National 5 Chemistry Course Support Notes

(abridged)

The **Mandatory Course key areas** are from the *Course Assessment Specification*. **Suggested learning activities** are not mandatory. This offers examples of suggested activities, from which you could select a range. It is not expected that all will be covered. Centres may also devise their own learning activities. **Suggested exemplification of key areas** is not mandatory. It provides an outline of the level of demand and detail of the key areas.

Risk assessment should always be carried out by teachers/lectures prior to doing any of the experiments and demonstrations listed in the table.

Chemical Changes and Structure		
Mandatory Course key areas	**Suggested learning activities**	**Exemplification of key areas**
Rates of reaction Average rate of reaction calculated from graph to show change in rate of reaction as reaction progresses.	Various videos are available commercially from TWIG website in both the 'Atoms and bonding' and 'Reactions' sections. Learners can carry out a series of experiments that involve production of a gas, eg acid with metal carbonate or metal. Alternatively, an effervescent tablet can be added to water. Learners can collect data manually or by using data-logging technology. The learners can construct graphs and calculate the average rate of reaction. Alternative variables such as colour and pH can be investigated where equipment is available.	Calculations of the average rate of a chemical reaction from a graph of the change in mass or volume against time. Learners should be familiar with the factors affecting rates of reaction for this Course.

Atomic structure and bonding related to properties of materials Nuclide notation. Isotopes and relative atomic mass. Ions. Ionic bonding. Covalent molecular, covalent network and ionic lattices. Physical properties of chemicals explained through bonding. Chemical and ionic formulae including group ions.	Element top trumps, available on the TES website or the Royal Society of Chemistry website, can be used to introduce nuclide notation and isotopes. The stability of different isotopes can be discussed at this point. Various interactive periodic tables can be found online on the Royal Society of Chemistry website. They can be used to show the properties of elements that are not available. A discussion of the noble gases' lack of reactivity and possible reasons why — relating to outer electron number — can be used to introduce the Octet Rule of Thumb. Balloons can be used to demonstrate the shape of electron orbitals. A wide variety of models can be made and used to demonstrate molecular shape. Models can be used to show lattice structure. Magnets can be used to demonstrate electrostatic attraction and repulsion. Learners can engage in practical activities on electrical conductivity, melting point and boiling point to explore the effects of bonding.	Learners should have knowledge of: sub-atomic particles, their charge, mass and position within the atom, the structure of the periodic table, groups, periods and atomic number. They should also be familiar with the seven diatomic elements. When there is an imbalance in the number of positive protons and electrons the particle is known as an ion. Chemists use nuclide notation to show the numbers of sub-atomic particles in an atom or ion. Isotopes are atoms of the same element with different mass numbers. Relative atomic mass is the average mass of the isotopes present taking into account their relative proportions. In a covalent bond, the shared pair of electrons is attracted to the nuclei of the two bonded atoms. More than one bond can be formed between atoms leading to double and triple covalent bonds. Covalent substances can form either discrete molecular or giant network structures. Diagrams show how outer electrons are shared to form the covalent bond(s) in a molecule and the shape of simple two-element compounds. Covalent molecular substances have low melting and boiling points due to only weak forces of attraction between molecules being broken. Giant covalent network structures have very high melting and boiling points because the network of strong covalent bonds must be broken. Ionic bonds are the electrostatic attraction between positive and negative ions. Ionic compounds form lattice structures of oppositely charged ions. Ionic compounds

		have high melting and boiling points because strong ionic bonds must be broken in order to break down the lattice. Dissolving also breaks down the lattice structure. Ionic compounds conduct electricity, only when molten or in solution due to the breakdown of the lattice resulting in the ions being free to move. Experimental procedures are required to confirm the type of bonding present in a substance.
Formulae and reaction quantities Balanced equations, including state symbols Gram formula mass, calculations relating mass, volume of solutions, concentration and moles	Learners could prepare standard solutions to reinforce use of calculations.	Chemical and, ionic formulae including compounds containing group ions are used. The chemical formula of a covalent molecular substance gives the number of atoms present in the molecule. The formula of a covalent network or ionic compound gives the simplest ratio of atoms/ions in the substance. **Moles** The gram formula mass is defined as the mass of one mole of a substance. Using the chemical formula of any substance the gram formula mass can be calculated using relative formula masses of its constituent elements. The concentration of solutions in moles per litre. Calculations to determine the concentration and volume and the mass of a substance through the number of moles present.

