Name: Chandra Shekhar

College: IIT Gandhinagar

Subject: Chemistry

Weightage: Regular

Title: D & F Block Elements

d-Block and f-Block Elements

Authored by Chandra Shekhar

1. d-Block Elements (Transition Elements)

d-block elements lie between Groups 2 and 13 and are called transition elements as they exhibit transitional properties. They have partially filled d-orbitals in either their atomic or ionic forms. Zn, Cd, and Hg are not true transition metals as their d-orbitals are completely filled.

2. Electronic Configuration

- **First series (3d):** Sc to Zn

- **Second series (4d):** Y to Cd

- **Third series (5d):** La/Hf to Hg

An incomplete fourth series begins with actinium.

General Configuration: $(n-1)d^{1-9}ns^{1-2}$

3. Metallic Character

All are metals with hcp, ccp, or bcc lattices. Their strong metallic bonding arises from high effective nuclear charge and many valence electrons, leading to hardness, high density, and high enthalpy of atomization.

4. Oxidation States

They show variable oxidation states because both ns and $(n-1)d$ electrons participate in bonding.

- +2 is common in the first series (from 4s electron loss).

- In +2, +3 states: mostly ionic bonding.

- In higher oxidation states (e.g., MnO_4^-, CrO_4^{2-}): covalent bonding.

- Highest known oxidation state is +8.

5. Complex Formation

Reasons:

- High charge and small ionic size.

- Availability of low-energy vacant d-orbitals.

6. Color of Compounds

Due to d-d electronic transitions in partially filled d-orbitals. Ligands split d-orbitals into slightly different energies, and visible light is absorbed during electron promotion, giving rise to color.

7. Catalytic Properties

- **Intermediate Formation:** Variable oxidation states help form reactive intermediates.

- **Adsorption Theory:** Finely divided metals offer large surface area for reactants.

8. Magnetic Behaviour

- **Paramagnetic:** Due to unpaired electrons; attracted in a magnetic field.

- **Diamagnetic:** Repelled slightly; no unpaired electrons.

Magnetic moment (μ) is given by:

$$\mu = \sqrt{n(n+2)} \text{ B.M.,}$$

where n = number of unpaired electrons.

9. Formation of Alloys

Similar atomic radii allow substitution in crystal lattices forming solid solutions and homogeneous, hard, high-melting alloys.

10. Interstitial Compounds

Transition metals accommodate small atoms like H, C, N in lattice voids. This increases strength but reduces malleability and ductility.