

Mearns Castle High School

National 5

Chemistry



Learning Outcomes

Unit 1: Chemical Changes and Structure

(a) Reaction Rates

	The factors affecting the rate of a reaction are concentration, temperature, particle size and presence of a catalyst.
	Reactions can be followed by measuring changes in concentration, mass and volume of reactants and products.
	The average rate of a reaction, or stage in a reaction, can be calculated from initial and final quantities and the time interval.

(b) Atomic Structure and Bonding

	<u>Atomic Structure</u>
	The periodic table is arranged in groups (vertical columns) and periods (horizontal rows).
	Group 1 is the Alkali metals, group 7 is the Halogens and group 0 is the Noble Gases. The block between Groups 2 and 3 are called the Transition Metals
	Every element has its own symbol and atomic number
	Every element is made up of very small particles called atoms
	Atoms have a nucleus, which contains protons and neutrons, with electrons moving around the outside
	The atomic number of an element gives the number of protons in its nucleus
	Protons have a charge of one positive, electrons have a charge of one negative and neutrons are neutral (have no charge)
	An atom is neutral because the number of protons is equal to the number of electrons
	Protons and neutrons have a mass of 1 amu, electrons have a mass of (almost) zero
	The mass number of an element is equal to the number of protons + the number of neutrons
	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.
	When there is an imbalance in the number of positive protons and electrons the particle is known as an ion.
	Nuclide notation is a short hand way of showing the number of subatomic particles in an atom or ion

	<u>Bonding</u>
	A diatomic molecule is one containing 2 atoms. The following elements exist as diatomic molecules: Hydrogen, nitrogen, oxygen, the halogens
	Non-metal atoms bond by sharing electrons. This is a covalent bond
	A molecule is a group of atoms joined by covalent bonds
	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
	Electron Sharing Diagrams can be used to show how electrons are shared in a covalent bond
	Diagrams can show the shape of simple 2 element molecules
	Covalent substances can form either discrete molecular or giant network structures.
	Metals and non-metals bond with one another by transferring electrons. This is an ionic bond.
	Ionic bonds are the electrostatic attraction between positive and negative ions.
	Ionic compounds form lattice structures of oppositely charged ions.
	<u>Properties</u>
	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.
	Covalent substances cannot conduct electricity in any state as there are no charged particles free to move
	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.

(c) Formulae and Reaction Quantities

	<u>Formulae</u>
	Formulae can be written from prefixes mono-, di-, tri- etc.
	Formulae for simple 2 element compounds can be written from the group number
	Formulae can be written for compounds containing transition metals given a roman numeral
	Formula can be written for group ions using brackets
	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.
	Formula equations can be balanced to show the relative number of moles of reactant(s) and product(s)
	State symbols can be used to show the physical state of substances in an equation.
	<u>Moles</u>
	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 number of moles can be calculated from the mass of a substance and vice versa.
	The mass of a reactant or product can be calculated using a balanced equation.
	The concentration of a solution is expressed in mol l^{-1} .
	The number of moles of solute, volume and concentration of a solution can be calculated from the other two variables.

(d) Acids and Bases

	Acids have a pH of less than 7, neutral solutions have a pH of 7, Alkaline solutions have a pH greater than 7
	Non-metal oxides which dissolve in water produce acid solutions. Metal oxides and hydroxides which dissolve in water produce alkaline solutions. Ammonia dissolves in water to produce an alkali.
	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
	Neutralisation is the reaction of acids with bases. The pH moves towards 7.
	Metal oxides, metal hydroxides and metal carbonates are examples of bases.
	A salt and water are always formed in neutralisation reaction. When the base used is a metal carbonate, carbon dioxide is also formed.
	The name of the salt formed can be determined from the name of the acid and base.
	Insoluble salts can be made by a precipitation reaction
	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.
	The concentration of acids/alkalis can be calculated from the results of volumetric titrations.

Unit 2: Nature's Chemistry

(a) Homologous Series

	The alkanes are an homologous series of hydrocarbons
	The general formula for the alkanes is C_nH_{2n+2} .
	An alkane can be identified from the '-ane' ending.
	Straight-chain alkanes can be named from molecular formulae, shortened and full structural formulae (only C_1 to C_8)
	Molecular formulae can be written and shortened and full structural formulae can be drawn, given the names of straight-chain alkanes (only C_1 to C_8).
	Branched-chain alkanes can be systematically named from shortened and full structural formulae (only C_4 to C_8).
	The alkenes are another homologous series of hydrocarbons
	The general formula for the alkenes is C_nH_{2n}
	An alkene can be identified from the carbon to carbon double bond and the '-ene' ending.
	Straight-chain alkenes can be named, incorporating the position of the double bond, from shortened and full structural formulae (only C_2 to C_8).
	Molecular formulae can be written and shortened and full structural formulae can be drawn, given the names of alkenes (only C_2 to C_8).
	Branched-chain alkanes can be systematically named from shortened and full structural formulae (only C_4 to C_8).
	Alkenes are described as unsaturated hydrocarbons and can undergo addition reactions that convert them into alkanes.
	The cycloalkanes are a third homologous series of hydrocarbons
	The general formula for the cycloalkanes is C_nH_{2n} .
	Cycloalkanes can be named from molecular formulae, shortened and full structural formulae (only C_3 to C_8)
	Molecular formulae can be written and shortened and full structural formulae can be drawn, given the names of cycloalkanes (only C_3 to C_8).
	A homologous series is a set of compounds with the same general formula and similar chemical properties.
	Isomers are compounds with the same molecular formula but different structural formulae.
	Isomers can be drawn for given molecular formulae, shortened and full structural formulae.
	Isomers have different properties

