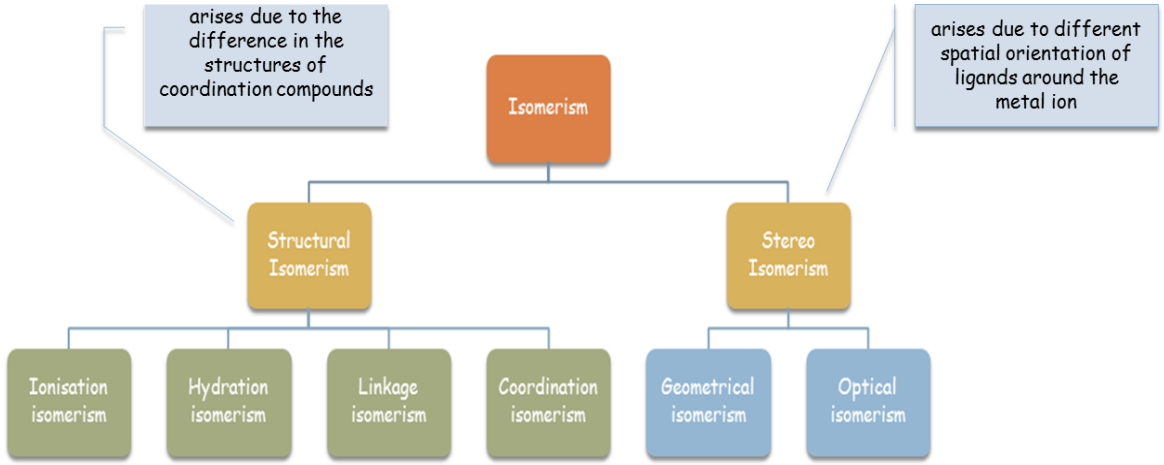
Quadrant III

Resource: Lecture notes

STEREO-ISOMERISM IN CO-ORDINATION COMPOUNDS



Compounds with the same formula but different arrangements of the atoms are called **isomers**.

STEREOISOMERS are those which have different orientations of Ligands around the central metal atom.

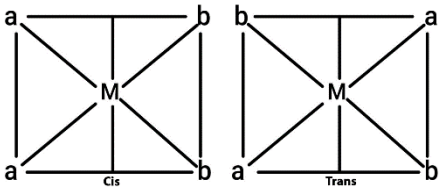
Co-ordination No.	Geometry	Geometrical isomers	Optical isomers
4	Tetrahedral	Not possible	Possible, but rare
4	Square planar	Possible	Not possible
6	Octahedral	Possible	Possible

Geometrical isomerism in complexes with coordination number 4, Square planar

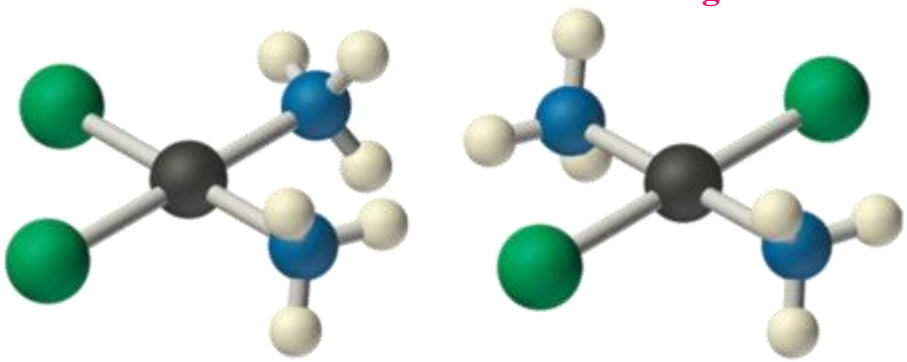
Compound type	No. of isomers
1. Ma_2b_2	2 (cis- and trans-)
2. Ma_2bc	2
3. Mabcd	3
4. Unsymmetrical ligands	2

Note: cis-PtCl2(NH3)2 is an anti-cancer agent (cisplatin) whereas the trans-isomer is inactive against cancer (it is toxic), and so not useful in Chemotherapy.

