

STUDY COURSE MATERIAL-6

CHEMISTRY

SESSION-2020-21

CLASS- XII

TOPIC: CO-ORDINATION COMPOUNDS

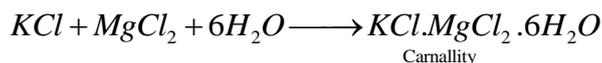
DAY-1

❖ TEACHING MATERIAL

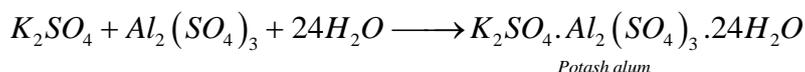
DOUBLE SALTS AND COORDINATION COMPOUNDS

It is well known that when solutions containing two or more salts in stoichiometric (i.e., simple molecular) proportions are evaporated or simply mixed, new compounds, called **molecular** or **addition compounds** are formed. For example,

- (i) When saturated solution of potassium chloride and magnesium chloride is evaporated, we get a new substance called *carnallite*.



- (ii) When saturated solutions of potassium sulphate and aluminum sulphate are mixed and the solution is evaporated, we get the well known compound, *potash alum*.



- (iii) If we add a solution of potassium cyanide to a white precipitate of nickel cyanide, $Ni(CN)_2$, the precipitate immediately dissolves and a red orange solution of a new compound is obtained.



Broadly, such addition or molecular compounds can be grouped into two categories.

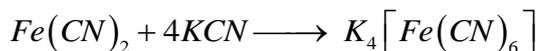
1. **Double salts** : *Double salts are those molecular compounds which exist only in crystal lattices and lose their identity when dissolved in water.* These are formed by mixing two apparently saturated compounds. Some well known double salts are



Shape and size of the crystals of a double salt are different from that of its component salts. As mentioned above, these compounds exist (are stable) in the solid state and as soon as the lattice is disrupted on dissolution in water or any other solvent or on melting, they decompose into their individual constituents. Thus their solutions will show the same physical and chemical properties as a

mixture of solutions of their components. Thus, for example, aqueous solution of potash alum will give the tests of K^+ , Al^3 and SO_4^{2-} ions.

2. **Coordination or Complex compounds :** *Coordination compounds are those molecular compounds which retain their identities even when dissolved in water or any other solvent and their properties are completely different from those of the constituents.* For example, potassium ferrocyanide is a complex compound. It is formed by adding KCN to a saturated solution of ferrous cyanide.



When potassium ferrocyanide is dissolved in water, it does not give the usual tests for Fe^{2+} and CN^- ions indicating that these ions which were originally present are not formed when potassium ferrocyanide is dissolved in water, Actually these ions are present in the form of a new ion, called ferrocyanide ion which is a **complex ion** and does not ionize into constituent ions.



Compounds containing complex ions are called **complex compounds**. Since the complex ions have coordinate bonds in their structures, these are also known as coordinate ions and hence the corresponding compound as coordinate compound.

Other common complex ions are nickel cyanide, $[Ni(CN)_4]^{2-}$, copper ammonium, $[Cu(NH_3)_4]^{2+}$, argentocyanide, $[Ag(CN)_2]^+$

Thus **complex ion** may be defined as an electrically charged (cationic or anionic) or even a neutral species and is formed by the combination of a simple cation with more than one neutral molecule or negative ion. For example, ferrocyanide ion is formed by the union of six cyanide ions with ferrous ion;

$[Ag(NH_3)_2]^+$ is formed by the combination of two moles of ammonia and one mole of Ag^+ ion.

The anions or neutral molecules attached to the central metal atom are called **ligands**. The central metal cation is generally a transition metal and has a positive oxidation state. Coordination compounds in which the metal is in zero oxidation state (e.g., carbonyls) are also known.

