3.1.4 Energetics

The enthalpy change in a chemical reaction can be measured accurately. It is important to know this value for chemical reactions that are used as a source of heat energy in applications such as domestic boilers and internal combustion engines.

Prior knowledge:

GCSE Chemistry
- Exothermic and endothermic reactions.

3.1.4.1 Enthalpy change

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
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.	0.2 weeks	**Students should be able to:** • define enthalpy change and standard conditions • define standard enthalpy changes of combustion and formation.	• 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).	• June 2002 Unit 2 Question 1a and 1b (QS02.2.01)	Some everyday examples of exothermic and endothermic reactions: http://antoine.frostburg.edu/chem/senese/101/thermo/faq/exothermic-endothermic-examples.shtml

3.1.4.2 Calorimetry

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
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. Students could research value. Different precision of thermometers. Construct all tables and graphs	1.5 weeks	**Students should be able to:** • recall the equation $q = mc\Delta T$ • Calculate ΔH for reactions using calorimetry experiment data.	• 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 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).	• 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)	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: 9780719539510

			• Students could research how accurate values are found for the energy content in food and fuels.		

3.1.4.3 Applications of Hess's law

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Understand Hess's law. Use Hess's law to calculate enthalpy changes using enthalpies of formation and combustion. **Required practical 2** Measurement of an enthalpy change. Enthalpy of formation of MgO.	1.5 weeks	**Students should be able to:** • Recall the equation $q = mc\Delta T$ • Calculate ΔH for reactions using calirometry experiment data	• Students calculate Hess's law plus enthalpies of formation and enthalpies of combustion (AO2 - Apply knowledge and understanding). • 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).	• 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) • June 2002 Unit 2 Question 1 (QS02.2.02)	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: 9780719539510

3.1.4.4 Bond enthalpies

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources

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.	0.5 weeks	**Students should be able to:** • calculate enthalpy changes using mean bond enthalpies • understand why most bond enthalpies are mean values.	• Students calculate ΔH for reactions using mean bond enthalpies (AO2 - Apply knowledge and understanding).	• 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	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: 9780719539510

3.1.5 Kinetics

The study of kinetics enables chemists to determine how a change in conditions affects the speed of a chemical reaction. Whilst the reactivity of chemicals is a significant factor in how fast chemical reactions proceed, there are variables that can be manipulated in order to speed them up or slow them down.

Prior knowledge:

GCSE Chemistry
- Reaction rates.

3.1.5.1 Collision theory

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Collision theory.	0.1 week	**Students should be able to:** • explain that reactions can only take place when particles collide with energy greater than or equal to the activation energy.	• Students should be able to explain why reacts do or do not take place using collision theory (AO1 - Demonstrate knowledge and understanding).		Collision theory simulator: http://www.kscience.co.uk/animations/collision.htm

3.1.5.2 Maxwell–Boltzmann distribution

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Drawing Maxwell–Boltzmann distribution curves.	0.1 week	**Students should be able to:** • draw and interpret Maxwell–Boltzmann distribution curves.	• Students draw and Maxwell–Boltzmann curves at different temperatures, pressures and number of particles, 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).	• June 2013 Unit 2 Question 3 (QS13.2.03) • January 2012 Unit 2 Question 3 (QW12.2.03) • June 2006 Unit 2 Question 2 (QS06.2.02) • January 2002 Unit 2 Question 7 (QW02.2.07)	Maxwell–Boltzmann curve simulator: http://www.docbrown.info/BBCbasic/kpts.htm

3.1.5.3 Effect of temperature on reaction rate

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Understand how and why temperature affects the rate of chemical reactions. **Required practical 3** Investigation of how the rate of a reaction changes with temperature. Students could research method . Calculate rate and plot simple curve.	0.4 weeks	**Students should be able to:** • define the term rate of reaction • explain how and why temperature affects the rate of reactions using Maxwell–Boltzmann distributions.	• 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 l - Measure rates of reaction by at least two different methods, for example an initial rate method).	• 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)	Sodium thiosulfate practical: http://www.rsc.org/learn-chemistry/resource/res00000448/the-effect-of-temperature-on-reaction-rate Collision theory simulator: http://www.kscience.co.uk/animations/collision.htm

3.1.5.4 Effect of concentration and pressure

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Understand how and why concentration and pressure affect the rate of chemical reactions.	0.3 weeks	**Students should be able to:** • explain how and why concentration of solutions affects the rate of reactions. • explain how and why pressure of gases affects the rate of reactions.	• 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 l - Measure rates of reaction by at least two different methods, for example a continuous 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)	• June 2012 Unit 2 Question 1a, 1b, 1c and 1d (QS12.2.01)	Collision theory simulator: http://www.kscience.co.uk/animations/collision.htm

3.1.5.5 Effect of catalysts

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources

Understand how and why a catalyst affects the rate of chemical reactions.	0.2 weeks	**Students should be able to:** • state what a catalyst is • explain how and why a catalyst affects the rate of reactions.	• 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).	• 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	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 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

3.1.6 Chemical equilibria, Le Chatelier's principle and K_c

In contrast with kinetics, which is a study of how quickly reactions occur, a study of equilibria indicates how far reactions will go. Le Chatelier's principle can be used to predict the effects of changes in temperature, pressure and concentration on the yield of a reversible reaction. This has important consequences for many industrial processes. The further study of the equilibrium constant, K_c, considers how the mathematical expression for the equilibrium constant enables us to calculate how an equilibrium yield will be influenced by the concentration of reactants and products

Prior knowledge:

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).

