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3. Types of Isomerism in Organic Compounds

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ABSTRACT

Isomers are compounds that have the same qualitative and quantitative element composition, so their relative molecular weights and general formulas are identical, but their structures - including their 3D arrangement - differ. Propyl chloride and propane are not isomers because their qualitative element compositions differ.

Although they are made up of the same elements, propane and propene are not isomers because their quantitative compositions differ. Propene and cyclohexane are not isomers because, despite being composed of the same elements in the same ratio, their relative molecular weights differ.

KEYWORDS:

Compounds, Organic Compounds, Isomerism, Structural Isomerism, Chain Isomerism, Position Isomerism, Functional Isomerism, Metamerism, Tautomerism, Ring-Chain Isomerism, Stereo Isomerism, Geometric Isomerism, Optical Isomerism, Ionization Isomerism.

Introduction:

Isomers are chemical compounds that have identical chemical formulae but differ in properties and atom arrangement in the molecule. As a result, compounds that exhibit isomerism are referred to as isomers.

The term "isomer" comes from the Greek words "isos" and "meros," both of which mean "equal parts." In the year 1830, the Swedish chemist Jacob Berzelius coined this term.

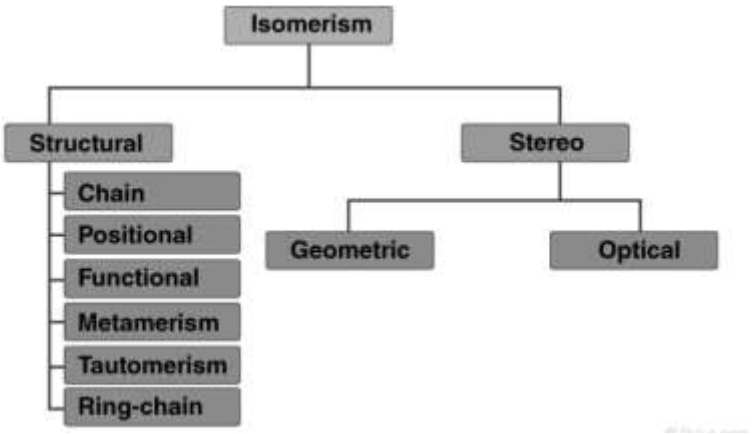
Isomers are compounds that have the same qualitative and quantitative element composition; thus, their relative molecular weights and general compositions are identical; however, their structures, such as the sequence of attachment and or agreement of the atoms or groups in space, differ.

This structural variation, *i.e.*, different fundamental formulas or three-dimensional atom structure, can result in molecules with distinct chemical and physical characteristics, and thus these compounds behave as different compounds with the same molecular formula.

It is a phenomenon in which two or more compounds have the same chemical formula but differ in their structural formulas and properties. This is primarily due to differences in structural or spatial arrangements. The compounds that exhibit this phenomenon are isomers.

Isomerism Types:

Isomerism is classified into two main types, each of which has several subtypes. **Structural isomerism** and **stereoisomerism** are the two most common types. The following diagram depicts the classification of different types of isomers.

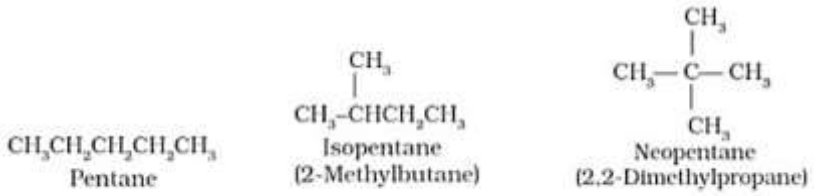


Structural Isomerism:

When two isomers have the same molecular formula but different structures, they are structural isomers. The following types of structural isomerism exist. Let's go over each of these types one by one.

1. Chain Isomerism:

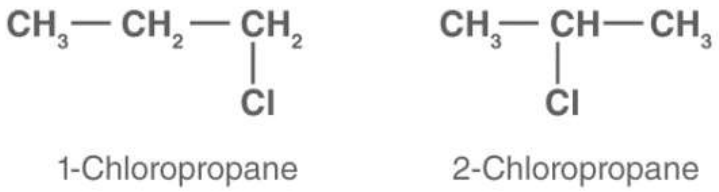
Chain isomers occur when two or more compounds have the same molecular formula but differ in the carbon atom branching. For example, C_5H_{12} can be represented by three compounds: Pentane with the formula $CH_3CH_2CH_2CH_2CH_3$.



