

STUDY MATERIAL



Dumkal College

Basantapur, Dumkal

**Topic: Coordination Chemistry-I : IUPAC nomenclature
of coordination compounds**

Course Code: CHEMHT-9

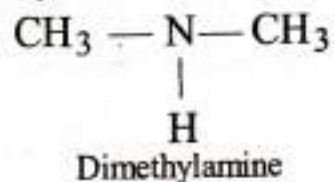
Semester: IV (Hons)

Name of the Teacher: Saleha Khatun

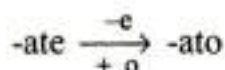
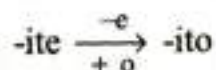
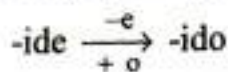
Name of the Department: Chemistry

The rules recommended by the International Union of Pure and Applied Chemistry (IUPAC) for naming of coordination compounds are as follows :

1. If a coordination compound is ionic (*i.e.*, the coordination compound contains either a complex cation or complex anion or both), the cation is named first followed by the anion and the cation is separated by a space from the anion, just as in other simple salts. No space is used within the name of the complex ion. For example, in $K_4[Fe(CN)_6]$ and $[Co(NH_3)_6]Cl_3$ the cations K^+ and $[Co(NH_3)_6]^{3+}$ are named first followed by the names of anions $[Fe(CN)_6]^{4-}$ and Cl^- respectively.
2. If a coordination compound is neutral, the name of compound is written as one word (*i.e.*, the name of neutral complex compound is given without space).
3. In the name of a complex ion or non-ionic complex, the ligands are named first but in alphabetical order before the name of the metal ion or atom. The numeral prefixes such as di, tri, tetra *etc.* which indicate the number of ligands of a particular type are ignored in determining the order.
4. Oxidation number of metal cation or atom is written in Roman numeral in parentheses immediately following the name of the metal. There is no space between the name of metal and parentheses.
5. If the complex ion or neutral complex contains more than one ligand of a particular kind, the Greek prefixes di, tri, tetra, penta, hexa- and so forth are used for 2, 3, 4, 5, 6 and so forth respectively.
6. If the name of the ligand itself contains a Greek prefix, its name is put in parentheses and the prefixes *bis*, *tris*, *tetrakis*, *pentakis*, *hexakis*, *heptakis* are used for 2, 3, 4, 5, 6 and 7 respectively to specify the number of ligands. For example, the ligand ethylenediamine already contains di, therefore, if two or three such ligands are present in a complex, the name is *bis* (ethylenediamine) or *tris* (ethylenediamine).
7. The prefixes *bis*, *tris*, *tetrakis* and so forth are also used for complex ligands. For example, if two CH_3NH_2 ligands are present in a complex, the prefix *bis*- is used. Thus the name of the ligand is *bis* (methylamine). If we name it as dimethylamine, we are referring to the following compound :



8. The names of anionic ligands end with the letter o. They are usually obtained by changing anionic endings -ide to -o, -ite to -ito and -ate to -ato. But according to latest IUPAC convention, all the anionic ligands names are obtained by replacing the last letter e by o.



The names of anionic ligands are given in Table 1.1.

In case of ambidentate ligands, the atom which is bonded to the metal cation is specified by placing the symbol of the bonded atom after the name of the ligand separated by hyphen. These ligands are also given specific names for each mode of attachment. Some examples are given below :

Name and Mode of Attachment of Ambidentate Ligands

Ambidentate Ligands	Name and Mode of Attachment
NO_2^-	- NO_2^- , nitrito - N or nitro
SCN^-	- ONO^- , nitrito - O or nitrito
	- SCN^- , thicyanato - S or thicyanato
	- NCS^- , thicyanato - N or isothiocyanato

Neutral ligands are given the same name as the parent molecule, though there are exceptionally some ligands which are given special names.

Neutral ligands having usual names :

Neutral Ligands	Names
N_2	dinitrogen
O_2	dioxygen
$\text{C}_5\text{H}_5\text{N}$	pyridine
bpy	bipyridyl
CH_3NH_2	methylamine
$(\text{CH}_3)_2\text{NH}$	dimethylamine
$\text{NH}_2 - \text{NH}_2$	hydrazine
NH_2OH	hydroxylamine

NH_2CONH_2
 NH_2CSNH_2
 $(\text{CH}_3)_2\text{SO}$, DMSO
 CH_3CN
 PPh_3 ✓
 PCl_3 ✓

urea
 thiourea
 dimethylsulphoxide
 acetonitrile or methylcyanide
 triphenylphosphine
 trichlorophosphine

Ligands having special names :

Neutral Ligands	Name
NH_3	ammine
CO	carbonyl
CS	thiocarbonyl
H_2O	aqua
NO	nitrosyl

9. The vowel ending the numeral prefix of the ligands will not be ignored while writing the name. For example, if there are four NH_3 , and two oxide ligands, then these are named as tetraammine and trioxide respectively. Mono is an exception, mono + oxide \rightarrow monoxide.
10. For a complex cation or neutral complex, the usual name of the metal is used. If the complex is an anion, the ending -ate either adds to the name of metal or replaces -ium, -en or -ese ending.

Name of metals obtained by replacing ending - ium by - ate.

