70

RAJARATA UNIVERSITY OF SRI LANKA

FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Third Year Semester II Examination- September/November 2014

CHE 3207- ELECTROCHEMISTRY

Answer **ALL** questions   Time: **Two** Hours

Use of a non-programmable calculator is permitted

1.

(a) Given below is a scheme of reactions pertaining to corrosion of metallic Ni in an aerated aqueous solution.

1. $Ni^{2+} + 2\,e^- \rightarrow Ni$
2. $NiO + 2\,H^+ + 2\,e^- \rightarrow Ni + H_2O$
3. $Ni^{2+} + 2\,H_2O \rightarrow Ni(OH)_2 + 2\,H^+$
4. $NiO + H_2O \rightarrow Ni(OH)_2$
5. $2H^+ + 2\,e^- \rightarrow H_2$
6. $O_2 + 4\,H^+ + 4\,e^- \rightarrow 2\,H_2O$
7. $O_2 + 2\,H_2O + 4\,e^- \rightarrow 4\,OH^-$
8. $2\,H_2O + 2\,e^- \rightarrow H_2 + 2\,OH^-$

   i.   Identify each reaction as pH and potential dependent or independent

   ii.   Calculate the standard redox potential (E^0) of Ni^{2+}/Ni and obtain an equation for the relation between potential (E) and concentration of Ni^{2+} ions.

   iii. Starting from the Nernst equation, show that the potential corresponding to eq. 3 is given by

$$E_{ox/red} = 0.11 - 0.059\ pH$$

   Chemical potential (μ^θ) values are as follows. $F = 96500\ C\ mol^{-1}$

substance	μ^θ/ J mol^{-1}
Ni	0
Ni^{2+}	46398
H_2O	-23694
$Ni(OH)_2$	-452694
H^+	0

   iv.   Draw potential – pH diagram for the dissolution of Ni indicating the potential (calculated in parts ii and iii) at pH = 0 for equations 1, 3 and 5. Starting pH of the diagram should be zero.

(b) Draw a fully labeled polarization diagram (E vs. log i) indicating I $_{corr}$ and E $_{corr}$ for the corrosion of iron in a deaerated solution at pH 5.

2.

    (a) Distinguish the following, encountered in voltammetry
       i.   Faradaic and non Faradaic charge transfer
       ii. Ideally polarized and non polarized electrode

    (b) Explain the term "cathodic over potential"

    (c) Polarography is a highly elegant technique invented by Jaroslav Heyrovsky for which
       he received the Nobel Prize in 1959.
       i   What is the unique feature of polarography which separates it from other
          electroanalytical techniques?
       ii Sketch a polarogram and label two important details of the polarographic wave
          on your diagram.

3.

    (a) By writing the equations for the two chemical half reactions explain how the lead-
       acid accumulator works.

    (a) Explain the following characteristics of battery:
       (i) cell potential (ii) energy efficiency & (iii) capacity.

    (b) What is fuel cell? Write the difference between conventional cell and fuel cell and
       mention the advantages of fuel cell.
    (c) Discuss the construction and working principle of hydrogen-oxygen fuel cell and
       enzymatic bio fuel cell. Comment on the advantages and disadvantages associated?

4.   Describe an electrochemical cell with the appropriate reactions involved in the
      treatment of water contaminated by fluoride and Calcium. Comment on the
      advantages and disadvantages over a conventional treatment method based on
      adsorption or ion-exchange phenomenon.