

## ISOMERISM OF COORDINATION COMPLEXES

Compounds that have the same chemical formula but different structural arrangements are called isomers.

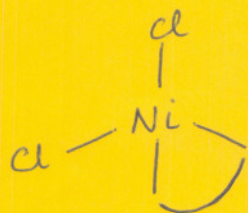
Many different types of isomerism can occur in coordination compounds.

### CONFORMATIONAL ISOMERISM

These isomers have different stereochemistry

Eg: tetrahedral and square planar forms of  $\text{NiCl}_2(\text{Ph}_2\text{PCH}_2\text{CH}_2\text{PPh}_2)$

dichloro 1,2-<sup>bis</sup>(diphenylphosphino)ethane nickel (II)



tetrahedral

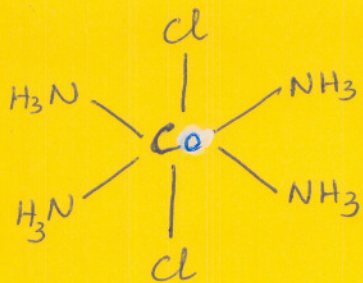


square planar

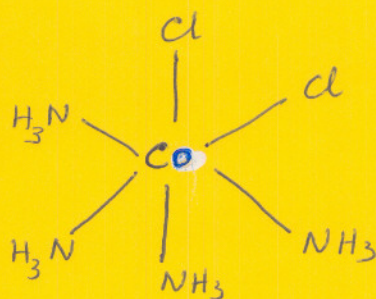
### GEOMETRICAL ISOMERISM

Ligands may be adjacent (cis) or opposite (trans) to each other.

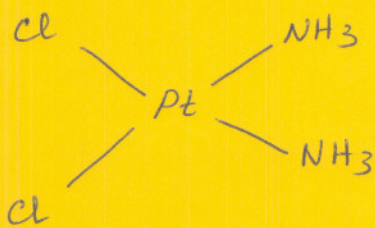
21  
 Eg: Octahedral  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$  can have cis and trans forms



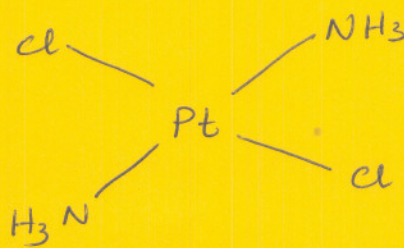
trans  
(green)



cis  
(violet)



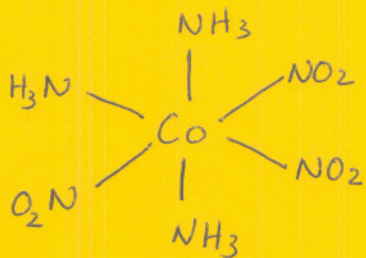
cis



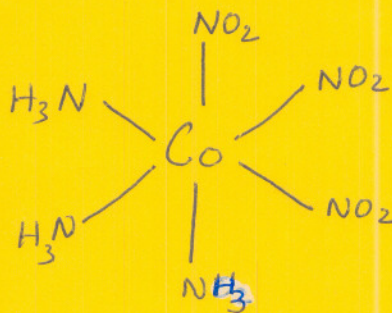
trans

(both are square planar complexes)

Facial and meridional isomers are also geometrical isomers



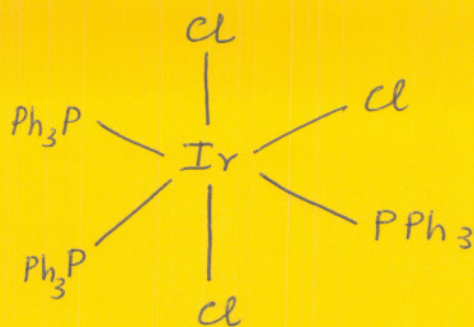
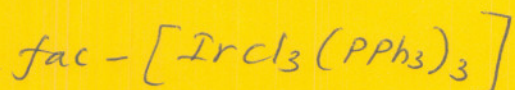
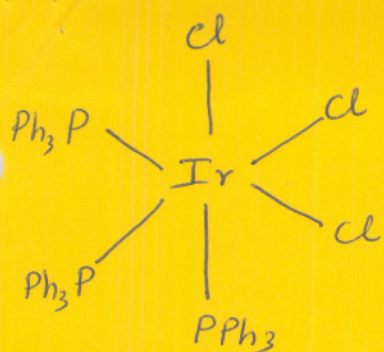
mer