Metal	Anion Name
aluminium	aluminate
scandium	scandate
titanium	titanate
vanadium	vanadate
chromium	chromate
zirconium	zirconate
palladium	palladate
rhodium	rhodate
rhenium	rhenate

Name of metals in complex anion obtained by addition of ending- ate.

Metal	Anion Name
manganese	manganate
cobalt	cobaltate
nickel	nickelate
zinc	zincate
platinum	platinate
tungsten	tungstate
molybdenum	molybdate

Name of metals originated from Latin name :

Metal	Anion Name
iron	ferrate ✓
copper	cuprate ✓
silver	argentate ✓
lead	plumbate ✓
gold	aurate ✓
tin	stannate ✓

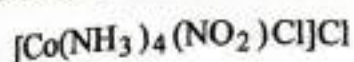
The rules given above are illustrated by the following examples :

(a) Non- ionic or Neutral Complexes :

$[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$	triamminetrichlorocobalt(III)
$[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$	triamminetrinitrocobalt(III)
	OR
	triamminetrinitrito - N cobalt(III)
$[\text{Rh}(\text{NH}_3)_3(\text{NCS})_3]$	triamminetriisothiocyanatorhodium(III)
	OR
	triamminetrithiocyanato - N rhodium(III)
$[\text{Ni}(\text{CO})_4]$	tetracarbonylnickel (0)
$\text{Fe}(\text{C}_5\text{H}_5)_2$	<i>bis</i> (cyclopentadienyl) iron(II)
$[\text{Cu}(\text{CH}_3\text{NH}_2)_2\text{Cl}_2]$	dichloro <i>bis</i> (methylamine) copper(II)
$[\text{Cr}(\text{C}_6\text{H}_6)_2]$	<i>bis</i> (benzene) chromium(0)
$[\text{CuCl}_2\{\text{O} = \text{C}(\text{NH}_2)_2\}_2]$	dichloro <i>bis</i> (urea) copper(II)

(b) Complexes Containing Complex Cations

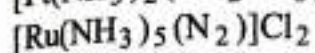
$[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$	hexaamminecobalt(III) chloride
$[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$	pentaamminechlorocobalt(III) chloride
$[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{Cl}_3$	tetraamminediaquacobalt(III) chloride
$[\text{Fe}(\text{CNCH}_3)_6]\text{Cl}_2$	<i>hexakis</i> (methylisocyanide) iron(II) chloride
$[\text{Co}(\text{en})_3]\text{Cl}_3$	<i>tris</i> (ethylenediamine)cobalt(III) chloride



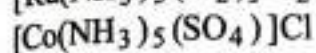
tetraamminechloronitrocobalt (III) chloride
OR



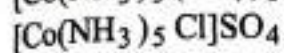
tetraamminechloridonitrito-N cobalt (III) chloride
diamminechloromethylamine platinum (II) chloride



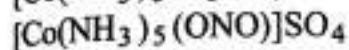
pentaamminedinitrogenruthenium (II) chloride



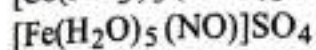
pentaamminesulphatocobalt (III) chloride



pentaamminechlorocobalt (III) sulphate



pentaamminenitrito- O cobalt (III) sulphate



pentaaquanitrosyliron (I) sulphate

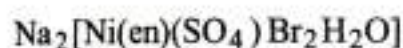
Magnetic moment measurements show that in complexes of iron, NO is present in + 1 oxidation state. Therefore oxidation state of Fe in $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+}$ is + 1.

Coordination Compounds Containing Complex Anion

$\text{Na}_2[\text{Fe}(\text{CN})_5(\text{NO})]$ sodiumpentacyanonitrosylferrate (II). As discussed earlier that in complexes of iron, NO exists in + 1 oxidation state. Oxidation state of iron in $\text{Na}_2[\text{Fe}(\text{CN})_5(\text{NO})]$ is + 2 as calculated below. Let the oxidation number of Fe is x . Then

$$+1 \times 2 + x + (-1 \times 5) + 1 = 0$$

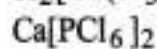
$$x = +2$$



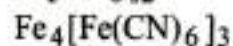
sodiumaquadibromo ethylene
diamine sulphatonickelate(II)



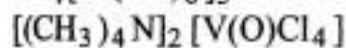
potassium tetraazidocobaltate(II)



calcium hexachlorophosphate(V)

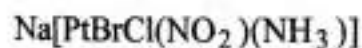


iron hexacyanoferrate(II)



tetramethylammonium

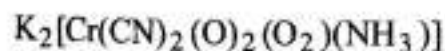
tetrachlorooxovanadate(IV)



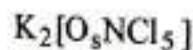
sodium amminebromochloronitrito-N
platinate(II)



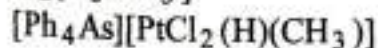
potassium ethylenediaminetetraacetato
cobaltate(III)



potassium amminedicyanodixoperoxo
chromate(VI)



potassium pentachloronitridoosmate(VI)

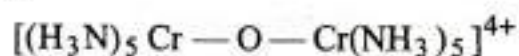


tetraphenylarsonium

dichlorohydridomethylplatinate(II)

