Year 12 Chemistry Curriculum Unit Overview

Year 12 A Level Chemistry Module 1: **3.1.1 Atomic structure**				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
describe the structure of atoms in terms of protons, neutrons and electrons. recall the relative mass and relative charge of protons, neutrons and electrons. To define atoms and ions in terms of protons, neutrons and electrons. Explain the existence of isotopes. How a TOF mass spectrometer works and some of its simple	Students research how the model of the atom changed over time (examples of key contributions could include the Ancient Greeks, Dalton, Thompson, Rutherford, Bohr, Chadwick) (AO1 - Knowledge and understanding of atomic structure; AO3 - Evaluate how and why atomic structure model developed over time). Students identify atoms and ions from numbers of protons, neutrons and electrons, and vice versa (AO2 - Apply knowledge and understanding). Students determine the relative atomic mass of elements using isotope abundance data (this could include data for elements found in meteorites to show some difference) quoting answers to a suitable number of significant figures for data provided (AO2 - Apply knowledge and understanding; MS1.1 - Use an appropriate number of significant figures to find relative masses; MS1.2 - Find arithmetic means to find relative masses. Students look at the mass spectra of compounds to determine the relative formula mass (AO2 - Apply knowledge and understanding). Students write the electron structure of atoms and ions	SAM AS Paper 1 (set 1) Q2 June 2013 Unit 1 Question 1a, 1b, 1c and 1f (QS13.1.01) January 2012 Unit 1 Question 7a (QW12107) June 2010 Unit 1 Question 8a (QS10.1.8A) January 2012 Unit 1 Question 5a and 5b (QW12.01.05) June 2013 Unit 1 Question 6b, 6c and 6d (QS13.01.06) January 2010 Unit 1 Question 2 (QW10.01.02) June 2009 Unit 1 Question 1a and 1b (QS09.01.01)	**GCSE Chemistry** - The structure of atoms (although this is revisited here). **GCSE Physics** - The structure of atoms (although this is revisited here). - The effect of a force on moving objects. - The effect of a magnetic field on a moving, electrically charged particle (Separate Science)	RSC timeline: http://www.rsc.org/chemsoc/timeline RSC: Chemists in a social & historical context: http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives?cmpid=CMP00002843 RI Christmas Lecture – section on atomic structure http://www.rsc.org/learn-chemistry/resource/res00001119/ri-christmas-lectures-2012-atomic-structure RSC: Build an atom simulation: http://www.rsc.org/learn-chemistry/resource/res00001433/build-an-atom-simulation-rsc-funded RSC Spectral School: http://www.rsc.org/learn-chemistry/collections/spectroscopy Isotope data:

uses. Describe the electron structure of atoms and ions. Define and write equations for ionisation energy. Explain how ionisation energy data provides evidence for electron structure.	with *Z*=1-36 (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students research values of first ionisation energies for elements *Z*=1–36 and plot them on a graph and then explain trends (AO2 - Apply knowledge and understanding; MS3.2 - Plot two variables from experimental or other data). Students write explanations for trends in ionisation energies down a group and across a period (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students determine which Group an element is in using successive ionisation energy data (AO2 - Apply knowledge and understanding).	January 2002 Unit 1 Question 4d (QW02.01.04)		http://www.chem.ualberta.ca/~massspec/atomic_mass_abund.pdf Data on isotopes in meteorites: 'The Elements: Their Origin, Abundance, and Distribution' by P. A. Cox AQA Time of flight mass spectrometry Teachers' Notes and Student guide: http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-SG-TOFMS.PDF http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-SG-TOFMS-QA.PDF Orbitron (shows shapes of orbitals): http://winter.group.shef.ac.uk/orbitron/ Ionisation energy data (1st and successive) http://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements

Year 12 A Level Chemistry Module 2: **3.1.2 Amount of substance**				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Relative mass of atoms, elements and compounds. Calculations using moles for solids and solutions. Perform calculations using the ideal gas equation. Calculate empirical and molecular formulae from data. To write balanced full and ionic equations. To use equations to calculate masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions. To understand the importance of processes having a high atom economy	The relative mass of different substances is calculated from the formula (AO2 - Apply knowledge and understanding) The mass of everyday objects could be measured relative to a specific object of known mass (AO2 - Apply knowledge and understanding) Determine the relative formula mass (M_r) of substances using relative atomic mass values (AO2 - Apply knowledge and understanding) Students could research why ^{12}C was chosen as the standard (AO3 - Analyse, interpret and evaluate scientific information). Students calculate the mass (in g) of atoms/ions using the masses sub atomic particles, quoting answers to a suitable number of significant figures for data provided (AO2 - Apply knowledge and understanding). Practical opportunity: Students measure out 1 mole (and other mole quantities) of different substances (eg sucrose, salt, water) (AO2 - Apply knowledge and understanding). Students practice doing calculations involving Avogadro constant, involving mass, M_r and moles, and involving concentration, volume and amount of substance and quoting the final results to the appropriate number of significant figures for data provided (AO2 - Apply knowledge and understanding; MS1.1 - Use an appropriate number of significant figures to find relative masses). Students find the concentration of NaCl in intravenous saline (9 g per dm^3), glucose in isotonic sports drinks (17 g in 500 cm^3) and other similar calculations for everyday solutions. (AO2 - Apply knowledge and understanding). Students research how Avogadro determined the value of his constant (AO3 - Analyse, interpret and evaluate scientific	Students can calculate M_r given the formula of compounds Calculating the mass (in g) of atoms/ions using the masses sub atomic particles to 5 sf Calculations linking mass, M_r and moles Calculations linking volume, moles and concentration Calculations to determine the mass of a substance needed to produce a set volume of a solution with a pre-determined concentration. Calculations to determine the concentration of a	**GCSE Chemistry** - Relative atomic mass, relative molecular mass, relative formula mass (although this is revisited here). - Writing formulae (elements, common compounds and ionic compounds). - Balancing equations (although this is revisited here). - Moles (although this is revisited here). - Calculations involving Masses (although this is revisited here). - Concentration of solutions (Separate Science - although this is revisited here). - Empirical and molecular formulae (although this is revisited here).	Suitable resources can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required) Finding M_r of butane: http://www.nuffieldfoundation.org/practical-chemistry/determining-relative-molecular-mass-butane Data on gas cylinders: http://www.boconline.co.uk/en/index.html Finding empirical formula of copper oxide http://www.nuffieldfoundation.org/practical-chemistry/finding-formula-copper-oxide RSC resource on elemental

