

AQA Chemistry A-level

Organic Chemistry I Definitions

Selected Definitions modified or taken from: [AQA Specification for GCSE Chemistry, 8462, Version 1.1 04 October 2019](#) & [AQA Specification for AS & A-Level Chemistry, 7404 & 7405, Version 1.1, December 2015](#)



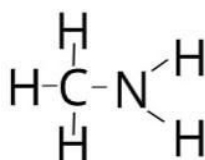
Definitions and Concepts for AQA Chemistry A-level

Organic Chemistry I

3.1 Introduction to Organic Chemistry

Chain isomers: Isomers that occur due to the branching in the carbon chain.

Displayed formula: A type of structural isomer that shows all the bonds between every atom in the compound. E.g.



Empirical formula: The smallest whole number ratio of atoms of each element in a compound. E.g. CH_2 is the empirical formula of C_2H_4 .

E-Z isomerism: A type of stereoisomerism that occurs due to the restricted rotation around the carbon double bond. This results in two different groups on one end of the bond and two different groups on the other end. If the highest priority groups for each carbon are found on the same side of the molecule, then it is the Z-isomer. If the highest priority groups for each carbon are found on opposite sides of the molecule, then it is the E-isomer.

Free-radical: An uncharged molecule or atom with an unpaired valence electron.

Functional group: The group of atoms responsible for the characteristic reactions of a particular compound.

Functional group isomers: Isomers that contain different functional groups. This means they belong to different homologous series.

General formula: A type of empirical formula that represents the composition of any member of an entire class of compounds. For example, alkanes all have the general formula $\text{C}_n\text{H}_{2n+2}$.

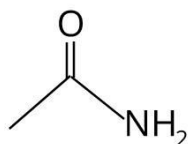
Homologous series: A series of compounds with the same functional group and similar chemical properties. For example, all alkanes belong to the same homologous series.

Molecular formula: Total number of atoms of each element in the compound.

Position isomer: Isomers where the carbon backbone of the isomers are the same but the important groups are at different positions on the backbone.



Skeletal formula: A diagram representation of an organic compound in which lines represent bonds between atoms and atoms are represented by their symbol. Hydrogens are assumed to be at the end of the line if no other atomic symbol is present. E.g:



Stereoisomerism: Occurs when two double bonded carbon atoms each have two different atoms or groups attached to them. Includes E/Z isomerism. This is a consequence of a restricted rotation around the C=C double bond.

Structural formula: A formula which shows the arrangement of atoms in the molecule of a compound but does not show all the bonds between them. E.g. $\text{CH}_3\text{CH}_2\text{COCH}_3$.

Structural isomerism: Structural isomers are compounds which have the same molecular formula but a different structural formula.

3.2 Alkanes

Catalytic converter: A device fitted in a car to reduce the amount of emissions from an internal combustion engine. They use expensive metals like platinum and rhodium as the heterogeneous catalyst. The catalyst is mounted on a ceramic honeycomb to maximise the surface area.

Catalytic cracking: A type of cracking that 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. †

Combustion of alkanes: Combustion of alkanes releases energy. During combustion, the carbon and hydrogen in the fuels are oxidised. Alkanes can undergo complete or incomplete combustion. Water and carbon dioxide are the only products of the complete combustion, whereas carbon monoxide and carbon particulates can be produced in incomplete combustion.

Cracking: A process which involves breaking C-C bonds in alkanes to produce shorter chained alkanes and alkenes.

Crude oil: A finite resource found in rocks. It is the remains of an ancient biomass consisting mainly of plankton that was buried in mud. Most of the compounds in crude oil are hydrocarbons.

Fractional distillation: A method of separating a mixture of substances according to their different boiling points. Commonly used to separate crude oil into different fractions.



Hydrocarbons: Compounds made up of carbon and hydrogen atoms only.

Saturated: Organic compounds are saturated if all the carbon-carbon bonds are single C-C bonds. Alkanes are saturated hydrocarbons.

