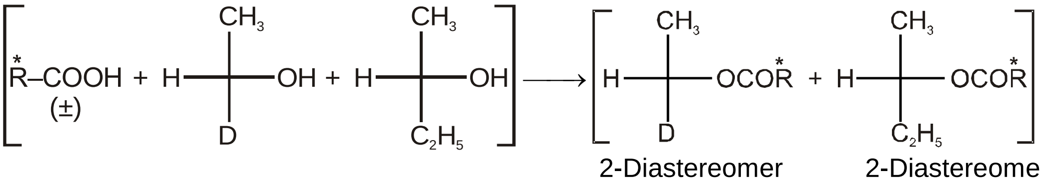
# SOLUTIONS OF STEREOISOMERISM

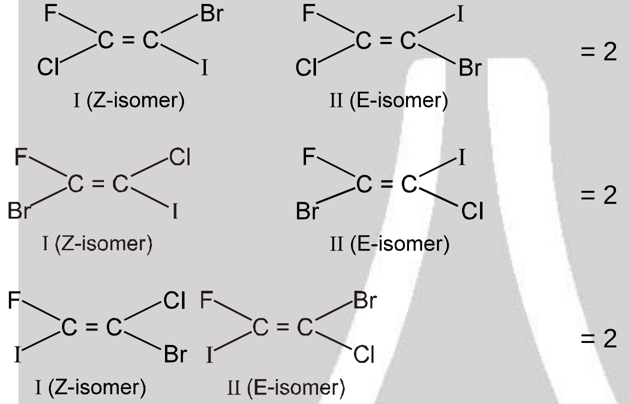
## EXERCISE # 1

## PART - I

**G-4.**



**I-6.** Molecule $C_2BrClFI$ shows geometrical isomerism as E & Z-isomers.



Hence total isomers are six.

## PART - II

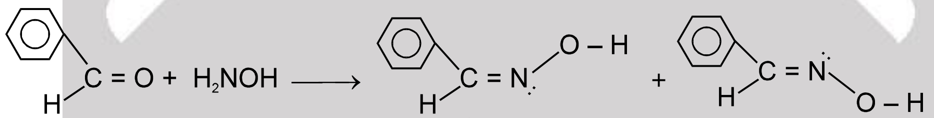
**A-1.** Stereoisomers have same connectivity of atoms but different orientations (configurations) in space.

**A-2.** Follow conditions of geometrical isomerism.

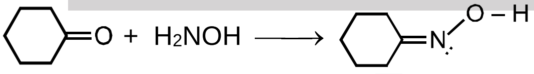
**A-3.** Follow conditions of geometrical isomerism.

**A-4.** Follow conditions of geometrical isomerism.

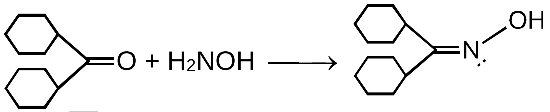
**A-5.** (A)



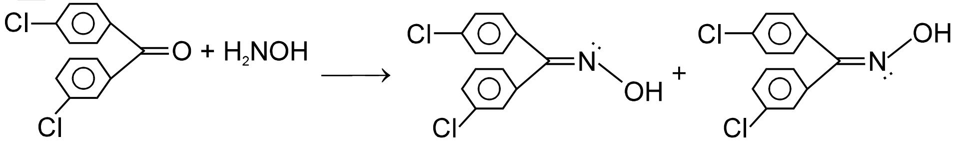
(B)



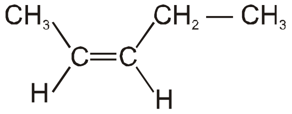
(C)



(D)

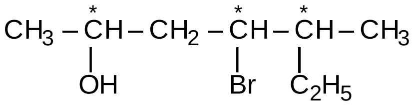


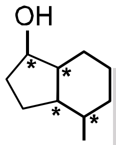
**B-1.** (Z)-2-pentene



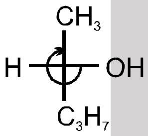
[Senior groups at same side of restricted rotation]

**B-2.** E-isomers have senior groups on anti-orientation.

**C-2.** 
$\mathrm{CH_3-\underset{\substack{|\\ OH}}{\overset{*}{C}H}-CH_2-\underset{\substack{|\\ Br}}{\overset{*}{C}H}-\underset{\substack{|\\ C_2H_5}}{\overset{*}{C}H}-CH_3}$ has three chiral carbons.

**C-3.** 

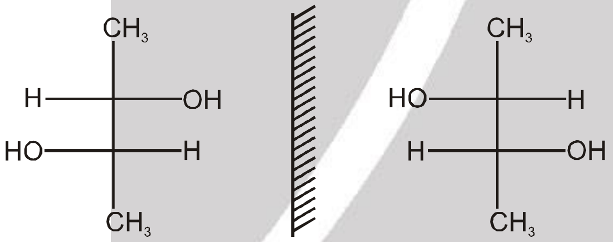
Four chiral carbon atoms

**D-1.** 

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

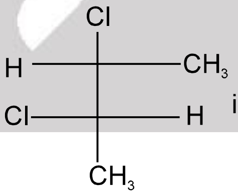
**D-2.** (A) E (B) R (C) S (D) Z

**D-3.** First decide the (R/S) configuration in wedge-dash and then draw fischer projection for same configuration.

**F-2.** 

non-super imposible mirror image stereoisomers.

