WJEC Chemistry A-Level

C3.1: Organic Compounds

Detailed Notes

English Specification

Nomenclature

Different organic compounds have **specific naming rules** that identify them to a certain group of compounds.

1. **Alkanes**
   These carbon compounds all have the suffix **-ane**.
   Eg. Methane or Pentane.

2. **Alkenes**
   These carbon compounds all have the suffix **-ene**.
   Eg. Ethene.

3. **Halogenoalkanes**
   These have a prefix of **the halogen** in the compound and a suffix of **-ane**, indicating an alkane.
   Eg. Chloroethane.

4. **Alcohols**
   These compounds have the suffix **-ol**.
   Eg. Methanol.

5. **Carboxylic Acids**
   These compounds have the suffix **-oic acid**.
   Eg. Ethanoic Acid.

Naming organic compounds

Naming organic compounds is something that you must be comfortable with in order to understand the rest of organic chemistry. You are required to be able to name organic compounds which have up to **6 carbons in a chain**.

Carbons in chain	**1**	**2**	**3**	**4**	**5**	**6**
Prefix	meth-	eth-	prop-	but-	pent-	hex-

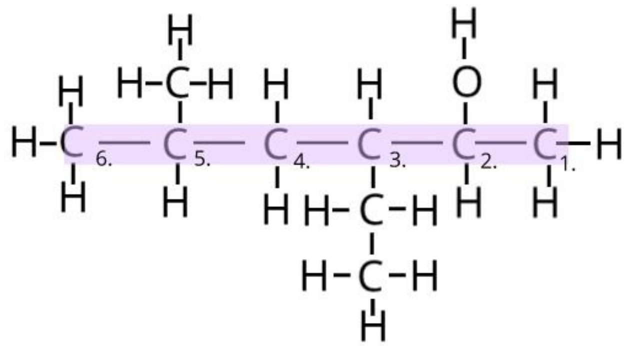
Follow these rules when naming organic compounds:

1. Identify the **longest carbon chain** that contains the functional group.
2. Identify the **functional group** on the chain. This gives you the suffix or prefix.
3. Count along the carbon chain so that the **functional group has the lowest number**. See the example below to illustrate this.
4. If there are any **side chains**, add these as **prefixes** (e.g. methyl-) to the beginning of the name. Do the same if there are other (less important) functional groups. Put these at the start of the name in **alphabetical order**.

5. If there are **two or more identical functional groups** or side chains use the prefixes di-, tri- and tetra- before that section of the name.

Example:

1. The longest carbon chain is **6 carbons long** so the prefix is hex-.
2. The most important functional group on the chain is the **-OH** alcohol. The suffix is therefore -ol.
3. The alcohol is on **the second carbon** in the chain (count from the side closest to this functional group). The suffix becomes **-2-ol.**
4. There are **two side chains**:
   An ethyl on the third carbon: 3-ethyl
   A methyl on the fifth carbon: 5-methyl
5. Place the prefixes in alphabetical order and add them to the name:
   3-ethyl-5-methylhexan-2-ol.



Types of Formula

There are different ways of **writing** and **representing** organic compounds:

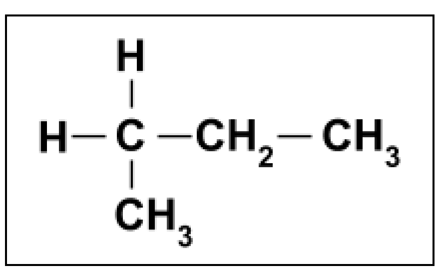
1. **Empirical Formula**
   - The **simplest whole number ratio** of atoms of each element in a compound.

2. **Molecular Formula**
   - The **true number** of atoms of each element in a compound.

