

## CONCEPT MAP

### COORDINATION COMPOUNDS

Metal atoms are bound to many anions or neutral molecules. Structure first formulated by Alfred Werner.

- **Primary valence** (ionisable): Oxidation state of central metal.
- **Secondary valence** (non-ionisable) : No. of groups bound directly to the metal ion (coordination number).

#### Important terms

- **Coordination entity** : Central metal atom/ion + bonded ions/molecules.
- **Central atom/ion** : Lewis acids.
- **Ligands** : Ions/molecules bound to central atom/ion.
- **Coordination number** : Number of ligand or donor atoms bonded directly to metal.
- **Coordination sphere** : Central metal/ion + attached ligands enclosed in square bracket.
- **Coordination polyhedron** : Spatial arrangement of ligands.
- **Oxidation no. of central atom** : Charge it would carry if all ligands are removed along with their shared electron pairs.

#### Isomerism

##### Structural

- **Linkage** in those having ambidentate ligand.
- **Coordination** by interchange of ligands.
- **Ionisation** : Counter ion displaces the potential ligand.
- **Solvate or hydrate** : Solvent molecule present differently (directly bonded or free).

##### Stereoisomerism

- **Geometrical** : Different possible geometrical arrangements of the ligands.
  - In square planar
    - *cis*
    - *trans*
  - In octahedral
    - **Facial** (Three donor atoms of the same ligands occupy adjacent positions at the corners of the octahedral face)
    - **Meridional** occupies the meridian of the octahedron.
- **Optical** : Non-superimposable mirror images → enantiomers and chiral.
  - **Dextro** (*d*) : Rotate the plane of polarised light to right
  - **Laevo** (*l*) : Rotate the plane of polarised light to left

#### Bonding

##### Valence Bond Theory

Under the influence of ligands hybridised orbitals  $[(n-1)d, ns, np]$  or  $[ns, np, nd]$  overlap with ligand orbitals.

- **Inner orbital complex** : (low spin) or spin paired complex. Uses  $3d$  orbital in hybridisation.
- **Outer orbital complex** (High spin or spin free complex) Uses  $4d$  orbital in hybridisation.
- **Magnetism**
  - Paramagnetism (having unpaired electrons)
  - Diamagnetism (all paired electrons)

##### Crystal Field Theory

Metal-ligand bond considered as ionic, under ligand's influence,  $d$ -orbitals are splitted into two levels with energy difference  $\Delta_o$  or  $\Delta_t$ .

In tetrahedral complexes : energy of $t_{2g}$	In octahedral complexes : energy of $e_g$	Crystal field splitting energy
$(d_{xy}, d_{yz}, d_{zx})$	$(d_{x^2-y^2}, d_{z^2})$	(CFSE) = $(-0.4x + 0.6y)\Delta_o$
energy of $e_g$	energy of $t_{2g}$	where, $x$ = no. of $e_g$ orbitals $y$ = no. of $t_{2g}$ orbitals.
$(d_{x^2-y^2}, d_{z^2})$	$(d_{xy}, d_{yz}, d_{zx})$	
$\Delta_t = \frac{4}{9} \Delta_o$		