AQA A-LEVEL CHEMISTRY

SUMMARY OF ADDITIONAL CONTENT NEEDED FOR PAPER 2

Topic 16 – Aldehydes, Ketones and Optical Isomerism

Topic 17 – Carboxylic Acids, Amines, Esters and Acylation

Topic 18 – Aromatic Chemistry

Topic 19 – Amino Acids, Polymers, Biochemistry and Organic Synthesis

Topic 20 – Chromatography and Spectroscopy

Topic 16 – Aldehydes, Ketones and Optical Isomerism

* I can state that optical isomerism is a form of stereoisomerism and occurs

as a result of chirality in molecules, limited to molecules with a single chiral centre (asymmetric carbon atom)

* I can explain that optical isomers (enantiomers) exist as non-superimposable

mirror images and that they differ in their effect on plane polarised light

* I can state that a mixture of equal amounts of enantiomers is called a racemic mixture (racemate)
* I can recognise the presence of a chiral centre and draw the structural formulas and displayed formulas of enantiomers
* I can explain how racemic mixtures (racemates) are formed and why they are optically inactive
* I can describe the oxidation of aldehydes to carboxylic acids and use Fehling’s and Tollen’s reagents to distinguish between aldehydes and ketones
* I can describe for reduction reactions of aldehydes (to primary alcohols) and ketones (to secondary alcohols) using NaBH4 in aqueous solution
* I can write overall equations for reduction reactions of aldehydes and ketones using [H] as the reductant
* I can outline the nucleophilic addition mechanism for reduction reactions with NaBH4 (the nucleophile should be shown as H-)
* I can write overall equations for the formation of hydroxynitriles using HCN
* I can outline the nucleophilic addition mechanism for the reaction with KCN followed by dilute acid
* I can explain why nucleophilic addition reactions of KCN, followed by dilute acid, can produce a mixture of enantiomers
* I can describe the hazards of using KCN

Topic 17 - Carboxylic Acids, Amines, Esters and Acylation

* I can describe the structures of carboxylic acids, esters, acid anhydrides, acyl chlorides and amides
* I can describe carboxylic acids as weak acids which liberate CO2 from carbonates
* I can outline the preparation of primary aliphatic amines by the reaction of ammonia with halogenoalkanes and by the reduction of nitriles
* I can describe amines are weak bases and I can explain the difference in base strength between ammonia and primary aliphatic amines in terms of the availability of the lone pair of electrons on the N atom
* I can describe the reaction of carboxylic acids and alcohols, in the presence of an acid catalyst, to give esters
* I can describe the nucleophilic addition–elimination reactions of water, alcohols, ammonia and primary amines with acyl chlorides and acid anhydrides and outline the mechanism of the nucleophilic addition–elimination reactions of acyl chlorides with water, alcohols, ammonia and primary amines
* I can describe the industrial advantages of ethanoic anhydride over ethanoyl chloride in the manufacture of the drug aspirin
* I can describe amines are nucleophiles and describe the nucleophilic substitution reactions of ammonia and amines with halogenoalkanes to form primary, secondary, tertiary amines and quaternary ammonium salts
* I can describe the use of quaternary ammonium salts as cationic surfactants.
* I can describe common uses of esters (eg in solvents, plasticisers, perfumes and food flavourings)
* I can describe the hydrolysis of esters in acid or alkaline conditions to form alcohols and carboxylic acids or salts of carboxylic acids
* I can describe vegetable oils and animal fats as esters of propane-1,2,3-triol (glycerol), which can be hydrolysed in alkaline conditions to give soap (salts of long-chain carboxylic acids) and glycerol
* I can describe biodiesel as a mixture of methyl esters of long-chain carboxylic acids, which is produced by reacting vegetable oils with methanol in the presence of a catalyst

Topic 18 – Aromatic Chemistry

* I can describe the nature of the bonding in a benzene ring, limited to planar structure, bond length intermediate between single and double and delocalisation of p electrons which makes benzene more stable than the theoretical molecule cyclohexa-1,3,5-triene
* I can use thermochemical evidence from enthalpies of hydrogenation to account for this extra stability
* I can explain that electrophilic attack on benzene rings results in substitution, limited to monosubstitutions, and why substitution reactions occur in preference to addition reactions
* I can outline the electrophilic substitution mechanism of nitration, including the generation of the nitronium ion, and I can describe nitration as an important step in synthesis, including the manufacture of explosives and formation of amines
* I can outline the electrophilic substitution mechanism of Friedel–Crafts acylation, using AlCl3 as a catalyst, and I can describe Friedel-Crafts acylation as an important step in synthesis

