



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE

SCH 856: ANALYTICAL ELECTROCHEMICAL TECHNIQUES

DATE: Monday, 15th May 2017

TIME: 9.00 a.m. - 12.00 p.m.

INSTRUCTIONS:

Answer ALL questions

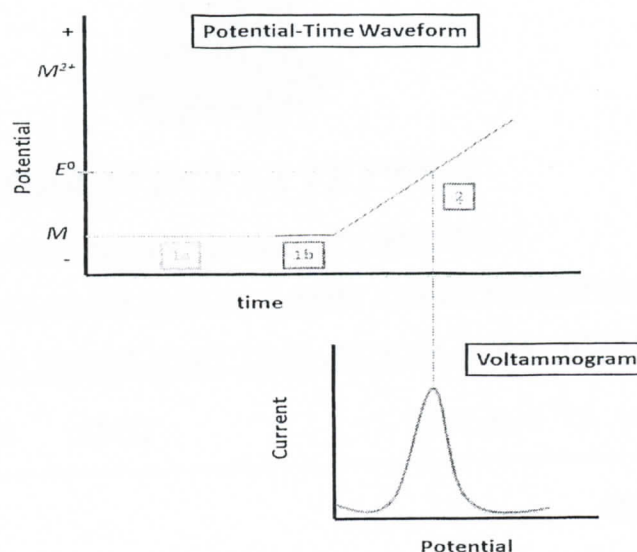
Some useful constants: 1 Faraday = 96,500 C

Question 1 (30 marks)

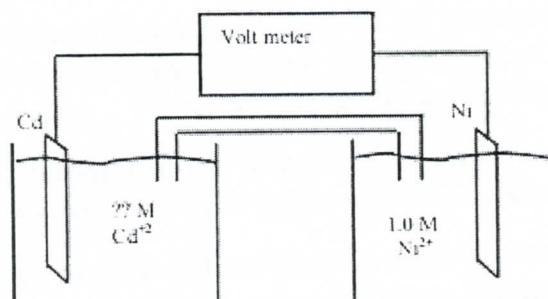
- Electrodes are prepared by surface modification to produce an electrode suited for a particular function. Discuss three ways of chemically modifying electrodes. What are the advantages of electrode modification? (9 marks)
- For a point of zero charge of 0.5V, draw the organization of the electrical double layer at a potential of this value. Assume a high value of excess surface charge. (4 marks)
- Name and describe the three primary modes of mass transport. Illustrate concentration distance profiles for Ox in the following redox reaction $\text{Ox} + e = \text{Red}$ when under steady state and non- steady state diffusion conditions. (9 marks)
- In a three electrode cell describe the functions of the electrodes, their properties and their proper configuration in an electrode cell. (8 marks)

Question 2 (24 marks)

- Let's say that you wanted to determine the heavy metal identities and concentrations in sediment and suspended solid samples obtained from Lake Nakuru. You could use Atomic Absorption Spectroscopy (AAS). However, another technique which is particularly good at detecting metals at the ppb level is anodic stripping voltammetry (ASV).
 - What are the advantages of ASV over AAS? (4 marks)
 - What is the most common type (i.e. material used) of working electrode used in ASV and what is its advantage? (4 marks)
 - The following figure depicts the potential-time waveform for an ASV experiment. Explain the parts of the figure labeled 1a and 1b. (4 marks)



- (iv) How could the experimental conditions for anodic stripping voltammetry be modified to increase the analyte signal during an analysis? (4 marks)
- b) The potential for a voltaic cell shown below is 0.240V at 25⁰ C and the standard cell potential is $E^0_{\text{cell}} = 0.170 \text{ V}$. What is the concentration of the cadmium ion solution? (4 marks)



- c) Discuss the advantages of saturated calomel electrode versus standard hydrogen electrode (SHE). (4 marks)

Question 3 (16 marks)

- a) What is surface tension and why does it change with potential? (4 marks)
- b) Design an experiment to determine the potential of zero charge (PZC) of Hg in contact with 0.1M NaCl. Provide specifics about the experiments and show what the data would look like. (6 marks)
- c) Clearly sketch and label a carbon microelectrode. (3 marks)
- d) Explain why microelectrodes are most preferred over normal electrodes. (3 marks)