



# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF APPLIED CHEMISTRY

INORGANIC CHEMISTRY I

SCH 1201

Second Semester Examination Paper

May 2015

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Periodic Table

Examiner's Name: DR H. Chiririwa

## INSTRUCTIONS

Answer All questions in section A and Any Three questions in Section B.

Answer each question on a FRESH page.

## MARK ALLOCATION

SECTION	MARKS
A	40
B	60
TOTAL	100

**SECTION A** Answer ALL questions. Each question carries 10 marks.

1. (a) What two properties are generally considered important in a solvent for electrochemical reactions. [2 marks]
- (b) Boric acid,  $B(OH)_3$ , acts as an acid in water, but does not do so via ionization of a proton. Rather, it serves as a Lewis acid towards  $OH^-$ . Explain with the use of a balanced equation. [2 marks]
- (c) Briefly discuss Bronsted-Lowry definition and show how it is included as a special case in the solvent system definition. [4 marks]
- (d) Distinguish between solvolysis and solubility. [2 marks]
2. (a) A coordination compound can be defined according to its structure and also according to its reaction chemistry. Give two definitions that collectively satisfy this statement. [4 marks]
- (b) Draw the structure of the following complex:  
Tris(ethylenediamine)cobalt(III) [2 marks]
- (c) Name three common geometries associated with the eight-coordination. Draw the structure of one of them. [4 marks]
3. (a) What do you understand by the term *inert-pair effect*. [2 marks]
- (b) State any four common properties of the transition elements. [4 marks]
- (c) Sulphur forms both discrete polyatomic molecules and extended structures.  
(i) Name one discrete polyatomic molecule of sulphur.  
(ii) What is *catenasulphur* [4 marks]
4. (a) What is a coordination compound? [2 marks]
- (b) Name and draw the two common geometries associated with the five coordination [4 marks]
- (c) Name the following complexes:  
(i)  $[Co(NH_3)_5][Fe(CN)_5H_2O]$   
(ii)  $Na_2[Fe(CN)_6] \cdot 2H_2O$  [4 marks]

**SECTION B** Answer any THREE questions from this section. Each question carries 20 marks.

5. (a) Name an important industrial process that employs a molten salt as a solvent. [2 marks]
- (b) HBr, HClO<sub>4</sub>, and HI are relatively strong Bronsted acids. For these acids to be distinguished according to acid strength they have to be studied in solvents such as sulphuric acid. What is a Bronsted acid? Write the Bronsted equilibrium for the solvent sulphuric acid indicating the strongest acid and strongest base that can exist in it. [6 marks]
- (c) How is the solvent *Aqua Regia* prepared? Which two molecules in mixture give the solvent a high oxidizing power? Give one example of the application of the solvent. [6 marks]
- (d) Separate the following solvents into protic and non-protic groups. For the protic group, write the possible Bronsted and Lowry pairs. [6 marks]
- NH<sub>3</sub>, HCl, BrF<sub>3</sub>, IF<sub>5</sub>, Cl<sub>3</sub>PO, AsCl<sub>3</sub>, CH<sub>3</sub>CONH<sub>2</sub>.
6. (a) In substitution reactions of Octahedral complexes, there are four main mechanisms that have been established. Name them and use the substitution of ligand X by ligand Y in the ML<sub>5</sub>X complex to illustrate each. [6 marks]
- (b) Name the following complex compounds and ions: [8 marks]
- (i) [Pt(NH<sub>3</sub>)<sub>5</sub>Cl](NO<sub>3</sub>)<sub>3</sub>  
(ii) Mg[Ni(Cl)<sub>4</sub>]  
(iii) Fe(NH<sub>3</sub>)<sub>3</sub>Cl<sub>3</sub>  
(iv) [Fe(NH<sub>3</sub>)<sub>6</sub>]Cl<sub>3</sub>
- (c) What is a *strong trans director* ligand? [6 marks]
- Use the synthesis of the cis and trans isomers of [Pt(NH<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub>] to demonstrate and discuss this phenomena

7. Solution behaviour can be divided into three sections: (i) solubility and solvolysis, (ii) acid-base behaviour, and (iii) oxidation- reduction behaviour.
- (a) Differentiate the terms solvation and solvolysis. What are these processes termed when the solvents are water and ammonia? [8 marks]
- (b) What two properties are considered important in a solvent for electrochemical reactions? [2 marks]
- (c) Write the auto-ionization reactions for the following solvents  
 $\text{H}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{BrF}_3$ ,  $\text{HF}$ ,  $\text{IF}_5$ ,  $\text{Cl}_3\text{PO}$ ,  $\text{N}_2\text{O}_4$ ,  $\text{AsCl}_3$ ,  $\text{CH}_3\text{CONH}_2$  [10 marks]
8. (a) Explain why tetrahedral complexes always have high spin complexes. Also give an explanation of why  $\Delta_{\text{tet}}$  is  $4/9 \Delta_0$ . [6 marks]
- (b) What is meant by:
- (i) metal-to-ligand bonding and
- (ii) ligand-to-metal bonding? [4 marks]
- (c) Draw the six metal orbitals with  $\sigma$ -symmetry (sigma symmetry) and ligand group orbitals ( $\Sigma$ ) that overlap properly with those of metal orbitals to form  $\sigma$ -type MO's in an  $\text{ML}_6$  complex. [10 marks]

**END OF QUESTION PAPER!!!**