Thermal cracking: A type of cracking that takes place at high pressure and high temperature and produces a high percentage of alkenes.

3.3 Halogenoalkanes

Chlorofluorocarbons: Chlorofluorocarbons, also known as CFCs, are chemicals containing carbon, chlorine and fluorine atoms. CFCs contribute to ozone depletion so they are banned for use in refrigerants and solvents.

Electrophile: Electron pair acceptor in an organic mechanism. Attracted to areas with a lot of electrons/high negative charge.

Elimination: A reaction in which a molecule loses atoms or groups of atoms to form a C=C bond.

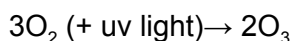
Free radicals: A species with an unpaired electron. Represented in mechanisms by a single dot.

Free radical substitution: A photochemical reaction between halogens and alkanes to form halogenoalkanes. The reaction requires UV light and involves three stages: initiation, propagation and termination. Initiation initially creates a radical species. Propagation involves a series of chain reactions where free radicals bond to molecules to form new free radicals. Termination involves the reaction of free radicals with other free radicals to form new molecules.

Nucleophile: An atom or molecule that donates an electron pair to form a covalent bond. Attracted to electron-deficient areas.

Nucleophilic substitution: The reaction of an electron pair donor (the nucleophile) with an electron pair acceptor (the electrophile). Involves one species being replaced with another species.

Ozone: Ozone is formed naturally in the upper atmosphere. It is beneficial because it absorbs ultraviolet radiation and this prevents harmful radiation reaching the earth. Ozone is formed by the following reaction:



Ozone depletion: Chlorine atoms catalyse the decomposition of ozone and contribute to the hole in the ozone layer.

Polar bond: A covalent bond where the electrons are not distributed equally. This causes the molecule to have a slight dipole so that one end is slightly positively charged and the other end is slightly negatively charged. Halogenoalkanes contain polar bonds due to the difference in electronegativity between the halogen atom and carbon atom.

3.4 Alkenes

Addition polymer: A polymer formed by addition polymerisation. Formed from monomers with C=C bonds.

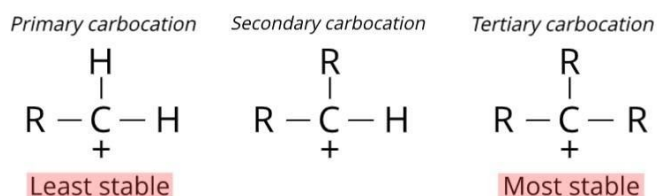
Addition polymerisation: The process by which addition polymers are formed. Lots of short chain monomers (alkenes) join together to form a long chain polymer by the 'opening up' of all the double carbon bonds.

Alkenes: Alkenes are hydrocarbons with a double bond between two of the carbon atoms in their chain, causing them to be unsaturated. They have the general formula C_nH_{2n} .

Carbocation: A carbon atom bearing a positive charge.

Electrophile: Electron pair acceptor in an organic mechanism. Attracted to areas with a lot of electrons/high negative charge.

Major/minor products: Major and minor products are formed from electrophilic addition due to the relative stabilities of the primary/secondary/tertiary carbocation intermediates. The major product is formed from the most stable intermediate and the minor product is formed from the least stable intermediate.



Monomer: A short chain molecule that when bonded to other monomers forms a polymer.

Plasticiser: A chemical added to polymers to improve flexibility and workability. Plasticisers are often added to polychloroethene (PVC) to make it more flexible, making it suitable for uses such as electrical cables and clothing as well as plastic windows and guttering.



Polymer: Large long-chain molecules made up of lots of small monomers joined together by covalent bonds.

Repeat unit: The part of a polymer whose repetition would produce the complete polymer chain.

Unsaturated: Organic compounds are unsaturated if they have at least one double carbon bond (C=C). Alkenes are unsaturated hydrocarbons.

