



MACHAKOS UNIVERSITY

University Examinations 2020/2021 Academic Year
SCHOOL OF PURE AND APPLIED SCIENCES
DEPARTMENT OF PHYSICAL SCIENCES
FIRST YEAR SECOND SESSION EXAMINATION FOR
MASTER OF SCIENCE (CHEMISTRY)
SCH 841: ADVANCED ELECTROCHEMISTRY

DATE: 28/8/2021

TIME: 8.30-11.30 AM

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 15 marks).

SECTION A - COMPULSORY.

QUESTION ONE (30 MARKS)

- a) An electrochemical system is a useful tool for voltametric measurements. Explain;
- i. The basic components of a modern electrochemical system (3 marks)
 - ii. The working principles of;
 - I) Two-electrode system (2 marks)
 - II) Three-electrode system (3 marks)
- b) Prof. Wang'ombe who is a farmer in Machakos subcounty suspected that the water consumed by his animals was the source of their death. Explain any **two** electrochemical techniques that can be used to identify and quantify the contaminants in the water. Discuss each technique with respect to:
- i. It's working principles (8 marks)
 - ii. Analyte identification and quantification (7 marks)
- c) Explain the application of the following equations in describing electrochemical systems.
- i. Nernst equation (4 marks)
 - ii. Cottrell equation (3 marks)

SECTION B: ANSWER ANY TWO QUESTIONS

QUESTION TWO (15 MARKS)

- a) Thwake dam construction in Makueni County is a major project of the Government of Kenya. Upon its completion, it is proposed to be the major source of water for use at the Konza Technopolis. The main source of water for the dam will be Nairobi River which is suspected to be highly contaminated by heavy metals. Explain the applicability of stripping voltametric techniques in the detection and quantification of the heavy metals. Discuss the techniques in terms of;
- i. Their working principles (6 marks)
 - ii. The equations that govern the detection of the heavy metals (4 marks)
- b) Using relevant examples, explain the application of ion selective electrodes in electrochemical analysis (5 marks)

QUESTION THREE (15 MARKS)

- a) Mass transfer of analytes to the electrochemical electrode systems occurs in different modes/ways;
- i. Explain the different modes/ways of mass transfer (3 marks)
 - ii. Explain how the following equations describe the different modes of mass transfer;
 - I. Nernst – Planck equation (3 marks)
 - II. Fick's laws of diffusion (3 marks)
- b) Explain the principles of potentiometric measurements (6 marks)

QUESTION FOUR (15 MARKS)

- a) The study of electrode kinetics is very fundamental in understanding electrochemical processes. Explain the application of the following concepts and equations in the study of electrode kinetics:
- i. Over potential (3 marks)
 - ii. Butler – Volmer equation (4 marks)
 - iii. Tafel equation (4 marks)
- b) Using relevant equations, explain the concept of chemical reversibility (4 marks)

QUESTION FIVE (15 MARKS)

- a) Polarographic techniques are useful for electroanalytical analysis of reducible species. Discuss this aspect with reference to:
- i. Working principles of polarography (5 marks)
 - ii. Analyte quantification (3 marks)
- b) Explain the application of the Heyrovsky-Ikovic equation in polarography (3 marks)
- c) Explain the chemistry of metal corrosion (4 marks)