HINTS & SOLUTIONS

TOPIC : ISOMERISM (STEREOISOMERISM)

EXERCISE # 1

SECTION (A)

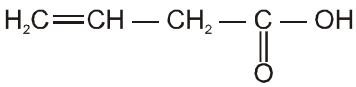
1. Stereoisomers have same connectivity of atoms but different orientations (configurations) in space.

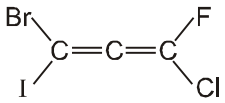
2. Follow conditions of geometrical isomerism.

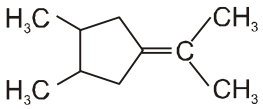
3. Follow conditions of geometrical isomerism.

5. Follow conditions of geometrical isomerism.

6. Follow conditions of geometrical isomerism.

9. 3-Butenoic acid  does not show geometrical isomerism because two similar groups (H) are present on one the doubly bonded carbon atom while in others the two doubly bonded carbon atoms have different atoms or groups.

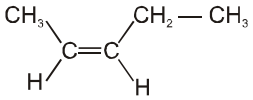
10. (3)  is non planner molecule.

(4)  In this structure geometrical isomersim is arise around C — C in the ring.

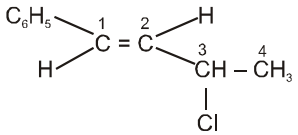
11. In option 1, 3 and 4 one carbon atom of C = C is linked to two similar groups so they can not show geometrical isomerism.

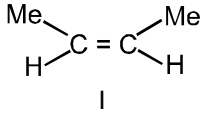
SECTION (B)

1. (Z) -2-pentene

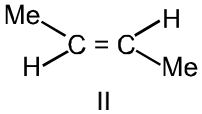


[Senior groups at same side of restricted rotation]

4.  trans-3-chloro-1-phenyl but-1-ene.

7. 

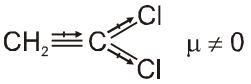
I



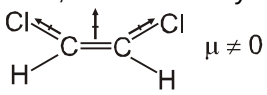
II

(1) Dipole moment I > II
(2) Boiling point I > II
(3) Solubility in H_2O I > II
(4) Melting point II > I

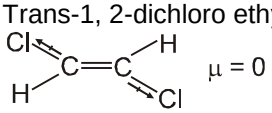
9. (1) 1, 1-dichloro ethylene



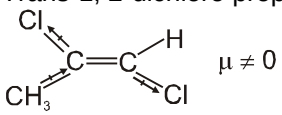
(2) cis-1, 2-dichloro ethylene



(3) Trans-1, 2-dichloro ethylene

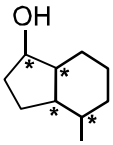


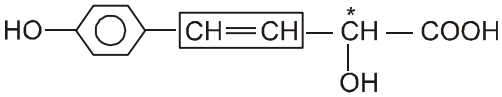
(4) Trans-1, 2-dichloro propene



SECTION (C)

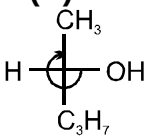
2. $CH_3-\overset{*}{C}H(OH)-CH_2-\overset{*}{C}H(Br)-\overset{*}{C}H(C_2H_5)-CH_3$ has three chiral carbons.

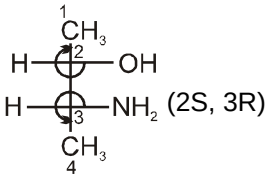
3.  Four chiral carbon atoms

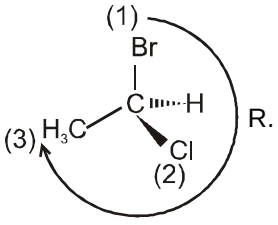
5. 

Due to presence of C == C and chiral carbon atom it will show geometrical and optical isomerism respectively.

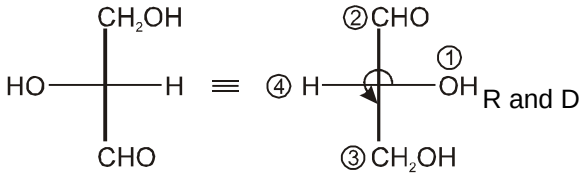
Section (D)

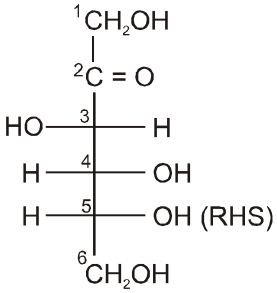
1.  the arrow is clockwise but least priority group is on horizontal line of fischer projection.

2.  (2S, 3R)

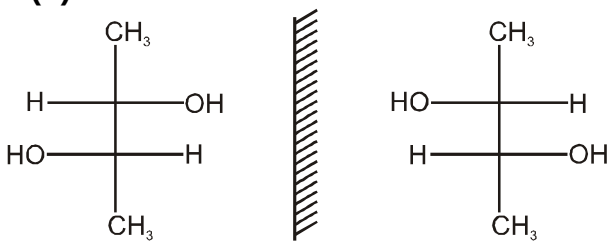
3.  R.

4. First decide the (R/S) configuration in wedge-dash and then draw fischer projection for same configuration.

5.  R and D

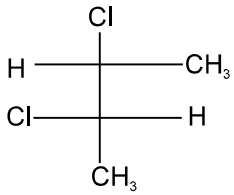
8.  (D-Configuration)

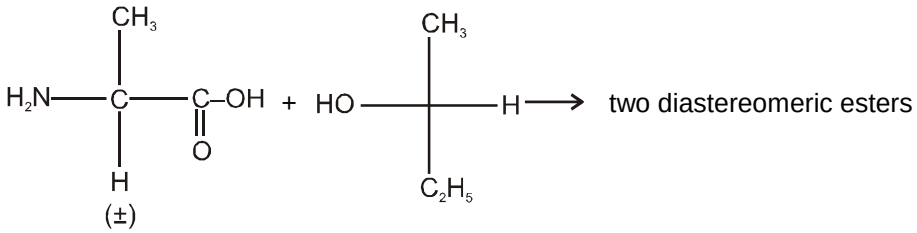
SECTION (F)

3. 

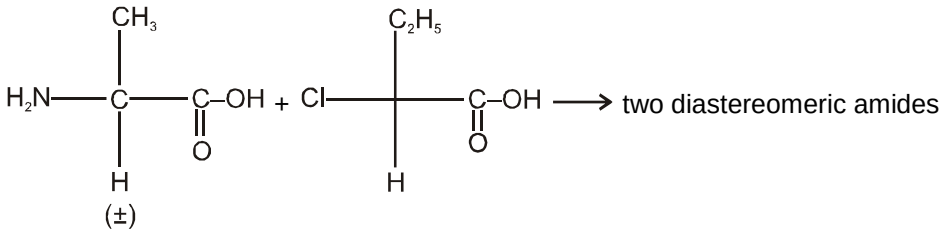
non-super imposible mirror image stereoisomers.

SECTION (G)

2. Compound  is a meso compound hence it has zero optical rotation.

4.  two diastereomeric esters

(±)

 two diastereomeric amides

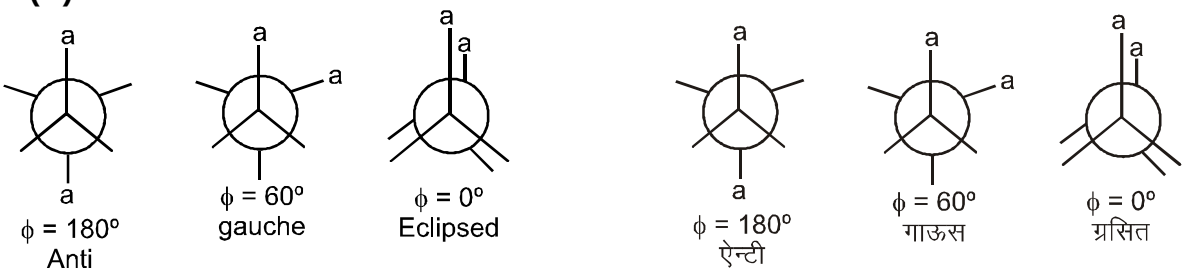
(–) –2–chlorobutanoicacid

Racemic mixture can be resolved by using optically active compounds.

5. Enatiomers have same physical properties so they can not be separated by any physical method which diastereomers have different physical properties.

Section (H)

1.



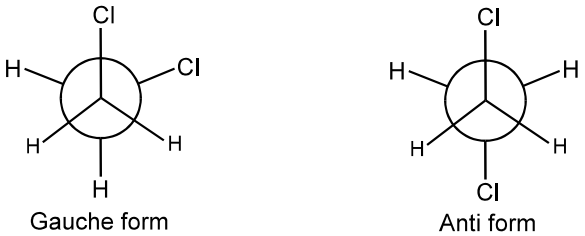
2. The eclipsed and staggered conformation of ethane is due to free rotation about C — C single bond.

3. Deviation in normal bond angles increases the angle strain. In cyclopropane deviation in bond angle is maximum.

SECTION (I)

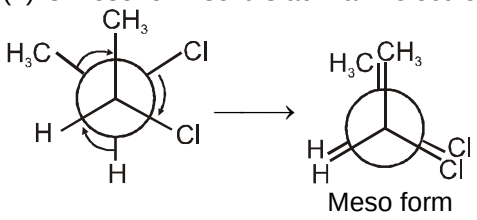
1. Anti form of butane is more stable because of less strains.

4. Cl – CH_2 – CH_2 – Cl has two staggered conformations.



Only Gauche form is polar. Anti form is nonpolar.

5. (1) is meso form so it is achiral molecule

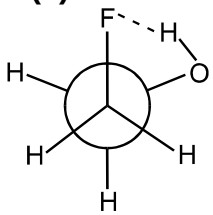


Meso form

6. X = Hydrogen, Y = $–CH(CH_3)_2$

SECTION (J)

1.



Although steric repulsion exist but hydrogen bonding as shown above, gives stability to the gauche form.

SECTION (L)

1. Unsymmetrical compound with 2 stereocentres has 4 geometrical isomers ($2^2 = 4$).

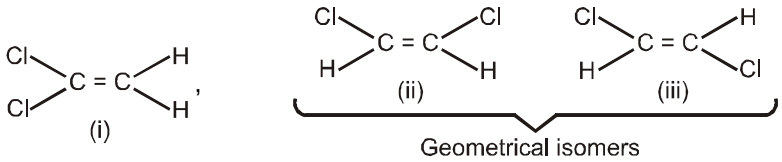
2. Unsymmetrical compound with 2 stereocentres has 4 geometrical isomers.

3. Unsymmetrical compound with 2 stereocentres has 4 geometrical isomers.

4. Unsymmetrical compound with 2 stereocentres has 4 geometrical isomers.

5. Geometrical isomers for symmetrical compounds = $2^{n-1} + 2^{\frac{n-1}{2}}$
n = 3, total G.I. = 6

6. Number of geometical centres (n) = 4. So, total G.I. = $2^4 = 16$

7. 

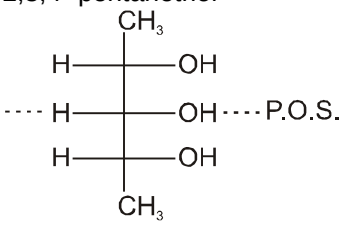
$\Rightarrow$ Total no. isomers are 3.
$\Rightarrow$ C is sp^2 hybridised in each isomer, therefore geometry is trigonal planar.

8. Unsymmetrical compound with 2 chiral centres has $2^2 = 4$ stereoisomers.

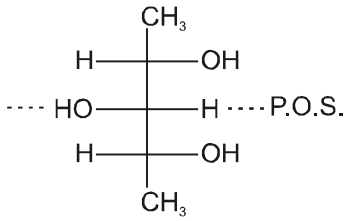
9. Symmetrical compound with three chiral centres has $2^{n-1} = 2^{3-1} = 4$ stereoisomers.

10. Unsymmetrical compound with three chiral centres has $2^n = 2^3 = 8$ stereoisomers.

11. 2,3,4 -pentanetriol

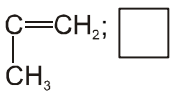


(Meso-I)

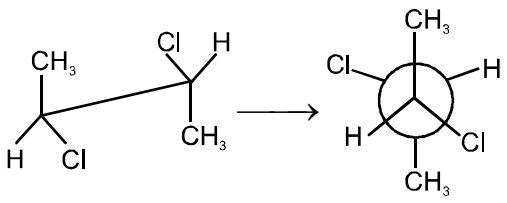


(Meso-II)

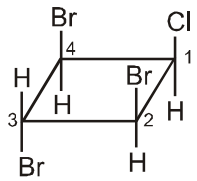
12. C_4H_8 (D.U. = 1) ; Total isomers = 6

$H_3C–H_2C–CH=CH_2$; $CH_3–CH=CH–CH_3$ (cis/trans.) ;  ; 

EXERCISE # 2

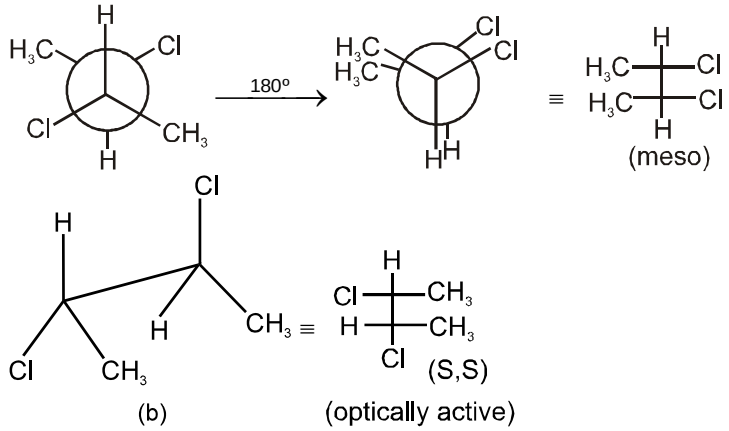
2. 

Option D is identical with newman projection (both are meso).

3. This structure 

has plane of symmetry across 1-3 but there is no centre of symmetry.

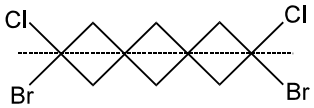
4.



(b) (optically active)

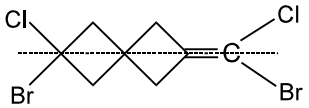
6. Size and number of groups are less then torsional energy is minimum.

7. (1)



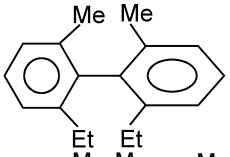
Plane of symmetry so it is achiral

(2)



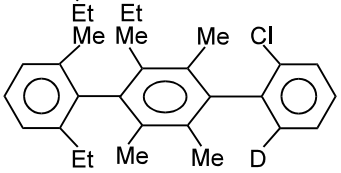
Plane of symmetry so it is achiral

(3)



Optical active because both phenyl rings in the perpendicular plane.

(4)

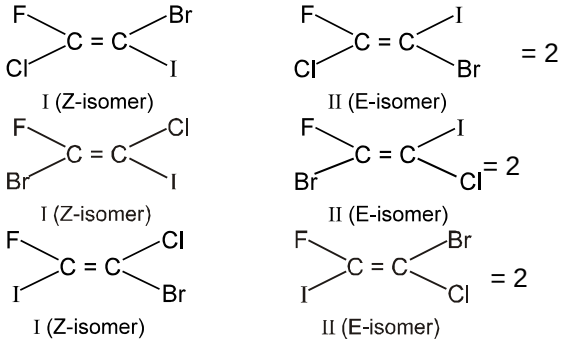


Plane of symmetry so it is achiral

8. $CH_3 - \overset{*}{C}H - CH_2 - CH_3$ has chiral carbon.

NH_2

12. Molecule $C_2BrClFI$ shows geometrical isomerism as E & Z-isomers.



Hence total isomers are six.

13. 3 (oct-2-ene, oct-3-ene, oct-4-ene)

14. 4 (All geometrical isomer)

16. Number of optically active stereoisomers = 2.

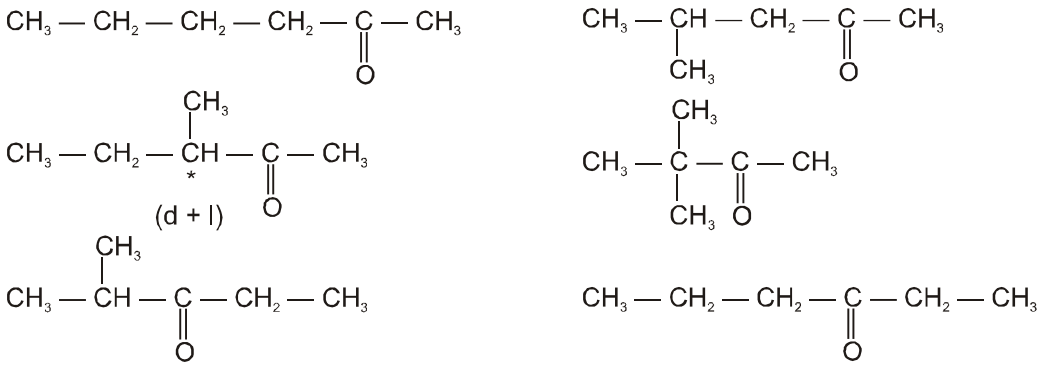
17. Have 8 spatial orientation due to chiral C, $\diagdown C = C \diagup$ bond & along 2, 2′, 6, 6′ biphenyl.

18. Unsymmetrical compound with 2 chiral centres has $2^2 = 4$ stereoisomers.

19. Number of optically active stereoisomers of tartaric acid = 2.

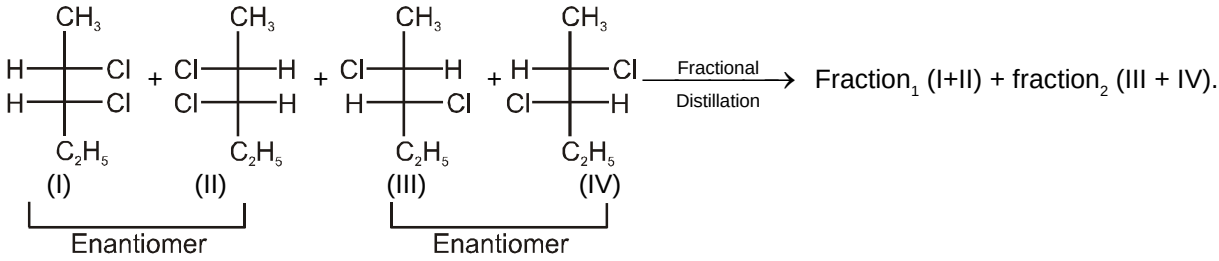
20. $C_6H_{12}O$

D.U. = 1



∴ Total no. of ketones = 7

21.



