NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER EXAMINATIONS - MAY 2002
INORGANIC CHEMISTRY II - SCH1201
TIME: 3 HOURS

INSTRUCTIONS TO CANDIDATES

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

Atomic Mass Tables Required

SECTION A

1. Which has the broader applications in terms of definitions of acids and bases, the Arrhenius-Ostwald or the Bronsted-Lowry definitions. Give the two definitions and explain. (6 marks)

2. (a) Write the formulas for the conjugate acid and the conjugate base of ammonia, NH_3. (2 marks)

   (b) What relationship exists between the strength of the conjugate acid and the conjugate base for a neutral substance such as NH_3? (4 marks)

3. Geochemical classifications distinguish metals as *lithophile* if they tend to occur as oxides, and *chalcophile* if they tend to occur as sulphides. What property of the metal determines this distinction, and why? Classify the following metals geochemically: Ag, Al, Hg, Li. (8 marks)

4. Name the following compounds according to IUPAC rules:
   (i) K_2FeO_4 (ii) $K[PtCl_3(C_2H_4)]$ (iii) $K_2[Co(N_3)_4]$ (iv) $[Cr(OH)(H_2O)_3(NH_3)_2](NO_3)_2$ (4 marks)

5. (a) Distinguish between structural isomerism and geometric isomerism as applied to co-ordination compounds. (2 marks)

   (b) Give one example of each of the following types of structural isomers:-

   (i) Ionisation isomers

   (ii) Linkage isomers

   (iii) Co-ordination isomers (6 marks)

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6. Sketch all the possible geometric isomers of $[CoBrCl(en)(NH_3)_2]^+$ and indicate which would exhibit optical activity. (8 marks)

7. (a) Discuss briefly the factors working for and against the maximum spin state of *d* electrons in transition metal complexes. (5 marks)

(b) Given the following information regarding the Co(III) (d^6) complexes

$[Co(OH_2)_6]^{3+}$ $\lambda_{max} = 740$ nm

and

$[Co(CN)_6]^{3-}$ $\lambda_{max} = 460$ nm

estimate the ligand field splitting (in kJ mol^{-1}) for each complex. Assuming one of these is a strong field complex and the other a weak field complex, predict for each the spin magnetic moment (in units of μ_B). [Planck's constant $h = 6.628 \times 10^{-34}$ J s; velocity of light $c = 2.998 \times 10^8$ m s^{-1}; Avogadro's No. $N = 6.023 \times 10^{23}$]mol^{-1}] (10 marks)

SECTION B

8. Consider acetic acid CH_3COOH as a solvent. Its relative permittivity is about 10.

(a) What is its probable mode of self-ionisation? (2 marks)

(b) Name two substances that will be acids and two that will be bases in acetic acid. Write equations to support your answers. (12 marks)

(c) How will acetic compare to water as a solvent for ionic compounds? (1 mark)

9. Account for the following observations in terms of Lewis acid-base theory, indicating which species are acids, which bases, and which complexes. Write an equation for each chemical reaction and classify it.

AlF_3 is insoluble in HF, but dissolves if when NaF is present. When BF_3 is passed into the solution, AlF_3 is precipitated. (15 marks)

10. (a) Explain the difference between a ligand's Lewis base strength and its nucleophilicity. How is each measured? (6 marks)

(b) For PtX_4^{2-} complexes both ligand exchange rates and thermodynamic stability increase in the order X = Cl < Br < I < CN. Use the probable mechanism of ligand exchange to explain why these observations are not inconsistent. (9 marks)

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11. (a) Draw all the isomers possible for a five-coordinate species $M(en)_2Cl$, where en is ethylenediamine, assuming it to be (i) a square pyramid, (ii) a trigonal bipyramid. (6 marks)

(b) In practice no isomers can be isolated for these complexes. Explain this observation in terms of the Berry pseudorotation mechanism. Account for all the isomers you listed in (a). (9 marks)

12. Identify the following reaction by type (oxidation, reduction, substitution, etc.), and predict the products:

(a) $W(CO)_6 + PPh_3 \rightarrow$ (3 marks)

(b) $Re_2(CO)_{10} + Br_2 \rightarrow$ (3 marks)

(c) $[CpMo(CO)_3]_2 + KH \rightarrow$ (3 marks)

(d) $Re(CO)_5^- + CH_3I \rightarrow$ (3 marks)

(e) $CpFe(CO)_2Cl + PPh_3 \rightarrow$ (3 marks)

END OF QUESTION PAPER!!!!

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