



## Types of Stereo Isomerism

Optical Isomerism      Geometrical Isomerism      Conformational Isomerism

- (I) Optical Isomerism :** The compounds having the same molecular formula, the same structural formula but different behaviour towards the plane polarised light are known as Optical Isomers. Terminology used in optical isomerism.

- **Plane polarised light:** Light having vibrations restricted to one plane only is called plane polarised light.
- **Optically active compounds :** The compounds capable of rotating the plane of polarisation of plane polarised light are known as optically active compounds.
- **Optical activity:** It is the ability of a substance to rotate the plane of polarisation of plane polarised light.
- **Dextrorotatory compounds (d or +) :** The compounds which rotate the plane of polarisation of plane polarised light towards the right hand side are called dextro rotatory.
- **Laevo rotatory compounds (l or -) :** The compounds which rotate the plane of polarisation of plane polarised light towards the left hand side are called laevo rotatory.
- **Specific rotation :** The rotatory power of optically active compounds is compared in terms of specific rotation.

$$[\alpha]_D^t = \frac{\text{Observed rotation in degrees}}{\text{Length of tube in decimeter} \times \text{Concentration of solution in g/ml}}$$

$$[\alpha]_D^t = \frac{\theta}{\ell \times C}$$

- D corresponds to D line of Sodium light ( $\lambda = 5893\text{\AA}$ )
- t corresponds to temperature
- Rotation is observed and measured with a polarimeter. The specific rotation varies with light  $\lambda$  and temperature.
- **Optical activity due to Crystalline Structure :** Some compounds are optically active only in crystalline form. They lose their optical activity when dissolved or fused e.g. Quartz.

Optical activity due to molecular structure : Some compounds are optically active in solid as well as in solution e.g. tartaric acid. Hence their optical activity is due to their molecular structure which remains the same in solid form and in solution.

- **Asymmetric carbon atom :** A carbon atom attached to four different atoms and groups is called asymmetric carbon atom. e.g.  $\text{CH}_3\overset{*}{\text{CHOHCOOH}}$ .

## STEREOISOMERISM

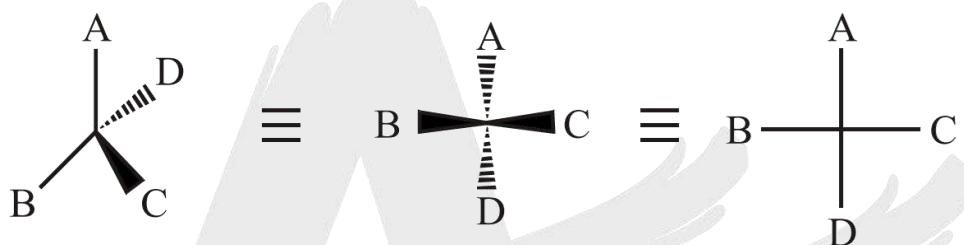
- **Chirality:** If the mirror image of the molecule is different from the molecule it is said to be a chiral molecule. In such case if one configuration of the molecule is placed above its mirror image configuration, the similar atoms and groups do not fall over each other and the configurations are said to be non-superimposable.

If object and mirror image configurations are superimposable (similar atoms and groups fall over each other) the molecule is said to be "Achiral".

Chirality is the necessary condition for a compound to be optically active.

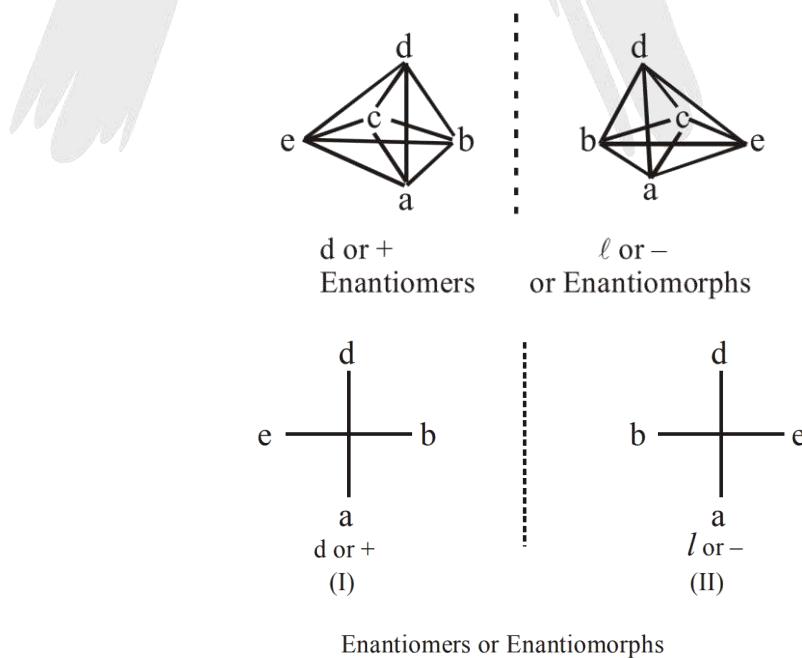
**Enantiomers :** Pairs of nonsuperimposable mirror images are called enantiomers.

**Fischer Projections :** Fischer projections are drawn with a cross, with chiral atom at the centre of the cross.

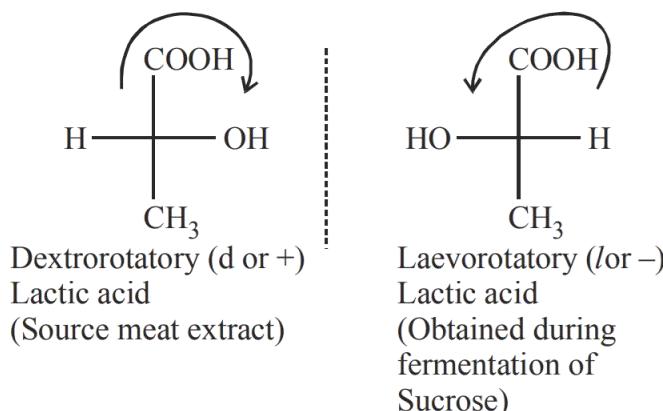


The horizontal line represents wedges (bonds) coming out of the plane of the paper. The vertical line represents dashed lines (bonds) in the plane of the paper (Bow-tie convention). The carbon chain is drawn along the vertical line of the projection with most highly oxidised carbon substituent at the top. Fischer projections are very useful to determine chirality of a compound.

**Lebel and Van't Hoff's theory about optical isomerism :** The tetrahedral structure of a compound containing asymmetric carbon atom (\* Cabed) gives two configurations related to each other as object and its mirror image but are non-superimposable.

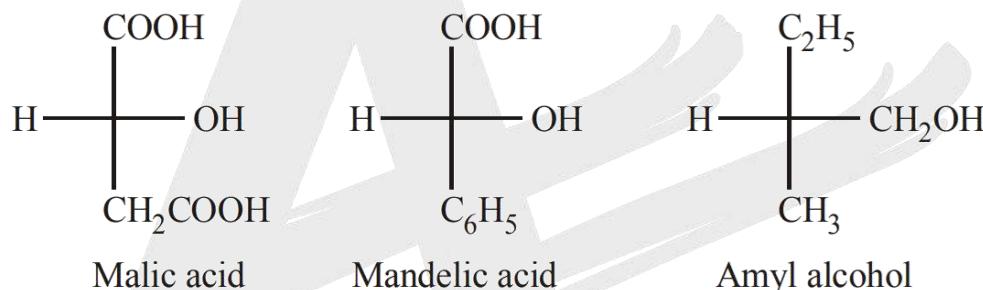


**Optical isomerism of Lactic acid :**  $\text{CH}_3\text{CHOH}.\text{COOH}$



**Racemic Lactic acid :** It is an equimolar mixture of d - and l - forms. It is optically inactive due to external compensation of optical rotation. It is present in sour milk. It can be resolved.

**Examples of optically active compounds containing one asymmetric C-atom.**



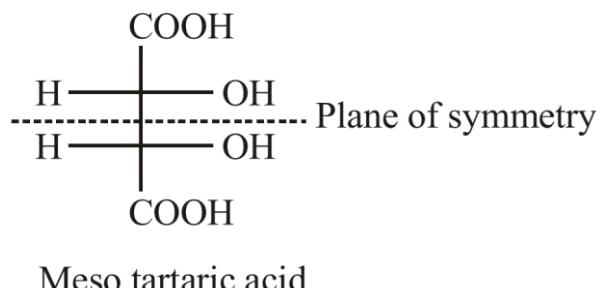
Number of optically active forms is given by  $2^n$  where  $n$  is number of asymmetric C-atoms different in nature.

**Resolution :** The separation of d - and l-forms present in a racemic mixture is known as resolution.

**Conditions for Chirality:** Absence of

- (I) Plane of symmetry
- (II) Centre of symmetry
- (III) Alternating axis of symmetry.

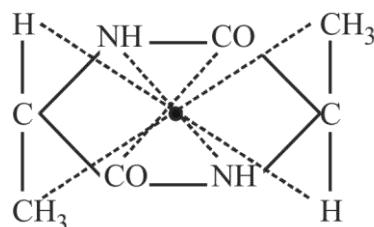
**Plane of Symmetry:** A plane which divides the molecule in two portions in such a way that one portion is the mirror image of the other eg. Tartaric acid.



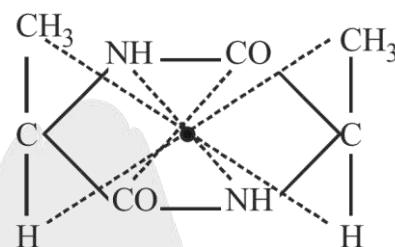
It is optically inactive due to internal compensation of optical rotation. It cannot be resolved.

**STEREOISOMERISM**

**Centre of Symmetry :** It is a point from which lines, when drawn on one side to meet the groups and produced to an equal distance on the other side of the point will meet the same original groups.

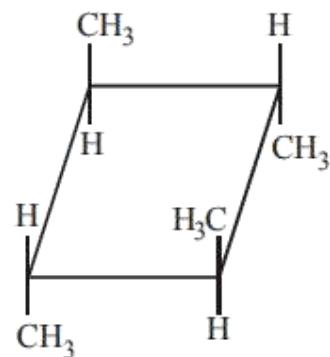
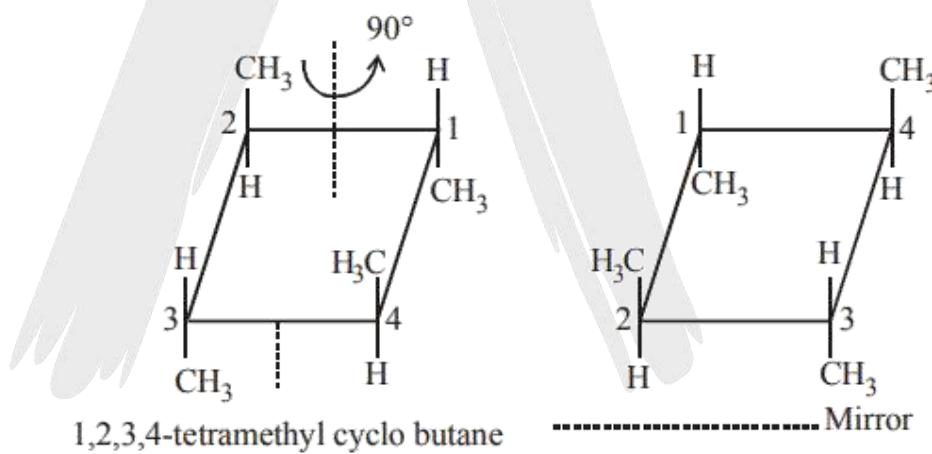


Trans: 1,4-dimethyl diketo piperazino (Inactive)  
Contains centre of symmetry

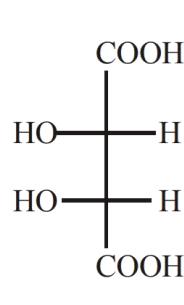
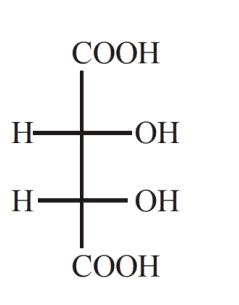


cis: 1,4-dimethyl diketo piperazino (Active)  
No centre of symmetry

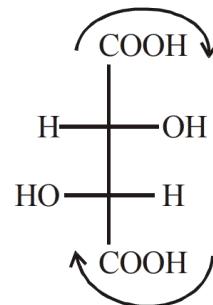
**Alternating axis of symmetry:** If a molecule is rotated through an angle of  $\frac{360^\circ}{n}$  about the axis and then reflected in a plane perpendicular to the axis, gives back the original molecule it is said to possess the n fold alternating axis of symmetry.



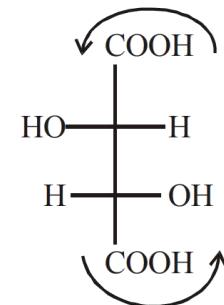
**Optical Isomerism of tartaric acid :** (It contains two similar asymmetric C-atoms).



Meso tartaric acid  
(I) (II)



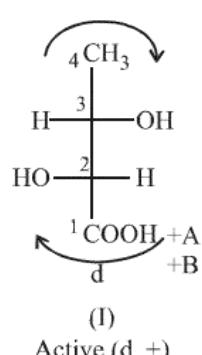
d-tartaric acid  
(III)



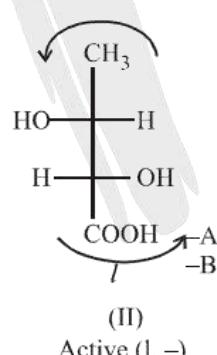
l-tartaric acid  
(IV)

- When the configuration II is rotated through an angle 180° the configuration I is obtained hence they are not enantiomers but represent one single compound.
- d-tartaric acid is obtained from grapes and tamarind. Its mpt is 170°C.
- l-tartaric acid is prepared by resolving racemic acid. Its mpt is 170°C.
- Meso-tartaric acid is obtained by oxidation of maleic acid, heating d-tartaric acid with water at 170°C. Its mpt is 143°C.
- Racemic tartaric acid ( dl or  $\pm$  ). It is obtained from Argol. Its mpt is 206°C. It is an equimolar mixture of d and l forms.
- Racemic tartaric acid can be resolved into d and l forms. It is a mixture of two compounds.
- Meso-tartaric acid cannot be resolved. It is a single compound.

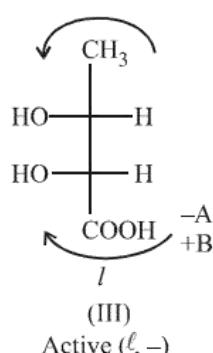
### Optical Isomerism of the compound containing two dissimilar C-atoms : Example $\alpha, \beta$ -dibromo cinnamic acid and 2,3-dihydroxy butanoic acid.



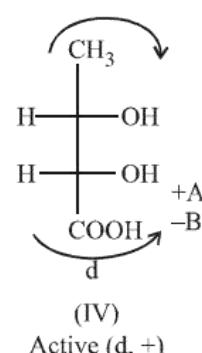
(I)  
Active (d, +)



(II)  
Active (l, -)



(III)  
Active (l, -)



(IV)  
Active (d, +)

## STEREOISOMERISM

Let optical rotation due to chiral centre  $C_3$  and  $C_2$  be A and B and further A > B. In the above case I-II and III-IV are pairs of enantiomers where as I-III; I-IV, II-III, and II-IV are pairs of diastereoisomers.

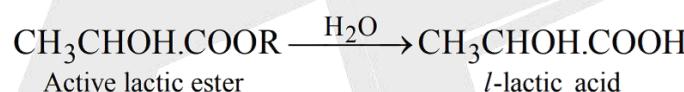
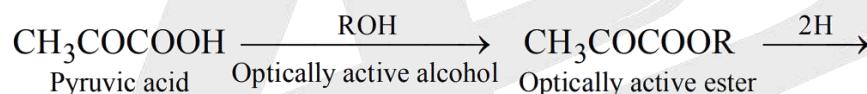
**Diastereoisomers :** Stereo isomers which are not mirror images of each other are called diastereoisomers. They have different physical properties (mpt, bpt, solubility) and are often easy to separate by distillation, recrystallisation, chromatography etc.)

The same compound pair are called the meso diastereoisomer (I-II in case of Tartaric acid see above).

Most diastereoisomers are either geometric isomers or compounds with two or more chiral atoms.

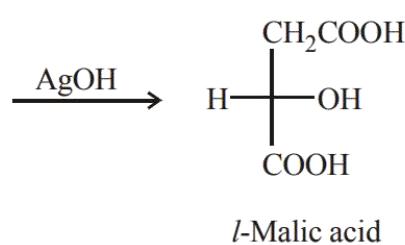
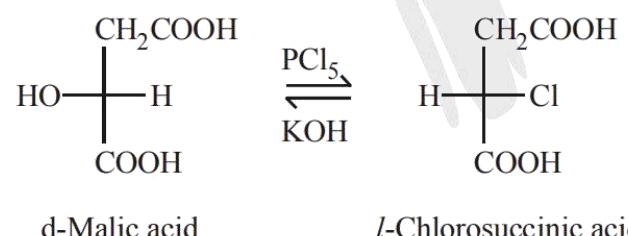
**Enantiomers :** Enantiomers are non-superimposable mirror image isomers. They have identical physical properties (bpt, mpt, density etc.) except for their rotation of plane polarised light. They are much more difficult to separate. In nature very often only one enantiomer is produced. Living organisms are one of the best sources of optically active compounds (plants, enzymes, animals, cells etc.).

**Asymmetric synthesis:** The synthesis of an optically active compound from optically inactive compound under the influence of an optically active compound without resolution is known as asymmetric synthesis.



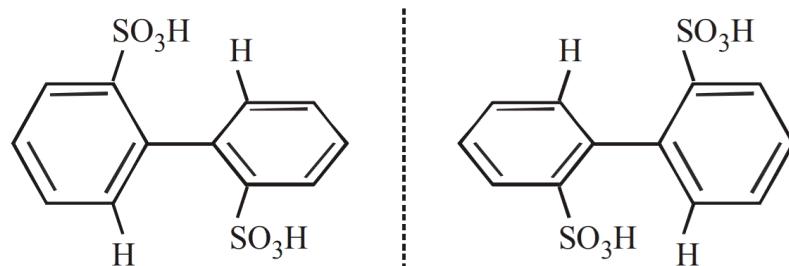
**Racemisation :** The transformation of an optically active isomer under the influence of heat, light or some reagents into an inactive isomer is called racemisation.

**Walden inversion / Optical inversion :** The conversion of an enantiomer into another is called Walden inversion.



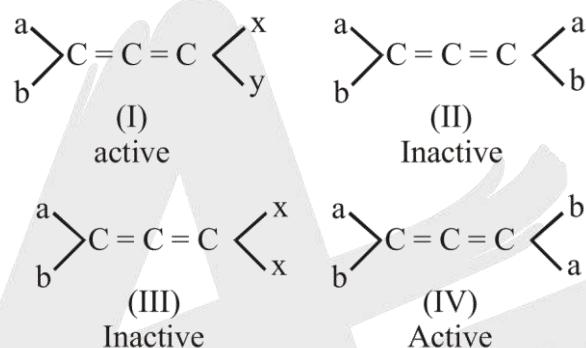
**Optical isomerism due to restricted rotation :**

**(I) Diphenyls :**



Enantiomers of diphenyl disulphonic acid

**(II) Substituted allenes :** Unsymmetrically substituted allene ( $\text{CH}_2 = \text{C} = \text{CH}_2$ ) are optically active.

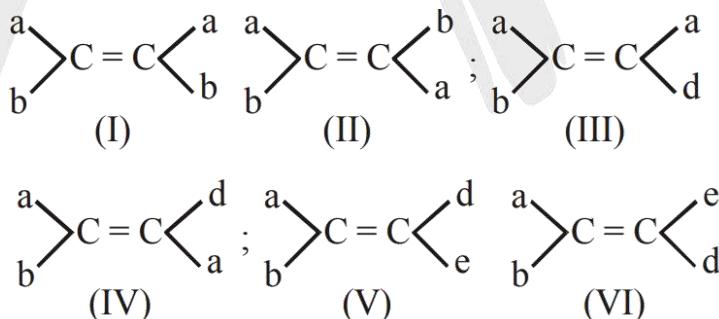


**Enantiomeric excess (Optical Purity):** It is given by Optical purity = O.P.

$$= \frac{\text{Observed rotation}}{\text{Pure enantiomer rotation}} \times 100\% \text{ Or } \text{O.P.} = \frac{d-1}{d+1} \times 100\%$$

where  $d$  and  $\ell$  are ratio of two forms

**Geometrical isomerism :** Alkenes with double bonds cannot undergo free rotation and can have different geometrical shapes with two different groups on each end of the double bond. e.g. molecules  $\text{C}_2\text{a}_2\text{b}_2$ ,  $\text{C}_2\text{a}_2\text{bd}$  or  $\text{C}_2\text{abde}$ .



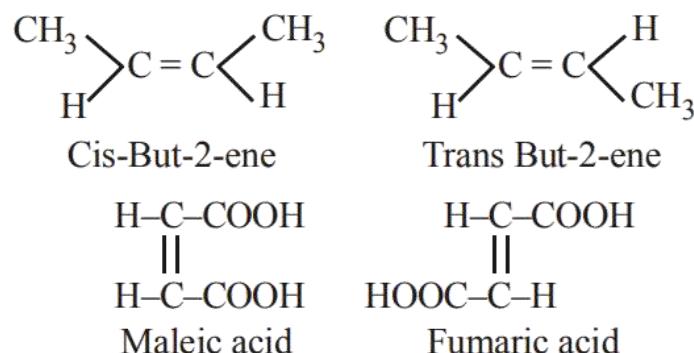
I-II, III-IV and V-VI are pairs of geometrical isomers.

**Nomenclature :**

**Cis Isomer :** Contains the similar atoms or groups on the same side.

**Trans Isomer:** Contains the similar atoms or groups on the opposite side.

**Examples :**

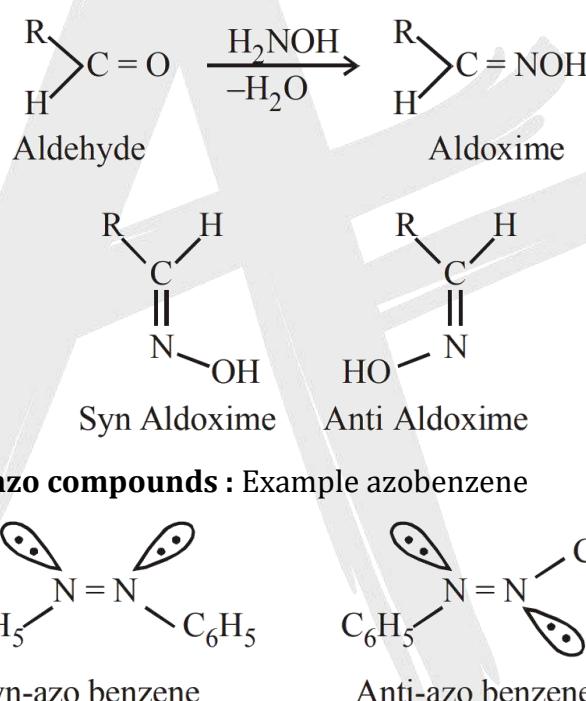


### Geometrical Isomerism of Oximes

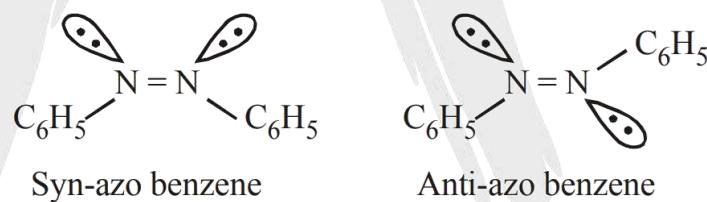
**Aldoximes :**

#### Geometrical Isomerism of Oximes Aldoximes :

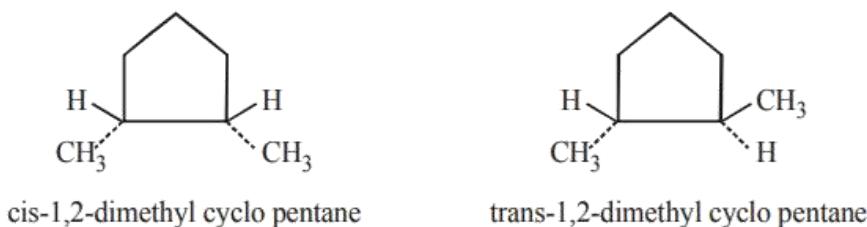
**Ketoximes :**



#### Geometrical isomerism of azo compounds : Example azobenzene



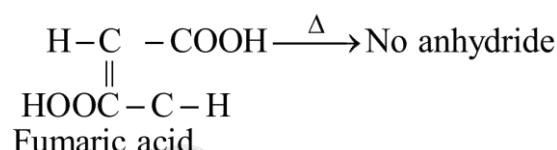
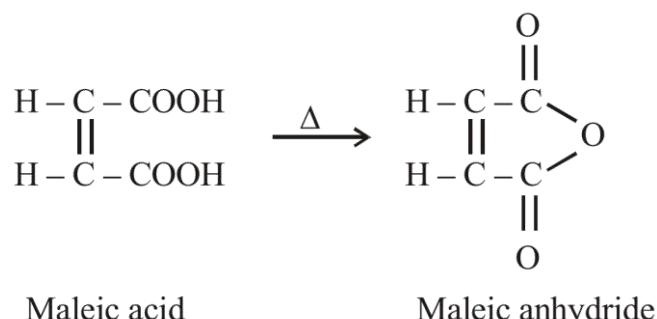
#### Geometrical isomerism in cyclo alkanes : Cyclo alkanes also cannot undergo free rotation.



#### Determination of configuration of geometrical Isomers :

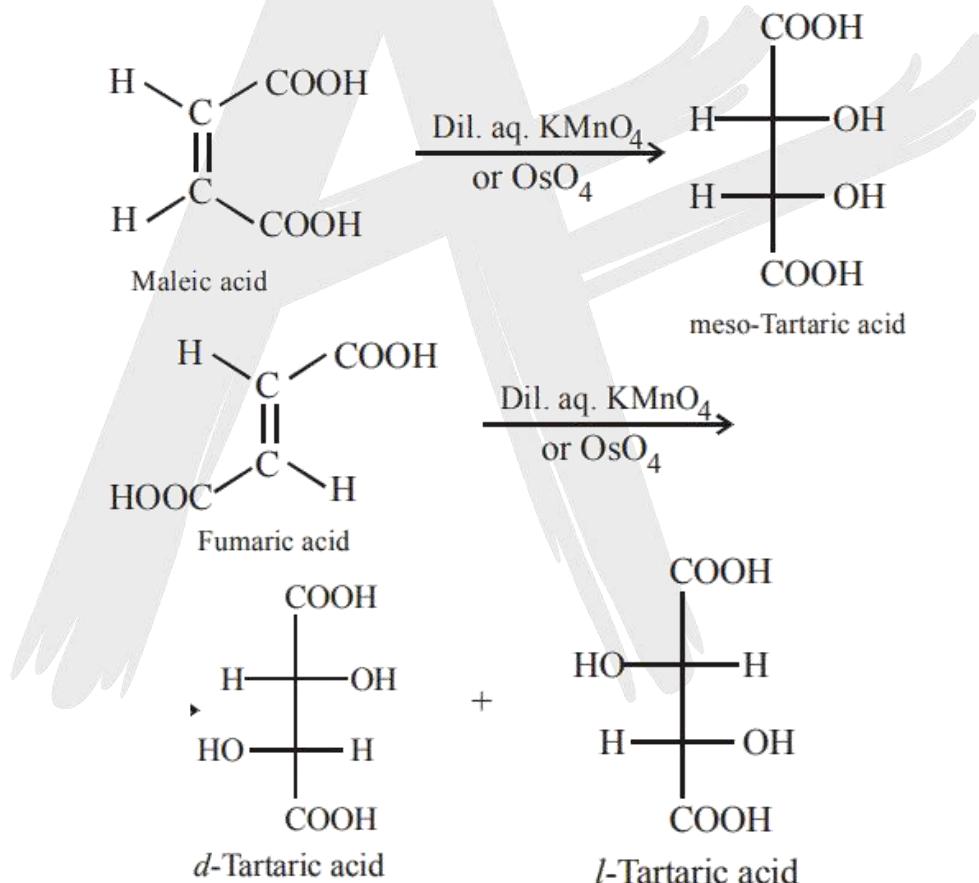
**(I) Physical methods :** In general the cis isomer has low mpt, higher bpt, high density higher dipole moment, greater solubility, higher refractive index, higher heat of combustion.

### **(II) By Cyclisation :**



Hence Maleic acid must be cis isomer.

### **(III) By Oxidation :**

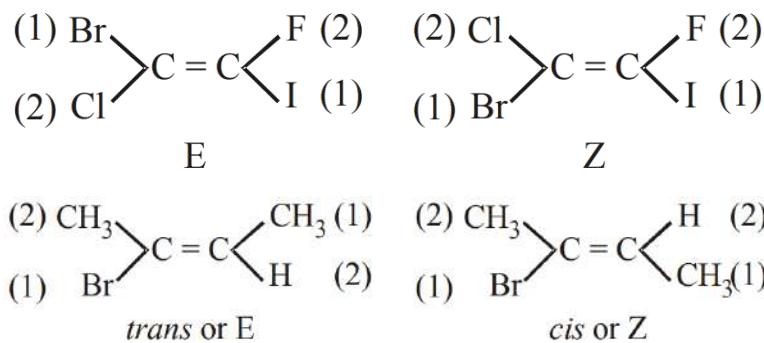


Hence Maleic must be cis and fumaric must be trans.

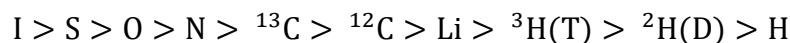
### **E, Z system of Nomenclature for Geometrical Isomers:**

If two high-priority groups are on the same side, the configuration is Z (German, Zusammen = together).

If they are on opposite side, the configuration is E (German; entgegen = opposite)

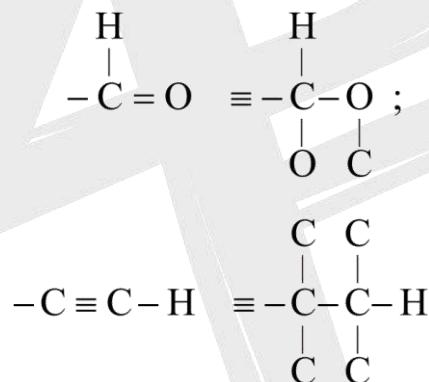


**Assignment of Priority:** Atoms with higher atomic numbers receive higher priorities



**R and S Assignments :** Enantiomers are designated as (R) and (S) according to following rules

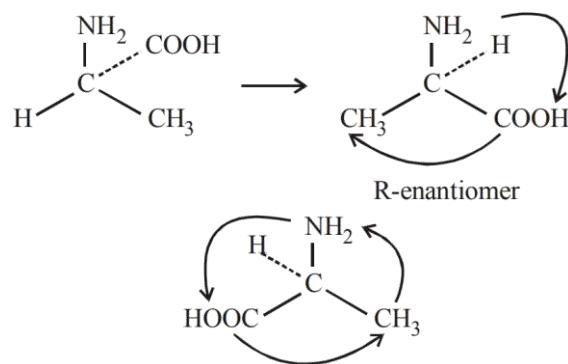
- (I) Atoms with higher atomic numbers receive higher priorities.
- (II) When the same atom is bound directly to the chiral carbon, we go to the next atom along the chain.
- (III) Double and triple bonds are treated as if each bond were to a separate atom. e.g.



Thus between  $-\text{CHO(O, O, H)}$  and  $-\text{CH}_2\text{OH(O, H, H)}$  the former will have priority.

- (IV) The molecule is drawn in three dimensions in such a way that the bond between the chiral carbon and the lowest priority group heeds back into the paper.
- (V) Draw an arrow from the group of highest priority, to the second, to the third priority group.
- (VI) If the arrow is clockwise, the chiral carbon is assigned (R). If the arrow is anticlockwise the chiral carbon is assigned (S).

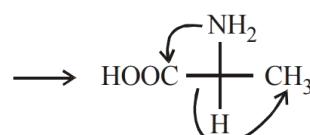
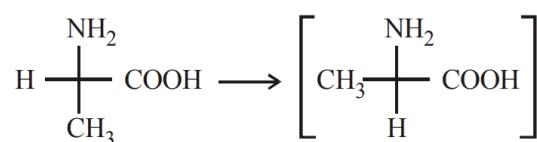
**Example:** Alanine



**STEREOISOMERISM**

(Always exchange the groups twice to get the same compound. If you exchange the groups once you get the enantiomer).

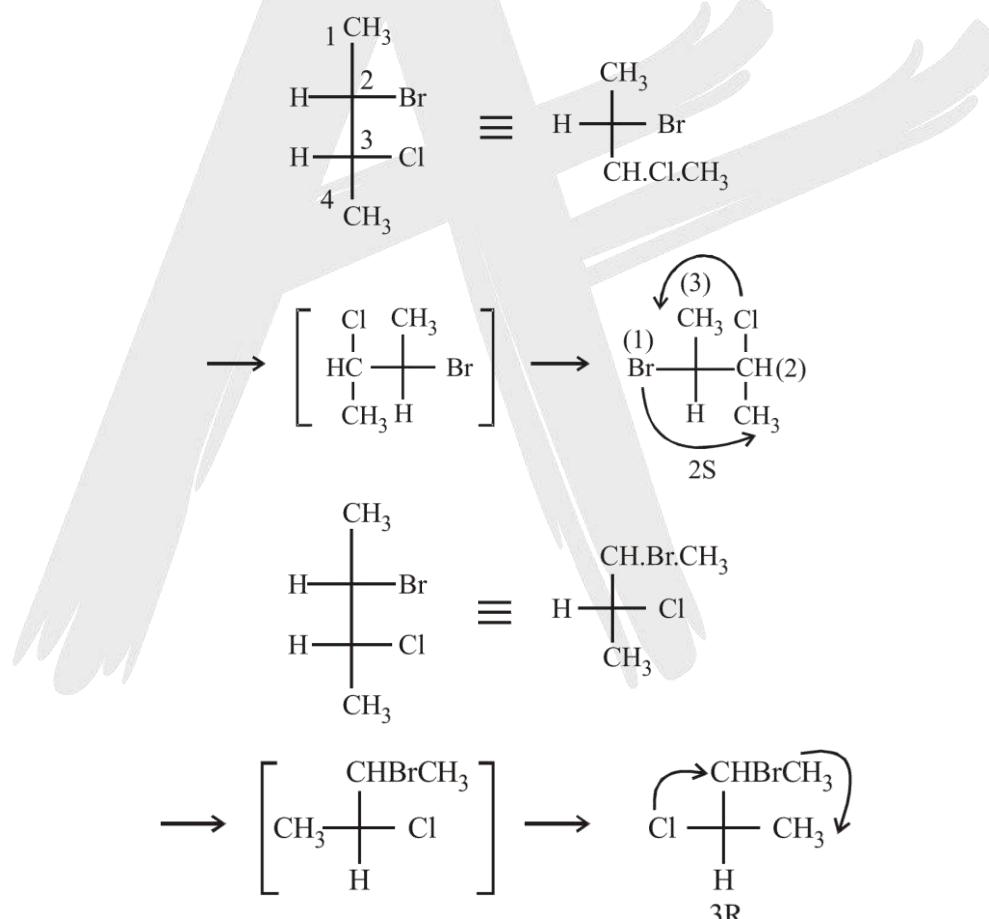
**By using Fischer Projections :**



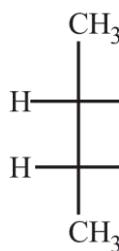
(S) enantiomer

Move the group of lowest priority to the bottom.

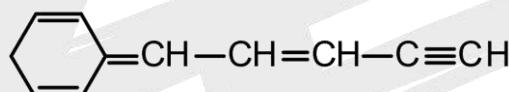
Molecules with two or more chiral atoms.

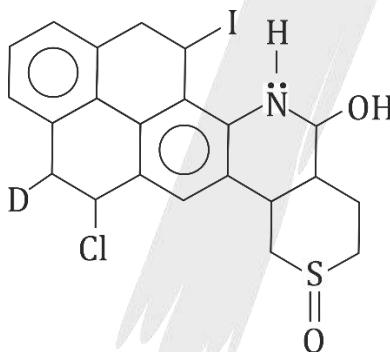


Hence the compound

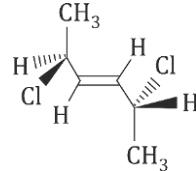


## **EXERCISE – I**



has ' x ' chiral centre then find the value of x :



**Q8.**

Configuration of compound is :



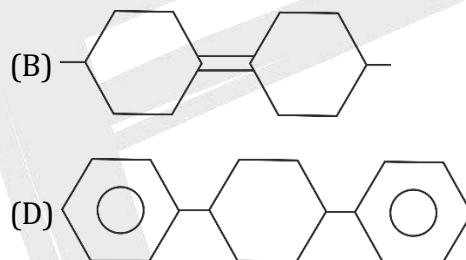
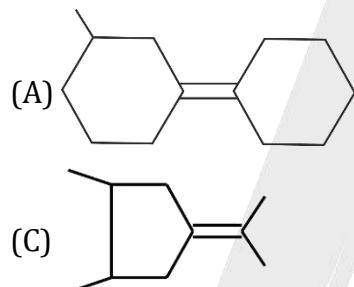
**Q9.** Which of the given conformation of n-butane is chiral?



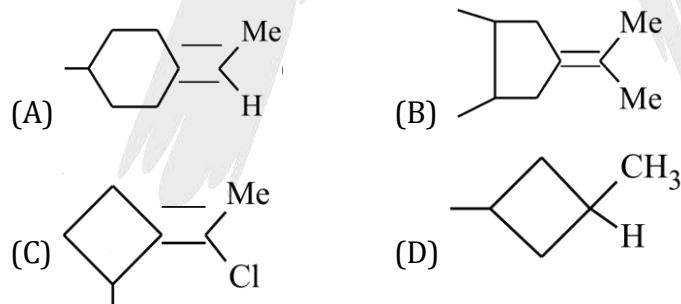
**Q10.** Minimum molecular weight of a hydrocarbon containing minimum number of C-atom to show optical isomerism.



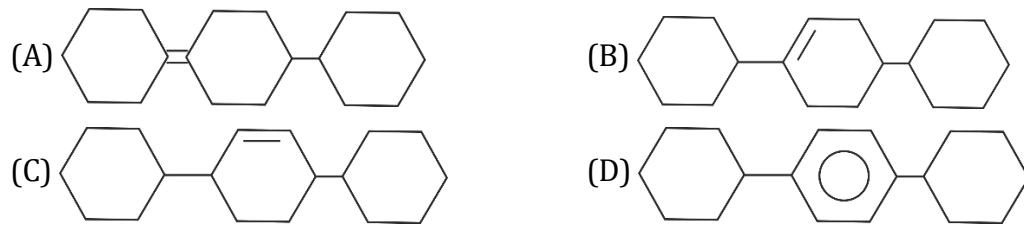
### **Q.11** Compounds which can show both optical as well as geometrical isomerism:



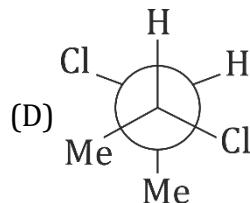
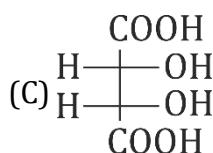
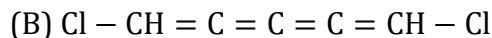
**Q12.** Which of the following will not show optical isomerism:



**Q13.** Optical & geometrical isomerism both can be shown by



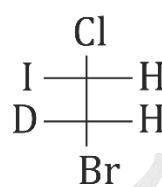
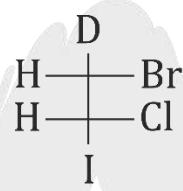
**Q14.** Which of the following will not show optical isomerism.



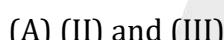
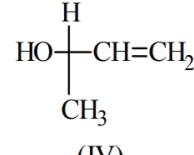
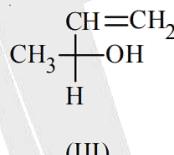
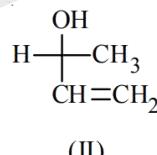
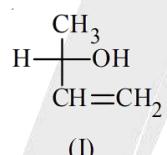
**Q15.** Meso-tartaric acid and d-tartaric acid are :



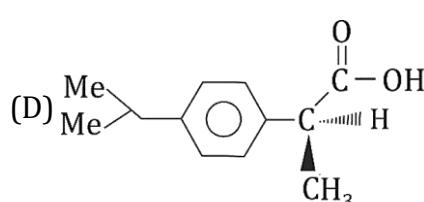
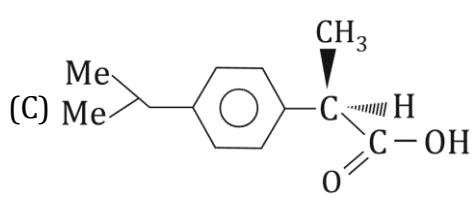
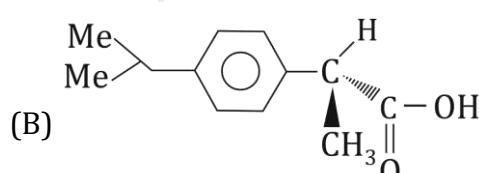
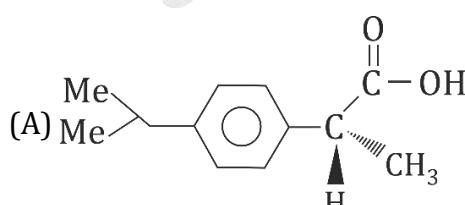
**Q16.** The two compounds given below are :



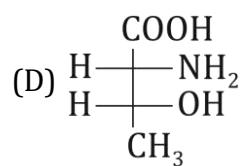
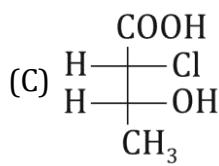
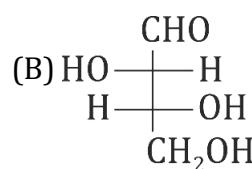
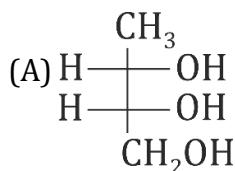
**Q17.** Which of the following combinations amongst the four Fischer projections represents the same absolute configurations?



**Q18.** The S-ibuprofen is responsible for its pain reliving property. Which one of the structures shown is S-ibuprofen :



**Q19.** Which of the following is a 'threo' isomer :



**Q20.** Number of possible stereoisomers of glucose are:

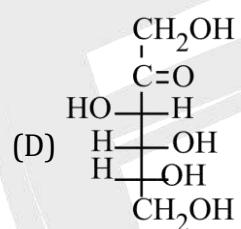
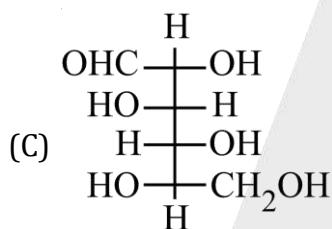
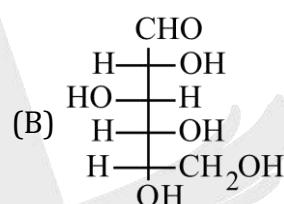
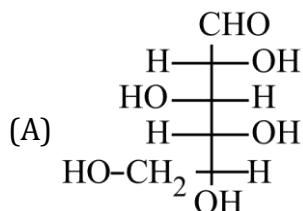
(A) 10

(B) 8

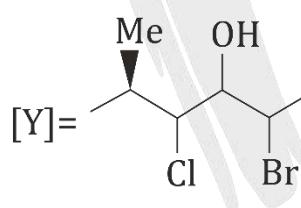
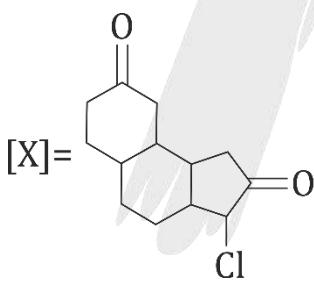
(C) 16

(D) 20

**Q21** Which of the following is not D sugar :



**Q22.** Number of chiral centres in [X] & [Y] is a & b respectively. The value of (a-b) is



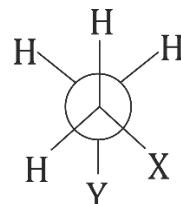
(A) 1

(B) 2

(C) 3

(D) 4

**Q23.** For the newman projection of n-butane, which of the following pair(s) of (X,Y) is/are possible?



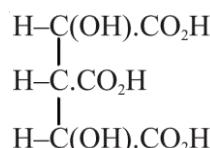
(A) (CH<sub>3</sub>, CH<sub>3</sub>)

(B) (CH<sub>3</sub>, Et)

(C) (H, Et)

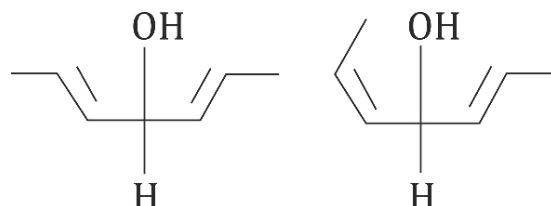
(D) (Et, H)

**Q24.** How many stereoisomers can exist for the following acid.



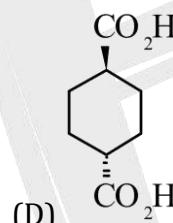
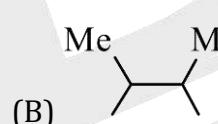
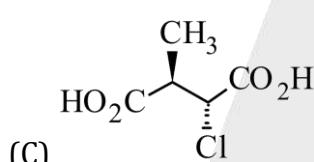
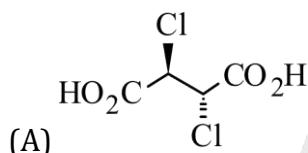
- (A) Two      (B) Four      (C) Eight      (D) Six

**Q25.** Incorrect relationship between given compounds are



- (A) Both are geometrical isomers      (B) Both are stereo isomers  
 (C) Both are enantiomers      (D) Both are diastereomers

**Q26.** Identify meso compound.



**Q27.** A pure sample of 2-chlorobutane shows rotation of PPL by  $30^\circ$  in standard conditions. When above sample is made impure by mixing its opposite form, so that the composition of the mixture becomes 87.5% d-form and 12.5% l-form, then what will be the observed rotation for mixture.

- (A)  $-22.5^\circ$       (B)  $+22.5^\circ$   
 (C)  $+7.5^\circ$       (D)  $-7.5^\circ$

**Q28.** When an optically active compound is placed in a 10dm tube is present 20gm in a 200ml solution rotates the PPL by  $30^\circ$ . Calculate the angle of rotation & specific angle of rotation if above solution is diluted to 1 Litre.

- (A)  $16^\circ$  &  $36^\circ$       (B)  $6^\circ$  &  $30^\circ$   
 (C)  $3^\circ$  &  $30^\circ$       (D)  $6^\circ$  &  $36^\circ$

**Q29.** Identify % optical purity if 6gm (+) – 2-butanol is mixed with 2gm (–) – 2-butanol.

- (A) 50%      (B) 66.6%  
 (C) 33.3%      (D) 75%



EXERCISE - II

(JEE Advanced Oriented Level-II)

**Q1.** Molecular formula  $C_5H_{10}O$  can have :

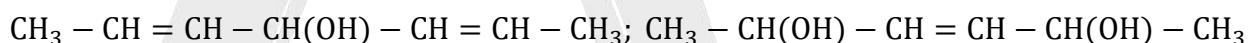
- (A) 6-Aldehyde, 4-Ketone
- (B) 5-Aldehyde, 3-Ketone
- (C) 4-Aldehyde, 3-Ketone
- (D) 5-Aldehyde, 2 -Ketone

**Q2.** Statement 1: is a chiral resolvable molecule.

Statement 2: Et is non-superimposable on its mirror image.

- (A) Statement- -1 is true, Statement- 2 is true; Statement -2 is not the correct explanation of Statement -1
- (B) Statement-1 is true, Statement-2 is true ; Statement-2 is the correct explanation of Statement-1
- (C) Statement-1 is true, Statement-2 is false
- (D) Statement- 1 is false, Statement- 2 is true

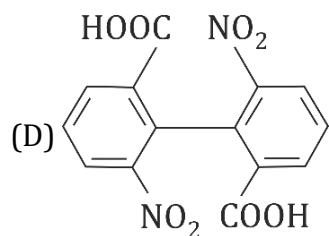
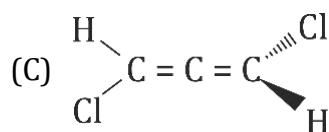
**Q3.** Total number of stereoisomer of following compounds are respectively



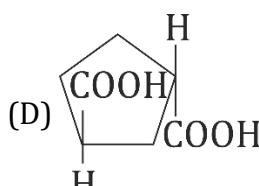
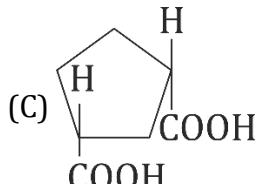
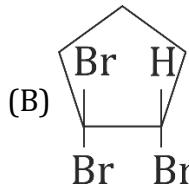
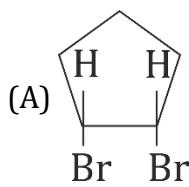
- (A) 4,6
- (B) 8
- (C) 6,6
- (D) 8,8

**Q4.** Which of the following compounds are optically active?

- (A)  $CH_3 - CH(OH) - CH_2 - CH_3$
- (B)  $H_2C = CH - CH_2 - CH = CH_2$



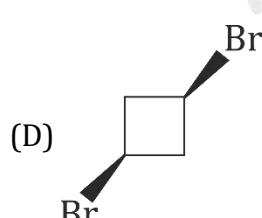
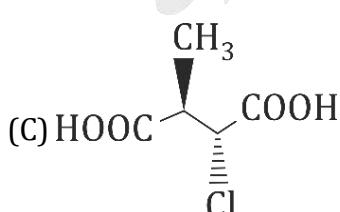
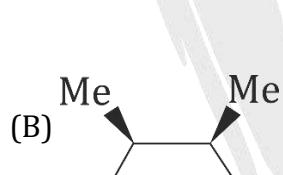
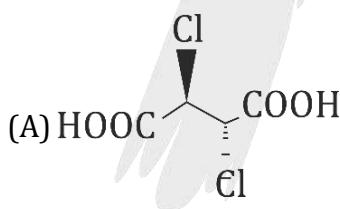
**Q5.** Which out the following are Non-resolvable :



**Q6.** Which of the following statements is/are not correct:

- (A) Metamerism belongs to the category of structural isomerism
- (B) Tautomeric structures are the resonating structures of a molecule
- (C) Keto form is always more stable than the enol form
- (D) Geometrical isomerism is shown only by alkenes

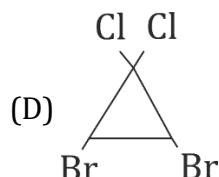
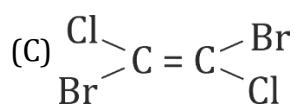
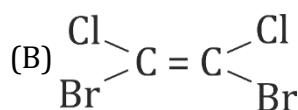
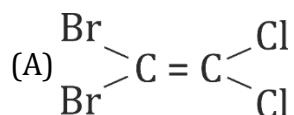
**Q7.** Identify compounds which are not meso:



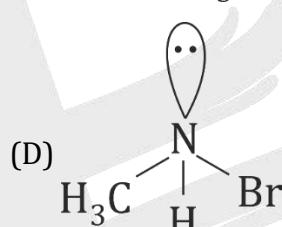
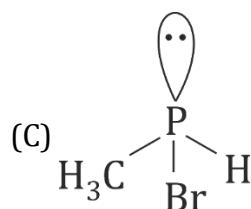
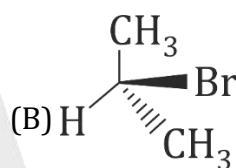
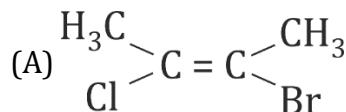
**Q8.** Which of the following statements for a meso compound is/are correct :

- (A) The meso compound has either a plane or centre of symmetry or both
- (B) The meso compound is optically inactive due to internal compensation.
- (C) The meso compound is achiral
- (D) The meso compound is formed when equal amounts of two enantiomers are mixed

**Q9.** Compound A having molecular formula  $C_2Cl_2Br_2$ . A having plane of symmetry (POS), centre of symmetry (COS) &  $C_2$  axis of symmetry, A is :



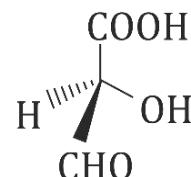
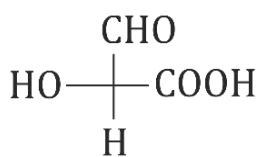
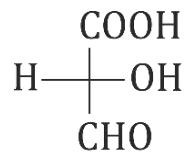
**Q10.** Among the following the non-resolvable compound is/are :



**Q11.** Compound HO- is/are ?

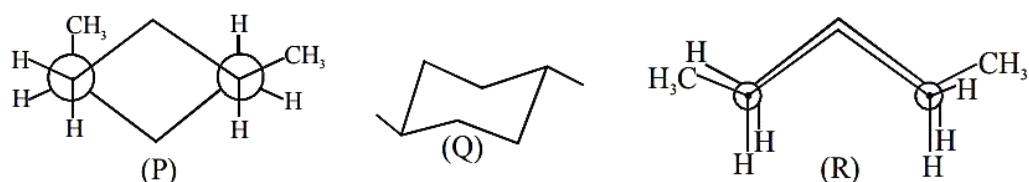
- (A) (2R, 3S), L
- (B) L, Erythro
- (C) Threo, D
- (D) (2R, 3S), D

**Q12.** Relation between compounds are :



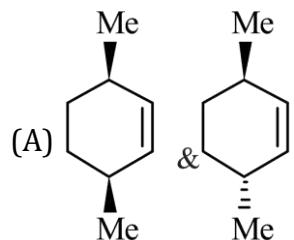
- (A) I & II = Enantiomers
- (B) II & III = Enantiomers
- (C) I & II = Identical
- (D) II & III = Identical

**Q13.** Compare the stability of following conformations of 1,4-Dimethyl cyclohexane :

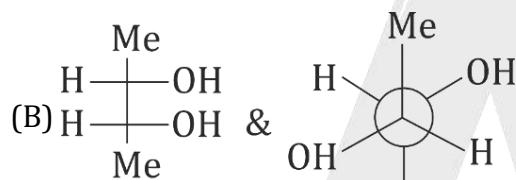


- (A) P = Q > R      (B) P > Q > R      (C) Q > P > R      (D) R > P = Q

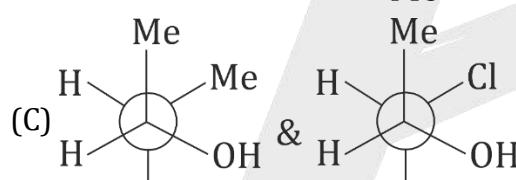
**Q14.** Identify correct relation between pair of compounds ?



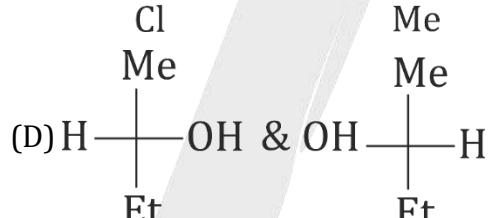
Diastereomers



Identical



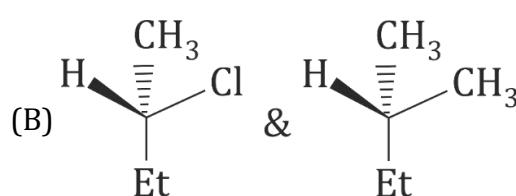
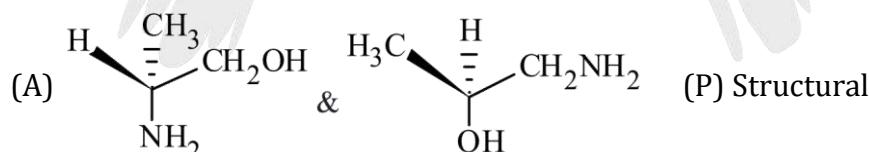
Diastereomers



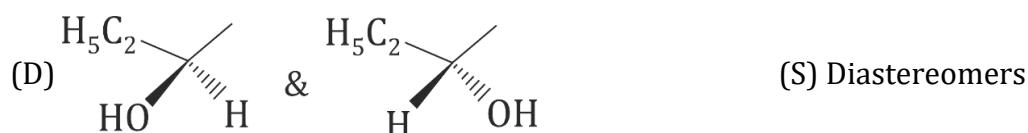
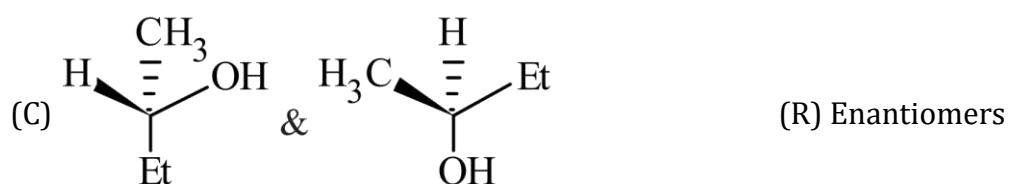
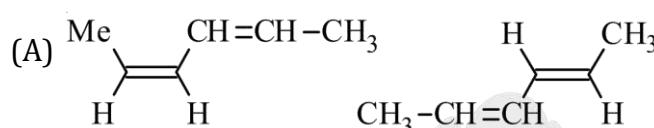
Enantiomers

**Q15.** Column-I

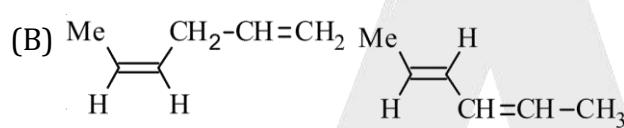
Column-II



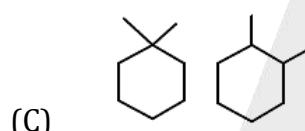
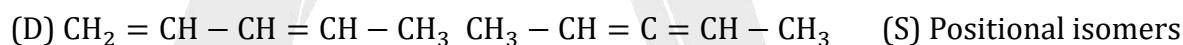
(Q) Identical

**Q16. Column-I****Column-II**

(P) Geometrical isomers



(Q) At least one of the

compound can show  
Geometrical Isomerism(R) At least one of the  
compound can show  
Optical Isomerism**Q17. Column-I**

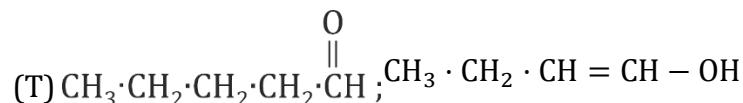
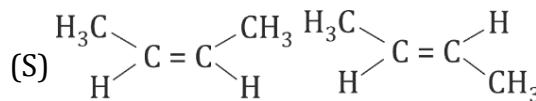
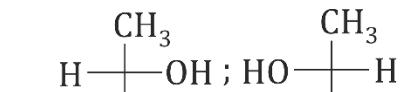
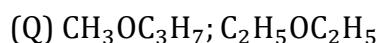
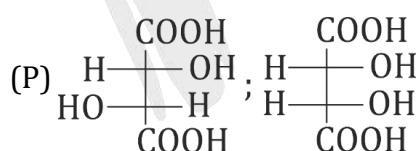
(A) A pair of metamer

(B) Tautomerism

(C) A pair of geometrical isomer

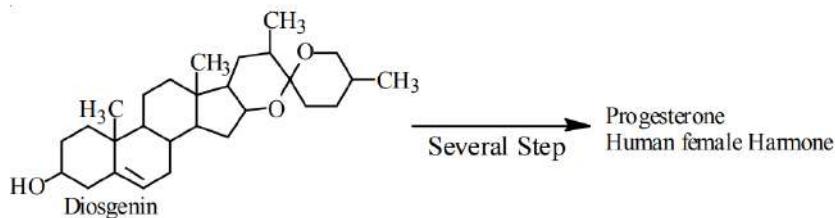
(D) A pair of diastereomers

(E) A pair of optical isomer

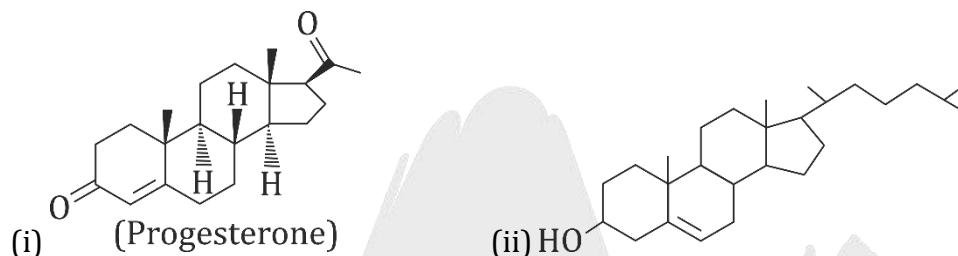
**Column-II**

## Subjective Type Questions:

**Q18.** What is number of chiral centres present in Diosgenin is :



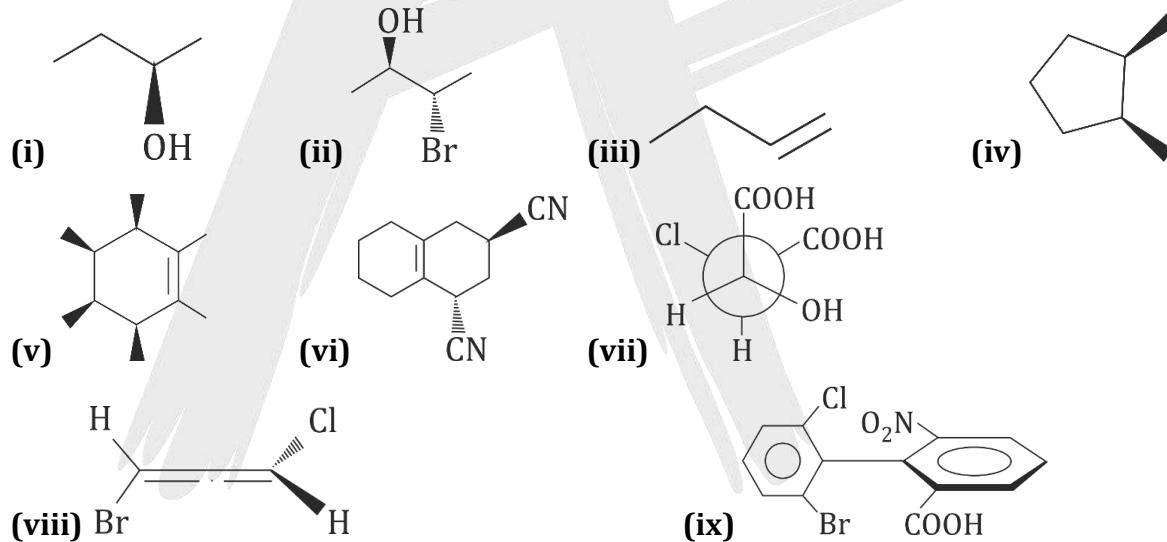
**Q19.** Calculate the total number of chiral carbon atoms in.



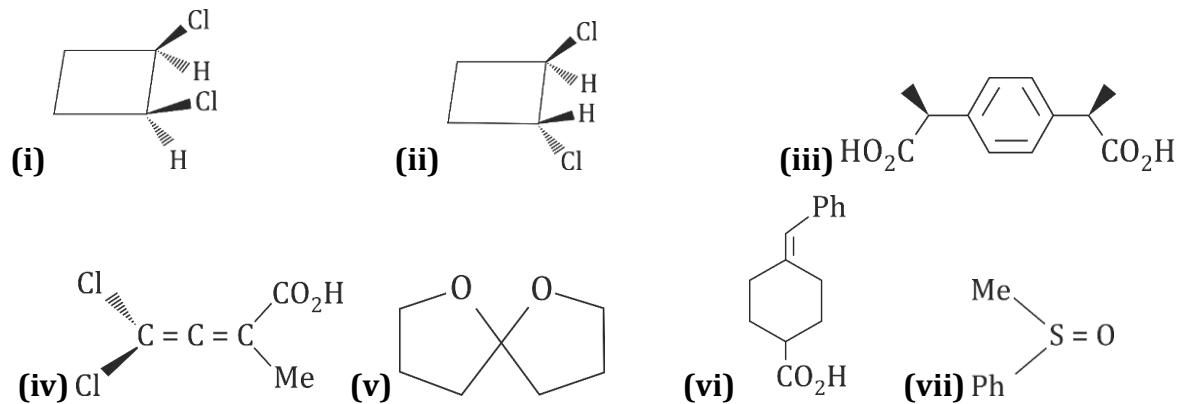
**Q20** Total number of isomers of bromochlorofluorooiodo propadiene is ?

**Q21** Find out the total number of cyclic isomers of  $C_6H_{12}$  which are optically active?

**Q22.** How many of the given compounds are chiral :

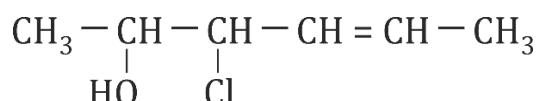


**Q23.** With reasons, state whether each of the following compounds I to VIII is chiral

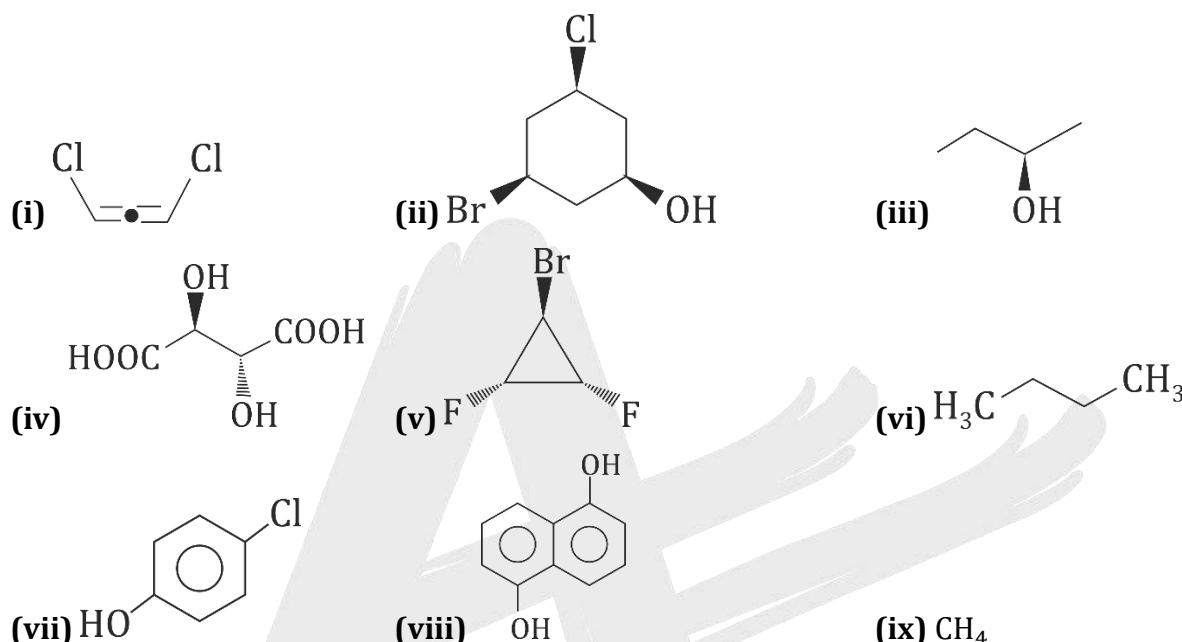


**STEREOISOMERISM**

- Q24.** How many cyclopentane structures (including stereo) are possible for  $C_7H_{14}$ .
- Q25.** The number of diastereoisomers (excluding optical) for 1-bromo-2-chloro-3-iodocyclopropane.
- Q26.** Identify total number of stereoisomers for the following compound :



- Q27.** How many of the given molecule / species are chiral :



- Q28.** For the compound '5-Methyl hept-3-en-2-one' if :

- (i) Total number of stereoisomers possible is 'x'
- (ii) Total number of enantiomeric pairs possible is 'y' Then represent your answer as 'xyx'  
[For example x = 1, y = 2 then answer is 121]

- Q29.** How many of following has same number of stable conformation?

- |               |                   |                    |
|---------------|-------------------|--------------------|
| (1) Ethane    | (2) Propane       | (3) Butane         |
| (4) Isobutane | (5) Neopentane    | (6) Neohexane      |
| (7) Methanol  | (8) Dimethylether | (9) Ethyl Chloride |

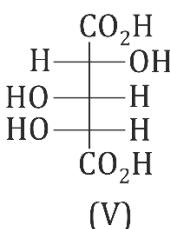
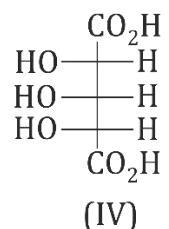
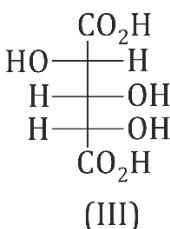
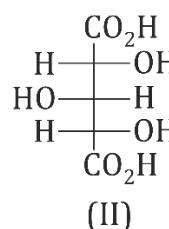
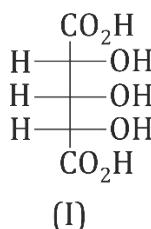
- Q30.** How many of following has only three stable conformation?

- |                        |                           |                    |
|------------------------|---------------------------|--------------------|
| (1) 2,2-dimethylbutane | (2) isopropanol           | (3) 2-chlorobutane |
| (4) Pentane            | (5) (+) 2,3-Dibromobutane | (6) Ethanol        |

EXERCISE - III

## (JEE ADVANCE ORIENTED LEVEL-II)

**Q1.** Observe the given compounds and answer the following questions.



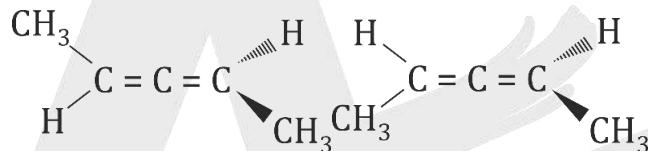
**(i)** Which of the above formulae represent identical compounds ?

- (A) I and II (B) I and IV (C) II and IV (D) III and IV

**(ii)** Which of the above compounds are enantiomers ?

- (A) II and III (B) III and IV (C) III and V (D) I and V

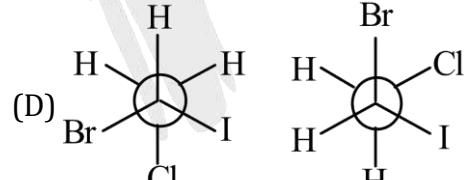
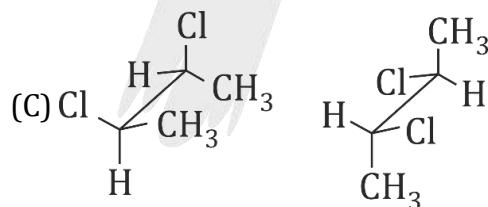
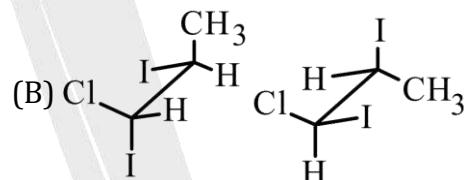
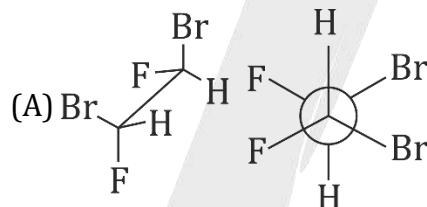
**Q2.** Which of the following option is correct regarding the given compounds :



- (A) Both are identical  
(C) Both are optically active

- (B) Both are optically inactive  
(D) Geometrical isomer

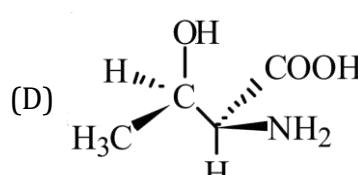
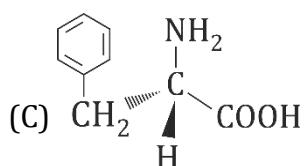
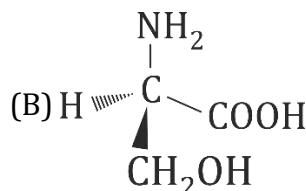
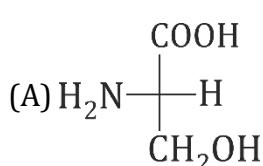
**Q3.** Which of the following pairs of compound is/are identical ?

**Multiple Correct Type:**

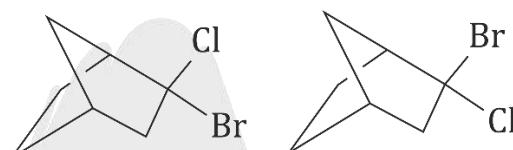
**Q4.** Which of the following statements is/are not correct for D-(+) glyceraldehyde :

- (A) The symbol D indicates the dextrorotatory nature of the compound  
(B) The sign(+) indicates the dextrorotatory nature of the compound  
(C) The symbol D indicates that hydrogen atom lies left to the chiral centre in the Fischer projection diagram  
(D) The symbol D indicates that hydrogen atom lies right to the chiral centre in the Fischer projection diagram

**Q5.** Which of the following are correct representation of L-amino acids :



**Q6.** Identify relation between these two compounds :



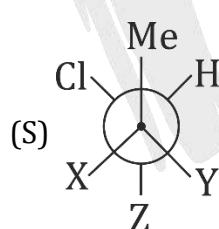
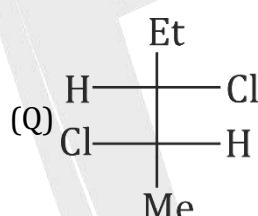
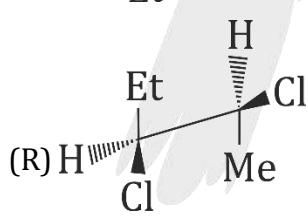
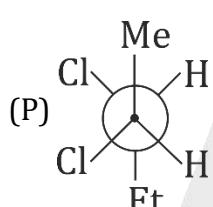
(A) Homomers

(C) Diastereomers

Comprehension Type:

**Paragraph for Q.No. 7 to 8**

Four compounds are given below 'S' is a stereoisomer of P.



**Q7.** P & Q are related as :

(A) Identical

(B) Enantiomer

(C) Diastereomer

(D) Positional isomerism

**Q8.** If Q and S are enantiomer then which is/are correctly matched :

(A) X=H

(B) Y=Cl

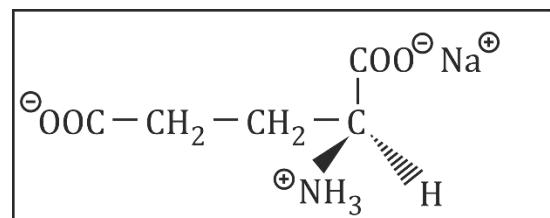
(C) Z=Et

(D) X=Cl



## Paragraph for Q. No. 9 to 11

S(+) Mono sodium Glutamate (MSG) is a flavour enhancer used in many foods. Fast foods often contain substantial amount of MSG and is widely used in Chinese food. If one mole of above MSG was placed in 845ml solution and passed through 200 mm tube, the observed rotation was found to be + 9.6°



- Q9.** Find out the specific rotation of (-) MSG:

- (A) + 24°
- (B) +56.8°
- (C) -48°
- (D) None of these

- Q10.** Find out the approximate percentage composition of (-) MSG in a mixture containing (+) MSG and (-) MSG whose specific optical rotation is -20° :

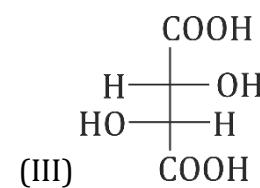
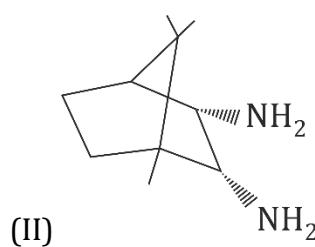
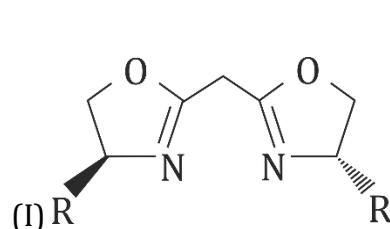
- (A) 83.3%
- (B) 16.7%
- (C) 91.6%
- (D) 74%

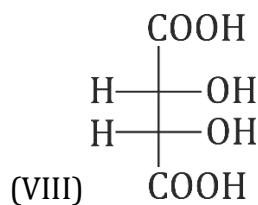
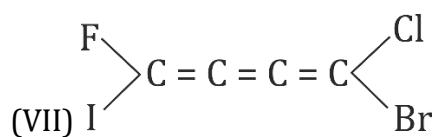
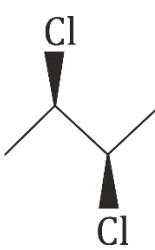
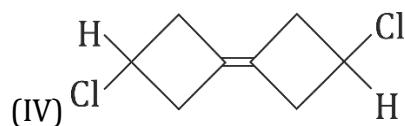
- Q.11** If 33.8 g of (+) MSG was put in 338ml solution and was mixed with 16.9 g of (-) MSG put in 169ml solution and the final solution was passed through 400 mm tube. Find out observed rotation of the final solution:

- (A) +1.6°
- (B) +4.8°
- (C) +3.2°
- (D) None of these

## Paragraph for Q. No. 12 to 13

Among the following structures?





**Q12.** Among the following structures?



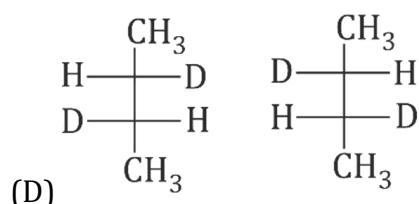
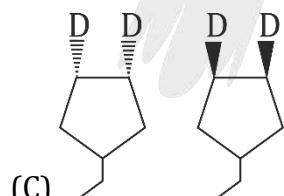
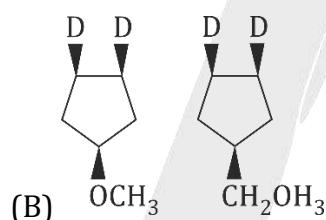
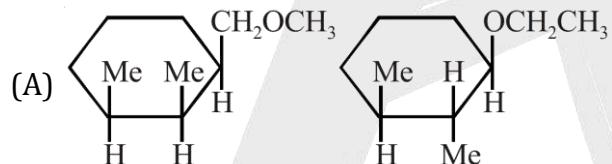
**Q13.** Which of the following will not show optical isomerism



**Q14.** Matrix Match Typed

### **Column-I**

## (Compounds)



## Column-II

(Relation)

### (P) Metamers

### (Q) Functional Isomer

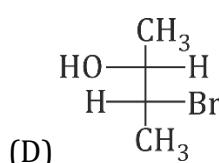
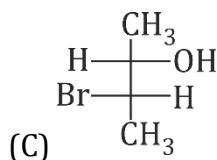
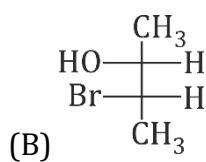
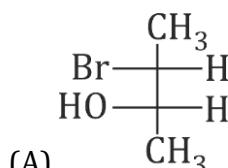
(R) Geometrical isomer

### (S) Enantiomer

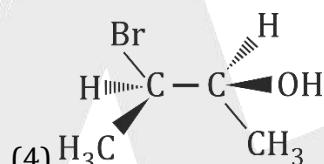
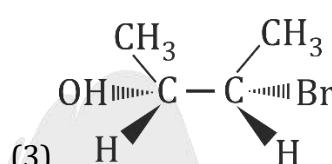
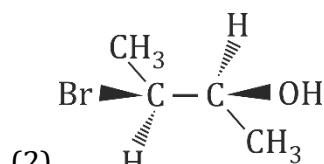
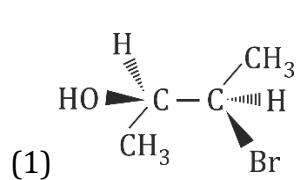
(T) Diastereomer

**Q15.** Match List-I, II, III with each other :

List-I



List-II



List-III

(i) (2R, 3R)

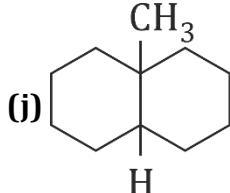
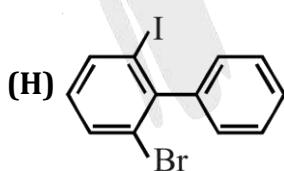
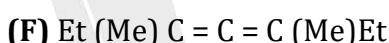
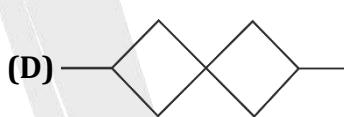
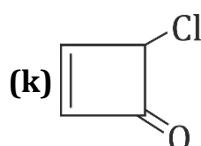
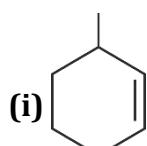
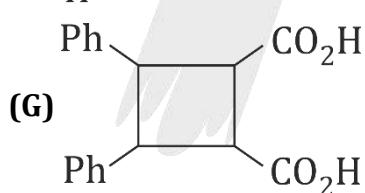
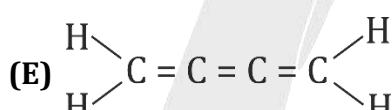
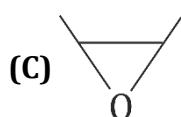
(ii) (2S,3S)

(iii) (2S,3R)

(iv) (2R,3S)

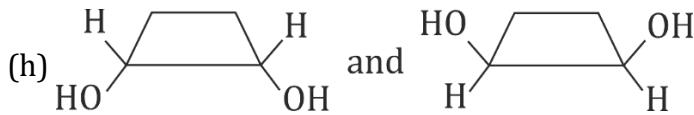
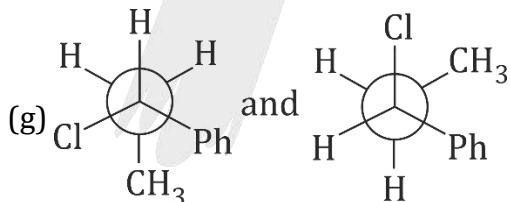
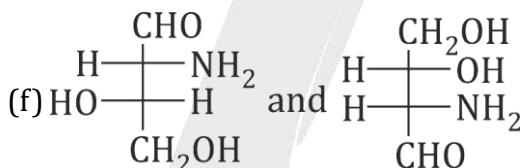
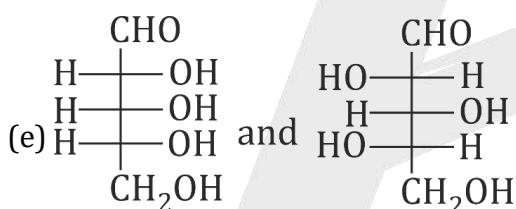
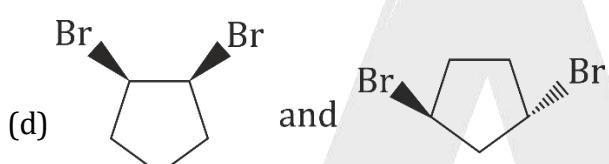
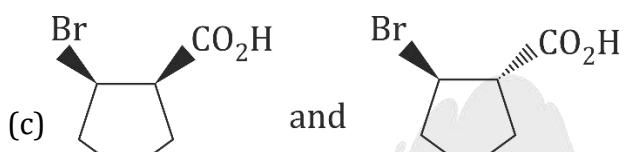
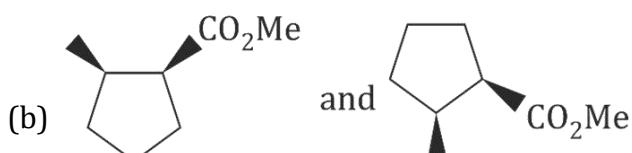
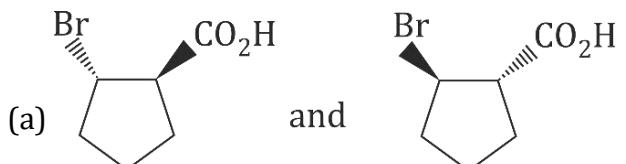
### Subjective Type:

**Q16.** In what stereoisomeric forms would you expect the following compounds to exist ?

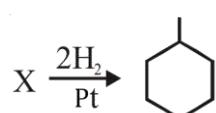


**Q17.** Calculate the number of Benzenoid isomers possible for  $C_6H_3ClBrI$ .

**Q18.** What are the relationships between the following pairs of isomers ?



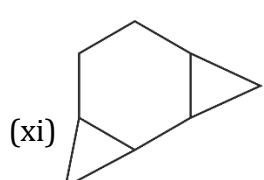
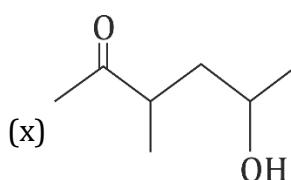
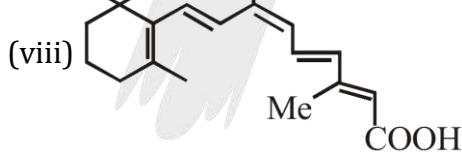
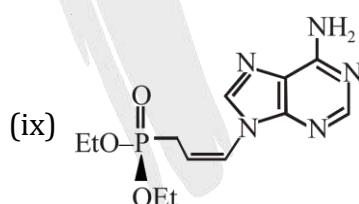
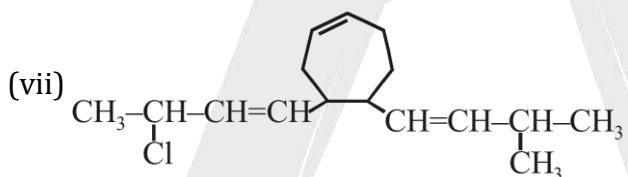
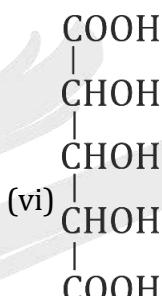
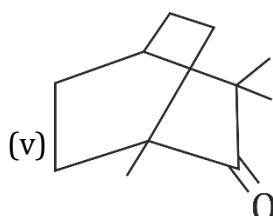
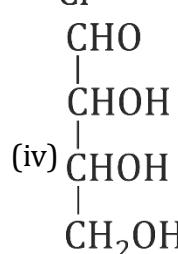
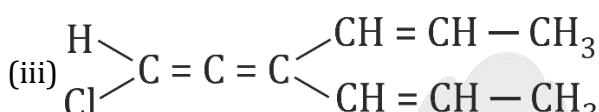
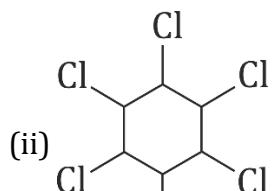
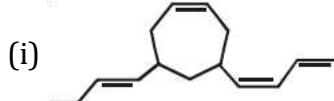
**Q19.**



Find out total number of structures of X.

**Q20.** Calculate the number of chiral center in the molecule Ethyl 2,2-dibromo-4-ethyl-6-methoxy cyclohexane carboxylate.

**Q21.** Calculate the total number of stereoisomers possible for

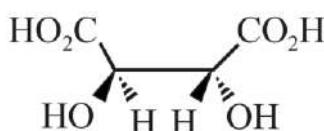


**Q22.** Find the total number of stable conformation having non zero dipole moment for meso-2,3-dichloro butane

### **EXERCISE-IV (A) (JEE MAINS)**



- Q8.** Which types of isomerism is shown by 2,3-dichloro butane [AIEEE-2005]  
 (A) Structural      (B) Geometric      (C) Optical      (D) Diastereo
- Q9.** The absolute configuration of is: [AIEEE-2008]



- (A) S, S      (B) R, R      (C) R, S      (D) S, R
- Q10.** The number of stereoisomers possible for a compound of the molecular formula  $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}(\text{OH}) - \text{Me}$  is [AIEEE-2009]  
 (A) 4      (B) 6      (C) 3      (D) 2

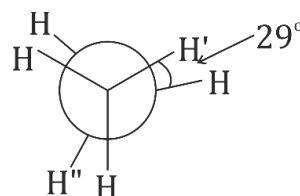
- Q11.** Out of the following, the alkene that exhibits optical isomerism is : [AIEEE-2010]  
 (A) 2-methyl-2-pentene      (B) 3-methyl-2-pentene  
 (C) 4-methyl-1-pentene      (D) 3-methyl-1-pentene

- Q12.** The optically inactive compound from the following is : [JEE-MAIN 2015]  
 (A) 2-chloropropanal      (B) 2-chlorobutane  
 (C) 2-chloro-2-methylbutane      (D) 2-chloropentane

- Q13.** The absolute configuration of : [JEE-MAIN 2016]
- 
- (A) (2R, 3R)      (B) (2R, 3S)      (C) (2S, 3R)      (D) (2S, 3S)

- Q14.** Which of these factors does not govern the stability of a conformation in acyclic compounds ? [JEE MAIN-2019]  
 (A) Steric interactions      (B) Torsional strain  
 (C) Electrostatic forces of interaction      (D) Angle strain

- Q15.** In the following skew conformation of ethane,  $\text{H}' - \text{C} - \text{C} - \text{H}''$  dihedral angle is: [JEE MAIN-2019]



- (A)  $58^\circ$       (B)  $151^\circ$       (C)  $120^\circ$       (D)  $149^\circ$



**Q16.** Which of the following compounds will show the maximum 'enol' content?

[JEE MAIN-2019]

- (A)  $\text{CH}_3\text{COCH}_2\text{COCH}_3$   
(C)  $\text{CH}_3\text{COCH}_2\text{COOC}_2\text{H}_5$

- (B)  $\text{CH}_3\text{COCH}_3$   
(D)  $\text{CH}_3\text{COCH}_2\text{CONH}_2$

**Q17.** Number of chiral centers in chloramphenicol is :

[JEE MAIN-2020]

**Q18** The total number of monohalogenated organic products in the following (including stereoisomers) reaction is

[JEE MAIN-2020]

A

- (i)  $\text{H}_2/\text{Ni}/\Delta$   
(ii)  $\text{X}_2/\Delta$

(Simplest optically

active alkene)

## **EXERCISE-IV**

## (B) (JEE Advanced)

- Q1.** The  shows: [IIT JEE - 1995]

- (A) Geometrical isomerism                          (B) Optical isomerism  
(C) Geometrical & optical isomerism              (D) tautomerism

**Q2.** How many optically active stereoisomers are possible for butane -2,3-diol:

[IIT JEE - 1997]

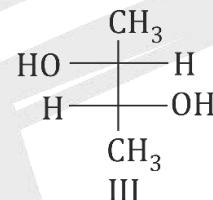
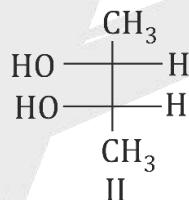
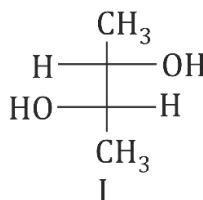
- (A) 1      (B) 2      (C) 3      (D) 4

- Q3.** The number of possible enantiomeric pairs that can be produced during monochlorination of 2 -methyl butane is : [IIT JEE - 1997]

- (A) 2      (B) 3      (C) 4      (D) 1

- Q4.** Identify the pairs of enantiomers and diastereomers from the following compounds I, II and III

[IIT JEE - 2000]





- Q6:** On monochlorination of 2-methylbutane, the total number of chiral compounds formed is :

[IIT JEE - 2004]

- (A) 2      (B) 4      (C) 6      (D) 8

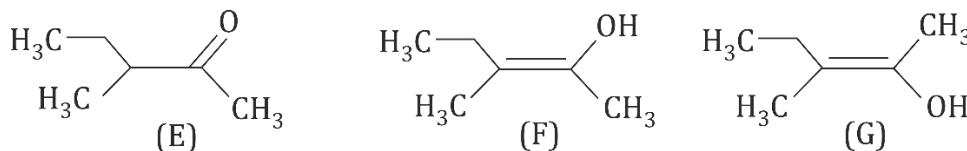
- Q7.** Statement-I :Molecules that are not superimposable on their mirror images are chiral Because  
Statement-II :All chiral molecules have chiral centres. [IIT JEE - 2007]

- (A) Statement-1 is True, Statement-2 is True ; Statement-2 is a correct explanation for Statement-1

- (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
  - (C) Statement-1 is True, Statement-2 is False.
  - (D) Statement- 1 is False, Statement- 2 is True.

**Q8.** The correct statement(s) concerning the structures E, F and G is (are)

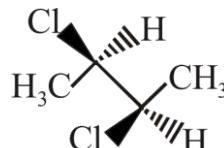
[IIT JEE - 2008]



- (A) E, F and G are resonance structures      (B) E, F and E, G are tautomers  
 (C) F and G are geometrical isomers      (D) F and G are diastereomers

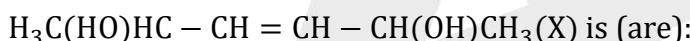
**Q9.** The correct statement(s) about the compound given below is (are)

[IIT JEE - 2008]



- (A) The compound is optically active  
 (B) The compound possesses centre of symmetry  
 (C) The compound possesses plane of symmetry  
 (D) The compound possesses axis of symmetry

**Q10.** The correct statement(s) about the compound

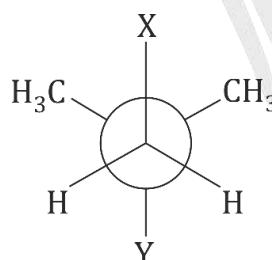


[IIT JEE - 2009]

- (A) The total number of stereoisomers possible for X is 6  
 (B) The total number of diastereomers possible for X is 3  
 (C) If the stereochemistry about the double bond in X is trans, the number of enantiomers possible for X is 4  
 (D) If the stereochemistry about the double bond in X is cis, the number of enantiomers possible for X is 2

**Q11.** In the Newman projection for 2,2-dimethylbutane

[IIT JEE - 2010]



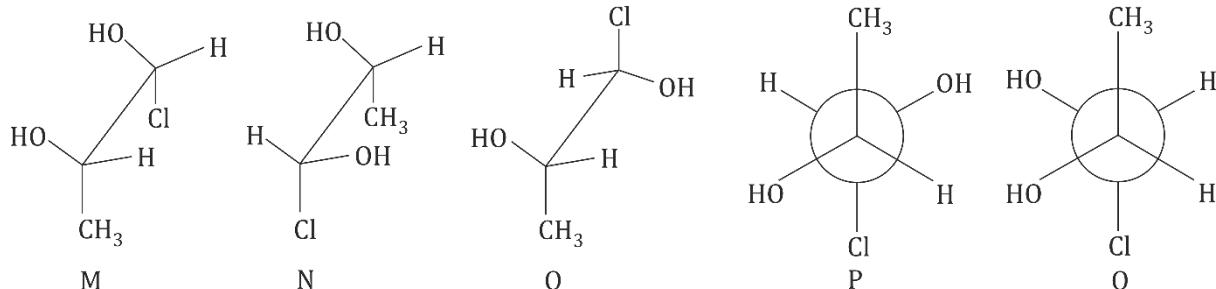
X and Y can respectively be

- (A) H and H  
 (B) H and  $\text{C}_2\text{H}_5$   
 (C)  $\text{C}_2\text{H}_5$  and H  
 (D)  $\text{CH}_3$  and  $\text{CH}_3$

**STEREOISOMERISM**

**Q12.** Which of the given statement(s) about N, O, P and Q with respect to M is (are) correct ?

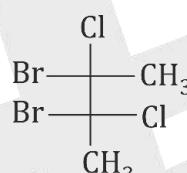
[IIT JEE - 2012]



- (A) M and N are non-mirror image stereoisomers
- (B) M and O are identical
- (C) M and P are enantiomers
- (D) M and Q are identical

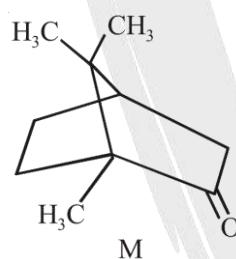
**Q13.** The total number(s) of Stable conformers with non-zero dipole moment for the following compound is (are)

[IIT JEE - 2014]



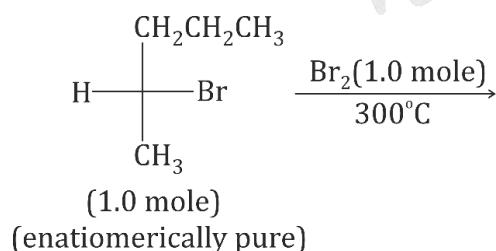
**Q14.** The total number of stereoisomers that can exist for M is :

[IIT JEE - 2015]



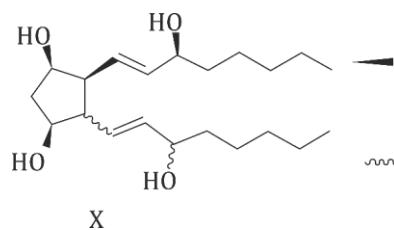
**Q15.** In the following monobromination reaction, the number of possible chiral products is

[IIT JEE - 2016]



**Q16.** For the given compound X, the total number of optically active stereoisomers is

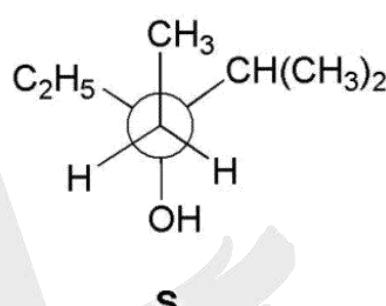
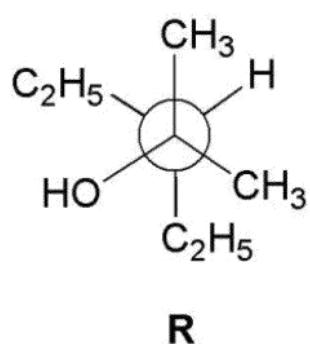
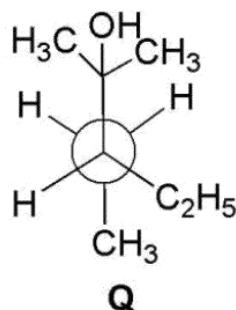
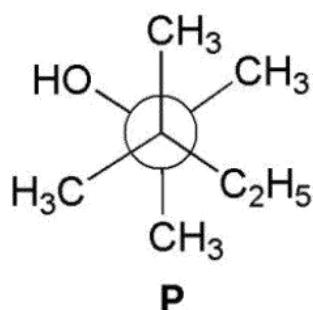
[IIT JEE - 2018]





**Q.17** Newman projections **P**, **Q**, **R** and **S** are shown below:

[IIT JEE - 2020]

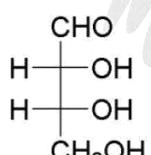


Which one of the following options represents identical molecules?

- (A) P and Q
- (B) Q and S
- (C) Q and R
- (D) R and S

**Q.18** The Fischer projection of D-erythroose is shown below.

[IIT JEE - 2020]

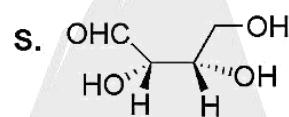
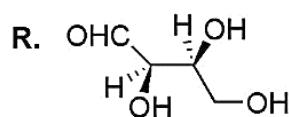
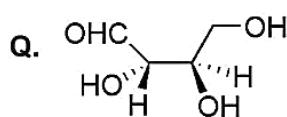
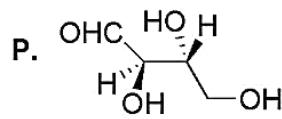


D-Erythroose

D-Erythroose and its isomers are listed as **P**, **Q**, **R**, and **S** in **Column-I**. Choose the correct relationship of **P**, **Q**, **R**, and **S** with D-erythroose from **Column II**.



## Column-I



## Column-II

1. Diastereomer
2. Identical
3. Enantiomer

(A) P → 2, Q → 3, R → 2, S → 2

(B) P → 3, Q → 1, R → 1, S → 2

(C) P → 2, Q → 1, R → 1, S → 3

(D) P → 2, Q → 3, R → 3, S → 1

**Q.19** Question 6: An organic compound ( $C_8H_{10}O_2$ ) rotates plane-polarized light. It produces pink color with neutral  $FeCl_3$  solution. What is the total number of all the possible isomers for this compound?

[IIT JEE - 2020]

**ANSWER KEY****EXERCISE I (MAINS ORIENTED)**

- Q1.** (D)    **Q2.** (D)    **Q3.** (A)    **Q4.** (A)    **Q5.** (A)    **Q6.** (B)    **Q7.** (B)  
**Q8.** (D)    **Q9.** (C)    **Q10.** (C)    **Q11.** (C)    **Q12.** (D)    **Q13.** (C)    **Q14.** (A)  
**Q15.** (C)    **Q16.** (A)    **Q17.** (C)    **Q18.** (D)    **Q19.** (B)    **Q20.** (C)    **Q21.** (B)  
**Q22.** (B)    **Q23.** (ACD) **Q24.** (B)    **Q25.** (C)    **Q26.** (A)    **Q27.** (B)    **Q28.** (B)  
**Q29.** (A)    **Q30.** (C)    **Q31.** (A)    **Q32.** (D)    **Q33.** (B)    **Q34.** (A)    **Q35.** (B)

**EXERCISE-II (JEE ADVANCE ORIENTED LEVEL-II)**

- 1.** B    **2.** B    **3.** A    **4.** ACD    **5.** AC    **6.** BCD  
**7.** BCD    **8.** BC    **9.** C    **10.** ABD    **11.** CD    **12.** AD  
**13.** C    **14.** ABCD  
**15.** (A) → P ; (B) → R ; (C) → Q ; (D) → R  
**16.** (A) → P,Q ; (B) → Q,S ; (C) → Q,R,S ; (D) → Q,R,S  
**17.** (A) → Q; (B) → T; (C) → S; (D) → P,S; (E) → P,R;  
**18.** 11    **19.** (i) 6, (ii) 8    **20.** 6    **21.** 8    **22.** 6  
**23.** Achiral : I, III , IV ; chiral : II,V, VI, VII  
**24.** 8    **25.** 4    **26.** 8    **27.** 3    **28.** 424    **29.** 8  
**30.** 3

**EXERCISE-III (JEE ADVANCE ORIENTED LEVEL-II)**

- Q1.** (i)(B); (ii)(C)    **Q2.** (C)    **Q3.** (C)    **Q4.** (AD)    **Q5.** (ACD)  
**Q6.** (C)    **Q7.** (B)    **Q8.** (CD)    **Q9.** (D)    **Q10.** (C)    **Q11.** (C)  
**Q12.** (A)    **Q13.** (C)  
**Q14.** (A) → P ; (B) → Q ; (C) → R,S ; (D) → S  
**Q15.** (A) → 4-iii ; (B) → 3-iv ; (C) → 2-ii ; (D) → 1-i  
**Q16.** Optical : a,b,c,d,f,g,i,j,k ; Geometrical isomer : c,g,j ; None : e, h  
**Q17.** (10)  
**Q18.** (a) Enantiomers, (b) Enantiomers, (c) Geometrical isomers & Diastereomers,  
(d) Positional, (e) Optical, (f) Diastereomers  
(g) Enantiomers, (h) Identical, (i) Geometrical isomers (Diastereomers)  
**Q19.** (7)  
**Q20.** (3)  
**Q21.** (i) 2<sup>4</sup> (ii) 9 (iii) 4 (iv) 4 (v) 0, (vi) 4 (vii) 2<sup>5</sup>, (viii) 2<sup>4</sup>, (ix) 2, (x) 4, (xi) 3  
**Q22.** (2)



## EXERCISE-IV (A) (JEE MAINS)

- Q1.** (D)    **Q2.** (D)    **Q3.** (B)    **Q4.** (B)    **Q5.** (C)    **Q6.** (A)  
**Q7.** (C)    **Q8.** (C)    **Q9.** (B)    **Q10.** (A)    **Q11.** (D)    **Q12.** (C)  
**Q13.** (C)    **Q14.** (D)    **Q15.** (D)    **Q16.** (A)    **Q17.** (2)    **Q18.** (8)

## EXERCISE-IV (B) (JEE ADVANCED)

- Q1.** (B)    **Q2.** (B)    **Q3.** (A)  
**Q4.** Enantiomers - I and III ; Diastereomers - I & II and II & III  
**Q5.** (D)    **Q6.** (B)    **7.** (C)    **8.** (BCD)    **9.** (AD)    **10.** (AD)  
**11.** (BD)    **2.** (ABC)    **13.** (3)    **14.** (2)    **15.** (5)    **16.** (7)  
**Q17.** (C)    **Q18.** (C)    **Q19.** (C)

