

CAIE Chemistry A-level

Topic 13 - An Introduction to Organic Chemistry

Flashcards

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What is a functional group?



What is a functional group?

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



What is a homologous series?



What is a homologous series?

A series of organic compounds with the same functional group and with successive members differing by $-\text{CH}_2$.



What is an alkane? Include the general formula



What is an alkane? Include the general formula

A saturated hydrocarbon with general formula $C_n H_{2n+2}$.

Suffix: -ane.



Give the molecular, displayed and skeletal formulae of butane

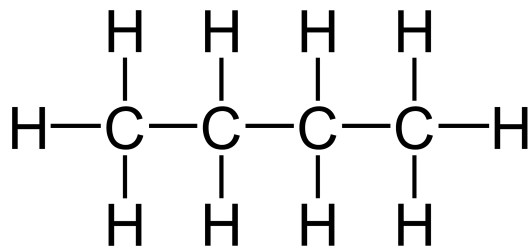


Give the molecular, displayed and skeletal formulae of butane

Molecular:



Displayed:



Skeletal:



What is an alkene? Include the general formula



What is an alkene? Include the general formula

An unsaturated hydrocarbon with the
general formula C_nH_{2n} .

Suffix: -ene.



Write the molecular and skeletal formulae of but-2-ene



Write the molecular and skeletal formulae of but-2-ene

Molecular: C_4H_8

Skeletal:



The number 2 in but-2-ene signifies that the double bond is between the 2nd and 3rd carbon.



What is a halogenoalkane?



What is a halogenoalkane?

An alkane where a hydrogen atom has been replaced by a halogen atom.

Prefix: fluoro-/ chloro-/ bromo-/ iodo-.

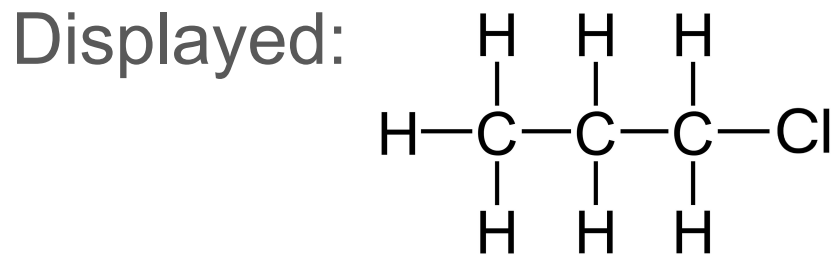


Write the molecular, displayed and skeletal formulae of 1-chloropropane.



Write the molecular, displayed and skeletal formulae of 1-chloropropane

Molecular: C_3H_7Cl



The '1' refers to the carbon the halogen atom is bonded to.



What is an alcohol? Include the general formula



What is an alcohol? Include the general formula

An organic compound with a lone hydroxyl group (-OH) attached to an alkyl group. The general formula is $C_n H_{2n+1} OH$.

Suffix: -ol.



Write the molecular and skeletal formulae of propan-2-ol



Write the molecular and skeletal formulae of propan-2-ol

Molecular: C_3H_8O



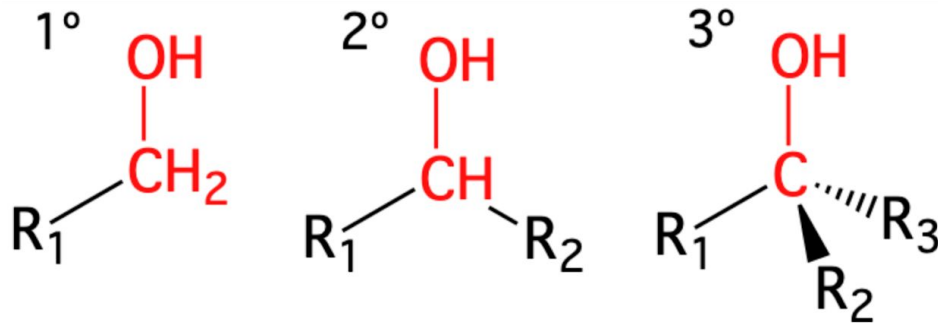
The '2' refers to the position of the hydroxyl group.



How are alcohols classified?



How are alcohols classified?



