



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PURE & APPLIED SCIENCES
JUNE 2020 EXAMINATION QUESTION

CHM409: ELECTROCHEMISTRY

CREDIT: 2

TIME: 2 HOURS

INSTRUCTION: ANSWER QUESTION ONE & ANY OTHER THREE QUESTIONS.

QUESTION 1

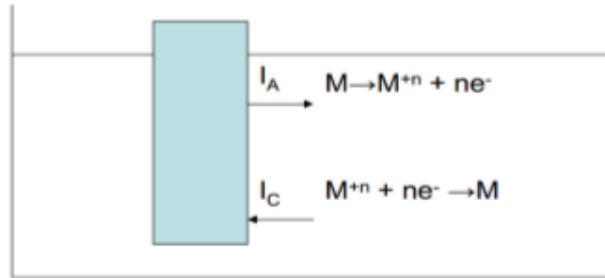
- 1.(a) In every electrochemical system, it is required that there should be an anode and a cathode. If a piece of iron metal is immersed in a solution of HCl, do you expect to have the anode and the cathode in that system? Give reasons for your answer. (3 marks)
- (b) How is an electrical double layer formed and under what condition can the double layer be regarded as a capacitor (2 marks)
- (c) State four factors that affect the electric double layer structure and its capacity (5 marks)
- (d) What can the composition of an electric double layer influence in an electrochemical cell? (2 mark)
- (e) How can a surface of an electrode be charged? (2 marks)
- (f) At what location does Faradic and non-Faradic electron transfer occurs in an electrochemical cell (2 marks)
- (g) State two factors that are responsible for differences in ionic concentration in the bulk electrolyte (2 marks)
- (h) Where does mass transport occurs in an electrochemical cell? (2 mark)
- (i) Highlight three different zones around an electrode in a cell (3 marks)
- (j) Use Cu and CuSO₄ to explain the structure of electric double layer (2 marks)

QUESTION 2

- 2 (a)
- (i) What are the component that makes up an electrochemical cell? (2 mark)
- (ii) How does current flow in an electrochemical cell ? (2mark)
- (iii) What is the direction of movement of ions in an electrochemical cell? (1.5 mark)
- (iv) What is the relationship between the direction of electron and ion movement ? (1.5 mark)
- (v) How is half cells connected to each other in an electrochemical cell? (2 marks)
- (b) Differentiate between Guoy Chapman and Stern models of electric double layer (3 marks)
- (c) Write short note on specifically adsorbed ion (2 marks)
- (d) State two industrial application of electrochemistry (1 mark)

QUESTION 3

3.(a) Consider the following single cell presented in the diagram below and answer the question that follows,



- (i) If the equilibrium cell reaction is $Mn^{n+} = Mn + ne^-$ and the cathodic and anodic current are as indicated in the Figure above, define exchange current density and write an expression (in terms of current for the exchange current density) (3 marks)
- (ii) Explain what will happen to the equilibrium if current is pumped into the cell considering the direction of the reaction, the electrode potential, dominant current and plot of electrode potential versus current (Use appropriate equation to support your answer) (6 marks)
- (iii) Explain what will happen to the equilibrium if current is pumped out (i.e removed) from the cell considering the direction of the reaction, the electrode potential, dominant current and plot of electrode potential versus current (Use appropriate equation to support your answer) (6 marks)

QUESTION 4

4.(a) If the concentration of the cations vary from near the surface concentration (C_S) to the bulk concentration (C_B) across the cathode over a distance (δ), derive equation for the following.

- (i) Concentration gradient (3 marks)
- (ii) Current density, J (3 marks)
- (iii) Limiting current (4 marks)
- (iv) Activation overpotential (4 marks)

Based on the above derivation, explain what would happen if (i) $I_C > I_L$ (1 marks)

QUESTION 5

- 5.(a) Define the term flux and write an expression to support your answer (3 marks)
- (ii) What is the fundamental requirement for transportation (2 mark)
- (b) In the absence of turbulence, highlight the three major mechanism ions can be transported from the solution to the electrode (3 marks)
- (c) Write an expression for the rate of transfer in the y direction per unit area perpendicular to y at any point in the fluid (3 marks)
- (d) Write short note on ion transport with respect to movement of positive and negative ions (3 marks)
- (e) What is transport number (1 mark)