Naming of Bridged Polynuclear Complexes

A ligand that bridges two metal cations or atoms is denoted by prefix μ - added to the name of the bridging ligands. For example :



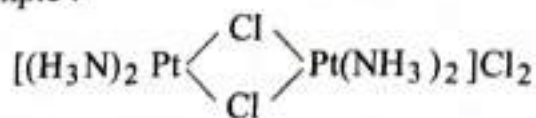
μ - oxo bis [pentaammine chromium (III)]

OR pentaammine chromium (III) - μ - oxopentaammine chromium (III)

OR

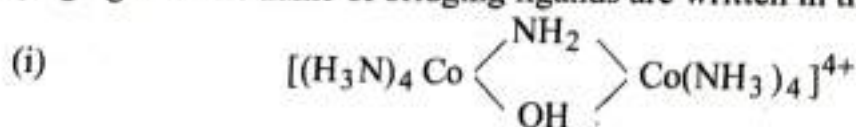
μ - oxodecaammine dicobalt (III) ion

If a complex has two, three or four bridging ligands of same kind then the prefix di- μ -, tri- μ tetra- μ are used respectively. For example :

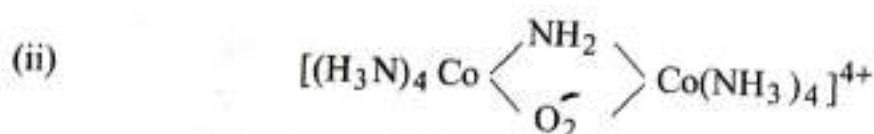


di- μ chloro bis [diammine platinum (II)] Chloride
OR diammine platinum (II) - di- μ - chloro diammine platinum (II) chloride

If a complex has two or more different kind of ligands, then prefix μ - is used for each kind of bridging ligand. The name of bridging ligands are written in the alphabetical order. For example :



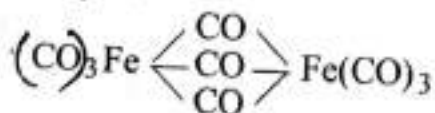
μ - amido - μ - hydroxo bis [tetraamminecobalt (III)]
OR tetraammine cobalt (III) - μ - amido - μ - hydroxotetraammine cobalt (III)
OR μ - amido - μ - hydroxo-octaamminecobalt (III).



μ - amido - μ - superoxo bis [tetraamminecobalt (III)]
OR μ - amido - μ - superoxo-octaamminecobalt (III).
OR tetraammine cobalt (III) - μ - amido - μ - superoxotetraammine cobalt (III)

For this complex ion, magnetic moment measurements show that the bridging $\text{—O}_2\text{—}$ ligand acts as superoxide (O_2^-) ion.

If the bridging and the terminal (non-bridging) ligands both are of same kind, then the bridging ligands are named first. For example :



or
tri- μ - carbonyl bis [tricarbonyliron(0)]
tri- μ - carbonyl hexacarbonyldiiron(0)

If a bridging ligand bridges more than two metal centres, prefix μ_3^- , μ_4^- etc is used to indicate the number of metal centres bridged with a given ligand. For example, in basic beryllium acetate, $[\text{Be}_4\text{O}(\text{CH}_3\text{COO})_6]$, O^{2-} ligand bridges four Be atoms. Therefore, the name of this compound is:

μ_4 - oxo hexa - μ -acetato tetraberyllium (II)
The structure of basic beryllium acetate is shown in Figure 3.1.