(R group - any alkyl chain)

- Primary, 1° - The carbon bonded to the hydroxyl group is bonded to one R group only.
- Secondary, 2° - The carbon bonded to the hydroxyl group is bonded to two R groups.
- Tertiary, 3° - The carbon bonded to the hydroxyl group is bonded to three R groups.



What is an aldehyde? Give the functional group

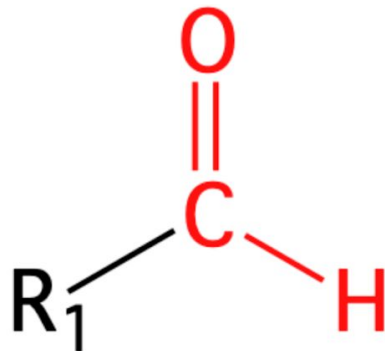


What is an aldehyde? Give the functional group

An organic compound with the -CHO functional group.

Suffix: -al.

E.g. Propanal.



What is a ketone? Give the functional group

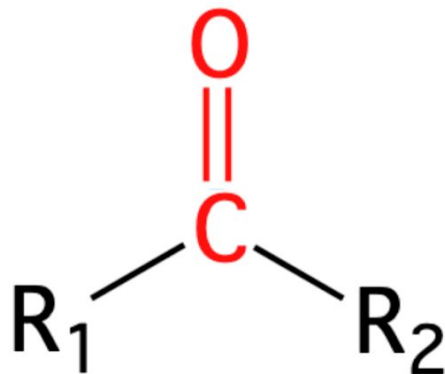


What is a ketone? Give the functional group

An organic compound with the RCOR' functional group.

Suffix: -one.

E.g. Propanone.



What is a carboxylic acid? Give the functional group

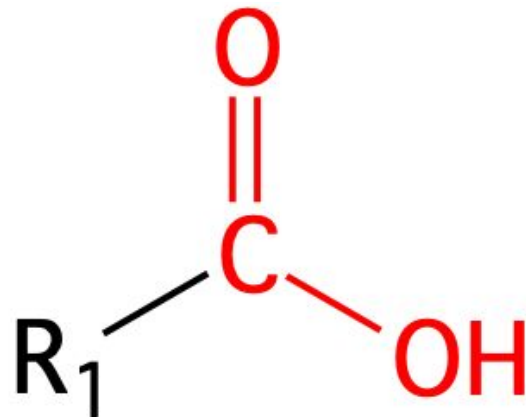


What is a carboxylic acid? Give the functional group

An organic compound with the -COOH functional group.

Suffix: -oic acid.

E.g. Ethanoic acid.



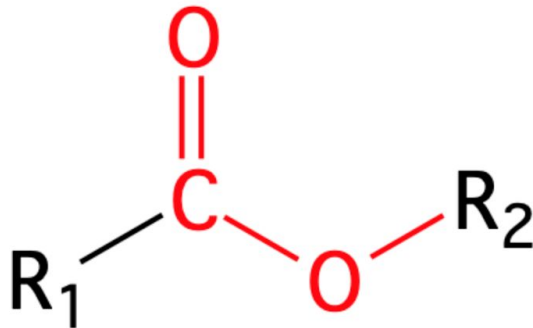
What is an ester? Give the functional group



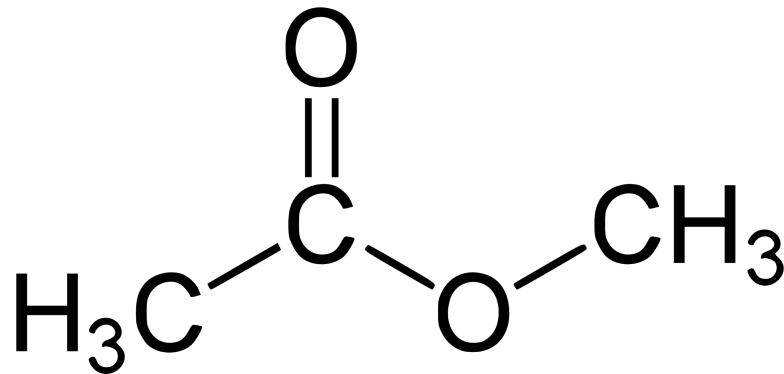
What is an ester? Give the functional group

An organic compound commonly formed from a condensation reaction between an alcohol and a carboxylic acid.

