General characteristics of d block Elements

(i) Metallic character

All the transition elements are metallic in nature. They have tendency to form strong covalent bonds due to partially filled d-subshell (except Zn, Cd and mercury (Hg)) as well as strong metallic bond due to large number of electrons that can be lost. So their melting and boiling points are very high (more than 1000°C except Zn, Cd and Hg). They have high densities and are very hard and brittle.

2) Atomic Radii

Due to small screening effect of d-subshell the atomic radius decreases with increase in atomic number. The size of transition elements is small due to which their densities and ionication energies are high.

3) Oxidation state

During formation of compounds, d-orbital of inner shell can also participate in bonding. Hence the transition elements exhibit variable oxidation states. (except 3rd group and 12th group elements)

- The oxidation state of 3rd group elements (Sc, Y, La, Ac is +3 whereas the oxidation state of 12th group (Zn, Cd and Hg) is +2 only.
- In lower oxidation state (+2, +3), the bonds formed are ionic whereas in higher oxidation states the bonds
- formed are covalent.
- The highest possible oxidation state is +8 for transiti elements.

4) Ionization energy –

Ionization energy of transition elements lies between those of s-block and p-block elements. Ionization energy of transition elements in a particular series increases due to increase in nuclear charge.

- The ionization energies of 5d elements is more than those of 3d and 4d-elements because of very poor shielding of the nucleus by 4f-electrons.

5) Complex formation

Transition metal ions have a great tendency to form complexes with other molecules or ions. This property of formation of complexes is due to vacant d-orbitals and high nuclear charge with small size which facilitates the acceptence of electrons from the ligands.

- The complexes of transition elements of small size are more stable as compared to those of large size elements in a particular series with same oxidation state.
- If the oxidation state is different for the same metal, then the complex with greater oxidation state of central metal will be more stable.

) Colour :-

- The d-orbitals of the transition metal ions and their complexes do not have same energies.
- Under the influence of anions or ligands, the d-orbitals split into two sets. The energy difference of these two sets corresponds to visible region of spectrum.
- Due to the absorption of visible radiation for d-d transition, most of the compounds and complexes of transition elements are coloured.
- The colour will appear if the central metal contains partially filled d-subshell. But if the d-subshell is completely filled, the complex shall be colourless (eg. Cu^+, Ag^+, Sc^{3+} etc)
- The colour of the complex ion is attributed to the presence of unpaired electoons in d-subshell which undergoes d-d transitions.

So the compounds or Ions of transition elements appear to be coloured due to these reasons

i) d-d transitions
ii) Charge transfer

- Charge transfer

If the central metal ion has no unpaired d electrons then colour of complex or ions are due to charge transfer. as in case of PbO_2, MnO_4^-, $Cr_2O_7^{2-}$, Sn^{2+} and Sn^{4+} etc.

- In these ions transition of electoons occur from orbital of one atom to orbital of another atom by absorbing radiation to produced dark colour.
- This transition occur in UV region (1800 – 4000) is known as charge transfer.

7) Catalytic properties

- Transition metals and their compounds can absorb large number of substances on their surface, which can absorb large number of substances on their surfaces, which react faster due to increased concentratio at the surface (adsorption theory of catalysis). So they can catalyse many reactions.
- Transiteon metals can form intermediate compounds with many substances due to variable oxidation states. So they provide an alternate path with reduced activation energy for several chemical reactions (activated complex theory). Hence rate of a reaction is increased when the reaction is carried out in presence of a transition metal as catalyst.