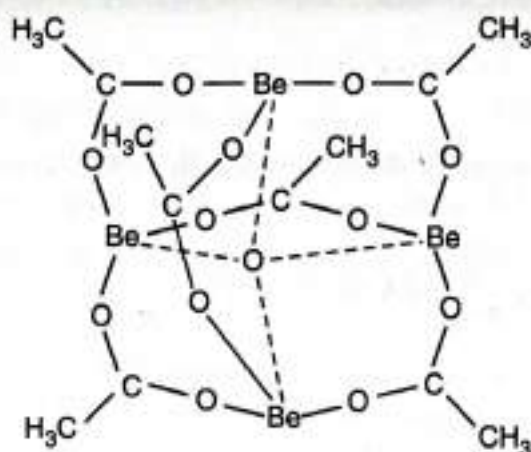
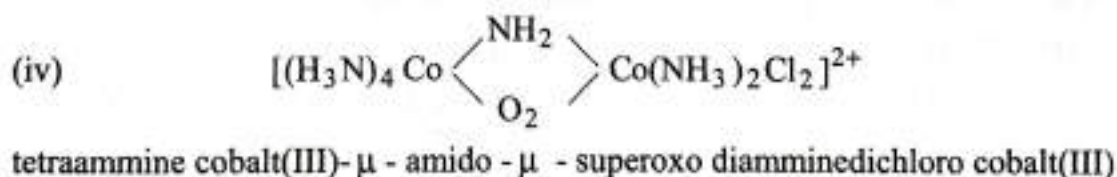
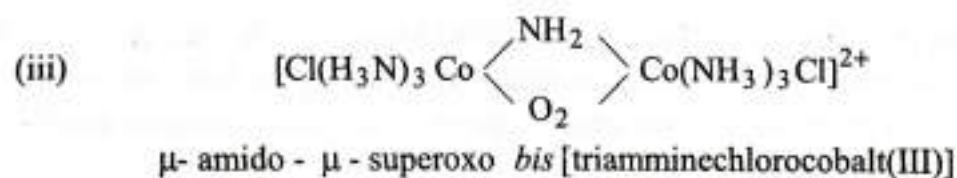
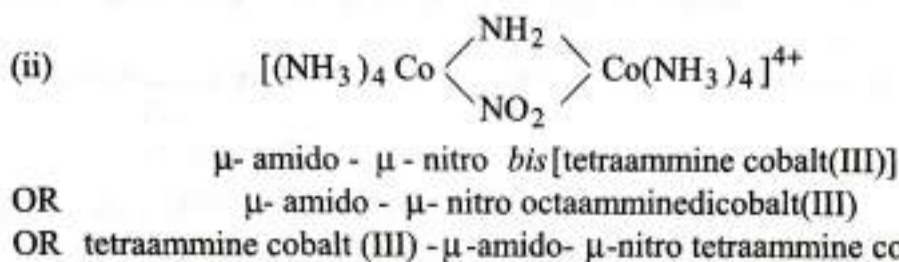
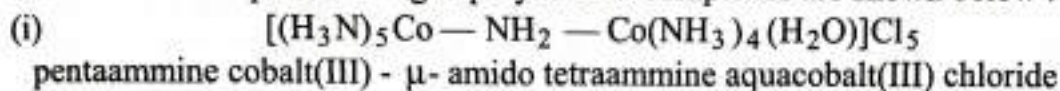
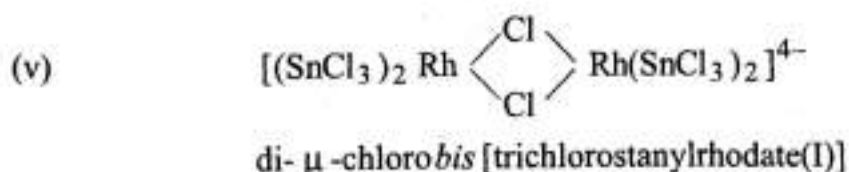


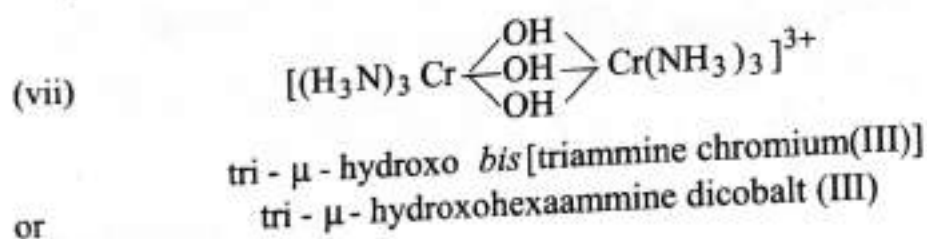
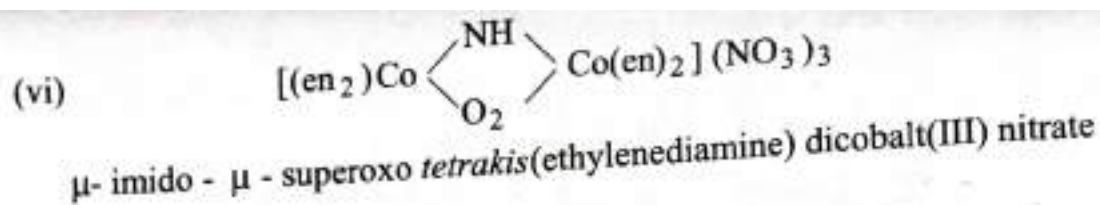
Figure 3.1 Structure of basic beryllium acetate $[\text{Be}_4\text{O}(\text{CH}_3\text{COO})_6]$.

Some other examples of bridged polynuclear complexes are shown below :



Note : A symmetric bridged dinuclear complex, can be named by any three methods as shown earlier in examples (i), (ii) and (iii) but an unsymmetric complex can be named by only one method as given in example (iv).





Naming of Coordination Compounds having Cation and Anion both as Complex Ions

If an ionic complex compound contains both the cation and anion as complex ions, the metal cation in complex cation has its usual name but in complex anion, the metal name ends in -ate. Though, it is difficult to calculate the oxidation states of two metals into two complex ions yet, for calculation of oxidation number of metals, the hit and trial method is used. For this it is to be known the common oxidation states of the two relevant metals.

The hit and trial method of calculation of oxidation states is illustrated by considering some examples as given below :

Example 1 : $[Pt(NH_3)_4][PtCl_4]$

In complex of platinum, the common (or stable) oxidation states are +2 and +4. Thus the positive and negative charges on complex cation and complex anion should satisfy one of these two oxidation states or both.

To decide whether Pt in both the complex ion has +2 or +4 or +2 in one complex ion and +4 in the other, we calculate the oxidation states of Pt in both complex ions by considering the following points :

- (i) If we consider -1 charge on anion, then charge on the cation will be +1. Thus, oxidation state of Pt in complex cation and complex anion can be calculated as :

Complex cation	Complex anion
$[Pt(NH_3)_4]^+$	$[PtCl_4]^-$
$x + 0 = +1$	$x - 4 = -1$
$x = +1$	$x = +3$

Thus, oxidation states of Pt are +1 and +3 which are not shown by platinum. Therefore, it is wrong.

