STEREOCHEMISTRY;
ISOMERISM; STRUCTURAL, STEREOISOMERISM, GEOMETRICAL and OPTICAL ISOMERISM
CONDITIONS FOR OPTICAL ISOMERISM

STEREOCHEMISTRY is subdiscipline of chemistry that deals with study of the relative spatial arrangement of atoms that form the structure of molecules and how they are manipulated

ISOMERISM is a phenomenon whereby certain compounds possessing the same molecular formular exist in different structural forms. These compounds are known as "ISOMERS"

Therefore, ISOMERS are two or more compounds that have the same molecular formula but different structural formula

Types of Isomerism

1. Structural
2. Stereo

Structural Isomerism

It arises from difference in the arrangement of atoms within the molecule resulting in two or more different structural formula

Classification of structural Isomerism

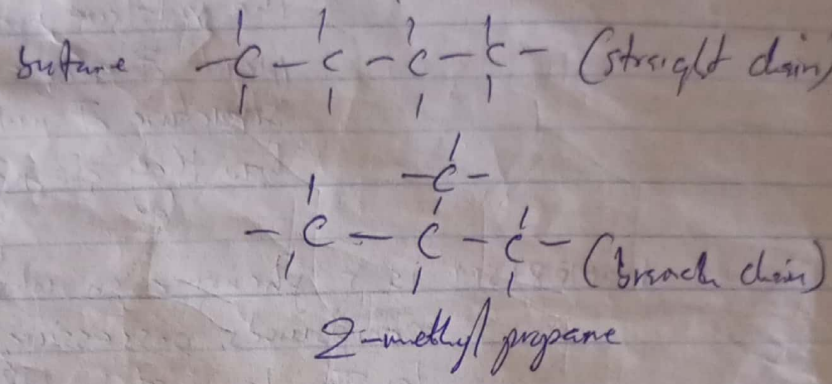
1. Skeletal or chain Isomerism
2. Position Isomerism
3. Functional group Isomerism

4) Metamerism
5) Tautomerism

Skeletal or Chain Isomerism

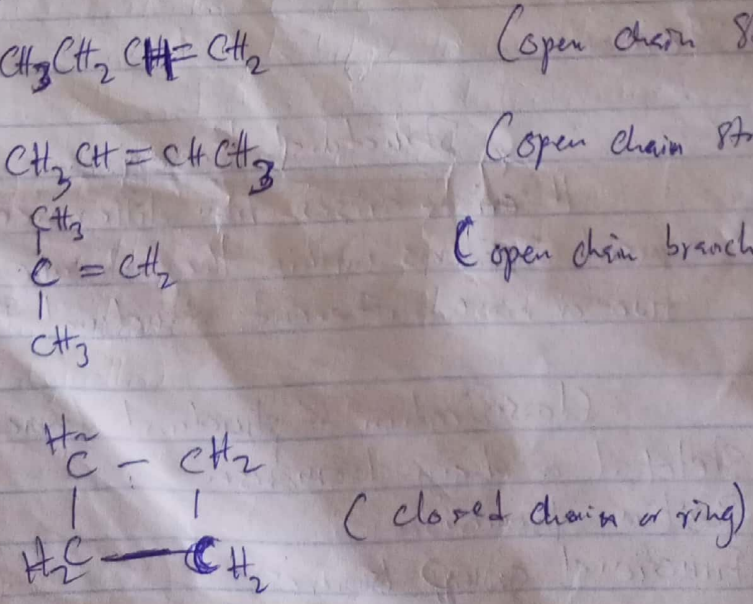
In skeletal or chain isomerism, isomers differ in the order in which carbon atoms linked in the molecule.

The simplest compound exhibiting this type of isomerism is butane C_4H_{10}



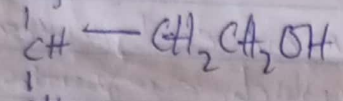
Another example is pentane (C_5H_{12}) which exists in three isomeric forms. Thus, the number of chain isomers increases with increase in the number of carbon atoms.

