

PRESENTATION

OF

ISOMERISM

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ISOMERISM

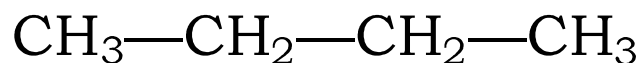
- **What is isomerism:-**

The compounds which have the same molecular formula but differ from each other in physical or chemical properties are called isomers and the phenomenon is called isomerism.

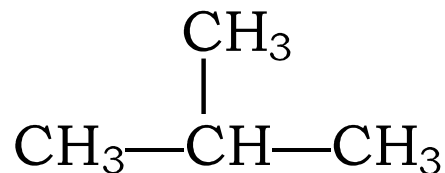
There are two main types of isomerism

- Structural isomerism
- Stereo isomerism

- **1. Structural Isomerism:-** When the isomerism is due to difference in the arrangement of atoms within the molecules without any reference to space is called structural isomerism.
- **(a) Chain isomerism:** Structural isomerism is of five type chain isomer have the same molecular formula but differ in the order in which the carbon atoms are bonded to each other.
- **Example :** n-Butane and isobutane

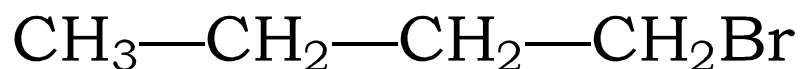


n-Butane

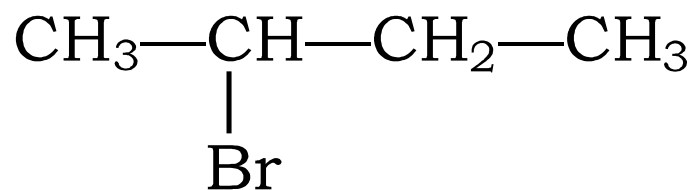


2 Bromobutane

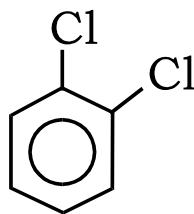
- **(b) Position isomerism:-** In this isomer have the same molecular formula but differ in the position of a functional group on the carbon chain.
- **Example :** 1-Bromobutene and 2- Bromobutane



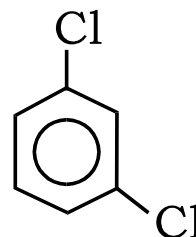
1-Bromobutane



2 Bromobutane



o-dichlorobenzene

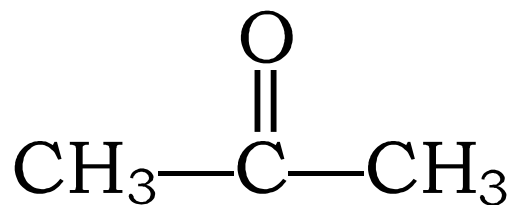


m-dichlorobenze

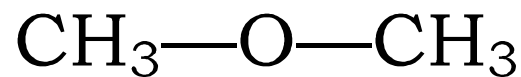
- **Functional isomerism:-** Functional isomers have the same molecular formula but different functional groups.



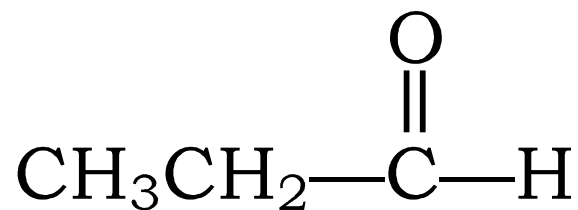
Ethyl alcohol



Acetone



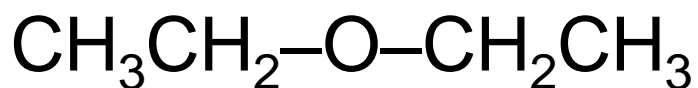
Dimethyl ether



Propionaldehyde

- **(d) Metamerism** : This type of isomerism is due to the unequal distribution of carbon atoms on either side of the functional group.