for society and industry. **Required practical 1** Make up a volumetric solution and carry out a simple acid–base titration.	information). Students will need to rearrange the ideal gas equation, work in appropriate units and quote answers to an appropriate number of significant figures (AO2 - Apply knowledge and understanding; MS0.0 - Recognise and make use of appropriate units in ideal gas calculations MS2.2 - Change the subject of the ideal gas equation; MS2.3 - Substitute numerical values into the ideal gas equation using appropriate units for physical quantities). Practical opportunity: Students find the M_r of a volatile liquid (AO2 - Apply knowledge and understanding; MS0.0 - Recognise and make use of appropriate units in ideal gas calculations ; MS2.2 - Change the subject of the ideal gas equation; MS2.3 - Substitute numerical values into the ideal gas equation using appropriate units for physical quantities; PS 3.2 - Process and analyse data; PS 4.1 - Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques). Practical opportunity: Students find the empirical formula of a metal oxide (eg magnesium oxide or copper oxide) (AO2 - Apply knowledge and understanding; PS 3.2 – process & analyse data using appropriate mathematical skills). Students find empirical formulae (and molecular formulae where relevant) from data (AO2 - Apply knowledge and understanding; MS0.2 - Use ratios, fractions and percentages). Students balance equations, including ones where formulae are given and some where they are not (AO2 - Apply knowledge and understanding). Students write ionic equations from given equations (AO2 - Apply knowledge and understanding). Students practise calculations to find masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions (AO2 - Apply knowledge and understanding; MS1.1 - Use an appropriate number of significant figures; MS2.3 - Substitute numerical values into algebraic equations using appropriate units for physical	solution when a set mass is dissolved in a set volume. Calculations using Avogadro's number to determine the number of particles in a solution or given mass. June 2006 Unit 1 Question 3 (QS06.1.03) June 2005 Unit 1 Question 2b (QS05.1.02) January 2005 Unit 1 Question 2b (QW05.1.02) January 2004 Unit 1 Question 4a (QW04.1.04) June 2010 Unit 1 Question 4a (QS10.1.04) June 2009 Unit 1 Question 2c (QS09.1.02) January 2011 Unit 1 Question 3 (QW11.1.03) June 2010 Unit 1 Question 3 (QS10.1.03) January 2009 Unit		microanalysis: http://www.nationalstemcentre.org.uk/elibrary/resource/9890/elemental-microanalysis Finding the M_r of a hydrated salt: http://www.nuffieldfoundation.org/practical-chemistry/finding-formula-hydrated-copperii-sulfate

	quantities). Practical opportunity: the yield for the conversion of magnesium to magnesium oxide (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills). Practical opportunity: Students find the M_r of a hydrated salt (eg copper sulfate or magnesium sulfate) by heating to constant mass (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills). **Required practical 1** - Make up a volumetric solution and carry out a simple acid–base titration (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills); PS 3.3 - Consider margins of error, accuracy and precision of data; AT d - Use laboratory apparatus for a variety of experimental techniques including titration, using burette and pipette; AT f - Use acid–base indicators in titrations of weak/strong acids with weak/strong alkalis).	1 Question 5 (QW09.1.05) June 2004 Unit 1 Question 2 (QS04.1.02) January 2004 Unit 1 Question 3 (QW04.1.03) January 2002 Unit 1 Question 7 (QW02.1.07) January 2009 Unit 1 Question 3		

Year 12 A Level Chemistry Module 3: **3.1.4 Energetics**				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Know that reactions can be exothermic or endothermic. Know what an enthalpy change and is and about standard conditions. Define standard enthalpies of formation and combustion. Understand and be able to use the equation $q = mc\Delta T$ to calculate molar enthalpy changes. **Required practical 2** Measurement of an enthalpy change. Understand Hess's law. Use Hess's law to calculate enthalpy changes using enthalpies of formation and combustion.	Students list examples of endothermic and exothermic reactions (AO2 - Apply knowledge and understanding). Students draw enthalpy profiles for exothermic and endothermic reactions (AO2 - Apply knowledge and understanding). Write balanced chemical equations, to include state symbols, to represent the changes shown by standard enthalpy changes of formation and combustion (AO2 - Apply knowledge and understanding). Students calculate molar enthalpy changes using provided data from calorimetry experiments (AO2 - Apply knowledge and understanding; MS0.0 - Recognise and make use of appropriate units in calculation ; MS1.1 - Use an appropriate number of significant figures; MS2.3 - Substitute numerical values into algebraic equations using appropriate units for physical quantities). Practical opportunity: Students find ΔH for a reaction by calorimetry eg • dissolution of potassium chloride • dissolution of sodium carbonate • neutralising NaOH with HCl • displacement reaction between $CuSO_4$ + Zn Combustion of alcohols (AO2 - Apply knowledge and understanding; MS1.3 - Identify	June 2002 Unit 2 Question 1a and 1b (QS02.2.01) January 2011 Unit 2 Question 9b and 9d (QW11.2.09) June 2009 Unit 2 Question 3 (QS09.2.03) June 2006 Unit 2 Question 1d (QS06.2.01) June 2002 Unit 2 Question 2 (QS02.2.02) January 2013 Unit 2 Question 3a (QW13.02.03) January 2013 Unit 2 Question 4 (QW12.2.04) June 2012 Unit 2 Question 2a (QS12.2.02) June 2011 Unit 2 Question 2 (QS11.2.02) June 2009 Unit 2 Question 2a (QS09.2.02)	**GCSE Chemistry** - Exothermic and endothermic reactions.	Some everyday examples of exothermic and endothermic reactions: http://antoine.frostburg.edu/chem/senese/101/thermo/faq/exothermic-endothermic-examples.shtml Nuffield Science Data Book (free download): http://www.nationalstemcentre.org.uk/elibrary/resource/3402/nuffield-advanced-science-book-of-data-second-edition Chemistry Data Book (Starck, Wallace, McGlashan) ISBN: 978071953951

Understand the term mean bond enthalpy. Use mean bond enthalpies to calculate approximate values for ΔH for reactions Understand why most bond enthalpies are mean values.	uncertainties in measurements and use simple techniques to determine uncertainty when data are combined; MS3.2 – Plot two variables from experimental data; PS 3.1 - Plot and interpret graphs; PS 3.2 - Process and analyse data using appropriate mathematical skills; PS 3.3 - Consider margins of error, accuracy and precision of data). Practical opportunity: Students could be asked to find ΔH for a reaction using Hess's law and calorimetry, then present data in appropriate ways. Examples of reactions could include: • thermal decomposition of $NaHCO_3$ • hydration of $MgSO_4$ • Enthalpy of formation of $CaCO_3$ (AO2 - Apply knowledge and understanding; AT a - Use appropriate apparatus to record a range of measurements (to include mass, time, volume of solutions, temperature); MS1.3 - Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined; MS3.2 – Plot two variables from experimental data; PS 3.1 - Plot and interpret graphs; PS 3.2 - Process and analyse data using appropriate mathematical skills; PS 3.3 - Consider margins of error, accuracy and precision of data). Students calculate ΔH for reactions using mean bond enthalpies (AO2 - Apply knowledge and understanding).	June 2002 Unit 2 Question 1 (QS02.2.02) January 2013 Unit 2 Question 6 (QW13.2.06) January 2006 Unit 2 Question 1 (QW06.2.01) June 2005 Unit 2 Question 1 (QS05.2.01) January 2003 Unit 2 Question 2 (QW03.2.02) January 2011 Unit 2 Question 9d		0