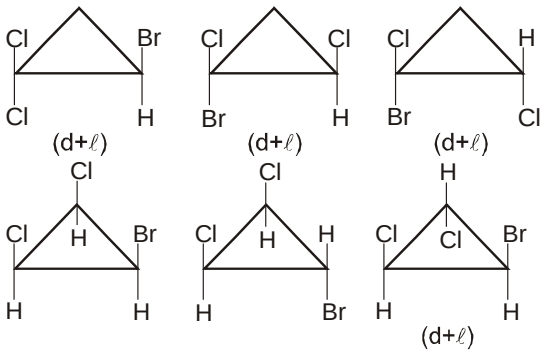
Fraction$_1$ (I+II) + fraction$_2$ (III + IV).

22. Number of optically active stereoisomers = 4 and total stereoisomers = 6.

23. Total no. of stereocentres (n) = 4

Total no. of optical isomers = $2^n = 2^4 = 16$

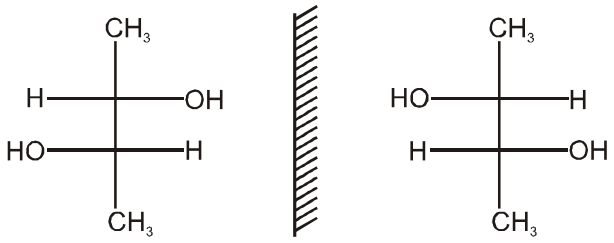
24.



3. Meso tartaric acid is optically inactive and it has plane of symmetry.

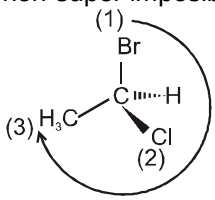
EXERCISE # 3
PART - I

1.



non-super imposible mirror image stereoisomers.

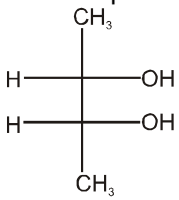
2.



Clock wise arrow represents 'R' configuration.

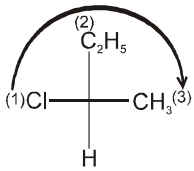
4. 3–Bromopentane does not have chiral carbon.

5.



meso form

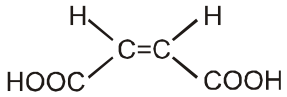
6.



clockwise arrow represent 'R' configuration.

7. Anti form of butane is more stable because of less strains.

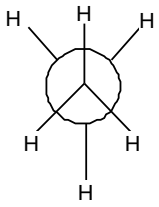
8.



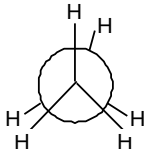
Maleic acid

It shows Geometrical isomerism but does not show optical isomerism.

10.



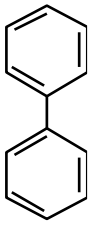
Staggered Newmann conformation



Eclipsed Newmann conformation

due to bond pair – bond pair repulsion (Torsional strain) Eclipsed conformation is less stable than staggered conformation.

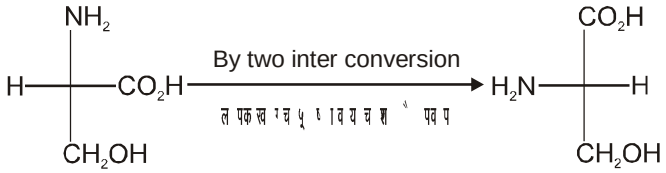
11. O-substituted biphenyls are optically active as both the rings are not in one plane hence their mirror mages are non-super imposable.

12.  Biphenyl

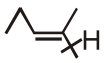
All carbon atom is sp^2 hybridised and its geometry is trigonal planar.

14. Among the three conformers of ethane (Eclipsed, staggered, gauche) bond angle and bond length remains the same while their energy, stability and dihedral angle are different.

PART - II

5. 