**G-2.** (B) +12 unit Since specific rotation [$\alpha$] is independent of $\ell$, C.

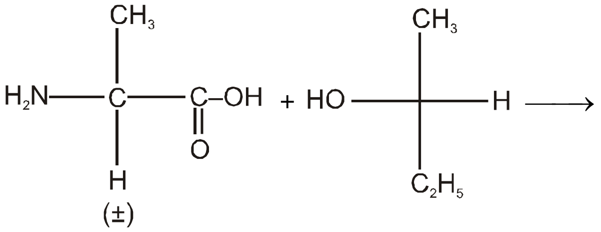
**G-3.** Compound 

is a meso compound hence it has zero optical rotation.

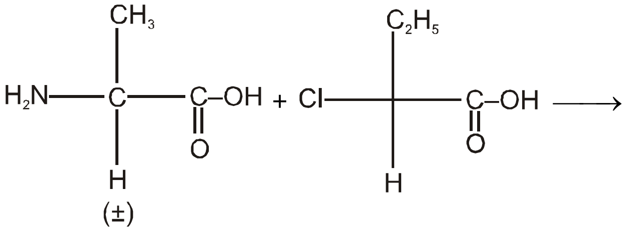
**G-4.** $$\%\text{ Enantiomeric excess} = \frac{\text{Excess of one enantiomer over other}}{\text{Entire mixture}} \times 100 = \frac{6-4}{6+4} \times 100 = 20\%$$

$$\%\text{ optical purity} = \frac{[\alpha]_{\text{observed}}}{[\alpha]_{\text{pure}}} \times 100 \Rightarrow 20 = \frac{[\alpha]_{\text{observed}}}{13.5} \times 100 \Rightarrow [\alpha]\text{ observed} = +2.7$$

**G-5.**



two diastereomeric esters

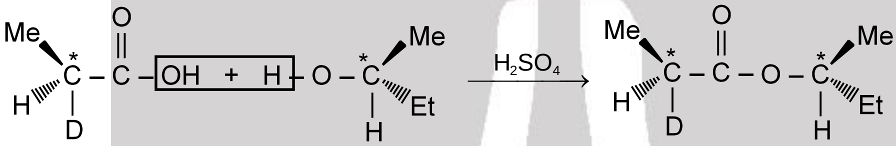


two diastereomeric amides

(–) –2–chlorobutanoicacid

Racemic mixture can be resolved by using optically active compounds.

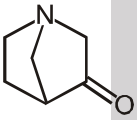
**G-6.**



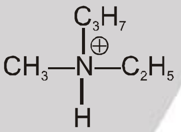
Since carbocation does not form any chiral carbon in this reactions hence racemic mixture can not form.

**G-7.** Enatiomers have same physical properties so they can not be separated by any physical method which diastereomers have different physical properties.

**H-1.**

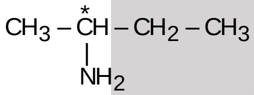


and



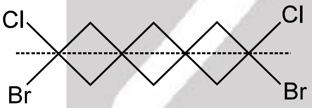
$CH_3—\overset{\oplus}{N}(C_3H_7)(H)—C_2H_5$ are chiral and optically active.

**H-2.**



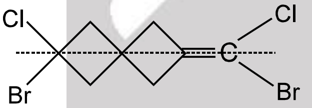
$CH_3-\overset{*}{C}H(NH_2)-CH_2-CH_3$ has chiral carbon.

**H-4.** (A)



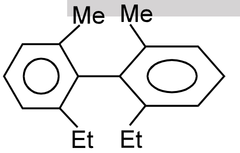
Plane of symmetry is present, so it is achiral.

(B)



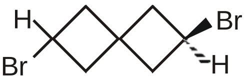
Plane of symmetry is present, so it is achiral.

(C)



Optical active because both phenyl rings in the perpendicular plane.

(D)



Optical active.

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

**I-2.** Unsymmetrical compound with 2 stereocentres has 4 geometrical isomers.

**I-3.** Unsymmetrical compound with 2 stereocentres has 4 geometrical isomers.

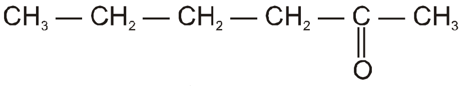
**I-4.** Unsymmetrical compound with 2 chiral centres has $2^2 = 4$ stereoisomers.

**I-5.** Number of optically active stereoisomers of tartaric acid = 2.

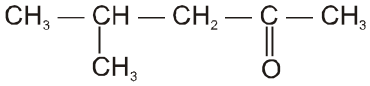
**I-7.** Number of optically active stereoisomers = 2.