3.1.6.1 Chemical equilibria and Le Chatelier's principle

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
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.	1.0 weeks	**Students should be able to:** • describe what is meant the term dynamic equilibrium • explain how changes in temperature, pressure and concentration affect the position of a system at equilibrium • explain why compromise conditions of temperature and pressure may be used for a reversible reaction in an industrial process.	• Predict and explain the effect of changes in temperature, pressure and concentration on the position of an equilibrium (AO2 - Demonstrate knowledge and understanding). • Practical Opportunity: Students carry out test-tube equilibrium shifts to show the effect of concentration and temperature (eg $Cu(H_2O)_6^{2+}$ with concentrated HCl). (AO2 - Demonstrate knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances). • Students explain how conditions in temperature and pressure are a compromise in examples of industrial processes (AO3 - Analyse, interpret and evaluate scientific information).	• 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)	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

3.1.6.2 Equilibrium constant K_c for homogeneous systems

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
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. Calculating the equilibrium constant of esterification reaction.	1.0 weeks	**Students should be able to:** • write an expression for K_c for a homogeneous equilibrium, including its units • calculate the moles and concentration of reagents at equilibrium • calculate the value of K_c • predict qualitatively how the value of K_c will change, if at all, as the position of an equilibrium moves as conditions are changed.	• 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 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)	RSC Resource pack on equilibria http://www.rsc.org/learn-chemistry/resource/res00000843/equilibria Many suitable resources can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required)

3.1.7 Oxidation, reduction and redox equations

Redox reactions involve a transfer of electrons from the reducing agent to the oxidising agent. The change in the oxidation state of an element in a compound or ion is used to identify the element that has been oxidised or reduced in a given reaction. Separate half-equations are written for the oxidation or reduction processes. These half-equations can then be combined to give an overall equation for any redox reaction.

Prior knowledge:

AS Chemistry
- Writing equations (3.1.2).

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Oxidation and reduction in terms of electron transfer. Oxidation states. Writing redox half equations and full equations.	1.0 weeks	**Students should be able to:** • determine oxidation states • write redox half equations • combine redox half equations to produce full equations • identify reduction and oxidation processes.	• 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). • Determine and then combine redox half equations for the reaction of a brass 2p coin with concentrated nitric acid (AO2 - Demonstrate knowledge and understanding).	• June 2013 Unit 2 Question 4a (QS13.2.04) • January 2012 Unit 2 Question 5a and 5b (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)	Many suitable resources can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required)

3.2 Inorganic Chemistry

3.2.1 Periodicity

The Periodic Table provides chemists with a structured organisation of the known chemical elements from which they can make sense of their physical and chemical properties. The historical development of the Periodic Table and models of atomic structure provide good examples of how scientific ideas and explanations develop over time.

Prior knowledge:

AS Chemistry
- Electron structure (3.1.1).
- Ionisation energy (3.1.1).
- Bonding (3.1.3).

3.2.1.1 Classification

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
How elements are classified as s, p, d or f block elements.	0.1 weeks	**Students should be able to:** • classify an element as an s, p,d or f block element using its electron structure.	• 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?	• June 2003 Unit 1 Question 1b (QS03.1.01) • June 2002 Unit 1 Question 6a (QS02.1.06)	

3.2.1.2 Physical properties of the Period 3 elements

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Trends in atomic radius, ionisation energy and melting point across Period 3.	0.4 weeks	**Students should be able to:** • describe and explain the trends across Period 3 in atomic radius, ionisation energy, melting points.	• 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).	• 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)	

3.2.2 Group 2, the alkaline earth metals

The elements in Group 2 are called the alkaline earth metals. The trends in the solubilities of the hydroxides and the sulfates of these elements are linked to their use. Barium sulfate, magnesium hydroxide and magnesium sulfate have applications in medicines whilst calcium hydroxide is used in agriculture to change soil pH, which is essential for good crop production and maintaining the food supply.

Prior knowledge:

GCSE Chemistry
- Writing formulas of ionic compounds.

Prior knowledge:

AS Chemistry
- Ionisation energy (3.1.1.3).
- Bonding (3.1.3).

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources
Trends in atomic radius, first ionisation energy and melting point. How elements Mg–Ba react with water. Solubility and some uses of Group 2 sulfates and hydroxides. Uses of Mg in the extraction of Ti and $CaO/CaCO_3$ in removing SO_2 from flue gases.	1 week	**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 • 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	• 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 corrosive,	• 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 Question 7 (QW12207)	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_meal.doc

Group 2 metals practical		ions; $Ca(OH)_2$ in agriculture; Mg in the extraction of Ti; $CaO/CaCO_3$ in removing SO_2 from flue gases.	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).		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

			• 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).		

3.2.3 Group 7(17), the halogens

The halogens in Group 7 are very reactive non-metals. Trends in their physical properties are examined and explained. Fluorine is too dangerous to be used in a school laboratory but the reactions of chlorine are studied. Challenges in studying the properties of elements in this group include explaining the trends in ability of the halogens to behave as oxidising agents and the halide ions to behave as reducing agents.

Prior knowledge:

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).

3.2.3.1 Trends in properties

Learning objective	Time taken	Learning Outcome	Learning activity with opportunity to develop skills	Assessment opportunities	Resources

Trends in electronegativity and boiling point down Group 7. Trends in oxidising power of halogens and reducing power of halide ions. Use of acidified silver nitrate to identify halide ions. **Required practical 4** Carry out simple test-tube reactions in aqueous solution to identify cations (Group 2, NH_4^+) and anions (Group 7 (halide), OH^-, CO_3^{2-}, SO_4^{2-}). Group 7 reactions practical.	1.5 weeks	**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 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.	• 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 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	• 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	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 (Volume 23, edition 1)

			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).		