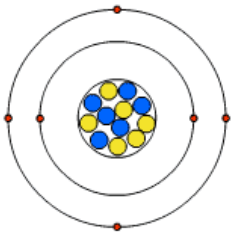
An Introduction to Organic Chemistry

Task 1 – Read the following information and answer the questions.

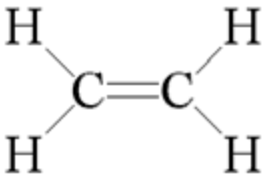
All organic compounds contain carbon atoms. There are a vast number of different organic compounds; more than 10 million organic compounds exist and around 300 hundred thousand organic compounds are discovered each year. Carbon can form so many compounds because:

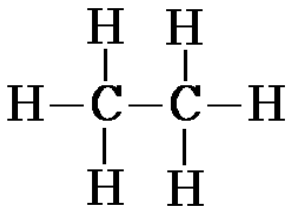
- It can form bonds with other carbon atoms to form chains and rings.
- Carbon can form a single, double or triple bond with another carbon atom.
- A carbon atom can bond with atoms of other elements such as oxygen, hydrogen, nitrogen, phosphorus, chlorine, fluorine, bromine and iodine.

Carbon is a group 4 of the periodic table and has 4 outer electrons. Therefore, it will form four covalent bonds with other atoms.

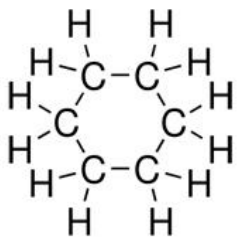


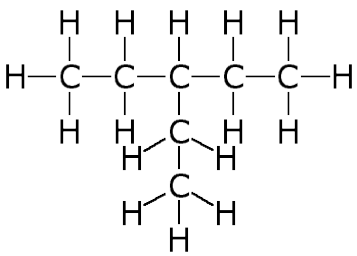
A hydrocarbon is an organic compound that contains carbon and hydrogen atoms only. Alkenes and alkanes are both hydrocarbons. A saturated hydrocarbon has only single bonds and therefore contains as much hydrogen as possible. An alkane is a saturated hydrocarbon. An unsaturated hydrocarbon contains carbon – carbon multiple bonds, therefore it will contain less hydrogen compared to its saturated sister molecule. An alkene is an unsaturated hydrocarbon.





Aliphatic hydrocarbons contain carbons atoms that are joined in straight (unbranched or branched) chains. Whereas alicyclic hydrocarbons contain carbon atoms joined in a ring structure.





Other organic compounds contain functional groups e.g. O-H in alcohols, COOH in carboxylic acids. The functional group will be attached to a carbon atom somewhere on the organic molecule. The functional group will determine the chemical properties of the molecule. Molecules with the same functional group will react in similar ways.

A homologous series is a family of organic compounds that contain the same functional group and have similar chemical properties but each successive member of the series differs by one carbon atom and two hydrogen atoms e.g. CH_4, C_2H_6, C_3H_8 or C_2H_5OH, C_3H_7OH, C_4H_9OH.

1. Why is carbon able to form so many compounds?

2. Where will you find carbon in the periodic table and how does this affect the way it will bond?

3. What is the difference between a saturated and unsaturated hydrocarbon?

4. What is the difference between an aliphatic and alicyclic hydrocarbon?

5. Name an example of a functional group.

6. What does the functional group determine?

7. What is a homologous series?

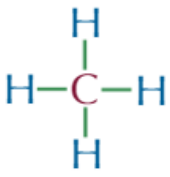
8. Name an example of a homologous series.

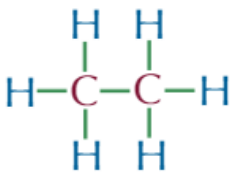
Task 2 – Summarise the information into a format of your choice, for example poster, flash cards, mind map…

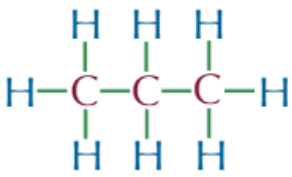
There are many organic molecules you will study as part of your A level course, you may have come across some of them before. Read the following information about seven of these homologous series and answer the questions. Do not worry about the names of the molecules, we will learn how to do this in the first few lessons. Over Summer your aim is to remember the names of the functional groups and recognise them.