Year 12 A Level Chemistry Module 4: **3.1.3 Bonding**				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Understand ionic bonding. Write formulas of ionic compounds. Understand covalent bonding, including co-ordinate bonds. Draw molecules with lines/arrows showing covalent/co-ordinate bonds. Understand metallic bonding. Understand the structure of ionic, molecular, giant covalent and metallic substances. Describe and sketch details of the structures of diamond, graphite, ice, iodine,	Students explain the properties of ionic compounds (AO2 - Apply knowledge and understanding). Students write the formula of ionic compounds, including those with common compound ions (AO2 - Apply knowledge and understanding). Rich question: Which of the following ionic compounds have the highest and lowest melting points: sodium chloride, potassium chloride; magnesium chloride – explain your reasoning? Students describe differences between ionic and covalent bonding (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students describe similarities and differences between covalent and co-ordinate bonds (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students draw diagrams of molecules showing covalent and co-ordinate bonds as lines/arrows respectively ("stick" diagrams) (AO2 - Apply knowledge and understanding). Students explain the properties of molecular substances (AO2 - Apply knowledge and understanding). Students describe differences between metallic, ionic and covalent bonding (AO2 - Apply knowledge and understanding). Students explain the properties of metals (AO2 - Apply knowledge and understanding). Rich question: Which metals have the highest and lowest	Write the formula of ionic compounds January 2012 Unit 1 Question 5 (QW12.1.05) Draw "stick" diagrams of molecules. June 2013 Unit 1 Question 3 (QS13.1.03) June 2011 Unit 1 Question 4 (QS11.1.04) June 2010 Unit 1 Question 7 (QS10.1.07) June 2006 Unit 1 Question 2 (QS06.1.02) January 2006 Unit 1 Question 6 (QW06.1.06) January 2005 Unit 1 Question 5a (QW05.1.05A)	**GCSE Chemistry** - Structure and bonding (re-visited here).	Nuffield Science Data Book (free download): http://www.nationalstemcentre.org.uk/elibrary/resource/3402/nuffield-advanced-science-book-of-data-second-edition RSC AfL exercise on hydrogen bonding: http://www.rsc.org/learn-chemistry/resource/res00000129/afl-what-are-

magnesium and sodium chloride. Work out, name and sketch the shape of molecules and ions. Explain why molecules and ions have the shapes that they have. Definition of electronegativity. How polar covalent bonds originate and deducing whether a bond is polar. How polar molecules originate and deducing whether a molecule has a permanent dipole. The three types of intermolecular force: van der Waals' forces, permanent dipole-dipole forces; and hydrogen bonds. How melting and boiling points of molecular substances depend on the relative strength of intermolecular forces.	melting points – sodium, potassium, magnesium – explain your reasoning? Students create a summary table to describe and explain the structure and properties of ionic, molecular, giant covalent and metallic substances (AO2 - Apply knowledge and understanding). Students sketch the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride as solids and label the diagrams to explain their melting/boiling points and conductivity (AO2 - Apply knowledge and understanding). Students determine which type of structure a substance has from its properties using data and/or experimentally (eg to test solubility, conductivity and ease of melting (AO2 - Apply knowledge and understanding). Make models of molecular shapes (AO2 - Apply knowledge and understanding; MS4.3 - Understand the symmetry of 2D and 3D shapes). Use balloons to represent electron pairs to demonstrate shapes (AO2 - Apply knowledge and understanding). Deduce, sketch and name the shapes of given molecules and ions, including bond angles (AO2 - Apply knowledge and understanding; MS4.1 - Use angles and shapes in regular 2D and 3D structures; MS4.2 - Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects; MS4.3 - Understand the symmetry of 2D and 3D shapes). Predict and explain the trend in electronegativity down a group and across a period (AO2 - Apply knowledge and understanding). Predict whether covalent bonds are polar or not (AO2 - Apply knowledge and understanding). Predict whether molecules have permanent dipoles or not (AO2 - Apply knowledge and understanding; MS4.3 - Understand the symmetry of 2D and 3D shapes). Students produce a summary to compare the three types	January 2003 Unit 1 Question 1e (QW03.1.01) June 2011 Unit 1 Question 3 (QS11.1.03) January 2010 Unit 1 Question 6 (QW10.1.06) June 2006 Unit 1 Question 5b (QS06.1.05B) June 2005 Unit 1 Question 4 (QS05.1.04) January 2004 Unit 1 Question 6a (QW04.1.06)		hydrogen-bonds-and-where-are-they-found The Structure of Ice and Water http://www.rsc.org/learn-chemistry/resource/res00000813/kitchen-chemistry-the-structure-of-ice-and-water

The impact of hydrogen bonding on the density of ice and melting/boiling points.	of intermolecular force (AO2 - Apply knowledge and understanding). Students explain trends in Group 4, 5, 6 and 7 hydrides (to show relative strength of the three types of force and the effect of M_r on van der Waals' forces) (AO2 - Apply knowledge and understanding). Practical opportunity: Students could try to deflect jets of various liquids from burettes to investigate the presence of different types and relative size of intermolecular forces (AO2 - Apply knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 1.2 - Apply scientific knowledge to practical contexts). Students explain why ice floats on water by reference to hydrogen bonding (AO2 - Apply knowledge and understanding).			

Year 12 A Level Chemistry Module 5: **3.1.5 Kinetics**				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Collision theory. Drawing Maxwell–Boltzmann distribution curves. Understand how and	Students should be able to explain why reacts do or do not take place using collision theory (AO1 - Demonstrate knowledge and understanding). Students draw and Maxwell–Boltzmann curves at different temperatures, pressures and number of particles,	June 2013 Unit 2 Question 3 (QS13.2.03) January 2012 Unit 2 Question 3 (QW12.2.03)	**GCSE Chemistry** - Reaction rates.	Collision theory simulator: http://www.kscience.co.uk/animations/collision.htm