The complex compounds may roughly be classified into two types, namely **penetrating** and **normal complexes**. *The penetrating complexes are those which possess sufficient stabilities to retain their identities in solution, examples are $[Fe(CN)_6]^{4-}$ and $[Co(NH_3)_6]^{3+}$. The normal complexes are those which are reversibly dissociated in solution into their components; examples are $Cd[CN]_4^{2-}$ and $[Co(NH_3)_6]^{3+}$.* However, it should be remembered that this classification is more in convenience than of fundamental importance.

❖ VIDEO-LINKS

LINK-1 : https://www.youtube.com/playlist?list=PLF_7kfnwLFCFnjki8KSeTQHyJ7OkdBdNA

DAY-2

❖ TEACHING MATERIAL

TERMS USED IN COORDINATE COMPOUNDS

1. **Central ion, Centre of coordination :** *The cation to which one or more neutral molecules or anions are attached is called the centre of coordination.* Since the central ion acts as an acceptor and thus has to accommodate electron pairs donated by the donor atom of the ligand, it must have empty orbitals.

This explains why the transition metals having empty *d*-orbitals form coordination compounds very readily.

Thus in the complexes $[Ni(NH_3)_6]^{2+}$ and $[Fe(CN)_6]^{3-}$, Ni^{2+} and Fe^{3+} respectively are the central ions.

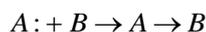
2. **Ligand** : Any atom, ion or molecule which is capable of donating a pair of electrons to the central atom is called a **coordinating group or ligand**. Further in a ligand, the particular atom which actually donates the electron pair is called the donor atom. The common donor atoms are N, O, S and halogens. The ligand containing one, two or more donor atoms are known as unidentate, bidentate and multidentate respectively. Examples of unidentate ligands are F^- , Cl^- , Br^- , I^- , CN^- , SCN^- , NO_2^- , NH_3 , H_2O pyridine, $(C_2H_5)_3N$ acetone, etc. Generally, a monodentate ligand is capable of forming only one coordinate bond to the metal atom.

The common examples of bidentate ligand are ethylenediamine and dimethyl glyoxime. These have two donor atoms which can simultaneously coordinate to the metal atom.

3. **Coordination number (CN)** : The total number of ligands attached to the central ion is known as the coordination number of that ion. Thus the coordination numbers of silver and copper ion in the complexes $[Ag(NH_3)_2]^+$ and $[Cu(H_2O)_4]^{2+}$ are 2 and 4 respectively.

Some common coordination numbers are 2, 3, 4 and 6. The lighter transition elements generally exhibit the coordination numbers of 4 and 6 while the heavier transition elements generally prefer to attain a coordination number greater than six, i.e. 7, 8 or 9.

-
1. Recall that a coordinate bond is formed when both the bonding electrons are donated by one atom.



Thus the two necessary factors for the formation of a coordinate bond are :

- The presence of a species having atoms which can donate a pair of electrons, such species or atom is called donor.
- The presence of an atom (in second compounds) having a vacant orbital that can accept a pair of electrons. Such atom is known as acceptor as it accepts a pair of electrons from the donor atom. This point explains why transition elements having empty *d*-orbitals form coordinate compounds very easily.

-
4. **Coordination sphere** : The central metal atom and the ligands directly attached to it are collectively termed as the coordination sphere. Coordination sphere is written inside square bracket, for example $[Co(NH_3)_6]^{3+}$. Remember that the central metal atom and the ligands inside the square bracket behave as a single entity.

5. **Oxidation number** : It is a number (numerical value) which represents the electric charge on the central metal atom of a complex ion. For example, the oxidation number of Fe, Co and Ni in $[Fe(CN)_6]^{4-}$, $[Co(NH_3)_6]^{3+}$ and $Ni(CO)_4$ is +2, +3 and zero respectively.

Determination of oxidation number and coordination number of a metal atom or ion in a complex. Let us take few examples to illustrate this.

- (i) **Potassium ferrocyanide, $K_4[Fe(CN)_6]$** : Since the complex has four monovalent cations outside the coordination sphere, the complex ion must carry four negative charge, i.e., it is $[Fe(CN)_6]^{4-}$

The number of CN^- ions (univalent ion), i.e., 6 represents the coordination number of the iron ion.

