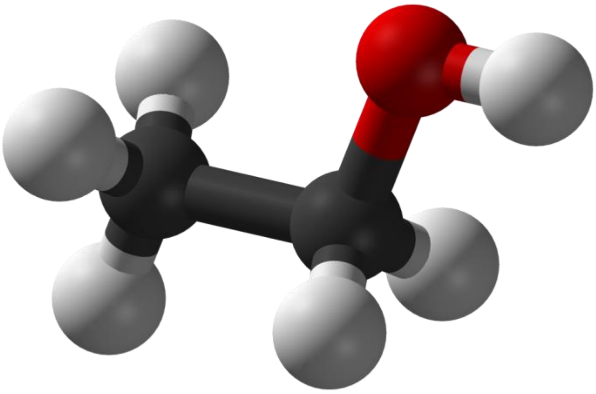
A-level Chemistry

3.3 Organic Chemistry

(Y12)



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Lesson Date(s)	Topic	Learning Outcomes From Specification	Key Words & Equations	Notes (Revision tips, exam technique tips, priorities for revision etc.)
	3.3.1.1 Nomenclature	Organic compounds can be represented by: empirical formula molecular formula general formula structural formula displayed formula skeletal formula. The characteristics of a homologous series, a series of compounds containing the same functional group. IUPAC rules for nomenclature. Students should be able to: draw structural, displayed and skeletal formulas for given organic compounds apply IUPAC rules for nomenclature to name organic compounds limited to chains and rings with up to six carbon atoms each apply IUPAC rules for nomenclature to draw the structure of an organic compound from the IUPAC name limited to chains and rings with up to six carbon atoms each.		

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	3.3.1.2 Reaction Mechanisms	Reactions of organic compounds can be explained using mechanisms. Free-radical mechanisms: the unpaired electron in a radical is represented by a dot the use of curly arrows is not required for radical mechanisms. Students should be able to: write balanced equations for the steps in a free-radical mechanism. Other mechanisms: the formation of a covalent bond is shown by a curly arrow that starts from a lone electron pair or from another covalent bond the breaking of a covalent bond is shown by a curly arrow starting from the bond. Students should be able to: outline mechanisms by drawing the structures of the species involved and curly arrows to represent the movement of electron pairs.		

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	3.3.1.3 Isomerism	Structural isomerism. Stereoisomerism. E–Z isomerism is a form of stereoisomerism and occurs as a result of restricted rotation about the planar carbon– carbon double bond. Cahn–Ingold–Prelog (CIP) priority rules. Students should be able to: define the term structural isomer draw the structures of chain, position and functional group isomers define the term stereoisomer draw the structural formulas of E and Z isomers apply the CIP priority rules to E and Z isomers.		

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	3.3.2.1 Fractional Distillation of Crude Oil	Alkanes are saturated hydrocarbons. Petroleum is a mixture consisting mainly of alkane hydrocarbons that can be separated by fractional distillation.		
	3.3.3.2 Modification of Alkanes by Cracking	Cracking involves breaking C–C bonds in alkanes. Thermal cracking takes place at high pressure and high temperature and produces a high percentage of alkenes (mechanism not required). 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 (mechanism not required). Students should be able to: explain the economic reasons for cracking alkanes.		

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	3.3.2.3 Combustion of Alkanes	Alkanes are used as fuels. Combustion of alkanes and other organic compounds can be complete or incomplete. The internal combustion engine produces a number of pollutants including NOx, CO, carbon and unburned hydrocarbons. These gaseous pollutants from internal combustion engines can be removed using catalytic converters. Combustion of hydrocarbons containing sulfur leads to sulfur dioxide that causes air pollution. Students should be able to: explain why sulfur dioxide can be removed from flue gases using calcium oxide or calcium carbonate.		
	3.3.2.4 Chlorination of Alkanes	The reaction of methane with chlorine. Students should be able to: explain this reaction as a free-radical substitution mechanism involving initiation, propagation and termination steps.		

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	3.3.3.1 Nucleophilic Substitution	Halogenoalkanes contain polar bonds. Halogenoalkanes undergo substitution reactions with the nucleophiles OH^-, CN^- and NH_3 Students should be able to: outline the nucleophilic substitution mechanisms of these reactions explain why the carbon–halogen bond enthalpy influences the rate of reaction.		
	3.3.3.2 Elimination	The concurrent substitution and elimination reactions of a halogenoalkane (eg 2-bromopropane with potassium hydroxide). Students should be able to: explain the role of the reagent as both nucleophile and base outline the mechanisms of these reactions.		