fac

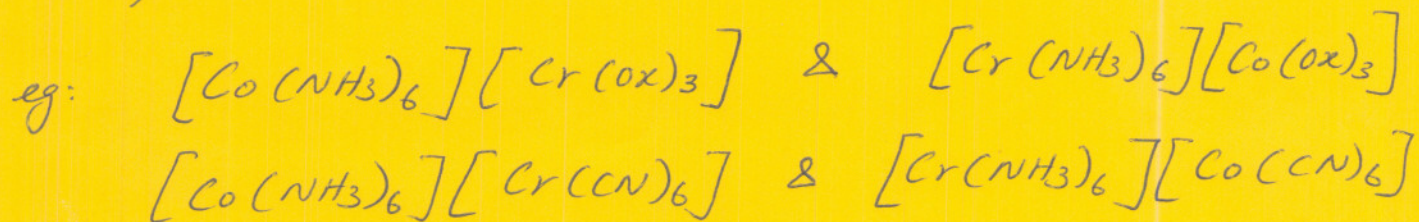
Two NH<sub>3</sub> ligands are trans with the third NH<sub>3</sub> in between

Three NH<sub>3</sub> ligands surround one face of the octahedron



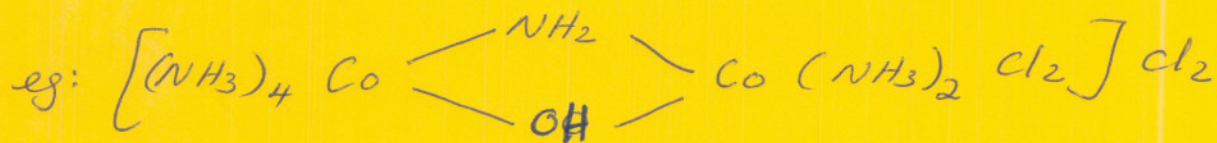
### COORDINATION ISOMERISM

When both positive and negative ions are complex, isomerism may be caused by the interchange of ligands between the two complex ions.

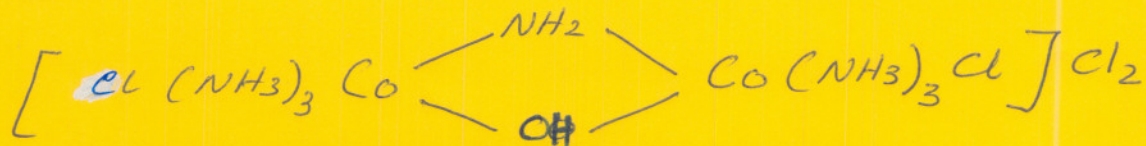


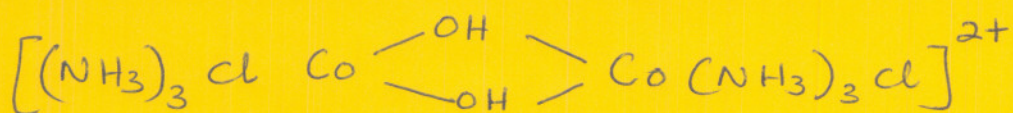
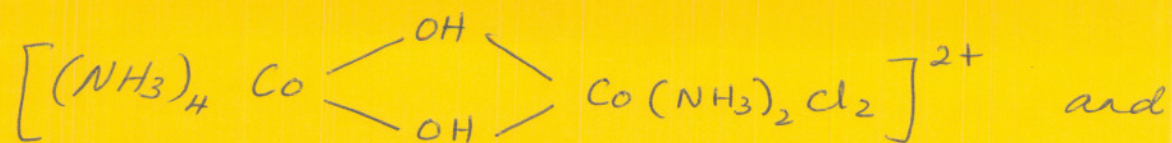
### COORDINATION POSITION ISOMERS

In polynuclear complexes an interchange of ligands between the different metal nuclei give rise to these isomers



