**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 4s, 4p and two 4d 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. \([\text{Fe(CN)}_6]^{3-}\) is a low-spin complex, whereas \([\text{Fe(NCS)}_6]^{3-}\) is a high-spin complex. Iron is in +3 oxidation state in both the complexes.

5.
   i) \([\text{VCl}_6]^{3-}\) has a \(d^2\) metal ion. CFSE = 0.8 \(\Delta_o\)
   
   ii) \([\text{Ru(bipy)}_3]^{3+}\) 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 \(\Delta_o\)

   iii) \([\text{PtBr}_6]^{2-}\) has a \(d^6\) metal ion. It should be a low-spin octahedral complex. CFSE = 2.4 \(\Delta_o\)

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