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**Knowledge Rich Curriculum Plan**

Science – Chemistry

Year 12



| **Science** **Year 12 Chemistry**  | **Unit: Introduction to Organic Chemistry** |  |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Practical Opportunities** |
| **Lesson:** **Organic Nomenclature** | * Students will know that the IUPAC rules for naming an organic compound state:
	+ The start of a chain tells us the number of carbons in there
	+ If there is a carbon carbon double bond, then the code is en(e)
	+ If there is only carbon carbon single bonds, then the code is an(e)
	+ if an organic compound contains a halogen, then the name starts with “halo” (e.g. chloro, iodo, etc.)
	+ If the organic compound is an alcohol, the name ends in “-ol”
	+ Numbers are used to state where the group is attached to the carbon chain
	+ Numbers and letters are separated by hyphens
	+ Numbers and numbers are separated by commas
	+ The prefixes “di”, “tri” and “tetra” are used if more than one of the same groups is present within the molecular
	+ The groups are organised alphabetically when naming organic compounds
	+ If an organic compound is a ring, then it is cyclic and the prefix “cyclo” is used
* Students will know how to apply IUPAC names when naming organic compounds.
* Students will know how to represent organic compounds using empirical formula, molecular formula, structural formula, displayed formula and skeletal formula
 | Displayed formula: method of representing a molecule that shows all bonds | * ***Students need to already know that a hydrocarbon contains hydrogen and carbon only***
* ***Students need to remember that the prefix of an organic compound tells us the length of the chain. Meth – 1 C, eth – 2 C, prop – 3 C, but – 4 C, pent – 5 C, hex – 6 C***
* ***Students need to already know that a homologous series is a series of compounds that contain the same functional group.***
 | Using Molymods |
| **Lesson:** **Reaction mechanisms** | * Students will know that a free radical is a highly reactive species with an unpaired electron. The unpaired electron is represented by a dot
* Students will know that a curly arrow is used to represent the movement of a pair of electrons.
* Students will know that a nucleophile is an electron pair donor
* Students will know that an electrophile is an electron pair acceptor.
 | Free radical: highly reactive species with an unpaired electronNucleophile: an electron pair donorElectrophile: an electron pair acceptor |  |  |
| **Lesson:** **Isomerism** | * Students will know that isomers have the same molecular formula of each other but different arrangements.
* Students will know that there are two types of isomerism, structural isomerism (a change in the structure) and stereoisomerism (difference in the spatial arrangement of a molecule).
* Students will know that structural isomerism can be broken down as chain isomers (whether the chain is straight or branched), functional group isomers (the functional group is different) and positional isomers (the position of the groups are different)
* Students will know that E-Z isomerism is a form of stereoisomerism, and occurs as a result of a restricted rotation around the carbon-carbon double bond.
* Students will know that for E-Z isomerism to exist there must be two different groups attached to the carbons either side of the double bond.
* Students will know that the Cahn-Ingold-Priority rules state that priority is given to the group of the highest Mr.
* Students will know that for E isomers, the groups are on the different sides of the carbon-carbon double bond, whereas in Z isomers the groups are on the same side.
* Students will know how to draw examples of the different structural isomers
* Students will know how to draw the structural formulas of E and Z isomers
* Students will know how to determine whether an isomer is either E or Z.
 | Isomers: molecules with the same molecular formula but different arrangements of atoms.Structural isomers: isomers that differ by the structure of the atomsStereoisomers: isomers that differ by the spatial arrangement of the molecules. |  | Molymod kits |

| **Science** **Year 12 Chemistry**  | **Unit: Alkanes** |  |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Practical Opportunities** |
| **Lesson:** **Crude Oil and Cracking** | * Students will know that the length of the carbon chain affects a molecules boiling point, viscosity and ease of ignition
* Students will know that the longer carbon chain molecules have high melting points, are viscous and are difficult to ignite.
* Students will know that some fractions of crude oil are more useful than others.
* Students will know that some fractions of crude oil are more abundant than others.
* Students will know that the more useful crude oil fractions tend to be the ones which are less abundant.
* Students will know that cracking is a process that breaks apart longer hydrocarbons into shorter chained hydrocarbons.
* Students will know that during cracking a Carbon-carbon bond is broken
* Students will know that catalytic cracking uses zeolites as the catalyst.