The oxidation state of iron can be easily determined as below, knowing that cyanide ion is unidentate and the complex on the whole carries -4 charge

$$[Fe(CN)_6]^{4-} \quad x + (-6) = -4 \quad \therefore x = +2$$

Thus here iron is present as Fe^{2+} or $Fe(II)$

- (ii) $[Co(NH_3)_3(NO_2)_3]$: Note that the complex does not carry any charge, i.e. it is neutral. Here the central atom is attached to three ammonia molecules and three NO_2^- radicals, both are unidentate. Thus here the CN of cobalt is 6.

Oxidation state of cobalt can be established as usual and given below

$$[Co(NH_3)_3(NO_2)_3] \\ x + (0)_3 + (-3) = 0 \quad x - 3 = 0 \quad \therefore x = +3$$

Thus the oxidation state of Co is +3.

- (iii) $[Cr(C_2O_4)_3]^{3-}$: Note that here the oxalate ligand is dinegative ion, i.e. it is bidentate, therefore three oxalate ligands carry a total charge of -6. Hence CN of Cr is 6. Now since the complex carries -3 charge, therefore the oxidation state of Cr must be +3.
- (iv) $Ni(CO)_4$: Here the CN of Ni is 4 since carbonyl group is unidentate. Further since the complex as well as the ligand has no charge, nickel atom must also be neutral i.e., it is in zero oxidation state.

6. **Complex ion** : As described earlier, a complex (coordinate) ion is an electrically charged or a neutral species formed by the combination of a central cation with more than one ligand species. The charge carried by a complex ion is the algebraic sum of charges carried by the central ion and the ligands coordinated to it. Charges of some complex compounds are given below :

Complex compound (ion)	Charge on complex (ion)	
(i) $[Cu(NH_3)_4]^{2+}$	+2 of Cu + 0 of NH_3 ;	\therefore Net charge = +2
(ii) $[Fe(CN)_6]^{4-}$	+2 of Fe + (-6) of 6 CN;	\therefore Net charge = -4
(iii) $[Co(NH_3)_5Cl]^{2+}$	+3 of Co + 0 of NH_3 + (-1) of Cl;	\therefore Net charge = +2
(iv) $[^1Co(NH_3)_3Cl_3]$	+3 of Co + 0 of NH_3 - 3 of 3 Cl;	\therefore Net charge = 0

Complex compounds as (iv) in the above case which do not carry any charge is a non-electrolyte as it is not capable of forming any ion.

Ions present outside the square bracket are ionisable.

❖ VIDEO-LINKS

LINK - 1 : https://www.youtube.com/playlist?list=PLF_7kfnwLFCFnji8KSeTQHyJ7OkdBdNA

❖ TEACHING MATERIAL

WERNER'S THEORY OF COORDINATION COMPOUNDS

The coordination compounds were known since 18th century but no satisfactory theory was available to explain the observed properties of these compounds. Alfred Werner in 1893 put forward his concept of auxillary (secondary) valency for advancing a correct explanation for the characteristics of the coordination compounds. The *fundamental postulates of Werner's theory* which was actually a result of dream and made Werner a noble prize winner in chemistry may be summarized as below.

1. Metals possess two types of valencies, namely *primary (principal) or ionizable valency and secondary (auxillary) or nonionizable valency*.

Primary valencies are those which a metal normally exhibit in the formation of its simple salts. Thus in the formation of $PtCl_4$, $CuSO_4$ and $AgCl$ the primary valencies of Pt, Cu and Ag are 4, 2 and 1 respectively, *Primary valencies are satisfied by negative ions*.

Secondary valencies are those which a metal cation exercises towards a neutral molecule or negative group in the formation of its complex ions. Thus secondary valencies may be satisfied by negative ions, neutral molecules having lone electron pair (e.g. H_2O , NH_3 , etc.) or even sometimes by some positive groups. In every case, the coordination number of the metal must be fulfilled.

