Answers to the Problems

1. a)

i) $K_3[Co(C_2O_4)_3]$

Co is in +3 oxidation state, there are 6 electron in the d orbital and coordination number is 6.

ii) $(NH_4)_2[CoF_4]$

Co is in +2 oxidation state, there are 7 electrons in the d orbital and coordination number is 4

iii) diamagnetic $[NiCl_2\{P(C_6H_5)_3\}_2]$

Ni is in +2 oxidation state, there are 8 electrons in the d orbital and coordination number is 4

iv) *cis*-$[CrCl_2(bipy)_2]Cl$

Cr is in +3 oxidation state, there are 3 electrons in the d orbital and coordination number is 6

v) $[Mn(H_2O)_6]SO_4$

Mn is in +2 oxidation state, there are 5 electrons in the d orbital and coordination number is 6

b)

i) Can exhibit optical isomerism

ii) Does NOT show isomerism

iii) The known square planar complexes with this formula are trans- and cis- forms are theoretically possible.

iv) The cis- form can exhibit optical isomerism and there is a possibility of a trans- form as well

v) Does NOT show isomerism.

2.

i) $K[Cr(oxal)_2(H_2O)_2].3H_2O$ - Both geometric (*cis-, trans-*) and optical isomers can exist.

ii) $[Co(en)_3]Cl_3$ - Two optical isomers can exist.

iii) $[CoCl(NO_2)(NH_3)_4]Br$ - A total of 10 isomers are possible. There are geometric, ionisation and linkage isomers possible.

iv) $PtCl_2(NH_3)(H_2O)$ - Geometric (*cis-, trans-*) isomers can exist.

3. $[CoF_6]^{3-}$ uses the 4*s*, 4*p* and two 4*d* orbitals to give sp^3d^2 hybridization, whereas $[Co(NH_3)_6]^{3+}$ uses two 3d, 4s and 4p orbitals to give d^2sp^3 hybridization. Valence bond theory does not provide the rationale for using higher energy orbitals in case of $[CoF_6]^{3-}$.

4. $[Fe(CN)_6]^{3-}$ is a low-spin complex, whereas $[Fe(NCS)_6]^{3-}$ is a high-spin complex. Iron is in +3 oxidation state in both the complexes.

5.

i) $[VCl_6]^{3-}$ has a d^2 metal ion. CFSE = 0.8 Δ_o

ii) $[Ru(bipy)_3]^{3+}$ has a d^5 metal ion. Being from the second row of transition metals it forms a low-spin complex with a reasonably strong ligand such as bipy. CFSE = 2.0 Δ_o

iii) $[PtBr_6]^{2-}$ has a d^6 metal ion. It should be a low-spin octahedral complex. CFSE = 2.4 Δ_o

iv) $[Ti(en)_3]^{2+}$ has a d^2 metal ion. CFSE = 0.8 Δ_o