



KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF CHEMISTRY

COURSE CODE: SCH 410

COURSE TITLE: COORDINATION AND ORGANOMETALLIC
CHEMISTRY

DURATION: 2 HOURS

DATE: 13/1/2022

TIME: 8-10AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of 3 printed pages. Please Turn Over



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QUESTION ONE COMPULSORY (30MKS)

- (a) Classify the following species as Bronsted Lowry or Lewis acids/ bases or both. Explain. [6 mks]
- $\text{Zn}(\text{OH})_2$
 - Na^+
 - AlCl_3
- (b) What is a pi- acid? Explain how CO acts as a lewis acid in metal carbonyls. [3 mks]
- (c) Using an example, describe the formation of chelate complexes on the stability of coordination compounds. [3 mks]
- (d) Explain the following observed overall stability constants ($\log \beta$) [2 mks]
- $\text{Hg}^{2+}/\text{F}^- = 1.0, \text{Hg}^{2+}/\text{I}^- = 12.9$
 - $\text{Mn}^{2+}/\text{en} = 5.7, \text{Mn}^{2+}/\text{EDTA} = 13.8$
- (e) Draw the structures for the following compounds [4 mks]
- HexaammineIron(iii)nitrate
 - Ammoniumtetrachlorocuprate(ii)
- (f) Explain the salient features of the valence bond theory (VBT) of coordination. [3 mks]
- (g) Write chemical equation to illustrate how the following may be prepared [3 mks]
- $\text{Ni}(\text{CO})_4$
 - $\text{Fe}(\text{CO})_5$
- (h) How does molecular orbital theory explain bonding and structure of metal carbonyls [3 mks]

QUESTION 2 (20 marks)

- Briefly describe the Jahn Teller effect [5 mks]
- State three biological compounds which are coordination compounds [3 mks].
- Draw the structure of Vitamin B₁₂ and state its use [12mks]

QUESTION 3 (20 Marks)

- (a) Discuss the applications of Chelating compounds in industry and medicine [10 Marks]
- (b) When cobalt carbonate is dissolved in dilute sulphuric acid, a light blue solution is obtained. When a few drops of ammonium hydroxide is added, a light blue precipitate is observed. The precipitate dissolves on addition of excess ammonia to give a deep blue solution.
- (i) Write a balanced chemical equation showing clearly the reactions taking place in each of the steps described above. [2 mks].

(ii) Draw energy level diagrams for the aqua complexes and ammine complexes and explain whether they are paramagnetic or diamagnetic. Explain the difference in colour. [8 mks]

QUESTION 4 (20 Marks)

(a) Draw the structure of a 'heme' complex in haemoglobin showing clearly the following structures: - [10 mks].

- (i) The central metal ion
- (ii) The nature of the ligand present
- (iii) The globin
- (iv) The fundamental groups attached to it

(b) Describe the mechanism of poisoning by carbon monoxide [2 mks].

(c) With the help of suitable examples, explain the meaning of the following term [4mks].

- (i) Lewis base
- (ii) Ambidentate ligand
- (iii) Coordination number
- (iv) Chelate

(d) Give the systematic names of the following complexes [4 mks].

- (i) $[\text{Pt}(\text{NH}_3)_5\text{Cl}]\text{Br}_3$
- (ii) $[\text{Co}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_3]_2(\text{SO}_4)_3$
- (iii) $\text{Fe}(\text{CO})_5$
- (iv) $(\text{NH}_4)_2[\text{Ni}(\text{C}_2\text{O}_4)(\text{H}_2\text{O})_2]$

QUESTION 5 (20 Marks)

(a) Use the crystal field theory to explain the following properties of coordination compounds [4 mks].

- (i) Transition metal complexes are paramagnetic
- (ii) Some transition metal complexes are diamagnetic

(b) Outline the catalytic process involved in the polymerization of ethane (Ziegler Natta Process) [6 mks].

(c) Starting with MoO_3 as a source of Mo and CO and PPh_3 as ligand sources plus other reagents of your choice, give equations and conditions for the synthesis of $\text{Mo}(\text{CO})_5\text{PPh}_3$. [10 mks]