

Isomerism In Inorganic compounds (or) Coordination compounds (or) Transition metal complexes.

Compounds having the same chemical formula but different physical and chemical properties due to the different structural arrangements are called isomers. This phenomenon is known as Isomerism.

Coordination compounds exhibit two major types of isomerism, namely

A) Structural isomerism and B) Stereoisomerism (space isomerism)

A) Structural isomerism

This isomerism arises due to the difference in structures of coordination compounds.

(i) Ionisation isomerism

Complexes which have the same empirical formula but give different ions in solution on ionisation are called ionisation isomers.

Example:

$[\text{Co}^{III}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ - (I) and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ - (II) are the two ionisation isomers. complex (I) gives white precipitate

of BaSO_4 with BaCl_2 solution while (II) does not give white precipitate.

Similarly (II) gives ^{yellow} precipitate of AgBr with AgNO_3 while (I) does not give yellow precipitate.

2. Hydrate isomerism

There are three isomers of $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ They are

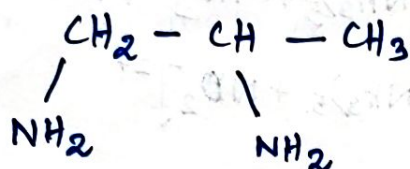
(a) $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ - It is violet in color. It does not lose water over H_2SO_4 and all Cl^- ions are immediately precipitated by Ag^+ ions.

(b) $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$ - It is green in colour. It loses H_2O over H_2SO_4 and two Cl^- ions are precipitated by Ag^+ ion.

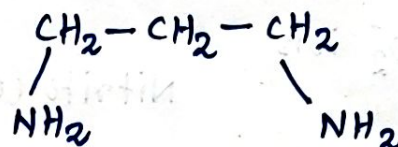
(c) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$ - It is green in colour. It loses two water molecules over H_2SO_4 and only one Cl^- ion is precipitated by Ag^+ ions.

3. Ligand Isomerism

Some ligands themselves are capable of existing as isomers. For example diamino propane can exist both as 1,2-Diamino propane (pn) and 1,3-Diamino propane (tn).

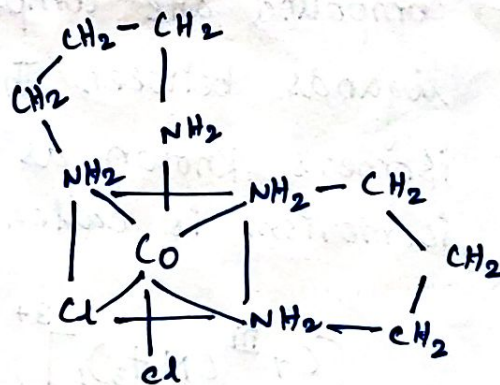
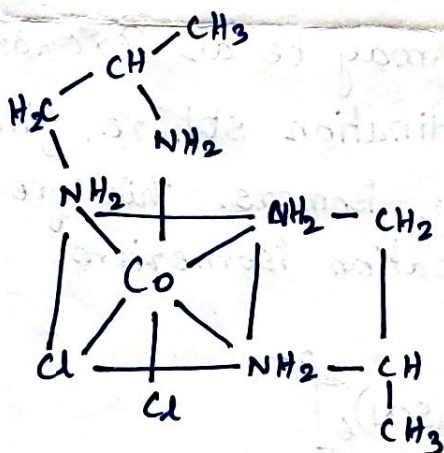


1, 2 - diamino propane



1, 3 - diamino propane.

When these ligands (i.e., pn and tn) are associated into complexes, the complexes are isomers of each other. one example of isomeric complexes having this ligand is $[\text{Co}(\text{pn})_2\text{Cl}_2]^+$ and $[\text{Co}(\text{tn})_2\text{Cl}_2]^+$ ions.