- (ii) If we consider -2 charge on complex anion, then charge on complex cation will be +2. Thus, oxidation states of Pt in the two ions can be calculated as :

Complex cation	Complex anion
$[Pt(NH_3)_4]^{2+}$	$[PtCl_4]^{2-}$
$x + 0 = +2$	$x - 4 = -2$
$x = +2$	$x = +2$

Thus, oxidation state of Pt in both the complex ions is +2 which is a stable oxidation state.
 (iii) If we consider -3 charge on anion, then charge on complex cation will be +3.

Complex cation

$$\begin{aligned} &[\text{Pt}(\text{NH}_3)_4]^{3+} \\ &x + 0 = +3 \\ &x = +3 \end{aligned}$$

Complex anion

$$\begin{aligned} &[\text{PtCl}_4]^{3-} \\ &x - 4 = -3 \\ &x = +1 \end{aligned}$$

Therefore, oxidation state of Pt are +1 and +3.

(iv) Now in the last, if we consider, -4 charge on complex anion, then charge on cation will be +4. Therefore oxidation states of Pt in complex cation and complex anion will be +4 and 0 respectively.

Complex cation

$$\begin{aligned} &[\text{Pt}(\text{NH}_3)_4]^{4+} \\ &x + 0 = +4 \\ &x = +4 \end{aligned}$$

Complex anion

$$\begin{aligned} &[\text{PtCl}_4]^{4-} \\ &x - 4 = -4 \\ &x = 0 \end{aligned}$$

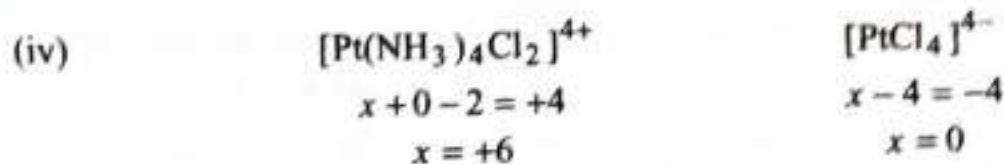
The oxidation states calculated in points number (i), (iii) and (iv) are not the common oxidation states of Pt. The oxidation state calculated in point number (ii) is +2 in both the complex ions which is the one of the two common oxidation states and it satisfies the charges on the complex cation and anion. Therefore, the name of the complex is :

tetraammineplatinum(II) tetrachloroplatinate(II)

Example 2 : $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2][\text{PtCl}_4]$

Oxidation states of Pt in both the complex ions can be calculated as discussed earlier :

	Complex cation	Complex anion
(i)	$\begin{aligned} &[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^+ \\ &x + 0 - 2 = +1 \\ &x = +3 \end{aligned}$	$\begin{aligned} &[\text{PtCl}_4]^- \\ &x - 4 = -1 \\ &x = +3 \end{aligned}$
(ii)	$\begin{aligned} &[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^{2+} \\ &x + 0 - 2 = +2 \\ &x = +4 \end{aligned}$	$\begin{aligned} &[\text{PtCl}_4]^{2-} \\ &x - 4 = -2 \\ &x = +2 \end{aligned}$
(iii)	$\begin{aligned} &[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^{3+} \\ &x + 0 - 2 = +3 \\ &x = +5 \end{aligned}$	$\begin{aligned} &[\text{PtCl}_4]^{3-} \\ &x - 4 = -3 \\ &x = +1 \end{aligned}$

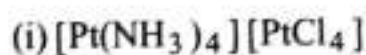


The oxidation states calculated in point number (i), (iii) and (iv) are not the common oxidation states of Pt.

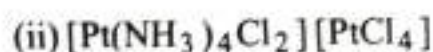
The oxidation states of Pt calculated in point number (ii) are +4 and +2 in complex cation and anion respectively which are the common oxidation states of Pt. Therefore the name of the complex is :
tetraamminedichloroplatinum(IV) tetrachloroplatinate(II)

An another method to decide the oxidation states of Pt in complex ions :

Pt in oxidation state of +2 always form complexes or complex ions of coordination number 4 and Pt in oxidation state of +4 always forms complexes of coordination number of 6. For example :



In this complex compound, coordination number of Pt in both the complex cation and complex anion is 4. Therefore oxidation state of Pt in both the complex ions is +2. Thus name of the complex is :
tetraammineplatinum(II) tetrachloroplatinate(II)



In this complex, coordination number of Pt in complex cation is 6 and in complex anion is 4. Therefore the oxidation states of Pt in complex cation and complex anion are +4 and +2 respectively. Therefore the name of the complex is :
tetraamminedichloroplatinum(IV) tetrachloroplatinate(II)

Example 3 : $[\text{Cr}(\text{NH}_3)_6][\text{CoF}_6]$

In such type of complexes the common oxidation states of both Cr and Co are +2 and +3 respectively. Thus either of these oxidation states of both would satisfy the charges on complex cation and complex anion. Oxidation states of Cr and Co can be calculated as :