In modern terminology the primary valency corresponds to oxidation number and the secondary to coordination number. Primary valencies are shown by dotted lines while secondary by thick lines.

2. Every metal has a fixed number of secondary valencies, e.g. cobalt³⁺ and platinum⁴⁺ were recognized to have six secondary valencies and copper²⁺ four. The total number of secondary valencies required by a metal is more commonly known as coordination number (C.N.)
3. The secondary valencies are always directed towards fixed positions in space about the central metal ion. Thus the number and arrangement of ligands² in space determines the stereochemistry of a complex. Thus in case of *six secondary valencies* the arrangement of secondary valencies was as directed to the apices of a *regular octahedral* while in case of *four secondary valencies* arrangement might be either in a *planar or a tetrahedral manner* and thus this postulate predicted the possibilities of a variety of type of isomerism in coordination compounds. Remember that primary valencies are non-directional.

To distinguish between the two types of valencies, Werner introduced the square brackets [] to enclose atoms making up the coordination complex and which are therefore not ionized. The portion enclosed in the bracket is known as *coordination sphere* and the portion present outside the bracket as ionizing sphere.

The important aspect of structure of five different complexes of $PtCl_4$ with ammonia prepared by Werner are given in **Table. 1**

Table 1. Coordination Compounds of $PtCl_4$ with NH_3

Complex	Modern formula	No. of Cl^- ions precipitated	Total number of ions
---------	----------------	---------------------------------	----------------------

$PtCl_4.6NH_3$	$[Pt(NH_3)_6]Cl_4$	4	5
$PtCl_4.5NH_3$	$[Pt(NH_3)_5Cl]Cl_3$	3	4
$PtCl_4.4NH_3$	$[Pt(NH_3)_4Cl_2]*Cl_2$	2	3
$PtCl_4.3NH_3$	$[Pt(NH_3)_3Cl_3]Cl$	1	2
$PtCl_4.2NH_3$	$[Pt(NH_3)_2Cl_4]$	0	0 (non-electrolyte)

In all these compounds, platinum exhibits a primary valency (oxidation number) of four and secondary valency (coordination number) of six.

- Complexes in which some of the ligands are neutral (e.g. NH_3 molecules) and others are anions (e.g. (Cl^-)) are called mixed complexes.
- As described earlier, the groups attached to the metal ion by means of secondary valencies are known as ligands.

❖ VIDEO-LINKS

LINK-1: https://www.youtube.com/playlist?list=PLF_7kfnwLFCFnji8KSeTQHyJ7OkdBdNA

DAY-4

❖ TEACHING MATERIAL

SIDWICK THEORY AND EAN RULE

Sidwick also suggested that the metal ion will continue accepting electron pairs till the total number of electrons in the metal ion and those donated by ligands is equal to that of the next higher noble gas. This total number of electrons is called **effective atomic number (EAN)** of the metal. This will become clear by taking the example of hexamminecobalt (III) ion, $[Co(NH_3)_6]^{3+}$.

Atomic number of Cobalt = 27

In the present complex, cobalt is present in the oxidation state of +3

∴ Total number of electrons in $Co^{3+} = 27 - 3 = 24$

Since each NH_3 ligand contributes two electrons to the cobalt ion.

Electrons contributed by 6 NH_3 ligands = $6 \times 2 = 12$

∴ The EAN of Co^{3+} in the complex = $24 + 12 = 36$

In general, EAN of metal = At. No. – Oxi. State + $CN \times 2$

In the said example since the number (36) corresponds to the atomic number of krypton, according to Sidwick the complex will be stable. Though EAN rule (i.e., those complexes are stable or those metal ions form complexes whose EAN is the same as the atomic number of the next noble gas) is applicable in many cases, there are several examples in which EAN rule is not obeyed.

