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**Knowledge Rich Curriculum Plan**

Science – Chemistry

Year 13



| **Science** **Year 13 Chemistry**  | **Unit: Further Isomerism** |  |  |  |
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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:** **Optical Isomerism** | * Students will know that optical isomerism is a type of stereoisomerism
* Students will know that a chiral carbon is a carbon that is bonded to 4 different groups
* Students will know that chiral carbons give rise to optical isomers
* Students will know that optical isomers are known as enantiomers
* Students will know that enantiomers are non super-imposable mirror images
* Students will know that enantiomers differ by their effect on plane polarised light (rotate it either clockwise or anticlockwise)
* Students will know that plane polarised light is a single plane of light
* Students will know that a mixture of equal amounts of enantiomers is called a racemic mixture (racemate)
* Students will know that a racemic mixture will have no overall affect on plane polarised light, as the light will be rotated by an equal amount in both directions.
* Students will know how to draw structural and displayed formulae to represent enantiomers
 | Chiral carbon: a carbon atom bonded to 4 different groupsEnantiomers: different optical isomersRacemic mixture: 50/50 mixture of the two enantiomers | * ***Students need to already know that isomers have the same formula but different structure/ spatial arrangements***
* ***Students need to already know that stereoisomers have the same structure but different spatial arrangement***
 | Molymod kitsPolarised light through sucrose |

| **Science****Year 13 Chemistry**  | **Unit: Aldehydes and ketones** |  |  |  |
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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:** **Nucleophilic addition** | * Students will know that aldehydes and ketones are referred to as carbonyl compounds.
* Students will know that NaBH4 can be used as a reducing agent
* Students will know that aldehydes can be reduced to form primary alcohols, whilst ketones can be reduced to form secondary alcohols
* Students will know how to represent the reduction of carbonyl compounds by writing equations, representing the reducing agent as [H]
* Students will know that the reduction of aldehydes and ketones are examples of nucleophilic addition, where the nucleophile is H-
* Students will know how to draw a mechanism to represent the reduction of aldehydes and ketones
* Students will know that aldehydes and ketones undergo nucleophilic addition when reacted with KCN followed by dilute acid, and that this produces hydroxynitriles.
* Students will know how to represent the nucleophilic addition of carbonyl compounds using a mechanism
* Students will know that aldehydes and unsymmetrical ketones form mixtures of enantiomers when they react with KCN followed by dilute acid.
* Students will know the KCN is toxic, and care must be taken when using it in a chemical reaction
 |  | * ***Students need to already know that aldehydes have the C=O functional group at the end of the carbon chain***
* ***Students need to already know that ketones have the C=O functional group in the middle of the carbon chain***
* ***Students need to already know that Tollens’ reagent or Fehling’s solution can be used to distinguish between aldehydes and ketones***
* ***Students need to already know that Aldehydes and ketones are formed from the oxidation of alcohol***
* ***Students need to already know that a nucleophile is a lone pair donor***
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| **Science****Year 13 Chemistry**  | **Unit: Carboxylic Acids and Derivatives** |  |  |  |
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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:** **Carboxylic Acids and Esters** | * Students will know that carboxylic acids are weak acids that will produce carbon dioxide when reacting with carbonates
* Students will know that carboxylic acids react with alcohol in the presence of an acid catalyst to form esters
* Students will know that the name of the ester formed is derived from the alcohol (alkyl) and the salt of the acid (-anoate)
* Students will know how to name and draw the structure of esters formed in the reaction between carboxylic acids and alcohols
* Students will know that esters are used in solvents, plasticisers, perfumes and food flavourings
* Students will know that vegetable oils and animal fats are esters of propane-1,2,3-triol
* Students will know that esters can be hydrolysed in acidic conditions to form alcohols and carboxylic acids
* Students will know that esters can be hydrolysed in alkaline conditions to form alcohols and salts of carboxylic acids.
* Students will know that vegetable oils and fats can be hydrolysed in alkaline conditions to give soap (long chained carboxylic acid salts) and glycerol
* Students will know that biodiesel is a mixture of methyl esters of long-chain carboxylic acids.