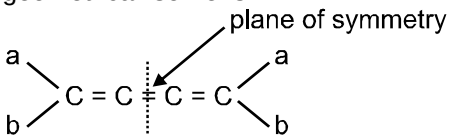
NH_2 group at LHS. So configuration is 'L'

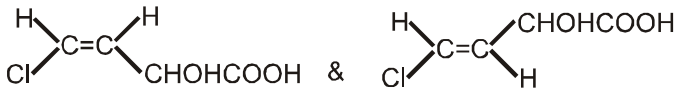
6. Compound  has not chiral centre.

7. Boiling points of isomeric compounds depends on dipole-dipole interactions and cis- isomers have greater dipole moments (more polar) than trans-isomers (less polar) generally.

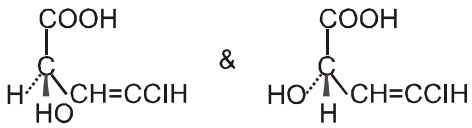
8. Since in ketoxime $(CH_3)_2C = NOH$ two same ($-CH_3$) groups are present on double bonded carbon atom, its other form is not possible and it does not exhibit geometrical isomerism.

9. Trienes have planar structure, thus do not exhibit optical isomerism. These structures can show geometrical isomerism.



10. 

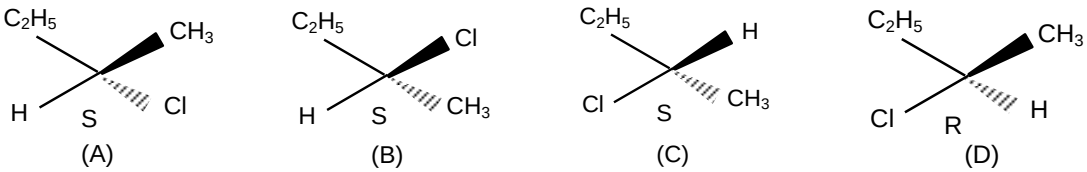
Geometrical isomers



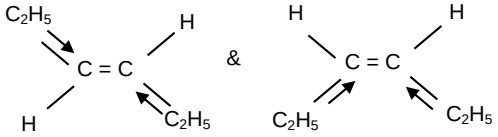
Optical isomers

CHCl = CHCHOHCOOH & CH_2=C(Cl)CH(OH)COOH Position isomers

CHCl = CHCHOHCOOH & O=CH–CH(Cl)$COOCH_3$ Functional isomers

14. 

15.



Trans – 3 – Hexene
$\mu = 0$

C is – 3 – Hexene
$\mu > 0$

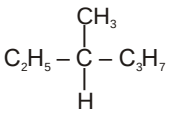
M. P. of Trans isomer High than ci'sIsomer.

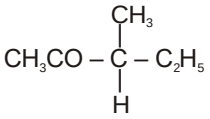
PART - III

1. An equimolar mixture of two i.e., dextro and laevorotatory optical isomers is termed as racemic mixture or dl form or (±) mixture.

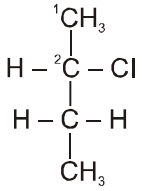
2. $Cl_2–C=CH–CH_2–CH_2–CH_3$
Identical groups (Cl) on C-I will give only one compound.

3. A chiral object or compound can be defined as the one that is not superimposable on its mirror image, or we can say that all the four groups attached to a carbon atom must be different. only I and II are chiral compounds.

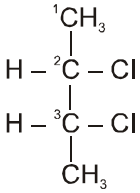
(I) 

(II) 

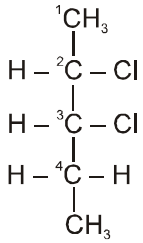
4.