Example: Diethyl ether and methyl propyl ether



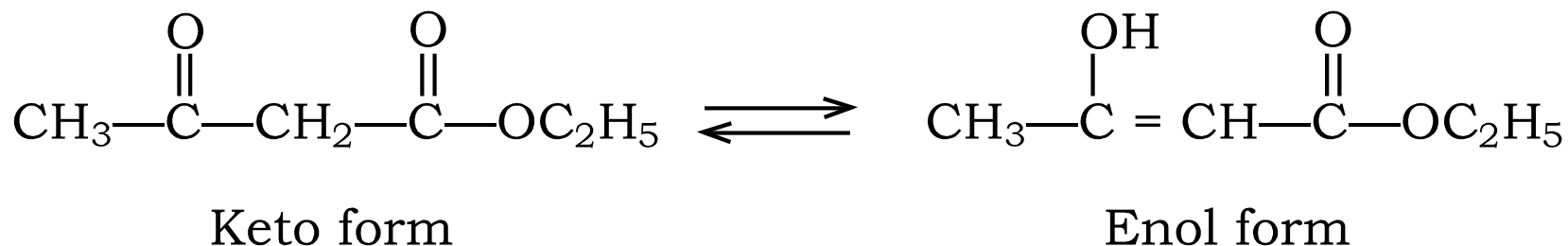
Diethyl ether



Methyl propyl ether

Tautomerism

- It is a special type of functional isomerism in which the isomers are in dynamic equilibrium with each other.
- For example ethyl acetoacetate in an equilibrium mixture of two forms, one is keto form and other is enol form.
- At room temperature the mixture contains 93% of keto form and 6% of the enol form.



Stereoisomerism

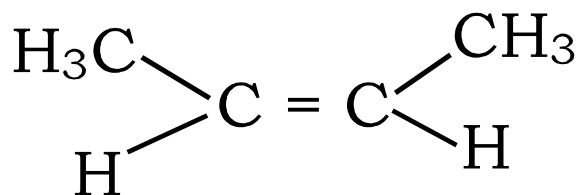
- When isomerism is caused by the different arrangement of atoms or groups in space the phenomenon is called stereoisomerism.
- The stereo isomers have the same structural formulas but differ in arrangement of atoms in space.
- Stereo isomerism is of two types
 - Geometrical or cis-trans isomerism
 - Optical isomerism
- **(a) Geometrical isomerism** :- This type of isomerism is due to restriction in rotation about double bonds or about single bonds in cyclic compounds.

Geometrical isomerism in Alkenes

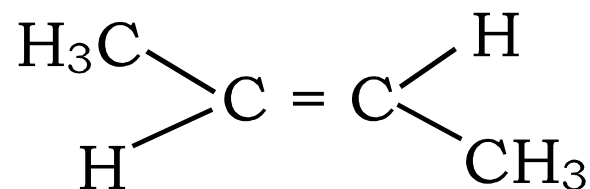
- The carbon atoms of the carbon-carbon double bond are Sp^2 hybridized.
- The carbon-carbon double bond consists of a σ bond and a π bond.
- The σ bond is formed by the overlap of Sp^2 hybrid orbital. The π bond locks the molecule in one position.
- The two carbons of the $C = C$ bond and the four atoms that are attached to them lie in one plane and their position in space are fixed.
- Therefore rotation around the $C = C$ bond is not possible because rotation would break the π bond.

- This restriction of rotation about the carbon-carbon double bond is responsible for the geometrical isomerism in alkenes.

