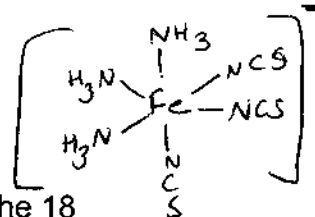


1. Nomenclature (12 marks)

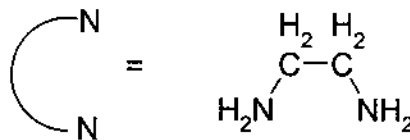
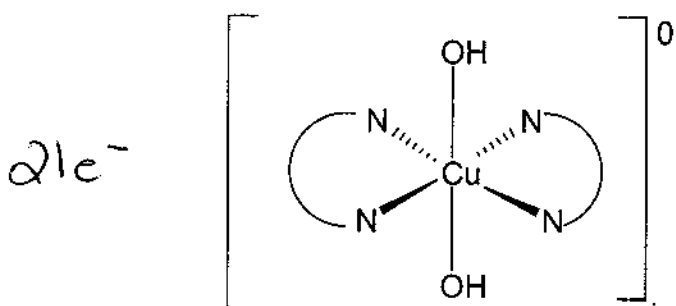
a) Draw the following complex. Don't forget to indicate the overall charge.

fac-triammine-tris(thiocyanato- κ -N)ferrate (II)



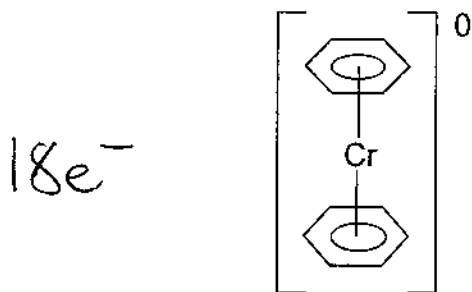
b) Give the name and formula of the following complexes. Do they obey the 18 electron rule?

i)



trans-bis(ethylenediamine)dihydroxo copper(II)

ii) $trans-[Cu(OH)_2(en)_2]$

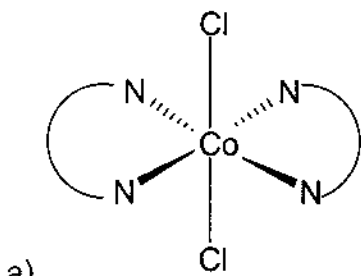


η^6 -bis(benzene)chromium(0)

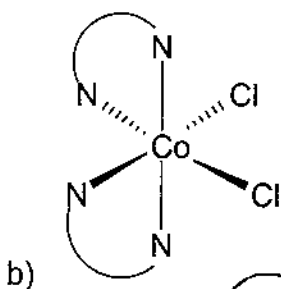
$[Cr(\eta^6-C_6H_6)_2]^0$

2. Isomerism (5 marks)

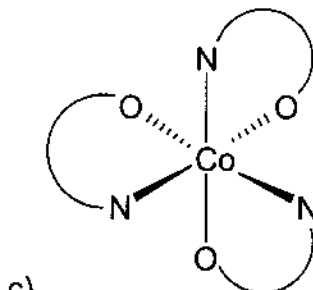
Are the following complexes optically active? If so, label them Δ or Λ .



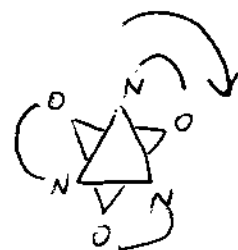
no



yes



yes



3. Ligand Field Theory (15 marks)

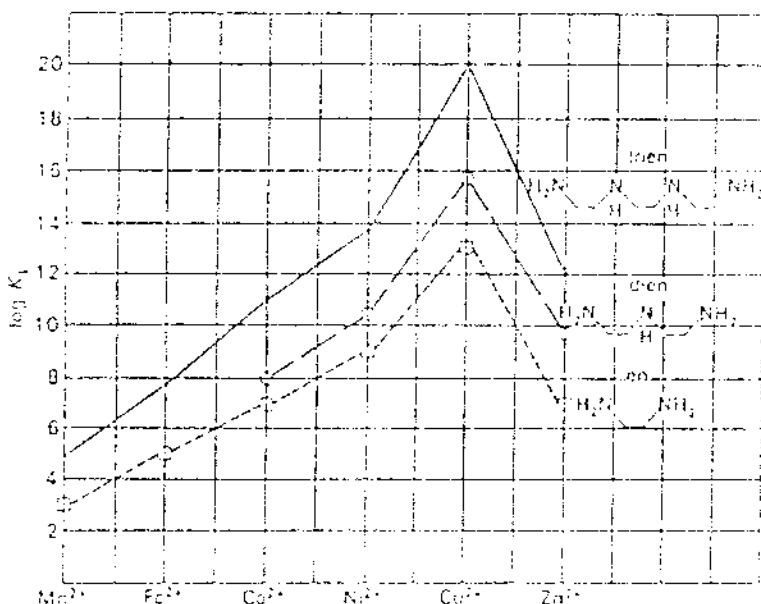
Draw the d-orbital splitting and fill in the appropriate number of d-electrons for the following complexes. Calculate the ligand field stabilization energy (LFSE) for each case. Calculate the magnetic moment for each example using the spin-only equation $\mu_{\text{eff}} = [n(n+2)]^{1/2}$. Which of these complexes will have a higher experimental magnetic moment due to orbital angular momentum?