Acids and bases Dissociation of water into hydrogen and hydroxide ions. pH is related to the concentration of hydrogen and hydroxide ions in pure water, acids and alkalis. Neutralisation. Titrations.	Learners can investigate the comparative conductivity of saline solution, tap water and distilled water. These measurements can be linked to ion concentration to develop an understanding of the dissociation of water molecules. Learners can use sequential ten-fold dilution and full-scale pH indicator or a pH meter.to study the effect of dilution on pH. Practical tasks could be carried out to demonstrate the formation of acids and alkalis from oxides. Learners can carry out acid-base titrations to acquire skills of accurate measurement. Accurate and precise end-point detection should be emphasised.	Learners should have knowledge of pH and acids and bases including neutralisation reactions and salt formation. A very small proportion of water molecules will dissociate into an equal number of hydrogen and hydroxide ions. The pH is a measure of the hydrogen ion concentration. A neutral solution has an equal concentration of hydrogen and hydroxide ions. A solution with a greater concentration of hydrogen ions than hydroxide ions is an acid. When the reverse is true the solution is known as an alkali. The effect of dilution of an acid or alkali with water is related to the concentrations of hydrogen and hydroxide ions. When added to water, soluble metal oxides produce metal hydroxide solutions, increasing the hydroxide ion concentration. Soluble non-metal oxides increase the hydrogen ion concentration. **Neutralisation reactions** For the neutralisation reactions of acids with alkalis or metal carbonates, the reacting species is determined by omission of spectator ions. Titration is an analytical technique used to determine the accurate volumes involved in chemical reactions such as neutralisation. An indicator is used to show the end-point of the reaction.

Nature's Chemistry		
Mandatory Course key areas	**Suggested learning activities**	**Exemplification of key areas**
Homologous series The study of cycloalkanes and branched chain alkanes and alkenes (up to C8). To include their physical, chemical properties, general formulae, systematic names, structural formulae, uses, reactions and isomers. Reactions — combustion and addition.	rsc-oilstrike.org — RSC website Scholar animations (including naming animations) Chemsketch (can get 3D models of hydrocarbons) Chemsketch is available for schools free of charge Hydration of alkenes: Website at practicalchemistry.org/experiments formulae identified and drawn. Learners can investigate the structure of isomers by using molecular models.	Alkenes are described as unsaturated hydrocarbons and can undergo addition reactions that convert them into alkanes. The cycloalkane family is a homologous series of hydrocarbons and is identified from the name and the general formula. Cycloalkanes, with no more than eight carbon atoms in their longest chain, are named from their full structural formulae, shortened structural formulae and molecular formulae. Structural formulae can be drawn and molecular formulae written from systematic names. Isomers including alkanes, branched alkanes, alkenes, branched alkenes and cycloalkanes. Isomers have different properties.
Everyday consumer products Uses of alcohols and carboxylic acids: to include their physical,	A number of alcohols can be examined to establish common properties. The miscibility of alcohol in water and the pH of the resultant solutions could be tested. The flammability of meths in camping stoves can be demonstrated whilst methanol can be discussed as a fuel in drag racing and speedway.	Alcohols An alcohol is identified from the –OH group and the ending '-ol'. Straight chain alcohols are named from the structure formulae. Given the names of straight-chain alcohols structural and molecular formulae can be written.

