oxidation number, applied to reactions of *s*- and *p*-block elements. Understand oxidation and reduction in terms of electron loss or electron gain. Know that oxidising agents gain electrons. Know that reducing agents lose electrons. Understand that a disproportionation reaction involves an element in a single species being simultaneously oxidised and reduced. Know that oxidation number is a useful concept in terms of the classification of reactions as redox and as disproportionation.	Carry out a series of displacement reactions. Introduce concept of oxidation numbers and use them to reassign each change as a redox reaction, writing both full and ionic equations. Thermite reaction can be used as a 'fascinator'. Give students a range of cards each showing they equation for a disproportionation reaction. Each group has 2 minutes to describe the link between each reaction. Groups then come up with a definition to describe their findings and feedback to rest of group.	Topic 3: 1–13	Advanced Practical Chemistry ISBN: 978-0-7195-750 7-5 http://www.rsc.org/learn-chemistry/resource/res00000511/redox-reactions

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		Be able to indicate the oxidation number of an element in a compound or ion, using a Roman numeral. Be able to write formulae given oxidation numbers. Understand that metals, in general, form positive ions by loss of electrons with an increase in oxidation number. Understand that non-metals, in general, form negative ions by gain of electrons with a decrease in oxidation number. Be able to write ionic half-equations and use them to construct full ionic equations.	Carry out a preparation of potassium iodate(V) to reinforce all concepts covered. Purity of sample can be determined by redox titration.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
13 **Chemistry of Group 1 and 2**	GCSE Periodic Table (Group 1) Week 2: Ionisation Energies	Understand reasons for the trend in ionisation energy down Group 2. Understand reasons for the trend in reactivity of the Group 2 elements down the group. Know the reactions of the elements Mg to Ba in Group 2 with oxygen, chlorine and water. Know the reactions of the oxides of Group 2 elements with water and dilute acid, and their hydroxides with dilute acid. Know the trends in solubility of the hydroxides and sulfates of Group 2 elements. Understand reasons for the trends in thermal stability of the nitrates and the carbonates of the elements in Groups 1 and 2 in terms of the size and charge of the cations involved. Understand the formation of characteristic flame colours by Group 1 and 2 compounds in terms of electron transitions. Understand experimental procedures to show: i. patterns in thermal decomposition of Group 1 and 2 nitrates and carbonates ii. flame colours in compounds of Group 1 and 2 elements.	Carry out comparison of reactions of Ca and Mg with HCl and use observations as a lead in to discuss trend in reactivity. Carry out experiments on properties of Group 2 compounds. Class can be divided into groups to focus on one particular aspect, to then feedback to their peers.	Topic 4A: 1–8	http://tinyurl.com/group2reactivity Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
14 **Chemistry of Group**	GCSE: Periodic Table (Group	Understand reasons for the trends in melting and boiling temperatures, physical state at room temperature, and electronegativity for Group 7 elements.	Carry out research task based on physical properties and uses of halogens.	Topic 4B: 9–11	

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7	7) Week 12: Oxidation Numbers, Writing Ionic Equations	Understand reasons for the trend in reactivity of Group 7 elements down the group. Understand the trend in reactivity of Group 7 elements in terms of the redox reactions of Cl_2, Br_2 and I_2 with halide ions in aqueous solution, followed by the addition of an organic solvent.	Carry out displacement reactions of halogens and use outcomes to inform discussion on reactivity of Group 7 elements.		http://tinyurl.com/halogendisplacement

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15 **Explaining Redox Reactions of Group 7 Using Oxidation Numbers**	Week 12: Redox Reactions	Understand, in terms of changes in oxidation number, the following reactions of the halogens: i. oxidation reactions with Group 1 and 2 metals ii. the disproportionation reaction of chlorine with water and the use of chlorine in water treatment iii. the disproportionation reaction of chlorine with cold, dilute aqueous sodium hydroxide to form bleach iv. the disproportionation reaction of chlorine with hot alkali. Understand the following reactions:	Students can use knowledge of oxidation numbers and disproportionation to predict the products from the reactions outlined on the specification. Predictions can be tested by demonstrations and/or videos.	Topic 4B: 12–14	
		i. solid Group 1 halides with concentrated sulfuric acid, to illustrate the trend in reducing ability of the halide ions	Predict likely effect of conc. sulfuric acid on halide compounds and test predictions by experiment.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		ii. precipitation reactions of the aqueous anions Cl^-, Br^- and I^- with aqueous silver nitrate solution, followed by aqueous ammonia solution iii. hydrogen halides with ammonia and with water. Be able to make predictions about fluorine and astatine and their compounds, in terms of knowledge of trends in halogen chemistry.	Research test for halide ions and use it to determine nature of an unknown halide solution.		http://www.rsc.org/learn-chemistry/resource/res00000464/testing-salts-for-anions-and-cations

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16 **Introduction to Carbon Chemistry**	GCSE: Products From Oil	Know that a hydrocarbon is a compound of hydrogen and carbon only. Be able to represent organic molecules using empirical formulae, molecular formulae, general formulae, structural formulae, displayed formulae and skeletal formulae. Know what is meant by the terms 'homologous series' and 'functional group'. Be able to name compounds relevant to this specification using the rules of International Union of Pure and Applied Chemistry (IUPAC) nomenclature. Be able to classify reactions as addition, elimination, substitution, oxidation, reduction, hydrolysis or polymerisation. Understand the term 'structural isomerism' and determine the possible structural, displayed and skeletal formulae of an organic molecule, given its molecular formula. Understand the term 'stereoisomerism', as illustrated by *E/Z* isomerism.	Introduce rules for recognising and naming different organic molecules. Students are given either a model and asked to draw and name it or given a name and asked to draw or model it. Test understanding using online quizzes or RSC AfL activity. Organise a competition between groups to find, draw model and name as many possible isomers of hexane. Ask students to all make a model of but-2-ene. Students compare models to find any differences and use this to lead into discussion on stereoisomerism.	Topic 6A 1–7	http://tinyurl.com/pk58nfq (RSC AfL activity) http://tinyurl.com/alkanesquiz (Example of an online quiz)

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
17 **Chemistry of Alkanes**	GCSE Products From Oil GCSE: Combustion of Fuels Week 16: Nomenclature	Know the general formula for alkanes. Know that alkanes and cycloalkanes are saturated hydrocarbons. Understand, in terms of intermolecular forces, the trends in boiling and melting temperatures with increasing chain length in alkanes. Understand, in terms of intermolecular forces, the effect of branching on boiling and melting temperatures of alkanes. Understand that alkane fuels are obtained from the fractional distillation, cracking and reforming of crude oil. Know that pollutants, including carbon monoxide, oxides of nitrogen and sulfur, carbon particulates and unburned hydrocarbons, are formed during the combustion of alkane fuels. Understand the problems arising from pollutants from the combustion of fuels, limited to the toxicity of carbon monoxide and the acidity of oxides of nitrogen and sulfur. Understand how the use of a catalytic converter solves some problems caused by pollutants.	Carry out experiments to test for unsaturation. Research and plot data of boiling temperatures for a range of alkanes. Students can attempt to explain overall trend as well as discuss any anomalies in terms of London forces. Carry out cracking of liquid paraffin to form ethene and / or fractional distillations of crude oil. Students produce PowerPoint on uses of alkanes as fuels, the possible environmental effects and the role of chemist's in reducing the environmental impact.	Topic 6B: 8–13 Topic 2A: 20 vii, viii	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/crudeoilRSC http://tinyurl.com/cat-convertRSC