Example : 2-Butene. It exists in two special arrangement



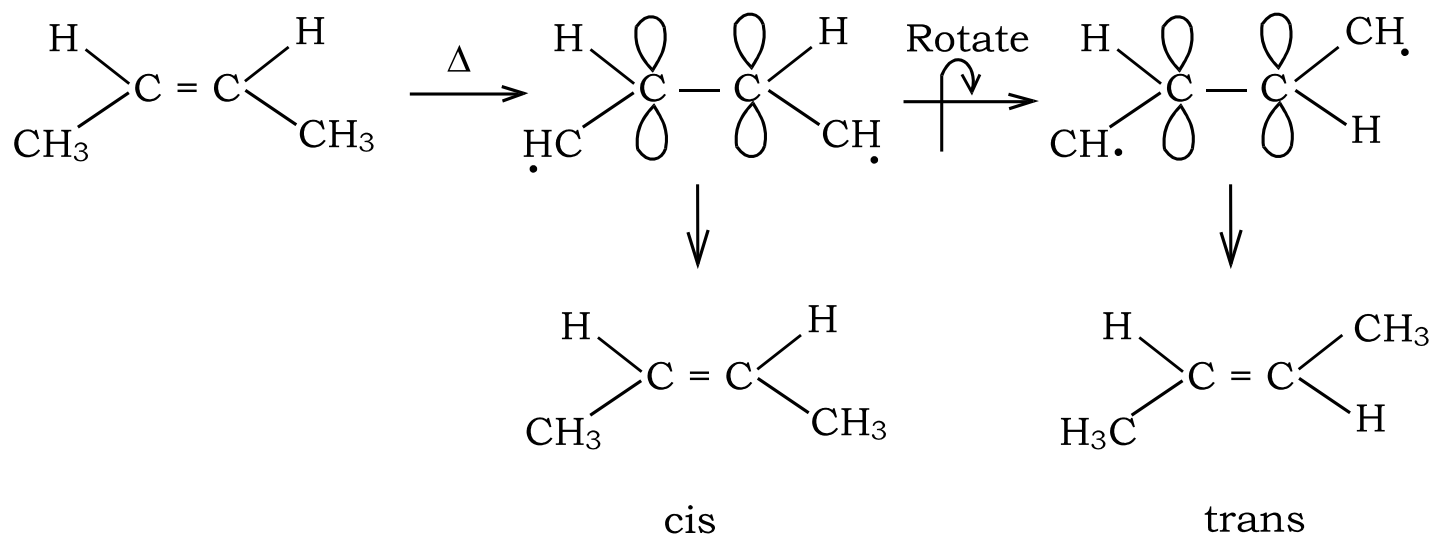
Cis-2-Butene



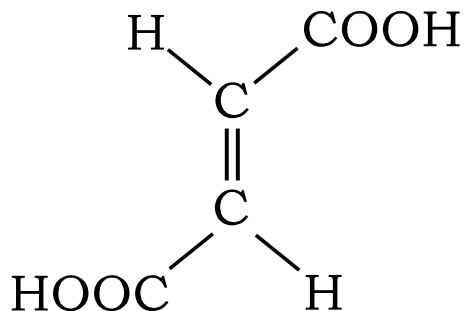
trans-2-Butene

- The cis isomer is one in which two similar groups are on the same side of the double bond.
- The trans isomer is that in which two similar groups are on the opposite sides of the double bond.

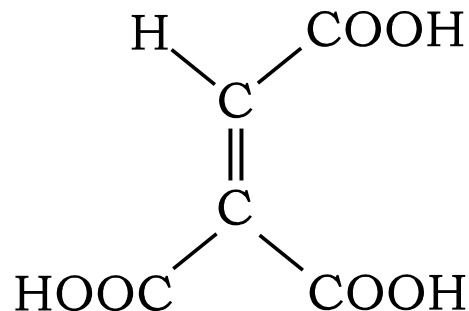
- The conversion of cis isomer is heated to a trans isomer is possible only if either isomer is heated to a high temperature or absorb light.
- The heat supplies the energy to break the π bond so that rotation about σ bond becomes possible on cooling, the reformation of π bond can take place in two ways giving mixture of trans-2-butene and cis-2-butene.



- **Example:** Butenedioic acid (HOOC–CH=CH–COOH)



trans-Butenedioic acid
(Fumaric acid)
mp = 130°C

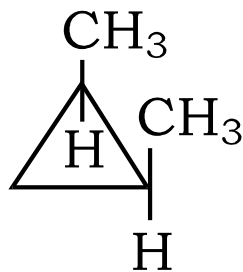


cis-Butenedioic acid
(Maleic acid)
mp = 288°C

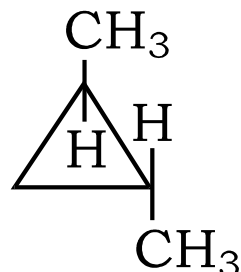
- These isomers differ in physical properties such as
- melting point, dipole moment and acidities.
- The trans isomer has no dipole, it is symmetrical and cis isomer is stronger than trans isomer.

Geometrical isomerism in cyclic compounds

- It is also possible in cyclic compounds. There can be no rotation about carbon-carbon single bonds forming a ring because rotation would break the bonds and break the rings.
- **Example:-** 1, 2-dimethyl cyclopropane exists in two isomeric forms.



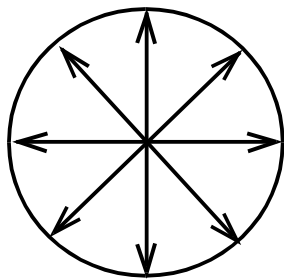
cis



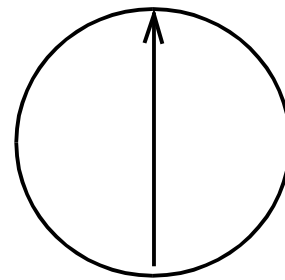
trans

- In cis 1,2-dimethyl cyclopropane, the two methyl groups are on the same side of the ring. In trans 1,2 dimethyl cyclopropane they are on opposite side.
- A requirement for geometrical isomerism in cyclic compounds is that there must be at least two other group besides hydrogen on the ring and these must be an different ring carbon atoms.

- **Optical isomerism:-** Optical isomerism is a type of stereo isomerism.
- Optical isomers is that they have the ability to rotate plane polarised light.
- **Optical activity:-** Light from ordinary electron lamp is composed of waves vibrating in many different planes.
- When it is passed through Nicol prism or polarised lenses light is found to vibrate in only one plane and is said to be plane polarised.



