# FACTFILE:
# GCE CHEMISTRY
## 2.2 NOMENCLATURE AND ISOMERISM

Rewarding Learning

## Nomenclature and isomerism in organic compounds

**Students should be able to:**

**2.2.1** define and demonstrate understanding of the terms structural and geometric isomerism, homologous series and functional group;

**2.2.2** apply IUPAC rules for nomenclature to name organic compounds with up to six carbon atoms and one or more functional groups;

**2.2.3** draw and name structural isomers of aliphatic compounds containing up to six carbon atoms, excluding cyclic structures;

**2.2.4** draw structural and skeletal formulae for organic compounds;

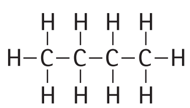
**2.2.5** demonstrate understanding that geometrical isomers result from restricted rotation due to an energy barrier about the carbon-carbon double bond and exist in E and Z forms;

**2.2.6** draw and identify the structural formulae of E and Z isomers.

### Representing organic compounds

Organic chemistry is the study of carbon-based compounds. Atoms of carbon can form strong covalent bonds with other atoms of carbon, giving rise to chains and rings of carbon atoms known as the carbon skeleton. Carbon can form single, double and triple covalent bonds with itself. Hydrogen is usually also bonded to carbon atoms in this skeleton, and the resulting compound is known as a ***hydrocarbon***, meaning it contains carbon and hydrogen only. Other atoms, such as oxygen, nitrogen and sulphur can be attached via covalent bonds to the carbon skeleton (replacing hydrogen atoms). The resulting compounds are usually more reactive than the basic hydrocarbon. Such groups are known as ***functional groups*** and these groups determine the chemical reactions of the molecule. In other words, the chemistry of an organic compound is determined by its functional group and a functional group's the reactive group within a compound. Organic molecules containing the same functional group are members of the same ***homologous series***. A homologus series contains compounds which have the same general formula similar chemical properties show a gradation in physical properties and successive members differ by a $CH_2$ unit.

Organic molecules can be represented by a structural formula or a skeletal formula which represents the basic carbon skeleton of a molecule. For example, butane has 4 carbons and 10 hydrogen atoms. This can be represented in a number of ways:

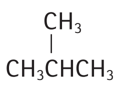
| Structural Formula: | Skeletal formula: |
|---|---|
|  |  |
| $CH_3CH_2CH_2CH_3$ | |

## Naming organic molecules

Organic molecules are named according to rules devised by the International Union of Pure and Applied Chemistry (IUPAC). Each homologous series has specific rules, however in general:

- The longest continuous carbon chain is identified and numbered. The first part of the main name indicates the number of carbon atoms in the longest chain: meth (1), eth (2), prop (3), but (4), pent (5), hex (6)
- Specific functional groups attached to the longest carbon chain are identified and give the main name of the compound
- Atoms (other than hydrogen) or groups attached to the carbon backbone are numbered based on the carbon atom(s) they are attached to. The carbon backbone is numbered in such a way that substituent groups are given the lowest number possible.
- Substituent groups are included at the start of the name.
- Hyphens are used in a name to link a number and letter.
- Commas are used in a name between numbers.

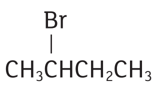
For example:



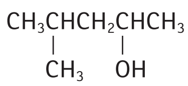
2-methylpropane

$CH_3CH{=}CHCH_2CH_3$

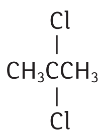
pent-2-ene



2-bromobutane



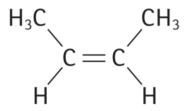
4-methylpentan-2-ol



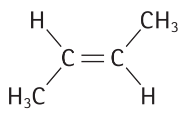
2,2-dichloropropane

**Structural isomers** are molecules which have the same molecular formula but a different structural formula. For example, the hydrocarbon $C_4H_{10}$ can exist as butane or 2-methylpropane.

In addition to structural isomerism, alkenes can also exhibit **geometric isomerism**. This is due to the fact that there is restricted rotation around the carbon-carbon double bond and can lead to different three-dimensional arrangements, geometic isomers are molecules with the same structural formula but different arrangement of atoms due to the presence of one or more c = c bond. Geometric isomerism only arises if there are two different atoms or groups on each of the carbons in the double bond. For example, alkene but-2-ene can exist as two gometric isomers.



*Z*-but-2-ene



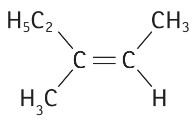
*E*-but-2-ene

Z is used when higher priority groups/atoms are on the same side of C=C bond and the term E is used when higher priority groups/atoms are on the opposite side of C=C bond. Priority is determined by the following convention.

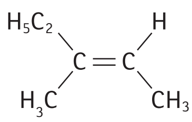
For example:

$C_2H_5 > CH_3 > H$ and $I > Br > Cl > F > C > H$
(in order of atomic number)

The alkene 3-methylpent-2-ene exhibits geometric isomerism, with E and Z isomers identified using priority rules:



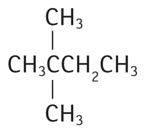
Z-3-methylpent-2-ene



E-3-methylpent-2-ene

# Revision Questions

**1** Which one of the following is the IUPAC name for the hydrocarbon shown below?




A. 2,2-dimethylbutane

B. 2,3-dimethylbutane

C. 1,4-dimethylhexane

D. 2,3-dimethylhexane

[1]

**2** 3-methylpent-2-ene, $CH_3CH{=}C(CH_3)CH_2CH_3$, exists as geometic stereoisomers.

(i) Explain the meaning of the term **geometic isomers.**

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(ii) Give **two** reasons why 3-methylpent-2-ene exists as geometic isomers.

**1.** ......................................................................................................................................

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**2.** ......................................................................................................................................

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(iii) Draw the E isomer of 3-methylpent-2-ene.

[1]

## Revision Questions

(iv) Draw and name a structural isomer of 3-methylpent-2-ene which cannot form geometric isomers.

[2]

**3** How many structural isomers have the formula $C_5H_{12}$?

A. Two

B. Three

C. Four

D. Five

[1]