**TDC Part II**

**Paper I, Group B**

**Inorganic Chemistry**



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**TOPIC:-UNIT -3,Introduction &General characteristics,Complex formation tendency,Magnetic properties**

**General characteristics**

* + 1. **Complex Formation Tendency**

The availability of various oxidation states facilitates the complex formation tendency. The complex formation tendency is found in the elements of second transition series also though it is less pronounced. These metals are weakly electropositive and do not form stable complexes with wide range of ligands as is found in case of first transition series elements. These elements from stable complexes with P, S and heavier halogens as donor atoms in the ligands in contrary to the elements of 3d sereis. They also form π complexes with CO as ligand. The 4d series elements show the common as well as unusual coordination numbers in their complexes which may be 4, 6 and even more than six. The examples are available for most of the second transition series elements in various oxidation states.

Yttrium forms complexes readily with NCS-, acac, EDTA etc., *viz*., [Y(NCS)6]3-, [Y(acac)3.H2O], [Y(EDTA)]- , respectively. Its complexes with C.N. 8 are also known.

Zirconium usually gives halo complexes of the type [ZrX6]2- and [ZrX7]3- (X = halide ions), [Zr(acac)4], [Zr(C2O4)4]4- , [Zr(bipy)3] and also [Zr2F13]5- and [ZrCl4]3(POCl3)2 type.

Niobium forms clusters only, e.g. [Nb6X12]n+, where n = 2, 3 or 4; [Nb6X14], [Nb6X15] and [Nb6X16], etc.

Molybdenum forms a variety of complexes having Mo in different oxidation states and coordination numbers. For example, [Mo2Cl8]4-, [Mo2Cl9]3-, [MoCl6]2-, [Mo(CO)5]2, [Mo2(CO)10]2-, [Mo(CO)6], [Mo(CNR)7]2+, [Mo(CN)8]4-, [Mo(S2CNMe2)4], etc.

Technitium also forms many complexes though not as many as are formed by manganese and rhenium. For example, [Tc(CO)4]3-, [Tc(CO)5]-, [Tc2(CO)10], [Tc(CN)7]4-, [Tc(CN)6]-, [Tc(NCS)6]-, [TcH9]2- etc.

Ruthenium forms a variety of complexes both with normal and π-ligands, such as N2, CO etc. For example, [Ru(NH3)5N2]3+, [Ru(NH3)6]3+, [Ru(CO)5], [Ru3(CO)12] etc.

The first complex further gives ploynuclear complex (N2 is weak π- ligand): [Ru (NH3)5 N2]3+ + [Ru (NH3)5. H2O]3+→ [(H3N)5 Ru-N2-Ru (NH3)5]4+ + H2O

The complexes of Rh, Pd and Cd are as follows:

[Rh(CO)4]-, [Rh4(CO)12], [Rh6(CO)16], [Pd(NH3)2Cl2], [Pd(NH3)4]2+, [Cd(CN)4]2-, [Cd (NH3)4]2+ and [[Pd(NH3)6]2+ etc.

## Magnetic Properties

The elements of second transition series exhibit paramagnetism due, obviously, to the presence of unpaired d-electrons in elemental or ionic forms. It has been observed that the magnetic moment, a measure of magnetism in the substances, increases with the number of unpaired electrons (the relationship of magnetic moment, µeff and number of unpaired electrons has been given in Unit 1 under magnetic properties of 3d-series elements). The relationship is called **spin only formula** because only spin contribution towards the total magnetic moment is considered and orbital contribution is regarded as quenched. However, if the orbital contribution is also considered in its full capacity to the total magnetic moment then the magnetic moment of the substance can be calculated by the formula:

µeff = ƒ4S (S + 1) + L(L + 1)

Where S is resultant spin angular momentum and L is the resultant orbital angular momentum.

In the ions/compounds/complexes of second transition series elements, the spin only formula is used to calculate the number of unpaired electrons from µeff values.