* Students will know that catalytic cracking produces a mixture of alkanes (high proportion are branched) and aromatic hydrocarbons.
* Students will know that thermal cracking uses high temperatures (450-750oC) and pressures (around 70 atmospheres)
* Students will know that thermal cracking produces a mixture of alkenes and alkanes.
 |  | * ***Students need to already know that hydrocarbons consist of carbon and hydrogen atoms only***
* ***Students need to already know that crude oil is a mixture of hydrocarbons***
* ***Students need to already know that crude oil is separated using fractional distillation***
* ***Students need to already know that fractional distillation separates crude oil into fractions based on their boiling point***
 |  |
| **Lesson:** **Combustion of alkanes** | * Students will know that an internal combustion engine produces a number of pollutants, including NOx, CO, carbon and unburned hydrocarbons.
* Students will know that NOx are produced due to high temperatures reached in the engine which causes atmospheric oxygen and nitrogen to react with each other.
* Students will know that gaseous pollutants are removed from internal combustion engines using catalytic converters.
* Students will know that sulfur dioxide can be produced when hydrocarbons containing sulfur impurities combust.
* Students will know that sulfur dioxide is removed from flue gases using calcium oxide or calcium carbonate.
 |  | * ***Students need to already know that combustion reactions see molecules react with oxygen in the air.***
* ***Students need to already know that complete combustion takes place when there is an adequate supply of oxygen***
* ***Students need to already know that incomplete combustion takes place when there isn’t an adequate supply of oxygen.***
* ***Students need to already know how to construct word and symbol equations***
 |  |
| **Lesson:** **Free Radical Substitution** | * Students will know free radical substitution takes place when an alkane (or halogenoalkane) reacts with a halide free radical.
* Students will know that the first step of free radical substitution is initiation. This takes place when a molecule (usually a halogen, X­2) is exposed to UV radiation to form two free radicals. X2 à 2X•
* Students will know that propagation is a chain reaction. And consists of two stages:
	+ 1st stage: the halide free radical reacts with an alkane (or halogenoalkane) to form HX and an alkyl free radical
	+ 2nd Stage: the alkyl free radical reacts with the halogen to form a halogenoalkane and regenerate the halide free radical
* Students will know that during the termination stage 2 fee radicals react with each other. This results in the forming of 3 different products.
* Students will know how to construct free radical substitution equations for a variety of different examples.
 | Substitution: reaction where a functional group takes the place of another functional group. | * ***Students need to already know that a free radical is a highly reactive species with an unpaired electron***
* ***Students need to already know that during a substitution reaction a functional group is replaced by another one***
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| **Science** **Year 12 Chemistry**  | **Unit: Halogenoalkanes** |  |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Practical opportunities** |
| **Lesson:** **Reactions of halogenoalkanes** | * Students will know that halogenoalkanes undergo nucleophilic substitution reactions
* Students will know that examples of nucleophiles are OH- (as part of a molecule, e.g. NaOH), CN- (usually as part of KCN) and NH3.
* Students will know that when drawing mechanisms it is important to represent the lone pair of electrons on a species.
* Students will know how to draw mechanisms to represent nucleophilic substitution reactions.
* Students will know that when halogenoalkanes react with aqueous hydroxide they undergo nucleophilic substitution, and when they react with ethanolic hydroxide they undergo elimination reactions.
* Students will know how to draw mechanisms to represent elimination reactions.
* Students will know that during elimination reactions hydroxide acts as a base.
 | Ethanolic: dissolved in ethanol | * ***Students need to already know a nucleophile is an electron pair donor***
* ***Students need to already know that a polar bond is one where two atoms with differing electronegativity are bonded to each other***
* ***Students need to already know that curly arrows represent the movement of a pair of electrons***
 | Test tube hydrolysis of halogenoalkanesPreparing chloroalkanes |
| **Lesson:** **Ozone Depletion** | * Students will know that ozone is naturally formed in the upper atmosphere, and that it’s beneficial as it absorbs ultraviolet radiation.
* Students will know that chlorofluorocarbons (CFCs) are molecules that contain carbon, fluorine and chlorine.
