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**University Examinations 2023/2024**

THIRD YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE CHEMISTRY

**SCH 3300: CHEMISTRY OF D-BLOCK ELEMENTS**

**DATE: DECEMBER 2023** **TIME:2 HOURS**

**INSTRUCTIONS:** *answer question one and any other two questions*

**QUESTION ONE 30 MARKS**

a) How many ions are produced from the following complexes in solution? (2 marks)
   (i) [Co(NH3)6]Cl2
   (ii) $[Co(NH_3)_4Cl_2]Cl$

b) Explain giving an examples each of the following:
   (i) Ligand (2 marks)
   (ii) coordination number (2 marks)
   (iii) homoleptic complex (2 marks)

c) Explain the difference between a weak field ligand and a strong field ligand. (2 marks)

d) Discuss the nature of bonding in metal carbonyls. (6 marks)

e) Determine the magnetic moment based on spin only formula for each of the following complexes (6 marks)
   **(i)** K[Cr(H2O)2(C2O4)2].3H2O
   **(ii)** K4[Mn(CN)6]

f) What is meant by stability of a coordination compound in solution? (2 marks)

g) Distinguish between thermodynamic stability and kinetic stability (2 marks)

h) Explain on the basis of valence bond theory that $[Ni(CN)_4]^{2-}$ ion with square planar structure is diamagnetic and the $[NiCl_4]^{2-}$ ion with tetrahedral geometry is paramagnetic. (4 Marks)

**QUESTION TWO 20 MARKS**

a) Give the oxidation state, *d*-orbital occupation and coordination number of the central metal ion in the following complexes: (12 marks)

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

ii. cis-[Cr(en)2Cl2]Cl

iii. (NH4)2[CoF4]

iv. **(**[Mn(H2O)6]SO4

b) Discuss briefly giving an example in each case the role of coordination compounds in:

i. biological system (2 marks)

ii. medicinal chemistry (2 marks)

iii. analytical chemistry (2 marks)

iv. extraction/metallurgy of metals (2 marks)

**QUESTION THREE (20 MARKS)**

a) Using the values of the octahedral crystal field splitting energy ( Δo) for the cobalt complexes and color wheel provided below, determine the color of each of the following : (8 marks)
(h=6.626 x $10^{-34}$j.s; c = 3.0 x $10^{8}$m/s; 1$cm^{-1}$ = 1.98630 x $10^{-23}$J)

| **Complex** | **Δ (cm-1)** |
|---|---|
| [Co(NH3)6]3+ | 22,900 |
| [Co(H2O)6]3+ | 18,200 |

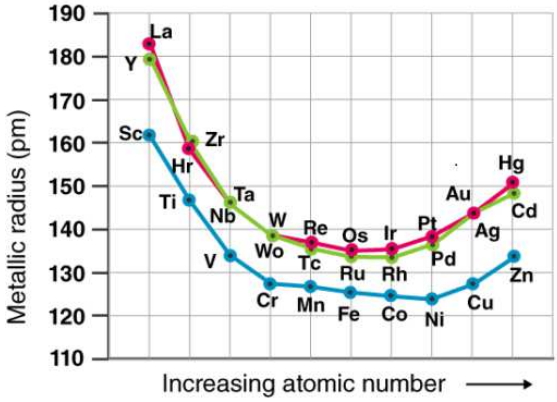

b) For each of the following pair of complexes, identify the one that has the larger Crystal field stabilization energy (CFSE). Explain your reasoning and show your working. (12 marks)

i. [Cr(OH2)6]2+ or [Cr(OH2)6]3+

ii. [Fe(CN)6]3- or [Fe(OH2)6]3+

**QUESTION FOUR 20 MARKS**

a) Explain trends in atomic radii observed in transition elements and which are summarized in the graph below. (7 marks)




b) Explain why:

(i) most transition elements and their compounds have good catalytic properties (2 marks)

(ii) Unlike s and p block elements, transition elements have high tendency to form complexes. (3 marks)

(iii) [Cr(NH3)6]3+ is paramagnetic while [Ni(CN)4]2− is diamagnetic.? (4 marks)

(iv) $[Fe(CN)_6]^{4-}$ and $[Fe(H_2O)_6]^{2+}$ are of different colours in dilute solutions. (4 marks)