	Complex cation	Complex anion
(i)	$[\text{Cr}(\text{NH}_3)_6]^+$ $x + 0 = +1$ $x = +1$ Not shown by Cr	$[\text{CoF}_6]^-$ $x - 6 = -1$ $x = +5$ Not shown by Co (Incorrect)
(ii)	$[\text{Cr}(\text{NH}_3)_6]^{2+}$ $x + 0 = +2$ $x = +2$ Shown by Cr	$[\text{CoF}_6]^{2-}$ $x - 6 = -2$ $x = +4$ Not shown by Co (Incorrect)

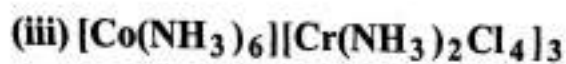
(iii)	$[\text{Cr}(\text{NH}_3)_6]^{3+}$ $x = +3$ Shown by Cr	$[\text{CoF}_6]^{3-}$ $x - 6 = -3$ $x = +3$ Shown by Co (Correct)
(iv)	$[\text{Cr}(\text{NH}_3)_6]^{4+}$ $x = +4$ Not shown by Cr	$[\text{CoF}_6]^{4-}$ $x - 6 = -4$ $x = +2$ Shown by Co (Incorrect)
(v)	$[\text{Cr}(\text{NH}_3)_6]^{5+}$ $x = +5$ Not shown by Cr	$[\text{CoF}_6]^{5-}$ $x - 6 = -5$ $x = +1$ Not shown by Co (Incorrect)
(vi)	$[\text{Cr}(\text{NH}_3)_6]^{6+}$ $x = +6$ Not shown by Cr	$[\text{CoF}_6]^{6-}$ $x - 6 = -6$ $x = 0$ Not shown by Co (Incorrect)

The calculations given above for oxidation states of Cr and Co show that oxidation states of Cr and Co in complex cation and complex anion is +3 which satisfies the charges on complex cation and complex anion and is the common oxidation state for both. Therefore, the name of the complex compounds is :

hexaammine chromium(III) hexafluorocobaltate(III)

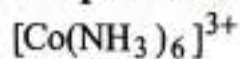
Some Examples of Such Type of Complexes are Given Below

- (i) $[\text{Co}(\text{en})_3][\text{Cr}(\text{CN})_6]$ *tris*(ethylenediamine)cobalt(III) hexacyanochromate(III)
- (ii) $[\text{Pt}(\text{py})_4][\text{PtCl}_4]$ tetrapyridineplatinum(II) tetrachloroplatinate(II)



In this complex, it is seen clearly that the charge on complex cation and complex anion will be +3 and -1 respectively. Therefore, oxidation states of Co and Cr can be calculated as :

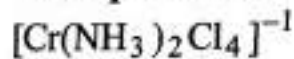
Complex cation



$$x + 0 = +3$$

$$x = +3$$

Complex anion

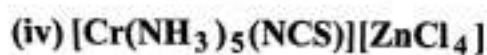


$$x + 0 - 4 = -1$$

$$x = +3$$

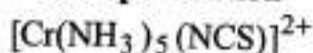
The oxidation states of both Co and Cr is +3. Therefore, name of the complex is :

hexaammine cobalt(III) tetraamminedichlorochromate(III)



In complexes Zn shows only +2 oxidation state, therefore, charge on complex anion is -2 and therefore, the charge on complex cation will be +2.

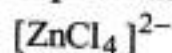
Complex cation



$$x + 0 - 1 = +2$$

$$x = +3$$

Complex anion



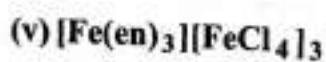
$$x - 4 = -2$$

$$x = +2$$

Oxidation states of Cr = +3

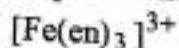
Thus, the name of the complex is :

pentaamminethiocyanato-N chromium(III) tetrachlorozincate(II)



In this complex, it is seen that the charge on complex cation is +3 and charge on complex anion is -1. Therefore, oxidation state of Fe in complex cation and complex anion can be calculated as :

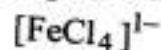
Complex cation



$$x + 0 = +3$$

$$x = +3$$

Complex anion

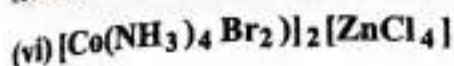


$$x - 4 = -1$$

$$x = +3$$

The oxidation state of Fe in both the complex ions is +3. Therefore, the name of the complex compound is :

tris(ethylenediamine)iron(III) tetrachloroferrate(III)



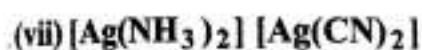
In this complex, charges on complex cation and complex anion are +1 and -2, respectively. Therefore, the oxidation states of cobalt and zinc can be calculated as :

$$\begin{array}{l} \text{Complex cation} \\ [\text{Co}(\text{NH}_3)_4 \text{Br}_2]^+ \\ x + 0 - 2 = +1 \\ x = +3 \end{array}$$

$$\begin{array}{l} \text{Complex anion} \\ [\text{ZnCl}_4]^{2-} \\ x - 4 = -2 \\ x = +2 \end{array}$$