Functional group:

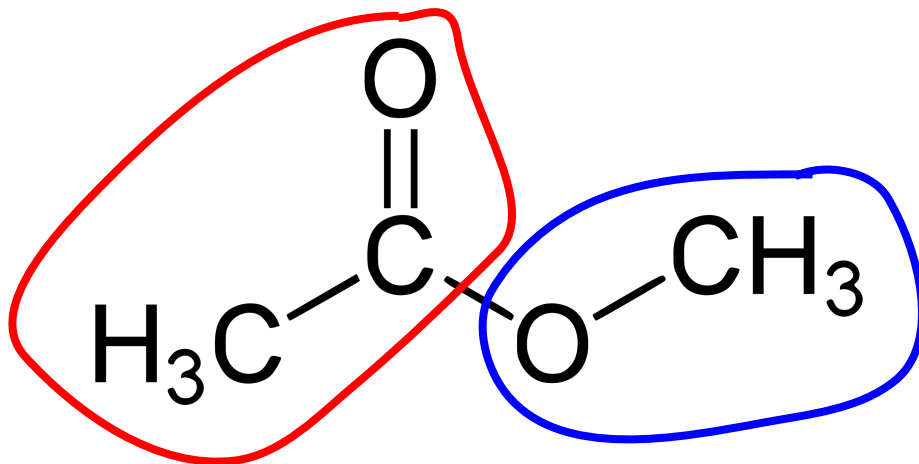


Name the ester shown below



Name the ester shown below

This part of the molecule is derived from the carboxylic acid, ethanoic acid.



This part of the molecule is derived from the alcohol, methanol.

Methyl ethanoate



What is a primary amine? Give the functional group

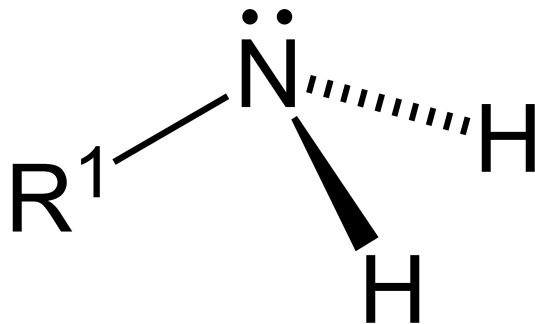


What is a primary amine? Give the functional group

An amine is a derivative of ammonia. In a primary amine, one hydrogen atom in ammonia is substituted with an alkyl group.

Suffix: -amine.

E.g. Propylamine.



What is a nitrile? Give the displayed formula of ethanenitrile

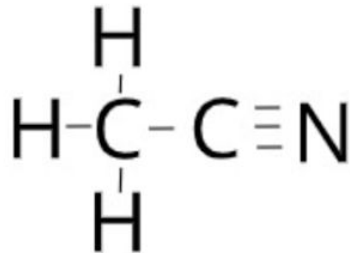


What is a nitrile? Give the displayed formula of ethanenitrile

A nitrile is an organic compound with a -CN functional group.

Suffix: -nitrile.

Ethanenitrile:



What is an aliphatic hydrocarbon?



What is an aliphatic hydrocarbon?

A compound containing only carbon and hydrogen atoms in which the carbon atoms are arranged in a linear or branched structure.



Describe how to name an organic compound

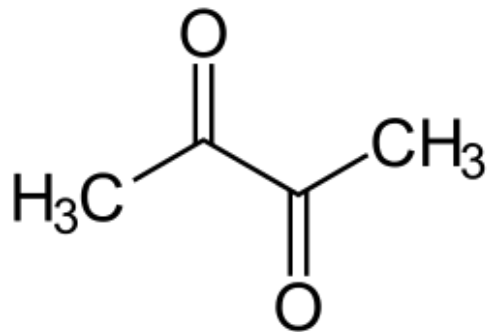


Describe how to name an organic compound

1. Identify the longest carbon chain that contains the functional group (this is the stem).
2. Identify the functional group (this gives the prefix/suffix).
3. Count the number of carbon atoms so that the functional group has the lowest number.
4. Add any side chains or less important functional as prefixes (in alphabetical order).
5. If there are two or more identical groups, use the prefixes di-/tri-/tetra- before that part of the name.



