

Name: _____

Date: _____

AQA A-LEVEL CHEMISTRY

Homologous Series: Identifying Organic Families

Learn Pack

Guided notes, worked examples and practice questions to be completed alongside the lesson.



Functional Groups

Functional groups are specific atoms or groups of atoms within a molecule that determine its characteristic reactions.

There are millions of different organic compounds and so chemists organise them into groups called homologous series, such as alkanes, alkenes and alcohols.

Lesson Objectives:

- Define functional groups and homologous series.
- Describe the characteristics shared by members of a homologous series.
- Identify the main homologous series found in Year 12 organic chemistry.

Homologous Series

A homologous series is:

a group or family of chemicals that all contain the same functional group

Each member of a homologous series will have certain key characteristics:

- Contain the same functional group
- Have similar chemical properties and therefore react in similar ways.
- Have the same general formula
- Differ in carbon chain length by CH_2
- Display a trend in physical properties, such as boiling points.

Exam Tip!

Exam questions often ask you to give two characteristics of a homologous series, however, sometimes they give you one and then ask you to state two others. Make sure you learn three characteristics of a homologous series.

Alkanes

Alkanes are a homologous series of organic molecules that only contain single bonds between carbon atoms.

Functional Group:	General Formula:
$C-C$	$C_n H_{2n+2}$
Prefix:	Suffix:
N/A	-ane
Displayed Formula	Name
<pre> H H H H - C - C - C - H H H H </pre>	propane

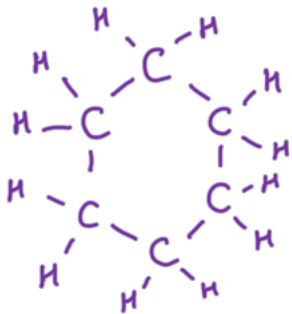
Alkenes

Alkenes are a homologous series of organic molecules that contain at least one carbon-carbon double bond.

Functional Group:	General Formula:
$C=C$	$C_n H_{2n}$
Prefix:	Suffix:
N/A	-ene
Displayed Formula	Name
<pre> H H H H C = C - C - C - H H H H </pre>	but-1-ene

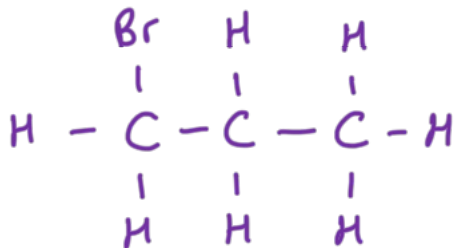
Cycloalkanes

Cycloalkanes are closely related to alkanes, however, instead of forming straight or branched chains, the carbon atoms are joined together to form a ring.

Functional Group:	General Formula:
$C-C$	$C_n H_{2n}$
Prefix:	Suffix:
cyclo-	-ane
Displayed Formula	Name
	cyclohexane

Halogenoalkanes

Halogenoalkanes are also closely related to alkanes; they are alkanes that have had one or more hydrogen atoms replaced with a halogen atom.

Functional Group:	General Formula:
$C-X$	$C_n H_{2n+1} X$
Prefix:	Suffix:
Fluoro- Chloro- Bromo- Iodo-	-ane
Displayed Formula	Name
	1-bromopropane

Alcohols

Alcohols are probably a familiar group of organic molecules that contain the hydroxyl functional group.

Functional Group:	General Formula:
-OH	$\text{C}_n\text{H}_{2n+1}\text{OH}$
Prefix:	Suffix:
hydroxy -	-ol
Displayed Formula	Name
$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{H} & \\ & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{O} - \text{H} \\ & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & \end{array} $	propan-1-ol

Aldehydes

Aldehydes are a homologous series of organic molecules that contain a carbon-oxygen double bond at the end of a carbon chain.

Functional Group:	General Formula:
-CHO	$\text{C}_n\text{H}_{2n}\text{O}$
Prefix:	Suffix:
N/A	-al
Displayed Formula	Name
$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & & \\ & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & \\ & & & & & // & \text{O} \\ & \text{H} & & \text{H} & & & \text{H} \end{array} $	propanal

Ketones

Like aldehydes, ketones contain a carbon-oxygen double bond. However, unlike aldehydes, this carbon-oxygen double bond is found within the carbon chain rather than at the end.