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
18 **Radical Substitution Reactions**	GCSE Combustion of Fuels Week 16: Classifying Reactions	Know that a radical: i. is a species with an unpaired electron and is represented in mechanisms by a single dot ii. is formed by homolytic fission of a covalent bond and results in the formation of radicals Understand the reactions of alkanes with: i. oxygen in air (combustion) ii. halogens, in terms of the mechanism of radical substitution through initiation, propagation and termination steps. Understand the limitations of the use of radical substitution reactions in the synthesis of organic molecules, in terms of further substitution reactions and the formation of a mixture of products.	Students view video on free radical reactions prior to lesson to enhance familiarity with key terms. Carry out combustion and halogenation reactions of alkanes. Use free radical substitution mechanism to introduce key terms related to organic mechanisms. Use 'Write–Cover–Rewrite' technique to embed knowledge of mechanism.	Topic 6B: 15–17	http://www.youtube.com/watch?v=5HgzsltWwK8
19 **Chemistry of Alkenes**	GCSE: Products from Oil Week 16: Classifying Reactions & Nomenclature	Know the general formula for alkenes. Know that alkenes and cycloalkenes are unsaturated hydrocarbons. Understand the bonding in alkenes in terms of σ- and π- bonds. Know what is meant by the term 'electrophile'. Understand the addition reactions of alkenes with: i. hydrogen, in the presence of a nickel catalyst, to form an alkane ii. halogens to produce dihalogenoalkanes iii. hydrogen halides to produce halogenoalkanes iv. steam, in the presence of an acid catalyst, to produce alcohols v. potassium manganate(VII), in acid conditions, to oxidise the double bond and produce a diol.	Students view video on electrophilic addition reactions prior to lesson to enhance familiarity with key terms. Carry out experiments to illustrate reaction of bromine with alkenes and compare to previous experimental work with alkanes.	Topic 6C: 18–22	http://www.youtube.com/watch?v=Z_GWBW_GVGA

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20 **Electrophilic Addition Reactions** **Preparation, Uses and Disposal of Polymers**	GCSE Production, uses and disposal of polymers Week 19: Reactions of Alkenes	Understand that heterolytic bond fission of a covalent bond results in the formation of ions. Understand the mechanism of the electrophilic addition reactions between alkenes and: i. halogens ii. hydrogen halides, including addition to unsymmetrical alkenes iii. other given binary compounds. Know the qualitative test for a C=C double bond using bromine water. Know that alkenes form polymers through addition polymerisation. Be able to identify the repeat unit of an addition polymer given the monomer, and vice versa. Know that waste polymers can be separated into specific types of polymer for: i. recycling ii. incineration to release energy iii. use as a feedstock for cracking. Understand, in terms of the use of energy and resources over the life cycle of polymer products, that chemists can contribute to the more sustainable use of materials. Understand how chemists limit the problems caused by polymer disposal by: i. developing biodegradable polymers ii. removing toxic waste gases caused by incineration of plastics.	Use mini whiteboard quiz to test understanding of mechanism with halogens. Students then use 'Write–Cover–Rewrite' technique to embed knowledge of mechanism and apply their knowledge to other examples of the reaction. They can further test their understanding using the RSC Mechanism Inspector. Carry out manufacture of 'slime' to introduce addition polymers. Students use smartphones to record the range of different polymers they use in a week. They can use the images collected along with their own research to prepare a presentation to explain the usefulness of polymers and how chemists limit the problems caused by widespread use.	Topic 6C: 24–29	http://tinyurl.com/mechinspect http://tinyurl.com/slimeRSC http://www.bpf.co.uk/sustainability/plastics_recycling.aspx http://www.wrap.org.uk/category/materials-and-products/plastics http://tinyurl.com/polymerfeedstock

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21 **Reactions of Haloalkanes**	Week 16: Classifying Reactions & Nomenclature	Know that halogenoalkanes can be classified as primary, secondary or tertiary. Understand what is meant by the term 'nucleophile'. Understand the reactions of halogenoalkanes with: i. aqueous potassium hydroxide to produce alcohols (where the hydroxide ion acts as a nucleophile) ii. aqueous silver nitrate in ethanol (where water acts as a nucleophile) iii. potassium cyanide to produce nitriles (where the cyanide ion acts as a nucleophile) iv. ammonia to produce primary amines (where the ammonia molecule acts as a nucleophile) v. ethanolic potassium hydroxide to produce alkenes (where the hydroxide ion acts as a base).	Carry out a preparation of primary halogenoalkane. Carry out experiments to show different reactions of halogenoalkanes with hydroxide ions in different solvents.	Topic 6D: 30–32	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
22 **Trends in Reactivity of Nucleophilic Substitution Reactions**	Week 16: Classifying Reactions & Nomenclature Week 21: Reactions of Halogenoalkanes Week 4: Understand	Understand that experimental observations and data can be used to compare the relative rates of hydrolysis of: i. primary, secondary and tertiary halogenoalkanes ii. chloro-, bromo-, and iodoalkanes using aqueous silver nitrate in ethanol. • CORE PRACTICAL 4: Investigation of the rates of hydrolysis of some halogenoalkanes Know the trend in reactivity of primary, secondary and tertiary halogenoalkanes. Understand, in terms of bond enthalpy, the trend in reactivity of chloro-, bromo, and iodoalkanes.	Interpret data from Core Practical 4. Research data for C-Cl, C-Br and C-I bonds and use this to help explain trend in data from Core Practical 4.	Topic 6D: 33–36	

	Risks and Hazards	Understand the mechanisms of the nucleophilic substitution reactions between primary halogenoalkanes and: i. aqueous potassium hydroxide ii. ammonia.	View video on SN2 mechanism prior to lesson. Use information to help construct models to show how nucleophiles attack primary halogenoalkanes.		https://www.youtube.com/watch?v=Z_85KXnBSYc

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
23 **Reactions and Uses of Alcohols**	Week 16: Classifying Reactions & Nomenclature Week 17: Alkanes as Fuels	Know that alcohols can be classified as primary, secondary or tertiary. Understand the reactions of alcohols with: i. oxygen in air (combustion) ii. halogenating agents iv. concentrated phosphoric acid to form alkenes by elimination. Understand the use of alternative fuels, including biodiesel and alcohols derived from renewable sources such as plants, in terms of a comparison with non-renewable fossil fuels.	Students name and draw a variety of alcohols using mini-whiteboards. Carry out a preparation of an alkene from an alcohol (e.g. cyclohexene from cyclohexanol). Carry out preparation and separation of ethanol by fermentation and distillation, comparing process to manufacture of ethanol from ethene and steam.	Topic 6E: 37, 38 i, ii, iv Topic 6B: 14	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/fermentRSC
24 **Reactions of Alcohols**	Week 4: Understand Risks and Hazards	Understand the reactions of alcohols with potassium dichromate(VI) in dilute sulfuric acid to oxidise primary alcohols to aldehydes (including a test for the aldehyde using Benedict's/ Fehling's solution) and carboxylic acids, and secondary alcohols to ketones. Understand the following techniques used in the preparation and purification of a liquid organic compound: i. heating under reflux iii. distillation v. boiling temperature determination. ● CORE PRACTICAL 5: The oxidation of ethanol	Carry out partial and complete oxidation of ethanol, testing products using Benedict's /Fehling's and sodium carbonate solution.	Topic 6E: 38 iii, 39 i, iii, v	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/microscaleoxialcohol (microscale version of oxidation reactions)