* Students will know that chlorine free radicals are formed in the upper atmosphere when ultraviolet breaks the C-Cl bond in CFCs
* Students will know that these chlorine free radicals catalysed the depletion of the ozone layer, contributing to the hole.
* Students will know that CFCs were used as solvents and refrigerants, but now are banned, and subsequently scientists have developed chlorine-free compounds.
* Students will know that the equations used to represent ozone depletion are:
	+ Cl• + O3 à ClO• + O2
	+ ClO• + O3 à 2O2 + Cl•
* Students will know that as Cl• acts as a catalyst, the overall equation is 2O3 à 3O2
 | Chlorofluorocarbons: molecules that contain chlorine, fluorine and carbon.Ozone: O3, a colourless unstable gasRefrigerants: molecules used for refigeration | * ***Students need to already know that free radicals are highly reactive species with an unpaired electron***
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| **Science** **Year 12 Chemistry**  | **Unit: Alkenes** |  |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Practical Opportunities** |
| **Lesson:** **Bonding in alkenes** | * Students will know that alkenes are unsaturated hydrocarbons
* Students will know that alkenes contain a double covalent bond.
* Students will know that alkenes contain a sigma and a pi bond
* Students will know that a sigma bond is formed by the overlap of s orbitals
* Students will know that a pi bond is formed by the overlap of p orbitals
* Students will know that the double bond is a centre of high electron density
* Students will know that the carbon-carbon double bond is unable to rotate.
 | Pi bond: formed by the overlap of p orbitalsSigma bond: formed by the overlap of s orbitals | * ***Students need to already know that alkenes are hydrocarbons that contain a carbon-carbon double bond***
* ***Students need to already know that a covalent bond is a shared pair of electrons***
 |  |
| **Lesson:** **Electrophilic addition** | * Students will know that alkenes undergo electrophilic addition, and examples of electrophiles include HBr, H2SO4 and Br2
* ­­Students will know how to represent electrophilic addition using mechanisms
* Students will know that electrophilic addition will result in the formation of major and minor products with unsymmetrical alkenes.
* Students will know that the formation of major and minor products is due to the stability of primary, secondary and tertiary carbocation intermediates
* Students will know that the order of stability for the carbocations is: tertiary > secondary > primary
* Students will know that some the stability of carbocations is dictated by the fact that alkyl groups can “push” their shared pair of electrons towards the positive carbon, stabilising it.
 | Carbocation: a molecular ion where the positive charge is found on a carbon atom | * ***Students need to already know that bromine water is used to test for an alkene, and a positive result is going from orange à colourless***
* ***Students need to already know that an electrophile is an electron pair acceptor***
* ***Students need to already know that a curly arrow represents the movement of a pair of electrons***
 | Testing for alkenes with bromine water |
| **Lesson:** **Addition Polymers** | * Students will know that addition polymers are formed from alkenes/ substituted alkenes.
* Students will know how to name addition polymers
* Students will know how to represent polymers from a monomer structure or the name
* Students will know how to identify the monomer from a polymer
* Students will know that polymers are very unreactive.
* Students will know that addition polymers are non-biodegradable as they can’t be hydrolysed.
* Students will know that PVC is used for a wide range of things, such as guttering, plastic windows, cable insulation, sheet materials, footwear and clothing.
* Students will know that plasticisers can be added to PVC to make it more flexible.
 |  | * ***Students need to already know that polymers are molecules made from many repeating units***
* ***Students need to already know that a monomer is the molecule that repeats to make a polymer***
 | Making Polymers |

| **Science** **Year 12 Chemistry**  | **Unit: Alcohols** |  |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Practical Opportunities** |
| **Lesson:** **Production of Alcohol** | * Students will know that alcohols can be manufactured through the hydration of alkenes and the fermentation of glucose.
* Students will know that the production of alcohol using hydration involves an acid catalyst.
* Students will know how to draw a mechanism to represent the production of ethanol using hydration of alkenes.
* Students will know that the production of alcohol using hydration is a continuous process.
* Students will know that production of alcohol using hydration requires a large amount of energy, which involves the burning of fossil fuels.
* Students will know that ethanol produced by fermentation requires a source of glucose, yeast and warm conditions.
* Students will know that ethanol produced by fermentation is impure, and can be purified using fractional distillation.
* Students will know that ethanol produced by fermentation is done through a batch process.
