Chemistry Study Materials for Class 12

(Notes Based on NCERT)

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The d & f - Block Elements

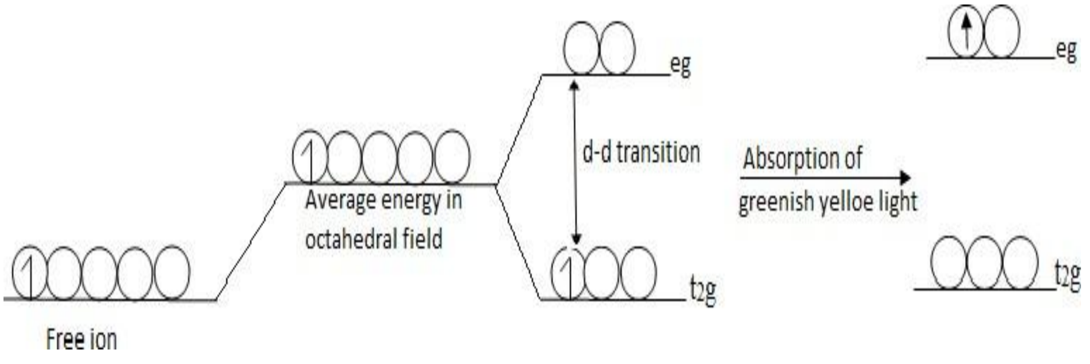
7. Complex Formation : The cations of transition metals have a great tendency to form complexes with several molecules or ions called ligands. The tendency of formation of complexes is due to the following two factors.

The cations of these metals are very small in size and have a high effective nuclear charge. Thus they have a very high positive charge density which facilitates the acceptance of lone pairs of electrons from other molecules or ions.

The transition metal cations have vacant inner d-orbitals which are of appropriate energy to accept lone pair of electrons from the ligands. The bonds involved in the formation of complexes are coordinate hence the complexes are termed as coordinate complexes.

8. Formation of Coloured Compound: the transition metal ions have unpaired d-electrons, which on absorbing visible light can jump from one d-orbital to another i.e., intra d-d transition takes place. Thus, when light falls certain visible wavelength are absorbed. The transmitted (unabsorbed) or reflected light (or colour) appears coloured and gives the colour of compounds. The ions having no d-d transition are colourless.

To understand the cause of colour in transition metal complexes, consider complex $[Ti(H2O)6]^{3+}$, In this case, titanium is in +3 oxidation state. The electronic configuration of Ti^{+3} : $[Ar]3d^1$



During the formation of complex, as the six water molecules approach Ti^{+3} ion from different side these develop a negative field around it, as they donate lone pair present on oxygen to metal ion. There occurs repulsion between electrons of metal ion and ligand and energy of degenerate orbitals of metal ions increase and ultimately they split into two set of orbitals. The electron present in Ti^{+3} , prefers lower set of d- orbitals. The energy gap between two set of d- orbitals is very less and the energy available in the visible light is sufficient to cause excitation of electron from lower set of d- orbitals to higher set of d –orbitals, called a d-d transitions. Ti^{+3} absorbs greenish yellow component of white light during excitation of electrons, hence its aqueous

solution appears as purple. This is because purple is the complimentary colour of greenish yellow in white light.

9. **Magnetic Properties**: Most of the transition elements show paramagnetism.

Paramagnetism arises from the presence of unpaired electrons in atoms, ions or molecules. The magnetic character is comparable in terms of magnetic moment given by the expression $\mu = \sqrt{(n + 2)}$ Bohr Magneton, where n= the number of unpaired electrons. In general, greater the number of unpaired electrons, greater is the magnetic character. The maximum paramagnetism is noticed in d^5 case which has maximum number of unpaired electrons.

10. Formation of alloys : due to their almost equal atomic sizes, they can mutually substitute one another in the crystal lattice to form alloys.

11. Formation of non-stoichiometric compounds and interstitial compounds. : transition metal can trap some of the small size atoms like hydrogen, boron, carbon, nitrogen etc., in the vacant spaces between the crystal lattice forming inter-orbital compounds. For example, FeC , Fe_8N, TiH_2. This property differentiates these metals from non-transition elements. The products obtained are hard and rigid. Non – stoichiometric compounds like i.e. $Fe_{0.98}O$,$Fe_{0.86}S$. $VH_{0.56}$, $TiH_{1.7}$ are offen classified as interstitial compounds.

12. Catalytic properties: Many transition metals and their compounds show catalytic properties ,the most common being Fe , Pt ,Ni, V_2O_5 etc.

This property may be either due to their variable valency (incomplete *d*- orbitals) which enables them to form unstable intermediate compounds or due to the fact that they can provide a suitable reaction surface.

13. Reactivity : The *d*- block elements are unreactive due to the following factors:

High ionisation energies : on account of small size of their atoms, ionisation energies of d- block elements are fairly high

High heats of sublimation: Due to presence of covalent bonding, these have high heats of sublimation.

The tendency to remain unreactive is more pronounced in platinum and gold in the third transition series.

14. Standard Electrode Potential : The standard reduction potential of all the transition elements (except Cu and Hg in 3d-series etc.) is lower (negative) than that of hydrogen(taken as Zero) . Thus all the transition elements, with negative reduction potential, liberate hydrogen from dilute acids

However, some metals evolve hydrogen very slowly because they are protected from the attack of acids by the formation of an impervious layer of an inert oxide. For example, chromium is so unreactive that it can be used as a protective non-oxidising metals.

15. Reducing Properties: Transition metals with sufficiently negative standard reduction potential should be good reducing agents i.e, they should be oxidised easily to their ions.

$M \rightarrow M^{2+} + 2e^-$

However they are not good reducing agents as compared to elements of Group 1 , 2 and 13 . This is because the transition metals have less tendency to form ions due to their low reactivity.

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