3.5 Alcohols

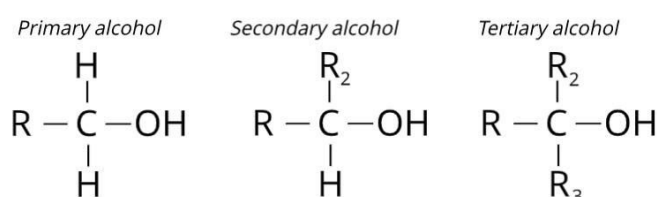
Alcohols: Alcohols contain the functional group –OH. The first four members of a homologous series of alcohols are methanol, ethanol, propanol and butanol.

Biofuel: A fuel derived from living matter. Examples include ethanol produced from the fermentation of glucose.

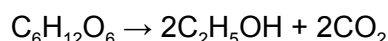
Carbon-neutral fuel: A fuel is described as carbon-neutral if the production and use of the fuel has no net increase on the amount of carbon dioxide in the atmosphere.

Classification of alcohols: Alcohols can be classified as primary, secondary or tertiary depending on how many carbon groups are bonded to the carbon that the –OH group is bonded to. They are classified as follows:

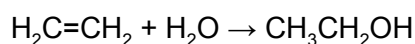
Distillation: An experimental procedure used to separate a mixture of liquids. The liquids separate out due to their different boiling points. Ethanol can be separated from water by distillation since ethanol has a lower boiling point.



Fermentation of glucose: An industrial process to produce ethanol. Glucose is extracted from sugar cane. Yeast provides the enzymes needed for fermentation and then the glucose produces ethanol and carbon dioxide. The reaction must be carried out anaerobically and at a warm temperature (30°C).



Hydration of alkenes: An industrial process that can be used to produce alcohols. The alkene is reacted with steam in the presence of an acid catalyst. Hydration of ethene:



Oxidation of alcohols: Alcohols can undergo oxidation with acidified potassium dichromate(VI). The products formed depend on which classification the alcohol is. Primary alcohols can be oxidised to aldehydes which can be further oxidised to carboxylic acids, secondary alcohols can be oxidised to ketones and tertiary alcohols are not easily oxidised.



3.6 Organic Analysis

Alcohol: a molecule containing the -OH functional group. Primary alcohols can be identified by a distillation reaction with acidified potassium dichromate, causing a colour change from orange to dark green (produces an aldehyde). Secondary alcohols can be identified with a reflux reaction with acidified potassium dichromate, causing a colour change from orange to dark green (produces a ketone). Tertiary alcohols cannot be oxidised with acidified potassium dichromate so the solution remains orange.

Aldehyde: a molecule containing the C=O functional group at the end of the molecule which causes the formation of a silver mirror when reacted with Tollens' reagent.

Alkene: a molecule containing the C=C functional group. Alkenes cause bromine water to decolourise.

Carboxylic Acid: a molecule containing the COOH functional group. Carboxylic acids react with sodium carbonate, causing effervescence and the production of carbon dioxide (this turns limewater cloudy).

Fingerprint Region: the region on an IR spectrum below 1500 cm^{-1} which is unique to each molecule.

Functional Group: a group of atoms responsible for the characteristic reactions of a compound.

Infrared Spectroscopy: a technique used to identify particular bonds and functional groups within a molecule. Infrared spectroscopy can also be used to identify impurities.

Mass spectrometer: gives accurate information about relative isotopic mass and also about the relative abundance of isotopes.

Mass Spectrometry: a technique used to identify compounds and determine relative molecular mass.

Molecular Formula: the total number of atoms of each element in the compound.



Relative atomic mass: The average mass of an atom of an element compared to 1/12th the mass of an atom of carbon-12.

Relative molecular mass: The average mass of one molecule of an element or compound compared to 1/12th the mass of an atom of carbon-12.

Wavenumber: represents the energy and frequency of infrared radiation absorbed by a bond in a molecule. This is the x-axis on IR spectra.