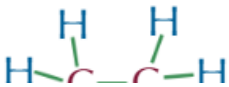
Alkanes

Alkanes have the general formula C_nH_{2n+2}. They've only got carbon and hydrogen atoms, so they're **hydrocarbons**. Every carbon atom in an alkane has four single bonds with other atoms. It's impossible for carbon to make more than four bonds, so alkanes are **saturated**.
Here are a few examples of alkanes —


methane


ethane


propane

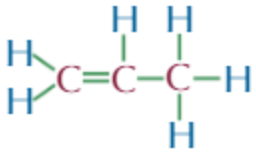


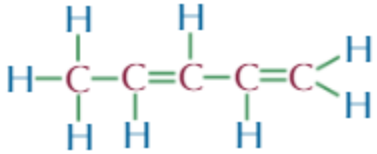
Alkenes

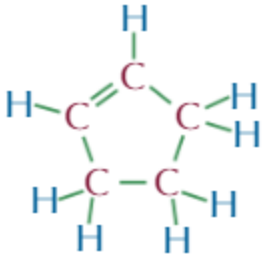
Alkenes have the general formula C_nH_{2n}. They're just made of carbon and hydrogen atoms, so they're hydrocarbons. Alkene molecules all have at least one C=C double covalent bond. Molecules with C=C double bonds are **unsaturated** because they can make more bonds with extra atoms in addition reactions.

Examples

Here are a few pretty diagrams of alkenes:


propene


penta-1,3-diene

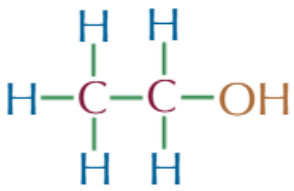

cyclopentene

A cyclic alkene has two fewer hydrogen atoms than an open-chain alkene. Carbons can only have four bonds — a double bond means that the carbons can make one less bond with a hydrogen.

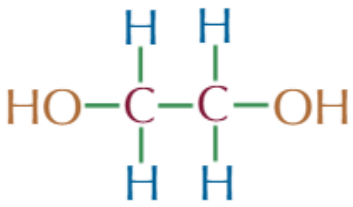
Alcohols

The **alcohol** homologous series has the general formula $C_nH_{2n+1}OH$. Alcohols are named using the same IUPAC naming rules as alkanes (see pages 211-213), but the suffix -ol is added in place of the -e on the end of the name.
You also need to indicate which carbon atom the alcohol functional group is attached to — the carbon number(s) comes before the -ol suffix.
If there are two -OH (hydroxyl) groups the molecule is a -diol, and if there are three it's a -triol.

Examples



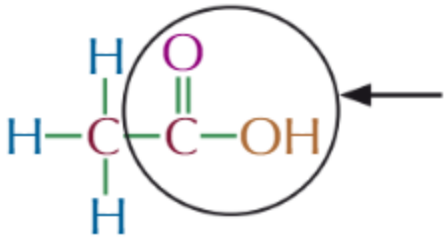
ethanol



ethane-1,2-diol

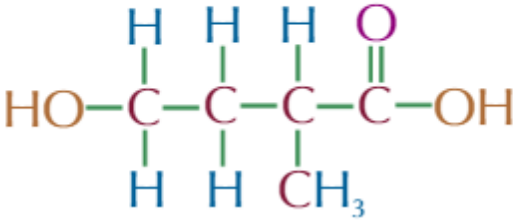
Carboxylic Acids

Carboxylic acids contain the carboxyl functional group –COOH.



To name them, you find and name the longest alkane chain, take off the 'e' and add '–oic acid'. The carboxyl group is always at the end of the molecule and when naming it's more important than other functional groups — so all the other functional groups in the molecule are numbered starting from this carbon.

Example

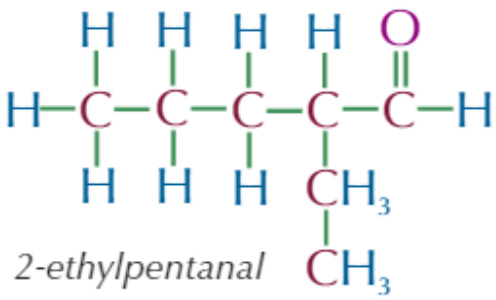


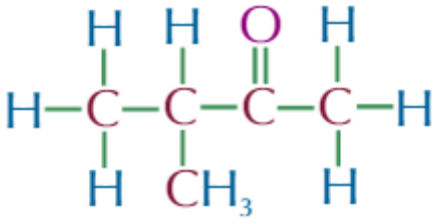
Aldehydes and Ketones

Aldehydes and **ketones** are both **carbonyl compounds** as they both contain the carbonyl functional group, C=O. The difference is, they've got their carbonyl groups in different positions. Aldehydes have their carbonyl group at the end of the carbon chain. Ketones have their carbonyl group in the middle of the carbon chain, see Figure 1.

Figure 1: *The difference between an aldehyde and a ketone. 'R' represents a carbon chain of any length.*

Example





Esters

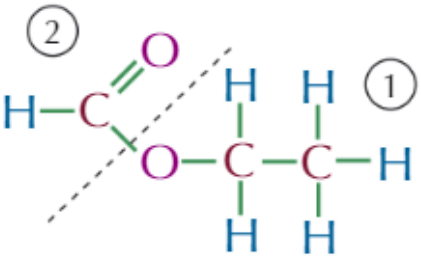
An **ester** is formed by reacting an alcohol with a carboxylic acid or a carboxylic acid derivative (see next page). So the name of an ester is made up of two parts — the first bit comes from the alcohol, and the second bit from the carboxylic acid (or its derivative).