* Students will know that ethanol produced by fermentation is an example of biofuel.
* Students will know that production of ethanol through fermentation is carbon-neutral, as the carbon dioxide released in the process is absorbed by the plant during photosynthesis.
* Students will know that production of ethanol using fermentation is not fully carbon-neutral due to transport.
 |  | * ***Students need to already know that alcohols contain an -OH group***
 | Production of ethanol through fermentation, followed with purification |
| **Lesson:** **Oxidation of Alcohols** | * Students will know that alcohols are classified as primary (one carbon bonded to the OH containing carbon), secondary (2 carbons bonded to the OH bonded carbon) or tertiary (3 carbons bonded to the OH bonded carbon)
* Students will know how to identify primary, secondary or tertiary alcohols
* Students will know that primary and secondary alcohols can be oxidised, using acidified potassium dichromate as the oxidising agent
* Students will know that [O] is used to represent oxidising agents
* Students will know that primary alcohols can be oxidised to from aldehydes (through distillation) or fully oxidised to form carboxylic acid (through reflux)
* Students will know that secondary alcohols can only be oxidised to form ketones
* Students will know that tertiary alcohols aren’t easily oxidised
* Students will know how to draw the arrangement of equipment to represent reflux and distillation
* Students will know how to write equations to represent oxidation reactions of alcohol
* Students will know that Tollens’ reagent and Fehling’s solution are used to distinguish between aldehydes and ketones
* Students will know that when testing an aldehyde with Tollens’ reagent a silver mirror forms, whilst nothing happens with a ketone
* Students will know that when testing an aldehyde with Fehling’s solution the solution goes from blue to red, whilst nothing happens with a ketone
* Students will know how to represent the organic products produced during oxidation of alcohols.
 |  | * ***Students need to already know alcohols have the functional group -OH***
* ***Students need to already know how to correctly name and represent alcohols***
 | Production of an aldehyde and production of a carboxylic acidUsing Tollen’s reagentUsing Fehling’s solution |
| **Lesson:** **Required Practical 5** | * Students will know how to produce and distil an organic product form a reaction (oxidation of alcohols)
 |  | * ***Students need to already know the equipment used through reflux and distillation***
 |  |
| **Lesson:****Elimination** | * Students will know that alcohols can undergo acid-catalysed elimination reactions, and that the products of this reaction is water and an alkene
* Students will know how to represent the elimination of alcohols using a mechanism
* Students will know that alkenes that are produced using elimination can be used to produce addition polymers without needing to use crude oil as a raw product.
 |  | * ***Students need to already know that a catalyst speeds up a reaction without itself being used up***
 | Making cyclohexene from cyclohexanol |

| **Science** **Year 12 Chemistry**  | **Unit: Organic Analysis** |  |  |  |
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| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Practical opportunities** |
| **Lesson:** **Mass Spectrometry** | * Students will know that during mass spectrometry of organic compounds, the compounds often split into fragments
* Students will know that precise atomic masses allow for some organic compounds to be differentiated
* Students will know how to use fragment patterns to determine the structure of an organic compound
* Students will know how to use precise atomic masses to determine the molecular formula of a compound
 |  | * ***Students need to already know that mass spectrometry is used to determine molecular formulae of compounds***
* ***Students need to already know that the stages of mass spectrometry are ionisation, acceleration, ion drift and detection***
 |  |
| **Lesson:** **Infrared Spectroscopy** | * Students will know that bonds in a molecule absorb infrared radiation at characteristic wavenumbers
* Students will know that certain functional groups will absorb infrared within a range of wavenumbers (as seen in the data booklet)
* Students will know that the fingerprint region is the region below 1500 cm-1, and can be used to identify a molecule
* Students will know how to use infrared spectra and the data booklet to identify particular bonds and functional groups within a molecule
* Students will know that the greenhouse gases (CO2, methane and water vapour) absorb infrared radiation, and that’s what causes the greenhouse effect.
 |  | * ***Students need to already know that organic compounds differ to each other due to the presence of functional groups***
 |  |
| **Lesson:****Required Practical 6: Tests for alcohol, aldehyde, carboxylic acid and alkene** | * Students will know how to test for alcohols, aldehydes, carboxylic acids and alkenes
 |  |  |  |