chemical properties. For straight chain alcohols and carboxylic acids (C1–C8) general formulae, systematic naming, structural formulae. Functional groups in alcohols, carboxylic acids and esters. Manufacture of esters as a use of alcohols and carboxylic acids. Uses of esters.	Examine a number of products such as screen wipes, disinfectant wipes and hand gels which contain isopropyl alcohol (propan-2-ol). Vinegar offers learners an introduction to carboxylic acids using a familiar example. To obtain a qualitative measure of the concentration of ethanoic acid in different vinegars. A marble chip is attached to the inside of the lids of a number of 35 mm film canisters using a small piece of reusable poster tack. Equal volumes of a variety of vinegars are poured into the film cans until they are one third full. The lids are placed onto the cans and the cans inverted at the same time. Ethanoic acid reacts with the marble liberating carbon dioxide gas which builds up until the lid seal breaks and the can shoots into the air like a rocket. The order in which the vinegar 'rockets' take off is a measure of the concentration of ethanoic acid in each. The concentration of ethanoic acid in vinegars can be determined quantitatively by measuring the volume of carbon dioxide liberated when excess carbonate salt is added to vinegar. Many carboxylic acids have unpleasant smells. (Great care must be taken in handling undiluted carboxylic acids as they are highly corrosive.) Many learners may describe their smell as 'like vomit'. It can be worthwhile commenting on the accuracy of their description as vomit contains carboxylic acids known as 'fatty acids' released from fats and oils during digestion. To demonstrate both the acidic nature of ethanoic acid and its use as a food preservative, pickled eggs can be produced by placing boiled eggs (still in their shells) into jars containing vinegar. The acid will dissolve the shell to leave a pickled egg in vinegar. Pickles (food preserved in	Alcohols are effective solvents, highly flammable, and burn with very clean flames resulting in their use as a fuel. **Carboxylic acids** Carboxylic acids can be identified by the carboxyl ending, the COOH functional group and the '-oic' name ending. Straight-chained carboxylic acids can be identified and named from the structural formulae. Given the name of straight chained carboxylic acid the structural formulae can be drawn. Vinegar is a solution of ethanoic acid. Vinegar is used in household cleaning products designed to remove limescale (a build up of insoluble carbonates on plumbing fixtures) and as a preservative in the food industry.

	vinegar) can be stored for a long time because the low pH prevents the growth of harmful bacteria and fungi. A 'smelling' session is one way of reinforcing the use of the 'fruity' type of scent/flavour associated with esters. Foam-fruit-type sweets, pear drops and other fruit flavoured sweets often have distinctive ester scents. Examples of esters responsible for fruit smells include: 3-methyl-1-butyl ethanoate = banana methyl butanoate = apple propyl ethanoate = pear Esters can be quickly synthesised on a test-tube scale by learners. Learners work in pairs to synthesise different esters and identify their properties. Websites provide extensive lists of the esters found in fruit. Learners could research the uses of esters.	**Esters** An ester can be made by reacting a carboxylic acid and an alcohol. Some uses of esters are in food flavouring, industrial solvents, fragrances and materials.
Energy from fuels Energy calculations involving $E_h = cm\Delta T$ (There is no requirement to calculate enthalpy per mole.) Calculations based on balanced equations	The flammability of meths in camping stoves can be demonstrated whilst methanol can be discussed as a fuel in drag racing and speedway. A demonstration of the flammability of alcohol is provided by the 'whoosh bottle' demonstration. A mixture of alcohol and air in a large polycarbonate bottle is ignited. The resulting rapid combustion reaction, often accompanied by a dramatic 'whoosh' sound and flames, demonstrates the large amount of chemical energy released in the combustion of alcohols.	Alkanes and alcohols can be used as fuels. Combustion reactions are exothermic reactions. The opposite of this is an endothermic reaction. When a substance is combusted the reaction can be represented using a balanced formulae equation. The quantities of reactants and products in these reactions can be calculated.

	Equally, the ‘alcohol gun’ experiment or the ‘flaming pumpkin’ could be demonstrated. Risk assessments should be carried out before doing any of these experiments. A more mysterious element can be introduced with the ‘non-burning £5 note’ experiment. The heat energy released when alcohol burn can be measured.	Different fuels provide different quantities of energy and this can be measured experimentally and calculated using $E_h = cm\Delta T$.

