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WORKSHEET 12

School: Ba Sangam College

Year: 13

Subject: Chemistry

Name:

Strand	4 - Materials
Sub strand	4.2- Organic Chemistry
Content Learning Outcome	-Define isomerism and describe the different types of isomerism. -Differentiate between the different types of isomerism.

Isomerism in Organic Compounds

Isomerism occurs where two or more compounds have the same molecular formula but different structural formulas.

Types of Isomers

1. Structural (also known as constitutional isomers)

-Structural isomerism occurs when the compounds have the same number and types of atoms but are arranged in different ways.

-The number of possible isomers increases rapidly as the length of the chain increases.

The different types of structural isomers are as follows:

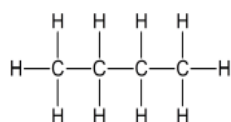
a. Chain isomers

-Chain isomers are molecules with the same molecular formula, but different arrangements of the carbon 'skeleton'.

-chain isomers arise because of the possibility of branching in carbon chains.

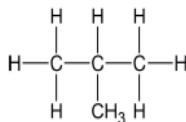
Example

The molecular formula C_4H_{10} represents two possible chain isomers:



Butane

and



2-methylpropane

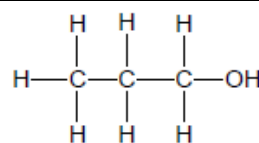
b. Position isomers

-Position isomers are based on the movement of a 'functional group' in the molecule.

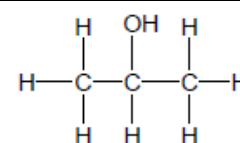
-The basic carbon skeleton remains unchanged, but important groups are moved around on that skeleton.

Example

The molecular formula C_3H_8O represents two possible position isomers:



Propan-1-ol



Propan-2-ol

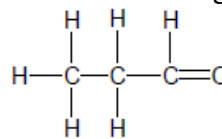
c. Functional group isomers

-Functional group isomers are isomers that contain different functional groups.

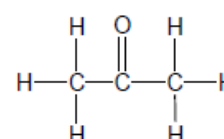
-This is where the molecular formula remains the same, but the type of functional group in the compounds is changed.

Example

The molecular formula C_3H_6O can represent two possible functional group isomers:



Propanal



Propan-2-one

Physical and Chemical Properties of the Structural Isomers

Chemical properties	Physical Properties
They have similar chemical properties.	Since the atoms have different arrangement in space, the isomers have different physical properties.
Example 2-methylpropane and butane are chain isomers of C_4H_{10} . 2-methylpropane has a lower boiling point than butane because the intermolecular forces between its molecules are weaker than those between the butane molecules. More energy is needed to break the intermolecular forces in butane, so butane boils at a higher temperature. The reason for the difference in intermolecular force strength is that butane molecules can align themselves more closely than the 2-methylpropane molecules - which have a branch that sticks out and prevents close packing of the molecules.	
$\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ & & \\ \text{H} & \text{CH}_3 & \text{H} \end{array}$	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
2-methylpropane	Butane

2. Stereoisomerism

-Stereoisomerism- the differences among isomers that arise as a result of the various possible orientation of their atoms in space.

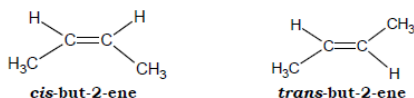
Types Of Stereoisomers

a. Geometrical isomers (diastereomers)

-Involves a double bond, usually C=C, that does not allow free rotation about the double bond.

Example

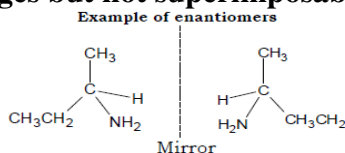
Cis-but-2-ene and *trans*-but-2-ene are two examples of geometric isomers.



b. Optical isomers (enantiomers)

-Involves an atom, usually carbon, bonded to four different atoms or groups of atoms. They exist in pairs, in which one isomer is the mirror image of the other.

