

CAIE Chemistry A-level

13: An Introduction to AS Level Organic Chemistry Definitions

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Definitions and Concepts for CAIE Chemistry A-level

An Introduction to AS Level Organic Chemistry

Addition: A reaction in which the reactants combine to form a single product.

Aldehyde: A compound containing the -CHO functional group at the end of an alkyl chain. Aldehydes can be oxidised to carboxylic acids by heating them under reflux with $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$.

Aliphatic: An molecule that only contains straight or branched alkyl chains.

Alkane: A homologous series of saturated hydrocarbons with the general formula $\text{C}_n\text{H}_{2n+2}$.

Amines: Compounds that contain the NR_3 functional group (where R could be hydrogen atoms or alkyl chains). Amines are basic as the nitrogen atom has a lone pair of electrons that can accept a proton. In a reaction between amines and dilute acids, salts are formed.

Bond angle: The angle between two bonds from the same atom in a covalently bonded compound.

Cahn-Ingold-Prelog (CIP) Priority Rules: A set of rules used to identify whether a stereoisomer is E or Z. Atoms with a higher atomic number have a higher priority. If the highest priority substituents on the same side of the double bond (both above or below), it's the Z isomer whereas if the highest priority groups are on the opposite sides (one above and one below), it's the E isomer.

Carboxylic acid: An organic compound containing the -COOH functional group.

Chain isomers: Structural isomers that have carbon backbones of differing lengths. These occur due to the branching in the carbon chain.

Chiral centre: A carbon atom that is bonded to 4 different atoms/groups of atoms.

Cis-trans isomerism: A type of E/Z isomerism in which the two substituent groups attached to the carbon atoms are the same. According to the CIP priority rules, cis isomers have the highest priority substituents on the same side of the double bond (both above or below) while trans isomers have them on the opposite sides (one above and one below).

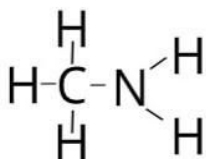
Condensation reaction: A reaction where two molecules react to form one larger molecule and a small molecule as a byproduct.





Cycloalkane: Saturated hydrocarbons that contain a cyclic ring. They only contain single bonds and have a general formula of C_nH_{2n} , which is different to alkanes.

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



Electrophile: A species that can accept electrons in a reaction, to form a chemical bond. Electrophiles are attracted to areas with a lot of electrons/high negative charge.

Electrophilic addition: A reaction where a π bond is broken and 2 new σ bonds form due to the addition of an electrophile.

Electrophilic substitution: A reaction in which an electrophile replaces an atom/group of atoms in a compound.

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

Empirical formula: Smallest whole number ratio of atoms of each element in a compound. For example, the empirical formula of benzene (C_6H_6), cyclobutadiene (C_4H_4) and acetylene (C_2H_2) are all "CH".

Enantiomers: Molecules that are non-superimposable mirror images of one another. Enantiomers have opposite effects on plane-polarised light.

Ester: A compound containing the $R-COO-R'$ functional group (where R and R' are alkyl groups).

Free radical: A species with an unpaired electron. These are 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 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.

Functional group: An atom/group of atoms responsible for the characteristic reactions of a compound.





Functional group isomers: Structural 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 C_nH_{2n+2} .

Geometric isomerism: A type of stereoisomerism that occurs due to the restricted rotation about the carbon double bond. This results in two different groups on either end of the double bond. 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.

Halogenoalkane: A saturated molecule where one or more of the hydrogen atoms in an alkane have been substituted for a halogen.

Heterolytic (bond breaking): The type of bond breaking in which both the electrons from the bond move together to one of the bonding atoms.

Homologous series: Series of organic compounds with the same functional group and general formula. Consecutive members of a series differ by $-CH_2$.

Homolytic (bond breaking): The type of bond breaking in which the electrons from the bond move separately, one goes to each of the atoms of the bonding pair.

