NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER EXAMINATIONS - MAY 2001
INORGANIC CHEMISTRY II - SCH1201
TIME: 3 HOURS

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INSTRUCTIONS TO CANDIDATES

Answer **ALL** questions from Section A and **ANY THREE** from Section B.

Atomic Mass Tables Required

SECTION A

1. (a) Name the types of addition compounds that are formed when stoicheometric amounts of two or more stable compounds join together. (2 marks)

   (b) Complete the following reactions, providing balanced equations for each:

   $KCl + MgCl_2 + H_2O \rightarrow$
   $CuSO_4 + NH_3 + H_2O \rightarrow$

   (4 marks)

2. Draw the structures of the following complexes, in which M stands for a d-block metal, and X for a non-metal. Indicate where there are any structures that are ambiguous, and suggest the structure you consider most likely:

   (a) $[M(NH_3)_4]^{2+}$ (b) $[M(NH_3)_2X_2]$ (c) $[M(NH_3)_3X]^{+}$ (d) $[M(NH_3)X_3]$ (e) $[MX_4]^{2-}$
   (6 marks)

3. Name the following co-ordination complexes according to the IUPAC rules:

   (a) $[CoCl(CN)(NO_2)(NH_3)_3]$ (b) $[Cd(SCN)_4]^{2-}$ (c) $K_3[Fe(CN)_5NO]$ (d) $[Cr(C_6H_6)_2]$
   (8 marks)

4. Describe the two general mechanisms for electron-transfer reactions. Complete and balance the following reactions:

   $$[Fe^{II}(CN)_6]^{4-} + [Ir\ ^{IV}Cl_6]^{2-} \rightleftarrows$$

   $$[Co^{III}(NH_3)_5X]^{2+} + Cr^{2+}(aq) + 5H^{+} \rightarrow$$

   (8 marks)

odd no's

5. Provide balanced chemical equations for:

(a) The hydrolysis of $TiCl_4$.

(b) A preparation of $[Co(NH_3)_6]^{3+}$

(c) Disproportionation of Mn^{3+} by water in weakly acid solution. (6 marks)

6. (a) Most six-coordinate complexes ML_6 have one of two structures. Draw these two structures. Which one of them is rare? (4 marks)

(b) Provide formulas for two d-metal complexes that have the more common six-coordinate structure. (2 marks)

7. Determine the electronic configuration in the form $t_{2g}^{\ m}\ e_g^{\ n}$, and the number of unpaired electrons for the following complexes:

(a) $[Cr(NH_3)_6]^{3+}$ (b) $[Co(NH_3)_6]^{3+}$ (c) $[Fe(CN)_6]^{3-}$ (6 marks)

SECTION B

8. (a) Name and discuss the five properties which mainly determine a liquid's ability as a solvent, giving examples that properly explain these properties. (10 marks)

(b) Write down the conjugate acids and conjugate bases of the following species:
(i) NH_3, (ii) NH_2^-, (iii) NH^{2-}, (iv) HI. (8 marks)

9. (a) The magnetic moment of $[Mn(NCS)_6]^{4-}$ is 6.06 μ_B. Calculate the number of unpaired spins and hence its electronic configuration. Is NCS^- a strong or weak field ligand? (10 marks)

(b) Draw the structures of, and name:

(i) any typical square-planar four-coordinate complex.

(ii) typical two-coordinate complexes of Ag and Au (one of each). (8 marks)

even no's

10. (a) Why is it that the freshly prepared hydroxide of

(i) Mn^{2+} is white, but turns dark brown in air,

(ii) Co^{2+} is blue, but turns pink on warming, and

(iii) Cu^{2+} is blue, but turns black on warming?

Write balanced equations to illustrate your answers. (9 marks)

(b) Sketch the periodic table, outlining the s- and p-blocks, and indicate on it which of these elements form:

(i) strongly acidic oxides,

(ii) strongly basic oxides, and

(iii) amphoteric oxides.

You should include Li, Be, B, C, Na, Mg, Al, Si, K, Ca, Ge, Ga, Rb, Sr, In and Sn. (9 marks)

11. (a) Draw the structures of (i) $Fe_2(CO)_9$, (ii) $Os_2(CO)_9$, (iii) $Os_3(CO)_{12}$, (iv) $Ru_3(CO)_{12}$, (v) $Co_4(CO)_{12}$, (vi) $Ir_4(CO)_{12}$. (12 marks)

(b) Provide balanced equations for three distinct routes to the anion $[Co(CO)_4]^-$. Predict its geometry. (6 marks)

END OF QUESTION PAPER!!!!

odd no's