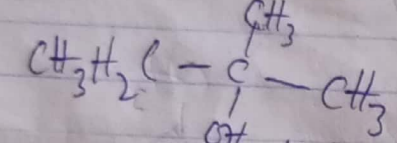
In some cases one of the isomers may have an open chain skeleton while the other may have a closed chain or ring (cyclic) skeleton. Example butene and cyclo butane both having the same molecular formula C_4H_8

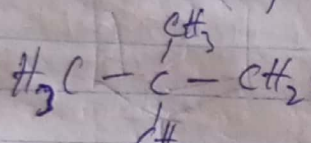


also, the class of compounds beside hydrocarbon might exist in higher isomeric forms. Example Pentanol $C_5H_{12}O$

1) $CH_3CH_2CH_2CH_2CH_2OH$
Pentan-1-ol

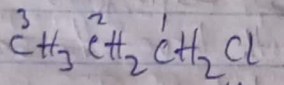
2) 
3-methyl-butan-1-ol

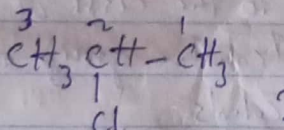
3) 
2-methylbutan-2-ol

4) 
2,2-Dimethylpropan-1-ol

Position Isomerism

In position isomerism, isomers differ in the placement of a functional group or substituent on the carbon chain. Example C_3H_7Cl

1) 
1-chloropropane

2) 
2-Chloropropane

Unsaturated hydrocarbons also exhibit this type of isomerism because of differences in the position of the double or triple bonds. Example C_4H_8

1) $CH_3CH_2CH=CH_2$

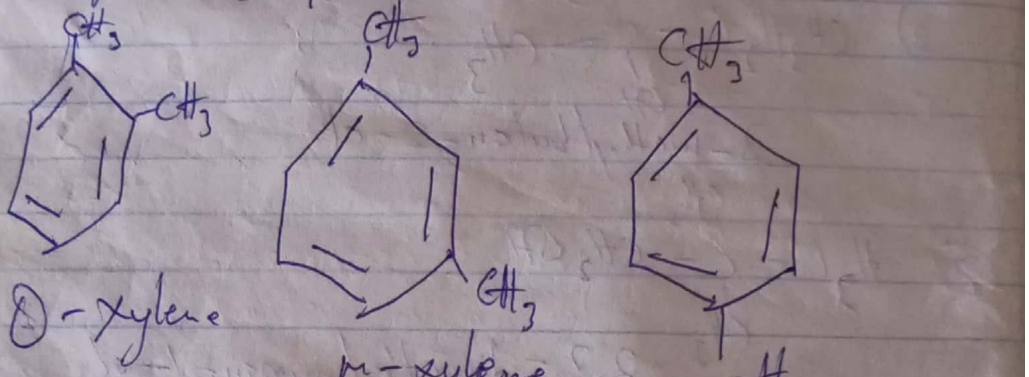
2) $CH_3CH=CHCH_3$

Also in butyne C_4H_6 with two positive isomers

1) $CH_3CH_2C\equiv CH$

2) $CH_3C\equiv C-CH_3$

The disubstituted benzene exist in these isomeric forms. O, m and P which are position isomers differing only in the position of the two substituents example C_8H_{10}



O-xylene
1,2-dimethylbenzene

m-xylene
1,3-dimethyl benzene

P-xylene
1,4-dimethylbenzene

Functional Group Isomerism

Functional group isomerism are exhibited by compounds differing in functional groups. Examples

1) Dimethyl ether and Ethanol: both have the same molecular formular C_2H_6O but the former has an ether linkage which belong to the class of ethers whereas ethanol has an alcoholic group and belongs to the class of alcohols

CH_3OCH_3
methoxymethane
(dimethyl ether)

