

# Isomerism in Coordination compounds

Ms. A.Jerli Auxilia,  
Assistant Professor,  
Department of Chemistry.

# Isomerism

The compounds having the same molecular formula but different structures and hence different physical and chemical properties are called isomers. The phenomenon of the existence of such compounds is known as isomerism.

Isomerism in coordination compounds may be divided into two main types

a) Structural Isomerism

b) Stereo Isomerism

## Isomerism in Coordination Compounds

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graph TD; A[Isomerism in Coordination Compounds] --> B[Structural Isomerism]; A --> C[Stereo Isomerism];
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### Structural Isomerism

1. Ionisation
2. Hydrate
3. Coordination
4. Linkage
5. Coordination position

### Stereo Isomerism

1. Geometrical
2. Optical

# Ionisation Isomerism

The difference arises from the positions of groups within or outside the coordination sphere. Therefore, these isomers give different ions in solution, hence the name ionisation isomerism.

Ex:

Colour of the compound

Structural and mode of Isomerism

Red-violet



Pentaamminebromo cobalt(III)sulphate

Red

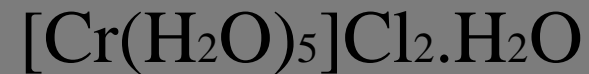


Pentaamminesulphate cobalt(III)bromide

# Hydrate Isomerism

This type of isomerism, which is similar to ionisation isomerism arises from replacement of a coordinated group by water of hydration.

Ex:



# Coordination Isomerism

This type of isomerism is observed in the case of compounds comprising of both cationic and anionic complexes.

Ex:



## Linkage Isomerism

In some ligands, there are two atoms which can donate their lone pairs. For example in  $\text{NO}_2^-$  ion, the nitrogen atom as well as the oxygen atom can donate their lone pairs. This gives rise to isomerism.

$[\text{Co}(\text{NO}_2)(\text{NH}_3)_3]\text{Cl}_2$       pentaamminenitro-Ncobalt(III)chloride

$[\text{Co}(\text{ONO})(\text{NH}_3)_5]\text{Cl}_2$       pentaamminenitrito-Ocobalt(III)chloride

# Stereoisomerism

## a) Geometrical Isomerism

The ligands occupy positions either adjacent to one another or opposite to one another. These are referred to as cis form and trans form respectively. This type of isomerism is also referred to as cis-trans isomerism.

### Geometrical Isomerism in complexes of Coordination number 4:

Complexes having coordination number 4 adopt either tetrahedral or square planar geometry

Ex:



*Geometrical isomerism cannot occur in complexes of the type Ma<sub>4</sub>, Ma<sub>3</sub>b, Mab<sub>3</sub>.*



## Geometrical Isomerism in complexes of coordination number 6:

The complexes having coordination number 6 adopt octahedral geometry. The octahedral complexes also exhibit geometrical isomerism.



*The complexes of the type  $\text{Ma}_6$  and  $\text{Ma}_5\text{b}$  would not show geometrical isomerism*

# Optical Isomerism

There are certain substances which can rotate the plane of polarised light. These are called optically active substances. The optically active isomers of a compound which rotate the plane of polarised light equally but in opposite directions are called enantiomers. The isomer which rotates the plane of polarised light to the right is called dextro rotatory designated as *d* and the one which rotates the plane of polarised light to the left is called laevo rotatory designated as *l*.

## Optical isomerism in complexes with coordination number 4

Tetrahedral complexes with coordination number 4 should exhibit optical isomerism because there is no plane of symmetry in their molecules.

Ex:

Bis(benzoylacetato beryllium(II) complex

## Optical Isomerism in complexes with coordination number 6

M(aa<sup>3</sup>): [Cr(ox)<sub>3</sub>]<sup>3-</sup>

M(aa)<sub>2</sub>b<sub>2</sub> or M(aa)<sub>2</sub>bc: [RhCl<sub>2</sub>(en)<sub>2</sub>]<sup>+</sup>

M(aa)b<sub>2</sub>c<sub>2</sub>: [CoCl<sub>2</sub>(en)(NH<sub>3</sub>)<sub>2</sub>]<sup>+</sup>

Complexes containing hexadentate ligands: [Co(EDTA)]<sup>-</sup>

Complexes containing unidentate ligands: The complexes of the type [Mabcdef] also expected to show optical isomerism. A complex of this type can theoretically have 15 geometrical forms, each of which should be optically active.