

**KABARAK**



**UNIVERSITY**

**EXAMINATIONS**

**2008/2009 ACADEMIC YEAR**

**FOR THE DEGREE OF BACHELOR OF EDUCATION  
SCIENCE**

**COURSE CODE: CHEM 321**

**COURSE TITLE: CO-ORDINATION CHEMISTRY**

**STREAM: Y3S2**

**DAY: FRIDAY**

**TIME: 9.00 – 11.00 A.M.**

**DATE: 27/03/2009**

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**INSTRUCTIONS:**

Answer **ALL** questions

**PLEASE TURN OVER**

1. (a) Define the following terms as applied in coordination chemistry;
- (i) Coordination compound (ii) Crystal field stabilization energy  
(iii) Coordination number (iv) Soft base [4 marks]
- (b) Draw the shapes of the *d* orbitals indicating clearly their electron densities distribution with respect to x, y and z axes [2.5 marks]
- (c) Write the electron configurations of the following atoms or ions;
- (i) Sc (ii) Fe (iii)  $\text{Co}^{3+}$  (iv)  $\text{Cu}^{2+}$   
[Atomic numbers: Sc = 21, Fe = 26, Co = 27 and Cu = 29] [4 marks]
- (d) Briefly explain why Zn is not considered as a transition metal  
[Atomic numbers: Zn = 30] [1 mark]
- (e) The table below shows properties of cobalt aqua fluorides. Study it and answer the questions that follow.

Compound	Number of particles as determined by cryoscopic measurements	Molar conductivity ( $\text{ohm}^{-1}\text{cm}^2$ )
$\text{CoF}_2 \cdot 4\text{H}_2\text{O}$	3	230
$\text{CoF}_2 \cdot 3\text{H}_2\text{O}$	2	97
$\text{CoF}_2 \cdot 2\text{H}_2\text{O}$	1	0

- (i) Explain the above observation on the basis of Werner's coordination theory [4 marks]
- (ii) What is the possible geometry of the compounds above? Briefly explain your answer [2 marks]
2. (a) Draw the structures of the following complex ions;
- (i)  $[\text{Mg}(\text{EDTA})]^{2-}$  (ii)  $[\text{VO}(\text{acac})_2]$  (iii)  $[\text{Zn}(\text{OH})_4]^{2-}$  (iv)  $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$  [4 marks]
- (b) Give the I.U.P.A.C names of the following compounds;
- (i)  $\text{K}_2[\text{Fe}(\text{CN})_4]$  (ii)  $[\text{Cr}(\text{NH}_3)_2\text{Cl}_3\text{H}_2\text{O}]$  (iii)  $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_4]$   
(iv)  $[(\text{en})_2\text{Fe}(\text{NH})_2\text{Fe}(\text{NH}_3)_4]\text{Br}_2$  [4 marks]

- (c) Write short notes on the following subjects giving an example in each case:
- (i) Chelating ligands (ii) ionization isomerism (iii) effective atomic number [6 marks]
- (d) Distinguish between;
- (i) Spectrochemical series and nephelauxetic series
  - (ii) Outer orbital and inner orbital complexes [4 marks]
3. The complex  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$  is octahedral and paramagnetic with a  $\mu$  spin only value of 2.83 Bohr Magneton. Account for the bonding in this complex using;
- (a) Valence bond theory (b) Crystal field theory (iii) Molecular orbital theory [Atomic number of Ni =28] [10 marks]
  - (b) Draw the splitting patterns of d orbitals in the following fields;
    - (i) Square planar (ii) tetragonal (iii) tetrahedral [7.5 marks]
  - (c) Compare and contrast crystal field and molecular orbital bonding theories [Hint: Give **two** similarities and **two** differences of the theories] [4 marks]
4. (a) What is the experimental evidence of Jahn Teller distortion ? [2 marks]
- (b) Will  $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$  undergo Jahn Teller distortion? Briefly explain your answer [Atomic numbers: Mn =25] [3 marks]
- (c) Account for the following observations;
- (i) Ligand field splitting parametric for octahedral ( $\Delta_{\text{oct}}$ ) is larger than that of tetrahedral ( $\Delta_{\text{tet}}$ )
  - (ii)  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  is coloured but  $[\text{Ti}(\text{H}_2\text{O})_6]^{4+}$  is not
  - (iii)  $d^9$  metal ions in a strong field rarely form square planar complex [Atomic number of Ti = 22] [6 marks]
- (d) Give two properties of a transition element [2 marks]