Coordination Compounds

Werner's Theory: Postulates
- In coordination compounds metals show primary and secondary linkages (valances)
- Primary valences are ionisable and are satisfied by negative ions.
- Secondary valences are non-ionisable and are satisfied by neutral molecules or negative ions.
- Ions/groups bound by secondary linkages to metal have characteristic spatial arrangements corresponding to different coordination numbers.

Colour
Caused by d-d transition; the colour is complementary to wavelength absorbed

Bonding

Crystal field theory
Ligands are point charges and there is electrostatic force of attraction between ligands and metal atom/ion. Degeneracy of d orbitals is lighted causing splitting of d orbitals. Δ0 depends upon the field produced by the ligand and charge on metal ion.

In metal carbonyls
Metal–carbon bond possess both σ and π character

Valance bond theory
Metal atom/ion under the influence of ligands can use its (n–1)d, ns, np or ns, np, nd orbitals for hybridisation; sp^3(Tetrahedral), dsp^2(square) planar, sp^3d (Trigonal pyramidal), sp^3d^2 and d^2sp^3 (Octahedral); Magnetic moment = $\sqrt{n(n+2)}$ BM

Uses
- In qualitative and quantitative chemical analysis.
- Estimation of hardness of water.
- In extraction metals.
- In purification of metals.
- In biological systems.
- As catalysts for industrial processes.
- In black and white photography.
- In medicinal chemistry.

Isomerism

Ionisation counter ion is a potential ligand and can displace a ligand
$[Co(NH_3)_5SO_4]Br$
$[CO(NH_3)_5Br]SO_4$

Coordination interchange of ligands between catonic and anionic entities of different metal ions
$[CO(NH_3)_6]\ [Cr(CN)_6]$
$[Cr(NH_3)_6]\ [CO(CN)_6]$

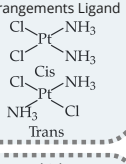
Solvate differ in number of water molecules attached to metal atom/ion
$[Cr(H_2O)_6]Cl_3$
$[Cr(H_2O)_5Cl]Cl_2.H_2O$

Linkage occurs in ambidentate ligand
$[CO(NO_2)(NH_3)_5]Cl$
$[CO(ONO)(NH_3)_5]Cl$

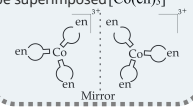
Structural: different bonds

Stereoisomerism: different spatial arrangements

Geometrical: different arrangements Ligand



Optical: images which cannot be superimposed $[Co(en)_3]^{3+}$



Coordination Compounds

Compounds in which a central metal atom or ion is linked to a fixed number of ions or molecules through coordinate bonds.

Formulas of monomuclear

- Central atom is listed first
- Ligands in alphabetical order.
- Formula is enclosed in square bracket.
- Polyatomic ligands in parenthesis.
- No space between ligand and metal.
- Charge is indicated outside brackets.
- Charge of cation(s) balanced by charge of anion(s)

Naming of monomuclear

- Cation is named first.
- Naming of ligands in alphabetical order.
- Anionic ligands end in–o, neutral and cationic are same
- Prefixes mono, di, tri etc. are used.
- Followed by roman numeral in parentheses.

Complex compound: do not dissociate into simple ions when dissolved in water ($K_4[Fe(Cn)]_6$)

Stability: expressed by equilibrium constant
Br = $K_1 \times K_2 \times K_3 .... K_n$

Double salt: Dissociate completely into simple ions when dissolved in water.
(Mohr's salt $FeSO_4$. $(NH_4)2SO_4.6H_2O$)

Terms

- Coordination entity : A central metal atom/ion bonded to fixed number of ions or molecules. $[Ni(CO)_4]$
- Central atom/ion : Atom/ion to which a fixed number of ions/groups are bound in a definite geometrical arrangement.
- Ligands : Ions or molecules bound to central atom/ion types :
  Unidentate – single donor, Didentate –two donors
  Polydentate – several donors,
  Chelating – Di-or polydentate which forms more than one coordinate bonds.
  Ambidentate : Can ligate through two different atoms.
- Coordination number : No. of ligand donor atoms to which metal is directly bonded
- Coordination sphere : Central atom/ion and the ligands attached to it and enclosed in square bracket.
- Oxidation number : Charge of central atom if all ligands are removed along with e– pairs shared with central atom.
- Homoleptic complex : Metal is bound to one type of donor groups. $[Co(NH_3)_6]_{3+}$
- Heteroleptic complex: Metal is bound to more than one type of donor groups