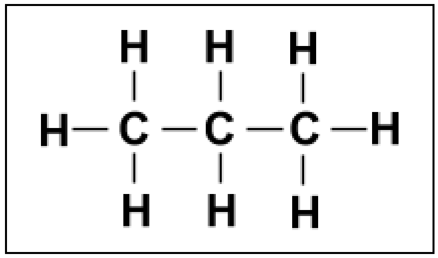
3. **General Formula**
   - All members of a **homologous organic series** follow the general formula.
   Example:

$$\text{Alkanes} = C_nH_{2n+2}$$

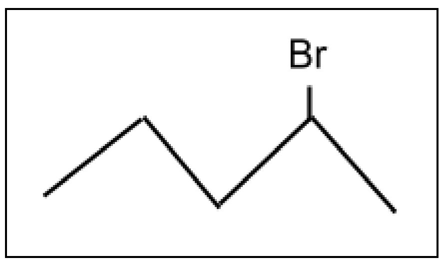
4. **Structural Formula**
   - Shows the **structural arrangement** of atoms within a molecule.
   Example:



5. **Displayed Formula**
   - Shows **every atom** and **every bond** in an organic compound.
   Example:



6. **Skeletal Formula**
   - Shows **only the bonds** in a compound and any **functional groups**.
   - **Vertices** are carbon atoms.
   - **Hydrogen** is assumed to be bonded to them unless stated otherwise.
   Example:



Homologous Series

Organic compounds are often part of a **homologous series**, in which all members follow a **general formula** and **react in a very similar way**. Each consecutive member differs by **CH_2** and there is an increase in **boiling points** as chain length increases.

Depending on the homologous series of the compound, organic compounds will have different **boiling temperatures** and **solubility**. A polar molecule will have **permanent dipole interactions** which will **increase** boiling temperature. Compounds like **alcohols** have **hydrogen bonding**, due to the -OH group, which gives alcohols relatively high boiling temperatures. The stronger the permanent dipole attractions and more hydrogen bonding there is, the **more soluble** an organic compound will be in water, as attractions will form with **polar water molecules**.

Isomerism

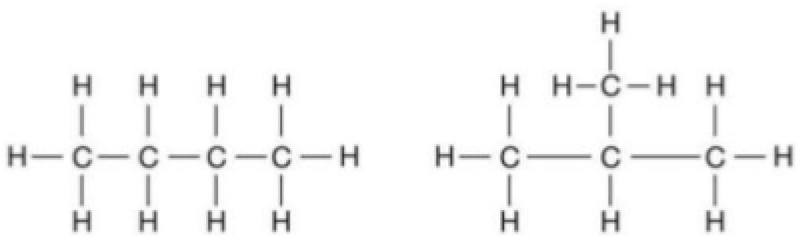
Isomers are molecules with the same **molecular formula** but a different **arrangement of atoms** within the molecule.

Structural Isomers

Structural isomers have the same molecular formula but different structural formulas. This means they have a different **structural arrangement** of atoms. They can be **straight chains** or **branched chains** but will always have the same molecular formula.

Example:

Molecular formula = C_4H_{10}



Butane   2 - methylpropane

Types of Species

Nucleophiles

These species are **'positive liking'**. They contain a **lone electron pair** that is attracted to **∂+ regions** of polar molecules. Some of the most common nucleophiles are:

- Cyanide ion, $^-$:CN
- Ammonia molecule, $:NH_3$
- Hydroxide ion, $^-$**:**OH

These nucleophiles are involved in **nucleophilic substitution** reactions with halogenoalkanes to form **nitriles**, **amines** and **alcohols**.Their lone electron pair should be shown.

Electrophiles

These are **electron acceptors** ('negative liking') and are attracted to areas of **high electron density**. Some of the most common electrophiles are:

- $H^{\partial+}$ (e.g. from HBr or H_2SO_4)
- $Br^{\partial+}$ (e.g. from Br_2)

They can be used to form **alcohols** or **halogenoalkanes** from alkenes, by undergoing **electrophilic addition** reactions.

Free Radicals

Alkanes react with halogens in the presence of **UV light** to produce halogenoalkanes. The UV light breaks down the halogen bonds, producing **reactive intermediates** called **free radicals**. These attack alkanes, resulting in a series of reactions; **initiation, propagation** and **termination**. This is covered in further depth in the 'Hydrocarbons' topic.
Free radicals are represented using a **dot** next to the chemical symbol:

Cl•

Fission

In chemistry, fission refers to the **splitting of a covalent bond**. There are two types of fission which you need to be aware of:

- **Homolytic fission** - the splitting of a covalent bond where each atom retains one electron from the bonding pair.
- **Heterolytic fission** - the splitting of a covalent bond where one atom retains both electrons from the bonding pair.

Homolytic fission produces **free radicals**, whereas heterolytic fission produces oppositely charged **ions**.