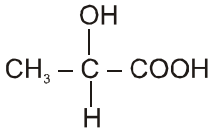
2-chlorobutane



2,3-Dichlorobutane

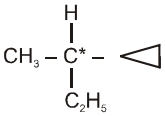


2,3-Dichloropentane

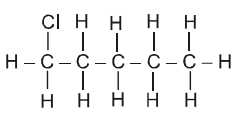


2-hydroxypropanoic acid

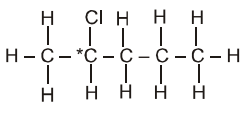
2,3-dichlorobutane have meso isomer due to the presence of plane of symmetry.

5.  Optically active due to presence of chiral carbon atom .

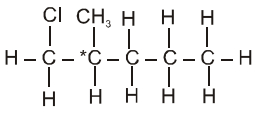
6. To be optically active the compound or structure should possess chiral or asymmetric centre but in the rest of the structure it is present.



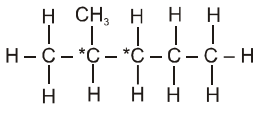
1-chloropentane



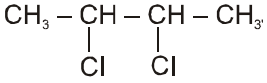
2-chloropentane



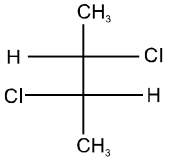
1-chloro-2-methyl pentane

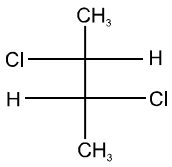


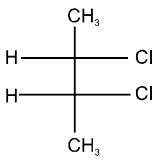
3-chloro-2-methyl pentane

7. Due to presence of two asymmetric carbon atoms in 2, 3-dichlorobutane, 

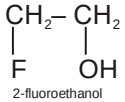
it exhibits optical isomerism.



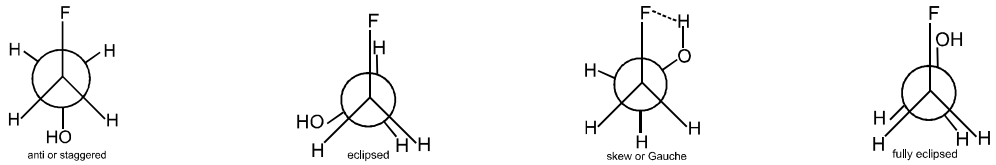




8.

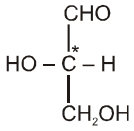


2-fluoroethanol



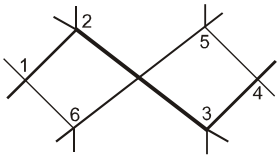
Gauche form is more stable due to intramolecular H-bonding

9.



Due to the presence of chiral carbon atom it is optically active, hence it is expected to rotate plane of polarized light.

10. The twist boat conformation of cyclohexane is optically active as it does not have any plane of symmetry



11. According to CIP rule first decide the seniority of groups and than decide the configuration.

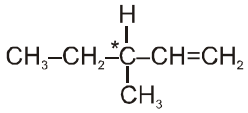
12. $CH_3–CH=CH–CH_3$

2-butene

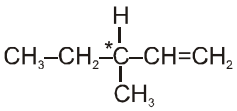
13. $CH_3–\underset{\text{OH}}{\overset{*}{C}}H–CH=CH–CH_3$ Total possible isomers are four.

cis – R
trans – R
cis – S
trans – S

14.



3-Methyl-1-pentene

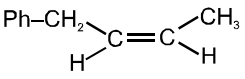


3-मेथिल-1-पेन्टीन

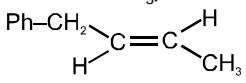
It is optical active since it has chiral carbon atom.

15. Molecules with restricted rotation and having two different groups on both restricted atoms can show geometrical isomerism.

1 - Phenyl - 2- butene ($Ph–CH_2–CH=CH–CH_3$)

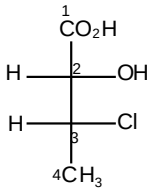


(cis)

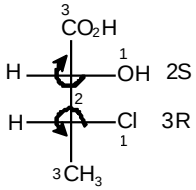


(trans)

16.



IUPAC numbering



Numbering according to CIP rules for R/S naming