C_2H_5OH
ethanol

2) Propionaldehyde and Acetone : Both have the same molecular Formula (C_3H_6O) but propionaldehyde has an aldehydic ($-CHO$) group. whereas acetone has a ketonic ($>CO$) group

CH_3CH_2CHO
propionaldehyde
(propanal)

CH_3COCH_3
Acetone
(propanone)

Metamerism

Here isomers differ in the groups attached to a functional group example

1) $C_2H_5OC_2H_5$
diethyl ether
(ethyl ethoxide)

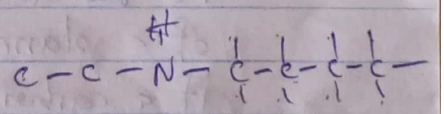
$CH_3OC_3H_7$
methyl propyl ether

2) $C_2H_5COC_2H_5$
diethyl ketone

$CH_3COC_3H_7$
methyl propyl ketone.

3) $C_3H_7NHC_3H_7$
dipropylamine

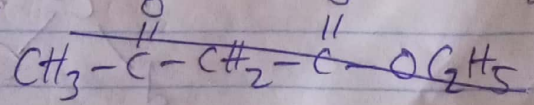
$C_2H_5NHC_4H_9$

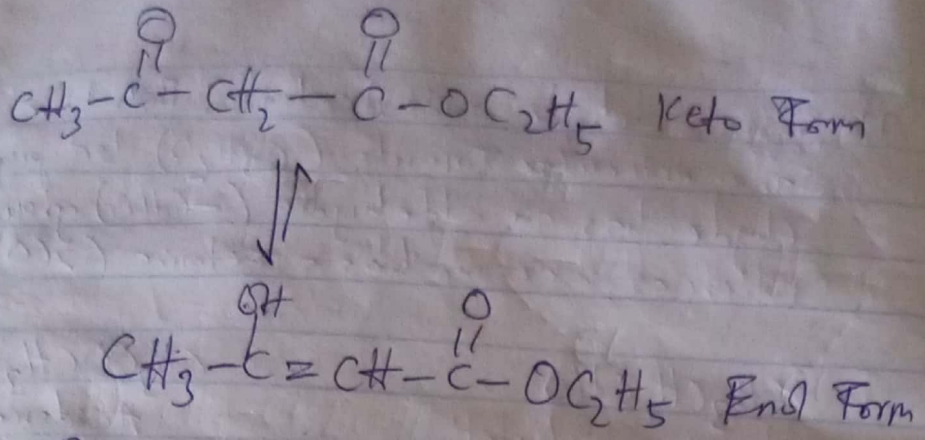


butyl ethyl amine

Tautomerism

Migration of a proton from a carbon atom to the adjacent atoms, the two forms are dynamic with each other.





Keto Form

Enol Form

This compound shows the properties of both keto and enol group.

STEREOISOMERISM

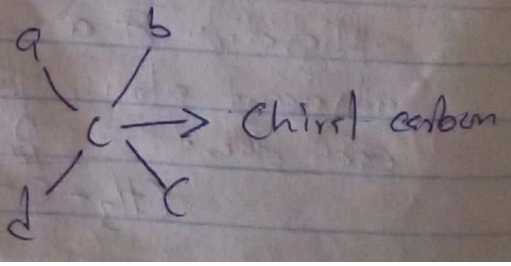
Stereochemistry is the study of structure showing different spatial arrangements of atoms or groups in a molecule. STEREOISOMERISM is shown by compounds that have the same structure but different spatial arrangements or configuration.