Topic 19 – Amino Acids, Polymers, Organic Synthesis and Biochemistry

* I can describe and explain that amino acids have both acidic and basic properties, including the formation of zwitterions, and I can draw the structures of amino acids as zwitterions and the ions formed from amino acids in acid solution and in alkaline solution
* I can describe the formation of condensation polymers by reactions between dicarboxylic acids and diols, dicarboxylic acids and diamines, and amino acids, I can draw the repeating unit from a section of the polymer chain, draw the structure(s) of the monomer(s) from a section of the polymer, describe the repeating units in polyesters (eg Terylene) and polyamides (eg nylon 6,6 and Kevlar), describe the linkages between these repeating units and state the typical uses of these polymers
* I can explain the nature of the intermolecular forces between molecules of condensation polymers
* I can explain that proteins are sequences of amino acids joined by peptide links, draw the structure of a peptide formed from up to three amino acids, describe and identify in diagrams the primary, secondary (α-helix and β–pleated sheets) and tertiary structure of proteins and explain how these structures are maintained by hydrogen bonding and sulfur–sulfur bonds
* I can describe polyalkenes as chemically inert and non-biodegradable, understand that polyesters and polyamides can be broken down by hydrolysis and are biodegradable, state the advantages and disadvantages of different methods of disposal of polymers, including recycling, and explain why polyesters and polyamides can be hydrolysed but polyalkenes cannot
* I can explain that hydrolysis of the peptide link in proteins produces the constituent amino acids
* I can describe enzymes as proteins, describe the action of enzymes as catalysts, including the concept of a stereospecific active site that binds to a substrate molecule, explain why a stereospecific active site can only bond to one enantiomeric form of a substrate or drug, describe the principle of a drug acting as an enzyme inhibitor by blocking the active site, and understand that computers can be used to help design such drugs
* I can describe a nucleotide as made up from a phosphate ion bonded to 2-deoxyribose which is in turn bonded to one of the four bases adenine, cytosine, guanine and thymine (structures given in the Chemistry data booklet), that a single strand of DNA (deoxyribonucleic acid) is a polymer of nucleotides linked by covalent bonds between the phosphate group of one nucleotide and the 2-deoxyribose of another nucleotide which results in a sugar-phosphate-sugar-phosphate polymer chain with bases attached to the sugars in the chain, and that DNA exists as two complementary strands arranged in the form of a double helix, and I can explain how hydrogen bonding between base pairs leads to the two complementary strands of DNA
* I can state that the Pt(II) complex cisplatin is used as an anticancer drug, explain that cisplatin prevents DNA replication in cancer cells by a ligand replacement reaction with DNA in which a bond is formed between platinum and a nitrogen atom on guanine, explain why cisplatin prevents DNA replication and explain why such drugs can have adverse effects
* I can appreciate that society needs to assess the balance between the benefits and the adverse effects of drugs, such as the anticancer drug cisplatin
* I understand that the synthesis of an organic compound can involve several steps, explain why chemists aim to design processes that do not require a solvent and that use non-hazardous starting materials, explain why chemists aim to design production methods with fewer steps that have a high percentage atom economy, and use reactions in this specification to devise a synthesis, with up to four steps, for an organic compound

Topic 20 – Chromatography and Spectroscopy

* I can appreciate that scientists have developed a range of analytical techniques which together enable the structures of new compounds to be confirmed
* I understand that Nuclear Magnetic Resonance (NMR) gives information about the position of 13C or 1H atoms in a molecule, that 13C NMR gives simpler spectra than 1H NMR spectra, the use of the δ scale for recording chemical shift, which depends on the molecular environment, that integrated spectra indicate the relative numbers of 1H atoms in different environments
* I can use 1H NMR and 13C NMR spectra and chemical shift data from the Chemistry Data Booklet to suggest possible structures or part structures for molecules, use integration data from 1H NMR spectra to determine the relative numbers of equivalent protons in the molecule and use the n+1 rule to deduce the spin–spin splitting patterns of adjacent, non-equivalent protons, limited to doublet, triplet and quartet formation in aliphatic compounds
* I can state that 1H NMR spectra are obtained using samples dissolved in deuterated solvents or CCl4, describe the use of tetramethylsilane (TMS) as a standard explain why TMS is a suitable substance to use as a standard
* I can explain that chromatography can be used to separate and identify the components in a mixture and that types of chromatography include thin-layer chromatography (TLC), in which a plate is coated with a solid and a solvent moves up the plate, column chromatography (CC), in which a column is packed with a solid and a solvent moves down the column, and gas chromatography (GC), in which a column is packed with a solid or with a solid coated by a liquid, and a gas is passed through the column under pressure at high temperature
* I can separate species by thin-layer chromatography (required Practical 12)
* I can explain that separation depends on the balance between solubility in the moving phase and retention by the stationary phase, I can compare retention times and Rf values with standards to identify different substances, calculate Rf values from a chromatogram and explain the use of mass spectrometry to analyse the components separated by GC
* I can explain that the mixture of amino acids produced by the hydrolysis of proteins can be separated and identified by thin-layer chromatography, explain that amino acids can be located on a chromatogram using developing agents such as ninhydrin or ultraviolet light and identified by their Rf values, and calculate Rf values from a chromatogram