(b) Everyday Consumer Products

	<u>Alcohols</u>
	An alcohol is identified from the hydroxyl (-OH) group and the ending '-ol'.
	Straight-chain alcohols can be named, incorporating the position of the hydroxyl group, from shortened and full structural formulae (only C ₁ to C ₈).
	Molecular formulae can be written and shortened and full structural formulae can be drawn, given the names of straight-chain alkanols (only C ₁ to C ₈).
	Alcohols are highly flammable and burn with a clean flame.
	Uses of alcohol include: the use of ethanol in alcoholic drinks, as effective solvents, and as a renewable fuel.
	<u>Carboxylic Acids</u>
	Carboxylic acids can be identified by the carboxyl ending, the COOH functional group and the '-oic' name ending.
	Straight-chain carboxylic acids can be named from shortened and full structural formulae (only C ₁ to C ₈).
	Molecular formulae can be written and shortened and full structural formulae can be drawn, given the name of straight-chain carboxylic acids (only C ₁ to C ₈).
	Vinegar is a solution of ethanoic acid.
	Vinegar is used in household cleaning products designed to remove lime scale and as a preservative in the food industry.
	<u>Esters</u>
	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.

(c) Energy From Fuels

	Alkanes and alcohols can be burned to release energy and as such are described as fuels.
	Burning (combustion) is the reaction of a substance with oxygen
	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.
	Reactions which give out heat (such as combustion) are described as exothermic.
	Reactions which take in heat are described as endothermic.
	Different fuels provide different quantities of energy and this can be measured experimentally.
	The quantity of energy released by burning a fuel can be calculated using the formula $Eh = cm\Delta T$.

Unit 3: Chemistry in Society

(a) Metals

	Metallic bonding is the electrostatic force of attraction between positively charged ions and delocalised electrons.
	Metal elements (solids, liquids) can conduct electricity due to the free moving electrons.
	<u>Reactions of Metals</u>
	Metals react with oxygen to produce a metal oxide.
	Metals react with water to produce a metal hydroxide and hydrogen gas.
	Metals react with acid to produce a salt and hydrogen gas.
	Balanced formula and ionic equations can be written to show the reactions above.
	Differences in the reaction rates give an indication of the reactivity of the metal and allow the construction of the reactivity series of metals.
	<u>Electrochemical Cells</u>
	Electricity can be produced by connecting different metals together, with an electrolyte, to form a simple cell.
	The voltage between different pairs of metals varies and this leads to the electrochemical series. The further apart 2 metals in the electrochemical series, the higher the voltage produced.
	Electricity can also be produced in a cell by connecting two different metals in solutions of their metal ions, and when at least one of the half-cells does not involve metal atoms.
	Electrons flow through the wires from the species higher in the electrochemical series to the one lower in the electrochemical series.
	The purpose of the 'ion bridge' (salt bridge) is to allow the movement of ions to complete the circuit.
	<u>Redox Reactions</u>
	Oxidation is a loss of electrons by a reactant in any reaction (e.g. a metal reacting to form a compound).
	Reduction is a gain of electrons by a reactant in any reaction (e.g. a compound reacting to form a metal).
	In a redox reaction, reduction and oxidation go on together.
	Ion-electron equations can be written for oxidation and reduction reactions.
	Ion-electron equations can be combined to produce redox equations.

	Electrochemical cells are redox reactions and ion electron and redox equations can be written for these, including those which include non-metals.
	Fuel cells and rechargeable batteries are two examples of technologies which utilise redox reactions.
	<u>Metal Ores</u>
	Ores are naturally occurring compounds of metals.
	The less reactive metals, including gold, silver and copper, are found uncombined in the Earth's crust and the more reactive metals have to be extracted from their ores.
	Some metals can be obtained from metal oxides by heat alone; some metal oxides need to be heated carbon; reactive metals must be extracted by electrolysis. The method of extraction is directly related to the reactivity of the metal.
	From the balanced equations for the extraction of metals the reducing agent can be identified.
	The percentage of a particular metal in an ore can be calculated.

(b) Properties of Plastics

	Plastics can be made by the processes of addition and condensation polymerisation.
	For both types of polymerisation, the structure of a polymer can be drawn from the structure of its monomer(s); and the structure of the monomer(s) can be derived given the structure of the polymer.
	The type of polymer can be identified from its structure.

(c) Fertilisers

	Plants require three essential elements for growth: Nitrogen, Phosphorus and Potassium.
	Artificial fertilisers must be soluble, and replace these nutrients in the soil to allow crop production.
	The Haber Process is one of the most important reactions in fertiliser production as it produces ammonia.
	The Haber process is a reversible reaction.
	Ammonia is a starting material in the production of nitric acid.
	The Ostwald Process uses ammonia to make nitric acid.
	Ammonia and Nitric acid can be reacted together to produce ammonium nitrate which is a good fertiliser.

(d) Nuclear Chemistry

	Radioactive elements can become more stable by giving out alpha, beta or gamma radiation.
	The three types of radiation have specific properties which can be described including their mass, charge and ability to penetrate different materials.
	Nuclear equations can be written to describe nuclear reactions.
	Balanced nuclear equations, involving neutrons, protons, alpha particles and beta particles, can be written.
	The time for half of the nuclei of a particular isotope to decay is fixed and is called the half-life.
	The quantity of radioisotope, half-life or time elapsed can be calculated given the value of the other two variables.
	Half-life for a particular isotope is a constant so radioactive isotopes can be used to date materials.
	Radioactive isotopes are used in medicine and industry.

(e) Chemical Analysis

	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. These include: <ul style="list-style-type: none">• Acid/base titrations• Precipitation• Flame testing