why temperature affects the rate of chemical reactions. **Required practical 3** Investigation of how the rate of a reaction changes with temperature. Understand how and why concentration and pressure affect the rate of chemical reactions. Understand how and why a catalyst affects the rate of chemical reactions.	identifying the most probable energy and particles with $E \geq E_a$ (AO2 - Demonstrate knowledge and understanding; MS3.1 - Translate information between graphical, numerical and algebraic forms). Use Maxwell–Boltzmann curves to explain why a small increase in temperature leads to a large increase in reaction rate (AO2 - Demonstrate knowledge and understanding). Students could investigate how knowledge and understanding of the factors that affect the rate of chemical reaction have changed methods of storage and cooking of food (AO2 - Demonstrate knowledge and understanding). Practical opportunity: Students could investigate the effect of temperature on the rate of reaction of sodium thiosulfate and hydrochloric acid by an initial rate method (AO2 - Demonstrate knowledge and understanding; PS 2.4 - Identify variables including those that must be controlled; PS 3.1 - Plot and interpret graphs; MS3.2 – Plot two variables from experimental data; AT I - Measure rates of reaction by at least two different methods, for example an initial rate method). Use collision theory, including diagrams, to explain why an increase in solution concentration leads to an increase in reaction rate (AO2 - Demonstrate knowledge and understanding). Use collision theory, including diagrams, to explain why an increase in gas pressure leads to an increase in reaction rate (AO2 - Demonstrate knowledge and understanding). Students could investigate the effect of changing the concentration of acid on the rate of a reaction of calcium carbonate and hydrochloric acid by a continuous monitoring method (AO2 - Demonstrate knowledge and understanding; AT I - Measure rates of reaction by at least two different methods, for example a continuous	June 2006 Unit 2 Question 2 (QS06.2.02) January 2002 Unit 2 Question 7 (QW02.2.07) June 2006 Unit 2 Question 2 (QS06.2.02) January 2004 Unit 2 Question 2 (QW04.2.02) January 2012 Unit 2 Question 3 (QW12.2.03) June 2012 Unit 2 Question 1a, 1b, 1c and 1d (QS12.2.01) June 2012 Unit 2 Question 1 (QS12.2.01) June 2011 Unit 2 Question 1 (QS11.2.01) January 2003 Unit 2 Question 3 (QW03.203) January 2011 Unit 2 Question 2b		Maxwell–Boltzmann curve simulator: http://www.docbrown.info/BBCbasic/kpts.htm Sodium thiosulfate practical: http://www.rsc.org/learn-chemistry/resource/res00000448/the-effect-of-temperature-on-reaction-rate RSC resources on catalysts http://www.rsc.org/learn-chemistry/resource/res00000378/faces-of-chemistry-catalysts RSC AfL activity on catalysis http://www.rsc.org/learn-chemistry/resource/res00000123/afl-how-do-catalysts-affect-reaction-rates

	monitoring method; PS 2.4 - Identify variables including those that must be controlled; PS 3.1 - Plot and interpret graphs; MS3.2 – Plot two variables from experimental data; MS3.5 - Draw and use the slope of a tangent to a curve as a measure of rate of change) Use a Maxwell–Boltzmann curve to explain how a catalyst increases the rate of a reaction (AO2 - Demonstrate knowledge and understanding). Students could research the use of catalysts in catalytic converters in cars (AO3 - Analyse, interpret and evaluate scientific information). Practical opportunity: Students could use Co^{2+} as a catalyst in the oxidation of potassium sodium tartrate by hydrogen peroxide (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances).			Practical showing the catalyst is involved in the reaction (using Co^{2+} as a catalyst in the oxidation of potassium sodium tatrate by hydrogen peroxide) http://www.nuffieldfoundation.org/practical-chemistry/involvement-catalysts-reactions

Year 12 A Level Chemistry Module 6: **3.1.6 Chemical equilibria, Le Chatelier's principle and K_c**				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Understand how reversible reactions can reach a state of dynamic equilibrium. Understand Le Chatelier's principle. Understand why a compromise temperature and pressure may be used for a reversible reaction in an industrial process. Understand the effect of a catalyst on an equilibrium. Write an expression for and calculate K_c including units. Predict the effect, if any, of changes in conditions on the value of K_c.	Write expressions for K_c and derive units for a variety of equilibria (AO2 - Demonstrate knowledge and understanding). Calculate the moles and concentration of reagents at equilibrium given initial quantities and the quantity of one reagent at equilibrium (AO2 - Demonstrate knowledge and understanding). Calculate K_c from data (AO2 - Demonstrate knowledge and understanding; MS2.3 - Substitute numerical values into algebraic equations using appropriate units for physical quantities. Practical opportunity: Students set up a reaction between ethanol and ethanoic acid with acid catalyst and leave to reach equilibrium before titrating and using the results to determine K_c (AO2 - Demonstrate knowledge and understanding; AT d - Use laboratory apparatus for a variety of experimental techniques including titration, using burette and pipette ; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 3.2 - Process and analyse data using appropriate mathematical skills). Students predict qualitatively how the value of K_c will change, if at all, as the position of an equilibrium moves as conditions are changed.	• June 2013 Unit 2 Question 10a (QS13.2.10) • June 2013 Unit 2 Question 1a (QS13.2.01) • January 2013 Unit 2 Question 2 (QW13.2.02) • January 2012 Unit 2 Question 2 (QW12.2.02) • June 2013 Unit 4 Question 2 (QS13.4.02) • January 2010 Unit 4 Question 1 (QW10.04.01) • June 2006 Unit 4 Question 2 (QS06.4.02) • January 2003 Unit 4 Question 2 (QW03.04.02)	**GCSE Chemistry** - Reaction rates. - Exothermic and endothermic reactions. - Equilibria (Separate Science but re-visited here). **AS Chemistry** - Energetics (useful to do this first, but not essential as GCSE knowledge would suffice). - Kinetics (useful to do this first, but not essential as GCSE knowledge would suffice).	RSC Resource pack on equilibria http://www.rsc.org/learn-chemistry/resource/res00000843/equilibria RSC AfL exercise http://www.rsc.org/learn-chemistry/resource/res00000117/afl-equilibrium-reactions Many suitable resources can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required) Co^{2+} equilibrium experiment: http://www.rsc.org/learn-chemistry/resource/res00000001/cobalt-equilibrium Many suitable resources can be found at http://www.docbrown.info/ and http://www.chemsheets.c

				o.uk/ (subscription required)

Year 12 A Level Chemistry Module 7: 3.2.1 Periodicity				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
classify an element as an s, p,d or f block element using its electron structure. describe and explain the trends across Period 3 in atomic radius, ionisation energy, melting points.	Write the electron structure of elements and state which block they belong to (AO2 - Demonstrate knowledge and understanding). Rich question: Is helium an s or p block element? Students plot data on graphs for atomic radius, first ionisation energy and melting point and explain those trends (AO1 - Demonstrate knowledge and understanding of scientific ideas; AO2 - Demonstrate knowledge and understanding; MS3.2 – Plot two variables from experimental or other data).	June 2003 Unit 1 Question 1b (QS03.1.01) June 2002 Unit 1 Question 6a (QS02.1.06) January 2011 Unit 1 Question 5 (QW11.1.05) January 2009 Unit 1 Question 4 (QW09.1.04) June 2003 Unit 1 Question 1c (QS03.01.01)	**AS Chemistry** - Electron structure (3.1.1). - Ionisation energy (3.1.1). - Bonding (3.1.3).	**Chemguide.co.uk** **A-levelchemistry.co.uk**

Year 12 A Level Chemistry Module 8: 3.1.7 Redox Reactions				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • determine oxidation states • write redox half	• Determine the oxidation state of each element in substances and ions (AO2 - Demonstrate knowledge and understanding). • Determine and then combine redox half equations (AO2 - Demonstrate knowledge and understanding).	June 2013 Unit 2 Question 4a (QS13.2.04) January 2012 Unit 2 Question 5a and 5b	**AS Chemistry** - Writing equations (3.1.2).	Many suitable resources can be found at http://www.docbrown.info/ and http://www.che

equations • combine redox half equations to produce full equations • identify reduction and oxidation processes.	Determine and then combine redox half equations for the reaction of a brass 2p coin with concentrated nitric acid (AO2 - Demonstrate knowledge and understanding).	(QW12.2.05) June 2011 Unit 2 Question 5a (QS11.2.05) January 2005 Unit 2 Question 2 (QW05.2.02) January 2002 Unit 2 Question 4 (QW02.2.04)		msheets.co.uk/ (subscription required)