Example 1 Apply the concept of EAN rule on the complexes $[Fe(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$. What conclusion you draw about the validity of the EAN rule from these two well-known complexes? [Atomic number of Fe = 26].

Solution (a) Let us take the case of $[Fe(CN)_6]^{4-}$

Oxidation state* of Fe in $[Fe(CN)_6]^{4-} = +2$

No. of electrons in iron = 26

\therefore No. of electrons in Fe(II) of the complex = $26 - 2 = 24$

Number of electrons donated by six CN^- ligands = $6 \times 2 = 12$

\therefore EAN of Fe (II) in $[Fe(CN)_6]^{4-} = 24 + 12 = 36$

Since this number (36) = number of electrons in the atom of the nearest noble gas (Kr.) the complex $[Fe(CN)_6]^{4-}$ follows the **EAN rule or the EAN rule is valid on this complex.**

(b) Now let us take the case of $[Fe(CN)_6]^{3-}$

Oxidation state of iron = +3

\therefore Number of electrons in Fe (III) of the complex = $26 - 3 = 23$

Number of electrons donated by six CN^- ligands = 12

\therefore EAN of Fe (III) in $[Fe(CN)_6]^{3-} = 23 + 12 = 35$

Since this number (35) is different from the electrons present in the next noble gas (Kr = 36), we can say that the **EAN rule is not valid** on this complex.

Example 2 Using the EAN rule, predict the molecular formulae of simple carbonyls of Fe. (at. number 26) and Cr (at. number 24). The metals have zero oxidation state in the carbonyls.

Note :- As mentioned earlier, Oxidation state of the metal in a complex can be determined by taking it x, e.g. in $[Fe(CN)_6]^{4-}$ $x - 6 = -4$; $\therefore x = 2$. Thus the oxidation state of Fe in $[Fe(CN)_6]^{4-}$ is +2

Solution Molecular formula of iron carbonyl

At number of iron = 26 ; At. No. of the next noble gas, Kr (I.e. EAN) = 36

\therefore No. of electrons to be provided by CO = $36 - 26 = 10$

Since each CO provides 2 electrons, total number of carbonyl (CO) group = $\frac{10}{2} = 5$

\therefore Molecular formula of simple iron carbonyl = $Fe(CO)_5$

Molecular formula of chromium carbonyl

At No. of chromium = 24 ; EAN = 36

\therefore No. of electrons to be provided by CO = $36 - 24 = 12$

\therefore No. of CO group $12/2 = 6$

Hence the molecular formula of chromium carbonyl will be $Cr(CO)_6$

❖ VIDEO-LINKS

LINK – 1 : https://www.youtube.com/playlist?list=PLF_7kfnwLFCFnji8KSeTQHyJ7OkdBdNA

DAY-5

❖ TEACHING MATERIAL

NOMENCLATURE OF CO-ORDINATION COMPOUNDS

The International Union of pure and Applied chemistry (IUPAC) publication Nomenclature of inorganic chemistry (1989), Blackwell scientific publishers, contains the rules for the systematic naming of coordination compounds. The basic rules are summarized here :

- The positive ion is named first followed by the negative ion.*
- When writing the name of a complex, the ligands are quoted in alphabetical order, regardless of their charge (followed by the metal).*
- When writing the formula of complexes, the complex ion should be enclosed by square brackets. The metal is named first, and then the coordinated groups are listed in the order: negative ligands, natural ligands, positive ligands (and alphabetically according to the first symbol within each group)*
 - The names of negative ligands end in –O, for example:*