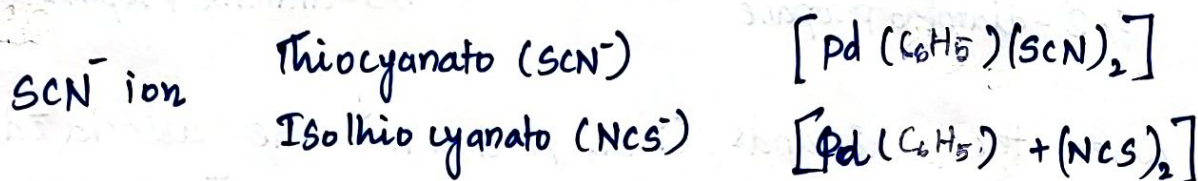
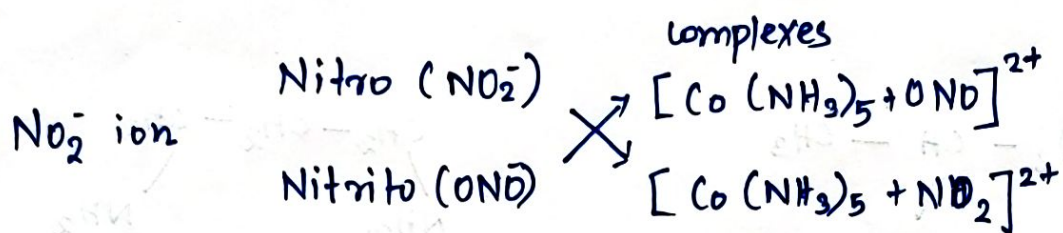


4) Linkage Isomerism

This type of isomerism is found in those complexes in which the ligands can coordinate with the central metal ion through either of the two atoms. The best known ligands of this type are NO_2^- , SCN^- and $\text{S}_2\text{O}_3^{2-}$ ions.

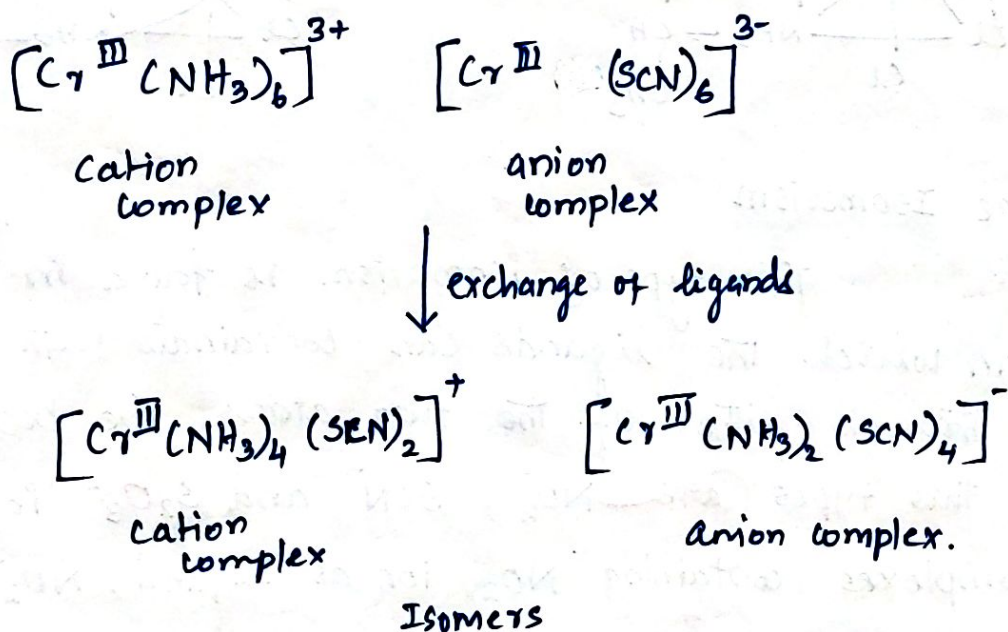
In complexes containing NO_2^- ion as ligand, NO_2^- ion may

attach with the central metal ion either through O-atom or through N-atom.



(5) Coordination Isomerism

If both cation and anion of a complex compound are complex, there may be an exchange of ligands between the two coordination sphere, giving rise to isomers known as coordination isomers. This type of isomerism is called as coordination isomerism.



Stereoisomerism

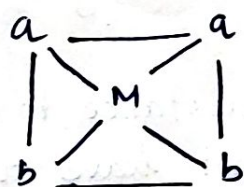
(1) Geometrical Isomerism:

This isomerism is due to ligands occupying different positions around the central metal atom or ion. The ligands occupy positions either adjacent or opposite to one another. This type of isomerism also known as cis-trans isomerism. When two same ligands are at right angle (90°), the form is cis form and when are present diagonally at (180°) to each other the form is termed trans form.

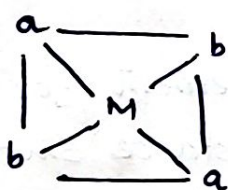
Geometrical isomerism is very common in coordination number 4 and 6 complexes.

Square planar complexes exhibit geometrical isomerism.

a) complexes with general formula, Ma_2b_2 (where both a and b are monodentate) can have cis and trans-isomer.