Year 12 A Level Chemistry Module 9: 3.2.3 Group 7 – The Halogens				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • describe and explain the trends down Group 7 in electronegativity and boiling points • describe and explain the trends in oxidising power of the halogens, illustrated by displacement reactions of halide ions • describe and explain the trends in reducing power of the halide ions, illustrated by	• Students plot data on graphs for electronegativity and boiling point and explain those trends (AO1 - Demonstrate knowledge and understanding of scientific ideas; AO2 - Demonstrate knowledge and understanding; MS3.2 – Plot two variables from experimental or other data). • Practical opportunity: Students carry out test-tube reactions of solutions of the halogen (Cl_2, Br_2, I_2) with solutions containing their halide ions (eg KCl, KBr, KI) (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 2.2 - Present results of test-tube reactions in appropriate ways). • Practical opportunity: Students record observations from reactions of NaCl, NaBr and NaI with concentrated sulfuric acid. (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 2.2 - Present results of test-tube	June 2002 Unit 2 Question 4 (QS02.2.04) June 2002 Unit 2 Question 3 (QS02.02.03) January 2002 Unit 2 Question 8 (QW02.2.08) January 2013 Unit 2 Question 9 (QW13.2.09) June 2012 Unit 2 Question 9 (QS12209) January 2010 Unit 2 Question 3 January 2013 Unit 2 Question 10 (QW13.2.10)	**AS Chemistry** - Ionisation energy (3.1.1). - Ionic equations (3.1.2). - Electronegativity (3.1.3). - Bonding (3.1.3). - Oxidation states and redox equations (3.1.7).	Video showing F_2 displacing other halides http://www.rsc.org/learn-chemistry/resource/res00000791/displacement-of-halogens Use of silver halides in non-digital photography http://electronics.howstuffworks.com/film7.htm *Chemistry Review* article: Iodine in medicine

reactions of concentrated sulfuric acid with solid sodium halides • describe and explain how halide ions can be identified using acidified silver nitrate and the solubility of silver halides in ammonia • explain why the silver nitrate used is acidified. • know the reactions of chlorine with water • know how and why chlorine is used in water treatment • evaluate advantages and disadvantages of adding chemicals to water • know the reaction of sodium hydroxide with water and uses of the solution formed.	reactions in appropriate ways). • Practical opportunity: Students could carry out tests for halide ions using acidified silver nitrate, including the use of ammonia to distinguish the silver halides formed (AO2 - Demonstrate knowledge and understanding; AT d - Use laboratory apparatus for qualitative tests for ions; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 2.2 - Present results of test-tube reactions in appropriate ways). Required practical 4: Students complete a series of test-tube reactions to identify some anions and cations (AO2 - Demonstrate knowledge and understanding; AT d - Use laboratory apparatus for qualitative tests for ions; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 2.2 - Present results of test-tube reactions in appropriate ways). Students investigate and evaluate the treatment of drinking water with chlorine (AO3 - Analyse, interpret and evaluate scientific information). Students investigate and evaluate the addition of sodium fluoride to water supplies (AO3 - Analyse, interpret and evaluate scientific information).	January 2010 Unit 2 Question 10a, 10b and 10c (QW10.2.10)		(Volume 23, edition 1) Review by University of York of fluoridation of water http://www.york.ac.uk/inst/crd/fluores.htm Detailed information about chlorination of water http://www.safewater.org/PDFS/resourcesknowthefacts/What+is+Chlorination.pdf Some information about treatment of water in swimming pools http://home.howstuffworks.com/swimming-pool5.htm

Year 12 A Level Chemistry Module 10: 3.3.1 Introduction to Organic Chemistry and Alkanes				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • give the empirical, molecular, general, structural, displayed and skeletal structure of organic molecules • describe the characteristics of a homologous series • draw the structure of, and name organic molecules with chains and rings with up to six carbon atoms each. • define structural isomerism and stereoisomerism • draw the structure of and name chain, position and functional group isomers	Give the empirical, molecular, general, structural, displayed and skeletal structure of organic molecules given one or more of these for each molecule (AO2 - Demonstrate knowledge and understanding; MS 4.2 – visualise and represent 2D and 3D forms including 2D representations of 3D objects). Make models of organic compounds (AO2 - Demonstrate knowledge and understanding; MS 4.2 – visualise and represent 2D and 3D forms including 2D representations of 3D objects). Name molecules given their structure, or draw the structure given the name (AO2 - Demonstrate knowledge and understanding). Make models of isomers (AO2 - Demonstrate knowledge and understanding; MS 4.2 – visualise and represent 2D and 3D forms including 2D representations of 3D objects). Draw and name isomers, including using CIP rules to name *E–Z* isomers (AO2 - Demonstrate knowledge and understanding; MS 4.2 – visualise and represent 2D and 3D forms including 2D representations of 3D objects). Identify pairs (or groups) of compounds which exhibit each type of isomerism (AO2 - Demonstrate	For various molecules students can complete the molecular, empirical, structural, displayed and skeletal formulas as well as the name where only one or more of these is given for each molecule. June 2013 Unit 2 Question 7a (QS13.2.07) January 2011 Unit 2 Question 7 (QW11.2.07) January 2002 Unit 3 Question 5 (QW03.2.05) January 2005 Unit 3 Question 4 (QW03.5.04) June 2011 Unit 2	**GCSE Chemistry** - Some simple organic chemistry, eg alkanes and alkenes (although this is revisited here). - Empirical and molecular formulas (although this is revisited here). Rather than teaching Section 3.3.1.2 on mechanisms here, each mechanism could be taught as they are encountered during teaching of specific organic reactions. - Some simple organic chemistry, eg alkanes and alkenes (although this is revisited here). - Fractional distillation of crude oil (although this is revisited here). - Empirical and molecular formulae (although this is	Molymod molecular models Many suitable exercises can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required) RSC mechanisms resource: http://www.rsc.org/learn-chemistry/resource/res00000638/curly-arrows-and-stereoselectivity-in-organic-reactions RSC resource of misconceptions about mechanisms: http://www.rsc.org/learn-chemistry/resource/res00001107/reaction-mechanisms

