

**W1-2-60-1-6**

**JOMO KENYATTA UNIVERSITY**

**OF**

**AGRICULTURE AND TECHNOLOGY**

**UNIVERSITY EXAMINATIONS 2015/2016**

**FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE IN CHEMISTRY**

**SCH 3132: ADVANCED ELECTROCHEMISTRY**

**DATE: DECEMBER 2015 TIME: 3 HOURS**

**INSTRUCTIONS:**

**QUESTION ONE**

1. i) Define the term Biosensor? [2 marks]

ii) Distinguish between Catalytic and Affinity biosensors?

In the case for Catalytic biosensors give THREE examples

of biocatalysts used and in the case of Affinity biosensors

give THREE examples of receptor molecules used. [6 marks]

iii) State the FOUR desired attributes of a good or ideal biosensor? [2 marks]

1. Starting with the electron transfer reaction

O + ne- Vf

==== R

Vb

Where O is the oxidized species and R is the reduced species, and

Vf is the rate of forward reaction and Vb the rate of reversed reactions.

Derive the Butler volume equation. [10 marks]

1. For the discharge of hydrogen ions from dilute sulphuric acid at a platinum electrode at 298K, the following current densities were observed for the

range of cathodic over voltages indicated.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| mV | 20 | 50 | 70 | 100 | 120 | 150 | 200 | 250 |
| I (mA cm-2) | 0.57 | 1.40 | 2.05 | 3.36 | 4.56 | 7.16 | 15.05 | 31.55 |

From the appropriate Tafel plot, calculate the transfer coefficient, 

and the exchange current density, I0 [10 marks]

**QUESTION TWO**

1. Define the term Electrical double layer. [2 marks]
2. Draw clearly the structure of the electrical double layer showing

the distinct parts. Name and describe the distinct parts of the

electrical double layer. [8 marks]

1. i) Plot Tafel plot for the cathodic and anodic branches of the

current over voltage curve. [4 marks]

ii) If the Tafel constants, a and b, have the values 1.54V and 0.119V respectively for the reaction of hydrogen ions at a lead cathode,

calculate the values of the transfer coefficient  and the

exchange current density. [4 marks]

**QUESTION THREE**

1. Distinguish between Faradaic and Non-faradaic currents. [5 marks]
2. The following mean currents for the applied potentials indicated,

were obtained for a reversible, diffusion-controlled reduction of

a metal ion Mn+ to metal M at a dropping mercury electrode at 298 K

(all mean current values have been corrected for the appropriate

residual current in the present of excess KCl at 298K.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E (V)vs S.C.E. | 0.97 | 0.98 | 0.99 | 1.01 | 1.02 | 1.03 | 1.04 | 1.05 |
| i (A | 2.134 | 4.255 | 7.718 | 17.100 | 20.644 | 22.831 | 25.000 | 25.000 |

By means of an appropriate graph, determine the half-wave potential (E ½ )

and the number of electrons (n) transferred per metal ion during the reduction process.

Given that the concentration of Mn+ was 2.98 x 10-3 mol dm-3, that the

rate of flow of mercury (n) was 3.299 mgs-1 and the drop time (t) was 2.47s, estimate the value of the diffusion coefficient(s) of the hydrated Mn+

cation.

[15 marks]

**QUESTION FOUR**

1. Calculate the emf of the following cell

Zn(s) | Zn2+ || Cu2+ |Cu(s)

 = 0.76V and  = 0.34V [3 marks]

1. What is the functions of
2. A glavanostat [1 mark]
3. A potentiostat [1 mark]
4. A solution containing 50mg of copper was electrolyzed at a constant

current of 0.250A causing metallic copper to deposit on a plantinum

electrode. What was the percentage of copper remaining in the

solution after 10 mins.? [5 marks]

1. i) Define Electrocapillarity? [2 marks]

ii) Write the first and second differential equation obtained

from the electrocapillary curve and state their importance. [3 marks]

iii) Distinguish between chronoamperometry and chronocolometry. [2 marks]

e) i) Plot an electrocapillary curve of parabolic shape that

corresponds to a linear change of the charge with the potential

and show its maximum point. What does the maximum point

correspond to? [2 marks]

ii) What is the major cause of deviation in parabolic behaviour

observed in e (i) [1 mark]