



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY)

SAN 302: BIOINORGANIC CHEMISTRY

DATE: 26/8/2022

TIME: 8.30-10.30 AM

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) Describe the following terms as used in bioinorganic chemistry:
- i. Ligand (1½ marks)
 - ii. Coordination number (1½ marks)
 - iii. Essential element (1½ marks)
 - iv. Cofactor (1½ marks)
 - v. Deficiency (1½ marks)
- b) A goat was progressively exposed to pastures with rare to abundant Fluoride levels.
- i. Draw a well labeled fluoride Response against Dose curve for the goat. (5 marks)
 - ii. Describe the three main phases of your curve (5 marks)
- c) Differentiate between essential macro and trace elements giving two examples under each. (3 marks)
- d) Discuss the characteristics of a hard and soft acid and a hard and soft base. Give one example of each case. (8 marks)
- e) Ethylenediamine is a bidentate ligand, draw its structure. (1½ marks)

SECTION B (ANSWER ANY TWO QUESTIONS)

QUESTION TWO (20 MARKS)

- a) Give the IUPAC names of the following compounds:
- i. $[\text{Cr}(\text{NH}_3)_3(\text{H}_2\text{O})_3]\text{Cl}_3$ (1 ½ marks)
 - ii. $[\text{Co}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_3]_2(\text{SO}_4)_3$ (1 ½ marks)
 - iii. $\text{Na}_4[\text{Fe}(\text{CN})_6]$ (1 ½ marks)
 - iv. $[\text{Pt}(\text{NH}_3)_5\text{Cl}]\text{Br}_3$ (1 ½ marks)
- b) Write the correct chemical formula for:
- i. Hexaamminecobalt (III) ion (1 ½ marks)
 - ii. Triamminetrinitrocobalt (III) (1 ½ marks)
 - iii. Diamminetetrachloroplatinum (IV) (1 ½ marks)
 - iv. Pentacarbonyliron (0) (1 ½ marks)
- c) Metals in biological systems are often bound to macrocycles.
- i. Define the term macrocycles. (1 mark)
 - ii. Draw the structure of the corrin macrocycle ring. (3 marks)

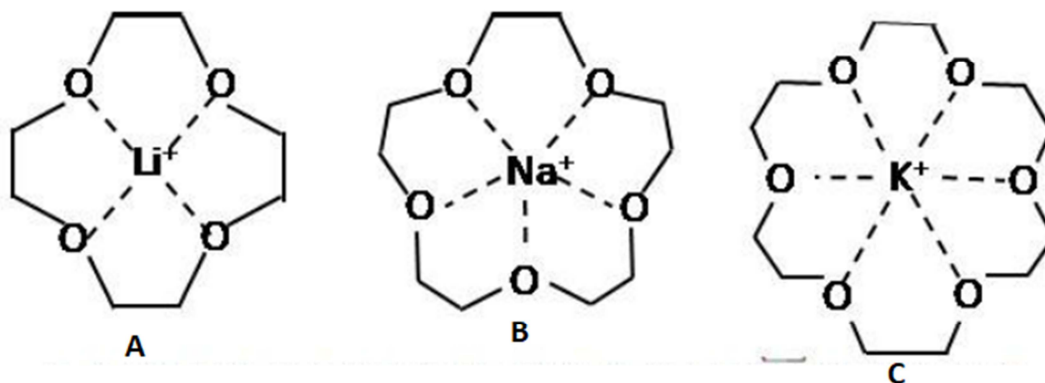
- d) Describe two properties of iron that can account for its extensive use in terrestrial biological reactions. (4 marks)

QUESTION THREE (20 MARKS)

- a) Describe the principles and operational features that distinguish each of the following spectroscopic methods in the study of macrocycles.
- Fourier transform - infra red (FT-IR) (3 marks)
 - UV-Vis spectroscopy (3 marks)
- b) Discuss how X-ray crystallography plays an important role in structure-based drug design and accurate analysis of crystal structures of target macromolecules and macromolecule–ligand complexes. (5 marks)
- c) Explain the biological significance of the following elements/ions.
- Mg^{2+} (2 marks)
 - $\text{Fe}^{2+}/\text{Fe}^{3+}$: in magnetite (Fe_3O_4) (2 marks)
 - Zn^{2+} (3 marks)
 - Cl^{1-} (2 marks)

QUESTION FOUR (20 MARKS)

- a)
 - Draw the porphyrin ring structure of a haem group in haemoglobin. (5 marks)
 - Describe briefly how haemoglobin transports oxygen to cell/tissues. (5 marks)
- b) Name the following synthetic macrocyclic polyethers. (6 marks)



- c) List four biological importance of crown ethers (4 marks)

QUESTION FIVE (20 MARKS)

- a) Differentiate between ion channels and Ionophores. (4 marks)
- b) Describe the three nitrogen fixation processes (6 marks)
- c)
 - i. State three reasons why certain elements are selected for use in biological systems. (3 marks)
 - ii. Explain why Molybdenum though a rare element in the earth's crust is utilized more biologically than Chromium. (2 marks)
 - iii. Despite the high abundance of Silicon, Aluminium and Titanium on earth, these elements are not much utilized biologically. Explain. (3 marks)
- d) Discuss the main function of vitamin B₁₂ in life and what its deficiency in the body leads to. (2 marks)