Scheme of work – A level Chemistry

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
25 **Carrying Out a Preparation of an Organic Liquid**	Week 22: Halogenoalkanes Week 23: Halogenating agents Week 24: Practical techniques Week :4 Understand Risks and Hazards	Understand the following techniques used in the preparation and purification of a liquid organic compound: ii. extraction with a solvent in a separating funnel iv. drying with an anhydrous salt. ● CORE PRACTICAL 6: Chlorination of 2-methylpropan-2-ol using concentrated hydrochloric acid	Students can research practical skills required in preparation for core practical using RSC Interactive Lab Primer,	Topic 6E: 39, ii, iv	http://www.chem-ilp.net/
26 **Enthalpy Changes**	GCSE: Exo- and Endothermic Reactions	Know that standard conditions are 100 kPa and a specified temperature, usually 298 K. Know that the enthalpy change is the heat energy change measured at constant pressure. Be able to construct and interpret enthalpy level diagrams showing an enthalpy change, including appropriate signs for exothermic and endothermic reactions. Be able to define standard enthalpy change of reaction, formation, combustion & neutralisation.	Check definitions using RSC starter activity.	Topic 8: 1–5	http://tinyurl.com/enthalpystarter

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand experiments to measure enthalpy changes in terms of: i. processing results using the expression transferred=mass x specific heat capacity × temperature change ($Q=mc\Delta T$) ii. evaluating sources of error and assumptions made in the experiments. ● CORE PRACTICAL 8: To determine the enthalpy change of a reaction using Hess's Law	Carry out experiments to determine enthalpy change of reaction and combustion, producing appropriate energy level diagrams and evaluation of data.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
27 **Using Hess's Law**	Week 26: Energy Changes in Chemical Reactions	Be able to calculate enthalpy changes in kj mol^{-1} from given experimental results. Be able to construct enthalpy cycles using Hess's Law. Be able to calculate enthalpy changes from data using Hess's Law. Know what is meant by the terms 'bond enthalpy' and ' mean bond enthalpy'. Be able to calculate an enthalpy change of reaction using mean bond enthalpies and explain the limitations of this method of calculation. Be able to calculate mean bond enthalpies from enthalpy changes of reaction.	Design experiments to find enthalpy changes (e.g. hydration of anhydrous magnesium sulfate; Hot dinner from a Can (RSC). Research bond enthalpy data and use to produce spreadsheet that will calculate the enthalpy changes for reactions.	Topic 8: 6–11	Advanced Practical Chemistry ISBN: 978-0-7195-750 7-5 http://tinyurl.com/hotdinnerRSC

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
28 **Born–Haber Cycles**	Week 8: Bonding	Be able to define lattice energy as the energy change when one mole of an ionic solid is formed from its gaseous ions. Be able to define the terms: i. enthalpy change of atomisation, ΔH_{at} ii. electron affinity. Be able to construct Born-Haber cycles and carry out related calculations. Know that lattice energy provides a measure of ionic bond strength. Understand that a comparison of the experimental lattice energy value (from a Born-Haber cycle) with the theoretical value (obtained from electrostatic theory) in a particular compound indicates the degree of covalent bonding. Understand the meaning of polarisation as applied to ions. Know that the polarising power of a cation depends on its radius and charge. Know that the polarisability of an anion depends on its radius and charge.	Students are given the definitions and have to decide which term they define, with reasons. After being shown a model example of a Born-Haber calculation, students can carry out calculations on a variety of ionic compounds. The Born-Haber values can be compared to theoretical values and any differences discussed in terms of ionic radii and charge.	Topic 13A: 1–11	

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Be able to define the terms enthalpy change of solution, $\Delta_{sol}H$, and enthalpy change of hydration, $\Delta_{hyd}H$. Be able to use energy cycles and energy level diagrams to carry out calculations involving enthalpy change of solution, enthalpy change of hydration and lattice energy. Understand the effect of ionic charge and ionic radius on the values of: i. lattice energy ii. enthalpy change of hydration.	Design an experiment to find the enthalpy of solution of a salt and use the result as part of a Hess cycle to find Lattice Enthalpy. Carry out problem solving task 'Cool Drinking' from RSC.		Advanced Practical Chemistry ISBN: 978-0-7195-750 7-5 http://tinyurl.com/cool-drinkRSC
29 **Entropy in Chemical Reactions**	GCSE: Exo- and Endothermic Reactions	Understand that, since some endothermic reactions can occur at room temperature, enthalpy changes alone do not control whether reactions occur. Know that entropy is a measure of the disorder of a system and that the natural direction of change is increasing total entropy (positive entropy change). Understand why entropy changes occur during changes of state, dissolving of a solid ionic lattice and reactions in which there is a change in the number of moles from reactants to products. Discuss typical reactions in terms of disorder and enthalpy change, including: i. dissolving ammonium nitrate crystals in water ii. reacting ethanoic acid with ammonium carbonate iii. burning magnesium ribbon in air iv. mixing solid barium hydroxide, $Ba(OH)_2.8H_2O$, with solid ammonium chloride.	Carry out a series of reactions to estimate changes in disorder due to system and surroundings. Use qualitatively to justify why a reaction occurs under a particular set of conditions.	Topic 13B: 12–17	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand that the total entropy change in any reaction is the entropy change in the system added to the entropy change in the surroundings, shown by the expression: $\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$. Be able to calculate the entropy change for the system, ΔS_{system}, in a reaction, given the entropies of the reactants and products. Be able to calculate the entropy change in the surroundings, and hence ΔS_{total}, using the expression $\Delta S_{surroundings} = - \Delta H/T$.	Carry out a series of calculations to confirm, using the total entropy change, whether a reaction is feasible under a given set conditions.		
30 **Gibbs Free Energy in Chemical Reactions**	Week 29: Entropy	Know that the balance between the entropy change and the enthalpy change determines the feasibility of a reaction and is represented by the equation $\Delta G = \Delta H - T\Delta S_{system}$. Be able to use the equation $\Delta \mathbf{G} = \Delta H - T\Delta S_{system}$ to: i. predict whether a reaction is feasible ii. determine the temperature at which a reaction is feasible. Be able to use the equation $\Delta G = -RT \ln K$ to show that reactions which are feasible in terms of ΔG have large values for the equilibrium constant and vice versa. Understand why a reaction for which the ΔG value is negative may not occur in practice. Know that reactions that are thermodynamically feasible may be inhibited by kinetic factors.	Students can be challenged to derive $\Delta G = \Delta H - T\Delta S_{system}$ from relationships highlighted in Week 6. They can revisit the calculations from Week 6 to show how ΔG can also determine feasibility, either quantitatively or qualitatively, by comparing ΔH and ΔS_{system}. Students can enhance understanding of key concepts by using the 'Quantum Casino' website in non-contact time. Students calculate ΔG for decomposition of hydrogen peroxide then observe that the predicted breakdown does not occur (quickly) at room temperature until a catalyst is added to increase rate.	Topic 13B: 18–22	http://www.rsc.org/learn-chemistry/resources/the-quantum-casino/

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
31 **Chemical Equilibria**	GCSE: Reversible Reactions	Know that many reactions are readily reversible and that they can reach a state of dynamic equilibrium in which: i. the rate of the forward reaction is equal to the rate of the backward reaction ii. the concentrations of reactants and products remain constant. Be able to predict and justify the qualitative effect of a change in temperature, concentration or pressure on a homogeneous system in equilibrium. Evaluate data to explain the necessity, for many industrial processes, to reach a compromise between the yield and the rate of reaction. Be able to deduce an expression for Kc, for homogeneous and heterogeneous systems, in terms of equilibrium concentrations.	Carry out experiments to observe effect of changes in conditions on an equilibrium (e.g. cobalt complexes). Apply the concept of qualitative predictions to a selection of novel reactions. Give students data for equilibrium concentrations and K_c for a range of equilibria. In groups they can try to find the relationship between equilibrium concentrations K_c and the balanced equation.	Topic 10: 1–4	http://www.rsc.org/learn-chemistry/resource/res00000001/cobalt-equilibrium