1. Complex of the type **Ma_2b_2**



2- D Figure

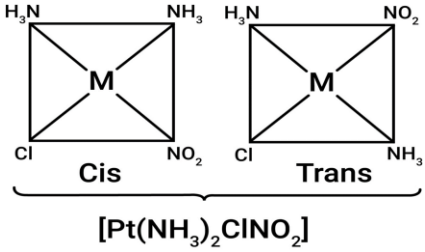


cis-$Pt(NH_3)_2Cl_2$ *trans*-$Pt(NH_3)_2Cl_2$

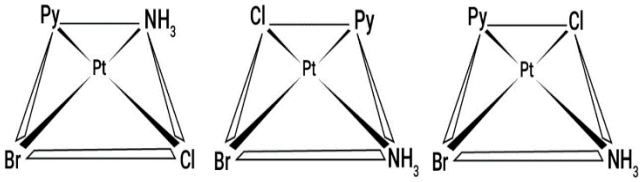
3- D Figure

In TRANS isomer two similar ligands occupy positions, 180 degree to each other. In the CIS isomer, two similar ligands occupy positions, 90 degree to each other.

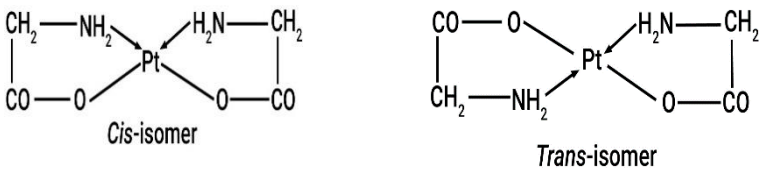
2. Complex of the type **Ma_2bc**



3. Complex of the type **Mabcd**

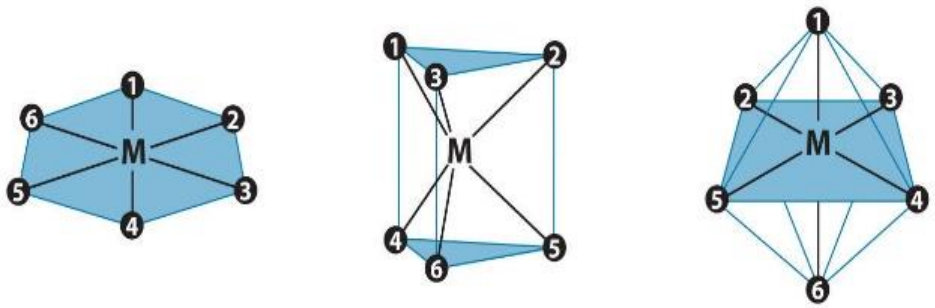


4. Unsymmetrical Ligands, glycinate ligand



Q. Draw the cis and trans isomers of the following compounds:
$(NH_3)_2IrCl(CO)$
$(H_3P)_2PtHBr$

CO-ORDINATION NUMBER 6



Hexagon Trigonal prism Octahedron

Geometrical isomerism in complexes with coordination number **6:**

i) Complexes with Monodentate ligands of type

$[Ma_6]$, $[Ma_5b]$ $[Ma_4b_2]$, $[Ma_3b_2c]$, $[Ma_3b_3]$, $[Ma_3bcd]$, $[Ma_2b_2c_2]$

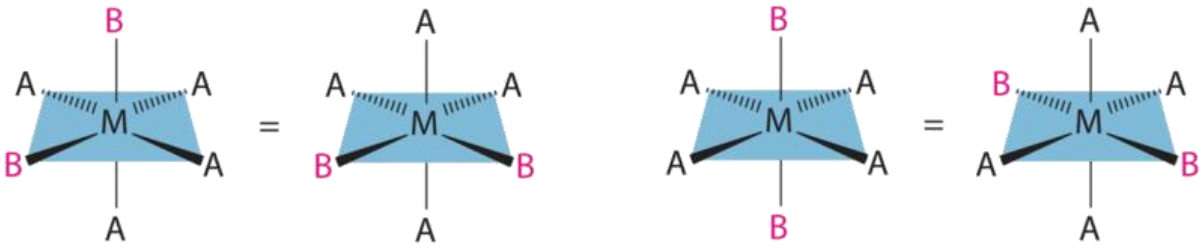
Co-ordination compounds, MA_6, MA_5B are possible, but their geometrical isomers do not exist because they exist in a single isomer form.