**I-8.** $C_6H_{12}O$

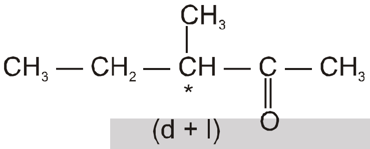
D.U. = 1



$CH_3-CH_2-CH_2-CH_2-\underset{\underset{O}{||}}{C}-CH_3$

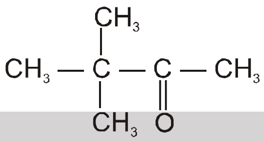


$CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-\underset{\underset{O}{||}}{C}-CH_3$

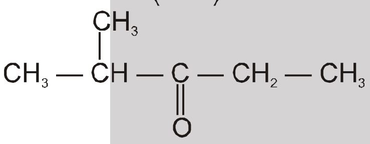


$CH_3-CH_2-\underset{*}{\overset{\overset{CH_3}{|}}{CH}}-\underset{\underset{O}{||}}{C}-CH_3$

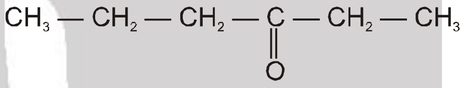
(d + l)



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



$CH_3-\overset{\overset{CH_3}{|}}{CH}-\underset{\underset{O}{||}}{C}-CH_2-CH_3$



$CH_3-CH_2-CH_2-\underset{\underset{O}{||}}{C}-CH_2-CH_3$

∴ Total no. of ketones = 7

**I-9.** Total no. of stereocentres (n) = 4

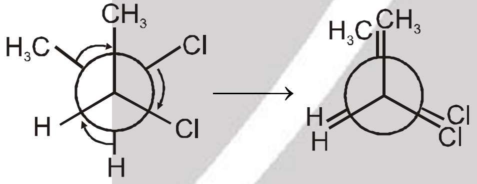
Total no. of optical isomers = $2^n = 2^4 = 16$

**J-1.** The eclipsed and staggered conformation of ethane is due to free rotation about C—C single bond.

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

**J-5.** Anti form of butane is more stable because of less strains.

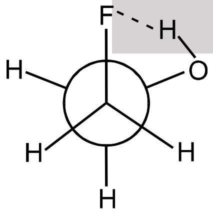
**J-7.** (A) is meso form so it is achiral molecule



Meso form

**J-8.** X = Hydrogen, Y = $-CH(CH_3)_2$

**J-9.**



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

**J-11.** Both are meso compounds (achiral) and identical with its mirror image.

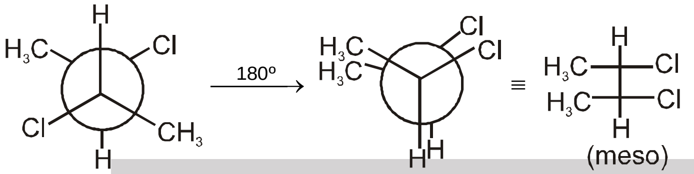
# EXERCISE # 2

## PART – I

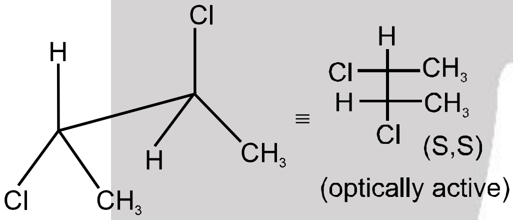
**1.** These molecules except D have at least one plane of symmetry. So these are symmetric achiral molecules.

**2.** Compound which has chiral carbon can show enantiomerism.

**3.**

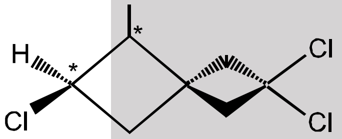


(meso)



(b)

**5.**



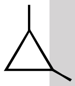
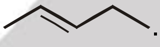
(chirality)

**6.** Since total two products are formed hence both carbonyl should be symmetrical.

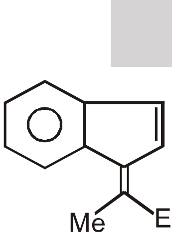
**7.** Number of geometical centres (n) = 4. So, total G.I. = $2^4$ = 16

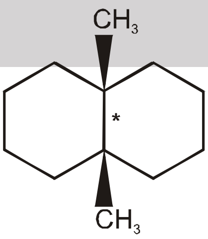
**9.** Have 8 spatial orientation due to chiral C, >C = C< bond & along 2, 2′, 6, 6′ biphenyl.

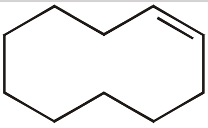
## PART - II

**1.** Only  and .

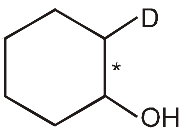
**2.**



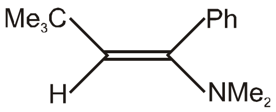




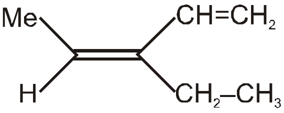
&



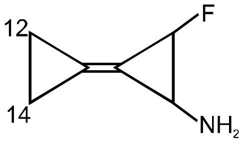
**3.**



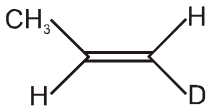
E



Z



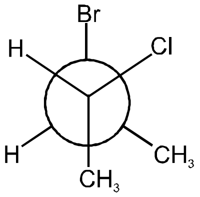
E



E

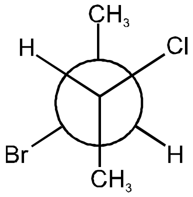
**5.** Acetic acid is optically inactive.

**6.**



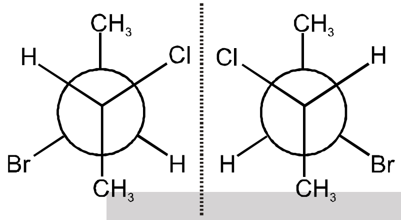
(A)

=



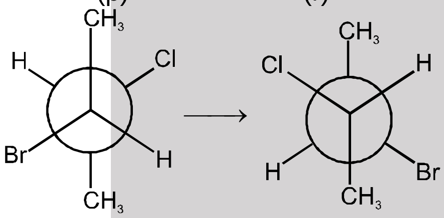
(p)

(P) is identical with (A).



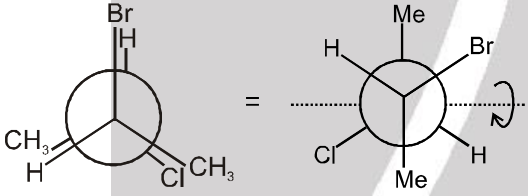
(p) (r)

Therefore (r) is an enantiomer of (A) as (P) is a mirror image of (r).



(s) (r)

Back side view is similar to (r), so enantiomer of (A).



Back side view is similar to (r), so enantiomer of (A).

**7.** Enatiomeric excess = $\frac{[\alpha]\text{ mixture}}{[\alpha]\text{ pure enantiomer}} \times 100 = \frac{-8}{-32} \times 100 = 25\%$

**8.** $[\alpha]_{\text{mix.}} = \frac{[\alpha]_R - [\alpha]_S}{100} = \frac{-150\times60+150\times40}{100} = -30$

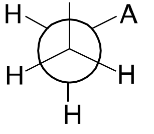
Or $[\alpha]_{\text{mix.}} = \frac{\left[\frac{d-\ell}{d+\ell}\times100\right]\times\left[\alpha\right]_{\text{pure}}}{100} = \frac{\left[\frac{60-40}{60+40}\times100\right]\times(-150)}{100} = -30$

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

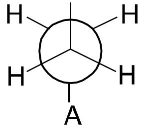
**10.** Geometrical isomers for symmetrical compounds = $2^{n-1} + 2^{\frac{n-1}{2}}$
n = 3, total G.I. = 6

**12.** Number of optically active stereoisomers = 4 and total stereoisomers = 6.

**13.**



Gauche form



Anti form

The following values are given in the question: $\mu_{obs}$ = 2D, $X_{anti}$ = 0.75, so $X_{gauche}$ = 1– 0.75 = 0.25

By using the formule ⇒ $\mu_{obs} = \sum \mu_i X_i$

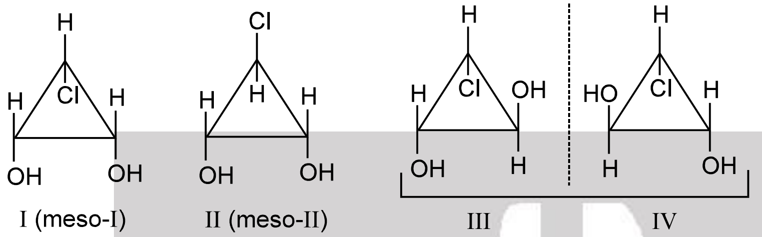
$\mu_{obs} = \mu_{gauche} \times X_{gauche} + \mu_{anti} \times X_{anti}$

$2 = \mu_{gauche} \times 0.25 + 0.75 \times 0$

$\mu_{gauche} = \frac{2}{0.25} = 8D$

**14.** There are five stereocentres in the compound total stereoisomers = $2^5–1 = 31$.

**15.** M has following orientations

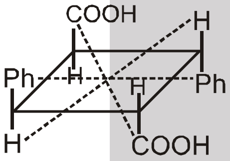


optically active enantiomers (d + ℓ)

Total geometrical orientations = 3

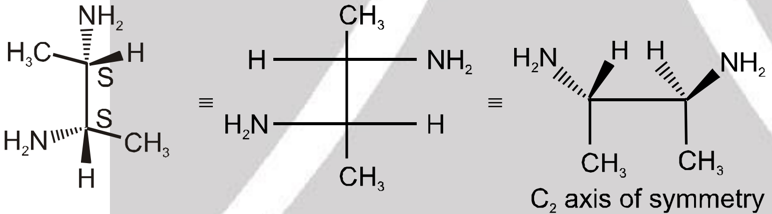
## PART - III

**6.**



COS present, POS absent, optically inactive

**11.**



Optically active

$C_2$ axis of symmetry

**12.** (I) and (II) are enantiomers

## PART - IV

**Sol. (3-5)**

(I) & (i) are enantiomers

(II) & (i) are identical compounds

(I) & (ii) are diastereomers

(III) & (iv) are meso compounds so they are identical

(IV) & (iii) are diastereomers

⇒ Enantiomers having same B.Pt or M.Pt so they can be separated by optical resolution.

⇒ Diastereomers having different B.Pt or M.Pt so they can be separated by Fractional distillation.

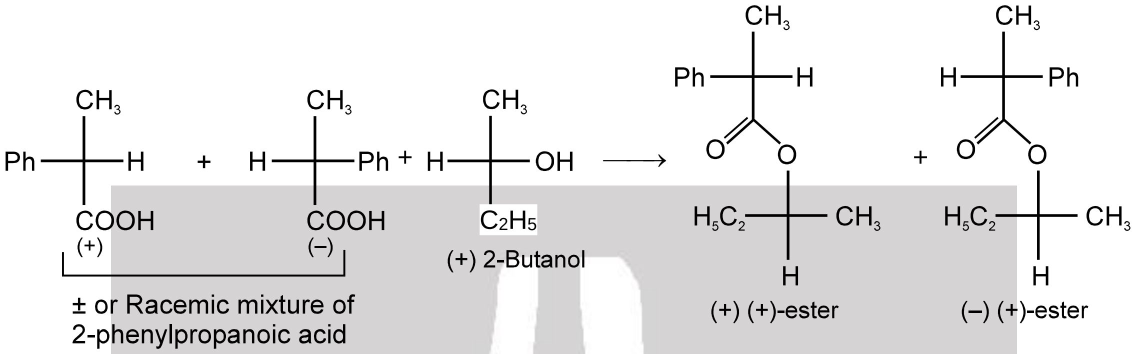
⇒ Mirror image of meso compound are identical & they have same BPt or MPt.

## EXERCISE # 3

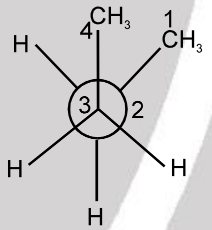
## PART - I

**1.** When optically active acid reacts with racemic mixture of an alcohol, it forms two types of isomeric esters. In each the configuration of the chiral centre of acid will remain the same. So the mixture will be optically active.

**2.**



**3.** Least stable staggered form of n–butane is



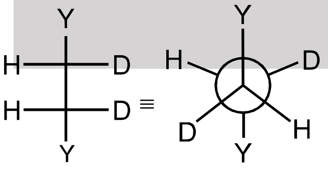
This is due to Vander Waal's strain developed between the methyl groups at $C_2$ & $C_3$. There is no torsional strain in the staggered form at torsional angle 60º.

**5.**

Gauche form　　Anti form

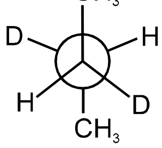
$\mu_{obs} = 1D$　　$x_{gauche} = 0.18$

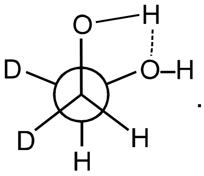
$$\Rightarrow \quad \mu_{obs} = \Sigma \mu_i x_i \quad \Rightarrow \quad 1 = \mu_{gauche} \times 0.18 + 0.82 \times 0 \quad \Rightarrow \quad \mu_{gauche} = \frac{1}{0.18} = 5.55\text{ D}$$



meso

(a) If Y is $CH_3$, the Newman projection is .



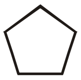
(b) If Y is OH, the Newman projection is 

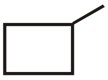
.

**8.** All geometrical isomers are diastereomers.

**9.** (X) has configurations
(1) R Z R (2) S Z S (3) R Z S (4) R E R (5) S E S (6) R E S

**10.**


(1)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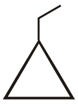
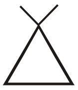
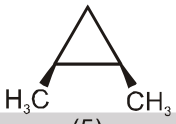
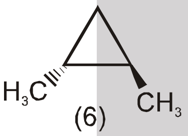

(3)

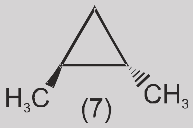

(4)



(5)
(cis, meso)



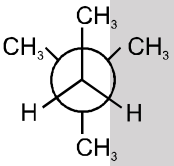
(6)

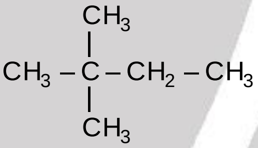


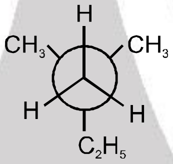
(7)

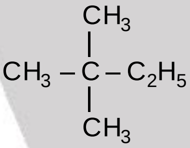
Trans (±)

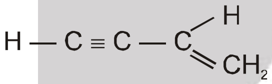
**11.**

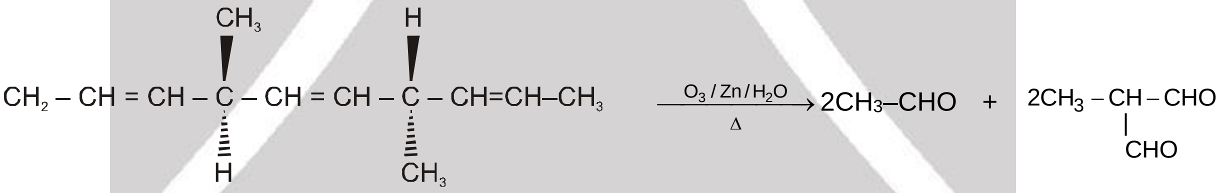


≡ 
$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-CH_2-CH_3$ ,



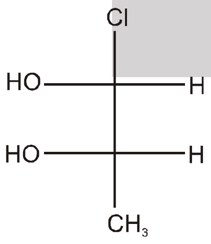
≡ 
$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-C_2H_5$

**12.** In (B) 
$H-C\equiv C-C(H)=CH_2$ and (C) $CH_2{=}{=}C{=}{=}O$ all atoms are always in same plane.

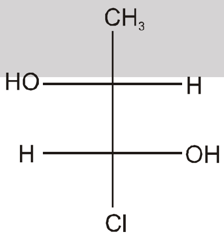
**13.** 
$CH_2-CH=CH-\overset{CH_3}{\underset{H}{C}}-CH=CH-\overset{H}{\underset{CH_3}{C}}-CH{=}CH{-}CH_3 \xrightarrow[\Delta]{O_3/Zn/H_2O} 2CH_3{-}CHO + 2CH_3-\underset{CHO}{CH}-CHO$

All optically inactive products

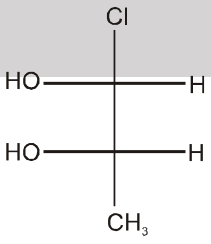
**14.**



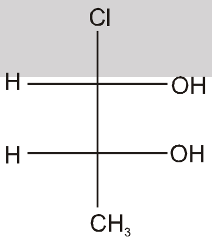
M



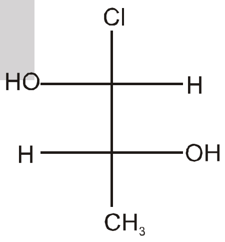
N



O

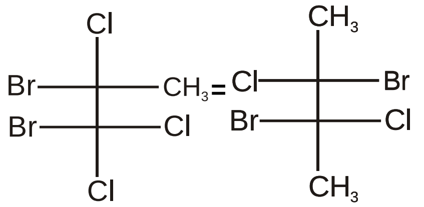


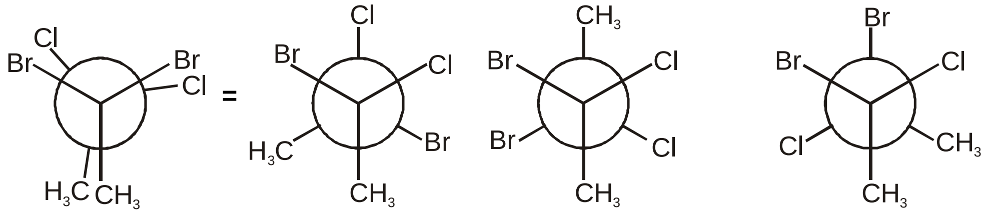
P



Q

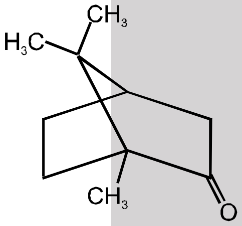
**15.**





Three stable (staggared) conformers exist (with $\mu \neq 0$)

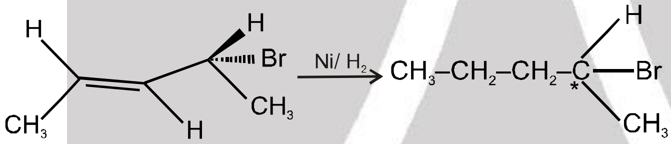
**16.** Total number of stereoisomers = 2



d + ℓ pair

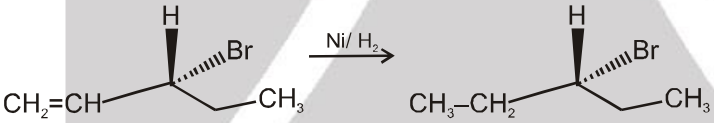
This molecule can not show geometrical isomerism so only mirror image will be other stereoisomer.

**17.** **(A)**



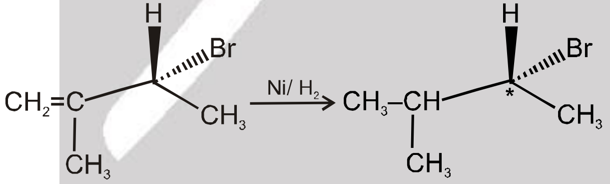
**(Optically active)**

**(B)**



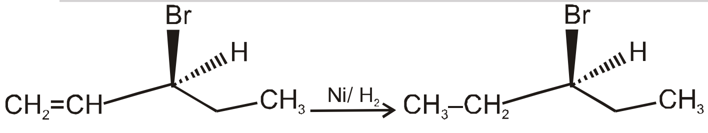
**(Optically inactive)**

**(C)**



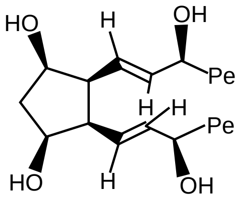
**(Optically active)**

**(D)**

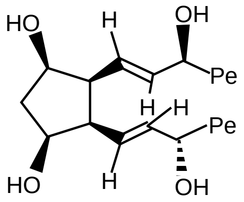


**(Optically inactive)**

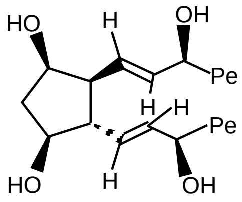
**18.**



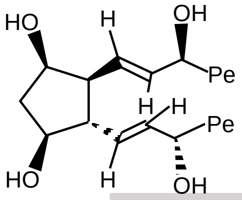
Optically Active



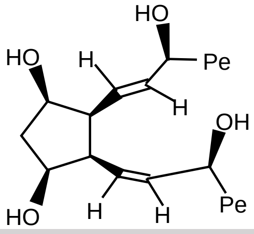
Optically Active



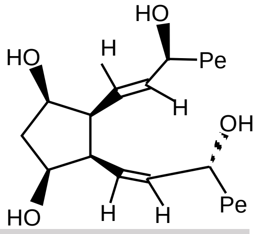
Optically Active



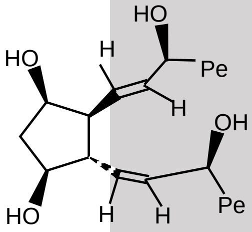
Optically Active



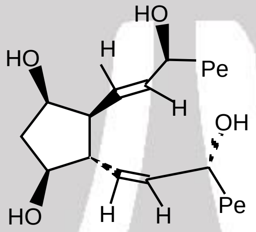
Optically Active



Optically Active

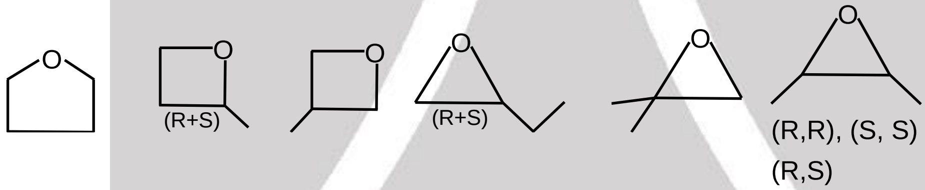


Optically Active



Optically Active

**19.**



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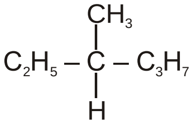
## PART - II

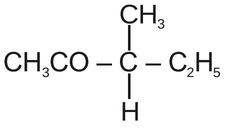
## JEE-MAIN (OFFLINE) SOLUTIONS

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

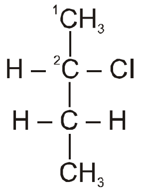
**2.** $Cl_2–C=CH–CH_2–CH_2–CH_3$
Identical groups (Cl) on C-I will give only one compound.

**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.

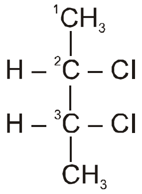
(I) 
$C_2H_5 – \underset{H}{\overset{CH_3}{C}} – C_3H_7$

(II) 
$CH_3CO – \underset{H}{\overset{CH_3}{C}} – C_2H_5$

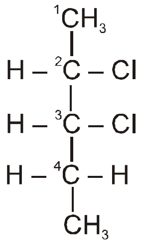
**4.**



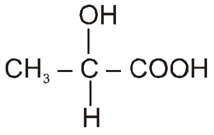
2-chlorobutane



2,3-Dichlorobutane



2,3-Dichloropentane

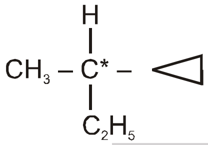


$CH_3-\overset{OH}{\underset{H}{C}}-COOH$

2-hydroxypropanoic acid

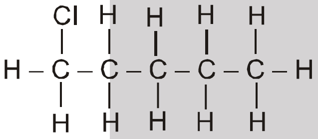
2,3-dichlorobutane have meso isomer due to the presence of plane of symmetry.

**5.**

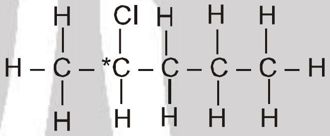


Optically active due to presence of chiral carbon atom .

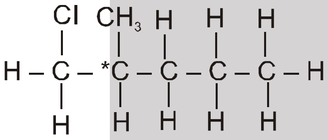
**6.** To be optically active the compound or structure should possess chiral or asymmetric centre but in the rest of the structure it is present.



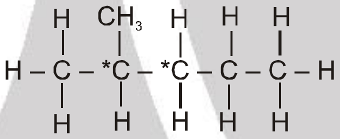
1-chloropentane



2-chloropentane

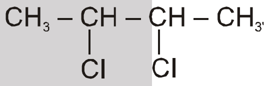


1-chloro-2-methyl pentane



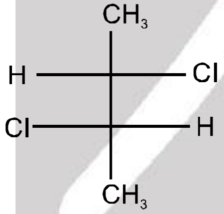
3-chloro-2-methyl pentane

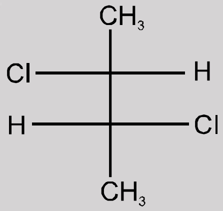
**7.** Due to presence of two asymmetric carbon atoms in 2, 3-dichlorobutane,

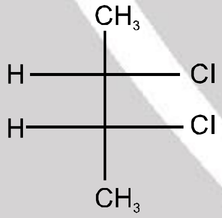


$CH_3-\underset{Cl}{CH}-\underset{Cl}{CH}-CH_3,$

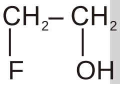
it exhibits optical isomerism.





