



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

**SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR
OF SCIENCE**

SCH 412: INTRODUCTION TO LIGAND FIELD THEORY

DATE: WEDNESDAY 4TH APRIL 2012

TIME: 2.00 P.M. – 4.00 P.M.

INSTRUCTIONS

Answer ALL questions

1. a) Define the following
- i) A microstate (2 marks)
 - ii) A Term (2 marks)
- b) State Pauli's Exclusion principle (5 marks)
- c) The following are some of the free ion terms which arise from a d⁷ ion:- 2F, 4F, 4F, 4P, 2G.
- i) State with, reasons, the ground state term
 - ii) State with, reasons, the number of electronic peaks expected and the number actually observed (5 marks)

(Total for Q.1...20 marks)

2. a) Outline briefly the basic principles of Crystal Field Theory, pointing out clearly the merits and drawbacks of this theory. (8 marks)
- b) Electronic bands are usually broad and sometimes have even shoulders. Outline briefly the various factors that cause broadening or even splitting of electronic bands. (12 marks)

(Total for Q.2... 20 marks)

3. a) A sample of cobalt (II) carbonate was dissolved in dilute hydrochloric acid to get solution labeled A. Solution A was divided into three portions, B, C and D. Solution B was treated with a large excess of concentrated hydrochloric acid.
- Solution C was reacted with a large excess of sodium cyanide. Solution D was treated with a large excess of ammonia

- i) Write balanced chemical equations to show the complexes formed in A, B, C and D. (8 marks)
- ii) Draw Energy level diagrams for complexes formed by complexes A, B, C and D. (8 marks)
- iii) Calculate the Crystal Field Stabilization Energy (CFSE) for each of the complexes A-D. (8 marks)
- iv) Draw a Tanabe-Sugano Energy level diagram for complex in A (4 marks)

Total for question 3..... 20 marks)

4. a) Explain what you understand by the following:-
 - i) A paramagnetic species (2 marks)
 - ii) A magnetically dilute species (2 marks)
 - iii) First order Zeeman Effect (4 marks)
 - iv) Second Order Zeeman (4 marks)
- b) The cobalt complex, $[\text{Co}(\text{NH}_3)_6]^{3+}$, has a magnetic moment of 0.4 BM at 300K. Yet, the calculated magnetic moment is 0 BM. Explain (6 marks)
 - i) Given that the spin-orbit constant, λ , for Co^{2+} is -520 cm^{-1} , and $10Dq$ value is 8200 cm^{-1} , calculate the effective magnetic moment for the cobalt complex (10 marks)

Total for Q.4 30 marks)

5. a) Plot a diagram showing the variation of lattice energies of the difluorides, MF_2 ($M = \text{Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn}$) As a function of atomic no. z , showing clearly:-
 - i) expected trends and the variation actually realized. (10 marks)
- b) Give a feasible explanation for each portion of the curve. (10 marks)