40

MASINDE MULIRO UNIVERSITY OFSCIENCE AND TECHNOLOGY

(MMUST)

Main CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

Semester I

THIRD YEAR SUPPLIMENTARY AND SPECIAL EXAMINATION

(BSC Chemistry)

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN CHEMISTRY

COURSE CODE: SCI 360

COURSE TITLE: Industrial Electrochemistry

DATE: 28/07/2022 **TIME:** 11.00 am – 1.00 pm

INSTRUCTIONS TO CANDIDATES

Answer all the Questions

Find the attached periodic table

TIME: 2 HOURS

Question One (15 marks)

1. a) Define the following terms:

    (i)   An electrochemical cell   (2 Marks)

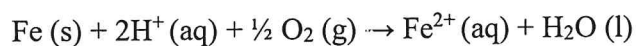   (ii)   Electrolyte   (2 Marks)

    (iii)   Electrode   (2 Marks)
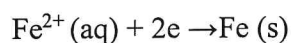
    b) Explain the difference between a galvanic cell and an electrolytic cell

(4 Marks)

    c) Define Standard Reduction Potential (**E**)   (4 Marks)

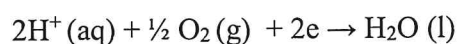   d) One of the reactions important in corrosion in an acid environment is

$$Fe \text{ (s)} + 2H^+ \text{ (aq)} + \tfrac{1}{2} O_2 \text{ (g)} \rightarrow Fe^{2+} \text{ (aq)} + H_2O \text{ (l)}$$

Culculate the equilibrium constant and state wheather it favor the formation of Fe^{2+} (aq)?
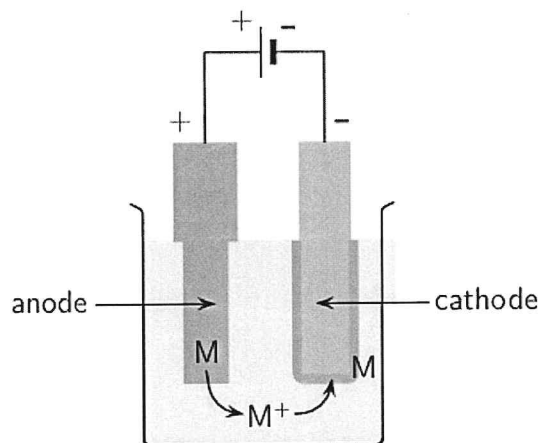**Show your working given** that;

$$Fe^{2+} \text{ (aq)} + 2e \rightarrow Fe \text{ (s)} \qquad\qquad E = -0.44V$$
$$2H^+ \text{ (aq)} + \tfrac{1}{2} O_2 \text{ (g)} + 2e \rightarrow H_2O \text{ (l)} \qquad E = +1.23V \qquad \text{(5 Marks)}$$

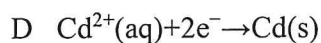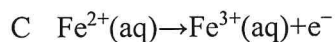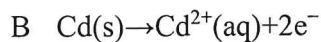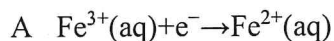## Question two (20 marks)

2. (a) During electroplating, metal atoms at the solid metal anode are oxidised, and move into solution. The metal ions in solution are reduced at the cathode, forming a thin layer of solid metal. Use the diagram to answer the following questions.   (4 marks)

(i) Which **one** of the equations below represents the half-reaction occurring at the **cathode** of an electrolytic cell that is used to electroplate an object?. Explain your choice of the answer. (4 marks)

A $Fe^{3+}(aq)+e^-\rightarrow Fe^{2+}(aq)$

B $Cd(s)\rightarrow Cd^{2+}(aq)+2e^-$

C $Fe^{2+}(aq)\rightarrow Fe^{3+}(aq)+e^-$

D $Cd^{2+}(aq)+2e^-\rightarrow Cd(s)$

(b) Explain each of the equations in (i) above in regard to the electrolysis process shown by the diagram. (8 marks)

(c). Complete the table comparing galvanic and electrolytic cells below. Use the properties in column one to complete the table (8 marls)

Properties	Galvanic cell	Electrolytic cell
Chemical reactions		
Energy changes		
Anode		
Cathode		
Cell set-up		
Electrolyte solution(s)		
Applications		

Question Three (17 marks)

4 (a). In the electrochemical cell below, carbon electrodes are used during the electrolysis of a concentrated salt-water solution.

Gas X | Gas Y

conc. NaCl(aq)

Electrode **P**   Electrode **Q**
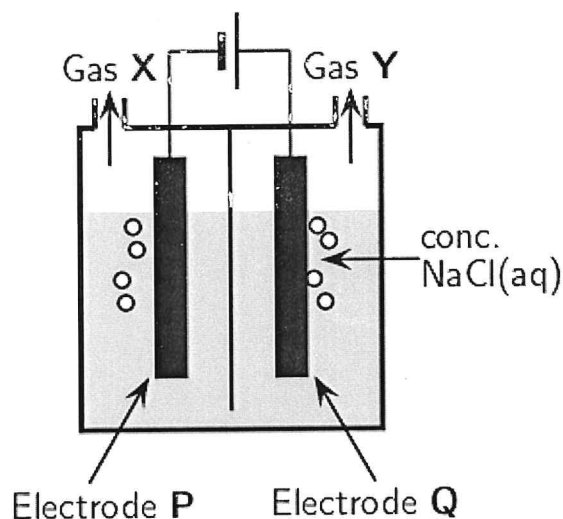
The balanced equation for the net (overall) cell reaction is:

$$2H_2O(\ell) + 2Cl^-(aq) \rightarrow Cl_2(g) + H_2(g) + 2OH^-(aq)$$
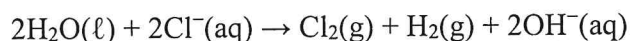
Study the above cell and reaction and then answer the questions which follow.

Use the above information to answer the following questions.

i.   What is the energy conversion that takes place in the electrochemical cell? Is it electrical to chemical or chemical to electrical?   (2 marks)

ii.   At which electrode, P or Q, does oxidation occur? Give a reason for your answer.

     (5 marks)

iii.   Give the name of Gas Y.   (2 marks)

iv.   Give the formula of Gas X   (2 marks)

v.   Give the half-reaction that takes place at the anode.   (3 marks)

vi.   Does the pH of the solution in the cell increase or decrease during the course of the reaction? Give a reason for your answer.   (3 marks)

Question Four (18 Marks)

4. a) The resistance of a sample (electrolyte) increases with the length L, and decreases with its cross-sectional area A, We can therefore write;

     $R = \rho L/A$ where; ρ is the constant of proportionality

                         R is the resistance

i.   What is the constant of proportionality ρ, called?   (2 Mark)

ii.   Define conductivity in relation to the constant (ρ) in (i) above, as used in measurement of conductivity of electrolyte solutions.   (2 Marks)

iii.   What are the units of conductivity as defined in (ii) above   (2 Mark)

iv. If conductivity mentioned in (ii) and (iii) above is designated k;

Derive the equation;   (5 Marks)

$k = L/RA$ where;   k; is the conductivity or specific conductance

R; is the resistance

L; is the length

A; is the cross sectional area

b) Explain what you understand by Molar conductivity and then define Molar conductivity.
(3 Marks)

c) Explain the meaning of "limiting equivalent conductance".   (3 Marks)

------------------------------------70 Marks------------------------------------