- 5 a) $[\text{FeCl}_4]^{2-}$ (tetrahedral)
 5 b) $[\text{Ru}(\text{bipy})_3]^{2+}$ (bipy=bipyridine)
 5 c) $[\text{Fe}(\text{OH}_2)_6]^{2+}$

see next page

4. Thermodynamics of Transition Metal Complexes (10 marks)

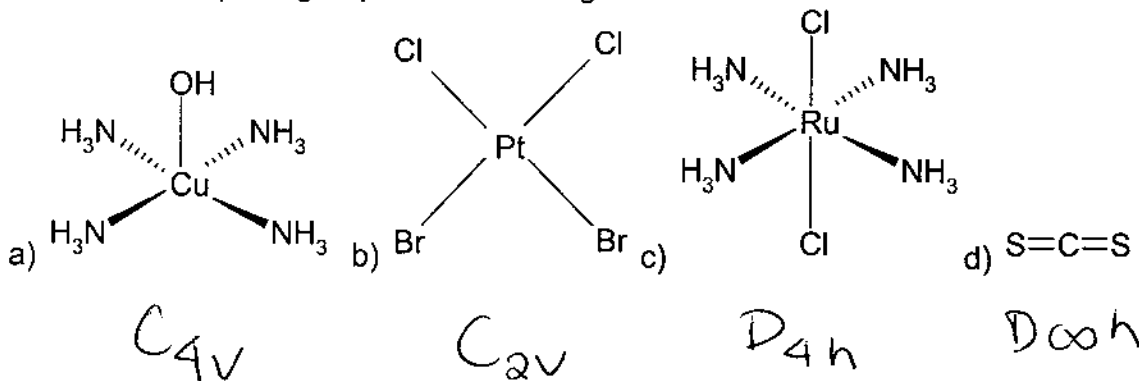
Explain the trends shown in the chart below (both the effect of metal ion on $\log K_1$ and the effect of ligand on $\log K_1$).

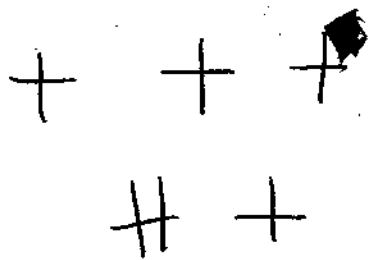


- general upward trend $\Rightarrow Z_{\text{eff}}$ (explain)
- increase to Ni²⁺ and decrease at Zn²⁺ \Rightarrow LFSE (explain)
- max at Cu²⁺ \Rightarrow Jahn-Teller effect (explain)
- ligand \Rightarrow chelate effect - entropy effect

5. Symmetry (8 marks)

Determine the point group of the following molecules.





Tetrahedral
 ∴ always high spin

d^6 high spin

$$\text{LFSE} = -0.6 \Delta_t$$

$$\mu = \sqrt{n(n+2)}$$

$$= \sqrt{4(4+2)}$$

$$= 4.9 \text{ BM}$$

no orbital angular momentum



4d metal

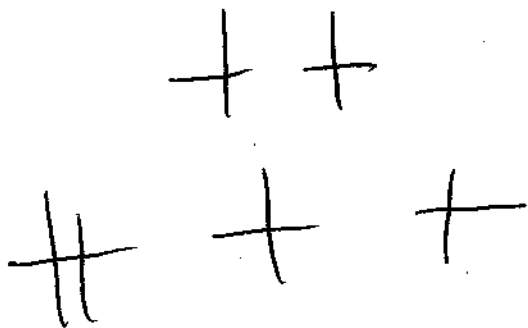
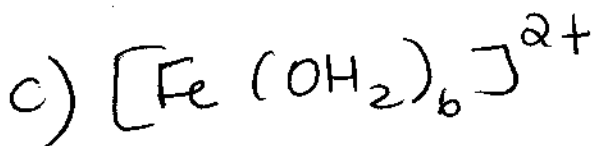
∴ low spin

d^6

$$\text{LFSE} = -2.4 \Delta_o$$

$$\mu = 0$$

no orbital angular momentum.



high spin
 d^6

$$\text{LFSE} = -0.4 \Delta_o$$

$$\mu = 4.9 \text{ B.M.}$$

→ orbital angular momentum ✓