2. Position Isomerism:

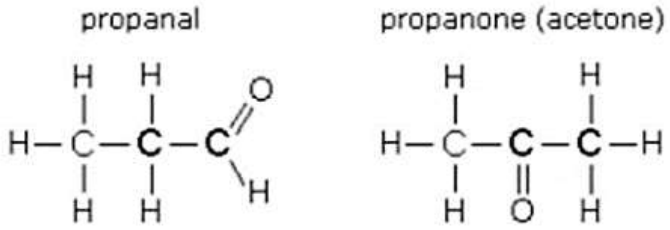
Isomers are position isomers when the position of the functional group or substituent atoms differs between two or more compounds. C_3H_7OH, for example, can be represented in two ways:

$CH_3CH_2CH_2OH$ -Propan-1-ol



3. Functional Isomerism:

When two or more compounds have the same molecular formula but differ in the functional group present, they are called isomers. C_3H_6O, for example, can be represented as a ketone and an aldehyde.



4. Metamerism:

Compounds exhibit this because of the presence of different alkyl chains on either side of the functional group. $C_4H_{10}O$ can be represented as ethoxyethane ($C_2H_5OC2H_5$) and methoxypropane ($CH_3OC_3H_7$), for example.

5. Tautomerism:

- A tautomer of a compound is an isomer of the compound that differs only in the position of protons and electrons.
- Typically, a compound's tautomers coexist in equilibrium and easily interchange.
- It happens as a result of an intramolecular proton transfer.
- Keto-enol tautomerism is a prominent example of this phenomenon.

6. Ring-Chain Isomerism:

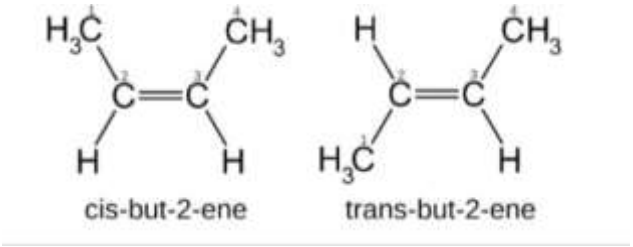
- Ring-chain isomerism occurs when one of the isomers has an open-chain structure and the other has a ring structure.
- They usually have a different number of pi bonds.
- C_3H_6 is an excellent example of this type of isomerism. As shown below, the resulting isomers are propene and cyclopropane.

Stereo Isomerism:

Stereoisomerism occurs when compounds with the same molecular formula differ in the relative positioning or orientation of atoms in space. Stereoisomers are compounds that exhibit stereoisomerism. Stereoisomerism can be further classified as follows:

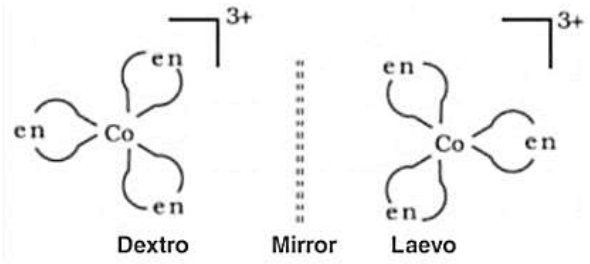
1. Geometric Isomerism

- It is also known as cis-trans isomerism.
- These isomers have different atomic spatial arrangements in three-dimensional space.
- Below is an illustration of the geometric isomerism observed in the acyclic But-2-ene molecule.



2. Optical Isomerism:

- Optical isomerism compounds have similar bonds but different spatial arrangements of atoms, resulting in non-superimposable mirror images.
- Enantiomers are another name for optical isomers.
- The optical activities of enantiomers differ from one another.
- As shown below, dextro enantiomers rotate the plane of polarised light to the right, whereas laevo enantiomers rotate it to the left.



3. Ionization Isomerism:

Ionisation isomers are compounds that produce different ions in solution despite having the same composition. This property is known as ionisation isomerism. Ionisation isomerism refers to compounds that produce different ions in solution despite having the same composition. When the counter ion in a complex salt is also a potential ligand, it can displace a ligand, which can then become the counter ion.

One example of ionisation isomerism is $[Co(NH_3)_5SO_4]Br$ and $[Co(NH_3)_5Br]SO_4$.

Ionisation isomerism can be seen in the compounds $[Co(NH_3)_5SO_4]Br$ and $[Co(NH_3)_5Br]SO_4$.

The following method can be used to create these ionisation isomers.

$[CoBr(NH_3)_5]SO_4 \rightarrow [CoBr(NH_3)_5]^{2+} + SO_4^{2-}$ = Red−Violet
$[CoSO_4(NH_3)_5]Br \rightarrow [CoSO_4^{2-}(NH_3)_5]^{+} + Br^{-}$ = Red

Conclusion:

As previously stated, Isomerism, the most important aspect of organic chemistry, states that compounds with the same molecular formula but different structures are isomers of each other, and this phenomenon is known as isomerism. Stereoisomers, Enantiomers, Diastereomers, and Constitutional Isomers are the four subparts of isomerism.

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