* Students will know that biodiesel is produced by reacting vegetable oils with methanol.
 |  | * ***Students need to already know that carboxylic acids contain the COOH functional group***
* ***Students need to already know how to represent carboxylic acids***
* ***Students need to already know how to represent alcohols***
 | Making EstersMaking Soap |
| **Lesson:** **Carboxylic acid derivatives** | * Students will know that acid anhydrides are formed when two carboxylic acid molecules join together and lose water (O=C – O – C=O)
* Students will know that acyl chlorides are formed where a carboxylic acid group has the OH replaced with a Cl
* Students will know that acyl chlorides are formed when carboxylic acids are reacted with PCl5, to produce the acyl chloride, POCL3 and HCl
* Students will know that amides are based on carboxylic acids, where the OH group has been replaced by an NH2
* Students will know how to represent acid anhydrides, acyl chlorides and amides.
 |  | * ***Students need to already know that carboxylic acids contain the functional group COOH***
 | Reactions of ethanoyl chloride |
| **Nucleophilic addition-elimination reactions** | * Students will know that acyl chlorides and acid anhydrides undergo nucleophilic addition elimination reactions.
* Students will know that acid anhydrides and acyl chlorides react with water to form alcohol and carboxylic acid (acid anhydride) or hydrogen chloride (acyl chloride)
* Students will know that acid anhydrides and acyl chlorides react with alcohol to form an ester and carboxylic acid (acid anhydride) or hydrogen chloride (acyl chloride)
* Students will know that acid anhydrides and acyl chlorides react with ammonia to form amides and carboxylic acids (acid anhydride) or hydrogen chloride (acyl chloride)
* Students will know that acid anhydrides and acyl chlorides react with amines to form N-substituted amides and carboxylic acid (acid anhydride) or hydrogen chloride (acyl chloride).
* Students will know how to represent the nucleophilic addition-elimination reactions using mechanisms.
* Students will know that the use of ethanoic anhydride over ethanoyl chloride for drug production is preferred as ethanoic anhydride is less hazardous and cheaper.
 |  | * ***Students need to already know how to represent acid anhydrides, acyl chlorides and amides***
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| **Required Practical 10** | * Students will know how to carry out practical work to prepare a pure organic solid and test its purity
* Students will know how to carry out practical work to prepare a pure organic liquid.
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| **Science****Year 13 Chemistry**  | **Unit: Aromatic 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:** **Benzene and bonding** | * Students will know that benzene is a molecule with the formula C6H6
* Students will know that benzene is a cyclical planar molecule, where the C-C bond lengths are in between what would be expected for a single bond and a double bond
* Students will know that the p orbital electrons in benzene are delocalised in a ring within the cyclical shape
* Students will know that the delocalisation of the p electrons means that benzene is more stable than the theoretical molecule cyclohexa-1,3,5-triene
* Students will know that due to the enthalpy of hydrogenation of cyclohexene (-120 kJ mol-1), it was expected that the enthalpy of hydrogenation for benzene would be -360 kJ mol-1.
* Students will know that the enthalpy change of hydrogenation of benzene is -208 kJ mol-1, showing that benzene is more thermochemically stable than hypothesised.
* Students will know how to name aromatic compounds.
 |  |  |  |
| **Lesson:** **Electrophilic Substitution** | * Students will know that electrophilic addition on benzene rings results in substitution.
* Students will know that nitration is an example of electrophilic addition on benzene, and is an important step in the synthesis of explosives and amines.
* Students will know that in nitration the electrophile is NO2+
* Students will know that the electrophile NO2+ is produced by the reaction: HNO3 + H2SO4 à NO2+ + HSO4- + H3O+
* Students will know how to represent nitration of benzene rings using a mechanism
* Students will know that Friedel-Crafts acylation sees a R-C=O group being added to the benzene ring
* Students will know that the electrophile in Friedel-Crafts acylation is R – C=O +
* Students will know that the electrophile in acylation is produced by: R-C=O-Cl + AlCl3 à R-C=O+ + AlCl4-
* Students will know how to represent Friedel-Crafts acylation using mechanisms.
 |  | * ***Students need to know that benzene rings contain delocalised p electrons***
* ***Students need to know that the benzene ring has a high electron density***
* ***Students need to know that an electrophile is an electron pair acceptor***
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| **Science****Year 13 Chemistry**  | **Unit: Amines** |  |  |  |
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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:** **Preparation of Amines** | * Students will know that primary aliphatic amines are prepared by the reaction of ammonia with halogenoalkanes
* Students will know how to draw mechanisms to represent the reaction between ammonia and halogenoalkanes
* Students will know that amines can be produced through the reduction of nitriles
* Students will know that aromatic amines are prepared through the reduction of nitro compounds.
