

UNIVERSITY OF RUHUNA
FACULTY OF FISHERIES AND MARINE SCIENCES & TECHNOLOGY
Academic Year 2023/2024

Bachelor of Science Honours in Fisheries and Marine Sciences Degree/ Bachelor of Science
Honours in Marine and Freshwater Sciences Degree

Level II Semester I Examination – October/November 2024

CHM 2111: Analytical Chemistry II

Part II- Essay- Answer one question only. (55 marks)

I) Answer all parts

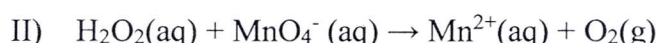
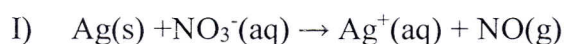
a)

I) What is meant by a redox reaction?

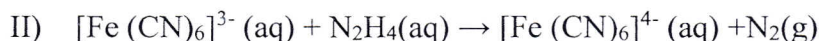
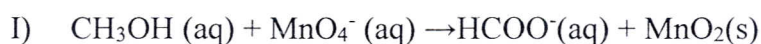
(04 marks)

II) Write the balanced equations for the following reactions under the given conditions A and B.
(Clearly indicate the half-reactions and net chemical reactions at each step)

A. Acidic medium



B. Basic medium



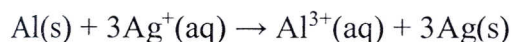
(16 marks)

b)

I) State the relationship between standard cell potential and standard Gibbs free energy.

(02 marks)

II) Determine the standard cell potential and standard Gibbs free energy for the following reaction.

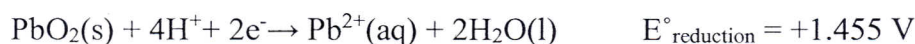
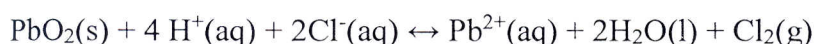


(08 marks)

III) Giving reasons, predict whether the above reaction is spontaneous or not.

(02 marks)

IV) Determine the K_{eq} for the following reaction at 25 °C.



(08 marks)

c)

- I) Briefly state what chromatography is.
- II) State the five types of chromatography according to the force of separation.
- III) What is normal phase and reverse phase chromatography? Briefly explain.

2) Answer all parts

a)

- I) Define the following common terms used in chromatography

- A. Analyte
- B. Chromatogram
- C. Effluent
- D. Retention time

- II) Distinguish between analytical chromatography and preparative chromatography.

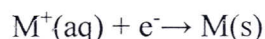
b)

- I) Starting from the relationship between Gibb's free energy (ΔG , ΔG°) and the reaction quotient (Q), derive the Nernst equation at room temperature (25 °C):

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0592}{n} \log Q$$

- II) The cell potential and the standard cell potential of a cell in the following reaction are 5 V and 5.06 V, respectively at room temperature, $\text{Ni(s)} + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Ni}^{2+}(\text{aq}) + 2\text{Ag(s)}$. Calculate the concentration of Ag^+ ions. (concentration of $\text{Ni}^{2+}(\text{aq})$ is 0.02M)

- III) From the following observations estimate the (range) E° for the following reaction.



Observations

- A. The metal M reacts with $\text{H}_2\text{SO}_4(\text{aq})$; but not with $\text{HI}(\text{aq})$; M displaces $\text{Au}^+(\text{aq})$, but not $\text{Fe}^{3+}(\text{aq})$.
- B. The metal M reacts with $\text{HI}(\text{aq})$, producing $\text{H}_2(\text{g})$, but displaces neither $\text{Al}^{3+}(\text{aq})$ nor $\text{Na}^+(\text{aq})$.

$$E^\circ \quad \text{SO}_4^{2-}(\text{aq})/\text{SO}_2(\text{g}) = 0.17 \text{ V}$$

$$E^\circ \quad \text{H}^+(\text{aq})/\text{H}_2(\text{g}) = 0 \text{ V}$$

$$E^\circ \quad \text{Au}^+(\text{aq})/\text{Au}(\text{s}) = 1.68 \text{ V}$$

$$(04 \text{ marks}) \quad E^\circ \quad \text{Fe}^{3+}(\text{aq})/\text{Fe}^{2+}(\text{s}) = 0.769 \text{ V}$$

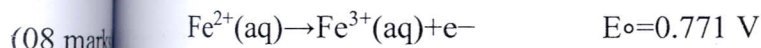
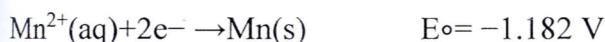
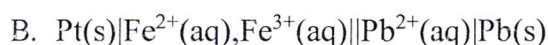
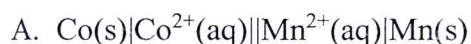
$$E^\circ \quad \text{Al}^{3+}(\text{aq})/\text{Al}(\text{s}) = -1.676 \text{ V}$$

$$(05 \text{ marks}) \quad E^\circ \quad \text{Na}^+(\text{aq})/\text{Na}(\text{s}) = -2.7144$$

(06 marks)

(10 marks)

IV) Write cell reactions for the electrochemical cells **A** and **B**, and calculate E°_{cell} for each reaction.

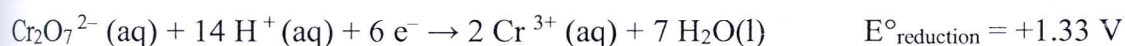
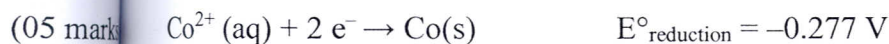
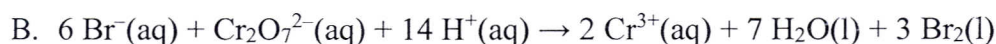
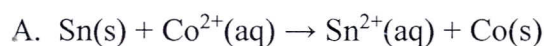


(02 marks)

(10 marks)

c)

I) Predict whether a spontaneous reaction will occur in the forward direction in the following reactions. Assume that all reactants and products are in their standard states.



(10 marks)

II) State the functions of the salt bridge in an electrochemical cell

(05 marks)

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