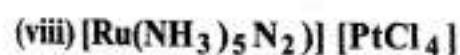
Therefore, oxidation states of cobalt and zinc are +3 and +2 respectively. Therefore, the name of the complex is :

tetraamminedibromocobalt(III) tetrachlorozincate(II)



It has been observed experimentally that the elements of group 11 (*i.e.*, Cu, Ag, Au) in +1 oxidation state and Hg in +2 oxidation state form complexes of coordination number 2. Therefore, in this complex oxidation state of Ag is +1 in both the complex ions. Therefore, the name of the complex compound is:

diammine silver(I) dicyanoargentate(I)



In this complex, coordination number of Pt is 4, therefore, oxidation state of Pt is +2. This indicates that charge on complex anion is -2 and on the complex cation is +2.

$$\begin{array}{l} \text{Complex cation} \\ [\text{Ru}(\text{NH}_3)_5 \text{N}_2]^{2+} \\ x + 0 + 0 = +2 \\ x = +2 \end{array}$$

$$\begin{array}{l} \text{Complex anion} \\ [\text{PtCl}_4]^{2-} \\ x - 4 = -2 \\ x = +2 \end{array}$$

The oxidation number calculations show that the oxidation state of both Ru and Pt is +2. Therefore, the name of the complex compound is :

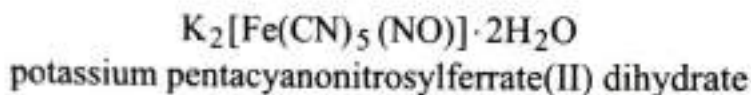
pentaamminedinitrogenruthenium(II) tetrachloroplatinate(II)

Naming of Complexes Containing Hydrated Water Molecules

In the coordination compounds which have hydrated water molecules, the number of water molecules are designated in the last of the name of a complex compound separated by a space as shown below :

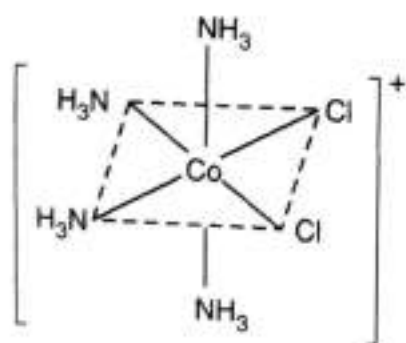
H_2O	monohydrate
$1\frac{1}{2}\text{H}_2\text{O}$	sesquihydrate
$2\text{H}_2\text{O}$	dihydrate
$3\text{H}_2\text{O}$	trihydrate and so forth

An important example is given below :

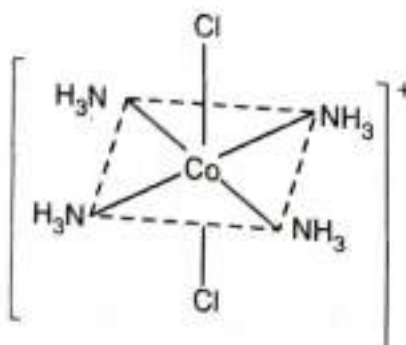


Naming of Geometrical Isomers

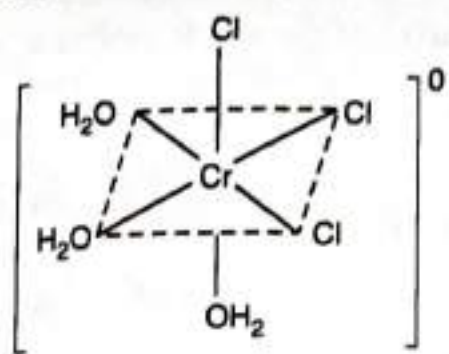
Geometrical isomers are named either by using the prefixes *cis-* and *trans-* or *fac-* (i.e., *facial*) and *mer-* (i.e., *meridional*) or by numbering system. If a complex shows only two geometrical isomers, the prefixes *cis-* or *trans-* and *fac-* or *mer-* are used before the name of the compound separating by hyphen. If more than two geometrical isomers are possible for a complex, then only numbering system can be used. For example :



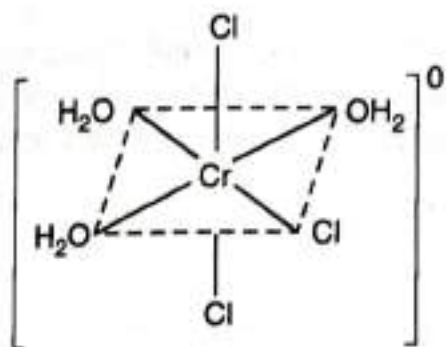
cis-tetraamminedichlorocobalt(III)



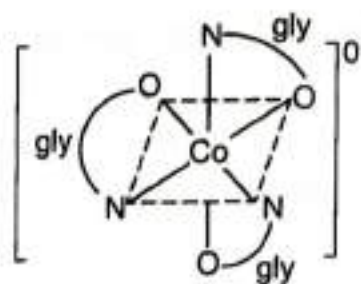
trans-tetraamminedichlorocobalt(III)