Scheme of work – A level Chemistry

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
32 **Equilibrium Expressions**	Week 29: Chemical equilibria	Be able to deduce an expression for *K*p, for homogeneous and heterogeneous systems, in terms of equilibrium partial pressures in atm.	Carry out experiments to determine equilibrium constants (e.g. ester hydrolysis, redox reactions).	Topic 11: 1–5	Advanced Practical Chemistry ISBN: 978-0-7195-7507-5 Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/eqmmicroscale

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Be able to calculate a value, with units where appropriate, for the equilibrium constant (*K*c and *K*p) for homogeneous and heterogeneous reactions, from experimental data. Know the effect of changing temperature on the equilibrium constant (*K*c and *K*p), for both exothermic and endothermic reactions. Understand that the effect of temperature on the position of equilibrium is explained using a change in the value of the equilibrium constant. Understand that the value of the equilibrium constant is not affected by changes in concentration or pressure or by the addition of a catalyst.	Calculate *K*c for a reaction at different temperatures then link back to qualitative predictions. Check understanding using RSC AfL activity.		Advanced Chemistry Calculations ISBN: 0-7195-4189-1 http://tinyurl.com/eqmafl
33 **Acid-base Equilibria**	GCSE: Weak and Strong Acids Week 7: Calculating Concentrations	Know that a Brønsted–Lowry acid is a proton donor and a Brønsted–Lowry base is a proton acceptor. Know that acid-base reactions involve the transfer of protons. Be able to identify Brønsted–Lowry conjugate acid-base pairs. Be able to define the term ‘pH’. Be able to calculate pH from hydrogen ion concentration. Be able to calculate the concentration of hydrogen ions, in mol dm^{-3}, in a solution from its pH, using the expression $[H^+] = 10^{-pH}$.	Students use acid-base simulation (RSC) to investigate properties of strong and weak acids, producing a summary document of their findings for self-assessment. Carry out experiments to find the pH of a range of solutions of different concentration. Compare experimental value to calculated value.	Topic 12: 1–8	http://tinyurl.com/acid-baseRSC

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand the difference between a strong acid and a weak acid in terms of degree of dissociation. Be able to calculate the pH of a strong acid.	Check understanding using RSC 'Acid Strength' task.		http://tinyurl.com/pr3urph (RSC 'Acid Strength' task)

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
34 **Acid-base Equilibria**	GCSE: Weak and Strong Acids Week 7: Calculating Concentrations Week 32: Equilibrium II	Be able to deduce the expression for the acid dissociation constant, K_w, for a weak acid and carry out relevant calculations. Be able to calculate the pH of a weak acid making relevant assumptions. Be able to define the ionic product of water, K_w. Be able to calculate the pH of a strong base from its concentration, using K_w. Be able to define the terms pK_a and pK_w. Be able to analyse data from the following experiments: i. measuring the pH of a variety of substances, e.g. equimolar solutions of strong and weak acids, strong and weak bases, and salts ii. comparing the pH of a strong acid and a weak acid after dilution 10, 100 and 1000 times. Be able to calculate K_a for a weak acid from experimental data giving the pH of a solution containing a known mass of acid.	Carry out experiments to find the pH of a weak acid at different concentrations. Use this data to find K_w to show this is a more useful way of comparing acidic strength. Introduce key definitions then in groups students carry out a problem solving exercise to find number of hydrogen ions in drops of water, acid and base.	Topic 12: 9–15	Advanced Practical Chemistry ISBN: 978-0-7195-7507-5 http://tinyurl.com/H-ionsRSC
35 **Titration Curves and Buffer Solutions**	Week 34: Equilibria Involving Weak Acids	Be able to draw and interpret titration curves using all combinations of strong and weak monobasic acids and bases. Be able to select a suitable indicator, using a titration curve and appropriate data. Understand how to use a weak acid–strong base titration curve to: i. demonstrate buffer action ii. determine K_a from the pH at the point where half the acid is neutralised. • CORE PRACTICAL 9: Finding the K_a value for a weak acid	Plot a series of titration curves using combinations of strong acids, strong bases, weak acids and weak bases. Students can annotate curves to show key features such as equivalence point and buffering as well as to justify choice of suitable indicator(s) and calculate K_a.	Topic 12: 16–24	Advanced Practical Chemistry ISBN: 978-0-7195-7507-5

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Know what is meant by the term 'buffer solution'. Understand the action of a buffer solution. Be able to calculate the pH of a buffer solution given appropriate data. Be able to calculate the concentrations of solutions required to prepare a buffer solution of a given pH.	Carry out calculations to work out quantities needed to make a buffer solution of a specific pH, then make the solution and measure its pH.		
		Understand the roles of carbonic acid molecules and hydrogencarbonate ions in controlling the pH of blood.	Research roles of buffer solutions in biological systems, identifying component parts of the buffer. Check understanding with problem solving task 'On the Acid Trail'.		http://tinyurl.com/acid-trail
		Understand why there is a difference in enthalpy changes of neutralisation values for strong and weak acids.	Carry out experiments to find enthalpy changes of neutralisation for both weak and strong acids.		Advanced Practical Chemistry ISBN: 978-0-7195-750 7-5
36 **Redox Equilibria – Electrode Potentials**	Week 12: Oxidation Numbers	Understand the terms oxidation and reduction in terms of electron transfer, applied to *s*-, *p*- and *d*-block elements. Understand the terms oxidation and reduction in terms of changes in oxidation number, applied to *s*-, *p*- and *d*-block elements.	Revisit redox and oxidation numbers as a 'mini whiteboard' or Pupil Response Unit Quiz.	Topic 14: 1–6	
		Know what is meant by the term 'standard electrode potential', $E^{\ominus}$. Know that the standard electrode potential, $E^{\ominus}$, refers to conditions of: i. 298 K temperature	Use 'flip learning' technique to introduce concept of standard electrode potential and hydrogen electrode in non-contact time using RSC video.		http://tinyurl.com/sepRSC

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		ii. 100 kPa pressure of gases iii. 1.00 mol dm^{-3} concentration of ions.	Students can add labels to an unlabelled diagram against the clock.		http://tinyurl.com/9l5c9an (Countdown Clock!)
		Know the features of the standard hydrogen electrode and understand why a reference electrode is necessary. Understand that different methods are used to measure standard electrode potentials of: i. metals or non-metals in contact with their ions in aqueous solution ii. ions of the same element in different oxidation states. ● CORE PRACTICAL 10: Investigating some electrochemical cells	Carry out experiments to compare electrode potentials against alternative reference (e.g. copper / copper sulfate), using platinum electrodes where necessary.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
37 **Redox Equilibria – Uses of E^{θ}_{cell}**	Week 36: Electrochemical Cells Weeks 29 & 30: Entropy & Gibbs energy	Be able to calculate a standard emf, E^{θ}_{cell} by combining two standard electrode potentials. Be able to write cell diagrams using the conventional representation of half-cells. Understand the importance of the conditions when measuring the electrode potential, *E*. Be able to predict the thermodynamic feasibility of a reaction using standard electrode potentials. Know that standard electrode potentials can be listed as an electrochemical series.	Students take photos of cells set up in practical lesson and annotate prints outs with the calculation for E^{θ}_{cell} and a conventional cell diagram. Carry out experiments to investigate how E_{cell} varies with concentration. Use difference between E^{θ} values to predict the thermodynamic feasibility of various reactions. Write an equation for each proposed reaction then test whether a reaction is observed.	Topic 14: 7–11	Advanced Practical Chemistry ISBN: 978-0-7195-7507-5 Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7

Scheme of work – A level Chemistry

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand that E^{θ}_{cell} is directly proportional to the total entropy change and to ln*K* for a reaction.	Students produce a summary of the links between E^{θ}_{cell}, ln*K*, ΔS_{total} and ΔG.		