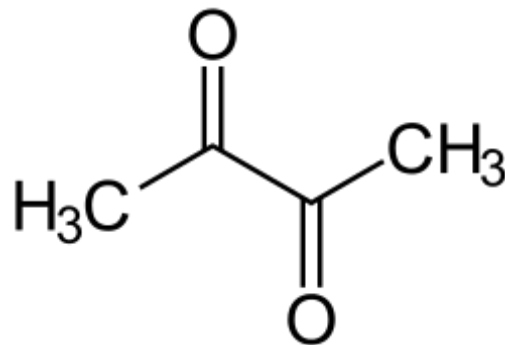
What is the molecular formula and empirical formula of the compound below?



What is the molecular formula and empirical formula of the compound below?

Molecular formula: $C_4H_6O_2$

Empirical formula: C_2H_3O

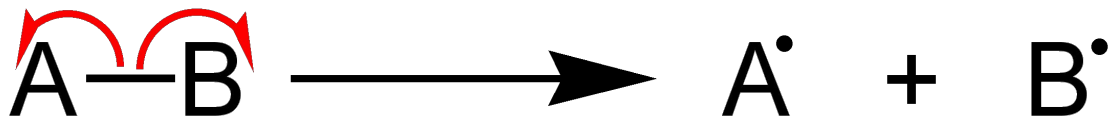


What is homolytic fission?



What is homolytic fission?

A covalent bond breaks. Each bonding atom receives one electron from the bonding pair, forming two radicals. Radicals are highly reactive, neutral species.

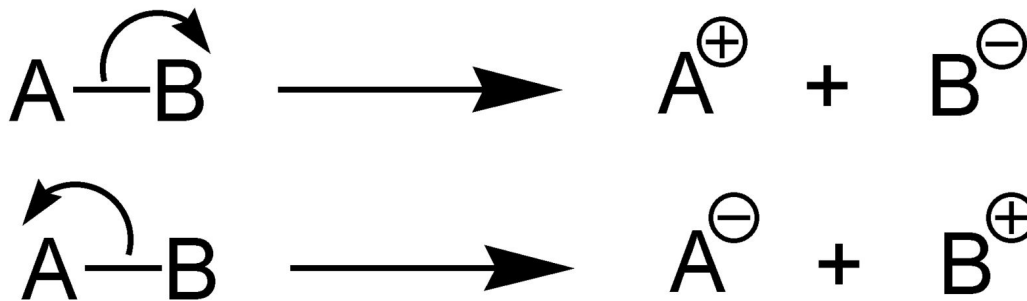


What is heterolytic fission?



What is heterolytic fission?

A covalent bond breaks. One bonding atom receives both electrons from the bonding pair.



[Jürgen Martens, CC BY-SA 3.0](#)



What is a free radical?



What is a free radical?

A highly reactive neutral species with an unpaired electron.



What are the three steps in a free radical substitution mechanism?



What are the three steps in a free radical substitution mechanism?

1. Initiation
2. Propagation
3. Termination



What is an electrophile?



What is an electrophile?

An electron pair acceptor



What is an nucleophile?



What is an nucleophile?

An electron pair donor



What is an addition reaction?



What is an addition reaction?

An addition reaction is a reaction where two reactants react to form one product.

The atom economy is 100%.



What is a substitution reaction?



What is a substitution reaction?

A substitution reaction is a reaction where an atom/group is replaced by another atom/group.

Atom economy is generally less than 100%.



What is an elimination reaction?



What is an elimination reaction?

An elimination reaction is a reaction where a small group of atoms are removed from a molecule and not replaced by anything else.

A dehydration reaction is an example of an elimination reaction since a molecule of water is removed.



What is a hydrolysis reaction?



What is a hydrolysis reaction?

The splitting of a compound/molecule using water.



What is a condensation reaction?



What is a condensation reaction?

The formation of a compound with the release of a small molecule, such as water.



What is oxidation?



What is oxidation?

Oxidation reactions involve the loss of electrons and lead to an increase in oxidation number.



What is reduction?



What is reduction?

Reduction reactions involve the gain of electrons and lead to a decrease in oxidation number.