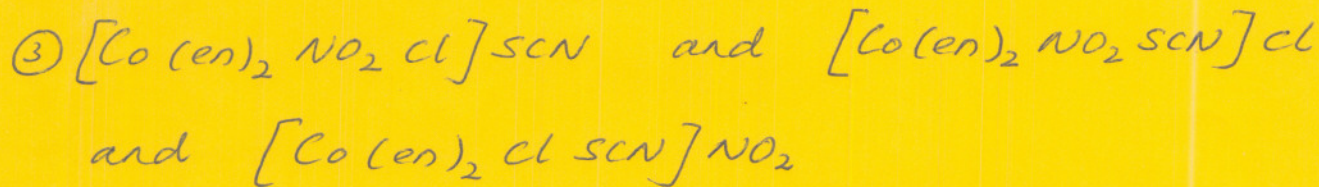
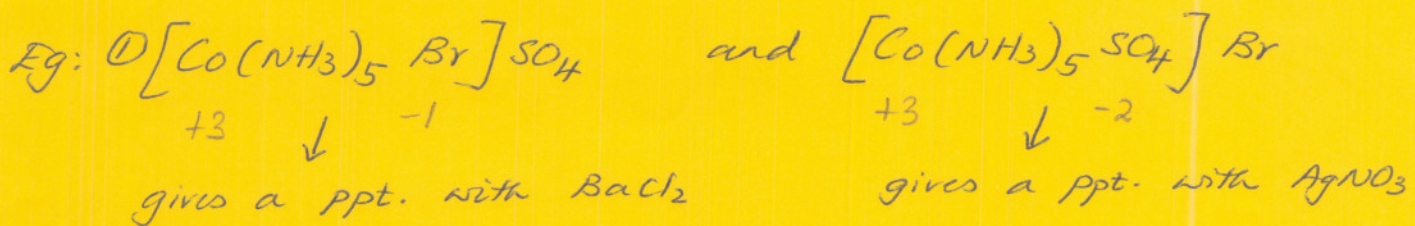
and





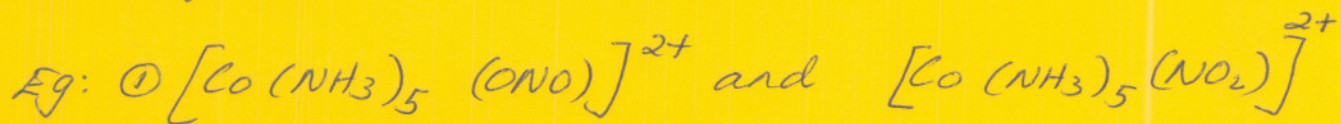
### IONIZATION ISOMERS

This type of isomerism is due to the exchange of ions between the inner sphere and the ions outside it. Therefore the ions present in solution are different.



## LINKAGE ISOMERISM

Ambidentate ligands give rise to linkage isomers by bonding to the metal through different donor atoms.



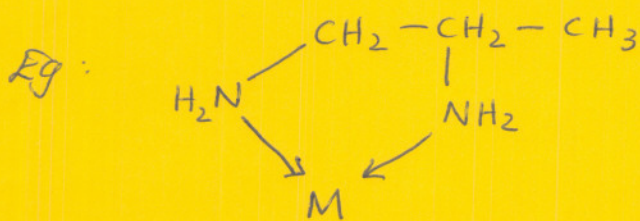
pentaamminenitritocobalt(III) ion      pentaamminenitrocobalt(III) ion



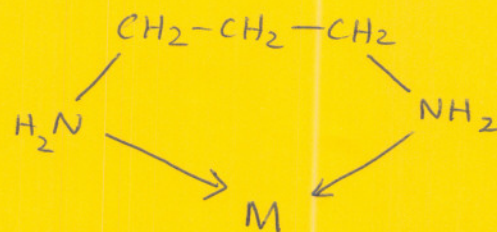
pentaqua thiocyanatochromium(III) ion      pentaqua isothiocyanatochromium(III) ion

## LIGAND ISOMERISM

If the ligands attached to the metal are isomers, then the metal complexes are ligand isomers.



1,2-diaminopropane ligand



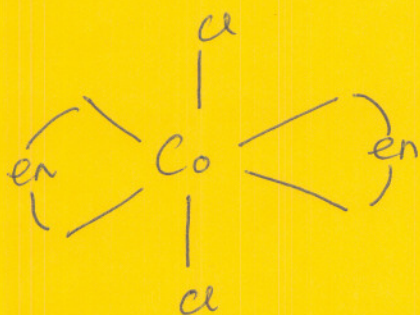
1,3-diaminopropane ligand.