To name an ester, just follow these steps:

1. Look at the alkyl group that came from the alcohol. This is the first bit of the ester's name.
2. Now look at the part that came from the carboxylic acid. Swap its '-oic acid' ending for 'oate' to get the second bit of the name.
3. Put the two parts together.

Example

Methanoic acid reacts with ethanol to produce the ester shown below:



1. This part of the ester came from the alcohol. It's an ethyl group, so the first part of the ester's name is ethyl-.
2. This part of the ester came from the carboxylic acid. It was methanoic acid, so the second part of the ester's name is -methanoate.
3. So this ester is ethyl methanoate.

Further Reading:

https://www.bbc.co.uk/bitesize/guides/z3v4xfr/revision/1

https://www.chemguide.co.uk/orgpropsmenu.html

Blooket Revision:

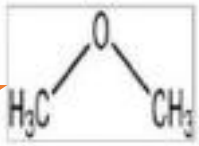
https://play.blooket.com/play?hwId=649d787493c4acca409c98fd

When you join the game, use your name only. If you want to rejoin the game, just add a number to the end of your name.

Task 3. Identify the functional groups in the following molecules.

The molecules with a star have not been included in this document, can you find out what they are?

A



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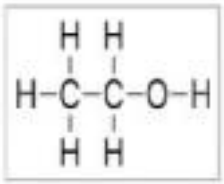
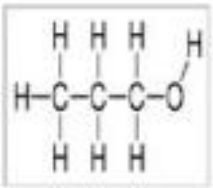


C



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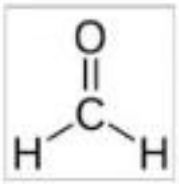

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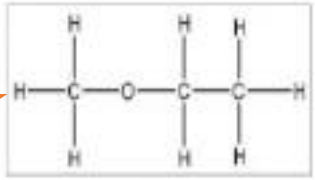

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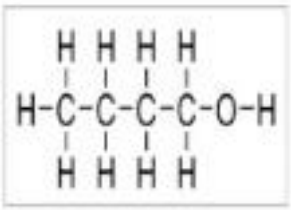
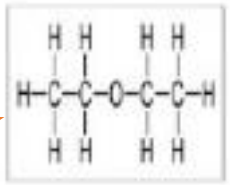
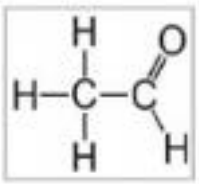


G



H



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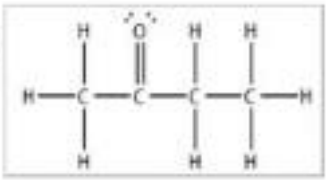

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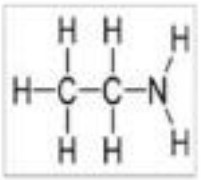

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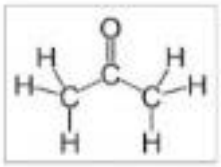

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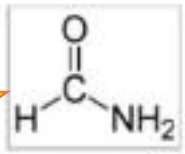

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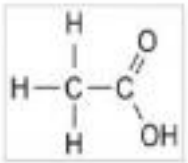

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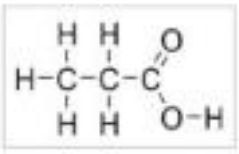

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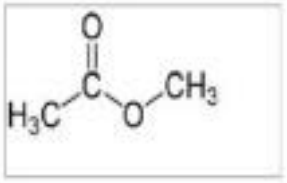

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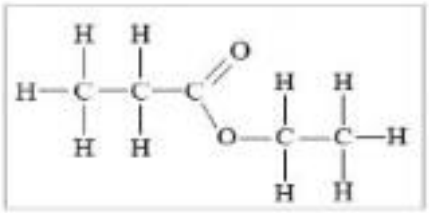

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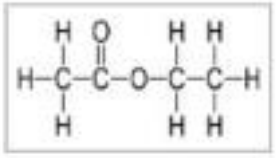

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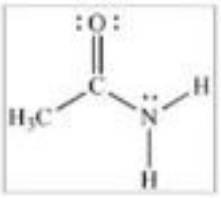

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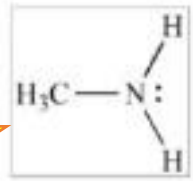

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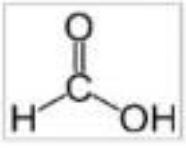

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