In organic redox reactions, how can oxidising and reducing agents be represented?



In organic redox reactions, how can oxidising and reducing agents be represented?

Oxidising reagents: [O]

Reducing reagents: [H]



What is electron repulsion theory?



What is electron repulsion theory?

Electron pairs are areas of negative charge that repel each other.

Lone pairs of electrons are more repulsive than bonding pairs.



Describe the shape and bond angles of ethene



Describe the shape and bond angles of ethene

Bond shape: Trigonal Planar

Bond angle: 120°



Describe the shape and bond angles in ethane



Describe the shape and bond angles in ethane

Bond shape: Tetrahedral

Bond angle: 109.5°



Explain the bond shape and angle in an ethane molecule



Explain the bond shape and angle in an ethane molecule

- Both carbon atoms promote an electron from the 2s orbital to the 2p orbital to form four identical sp^3 hybrid orbitals.
- These sp^3 orbitals arrange themselves as far apart as possible from each other.
- Each carbon atom then forms sigma bonds with the three hydrogen atoms. A sigma bond also forms between the two carbon atoms when the sp^3 orbitals overlap end-to-end.
- There are 4 bonding pairs of electrons which causes a tetrahedral bond shape and a bond angle of 109.5° .



Explain the bond shape and angle in an ethene molecule



Explain the bond shape and angle in an ethene molecule

- Both carbon atoms promote an electron from the 2s orbital to the 2p orbital to form three identical sp^2 hybrid orbitals. The other 2p orbital is unchanged.
- The three sp^2 orbitals arrange themselves as far apart as possible from each other.
- 2 sp^2 orbitals forms a sigma bond with a hydrogen. A sigma bond forms between the carbon atoms when the sp^2 orbitals overlap end-to-end, followed by a pi bond when the p-orbitals overlap sideways.
- There are 3 areas of electron density, creating a trigonal planar shape and a bond angle of 120° .



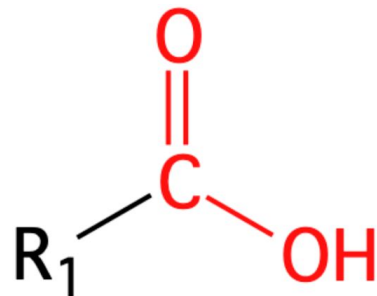
Predict the shape and bond angle
around carbon in RCOOH



Predict the shape and bond angle around carbon in RCOOH

There are three areas of electron density, similar to the structure of ethene.

- Bond shape: Trigonal planar
- Bond angle: 120°



What is structural isomerism?



What is structural isomerism?

Structural isomerism occurs between compounds which have the same molecular formula but a different structural formula.



What are the three divisions of structural isomerism?



What are the three divisions of structural isomerism?

1. Position isomerism
2. Chain isomerism
3. Functional group isomerism

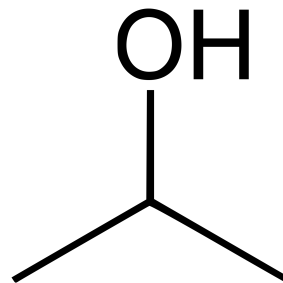
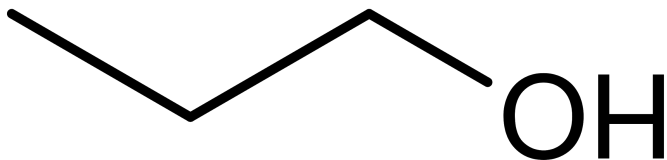


Why are propan-1-ol and propan-2-ol structural isomers?



Why are propan-1-ol and propan-2-ol structural isomers?

Propan-1-ol and propan-2-ol are position isomers since the position of the functional group has changed.

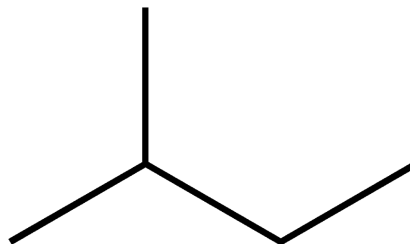
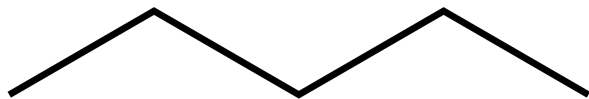


Why are pentane and 2-methylbutane structural isomers?