## OPTICAL ISOMERISM

A Chiral complex is one that is not superimposable on its mirror image. A chiral molecule does not have a  $S_n$  axis ( $S_1 = \text{mirror plane}$ ,  $S_2 = i$ )

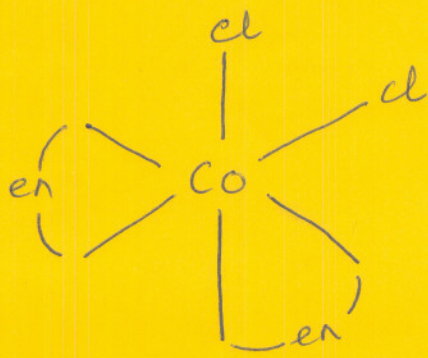
The two mirror images of a chiral complex are optical isomers. The pair of optical isomers are called an enantiomeric pair. Enantiomeric pairs rotate plane polarized light in opposite directions.

Eg:  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$

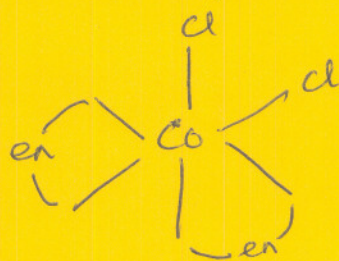


trans - dichlorobis(ethylenediamine) - cobalt (III) ion

Has  $i \Rightarrow$  achiral

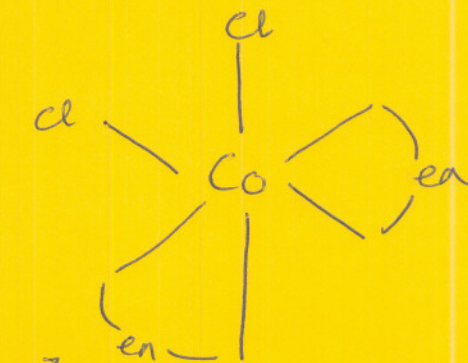


This has cis and trans forms

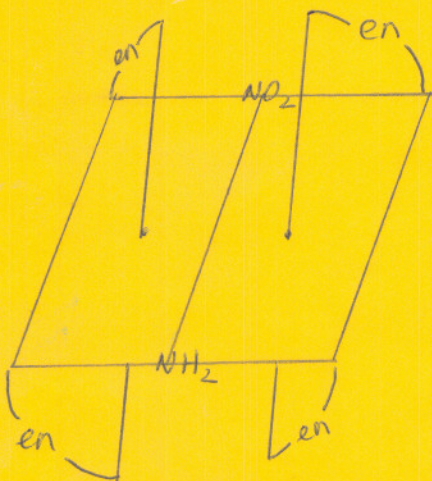
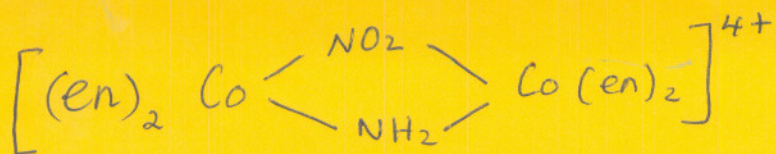


cis - dichlorobis(ethylenediamine)cobalt (III) ion

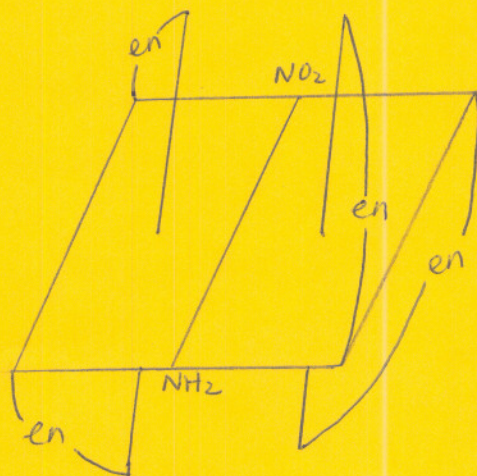
no  $S_n \Rightarrow$  chiral



enantiomeric pair (d and l forms)



Has a mirror plane  
 $\Rightarrow S_1 \Rightarrow$  achiral



no  $S_n$  axis  
 $\Rightarrow$  chiral molecule  
 $\therefore$  has d & l forms

enantiomeric pair

