Isomerism exhibited by coordination compounds

A) Structural isomerism

a) Coordination isomerism
b) Ionisation isomerism
c) Hydrate or Solvate isomerism
d) Linkage isomerism
e) Ligand Isomerism

B) Stereoisomerism

a) Geometrical isomerism
b) Optical isomerism

Coordination isomerism

$[Pt^{II}(NH_3)_4]$ $[CuCl_4]$ and $[Cu(NH_3)_4]$ $[PtCl_4]$

Tetraammine platinum (II) Tetrachloro cuparate (II)

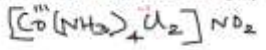
Tetraammine copper (II) Tetrachloro platinate (II)

Ionisation isomerism

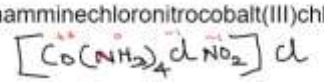
$[Co(NH_3)_5Br]SO_4$
pentaamminebromocobalt(III) sulphate

$[Co(NH_3)_5SO_4]Br$
pentaamminesulphatocobalt (III) bromide

Tetraamminedichlorocobalt(III) nitrite

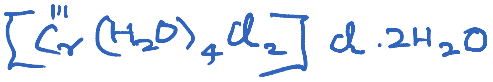


tetraamminechloronitrocobalt(III)chloride

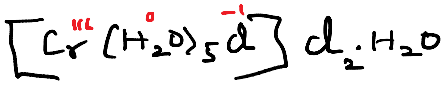


Hydrate or solvate isomerism
NOTE: These isomers have very different chemical properties and on reaction with $AgNO_3$ to test for Cl^- ions, would find 1, 2, and 3 Cl^- ions in solution respectively.

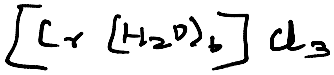
Tetraaquadichlorochromium(III) chloride dihydrate (bright green)



Pentaaquachlorochromium(III) chloride monohydrate (grey green)

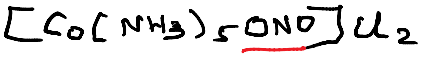


Hexaaquachromium(III) chloride (violet)



Linkage isomerism occurs with ambidentate ligands

The nitrito isomer – the ligand is attached through O atom - red
The nitro isomer – the ligand is attached through N atom - yellow

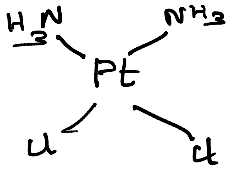


Stereoisomerism (space isomerism)
Isomerism arise by the difference in space about the central metal atom

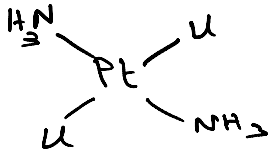
Two types:
1) Geometrical isomerism
2) Optical isomerism

Geometrical isomerism in square planar complexes (cis-trans isomerism) e.g. cis-diamminedichloroplatinum(II) and trans-diamminedichloroplatinum(II)

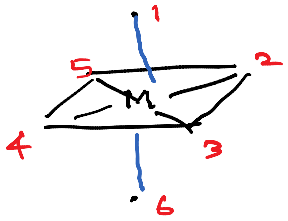
Cis-isomer

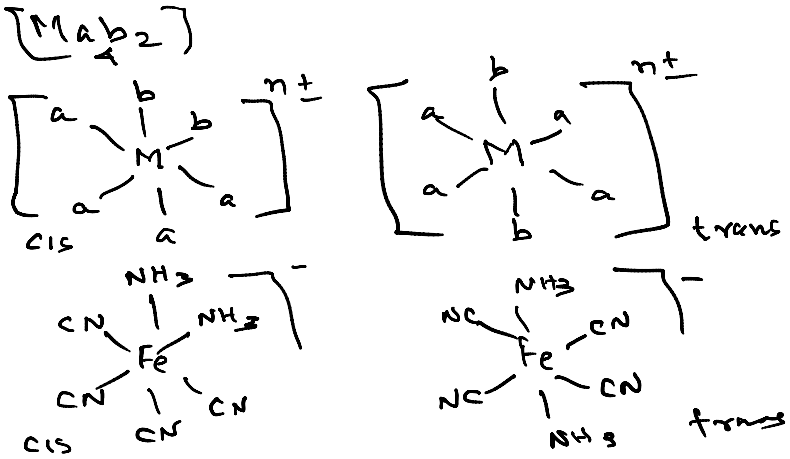


trans-isomer



Geometrical isomerism in octahedral complexes.
There are 12 edges. So, 12 cis-positions are possible.
(1,2) (1,3) (1,4) (1,5) (2,6) (3,6) (4,6) (5,6) (3,4) (4,5) (2,5) and (2,3).
There are three trans positions; they are (1,6) (2,4) and (3,5).

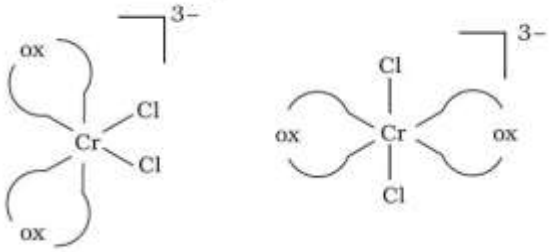




Optical isomerism
Optical isomers are mirror images. They are not superimposable on one another.
They are called enantiomers.
The molecules or ions that cannot be superimposed are called chiral.
The two forms of optical isomers are dextro (d) and laevo (l) .
Optical isomerism is common
in octahedral complexes involving
bidentate ligands

Out of the following two coordination entities which is chiral (optically active)?
(a) *cis*-$[CrCl_2(ox)_2]^{3-}$ (b) *trans*-$[CrCl_2(ox)_2]^{3-}$

The two entities are represented as



(a) *cis* – $[CrCl_2(ox)_2]^{3-}$ (b) *trans* – $[CrCl_2(ox)_2]^{3-}$

Out of the two, (a) *cis* - $[CrCl_2(ox)_2]^{3-}$ is chiral (optically active).