Hybridisation: The combining of two or more atomic orbitals to form new 'hybrid' orbitals which are different to the originals.

Hydrocarbon: A compound consisting of hydrogen and carbon atoms only.

Hydrolysis: A reaction in which a molecule is broken down by its reaction with water.

Initiation step: The first step in a radical substitution mechanism, involving the formation of the radicals.

Ketone: A compound containing the $C=O$ functional group within an alkyl chain. Ketones cannot be oxidised further.

Molecular formula: The actual number of atoms of each element in a molecule.

Nomenclature: The naming system for compounds.

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





Nucleophilic addition: A reaction in which an electrophilic π bond reacts with a nucleophile, breaking the π bond and forming 2 new σ bonds. Examples include carbonyl compounds reacting with NaBH_4 to form alcohols or with HCN to form hydroxynitriles.

Nucleophilic substitution: A reaction in which an electron pair donor attacks an electrophilic atom (an atom with a partial or full positive charge) to replace an atom/group of atoms.

Optical isomerism: A type of stereoisomerism present in compounds that are non-superimposable mirror images of one another caused by the presence of a chiral centre. They have the same molecular formula with different arrangements in space.

Oxidation: The loss of electron(s) which leads to an increase in oxidation number.

Planar: A molecule is said to be planar when all its atoms are in one plane.

Position isomer: Structural isomers that differ in their position of one or more functional groups. The carbon backbone of the molecules are the same.

Primary alcohol: An alcohol in which the $-\text{OH}$ is attached to a primary carbon atom (i.e. RCH_2OH). Primary alcohols can be oxidised with $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ to form either an aldehyde or a carboxylic acid, depending on the conditions.

Primary halogenoalkane: A halogenoalkane in which the carbon bonded to the halogen atom is itself only bonded to one other carbon atom.

Propagation step: A series of chain reactions in a free radical substitution reaction where free radicals react with molecules to form new free radicals.

Racemic mixture (racemate): A mixture containing equal amounts of enantiomers, a 50:50 mix of a pair of enantiomers.

Reduction: The gain of electron(s) which leads to a decrease in oxidation number.

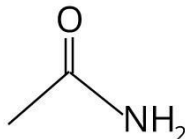
Saturated: Hydrocarbons that contain only single bonds.

Secondary alcohol: An alcohol in which the $-\text{OH}$ is attached to a secondary carbon atom (i.e. R_2CHOH). Secondary alcohols can be oxidised under reflux with $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ to form a ketone.

Secondary halogenoalkane: A halogenoalkane in which the carbon bonded to the halogen is itself bonded to two other carbon atoms.



Skeletal formula: A 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: Shows the arrangement of atoms in a molecule. E.g. butane:
 $\text{CH}_3(\text{CH}_2)_2\text{CH}_3$.

Structural isomers: Compounds that have the same molecular formula but a different structural formula. Structural isomers include chain isomers, functional group isomers and position isomers.

Substitution: A reaction in which one functional group is replaced with a different functional group.

Termination: The final steps in a radical substitution mechanism in which two radicals react together to form a species that only contains paired electrons.

Tertiary alcohol: An alcohol in which the -OH is attached to a tertiary carbon atom (i.e. R_3COH). Tertiary alcohols cannot be oxidised.

Tertiary halogenoalkane: A halogenoalkane in which the carbon bonded to the halogen is itself bonded to three other carbon atoms.

Unsaturated: Hydrocarbons that contain at least 1 carbon-carbon double bond which consists of a σ bond and a π bond.

π -bond: A type of covalent bond formed when adjacent p orbitals overlap above and below the σ single carbon bond. Pi (π) bonds can't be rotated. As π -bonds have low bond enthalpy, alkenes are more reactive than alkanes.

σ -bond: A type of covalent bond formed by direct overlap of orbitals between the bonding atoms to form a single carbon bond. These have a high bond enthalpy.