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
38 **Redox Equilibria – More uses of $E^\ominus_{cell}$**	Week 36: Electrochemical Cells Week 37: Calculating $E^\ominus_{cell}$	Understand the limitations of predictions made using standard electrode potentials, in terms of kinetic inhibition and departure from standard conditions. Understand how disproportionation reactions relate to standard electrode potentials. Understand the application of electrode potentials to storage cells. Understand that the energy released on the reaction of a fuel with oxygen is utilised in a fuel cell to generate a voltage. Know the electrode reactions that occur in a hydrogen-oxygen fuel cell.	A demonstration of a uncatalysed reaction and catalysed (e.g. decomposition of hydrogen peroxide) can be used to promote discussion regarding limitations of thermodynamic predictions. Research application of cells (e.g. lead-acid, lithium ion). Build fuel cell using kits. Write equations to show reactions at both electrodes. Use simulations or models to illustrate changes at electrodes.	Topic 14: 12–17	http://tinyurl.com/lead-acidRSC 'Building Better Batteries' – Education In Chemistry – July 2010 http://tinyurl.com/Hyd-CellSIM
39 **Redox Equilibria – Redox Titrations**	Week 7: Calculating concentrations & measurement uncertainties	Be able to carry out both structured and non-structured titration calculations including Fe^{2+}/MnO_4^-, and $I_2/S_2O_3^{2-}$. Understand the methods used in redox titrations. ● CORE PRACTICAL 11: Redox titration	Carry out redox titrations in a problem solving context (e.g. % of Fe in an iron tablet; 'Cleaning Solutions' – RSC).	Topic 14: 18–19	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/cleaningRSC

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
40 **Properties of Transition Metals and their Compounds**	GCSE: Periodic Table (Transition Metals) Week 2: Electronic Configuration Week 12: Oxidation Numbers	Be able to deduce the electronic configurations of atoms and ions of the *d*-block elements of Period 4 (Sc–Zn), given the atomic number and charge (if any). Know that transition metals are *d*-block elements that form one or more stable ions with incompletely-filled *d*-orbitals. Understand why transition metals show variable oxidation number. Know what is meant by the term ligand.	Practice a number of electronic configurations of atoms and ions, using copper and chromium as challenge activities.	Topic 15A: 1–11	
		Understand that dative (co-ordinate) bonding is involved in the formation of complex ions. Understand the meaning of the term coordination number. Know that a complex ion is a central metal ion surrounded by ligands.	Students can be shown a range of complex ion solutions with formulae, be asked to draw or model their shapes and deduce coordination number.		
		Know that transition metals form coloured ions in solution. Understand that the colour of aqueous ions, and other complex ions, results from the splitting of the energy levels of the *d*-orbitals by ligands. Understand where there is a lack of colour in some aqueous ions and other complex ions. Understand that colour changes in *d*-block metal ions may arise as a result of changes in: i. oxidation number ii. ligand iii. coordination number.	Students could make a colour wheel and use this as the start of a discussion regarding the colour of complex ion solutions.		http://www.chemguide.co.uk/inorganic/complexions/colour.html

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
41 **Transition Metal Complexes and Ligands**	Year 2 Week 12: Principles of TM chemistry	Understand why complexes with six-fold coordination have an octahedral shape, such as those formed by metal ions with H_2O, Cl^- and NH_3 as ligands. Know that transition metal ions may form tetrahedral complexes with relatively large ligands such as Cl^-. Know that square planar complexes are also formed by transition metal ions and that cis-platin is an example of such an ion.		Topic 15A: 12–19	

Scheme of work – A level Chemistry

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand the use of cis-platin as an anti-cancer drug in terms of its ability to bind to DNA in cancer cells, thereby preventing cell division. Be able to identify bidentate ligands, such as $NH_2CH_2CH_2NH_2$ and multidentate ligands, such as $EDTA^{4-}$. Know that haemoglobin is an iron(II) complex containing a multidentate ligand.	Research role of cis-platin in cancer treatments. Listen to podcast about cis-platin and produce summary notes.		http://tinyurl.com/cis-platin-podcast
		Know that a ligand substitution reaction occurs when an oxygen molecule bound to haemoglobin is replaced by a carbon monoxide molecule.	Listen to podcast about haemoglobin and produce summary notes.		http://tinyurl.com/haemo-podcast
42 **Redox Reactions of Transition Metals**	Weeks 40 & 41: Principles of TM chemistry	Know the colours of the oxidation states of vanadium (+5, +4, +3 and +2) in its compounds. Understand redox reactions for the interconversion of the oxidation states of vanadium (+5, +4, +3 and +2), in terms of the relevant *E* values.	Students can predict suitable reactants to form vanadium in each of its common oxidation states and carry out an experiment to confirm their predictions.	Topic 15B: 20–27	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		Understand, in terms of the relevant $E^\ominus$ values, that the dichromate(VI) ion, $Cr_2O_7^{2-}$: i. can be reduced to Cr^{3+} and Cr^{2+} ions using zinc in acidic conditions ii. can be produced by the oxidation of Cr^{3+} ions using hydrogen peroxide in alkaline conditions. Know that the dichromate(VI) ion, $Cr_2O_7^{2-}$, can be converted into chromate(VI) ions as a result of the equilibrium, $2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$.	Students can attempt justify redox reactions involving chromium using E_{cell} values. They can then construct half-equations and hence a full equation for each reaction.		
		Be able to record observations and write suitable equations for the reactions of $Cr^{3+}(aq)$, $Fe^{2+}(aq)$, $Fe^{3+}(aq)$, $Co^{2+}(aq)$ and $Cu^{2+}(aq)$ with aqueous sodium hydroxide and aqueous ammonia, including in excess.	Carry out experiments to investigate reactions of transition metal ions with sodium hydroxide and ammonia, writing ionic equations for each change. Observations/equations can be self-assessed.		http://tinyurl.com/ions-complex

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Be able to write ionic equations to show the difference between ligand exchange and amphoteric behaviour.			
		Understand that ligand substitution, and an accompanying colour change, occurs in the formation of: i. $[Cu(NH_3)_4(H_2O)_2]^{2+}$ from $[Cu(H_2O)_6]^{2+}$ via $Cu(OH)_2(H2O)_4$ ii. $[CuCl_4]^{2-}$ from $[Cu(H_2O)_6]^{2+}$ iii. $[CoCl_4]^{2-}$ from $[Co(H_2O)_6]^{2+}$. Understand that the substitution of small, uncharged ligands (such as H_2O) by larger, charged ligands (such as Cl^-) can lead to a change in coordination number.	Carry out a series of to show ligand exchange reactions of $[Cu(H_2O)_6]^{2+}$, recording colour changes, writing ionic equations and explaining any changes in coordination number.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
43 **Stability of Complexes and use of d-Block Elements/ Compounds as Catalysts**	Week 42: Reaction of TM elements Week 29: Entropy	Understand, in terms of the large positive increase in ΔS_{system}, that the substitution of a monodentate ligand by a bidentate or multidentate ligand leads to a more stable complex ion. Know that transition metals and their compounds can act as heterogeneous and homogeneous catalysts.	Carry out an investigation to deduce the relative stability of some complex ions and justify relative stability. (e.g. $[Cu(H_2O)_6]^{2+}$, $[Cu(NH_3)_4(H_2O)_2]^{2+}$, $[Cu(edta)]^{2-}$).	Topic 15B: 28–35	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/catalytic-copper
		Know that a heterogeneous catalyst is in a different phase from the reactants and that the reaction occurs at the surface of the catalyst. Understand, in terms of oxidation number, how V_2O_5 acts as a catalyst in the contact process.	Demonstrate use of a heterogeneous catalyst (e.g. copper in oxidation of propanone).		
		Understand how a catalytic converter decreases carbon monoxide and nitrogen monoxide emissions from internal combustion engines by: i. adsorption of CO and NO molecules onto the surface of the catalyst ii. weakening of bonds and chemical reaction iii. desorption of CO_2 and N_2 product molecules from the surface of the catalyst.	Students build a model of a catalytic converter to illustrate how catalyst reduces harmful emissions from road vehicles, annotating their model to clearly show the processes involved.		