• explain the cause of *E*–*Z* isomerism • draw the structure of and name *E*–*Z* isomers (using Cahn–Ingold–Prelog priority rules). • explain that alkanes are saturated hydrocarbons • explain how the alkanes in crude oil are separated by fractional distillation. • explain the commercial benefits of cracking • describe how thermal and catalytic cracking are completed and the types of compounds that are produced. • write equations for the complete and incomplete combustion of alkanes • explain how a number of pollutants including NO_x, CO, C and unburned hydrocarbons are formed in the internal combustion engine and how their	knowledge and understanding). Draw and name alkanes – (opportunity here to reinforce isomerism) (AO2 - Demonstrate knowledge and understanding; MS 4.2 – visualise and represent 2D and 3D forms including 2D representations of 3D objects). Describe and explain how alkanes in crude oil are separated by fractional distillation (AO1 - Demonstrate knowledge and understanding of scientific ideas). Practical opportunity: Separate some alkanes into fractions from a crude oil substitute mixture (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Practical opportunity: Crack some kerosene/paraffin (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Construct a table to compare thermal and catalytic cracking in terms of conditions and products (AO1 - Demonstrate knowledge and understanding of scientific ideas). Write balanced equations for the complete and incomplete combustion of alkanes (AO2 - Demonstrate knowledge and understanding). Construct a table to show why pollutants may be formed when fuels are burned and how these can be reduced (AO1 - Demonstrate knowledge and understanding of scientific ideas; AO3 - Analyse, interpret and evaluate scientific information). Write balanced equations for reactions of alkanes with halogens (AO2 - Demonstrate knowledge and understanding). Write balanced equations to show the steps in the	Question 9 January 2009 Unit 1 Question 6c (Qw09.1.06) January 2004 Unit 3 Question 5 (QW04.03.05) June 2001 Unit 3 Question 7 (QS01.03.07) June 2010 Unit 1 Question 4 (QS10.1.04) June 2010 Unit 1 Question 5 (QS10.1.05) January 2004 Unit 3 Question 2 (QW04.3.02) January 2009 Unit 1 Question 6d and 6e (QW09.01.06)	revisited here).	RSC AfL task on nucleophilic substitution http://www.rsc.org/learn-chemistry/resource/res00000115/afl-nucleophilic-substitution-reaction-mechanisms RSC Videos and animations on fractional distillation of crude oil http://www.rsc.org/learn-chemistry/resource/res00000027/oil-refining#!cmpid=CMP00002022 Animations of fractional distillation http://science.howstuffworks.com/environmental/energy/oil-refining2.htm http://bpes.bp.com/secondary-resources/science/ages-14-to-16/chemical-and-material-behaviour/hydrocarbons-from-crude-oil/ Animations and information about how the internal combustion works http://www.howstuffworks.com/engine.htm Statistics on a flue gas desulfurisation plant http://www.eon-uk.com/FGD.pdf

emissions can be reduced • why SO_2 may be formed when fuels are burned and how it can be removed from flue gases. • write equations for the reaction of halogens with alkanes • write equations to show the mechanism for the reaction of halogens with alkanes • represent the unpaired electron in a radical using a dot.	mechanism for these reactions (AO2 - Demonstrate knowledge and understanding). Students could look at the usefulness of halogenoalkanes as anaesthetics (AO1 - Demonstrate knowledge and understanding of scientific ideas). Demonstration: the reaction of chlorine with methane (AO2 - Demonstrate knowledge and understanding).			Anecdote about a plane running out of fuel http://www.rsc.org/learn-chemistry/resource/res00000037/anecdotes-gimli-glider Videos about catalytic converters http://www.rsc.org/learn-chemistry/resource/res00000378/faces-of-chemistry-catalysts

Year 12 A Level Chemistry Module 11: 3.3.3 Halogenoalkanes				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
• draw and name halogenoalkanes • write equations and mechanisms for reactions of halogenoalkanes with OH^-, CN^- and NH_3 • explain the relative rate of reaction of halogenoalkanes	Draw and name halogenoalkanes (AO2 - Demonstrate knowledge and understanding). Write equations and mechanisms for reactions of halogenoalkanes with OH^-, CN^- and NH_3 (AO2 - Demonstrate knowledge and understanding). Practical opportunity: Students carry out test-tube hydrolysis of halogenoalkanes to show their relative rates of reaction (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant,	January 2011 Unit 2 Question 8a and 8b (QW11.2.08) June 2010 Unit 2 Question 2 (QW10.2.02) June 2013 Unit 2 Question 5 (QS13.2.05) January 2011 Unit	**AS Chemistry** - Nomenclature of organic compounds (3.3.1). - Principles of curly arrow mechanisms (3.3.1).	RSC mechanisms resource: http://www.rsc.org/learn-chemistry/resource/res00000638/curly-arrows-and-stereoselectivity-in-organic-reactions RSC AfL task on nucleophilic substitution http://www.rsc.org/learn-chemistry/resource/res00000

• write equations and mechanisms for elimination reaction of halogenoalkanes using OH^- • understand the concurrent nature of elimination and substitution when halogenoalkanes react with OH^- • understand the different roles of the OH^- in these reactions. • understand the role of ozone in the atmosphere • understand how chlorine free radicals can be formed in the atmosphere from compounds such as CFCs • understand the mechanism for the depletion of ozone by chlorine free radicals • evaluate the role of chemists in the introduction of legislation to ban the use of CFCs and to find replacements.	flammable and toxic substances). Practical opportunity: Students prepare a chloroalkane, purifying the product using a separating funnel and distillation (AO2 - Demonstrate knowledge and understanding; AT a - Use appropriate apparatus to record mass, and boiling points ; AT b - Use water bath or electric heater or sand bath for heating ; AT d - Use laboratory apparatus for a variety of experimental techniques including distillation and heating under reflux, including setting up glassware using retort stand and clamps; AT g - Purify a liquid product, including use of separating funnel; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). write equations and mechanisms for reactions of halogenoalkanes with OH^-, both for elimination and substitution reactions (AO2 - Demonstrate knowledge and understanding). Students investigate the presence and role of ozone in the atmosphere (AO1 - Demonstrate knowledge and understanding of scientific ideas). Write equations and mechanisms for the formation of chlorine free radicals and the destruction of ozone (AO1 - Demonstrate knowledge and understanding of scientific ideas). Understand why suitable replacements for CFCs do not destroy ozone (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students investigate the role of chemists in the introduction of legislation to ban the use of CFCs and in finding replacements (AO3 - AO3 - Analyse, interpret and evaluate scientific information). Rich question – CFCs are still used in some countries – how can we stop this?	2 Question 8 (QW11.2.08) January 2010 Unit 2 Question 7 (QW10.2.07) June 2009 Unit 2 Question 8 (QS09.2.08) June 2002 Unit 3 Question 6 (QS02.3.06) January 2013 Unit 2 Question 7 (QW13.2.07) June 2011 Unit 2 Question 7 (QS11.2.07) June 2009 Unit 2 Question 11 (QS09.2.11)		115/afl-nucleophilic-substitution-reaction-mechanisms Mechanism animations http://science.jbpub.com/organic/movies/ Interactive mechanisms http://www.chem.ox.ac.uk/vrchemistry/iom/ RSC resource on CFCs and ozone: http://www.rsc.org/learn-chemistry/resource/res00000779/mario-molina-puts-ozone-on-the-political-agendas US EPA information http://www.epa.gov/ozone/science/sc_fact.html Nobel Prize 1995 http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1995/press.html *Chemistry Review* article: Do ants destroy the ozone layer (Volume 20, edition 4) *Chemistry Review* article: Thomas Midgley (Volume 15, edition 2)