Compound type	**No. of isomers**
1. Ma_4b_2	2 (cis- and trans-)
2. Ma_4bc	2 (cis- and trans-)
3. Ma_3b_3	2 (fac- and mer-)
4. $M(AA)_2b_2$	3 (2*cis- and 1 trans-)

here a, and b, represent monodentate ligands and AA is a bidentate ligand.

1. Octahedral Complexes containing only monodentate ligands

a) $[Ma_4b_2]^{n\pm}$

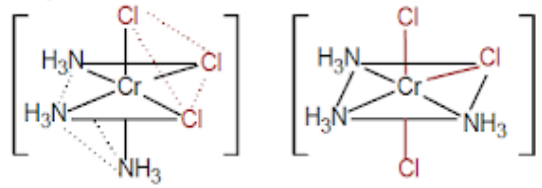


MA_4B_2 octahedral complex, *cis* isomer

MA_4B_2 octahedral complex, *trans* isomer

e.g $[Co(NH_3)_4Cl_2]^+$, If both Cl ligands are same side i.e 1,2 then cis isomer formed. If both Cl are opposite to each other then trans isomer formed.

b) Complexes of type [Ma3b3]$^{n\pm}$: If the same ligands occupy adjacent positions (1,2 & 3) at the corners,known as **facial (fac)** isomer, when the positions are opposite (4,5 & 6)/ around the meridian of the octahedron, **meridional (mer)** isomer

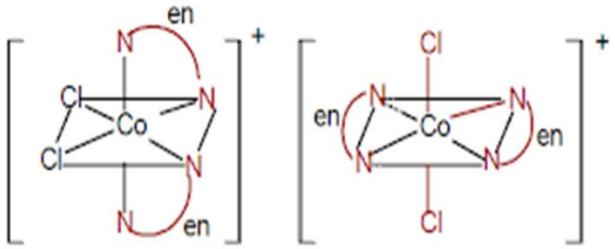


Cis / facial / fac-isomer trans / meridional / mer-isomer

Write the Geometrical isomer of [Ru(Py)3Cl3].

2. Octahedral Complexes containing monodentate and symmetrical bidentate ligands

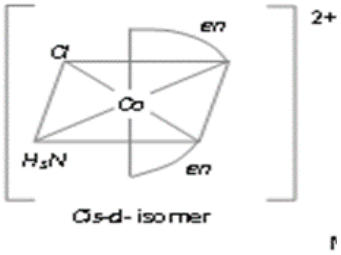
a) Complexes of type $[M(AA)_2b_2]^{n\pm}$



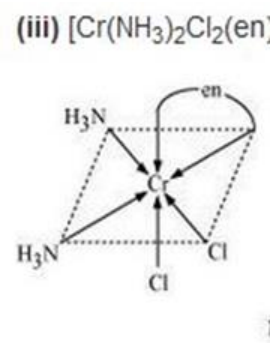
Cis-isomer trans-isomer

cis/trans form of $[Co(en)_2Cl_2]^+$

b) Complexes of type $[M(AA)2ab]^{n\pm}$



c) Complexes of type $[M(AA)a_2b_2]^{n\pm}$



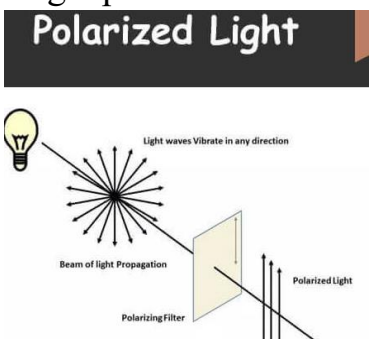
CIS ISOMER TRANS ISOMER TRANS ISOMER

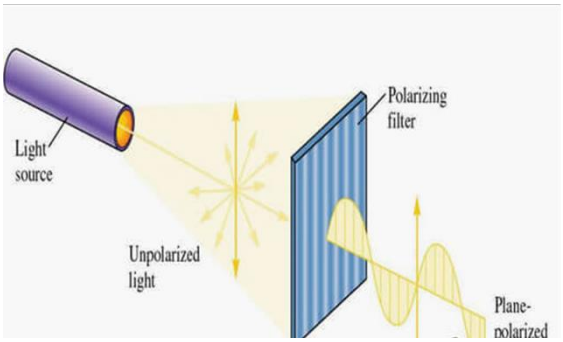
Write the above isomers.

OPTICAL ISOMERISM

Unpolarised: The light waves that have vibrations occurring within them at random angles without any plane.

