CHUKA   **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF MASTER OF SCIENCE

CHEM 842: ADVANCED ELECTROANALYTICAL METHODS

STREAMS: MSC   **TIME: 3 HOURS**

DAY/DATE: WEDNESDAY 04/12/2019   **2.30 P.M. – 5.30 P.M.**
INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

QUESTION ONE (20 MARKS)

(a)   (i)   Describe with help of a suitable diagram the structure of the electrical double

layer with its several distinct parts   [3 marks]

(ii)   Explain why in an electrochemical cell, the bulk electrolyte has uniform and

constant ion densities whereas the electrical-double layer is an inhomogeneous   fluid

[3 marks]

(iii)   Write short notes on the following

(I)   Chronoamperometry   [3 marks]

(II)   Chronocounlometry   [2 marks]

(b)   (i)   Explain how electrochemical impedance spectroscopy can be validated using

Kramerkronig test   [3 marks]

(ii)   Briefly discuss the advantages and disadvantages of electrochemical impendance

spectroscopy compared to other potentiostatic methods (other transient

methods)   like chronoamperometry for extracting kinetic parameters

[3 marks]

(c)   Discuss the various primary models of imaging in atomic force microscopy (AFM)

[3 marks]

QUESTION TWO (20 MARKS)

(a)   (i)   Explain how it is possible for a scanning tunneling microscope (STM) to image atoms on the surface of a sample given that one of the metals is the sample and the other is the probe.   [3 marks]

(ii)   For a finite depth energy well, the wave function within the barrier of width the tunneling current through the barrier and the decay length are related as shown below

Where if the work function and the barrier width are and in a scanning tunneling microscope experiment then determine for a barrier of width . Comment on your answer

[3 marks]

(iii)   Below is a sketch for the principle of scanning tunneling microscope (SIM) technique. If the work function and the tunneling gap column are and , respectively, calculate the probability for an electron to tunnel from the probe tip to the metal sample.

(b)   (i)   For the reaction in an electrochemical cell, the cyclic voltammetry

method provided the formal potential (standard potential) against a

reference electrode if the activity ratio is then

Calculate

    (I)   The applied potential at 25°C   [2 marks]

    (II)   The required energy for the reaction to proceed to the right as written

[2 marks]

    (ii)   A steel tank is hot dipped in a deaerated acid solution of

molarity zinc chloride ($zncl_2$) so that a 0.5 mm zinc coating is deposited on the

steel surface. This process produced a galvanized steel tank. Calculate the time it

takes for the zinc coating to corrode completely at a Data

Where   [2 marks]

    (iii)   Discuss the significant differences between the overpotential and the ohmic

potential .   [2 marks]

(c)   (i)   It is known that the standard electrode potential for pure crystalline zinc is

- 0.763V. Explain whether or not this value will change by cold working and

impurities   [2 marks]

QUESTION THREE (20 MARKS)

(a)   (i)   Explain briefly how Uv/vis absorption spectroscopy can be used in forensic

application for the determination of blood alcohol using the breathalyzer

test   [2 marks]

(ii) (I) Describe how iron in water and waste water can be determined using

phenanthroline reagent [2 marks]

(II) Explain why strong oxidizing agents are interferents, and why an excess

of hydroxylamine prevents interference [2 marks]

(III) The color of the complex is stable between pH levels 3 to 9. What are

some possible complications at more acidic of more basic [2 marks]

(IV) Cadmium is an interferent because if forms a precipitate with　　What

effect would the formation of precipitate have on the determination of

iron? [2 marks]

(V) Even high quality ammonium acetate contains a significant amount of

iron. Why is this source of iron not a problem [2 marks]

(b) (i) Describe principle of an application of the bipotentiostat to an experiment with a

rotating ring-disk electrode [2 marks]

(ii) Explain how electrodes are modified [1 mark]

(iii) Give a brief explanation why electrodes should be modified [1 mark]

(c) (i) Outline the advantages of combining of FT-IR spectroscopy with

electrochemistry

[1 mark]

(ii) Explain how electrochemical methods can be used for mitigation of CO_2 inorder

to reduce climate change being contributed by continuously increasing the

amount of CO_2 from fossil fuels in the atmosphere

[1 mark]

(iii) Explain why electrochemistry coupled offline of online with mass spectrometry

can be considered as an alternative to study oxidation production of the

emerging organic contaminants [1 mark]