 |  | * ***Students need to already know that amines are ammonia derivatives***
 |  |
| **Lesson:** **Base Properties** | * Students will know that due to the lone pair of electrons on the nitrogen, amines are weak bases
* Students will know that different amines have different strengths
* Students will know that the strength bases of aliphatic amines (from strongest to weakest) are tertiary > secondary > primary
* Students will know how to explain the strength of the bases, using the fact that alkyl groups have a tendency to push electrons away from them.
* Students will know that aromatic amines are weaker bases than primary amines as the lone pair of electrons on the nitrogen are delocalised within the ring.
 |  | * ***Students need to already know that bases are proton acceptors***
 |  |
| **Lesson: Nucleophilic Properties** | * Students will know that amines can undergo nucleophilic substitution reactions with halogenoalkanes to form primary, secondary, tertiary amines and quaternary ammonium salts
* Students will know that quaternary ammonium salts as cationic surfactants
* Students will know how to represent the nucleophilic substitution reactions with mechanisms
* Students will know that amines undergo nucleophilic addition-elimination reactions with acyl chlorides and acid anhydrides.
 |  | * ***Students need to already know that nucleophiles are electron pair donors.***
* ***Students need to already know that amines can react with halogenoalkanes through nucleophilic substitution***
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| **Science****Year 13 Chemistry**  | **Unit: Polymers** |  |  |  |  |
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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…* | **Assessment**  | **Practical Opportunities** |
| **Lesson:** **Condensation Polymers** | * Students will know that condensation polymerisation are polymer reactions that release a small molecule (normally water)
* Students will know that dicarboxylic acids are organic molecules that have two carboxylic acid functional groups
* Students will know that diols are organic molecules that have two alcohol groups
* Students will know that diamines are organic molecules that contain two amine groups
* Students will know that condensation polymers are formed by reactions between: a) dicarboxylic acids and diols, b) dicarboxylic acids and diamines
* Students will know that polyesters are formed between dicarboxylic acids and diols
* Students will know that polyamides are formed between dicarboxylic acids and diamines
* Students will know how to represent polyesters and polyamides
* Students will know how to draw repeating units, monomers from information given on the condensation polymer formed
* Students will know that condensation polymers have intermolecular forces acting between them, and that these can be Van der Waals and hydrogen bonding.
 |  | * ***Students need to already know that polymers are large molecules made of regularly repeating units***
* ***Students will know that carboxylic acids have the functional group COOH***
* ***Students will know that alcohols have the functional group OH***
* ***Students will know that amines have the functional group NH2***
 |  | Making Nylon-6,6 |
| **Lesson:** **Biodegradability and disposal of polymers** | * Students will know that polyalkenes are non-biodegradable
* Students will know that polyesters and polyamides can be broken down by hydrolysis, and are therefore biodegradable.
* Students will know how to evaluate the different methods of disposal of polymers.
* Students will know how to explain why polyesters and polyamides can be hydrolysed but polyalkenes cannot.
 |  | * ***Students need to already know that addition polymers are formed from alkene monomers***
* ***Students need to already know that condensation polymers are formed from dicarboxylic acids and diols are diamines***
* ***Students need to already know that polyalkenes are chemically inert***
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| **Science****Year 13 Chemistry**  | **Unit: Biochemistry** |  |  |  |  |
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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…* | **Assessment**  | **Practical Opportunities** |
| **Lesson:** **Amino Acids** | * Students will know that amino acids have both the carboxylic acid functional group and the amine functional group
* Students will know that amino acids have both acidic and basic properties
* Students will know how to draw the structure of amino acids and the ions they form in acidic solution and alkaline solution
* Students will know that amino acids can from zwitterions (both a positive charge and a negative charge within the same molecule)
* Students will know how to draw the structure of amino acids as zwitterions.
 |  | * ***Students need to already know that carboxylic acids have the functional group COOH***
* ***Students need to already know that amines have the functional group NH2***
 |  |  |
| **Lesson:** **Proteins** | * Students will know that a peptide link is a bond formed between a carboxylic acid functional group and an amine functional group
* Students will know that proteins are sequences of amino acids joined by peptide links
* Students will know that proteins can exist as a primary structure, secondary structure (alpha helix and beta pleated sheets) and tertiary structures.