Functional Group:	General Formula:
$R-CO-R$	$C_nH_{2n}O$
Prefix:	Suffix:
N/A	-one
Displayed Formula	Name
$ \begin{array}{ccccc} & H & & O & & H \\ & & & & & \\ H & - C & - & C & - & C & - H \\ & & & & & \\ & H & & & & H \end{array} $	propanone

Carboxylic Acids

Carboxylic acids are weak acids that contain the carboxyl functional group, and you'll study more about the reactions of carboxylic acids in Year 13.

Functional Group:	General Formula:
$-COOH$	$C_nH_{2n+1}COOH$
Prefix:	Suffix:
N/A	-oic acid
Displayed Formula	Name
$ \begin{array}{ccccc} & H & & H & & \\ & & & & & \\ H & - C & - & C & - & C = O \\ & & & & & \diagdown \\ & H & & H & & O-H \end{array} $	propanoic acid

Nitriles

Although nitriles are not a homologous series you'll study in detail until Year 13, you are expected to be able to recognise and eventually name them.

Functional Group:	General Formula:
-CN	N/A
Prefix:	Suffix:
N/A	-nitrile
Displayed Formula	Name
$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H} - \text{C} - \text{C} - \text{C} \equiv \text{N} \\ \quad \\ \text{H} \quad \text{H} \end{array} $	propanenitrile

Amines

Amines contain what is called an amino group and can be formed from reactions involving halogenoalkanes.

Functional Group:	General Formula:
-NH_2	N/A
Prefix:	Suffix:
amino-	-amine
Displayed Formula	Name
$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H} - \text{C} - \text{C} - \text{C} - \text{N} \begin{array}{l} \diagup \text{H} \\ \diagdown \text{H} \end{array} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $	propan-1-amine

Practise Questions – Fact Recall

1. What is a functional group?

An atom or group of atoms that determines a molecule's reactivity.

2. What is a homologous series?

A group of chemicals that all contain the same functional group.

3. State three characteristics of a homologous series.

- Contain the same functional group
- Have the same general formula
- Carbon chain length differs by CH_2 for consecutive members

4. Which homologous series contains a $\text{C}=\text{C}$ bond?

Alkenes

5. Which homologous series contains a $-\text{COOH}$ group?

Carboxylic acids

6. Which homologous series contains a $-\text{CN}$ group?

Nitriles

7. What is the prefix for alcohols?

Hydroxy

8. What is the general formula for alkanes?

$\text{C}_n\text{H}_{2n+2}$

9. What is the suffix for ketones?

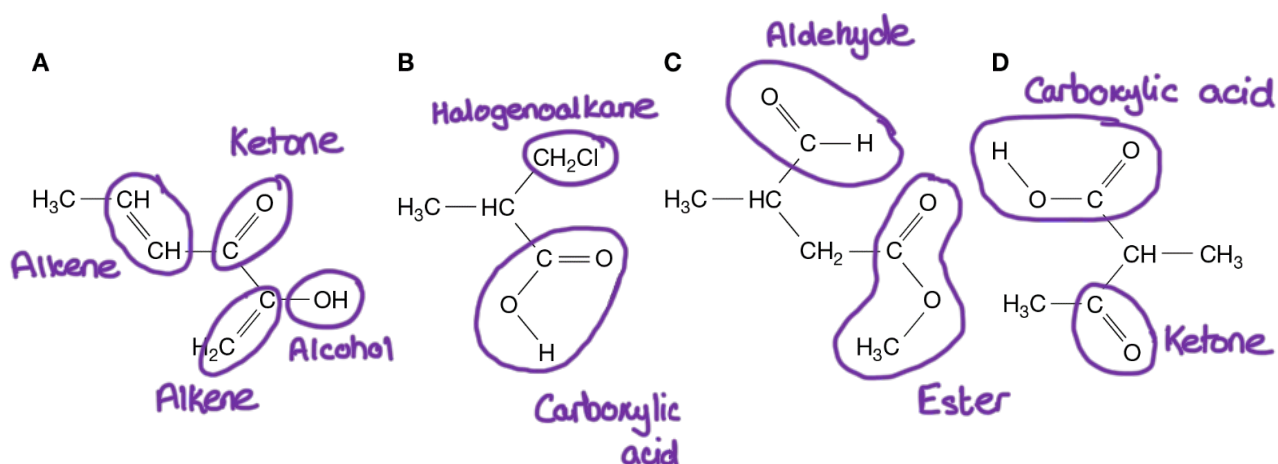
-one

10. What is the general formula for halogenoalkanes?

$\text{C}_n\text{H}_{2n+1}\text{X}$

Practise Questions – Application

1. Identify the functional groups in these molecules:



2. Identify the functional groups in these molecules:

