

CHEMISTRY

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01. Isomerism in Coordination Compounds

Isomers : Two or more compounds which have same chemical formula but different arrangement of atoms are called isomers.

Types of isomerism :

- (i) Structural isomerism
 - (a) Linkage isomerism
 - (b) Solvate isomerism or hydrate isomerism
 - (c) Ionisation isomerism
 - (d) Coordination isomerism
- (ii) Stereoisomerism
 - (a) Geometrical isomerism
 - (b) Optical isomerism

Structural isomerism: This type of isomerism arises due to the difference in structures of coordination compounds. Structural isomerism, or constitutional isomerism, is a form of isomerism in which molecules with the same molecular formula have atoms bonded together in different orders.

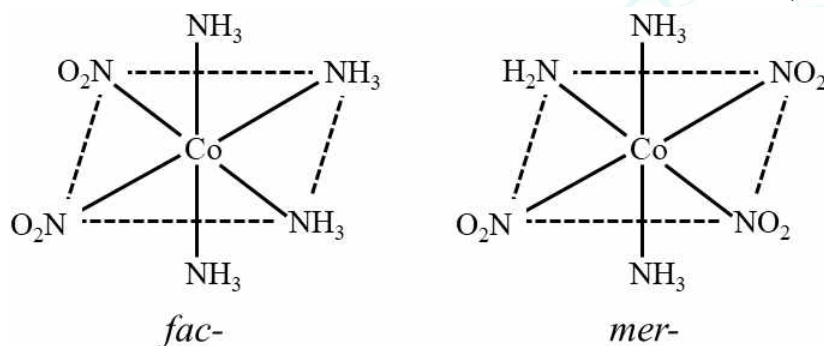
- (i) **Ionisation isomerism:** This form of isomerism arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand which can then become the counter ion. Example: $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$
- (ii) **Solvate isomerism:** It is isomerism in which solvent is involved as ligand. If solvent is water it is called hydrate isomerism, e.g., $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ and $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$
- (iii) **Linkage isomerism:** Linkage isomerism arises in a coordination compound containing ambidentate ligand. In the isomerism, a ligand can form linkage with metal through different atoms.
Example: $[\text{Co}(\text{NH}_3)_5\text{ONO}]\text{Cl}_2$ and $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$
- (iv) **Coordination isomerism:** This type of isomerism arises from the interchange of ligands between cationic and anionic entities of different metal ions present in a complex.
Example: $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{C}_2\text{O}_4)_3]$ and $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{C}_2\text{O}_4)_3]$

Stereoisomerism: This type of isomerism arises because of different spatial arrangement.

- (i) **Geometrical isomerism:** It arises in heteroleptic complexes due to different possible geometrical arrangements of ligands.
- (ii) **Optical isomerism:** Optical isomers are those isomers which are non superimposable mirror images.

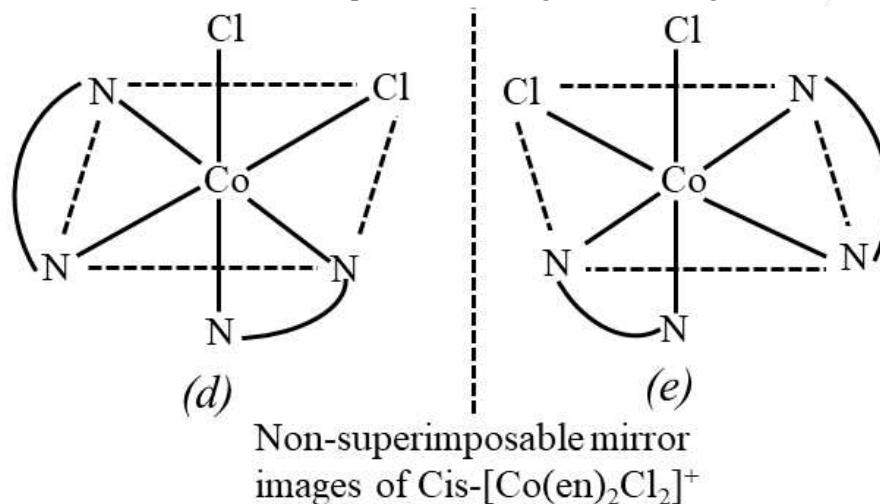
Fac and Mer isomers :

This type of geometrical isomerism occurs in octahedral coordination entities of the type $[\text{Ma}_3\text{b}_3]$ like $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$. If three donor atoms of the same ligands occupy adjacent positions at the corners of an octahedral face, it is called facial (fac) isomer. When the positions are around the meridian of the octahedron, it is called meridional (mer) isomer.



Optical isomerism :

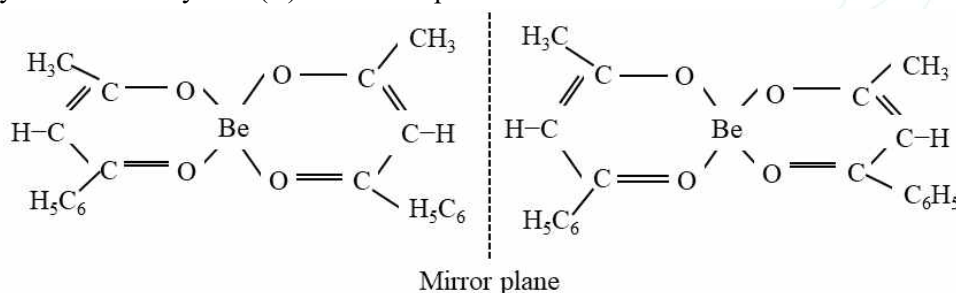
Optical isomerism is shown by those complex compounds whose molecules are not superimposable on their mirror images i.e., they are chiral molecules. Such molecules can rotate the plane of polarised light. The isomer which rotates the plane of polarised light to the right is called dextro rotatory and designated as *d* or (+) and the one which rotates the plane of polarised light to the left is called leavo rotatory and designated as *l* or (-). Optical isomerism is common in octahedral complexes involving bidentate ligands.



*The essential requirement for a substance to be optically active is that the substance should not have a plane of symmetry in its structure.

Optical isomerism is expected in tetrahedral complexes of the type *Mabcd* but no optical isomer has been isolated until now.

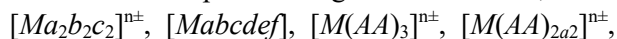
However, compounds containing two unsymmetrical bidentate ligands have been resolved into optical isomers and are known for Be(II), Zn(II) and B(II). For example, Bis-benzoylacetonato-beryllium(II) exhibits optical isomerism.



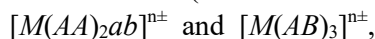
Optical isomers rarely occur in square planar complexes on account of the presence of axis of symmetry.

Optical isomerism is very common in octahedral complexes.

Octahedral complexes of general formulae,



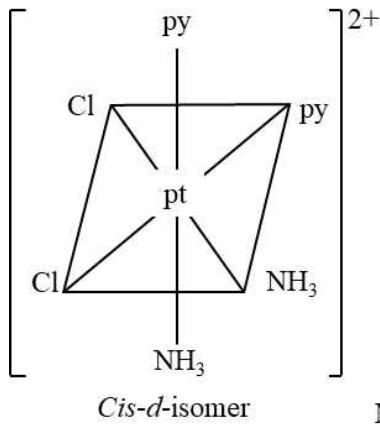
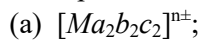
(where *AA* = symmetrical bidentate ligands)



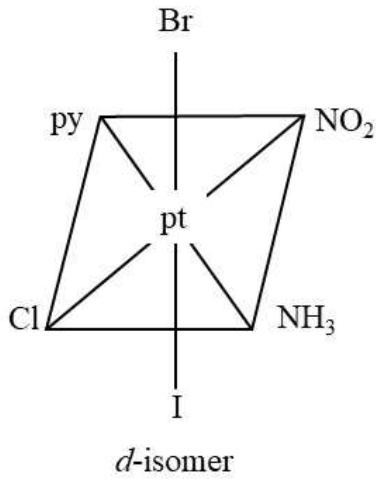
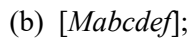
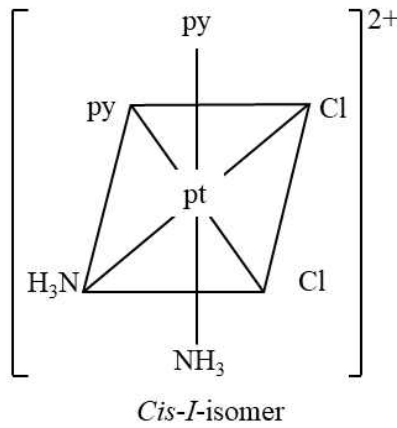
(where *AB* unsymmetrical ligands)

show optical isomerism.

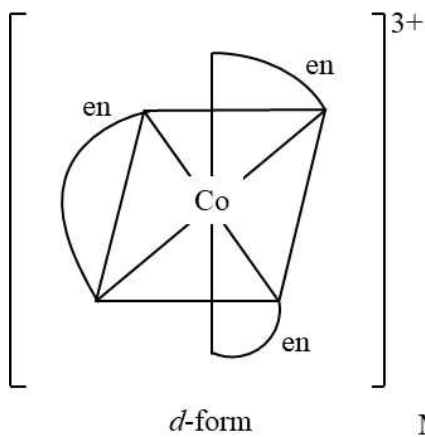
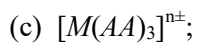
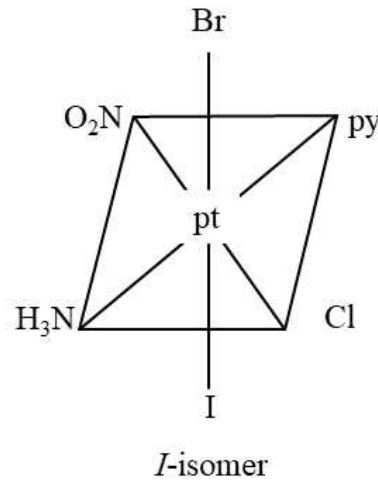
Examples :



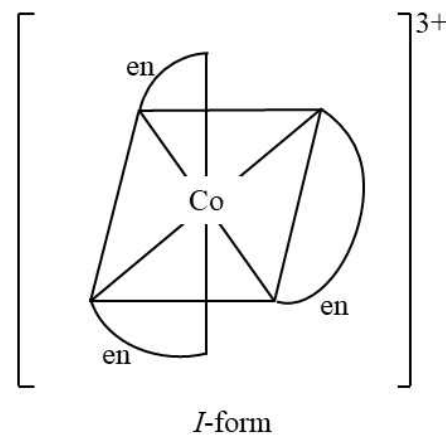
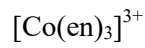
Mirror



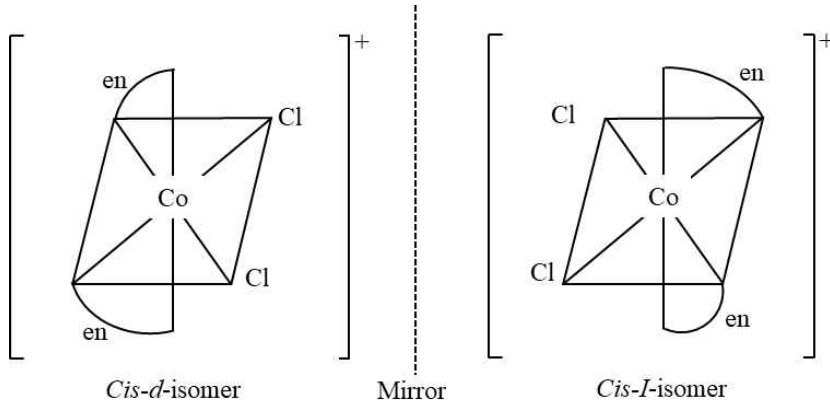
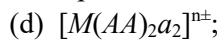
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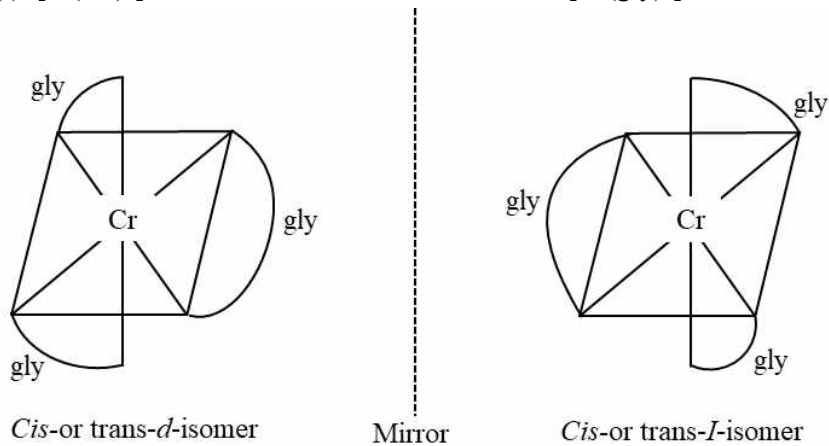
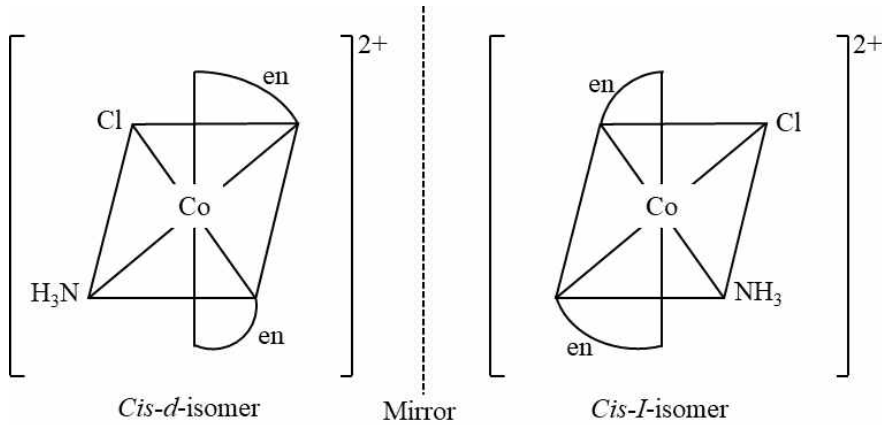
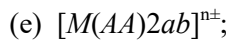
Mirror



Examples :



Trans form of $[M(AA)_2a_2]^{n\pm}$ does not show optical isomerism.



Some more examples are :