Year 12 A Level Chemistry Module 12: 3.3.4 Alkenes				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • draw alkenes understand that the double bond is an area of high electron density. • write equations and mechanisms for reactions of alkenes with HBr, H_2SO_4 and HBr • explain the potential formation of major and minor products in these reactions. • describe what a polymer is • identify the repeating unit of an addition polymer given the monomer structure and vice versa • name polymers from the name of the monomer • explain how polymers have developed over time • give some uses of PVC and how plasticisers can	Draw and name alkenes, including *E*–*Z* isomers (AO2 - Demonstrate knowledge and understanding; MS4.1 - Use angles and shapes in regular 2D and 3D structures of alkenes). Write equations for reactions of alkenes with HBr, H_2SO_4 and HBr (AO2 - Apply knowledge and understanding of scientific ideas). Draw mechanisms for reactions of alkenes with HBr, H_2SO_4 and HBr, including explaining why there may be major and minor products (AO2 - Apply knowledge and understanding of scientific ideas). Practical opportunity: Students test organic compounds for unsaturation using bromine water and record their observations (AO2 - Apply knowledge and understanding of scientific ideas; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Students could each make a model of a monomer using Molymods and then students collectively join them together to make a long polymer chain (AO2 - Apply knowledge and understanding). Draw the structure of the monomer, repeating unit of the polymer and a section of the polymer chain given one of the others; students should also be able to name the polymer from the monomer name and vice versa (AO2 - Apply knowledge and understanding of scientific ideas). Students should consider how polymer technology has developed over time (AO3 -Analyse, interpret and evaluate scientific information). Students should research uses of PVC and how plasticisers change its properties (AO3 - Analyse,	Draw and name alkenes. June 2012 Unit 2 Question 7 (QS12.2.07) June 2010 Unit 2 Question 6a (QS10.2.06) June 2012 Unit 2 Question 7 (QS12.2.07) June 2010 Unit 2 Question 6a (QS10.2.06)	**AS Chemistry** - *E*–*Z* isomerism (3.3.1). - Principles of curly arrow mechanisms (3.3.1). - Shapes of molecules (3.1.3).	RSC resource of misconceptions about mechanisms: http://www.rsc.org/learn-chemistry/resource/res00001107/reaction-mechanisms Mechanism animations http://science.jbpub.com/organic/movies/ Molymods RSC Polymers resource http://www.rsc.org/learn-chemistry/resource/res00000846/polymers Nuffield Practical Chemistry method to polymerise phenylethene http://www.nuffieldfoundation.org/practical-chemistry/addition-polymerisation

change its properties • explain why addition polymers are unreactive • explain the nature of the intermolecular forces between polyalkene molecules.	interpret and evaluate scientific information). Practical opportunity: Students make poly(phenylethene) (AO2 - Apply knowledge and understanding of scientific ideas; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances).			

Year 12 A Level Chemistry Module 13: 3.3.5 Alcohols				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • write equations and give conditions for the production of alcohols by hydration of alkenes • outline the mechanism for formation of ethanol from reaction of ethene with steam with an acid catalyst • write an equation, give and justify conditions for the	Write equations for the production of alcohols from alkenes (AO2 - Apply knowledge and understanding of scientific ideas). Produce a summary table to compare and contrast the two methods of making ethanol (AO1 - Demonstrate knowledge and understanding of scientific ideas). Outline the mechanism to make ethanol from reaction of ethene with steam with an acid catalyst (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students could produce ethanol by fermentation, followed by purification by fractional distillation (AO2 - Apply knowledge and understanding of scientific ideas; AT d - Use laboratory apparatus for a variety of experimental techniques including distillation and setting up glassware using retort stand and clamps; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances).	January 2005 Unit 3 Question 5a, 5b and 5c (QW.05.3.05) January 2002 Unit 3 Question 7 (QW02.3.07) January 2013 Unit 2 Question 5 (QW13.02.05) June 2006 Unit 3 Question 5 (QS06.3.05) January 2005 Unit 3 Question 3 (QW05.3.03)	**GCSE Chemistry** - What are biofuels? - Production of ethanol. - Addition polymers. **AS Chemistry** - Alkenes (3.3.4).	Making ethanol by fermentation: http://www.nuffieldfoundation.org/practical-chemistry/fermentation-glucose-using-yeast Biofuels website: http://www.thesolarspark.co.uk/the-science/renewable-energy/bio/ Biofuels website: http://www.biofuels.co.uk/

production of ethanol by fermentation of glucose • compare the two methods of producing ethanol • explain the meaning of the term biofuel • evaluate the use of ethanol as a biofuel • show using equations how ethanol made by fermentation can be regarded as carbon neutral but that in reality it is not. • classify alcohols as primary, secondary or tertiary. • identify products and write equations for oxidation reactions of alcohols. • use chemical tests to distinguish aldehydes and ketones. • identify products of alcohol elimination reactions • write equations and mechanism for alcohol elimination reactions • understand how	Evaluate the use of biofuels (AO3 - Analyse, interpret and evaluate scientific information). Show by use of chemical equation that the formation of ethanol by fermentation can be thought of as being carbon neutral, but why it is not in reality (AO1 - Demonstrate knowledge and understanding of scientific ideas). Draw and name alcohols and classify them as primary, secondary or tertiary (AO2 - Apply knowledge and understanding of scientific ideas). Write equations to show oxidation reactions of alcohols (AO2 - Apply knowledge and understanding of scientific ideas). Practical opportunity: Carry out test-tube reactions to distinguish tertiary alcohols from primary and secondary by reaction with acidified potassium dichromate(VI) (AO2 - Apply knowledge and understanding of scientific ideas; AT b - Use water bath or electric heater or sand bath for heating; AT d - Use laboratory apparatus for qualitative tests for organic functional groups; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Practical opportunity: Carry out test-tube reactions to distinguish aldehydes from ketones by reaction with Tollens' reagent and Fehling's solution (AO2 - Apply knowledge and understanding of scientific ideas; AT b - Use water bath or electric heater or sand bath for heating; AT d - Use laboratory apparatus for qualitative tests for organic functional groups; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Practical opportunity: The preparation of ethanal (AO2 - Apply knowledge and understanding of scientific ideas; AT b - Use water bath or electric heater or sand bath for heating; AT d - Use laboratory apparatus for a variety of experimental techniques including distillation and heating under reflux, including setting up glassware using retort stand and clamps; AT k - Safely and carefully handle solids and liquids,	June 2004 Unit 3 Question 3 (not part (a)(ii) (QS04.3.03) • June 2003 Unit 3 Question 4b (QS03.3.4B) • SAMs AS Paper 2 (set 1) Question 1		Press report about problems with biofuels: http://www.telegraph.co.uk/earth/energy/biofuels/10520736/The-great-biofuels-scandal.html BP biofuels resources: http://bpes.bp.com/secondary-resources/science/ages-14-to-16/energy-electricity-and-forces/biofuels-and-the-future/ Test-tube oxidation reactions of alcohols: http://www.nuffieldfoundation.org/practical-chemistry/oxidation-alcohols Disposal breathalysers are available (legal requirement for driving in France) The breathalyser reaction http://www.nuffieldfoundation.org/practical-chemistry/%E2%80%98breathalyser%E2%80%99-reaction Giant silver mirror http://www.nuffieldfoundation.org/practical-chemistry/giant-silver-

