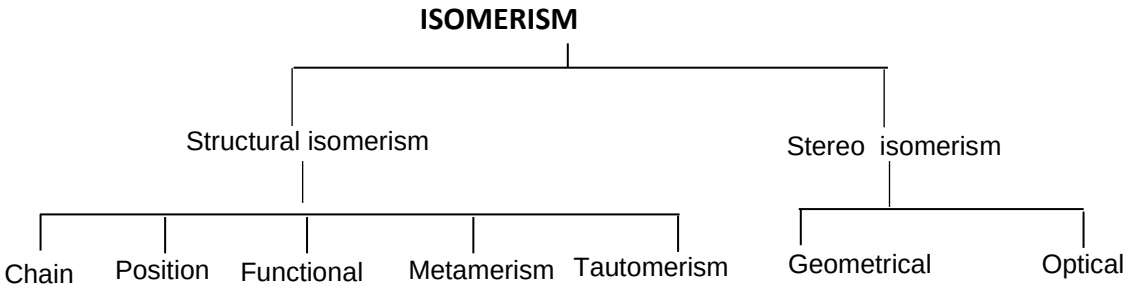
ISOMERISM

- The existence of two or more compounds with same molecular formula is called isomerism and those different compounds are called isomers.
- Isomers may differ in physical and in chemical properties
- Isomerism arises due to difference in the arrangement of atoms or groups in the molecule .

Types of isomerism :



Structural isomerism : It arises due to difference in the structures

Chain isomerism : It arises due to difference in the skeleton of carbon atoms.

- Chain isomers have different physical properties but similar chemical properties
- All types of organic compounds exhibit chain isomerism
- Alkanes will exhibit only chain isomerism
- Minimum number of carbons to exhibit chain isomerism by an alkane is 4.

Ex: C_4H_{10} i) $CH_3 - CH_2 - CH_2 - CH_3$ ii) $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$

n – Butane Isobutane

C_5H_{12} : i) $CH_3 - CH_2 - CH_2 - CH_2 - CH_3$ ii) $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CH_3$

n – Pentane

Isopentane

iii) $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - CH_3$ Neo pentane

C_6H_{14} : It has five chain isomers

POSITION ISOMERISM: It arises due to difference in the nature of substituent or functional group or multiple bonds.

Ex :

C_3H_7Cl i) $CH_3 - CH_2 - CH_2 - Cl$ ii) $CH_3 - \underset{\underset{Cl}{|}}{CH} - CH_3$

1 – Chloro propane 2 – chloro propane

$C_2H_4Cl_2$ i) $CH_3 - CHCl_2$ ii) $\underset{\underset{Cl}{|}}{CH_2} - \underset{\underset{Cl}{|}}{CH_2}$

1, 1 – dichloro ethane 1, 2 – dichloroethane

C_4H_8 i) $CH_2 = CH - CH_2 - CH_3$ ii) $CH_3 - CH = CH - CH_3$

But – 1 – ene But – 2 – ene

C_4H_6 i) $CH_3 - C \equiv C - CH_3$ ii) $HC \equiv C - CH_2 - CH_3$

But – 2 – yne But – 1 – yne

FUNCTIONAL GROUP ISOMERISM : It arises due to difference in the nature of functional group.

Ex : 1. Alcohols and Ethers

$CH_3 - CH_2 - OH$

Ethanol

$CH_3 - O - CH_3$

Methoxymethane

2. Aldehydes and Ketones

$CH_3 - CH_2 - CHO$

Proponal

$CH_3 - \underset{\underset{O}{||}}{C} - CH_3$

Acetone

3. Carboxylic acids and esters :

i) $CH_3 - COOH$

Ethanoic acid

$H - COOCH_3$

Methylmethanoate

ii) $CH_3\,COOC_2H_5$

Ethylacetate

$CH_3 - CH_2 - CH_2 - COOH$

Butanoicacid

- Alkenes and Cyclo alkanes are functional isomers.
- Alkynes, alkadienes and cycloalkenes are functional isomers
- Primary amines, secondary amines and tertiary amines are functional isomers
- Cyanides and isocyanides are functional isomers.
- Nitro and nitrites are functional isomers.

Metamerism: It arises due to difference in the nature of alkyl groups attached to same functional group.

i) Ethers : $CH_3 - CH_2 - O - CH_2 - CH_3$
$CH_3 - O - CH_2 - CH_2 - CH_3$

ii) Amines : $CH_3 - CH_2 - NH - CH_2 - CH_3$
$CH_3 - NH - CH_2 - CH_2 - CH_3$

iii) Esters : $CH_3COOC_3H_7$
$CH_3CH_2COOCH_2CH_3$

Tautomerism :

- It arises due to shifting of hydrogen from one electronegative atom to another electronegative atom.
- Tautomers are dynamic functional isomers and exist in dynamic equilibrium.
- Tautomers are interconversible with each other.
- The two tautomers have difference stabilities

Examples :

1. Acetaldehye : $CH_3 - \underset{\underset{H}{|}}{C} = O$ $CH_2 = CH - OH$

2. Acetone : $CH_3 - \underset{\underset{O}{||}}{C} - CH_3$ $CH_2 = \underset{\underset{OH}{|}}{C} - CH_3$

3. Urea : $NH_2 - \underset{\underset{O}{||}}{C} - NH_2$ $NH = \underset{\underset{OH}{|}}{C} - NH_2$

4. Aceto acetic ester : $CH_3 - \underset{\underset{O}{||}}{C} - CH_2 - COOC_2H_5$ $CH_3 - \underset{\underset{OH}{|}}{C} = CH - COOC_2H_5$

Stereo isomerism: It arises due to difference in the spatial arrangement of atoms or groups in the atoms.

Geometrical isomerism : It is due to the absence of free rotation of the atoms or groups about the double bond.

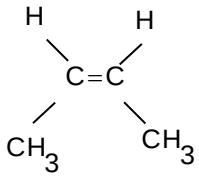
- It is found in alkenes, where double bonded carbons are attached to different atoms or groups.
- Geometrical isomers are of two types :
  1) **Cis – isomer :** Same or similar groups are present on same side.
  2) **Trans – isomer :** Same or similar groups are present on opposite sides.

Differences :

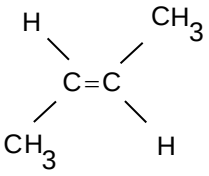
Cis isomer	Trans isomer
Less stable	More stable
Dipolemoment is more	Dipolemoment is zero or less
B.P. is more	B.P. is less
M.P. is less	M.P. is more

Ex:

1) 2 - Butene :

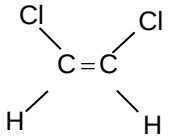


Cis – 2 – Butene

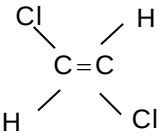


Trans – 2 – Butene

2) 1, 2 – dichloro ethene :



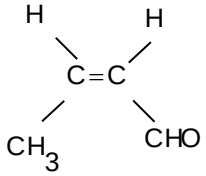
Cis 1, 2 – dichloro ethene



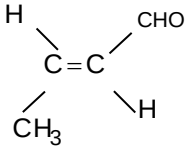
Trans 1, 2 – dichloro ethene

3) 2 Butenal :

Cl



Cis – 2 – Butenal



Trans – 2 – Butenal