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand the role of Fe^{2+} ions in catalysing the reaction between I^- and $S_2O_8^{2-}$ ions. Know that a homogeneous catalyst is in the same phase as the reactants and appreciate that the catalysed reaction will proceed via an intermediate species.	Students can make predictions regarding mechanism of catalysis in the reaction and investigate a number of possible transition metal ions as catalysts.		Advanced Practical Chemistry ISBN: 978-0-7195-750 7-5
		Know the role of Mn^{2+} ions in autocatalysing the reaction between MnO_4^- and $C_2O_4^{2-}$ ions. ● CORE PRACTICAL 12: The preparation of a transition metal complex	Students can investigate role of Mn^{2+} ions in the oxidation of $C_2O_4^{2-}$ ions by following the progress of the reaction using titrimetric techniques.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
44 **Chemical Kinetics**	GCSE Rates of Reaction	Know how factors, including concentration, temperature, pressure, surface area and catalysts, affect the rate of a chemical reaction. Understand how these factors affect the rate of a reaction, in terms of a qualitative understanding of collision theory and activation energy. Understand how changes in temperature and the use of a catalyst affect the rate of a reaction, in terms of a qualitative understanding of the Maxwell-Boltzmann model of the distribution of molecular energies.	Carry out a series of experiments to see how a variety of variables affect the rate of a reaction. Produce suitable graphs which can then be annotated to describe trends and explain them using collision theory. Give students a selection of reaction profiles with errors. Ask students to find and explain the errors.	Topic 9: 1–9	http://tinyurl.com/conc-rate http://tinyurl.com/surfacearea-rhubarb http://tinyurl.com/temp-rate

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand the role of catalysts in providing alternative reaction routes of lower activation energy. Be able to draw the reaction profiles of both an uncatalysed and a catalysed reaction.	Carry out experiments to see effect of catalysis (e.g. cobalt(II) salts on oxidation of Rochelle salt) and explain observations using reaction profiles.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
45 **The Rate Law**	Week 44: Chemical kinetics	Understand the terms: i. rate of reaction ii. rate equation iii. order with respect to a substance in a rate equation iv. overall order of reaction v. rate constant. Be able to determine and use rate equations of the form rate = $k[A]^m[B]^n$, where *m* and *n* are 0, 1 or 2. Be able to select and justify a suitable experimental technique to obtain rate data for a given reaction, including: i. titration ii. colorimetry iii. mass change iv. volume of gas evolved v. other suitable technique(s) for a given reaction. Understand that an initial-rate method, carrying out separate experiments where different initial concentrations of one reagent are used, can be used to investigate reaction rates. Be able to deduce the order (0, 1 or 2) with respect to a substance in a rate equation using data from an initial-rate method. ● CORE PRACTICAL 13b: Rates of reaction Following the rate of a reaction using a 'clock reaction' (Harcourt-Esson, iodine clock).	Students can research these key terms as part of a 'Flipped Learning' session. Many videos can be found on YouTube (a link to an example is shown). During contact time students can check their understanding using a series of worksheets, scaffolded in difficulty.	Topic 16: 1–3, 4 i, 6 ii,7	http://www.youtube.com/watch?v=TnpaL_syv44 (Example of an introduction to Rate Law)

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
46 **Studying the Kinetics of Reactions**	Week 45: Rate Equations	Understand the term half life. Understand the terms heterogeneous and homogenous catalyst. Understand that a continuous monitoring method to generate data to enable concentration-time or volume-time graphs to be plotted, can be used to investigate reaction rates. Be able to calculate the rate of reaction and the half-life of a first-order reaction using data from a concentration-time or a volume-time graph. Be able to deduce the order (0, 1 or 2) with respect to a substance in a rate equation using data from: i. a concentration-time graph ii. a rate-concentration graph. Understand how to obtain data to calculate the order with respect to the reactants (and the hydrogen ion) in the acid catalysed iodination of propanone. ● CORE PRACTICAL 13a: Rates of reaction Following the rate of the iodine-propanone reaction by a titrimetric method	Carry out a range of experiments to revisit the factors that affect rate, using a variety of techniques. These could include reactions between $CaCO_3$ and HCl (by gas collection) , iodine and propanone (by titration and/or initial-rate method) or iodide ions and hydrogen peroxide (by a 'clock' reaction). Students can then process data collected (e.g. graphs of concentration against time, calculation of estimate of initial rate) to determine orders and hence rate constants.	Topic 16: 4 ii, 5, 6 i	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/iod-clock

Scheme of work – A level Chemistry

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
47 **Using Kinetics to Investigate Mechanisms**	Week 46: Acid Catalysed Iodination of Propanone Week 22: Halogenoalkanes	Understand the term rate-determining step. Understand how to use data from the acid catalysed iodination of propanone to make predictions about species involved in the rate determining step understand how deduce a possible mechanism for this reaction. Be able to deduce a rate-determining step from a rate equation and vice versa. Be able to deduce a reaction mechanism, using knowledge from a rate equation and the stoichiometric equation for a reaction. Understand that knowledge of the rate equations for the hydrolysis of halogenoalkanes can be used to provide evidence for S_N1 or S_N2 mechanisms for tertiary and primary halogenoalkane hydrolysis. Understand the term activation energy.	Students can process data from rate experiments featuring the hydrolysis of different classifications of halogenoalkanes. Having determined the order with respect to the reactants they can propose mechanisms for each reaction.	Topic 16: 8–12	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		Be able to use graphical methods to find the activation energy for a reaction from experimental data. ● CORE PRACTICAL 14: Finding the activation energy of a reaction	Design an experiment to find the activation energy for the oxidation of glucose solution with MnO_4^- ions (in acidic or alkaline conditions).		
48 **Stereoisomers and Mechanisms**	Week 16: Classifying Reactions & Nomenclature Week 21: Halogenoalkanes	Know that optical isomerism is a result of chirality in molecules with a single chiral centre. Understand that optical isomerism results from chiral centre(s) in a molecule with asymmetric carbon atom(s) and that optical isomers are object and non-superimposable mirror images. Know that optical activity is the ability of a single optical isomer to rotate the plane of polarisation of plane-polarised monochromatic light in molecules containing a single chiral centre. Understand the nature of a racemic mixture.	Students research key concepts in as a Flipped Learning' task, using support videos. Give the students models of a pair of enantiomers and ask them to decide if they are different and if so, how. Use a starter to promote discussion of optical activity.	Topic 17A: 1–5	http://tinyurl.com/stereo-iso

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Be able to use data on optical activity of reactants and products as evidence for S_N1 and S_N2 mechanisms.	Use scaffolded questions to develop understanding of nucleophilic substitution from year 1.		http://tinyurl.com/stereo-selective-reactions