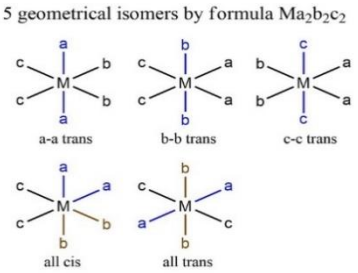
Polarised light: The light waves that have vibrations occurring within them in a single plane.



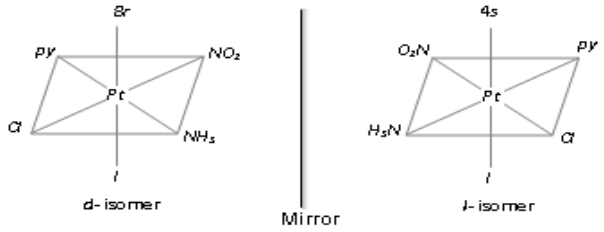


Optical isomerism in complexes with coordination number 6:
Complexes with Monodentate ligands of type $[Ma_6]$, $[Ma_5b]$, $[Ma_4b_2]$, $[Ma_3b_2c]$, $[Ma_3b_3]$, $[Ma_4bc]$, $[Ma_2b_2c_2]$, [Mabcdef]

1. $[Pt(NH_3)_2(py)_2Cl_2]^{2+}$ ion is an important example of octahedral complex of the **type $[Ma_2b_2c_2]$**



2. **[Mabcdef] e.g Pt(py)NH_3NO_2ClBr]**

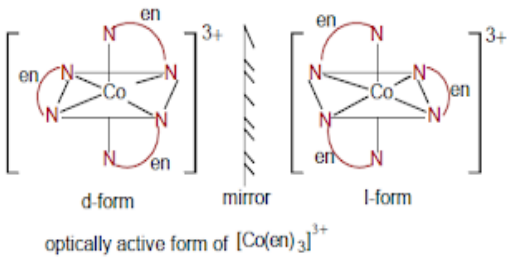


In order to show optical activity, molecule should not have any element of symmetry.

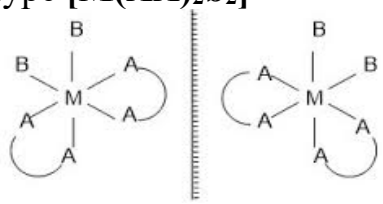
SYMMETRICAL BIDENTATE LIGANDS

a) Complex of type **$[M(AA)_3]$**

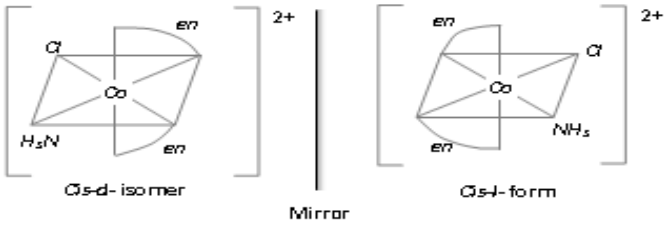
This complex do not have element of symmetry hence optically active & can resolve into'd' & 'l' isomers. E.g. [Cr(C2O4)3]3-, [Co(en)3]



b) Complex of type **$[M(AA)_2b_2]$**

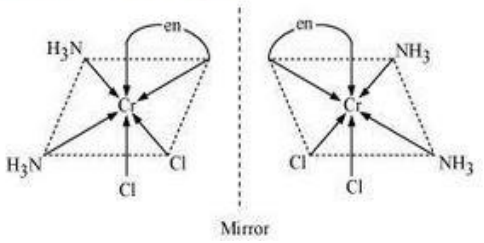


b) Complex of type **[M(AA)$_2$ab]:** $Co(en)_2NH_3Cl]^{2+}$



c) Complexes of **type [M(AA)a_2b_2]$^{n\pm}$**

(iii) $[Cr(NH_3)_2Cl_2(en)]^+$



CIS isomer is optically active

TRANS isomer is optically inactive

References and Credits

1. Selected Topics in INORGANIC CHEMISTRY-for BSc (Hons) Dr. Wahid U. Malik et al. 8th Edition, S Chand publishing Co. Ltd.

2. Principles of INORGANIC CHEMISTRY – B.R. Puri, L.R.Sharma, K.C. Kalia, 33rd Edition, Vishal Publishing Co.