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	3.3.3.3 Ozone Depletion	Ozone, formed naturally in the upper atmosphere, is beneficial because it absorbs ultraviolet radiation. Chlorine atoms are formed in the upper atmosphere when ultraviolet radiation causes C–Cl bonds in chlorofluorocarbons (CFCs) to break. Chlorine atoms catalyse the decomposition of ozone and contribute to the hole in the ozone layer. Appreciate 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. Chemists have now developed alternative chlorine-free compounds. Students should be able to: use equations, such as the following, to explain how chlorine atoms catalyse decomposition of ozone: Cl• + O3 → ClO• + O2 and ClO• + O3 → 2O2 + Cl•		

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	3.3.4.1 Alkene Structure, Bonding & Reactivity	Alkenes are unsaturated hydrocarbons. Bonding in alkenes involves a double covalent bond, a centre of high electron density.		
	3.3.4.2 Addition Reactions of Alkenes	Electrophilic addition reactions of alkenes with HBr, H_2SO_4 and Br_2 The use of bromine to test for unsaturation. The formation of major and minor products in addition reactions of unsymmetrical alkenes. Students should be able to: outline the mechanisms for these reactions explain the formation of major and minor products by reference to the relative stabilities of primary, secondary and tertiary carbocation intermediates.		

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	3.3.4.3 Addition Polymers	Addition polymers are formed from alkenes and substituted alkenes. The repeating unit of addition polymers. IUPAC rules for naming addition polymers. Addition polymers are unreactive. Appreciate that knowledge and understanding of the production and properties of polymers has developed over time. Typical uses of poly(chloroethene), commonly known as PVC, and how its properties can be modified using a plasticiser. Students should be able to: draw the repeating unit from a monomer structure draw the repeating unit from a section of the polymer chain draw the structure of the monomer from a section of the polymer explain why addition polymers are unreactive explain the nature of intermolecular forces between molecules of polyalkenes.		

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	3.3.5.1 Alcohol Production	Alcohols are produced industrially by hydration of alkenes in the presence of an acid catalyst. Ethanol is produced industrially by fermentation of glucose. The conditions for this process. Ethanol produced industrially by fermentation is separated by fractional distillation and can then be used as a biofuel. Students should be able to: explain the meaning of the term biofuel justify the conditions used in the production of ethanol by fermentation of glucose 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 outline the mechanism for the formation of an alcohol by the reaction of an alkene with steam I the presence of an acid catalyst discuss the environmental (including ethical) issues linked to decision making about biofuel use.		

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	3.3.5.2 Oxidation of Alcohols	Alcohols are classified as primary, secondary and tertiary. Primary alcohols can be oxidised to aldehydes which can be further oxidised to carboxylic acids. Secondary alcohols can be oxidised to ketones. Tertiary alcohols are not easily oxidised. Acidified potassium dichromate(VI) is a suitable oxidising agent. Students should be able to: write equations for these oxidation reactions (equations showing [O] as oxidant are acceptable) explain how the method used to oxidise a primary alcohol determines whether an aldehyde or carboxylic acid is obtained use chemical tests to distinguish between aldehydes and ketones including Fehling's solution and Tollens' reagent.		

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	3.3.5.3 Elimination	Alkenes can be formed from alcohols by acid-catalysed elimination reactions. Alkenes produced by this method can be used to produce addition polymers without using monomers derived from crude oil. Students should be able to outline the mechanism for the elimination of water from alcohols. **Required practical 5** **Distillation of a product from a reaction.**		
	3.3.6.1 Identification of Functional Groups by Test-tube Reactions	The reactions of functional groups listed in the specification. Students should be able to: identify the functional groups using reactions in the specification. **Required practical 6** **Tests for alcohol, aldehyde, alkene and carboxylic acid.**		

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	3.3.6.2 Mass Spectrometry	Mass spectrometry can be used to determine the molecular formula of a compound. Students should be able to: use precise atomic masses and the precise molecular mass to determine the molecular formula of a compound.		
	3.3.6.3 Infrared Spectroscopy	Bonds in a molecule absorb infrared radiation at characteristic wavenumbers. 'Fingerprinting' allows identification of a molecule by comparison of spectra. Students should be able to: use infrared spectra and the Chemistry Data Sheet or Booklet to identify particular bonds, and therefore functional groups, and also to identify impurities. The link between absorption of infrared radiation by bonds in CO_2, methane and water vapour and global warming.		