Why are pentane and 2-methylbutane structural isomers?

Pentane and 2-methylbutane are chain isomers since the branching changes the structural formula of a compound.

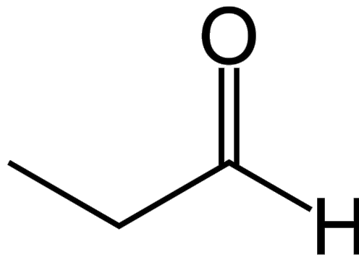
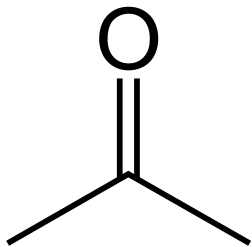


Why are propanal and propanone structural isomers?



Why are propanal and propanone structural isomers?

Propanal and propanone are functional group isomers since the functional group has changed.



What is stereoisomerism?



What is stereoisomerism?

Stereoisomerism occurs when compounds have the same molecular formula and structural formula but a different arrangement of atoms in space.



What causes geometrical (cis-trans) stereoisomerism?



What causes geometrical (cis-trans) stereoisomerism?

Geometrical isomerism is caused by the limited rotation around the carbon-carbon pi bond. This limited rotation means that any groups bonded to the carbon are fixed in position.



How do you determine whether an stereoisomer is cis or trans?



How do you determine whether a stereoisomer is cis or trans?

- In trans (or *E*) isomers, high priority groups are on opposite sides of the C=C bond (one above and one below).
- In cis (or *Z*) isomers, high priority groups are on the same side of the C=C bond (both above or both below).



How can you identify the highest priority group?



How can you identify the highest priority group?

- For molecules where only single atoms are attached to the carbons in the C=C, the highest priority group has the highest atomic mass.
- For non-complex small groups such as $-\text{CH}_3$, look at the atomic mass of the atom attached directly to the C=C. In $-\text{CH}_3$ this would be the carbon atom since we ignore the hydrogen atoms. The atom with the greatest atomic mass indicates the high priority group.
- For more complex groups (i.e. $\text{CH}_3\text{CH}_2\text{Cl}$), don't just observe the atomic mass of the carbon as it is directly attached to the C=C, look at what the carbon is directly attached to.

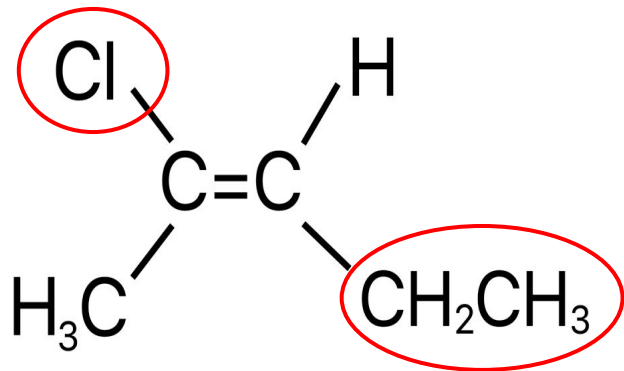


Draw the cis and trans isomers of
2-chloropent-2-ene



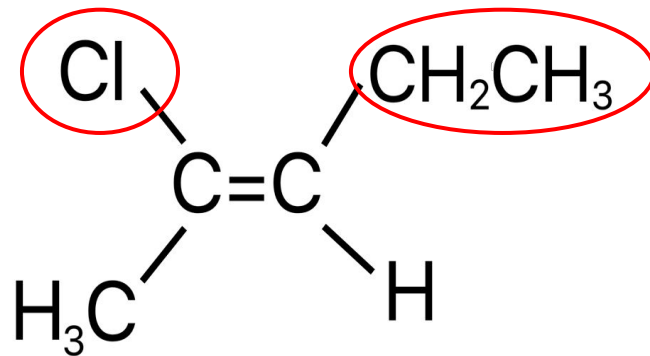
Draw the cis and trans isomers of 2-chloropent-2-ene

trans-2-chloropent-2-ene



The high priority groups are on opposite sides of the C=C bond.

cis-2-chloropent-2-ene



The high priority groups are on the same side of the C=C bond.