National 5 – Chemistry in Society		
Mandatory Course key areas	**Suggested learning activities**	**Exemplification of key areas**
Metals Metallic bonding and resulting electrical conductivity. Balanced ionic equations for reactions of metals, extraction of metals and reduction reactions. Electrochemical cells including a non-metal electrode. Reactions of metals — electrons flow, redox reaction, oxidation, reduction. Fuel cells and rechargeable batteries.	Internet search 'metallic bonding'. This will provide numerous websites to illustrate the bonding and what happens when a voltage is applied to it. The following internet site should provide details of various experiments to reduce metal compounds Internet search: 'rsc.org/Education Learn Chemistry' Carryout electrolysis of molten lead bromide Internet search: 'bbc.co.uk learning zone clips secondary chemistry' This should provide many short video clips covering various chemical reactions including those involving metals. Internet search 'Stem Central' this should bring up a website with resources and video clips related to fuel cells and a whole lot more. Make a lead/acid cell to show a declarable battery. Aluminium extraction Internet search: ♦ 'rsc.org/Education Alchemy' ♦ Iron and steel Internet search: ♦ 'rsc.org/Education Alchemy' ♦ 'bbc.co.uk learning zone clips secondary chemistry'	Metallic bonding can explain the conductivity of metals. Balanced ionic equations can be written to show the reaction of metals with water, oxygen, acids Ion-electron equations can be written for electrochemical cells including those involving non-metals. Combinations of these reactions form redox equations Fuel cells and rechargeable batteries are two examples of technologies which utilise redox reactions. The percentage of a particular metal in an ore can be calculated. From the balanced equations for the extraction of metals the reducing agent can be identified.

Properties of plastics Addition and condensation polymerisation including Polythene, and polyesters Representation of the structure of monomers and polymers. Natural polymers.	Polyesters Identifying polymers: Internet search: 'rsc.org/Education/polymer' For addition polymers: Identify monomer, polymer, repeating unit and naming polymers. Novel materials could be investigated for the following properties eg: conductivity, solubility, colour changing, water absorption. Smart materials.	Plastics can be made by the processes of addition and condensation polymerisation. The structure of a polymer can be drawn from the structure of its monomers and vice versa. The type of polymer can be identified from its structure.
Fertilisers The Haber process to produce ammonia. Commercial production of nitrate fertilisers. Percentage mass compositions of fertilisers.	Ammonia Internet search: Could discuss the history of the Haber process and Fritz Haber himself. 'rsc.org/Education Alchemy' Produce ammonia via heating an ammonium salt and a solid base such as soda lime and testing pH via damp litmus paper. Ammonia fountain experiment (internet search) Nitric acid Internet search: 'rsc.org/Education Alchemy'	The Haber process is one of the most important reactions in the production of fertilisers and is an example of a reversible reaction. Ammonia is the starting material for the commercial production of nitric acid, which is used to produce ammonium nitrate.

Nuclear chemistry Radiation process, alpha, beta and gamma radiation. Specific properties mass, charge and ability to penetrate different materials. Nuclear equations. Uses of radioisotopes. Half-life. Use of isotopes to date materials.	Find out about the uses of radioisotopes. Find out about the benefits and problems associated with radioisotopes, eg carbon dating. Analyse such information in terms of the nature of the radiation emitted and its consequent properties, the intensity of the radiation emitted and the half-life of the radioisotope(s) present. Internet search for: 'Institute of Physics teaching radioactivity'. Internet search for: 'uses of isotope ratios' These are used extensively in analysis across science disciplines.	Radioactive elements can become more stable by giving out alpha, beta or gamma radiation. These types of radiation have specific properties such as their mass, charge and ability to penetrate different materials. The time for half of the nuclei of a particular isotope to decay is fixed and is called the half-life. Half-life for a particular isotope is a constant so radioactive isotopes can be used to date materials. Nuclear equations can be written to describe nuclear reactions. Radioactive isotopes are used in medicine and industry.
Chemical analysis Techniques for monitoring the environment and methods for reducing pollution and titration with calculations.	Water analysis, soil analysis. These could be modified with various salts if necessary. Chemical ion tests with silver nitrate for halide ions or carrying out other precipitation reactions to determine other ions.	Chemists play an important role in society by monitoring our environment to ensure that it remains healthy and safe and that pollution is tackled as it arises. A variety of methods exist which enable chemists to monitor the environment both qualitatively and quantitatively, such as acid/base titration, precipitation, flame testing.