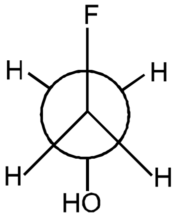


**8.**

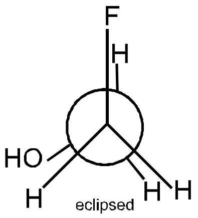


$\underset{F}{CH_2}-\underset{OH}{CH_2}$

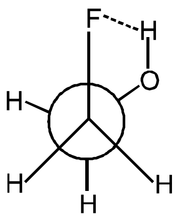
2-fluoroethanol



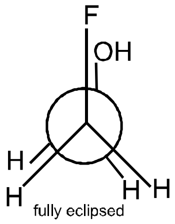
anti or staggered



eclipsed



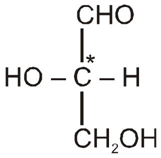
skew or Gauche



fully eclipsed

Gauche form is more stable due to intramolecular H-bonding

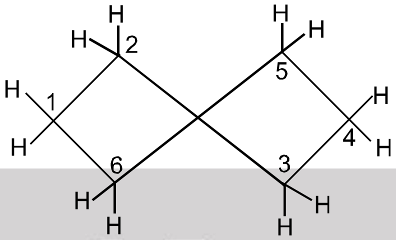
**9.**



$$\begin{array}{c}\mathrm{CHO}\\ |\\ \mathrm{HO-\overset{*}{C}-H}\\ |\\ \mathrm{CH_2OH}\end{array}$$

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

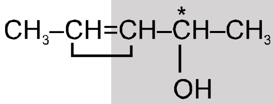
**10.** The twist boat conformation of cyclohexane is optically active as it does not have any plane of symmetry



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

**12.** $\mathrm{CH_3-CH=CH-CH_3}$

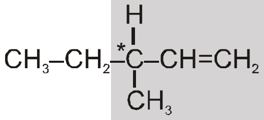
**13.**



$\mathrm{CH_3-\underbrace{CH=CH}-\underset{\underset{OH}{|}}{\overset{*}{C}H}-CH_3}$ Total possible isomers are four.

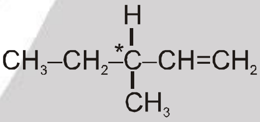
cis – R
trans – R
cis – S
trans – S

**14.**



$\mathrm{CH_3-CH_2-\overset{\overset{H}{|}}{\underset{\underset{CH_3}{|}}{\overset{*}{C}}}-CH=CH_2}$

3-Methyl-1-pentene

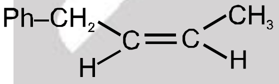


$\mathrm{CH_3-CH_2-\overset{\overset{H}{|}}{\underset{\underset{CH_3}{|}}{\overset{*}{C}}}-CH=CH_2}$

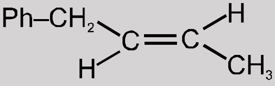
3-मेथिल-1-पेन्टीन

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 ($\mathrm{Ph-CH_2-CH=CH-CH_3}$)

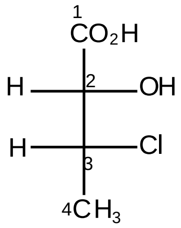


(cis)

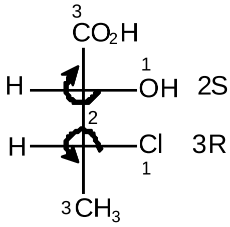


(trans)

**16.**



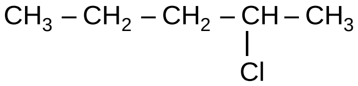
IUPAC numbering



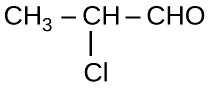
Numbering according to CIP rules for R/S naming

## JEE-MAIN (ONLINE) SOLUTIONS

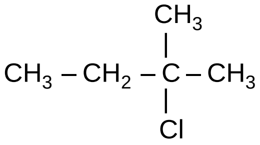
**2.**



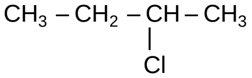
$CH_3-CH_2-CH_2-\underset{\substack{|\\ Cl}}{CH}-CH_3$



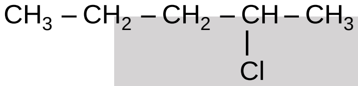
$CH_3-\underset{\substack{|\\ Cl}}{CH}-CHO$



$CH_3-CH_2-\overset{\substack{CH_3\\ |}}{\underset{\substack{|\\ Cl}}{C}}-CH_3$



$CH_3-CH_2-\underset{\substack{|\\ Cl}}{CH}-CH_3$



$CH_3-CH_2-CH_2-\underset{\substack{|\\ Cl}}{CH}-CH_3$

**3.** Both valences are identical in I.

**4.**