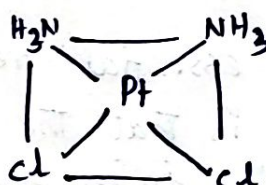


Cis-isomer

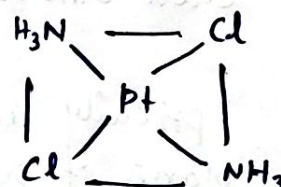


trans isomer

Ma_2b_2



cis-isomer



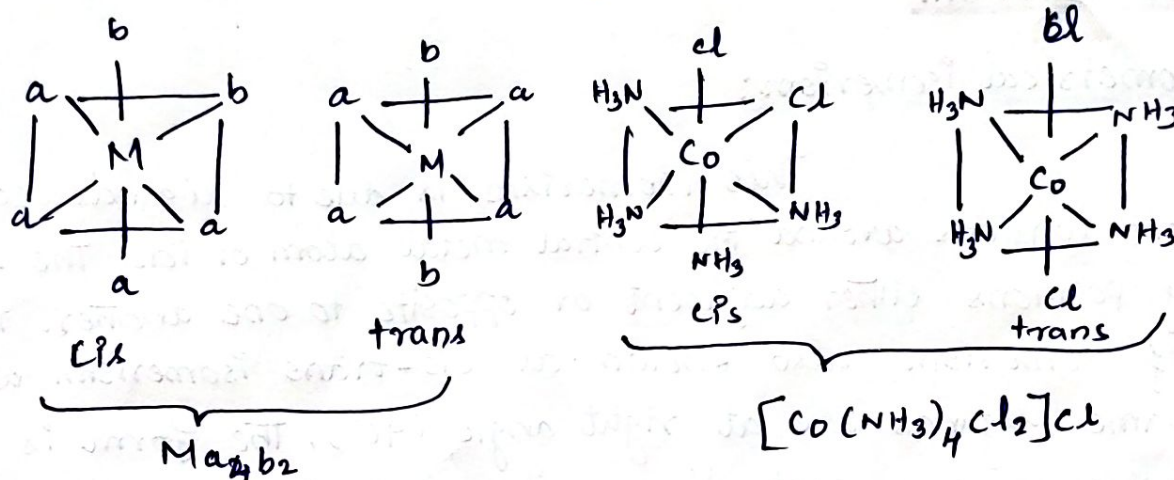
trans-isomer

$[Pt(NH_3)_2Cl_2]$

The complexes with general formula Ma_2b_2 , Ma_2bc , abc_3 also exhibit geometrical isomerism.

octahedral complexes (coordination number 6)

octahedral complexes of the type Ma_4b_2 , Ma_2b_4 , Ma_4bc and Ma_3b_3 exhibit geometrical isomerism.



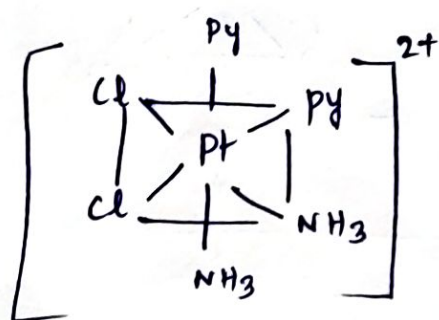
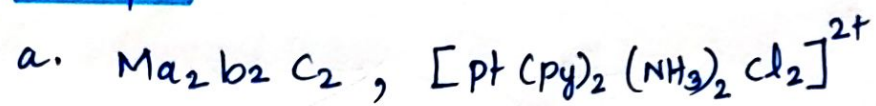
(2) Optical isomerism:

A coordination compound which can rotate the plane of polarised light is said to be optically active. When the coordination compounds have same formula but differ in their abilities to rotate directions of the plane of polarised light are said to exhibit optical isomerism and the molecules are optical isomer. The optical isomers are pair of molecules which are non-superimposable mirror image of each other.

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

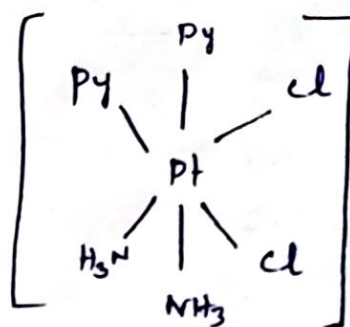
- ✓ The isomer which rotates the plane of polarised light to right direction is termed dextro-rotatory or (d-form) while the isomer which rotates the plane polarised light to left direction is termed laevo rotatory or (l-form). The two optically active isomers are collectively called enantiomers.

Examples :



cis- d - isomer

Mirror



cis- l - isomer