AQA AS-LEVEL CHEMISTRY

SUMMARY OF ADDITIONAL CONTENT NEEDED FOR PAPER 2

Topic 7 – Introduction to Organic Chemistry

Topic 8 – Reactions of Organic Compounds

Topic 9 – Analysis of Organic Compounds

Topic 7 – Introduction to Organic Chemistry

* I can deduce the empirical formula, molecular formula and general formula of any given organic compound
* I can draw the structural formula, displayed formula and skeletal formula of any given organic compound
* I can apply IUPAC rules for nomenclature to name an organic compound given the structure, and to draw the structure of an organic compound given the name, limited to chains and rings with up to six carbon atoms each
* I can describe the characteristics of a homologous series (a series of compounds containing the same functional group)
* I can define the term structural isomer and draw the structures of chain, position and functional group isomers
* I can define the term stereoisomer, draw the structural formulas of *E* and *Z* isomers and apply the CIP priority rules to *E* and *Z* isomers
* I can define alkanes as saturated hydrocarbons
* I can describe petroleum as a mixture consisting mainly of alkane hydrocarbons that can be separated by fractional distillation
* I can describe cracking as the breaking of C–C bonds in alkanes
* I can distinguish between thermal cracking (takes place at high pressure and high temperature and produces a high percentage of alkenes) and catalytic cracking (takes place at a slight pressure, high temperature and in the presence of a zeolite catalyst and is used mainly to produce motor fuels and aromatic hydrocarbons)
* I can explain the economic reasons for cracking alkanes
* I can describe alkanes as fuels, and that combustion of alkanes and other organic compounds can be complete or incomplete
* I can explain how the internal combustion engine produces a number of pollutants including NOx, CO, carbon and unburned hydrocarbons, and how these gaseous pollutants from internal combustion engines can be removed using catalytic converters
* I can explain how combustion of hydrocarbons containing sulfur leads to sulfur dioxide that causes air pollution
* I can explain why sulfur dioxide can be removed from flue gases using calcium oxide or calcium carbonate

Topic 8 – Reactions of Organic Compounds

* I can explain that the unpaired electron in a radical is represented by a dot
* I can write balanced equations for the steps in a free-radical mechanism
* I can show the formation of a covalent bond by a curly arrow that starts from a lone electron pair or from another covalent bond
* I can show the breaking of a covalent bond is by a curly arrow starting from the bond
* I can outline electrophilic addition, nucleophilic substitution and elimination mechanisms by drawing the structures of the species involved and curly arrows to represent the movement of electron pairs
* I can explain this reaction of methane with chlorine as a free-radical substitution mechanism involving initiation, propagation and termination steps
* I can explain that alkenes are unsaturated hydrocarbons
* I can explain that the high electron density of the carbon–carbon double bond leads to attack on these molecules by electrophiles
* I can describe, and outline the mechanisms of, the electrophilic addition reactions of alkenes with HBr, H2SO4 and Br2
* I can describe the use of bromine to test for unsaturation
* I can describe the formation of major and minor products in addition reactions of unsymmetrical alkenes, and explain the formation of major and minor products by reference to the relative stabilities of primary, secondary and tertiary carbocation intermediates
* I can draw the repeating unit of an addition polymer from a monomer structure or a section of a polymer chain, and vice versa
* I can name addition polymers
* I can explain why addition polymers are unreactive
* I can explain the nature of intermolecular forces between molecules of polyalkenes, and how its properties can be modified using a plasticizer
* I can explain that halogenoalkanes are much more reactive than alkanes because they contain polar bonds
* I can describe the substitution reactions of halogenoalkanes with the nucleophiles OH–, CN– and NH3
* I can outline the nucleophilic substitution mechanisms of these reactions
* I can explain why the carbon–halogen bond enthalpy influences the rate of reaction
* I can describe the uses of halogenoalkanes, including as refrigerants, as solvents and in pharmaceuticals
* I can explain that the use of some halogenoalkanes has been restricted due to the effect of chlorofluorocarbons (CFCs) on the atmosphere
* I can explain the concurrent substitution and elimination reactions of a halogenoalkane (eg 2-bromopropane with potassium hydroxide), in terms of the role of the reagent as both nucleophile and base, and outline the mechanisms of these reactions
* I can explain that ozone, formed naturally in the upper atmosphere, is beneficial because it absorbs ultraviolet radiation
* I can explain that chlorine atoms are formed in the upper atmosphere when ultraviolet radiation causes C–Cl bonds in chlorofluorocarbons (CFCs) to break, and that these chlorine atoms catalyse the decomposition of ozone and contribute to the hole in the ozone layer
* I can explain that results of research by different groups in the scientific community provided evidence for legislation to ban the use of CFCs as solvents and refrigerants, and that Chemists have now developed alternative chlorine-free compounds
* I can use equations, such as the following, to explain how chlorine atoms catalyse decomposition of ozone:

Cl• + O3 → ClO• + O2 and ClO• + O3 → 2O2 + Cl•

* I can explain that alcohols are produced industrially by hydration of alkenes in the presence of an acid catalyst
* I can explain that ethanol is produced industrially by fermentation of glucose, I can give the conditions for this process and I can explain that the ethanol produced industrially by fermentation is separated by fractional distillation and can then be used as a biofuel
* I can explain the meaning of the term biofuel
* I can justify the conditions used in the production of ethanol by fermentation of glucose
* I can write equations to support the statement that ethanol produced by fermentation is a carbon-neutral fuel and give reasons why this statement is not valid
* I can outline the mechanism for the formation of an alcohol by the reaction of an alkene with steam in the presence of an acid catalyst
* I can discuss discuss the environmental (including ethical) issues linked to decision making about biofuel use
* I can classify alcohols as primary, secondary and tertiary
* I can describe the oxidation of primary alcohols to aldehydes and the further oxidation to carboxylic acids
* I can describe the oxidation of secondary alcohols to ketones
* I can explain that tertiary alcohols are not easily oxidized
* I can explain that acidified potassium dichromate(VI) is a suitable oxidizing agent and I can write equations for these oxidation reactions (equations showing [O] as oxidant are acceptable)
* I can explain how the method used to oxidise a primary alcohol determines whether an aldehyde or carboxylic acid is obtained
* I can use chemical tests to distinguish between aldehydes and ketones including Fehling’s solution and Tollens’ reagent
* I can describe the formation of alkenes from alcohols by acid-catalysed elimination reactions
* I can explain that alkenes produced by this method can be used to produce addition polymers without using monomers derived from crude oil
* I can outline the mechanism for the elimination of water from alcohols

Topic 9 – Analysis of Organic Compounds

* I can identify functional groups using reactions in the specification.
* I can use mass spectrometry can be used to determine the molecular formula of a compound (by using precise atomic masses and the precise molecular mass)
* I can explain that bonds in a molecule absorb infrared radiation at characteristic wavenumbers
* I can explain how ‘Fingerprinting’ allows identification of a molecule by comparison of spectra
* I can use infrared spectra and the Chemistry Data Sheet or Booklet to identify particular bonds, and therefore functional groups, and also to identify impurities
* I can explain the link between absorption of infrared radiation by bonds in CO2, methane and water vapour and global warming.