F^-	Fluoro	H^-	Hydrido	HS^-	Mercapto
Cl^-	chloro	OH^-	hydroxo	S^{2-}	Thio
Br^-	Bromo	O^{2-}	OXO	CN^-	Cyano
I^-	Iodo	O_2^{2-}	Peroxo	NO_2^-	Nitro
 - Neutral groups have no special endings. Examples include NH_3 ammine, H_2O aqua, CO carbonyl and NO nitrosyl. The ligands N_2 and O_2 are called dinitrogen and dioxygen. Organic ligands are usually given their common names, for example phenyl, methyl, ethylenediamine, pyridine, triphenylphosphine.*
 - Positive group end in—ium, e.g. NH_2 hydrazinium.*
- Where there are several ligands of the same kind, we normally use the prefixes di, tri, tetra penta and hexa to show the number of ligand of that type. An exception occurs when the name of the ligand includes a number, e.g. dipyridyl or ethylenediamine. To avoid confusion in such cases, bis, tris and tetrakis are used instead of di, tri and tetra and the name of the ligand is placed in brackets.*
- The oxidation state of the central metal is shown by a Roman numeral in brackets immediately following its name (i.e. no space, e.g. titanium (III)).*

- Complex positive ions and neutral molecules have no special ending but complex negative ions end in—ate.
- If the complex contains two or more metal atoms, it is termed polynuclear. The bridging ligands which link the two metal atoms together are indicated by the prefix- *m* If there are two or more bridging groups of the same kind, this is indicated by *di m-*, *Tri m-* etc. Bridging groups are listed alphabetically with the other groups unless the symmetry of the molecule allows a simpler name. If a bridging group bridges more than two metals atoms it is shown as m_1, m_2, m_3 or m_4 to indicate how many atoms it is bonded to.
- Sometimes a ligand may be attached through different atoms. Thus *M-NO₂* is called nitro and *M-ONO* is called nitrito. Similarly the *SCN* group may bond *M-SCN* thiocyanato or *M-NCS* isothiocyanato. These may be named systematically thiocyanato –*S* or thiocyanato –*N* to indicate which atom is bonded to the metal. This convention may be extended to other cases where the mode of linkage is ambiguous.
- If any lattice components such as water or solvent of crystallization are present, these follow the name, and are preceded by the number of these groups in Arabic numerals. These rules are illustrated by the following examples :

IUPAC NOMENCLATURE OR COMPLEXES

Name of negative ligands

Ligand	Name	Ligand	Name
H ⁻	hydrido	HS ⁻	mercapto
O ²⁻	oxo	NH ₂ ⁻	amido
O ₂ ²⁻	peroxo	NH ²⁻	imido
O ₂ H ⁻	perhydroxo	NO ₃ ⁻	nitrato
OH ⁻	hydroxo	ONO ⁻	nitrito
F ⁻	fluoro	NO ₂ ⁻	nitro
Cl ⁻	chloro	N ³⁻	nitrido
Br ⁻	bromo	P ³⁻	phosphido
I ⁻	iodo	N ₃ ⁻	azido
CO ₃ ²⁻	carbonato	CNO ⁻	cyanato
C ₂ O ₄ ²⁻	oxalato	NCO ⁻	isocyanato
CH ₃ CO ₂ ⁻	acetato	SCN ⁻	thiocyanato or thiocyanato–S
CN ⁻	cyano	NCS ⁻	isothiocyanato or thiocyanato–N
SO ₄ ²⁻	sulphato	HCO ₃ ⁻	hydrogencarbonato
SO ₃ ²⁻	sulphito	S ₄ O ₆ ²⁻	tetrathionato
S ²⁻	sulphido	EDTA (⁻ O ₂ CCH ₂) ₂ NCH ₂ CH ₂ N (CH ₂ CO ₂ ⁻) ₂	ethylenediaminetetraacetato

HSO_3^-	hydrogensulphito	$\text{NH}_2\text{CH}_2\text{CO}_2^-$	glycinato
$\text{S}_2\text{O}_3^{2-}$	thiosulphato	C_5H_5^-	cyclopentadienyl

Ligands whose names end in –“ite” or –“ate” become –“ito” or –“ato”, i.e., by replacing the ending –e with –o.