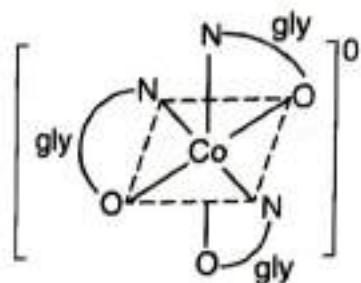
fac-triaquatrichlorochromium(III)



mer-triaquatrichlorochromium(III)



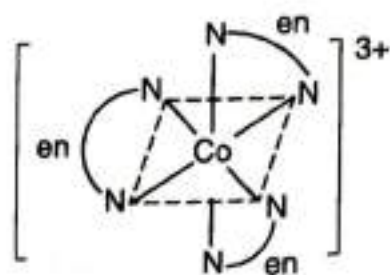
fac-triglycinatocobalt(III)



mer-triglycinatocobalt(III)

Naming of Optical Isomers

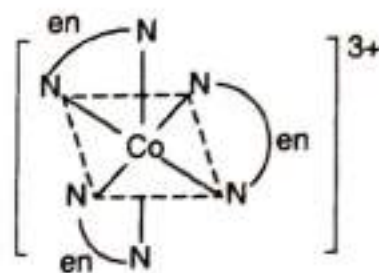
Optical isomers are designated either by *d* (or +) or *l* (or -) where *d*- and *l*- are standing for dextrorotatory and levorotatory respectively. For example :



d-tris(ethylenediamine)cobalt(III)



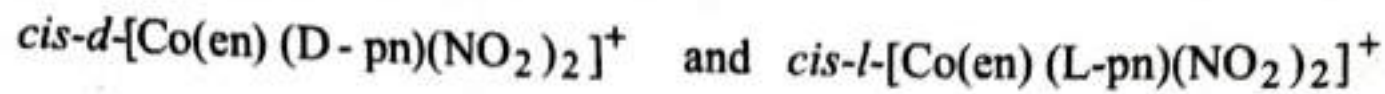
Mirror



l-tris(ethylenediamine)cobalt(III)

If a complex has optically active molecules. The configuration of the whole molecule or ion is represented by *d*- or *l*- and that of the ligand molecules by *D*- or *L*-.

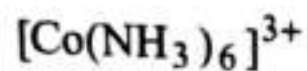
For example :



IUPAC Nomenclature on the Basis of Charge Number

The net charge on the complex ion is called the charge number. A charge number can be used as alternative to the oxidation number. The charge on the complex ion is indicated by an Arabic numeral. The number along with the sign of the charge is enclosed in parentheses. No space is left between the number and the rest of the name.

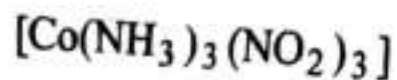
For example :



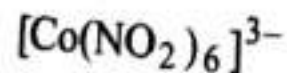
hexaamminecobalt(3+)



hexacyanoferrate (3-) or hexacyanidoferrate(3-)



triamminetrinitrito-N-cobalt(0)



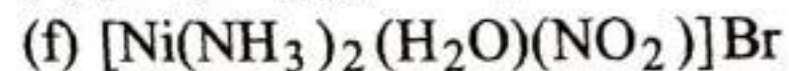
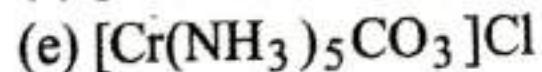
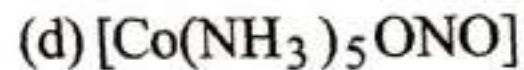
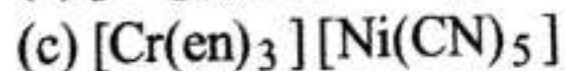
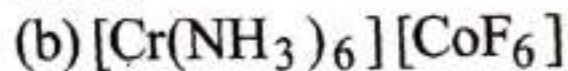
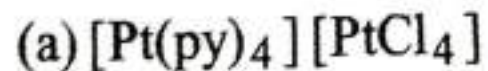
hexanitrito-N-cobaltate (3-)

Objective Questions

1. The IUPAC name of $\text{cis}[\text{Co}(\text{en})_2\text{Cl}_2]^+$ is:
 - (a) *bis*(ethylenediamine)dichlorocobalt(III)
 - (b) dichloro*bis*(ethylenediamine)cobalt(III)
 - (c) *cis*-dichloro*bis*(ethylenediamine)cobalt(III)
 - (d) *cis*-dichlorodi(ethylenediamine)cobalt(III)
2. The IUPAC name of $\text{trans}[\text{Cr}(\text{NCS})_4(\text{NH}_3)_2]^-$ is :
 - (a) *trans*-diaminetetraisothiocyanatochromate(II)
 - (b) *trans*-diamminetetraisothiocyanatochromate(III)

Subjective Questions

1. Write the IUPAC name of the following complexes :



2. Write the formula of following complexes :

(a) Pentaammine chromium(III)- μ -hydroxopentaammine chromium(III) chloride

(b) Diammine diaqua dicyano cobalt(III) chloride

(c) Pentaammine isothiocyanato chromium(III) tetrachlorozincate(II)

(d) Sodium dithiosulphatoargentate(I)

(e) Tetraammine carbonato cobalt(III) chloride

(f) Potassium tetrafluoroargentate(I)