Three types of stereoisomerism

1) Optical
2) Geometrical
3) Conformational

Optical Isomerism

It deals with the optical activities of a compound i.e the ability of a compound to rotate the plane of a plane polarized light in a definite direction. If a carbon atom in a molecule have four entirely different atoms or group such a carbon centre is said to be "ASYMMETRIC" and the carbon atom is called a "CHIRAL" carbon



CONDITION FOR OPTICAL ISOMERISM

1) Optically active molecule: A molecule that cannot be superimposed on it's mirror image. It is also called chiral molecule

2) Asymmetric or chiral cabon: A carbon atom that is bonded to four different groups

3) Dextrorotatory isomer or (+) isomer: An isomer which rotates the plane of polarized light to the right (clockwise direction)

4) Laevorotatory or (−) isomer: An isomer which rotates the plane of polarized light to the left (antic clockwise direction)

5) Racemic mixture: An equimolar mixture of two isomers. It does not rotate the plane of polarized light. The two mixture can only be seperated if they are made to combine with another optically active compound because they resemble each other closely in all properties except optical.

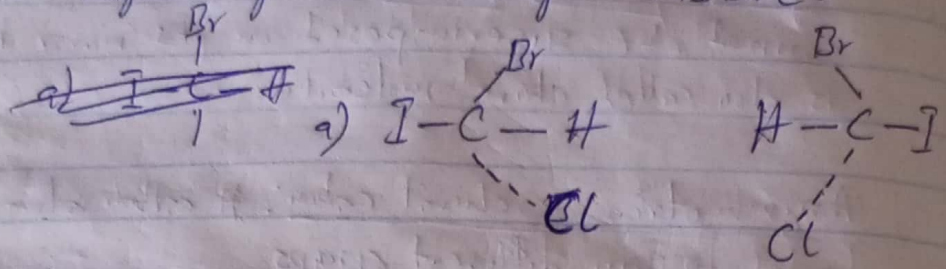
6) Meso-Compound: A compound which has more than one chiral carbon atom and is superimposible. meso compounds are optically inactive

7) Resolution: The seperation of a racemic mixture into two optically active components.

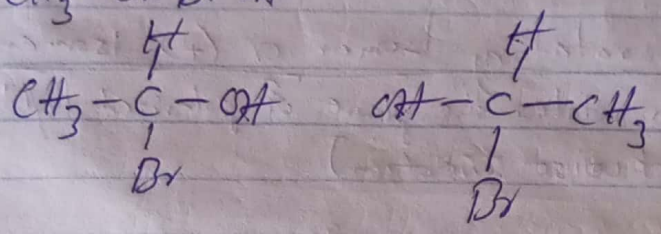
8) Racemisation: Is a phenomenon of conversion of one enantiomers into the other such that a mixture containing 50% of each is formed.

9) Enantiomers: They are optical isomers which rotates the plane of polarization by equal and opposite

amount. They are mirror images and therefore are not super impossible example CHIBrCl

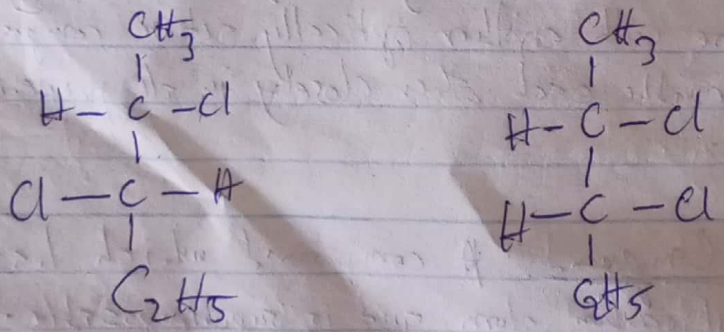


b) $CH_3-CHBrOH$



ii) Diastereoisomers: They are optical isomers which can rotate the plane of polarization by different amount. They are not mirror images and therefore are not superimposible

Example 2,3-dichloropentane



GEOMETRICAL ISOMERISM

It is also called cis-trans isomerism. Is characterised by compounds having the same structure but different spatial arrangement of their atom or groups. They do not rotate the plane of plane polarized light because of their molecular symmetry. Geometrical isomers differ in their physical and chemical properties.