-Enantiomers are two structures that are mirror images but not superimposable.



Note

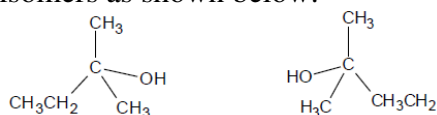
-Superimposable- is the ability of two objects/molecules to be able to fit on top of the other with no mismatch of parts.

-A **chiral carbon** is one which has four different groups attached to it.

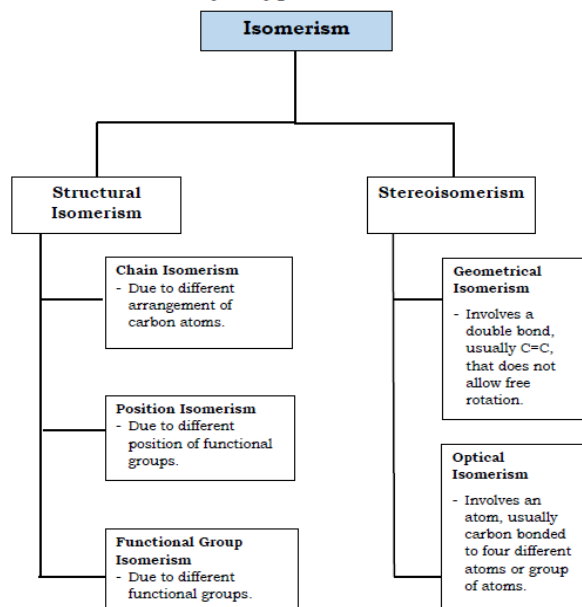
-A mixture of enantiomers in equal proportion is optically inactive, and is called a **racemic mixture**.

Example

The compound 2-methylbutan-2-ol has optical isomers as shown below.



Summary - Types of isomerism



Exercise

1. Draw the chain structural isomers of the following organic compounds.

a. C_6H_{14} b. C_5H_{12} c. C_4H_{10} d. $\text{C}_4\text{H}_9\text{Cl}$

2. How many chain isomer(s) does but-1-ene have?

3. Three unsaturated isomers of the organic compound C_4H_8 are but-1-ene, but-2-ene and 2-methylpropene.

a. Draw the structural formula of the three isomers given above.

b. From the above isomers, identify an isomer that has geometric isomers. Draw and name all the geometric isomers which exist for that isomer.

4. A compound having the molecular formula $\text{C}_4\text{H}_{10}\text{O}$ can show

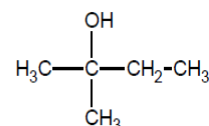
A. Functional isomerism

B. Positional isomerism

C. Both A and B

D. Only A

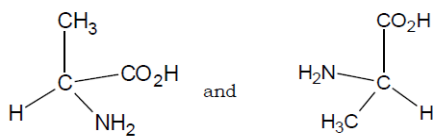
5. State if the following compound is optically active or not? Give a reason for your answer.



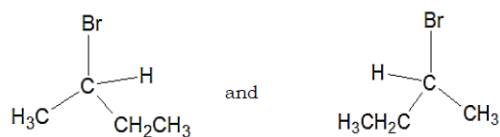
6. Explain why cis and trans isomers of 1,2-dichloroethane do not exist.

7. Which of the following terms: **Enantiomers**, **Diastereomers** or **Same compound**, best describe the pair of compounds shown below:

a.



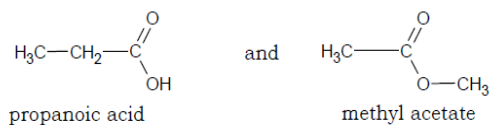
b.



8. Stereoisomers that are not mirror image isomers are known as _____.

9. Explain the difference between a position isomer and a functional group isomer. Give examples to support your answer.

10. Two structural isomers of the organic compound with the molecular formula $C_3H_6O_2$ are shown below.



State what type of structural isomers are the two above.

11. Draw a position isomer of the organic compound shown below.