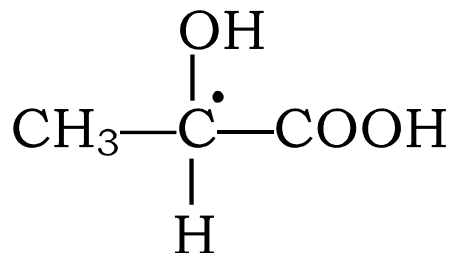
ordinary light



plane polarised light

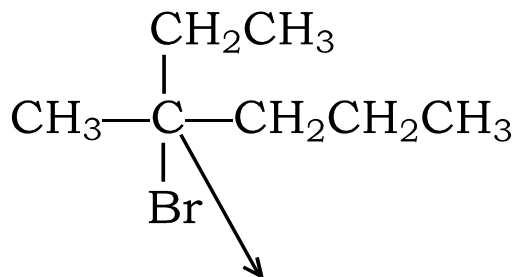
- Solution of same organic compounds have the ability to rotate the plane of polarised light.
- These compounds are said to be optically active. This property of a compound is called optical activity.
- The compound which rotates the plane of polarised light to the right (clockwise) is said to be Dextrorotatory. It is indicated by the sign (+).
- The compound which rotates the plane of polarised light to the left (anti clockwise) is said to Laevorotatory. It is indicated by the sign (–).
- The optical rotatory powers of two isomers are equal in magnitude but opposite in sign.

Optical isomerism of lactic acid

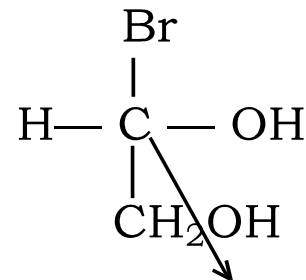


C[•] → asymmetric carbon atom

- **What is asymmetric carbon atom:** A carbon atom which is bonded to four different groups is called an asymmetric carbon atom.
- **Example**

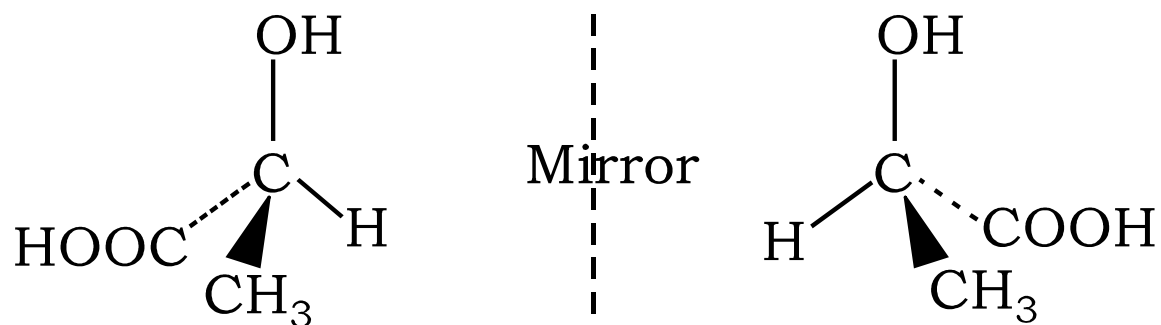


asymmetric carbon



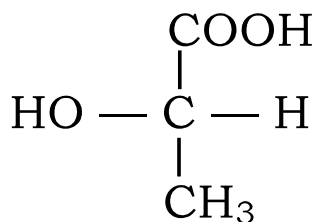
asymmetric carbon

- Presently asymmetric molecules are also called Dissymmetric or chiral molecules.
- Two three dimensional structures are possible for Lactic acid.



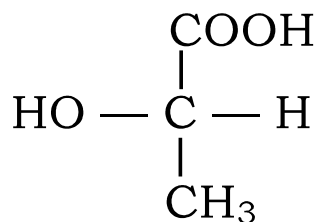
- These two structures are not identical because they cannot be super imposed on each other. Such non super imposable mirror image forms are optical isomers and are called enantiomers. Thus three forms of lactic acid are known. Two are optically active and the third is optically inactive.

- **(+) Lactic acid**:- It rotates the plane of polarised light to the right and is called dextrorotatory.
- **(-) Lactic acid** :- It rotates the plane of polarised light to the left and is called laevorotatory.
- **(±) Lactic acid** :- It does not rotate the plane of polarised light. It is optically inactive. It is an equimolar mixture of (+) and (-) forms.



(+) Acid
mp= 26°C

Optically active forms



(-) Acid
mp= 26°C

Equimolar mixture
of (+) and (-) form
(racemic mixture)

(±) Acid
mp= 18°C

Optically inactive