What is Isomerism?

Isomerism is the phenomenon in which more than one compounds have the same chemical formula but different chemical structures. Chemical compounds that have identical chemical formulae but differ in properties and the arrangement of atoms in the molecule are called **isomers**. Therefore, the compounds that exhibit isomerism are known as isomers. The word "isomer" is derived from the Greek words "isos" and "meros", which mean "equal parts". This term was coined by the Swedish chemist Jacob Berzelius in the year 1830.

Types

There are two primary types of isomerism, which can be further categorized into different subtypes. These primary types are **Structural Isomerism** and **Stereoisomerism**. The classification of different types of isomers is illustrated below.

Structural Isomerism

Structural isomerism is commonly referred to as constitutional isomerism. The functional groups and the atoms in the molecules of these isomers are linked in different ways. Different structural isomers are assigned different IUPAC names since they may or may not contain the same functional group.

Chain Isomerism

It is also known as skeletal isomerism.
The components of these isomers display differently branched structures.
Commonly, chain isomers differ in the branching of carbon
An example of chain isomerism can be observed in the compound C_5H_{12}, as illustrated below.

Position Isomerism

The positions of the functional groups or substituent atoms are different in position isomers.
Typically, this isomerism involves the attachment of the functional groups to different carbon atoms in the carbon chain.
An example of this type of isomerism can be observed in the compounds having the formula C_3H_7Cl.

Functional Isomerism

It is also known as functional group isomerism.
As the name suggests, it refers to the compounds that have the same chemical formula but different functional groups attached to them.
An example of functional isomerism can be observed in the compound C_3H_6O.

Metamerism

This type of isomerism arises due to the presence of different alkyl chains on each side of the functional group.
It is a rare type of isomerism and is generally limited to molecules that contain a divalent atom (such as sulfur or oxygen), surrounded by alkyl groups.

Example: $C_4H_{10}O$ can be represented as ethoxyethane ($C_2H_5OC_2H_5$) and methoxy-propane ($CH_3OC_3H_7$).

Tautomerism

A tautomer of a compound refers to the isomer of the compound which only differs in the position of protons and electrons.
Typically, the tautomers of a compound exist together in equilibrium and easily interchange.
It occurs via an intramolecular proton transfer.
An important example of this phenomenon is Keto-enol tautomerism.

Ring-Chain Isomerism

In ring-chain isomerism, one of the isomers has an open-chain structure whereas the other has a ring structure.
They generally contain a different number of pi bonds.
A great example of this type of isomerism can be observed in C_3H_6. Propene and cyclopropane are the resulting isomers, as illustrated below.

Stereoisomerism

This type of isomerism arises in compounds having the same chemical formula but different orientations of the atoms belonging to the molecule in three-dimensional space. The compounds that exhibit stereoisomerism are often referred to as stereoisomers. This phenomenon can be further categorized into two subtypes. Both these subtypes are briefly described in this subsection.

Geometric Isomerism

It is popularly known as cis-trans isomerism.
These isomers have different spatial arrangements of atoms in three-dimensional space.
An illustration describing the geometric isomerism observed in the acyclic But-2-ene molecule is provided below.

Optical Isomerism

Compounds that exhibit optical isomerism feature similar bonds but different spatial arrangements of atoms forming non-superimposable mirror images.
These optical isomers are also known as enantiomers.
Enantiomers differ from each other in their optical activities.
Dextro enantiomers rotate the plane of polarized light to the right whereas laevo enantiomers rotate it to the left, as illustrated below