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
49 **Chemistry of Carbonyl Compounds**	Week 16: Classifying Reactions & Nomenclature Week 24: Oxidation of Alcohols	Be able to identify the aldehyde and ketone functional groups.	Carry out qualitative tests to distinguish between aldehydes and ketones. Preparation of a 'giant silver mirror' test can be used as a 'hook' to generate initial interest in the lesson(s).	Topic 17B: 6–8	http://www.nuffieldfoundation.org/practical-chemistry/giant-silver-mirror
		Understand that aldehydes and ketones: i. do not form intermolecular hydrogen bonds, and this affects their physical properties			
		ii. can form hydrogen bonds with water, and this affects their solubility. Understand the reactions of carbonyl compounds with: i. Fehling's or Benedict's solution, Tollens' reagent and acidified dichromate(VI) ions ii. lithium tetrahydridoaluminate (lithium aluminium hydride) in dry ether	Make models of carbonyl compounds and water and use these to illustrate solubility.		
		iii. HCN, in the presence of KCN, as a nucleophilic addition reaction, using curly arrows, relevant lone pairs, dipoles and evidence of optical activity to show the mechanism	Use RSC Mechanism Inspector to introduce nucleophilic addition in a 'Flipped Learning' environment. Test understanding using a series of scaffolded question in class. Use 'Write–Cover–Rewrite' technique to embed knowledge of mechanism.		http://tinyurl.com/mechinspect
		iv. 2,4-dinitrophenylhydrazine, as a qualitative test for the presence of a carbonyl group and to identify a carbonyl compound given data of the melting temperatures of derivatives	Prepare a dry sample of a 2,4-dinitrophenylhydrazine derivative and identify the carbonyl compound by determining the melting temperature of the derivative.		http://tinyurl.com/24DNP-test http://tinyurl.com/24DNP-derivative

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		v. iodine in the presence of alkali.	Carry out a preparation of iodoform, using propanone. Alternatively carry out the iodoform reaction as qualitative test to distinguish between methanol and ethanol.		http://tinyurl.com/iodoformprep http://tinyurl.com/iodoform-test
50 **Chemistry of Carboxylic Acids and Derivatives**	Week 16: Classifying Reactions & Nomenclature Week 24: Oxidation of Alcohols Week 10: Intermolecular Forces	Be able to identify the carboxylic acid functional group. Understand that hydrogen bonding affects the physical properties of carboxylic acids, in relation to their boiling temperatures and solubility. Understand that carboxylic acids can be prepared by the oxidation of alcohols or aldehydes, and the hydrolysis of nitriles. Understand the reactions of carboxylic acids with: i. lithium tetrahydridoaluminate (lithium aluminium hydride) in dry ether ii. bases to produce salts iii. phosphorus(V) chloride (phosphorus pentachloride)	Students produce summary mind map of reactions involving carboxylic acids from GCSE and A level year 1, including appropriate reagents and conditions. Discussion of structural features of acids can lead to suggestions of further reactions, which can be researched and added to map.	Topic 17C: 9–16	
		iv. alcohols in the presence of an acid catalyst. Be able to identify the acyl chloride and ester functional groups.	Students could prepare a number of esters (test tube scale, with acids and alcohols) and practice writing equations and names of products. Alternatively (or additionally) they could carry a larger scale preparation of an ester (e.g. methyl benzoate, oil of wintergreen).		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		Understand the reactions of acyl chlorides with: i. water ii. alcohols iii. concentrated ammonia iv. amines.	Students could watch a demonstration of the reactions of ethanoyl chloride. Photos of the demos could be taken and annotated with descriptions and equations for each reaction.		Advanced Practical Chemistry ISBN: 978-0-7195-7507-5

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand the hydrolysis reactions of esters, in acidic and alkaline solution. Understand how polyesters are formed by condensation polymerisation.	Carry out an ester hydrolysis (e.g. preparation of aspirin). If you have contacts with a the outreach team at a local university the RSC have developed resources for the preparation and subsequent analysis of aspirin, which can be used as a synoptic task towards the end of the course.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 http://tinyurl.com/RSC-aspirin
51 **Chemistry of Arenes – Structure of Benzene**	Week 16: Classifying Reactions & Nomenclature Week 8: Bonding	Understand that the bonding in benzene has been represented using the Kekulé and the delocalised model, the latter in terms of overlap of *p*-orbitals to form π-bonds. Understand why benzene is resistant to bromination, compared with alkenes, in terms of delocalisation of π-bonds in benzene and the localised electron density of the π-bond in alkenes. Understand that evidence for the delocalised model of the bonding in benzene is provided by data from enthalpy changes of hydrogenation and carbon-carbon bond lengths.	Students can make models of benzene and ethene and use them to help compare the bonding in both and explain why benzene does not give a positive result for unsaturation. Draw and annotate energy level diagrams for hydrogenation of benzene and cyclohexene and use these as evidence for the delocalised model. Use starter activities to test understanding (e.g. naming rules). RSC have produced a series of these called 'Starters for 10'.	Topic 18A: 1–3	http://tinyurl.com/RSC-Starters

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
52 **Chemistry of Arenes – Electrophilic Substitution Reactions**	Week 51: Structure of Benzene	Understand the reactions of benzene with: i. oxygen in air (combustion with a smoky flame) ii. bromine, in the presence of a catalyst	Carry out small scale experiments to investigate the reactions of benzene, using safe derivatives of benzene.	Topic 18A: 4–7	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		iii. a mixture of concentrated nitric and sulfuric acids	Carry out preparation of methyl-3-nitrobenzoate.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		iv. halogenoalkanes and acyl chlorides with aluminium chloride as catalyst (Friedel-Crafts reaction).	Alternatively, this could be done as a longer synoptic project, staring with the synthesis of the ester methyl benzoate. This could link together several strands of organic content, the key practical skills as well as instrumental methods of determining structure (see Week 30).		
		Understand the mechanism of the electrophilic substitution reactions of benzene (halogenation, nitration and Friedel-Crafts reactions), including the generation of the electrophile.	Students can predict likely nature of attacking species and be introduced to mechanism Use 'Write–Cover–Rewrite' technique to embed knowledge of mechanism then test using 'mini-whiteboard' quiz.		

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand the reaction of phenol with bromine water. Understand reasons for the relative ease of bromination of phenol, compared to benzene.	Students are given structure of phenol and are shown the reaction of a phenol derivative with bromine. In groups they can be asked to 'snowball' an explanation for the observation(s).		Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 'Snowballing' explanations is sometimes called 'Pairs to Four' – can be found in The Teachers Toolkit – Paul Ginnis ISBN: 189983676-4
53 **Organic Compounds Containing Nitrogen**	Week 16: Classifying Reactions & Nomenclature	Be able to identify: i. the amine and amide functional groups ii. molecules that are amino acids.		Topic 18B: 8–13	
		Understand the reactions of primary aliphatic amines, using butylamine as an example, with: i. water to form an alkaline solution ii. acids to form salts iii. ethanoyl chloride iv. halogenoalkanes v. copper(II) ions to form complex ions.	Carry out experiments to investigate the reactions of amines.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7
		Understand reasons for the difference in basicity of ammonia, primary aliphatic and primary aromatic amines given suitable data.	Reasearch pK_a of a number of amines and use the data to list amines in order of basic strength. Justify order in terms of structure of amines.		