Name of Neutral ligands

Ligand	Name	Abbreviation	Ligand	Name	Abbreviation
H_2O	aqua/aquo	–	$\text{NH}_2(\text{CH}_2)_2\text{NH}_2$	ethylenediamine	(en)
NH_3	ammine	–	CH_3NH_2	methylamine	–
CO	carbonyl	–	C_6H_6	benzene	–
NO	nitrosyl	–	N_2	dinitrogen	–
CS	thiocarbonyl	–	O_2	dioxygen	–
NS	thionitrosyl	–	Ph_3P	triphenylphosphine	–
$\text{C}_5\text{H}_5\text{N}$	pyridine	(py)	CH_3COCH_3	acetone	–

Name of Positive ligands

Ligand	Name
NO^+	nitrosonium
NO_2^+	nitronium
NH_2NH_3^+	hydrazinium

Coordination compounds containing complex cationic ion

$[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$	Hexaammineplatinum (IV) chloride
$[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}$	Tetraammineaquochlorocobalt (II) chloride
$[\text{Cu}(\text{en})_2]\text{SO}_4$	<i>Bis</i> (ethylenediamine)copper(II) sulphate
$[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]^+$	Tetraaquodichlorochromium(III) ion
$[\text{Fe}(\text{H}_2\text{O})_4(\text{C}_2\text{O}_4)]_2\text{SO}_4$	Tetraaquooxalatoiron(III) sulphate
$[\text{Cr}(\text{NH}_3)_4(\text{ONO})\text{Cl}]\text{NO}_3$	Tetraamminechloronitritochromium(III) nitrate
$[\text{Ag}(\text{NH}_3)_2]\text{Cl}$	Diamminesilver(I) chloride
$[\text{Co}(\text{NH}_3)_5(\text{NCS})]\text{Cl}_2$	Pentaammineisothiocyanatocobalt(III) chloride
$[\{(\text{C}_6\text{H}_5)_3\text{P}\}_3\text{Rh}]\text{Cl}$	Tris(triphenylphosphine)rhodium(I) chloride

Coordination compounds containing complex anionic ion

$\text{K}_4[\text{Fe}(\text{CN})_6]$	Potassium hexacyanoferrate(II)
$\text{K}_3[\text{Fe}(\text{CN})_6]$	Potassium hexacyanoferrate(III)

$K_3 [Cr(C_2O_4)_3]$	Potassium trioxalatochromate(III)
$K_3 [Co(C_2O_4)_2 Cl_2]$	Potassium dichlorodioxalatocobaltate(III)
$K_2 HgI_4$	Potassium tetraiodomercurate(II)
$K_2 [PtCl_6]$	Potassium hexachloroplatinate(IV)
$Na [Ag(CN)_2]$	Sodium dicyanoargentate(I)
$[Ni(CN)_4]^{2-}$	Tetracyanonickelate(II) ion
$Na_3 [Co(NO_2)_6]$	Sodium hexanitrocobaltate(III)
$K_3 [Fe(CN)_5 NO]$	Potassium pentacyanonitrosylferrate(II)

Coordination compounds containing complex cationic and anionic ions :

$[Cr(NH_3)_6][Co(CN)_6]$	Hexaamminechromium(III) hexacyanocobaltate(III)
$[Pt(NH_3)_4][CuCl_4]$	Tetraammineplatinum(II) tetrachlorocuprate(II)
$[Cr(NH_3)_6][Co(C_2O_4)_3]$	Hexaamminechromium(III) trioxalatocobaltate (III)
$[Pt(py)_4][PtCl_4]$	Tetrapyridineplatinum(II) tetrachloroplatinate(II)

Non-ionic coordination compounds

$Fe(CO)_5$	Pentacarbonyliron(0)
$[Co(NO_2)_3(NH_3)_3]$	Triamminetrinitrocobalt(III)
$Cu(Gly)_2$	Diglycinatocopper(II)
$Ni(DMG)_2$	Bis(dimethylglyoximate) nickel(II)

❖ VIDEO-LINKS

LINK -1 : https://www.youtube.com/playlist?list=PLF_7kfnwLFCFnjki8KSeTQHjJ7OkdBdNA