addition polymers can be made from alkenes made this way without using monomers derived from crude oil.	including corrosive, irritant, flammable and toxic substances). Giant silver mirror demonstration. (AO2 - Apply knowledge and understanding of scientific ideas). Students should identify alkenes formed from elimination of alcohols and write equations and mechanism for their production (AO2 - Apply knowledge and understanding of scientific ideas). Practical opportunity: Students could carry out the preparation of cyclohexene from cyclohexanol, including purification using a separating funnel and by distillation (AO2 - Apply knowledge and understanding of scientific ideas; AT b - Use water bath or electric heater or sand bath for heating; AT d - Use laboratory apparatus for a variety of experimental techniques including distillation and heating under reflux, including setting up glassware using retort stand and clamps; AT g - Purify a liquid product, including use of separating funnel; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances.			mirror Preparation of cyclohexene http://www.chemsheets.co.uk/Chemsheets%20AS%20079%20(Preparation%20of%20cyclohexene).pdf *Chemistry Review* article: Heating under reflux (Volume 20, edition 2) *Chemistry Review* article: Distillation (Volume 14, edition 3)

Year 12 A Level Chemistry Module 14: 3.2.2 Group 2 – The Alkaline Earth Metals				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • know and explain trends in atomic radius, first ionisation energy and melting point from Mg–Ba • know the role of Mg in the extraction of Ti	Students plot data on graphs for atomic radius, first ionisation energy and melting point and explain those trends (AO1 - Demonstrate knowledge and understanding of scientific ideas; AO2 - Demonstrate knowledge and understanding; MS3.2 – Plot two variables from experimental or other data). Practical opportunity: Students test the reactions of Mg–Ba with water and Mg with steam and record their results (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including	• June 2012 Unit 2 Question 5 (QS12205) • June 2006 Unit 1 Question 5a (QS06.1.5A) • January 2005 Unit 1 Question 5b (QW05.1.5B) January 2012 Unit 2	**GCSE Chemistry** - Writing formulas of ionic compounds. Prior knowledge: **AS Chemistry** - Ionisation energy (3.1.1.3). - Bonding (3.1.3).	RSC AfL exercise on Group 2: http://www.rsc.org/learn-chemistry/resource/res00000118/afl-group-2 Royal College of Radiologists leaflet on barium meals: https://www.rcr.ac.uk/docs/patients/worddocs/CRPLG

• describe and write equations for the reactions of Mg–Ba with water • know the solubility of Group 2 sulfates and hydroxides • know uses of $Mg(OH)_2$ and $BaSO_4$ in medicine; $BaSO_4$ in testing for sulfate ions; $Ca(OH)_2$ in agriculture; Mg in the extraction of Ti; $CaO/CaCO_3$ in removing SO_2 from flue gases.	corrosive, irritant, flammable and toxic substances). Practical opportunity: Students test the solubility of Group 2 hydroxides by mixing solutions of soluble Group 2 salts with sodium hydroxide and record their results (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Practical opportunity: students test the solubility of Group 2 sulfates by mixing solutions of soluble Group 2 salts with sulfuric acid and record their results (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Practical opportunity: Students test for sulfate ions using acidified barium chloride and record their results (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). Students research uses of the following: $Mg(OH)_2$ and $BaSO_4$ in medicine; $BaSO_4$ in testing for sulfate ions; $Ca(OH)_2$ in agriculture; Mg in the extraction of Ti; $CaO/CaCO_3$ in removing SO_2 from flue gases (AO3 - Analyse, interpret and evaluate scientific information). Practical opportunity: Students identify some “unknown” group 2 compounds by their reactions with NaOH and sulfate ions. (AO2 - Demonstrate knowledge and understanding; AT d - Use laboratory apparatus for qualitative tests for ions; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances).	Question 7 (QW12207)		meal.doc Newspaper story about changes to recipe of milk of magnesia in 2013: http://www.dailymail.co.uk/news/article-2352139/Milk-Magnesia-disappears-British-shelves-ingredients-fall-foul-EU-meddlers.html

Year 12 A Level Chemistry Module 15: 3.3.6 Organic Analysis				
What are we learning?	**What knowledge, understanding and skills will we gain?**	**Evaluation and assessment methods**	**Implementation**	**What additional resources are available?**
Students should be able to: • carry out test-tube reactions in the specification to distinguish alcohols, aldehydes, alkenes and carboxylic acids, and interpret the observations from these reactions. • use precise atomic masses and the precise molecular mass to determine the molecular formula of a compound. • identify functional groups from infra-red spectra • understand how the "fingerprint" region of a spectrum can be used understand the link between absorption of infrared radiation	Practical opportunity: Students carry out test-tube reactions in the specification to distinguish alcohols, aldehydes, alkenes and carboxylic acids (AO2 - Apply knowledge and understanding of scientific ideas; AT b - Use water bath or electric heater or sand bath for heating; AT d - Use laboratory apparatus for qualitative tests for organic functional groups; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 2.2 - Present results of reactions in appropriate ways; PS 2.3 - Evaluate results and draw conclusions). Write equations for the reactions occurring. (AO2 - Apply knowledge and understanding of scientific ideas). Students use precise atomic masses to calculate the precise molecular mass of a compound in order to determine the molecular formula (AO2 - Apply knowledge and understanding of scientific ideas; MS1.1 - Use an appropriate number of significant figures). Students identify functional groups from infra-red spectra (AO2 - Apply knowledge and understanding of scientific ideas). Students research the relative effect of different gases on global warming (AO3 - Analyse, interpret and evaluate scientific information).	June 2012 Unit 4 Question 7 (QS12.4.07) January 2013 Unit 4 Question 6a (QW13.4.06) June 2012 Unit 2 Question 3c (QS12.2.03) January 2010 Unit 2 Question 6e (QW10.2.06) June 2012 Unit 2 Question 8bii (QS12.2.08) June 2011 Unit 2 Question 6e (QS11.1.06) January 2012 Unit 2 Question 10 (QS12.2.10) June 2009 Unit 2 Question 9 (QS09.2.09)	**AS Chemistry** - Mass spectrometry (3.1.1). - Halogenoalkanes (3.3.3). - Alkenes (3.3.4). - Alcohols (3.3.5).	Test-tube oxidation reactions of alcohols: http://www.nuffieldfoundation.org/practical-chemistry/oxidation-alcohols *Chemistry Review* article: Identifying an unknown compound (Volume 17, edition 3) Mass spectrometry calculator: http://www.sisweb.com/mstools/isotope.htm Spectroscopy in a suitcase from RSC (including potential visit to your school/college by a university team with IR spectrometer): http://www.rsc.org/learn-chemistry/resource/res00000283/spectroscopy-in-a-suitcase-ir-student-resources

by bonds in CO_2, methane and water vapour and global warming.				IR spectroscopy resources: http://www.chemsheets.co.uk/page3.html Greenhouse gas IR spectra: http://www.chem.wisc.edu/middlecamp/108-Fall08/work/IR_spec5.swf *Chemistry Review* article: Infrared spectrometers (Volume 21, edition 2)