learning

Scheme of work – A level Chemistry

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
		Understand, in terms of reagents and general reaction conditions, the preparation of primary aliphatic amines: i. from halogenoalkanes ii. by the reduction of nitriles. Know that aromatic nitro-compounds can be reduced, using tin and concentrated hydrochloric acid, to form amines. Understand that amides can be prepared from acyl chlorides.	Students can revisit the reactions of halogenoalkanes and nitration of aromatic rings. They can then suggest how to prepare amines and research suitable reagents. Revisit esterification reactions and use this to promote discussion on how acyl chlorides could be used to form amides. Test understanding of amines using RSC 'Starter for 10' activities.		http://tinyurl.com/RSC-Starters
54 **Condensation Polymers and Amino Acids**	Week 16: Classifying Reactions & Nomenclature Week 20: Polymers	Know that the formation of a polyamide is a condensation polymerisation reaction. Be able to draw the structural formulae of the repeat units of condensation polymers formed by reactions between: i. dicarboxylic acids and diols ii. dicarboxylic acids and diamines iii. amino acids.	Carry out 'Nylon Rope Trick' reaction. Students draw or model the structures of a range of polymers including proteins.	Topic 18B: 14 – 17	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7

		Understand the properties of 2-amino acids, including: i. acidity and basicity in solution, as a result of the formation of zwitterions ii. effect of aqueous solutions on plane-polarised monochromatic light. Understand that the peptide bond in proteins: i. is formed when amino acids combine, by condensation polymerisation ii. can be hydrolysed to form the constituent amino acids, which can be separated by chromatography.	Carry out experiments to show the properties of amino-acids, including paper chromatography of amino acids.		Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
55 **Instrumental Methods to Find the Structure of Organic Compounds**	Week 16: Use of Displayed, Structural & Skeletal Formulae Week 8: Bonding	Be able to use data from a mass spectrometer to: i. determine the relative molecular mass of an organic compound from the molecular ion peak ii. suggest possible structures of a simple organic compound from the m/z of the molecular ion and fragmentation patterns. Be able to use data from infrared spectra to deduce functional groups present in organic compounds and to predict infrared absorptions, given wavenumber data, due to familiar functional groups. ● CORE PRACTICAL 7: Analysis of some inorganic and organic unknowns	Students can research IR and mass spectra of simple organic compounds using Spectra School and can annotate spectra using data from data booklet. Molecular models can be made then broken up by students to try to identify peaks in mass spectra due to fragmentation.	Topic 7A: 1 Topic 7B: 2 Topic 19A: 1	http://spectraschool.rsc.org/
56 **Chromatography**	Week 54: Amino Acids	Know that chromatography separates components of a mixture between a mobile phase and a stationary phase. Be able to calculate R_f values from one-way chromatograms. Know that high performance liquid chromatography, HPLC, and gas chromatography, GC: i. are types of column chromatography ii. separate substances because of different retention times in the column iii. may be used in conjunction with mass spectroscopy, in applications such as forensics or drugs testing in sport.	Use paper chromatogram to illustrate key terms. Calculate R_f values of amino acids on paper chromatogram and attempt to match to accepted values for solvent used. View RSC video on Gas Chromatography. Use understanding of chromatography to help solve a synoptic problem (e.g. Patient Prognosis – RSC).	Topic 19C: 6–8	http://tinyurl.com/spec-videos http://tinyurl.com/patient-prognosis

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
57 **NMR Spectroscopy**		Understand that ^{13}C NMR spectroscopy provides information about the positions of ^{13}C atoms in a molecule. Be able to use data from ^{13}C NMR spectroscopy to: i. predict the different environments for carbon atoms present in a molecule given values of chemical shift, δ ii. justify the number of peaks present in a ^{13}C NMR Spectrum because of carbon atoms in different environments. Understand that high resolution proton NMR provides information about the positions of ^{1}H atoms in a molecule. Be able to use data from high resolution ^{1}H NMR spectroscopy to: i. predict the different types of proton present in a molecule given values of chemical shift, δ ii. relate relative peak areas, or ratio numbers of protons, to the relative numbers of ^{1}H atoms in different environments iii. deduce the splitting patterns of adjacent, non-equivalent protons using the n+1 rule and hence suggest the possible structures for a molecule iv. predict the chemical shifts and splitting patterns of the ^{1}H atoms in a given molecule.	Students research the key principles of NMR using 'Spectra School' – this could be in a 'flipped learning' environment. Students annotate large print spectra to map peaks against different carbon environments. Students are given information about the abundance of ^{13}C and ^{1}H and asked to suggest why ^{1}H spectra provide more information and 'snowball' in groups what kind of extra information might be derived from a ^{1}H spectra. Students use large print spectra of a simple molecule (e.g. ethanol) to illustrate what structural information can be derived from a ^{1}H spectrum. Use large print versions of spectra of an unknown compound and students can annotate and suggest structure.	Topic 19B: 2–5	http://tinyurl.com/Spec-homeRSC

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
58 **Identifying Organic Structures**	Week 2: Mass Spectrometr y	Be able to use data from mass spectra to: i. suggest possible structures of a simple organic compound given relative molecular masses, accurate to four decimal places ii. calculate the accurate relative molecular mass of a compound, given relative atomic masses to four decimal places, and therefore identify a compound.		Topic 19B: 1 Topic 18C: 18	http://www.chemguide.co.uk/analysis/masspec/mplus.html
		Be able to deduce the empirical formulae, molecular formulae and structural formulae of compounds from data obtained from combustion analysis, elemental percentage composition, characteristic reactions of functional groups, infrared spectra, mass spectra and nuclear magnetic resonance. ● CORE PRACTICAL 15: Analysis of some inorganic and organic unknowns	Carry out qualitative tests on a series of unknown organic compounds and use the observations and data from Combustion analysis, IR, Mass Spectrometry, and NMR to identify them.		'Identification of organic compounds' - Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7 Compound Confusion – RSC -http://tinyurl.com/comp-confuse

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
59 **Planning how to Synthesise Compounds**	All previous organic chemistry	Be able to plan reaction schemes, of up to four steps, to form both familiar and unfamiliar compounds.	Students can produce their own large-scale summary of the organic reactions covered in the specification, including appropriate reagents and conditions. Alternatively they could be given cards with names of products, reactants and reagents and they could construct a class-wall size summary together, which can be photographed by all group members. Students carry out synthesis problems / research using the 'Synthesis Explorer' as support.	Topic 18C: 19–20	http://www.rsc.org/learn-chemistry/resources/synthesis-explorer/instructions.asp
		Understand methods of increasing the length of the carbon chain in a molecule by the use of magnesium to form Grignard reagents and the reactions of the latter with carbon dioxide and with carbonyl compounds in dry ether.	Students research use of Grignard reagents in synthesis.		http://tinyurl.com/grignard-Chemguide

Week	Prior learning	Content of lessons	Teaching suggestions	Spec reference	Useful links
60 **Carrying out Preparations of Organic Compounds**	All previous organic chemistry	Be able to select and justify suitable practical procedures for carrying out reactions involving compounds with functional groups included in the specification, including identifying appropriate control measures to reduce risk, based on data about hazards. Understand the following techniques used in the preparation and purification of organic compounds: i. refluxing ii. purification by washing iii. solvent extraction iv. recrystallization v. drying vi. distillation, including steam distillation vii. melting temperature determination viii. boiling temperature determination. ● CORE PRACTICAL 16: The preparation of aspirin	Many of these techniques are likely to have been introduced and used in the earlier organic sections of the specification. This is an opportunity for students to plan and carry out a synthesis, considering quantities, equipment, techniques and risks. One example could be the two step conversion of benzoic acid to methyl-3-nitrobenzoate.	Topic 18C: 21–22	Nuffield Advanced Chemistry: 4th edition ISBN: 0-582-32835-7