* Students will know that the structure is influenced by intermolecular forces such as hydrogen bonding and sulfur-sulfur bonds.
* Students will know that peptide links can be hydrolysed into their amino acids
* Students will know how to draw the structure of a peptide formed from up to 3 different amino acids
* Students will know how to draw the amino acids that would form from the hydrolysis of a peptide
 |  | * ***Students need to already know how to draw amino acids***
* ***Students need to already know that amino acids contain the COOH and the NH­2­2 functional group***
 |  |  |
| **Enzymes** | * Students will know that enzymes are proteins
* Students will know that enzymes act as catalysts for chemical reactions
* Students will know that enzymes have stereospecific active sites that bind to a substrate molecule
* Students will know that some drugs act as enzyme inhibitors, blocking the active site
* Students will know that since the active site is stereospecific, only one enantiomer can act as a substrate.
 |  | * ***Students need to already know that proteins are formed from amino acids***
 |  |  |
| **DNA** | * Students will know that a nucleotide is made up from a phosphate ion bonded to 2-deoxyribose, which is then bonded to one of the four bases
* Students will know how to draw a diagram to represent a nucleotide
* Students will know that a single strand of DNA is a polymer of nucleotides linked by covalent bonds
* Students will know that hydrogen bonding occurs between the bases
* Students will know that bases are paired together depending on the number of hydrogen bonds they form with each other.
 |  | * ***Students need to already know that DNA is a double helix***
 |  |  |
| **Anti-cancer drugs** | * Students will know that cisplatin is used as an anti-cancer drug
* Students will know that cisplatin prevents DNA replication by a ligand replacement reaction with DNA where a bond is formed between platinum and a nitrogen atom on guanine.
* Students will know how to evaluate the use of anti-cancer drugs
 |  | * ***Students need to already know that cisplatin is a platinum complex***
 |  |  |

| **Science****Year 13 Chemistry**  | **Unit: Organic Synthesis** |  |  |  |
| --- | --- | --- | --- | --- |
| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Tiered Vocabulary**  | **Prior Knowledge:***In order to know this students, need to already know that…* | **Assessment**  |
| **Lesson:** **Organic Synthesis** | * Students will know how to apply the different mechanisms to a reaction pathway.
* Students will know how to devise a synthesis for an organic compound.
 |  | * ***Students need to already know the mechanisms involving nucleophilic substitution, nucleophilic addition, nucleophilic addition-elimination, electrophilic addition, electrophilic substitution, elimination, free radical substitution.***
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| **Science****Year 13 Chemistry**  | **Unit: Further 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…* | **Assessment**  | **Practical Opportunities** |
| **Lesson:** **NMR** | * Students will know that NMR can give information about the position of Carbon-13 or Hydrogen-1 atoms in a molecule.
* Students will know that each peak in an NMR is linked to the environment the atom is in.
* Students will know that carbon-13 NMR give simpler spectra than hydrogen-1 NMR.
* Students will know that the chemical shift scale is relative to the standard TMS.
* Students will know that integrated spectra of hydrogen-1 NMR shows the relative number of atoms in different environments.
* Students will know that NMR spectra are obtained using samples dissolved in CCL4
* Students will know how to interpret NMR spectra.
 |  |  |  |  |
| **Lesson:** **Chromatography** | * Students will know that thin layer chromatography is a plate that is coated in a solid and a solvent moves up the plate
* Students will know that a column chromatography involves a column being packed with a solid and a solvent moves down the column
* Students will know that gas chromatography involves a column being packed with a solid or a solid coated by a liquid, and a gas is passed through the column under pressure at high temperature.
* Students will know that the separation of the mixture within chromatography depends on the balance between solubility in the mobile phase and retention by the stationary phase.
* Students will know that retention times or Rf values are used to identify different substances.
* Students will know that mass spectrometry is used to analyse components separated by gas chromatography
* Students will know how to analyse samples in chromatography.
* Students will know how to perform thin-layer chromatography, using ninhydrin spray and UV to see the sample.
 |  | * ***Students need to already know that chromatography is used to separate and identify components in a mixture***
* ***Students need to already know that Rf values are calculated using distance moved by sample/ distance moved by solvent***
 |  | TLC |