NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

PHYSICAL CHEMISTRY II

SCH 2204

Second Semester Examination Paper

May 2016

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Dr. S. Majoni

INSTRUCTIONS

1. Answer ALL questions in section A and any three (3) questions in section B
2. Each question in section A carries 10 marks and in section B carries 20 marks

MARK ALLOCATION

QUESTION	MARKS
A1.	**10**
A2.	**10**
A3.	**10**
A4.	**10**
B1	**20**
B2	**20**
B3	**20**
B4	**20**
TOTAL POSSIBLE MARKS	**100**

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SECTION A

1) The following data were collected for the rate of disappearance of NO and O_2 in the reaction: $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

Exp. No	[NO] molL^{-1}	[O_2] molL^{-1}	Initial rate (molL^{-1} s^{-1})
1	0.0126	0.125	1.41 x 10^{-2}
2	0.0252	0.250	1.13 x 10^{-1}
3	0.0252	0.125	5.64 x 10^{-2}

Determine the rate law for the reaction. [10 marks]

2) a) By means of an example, explain what is meant by the term reaction intermediate. [3 marks]

b) Methyl acetate is hydrolyzed in solution according to the following equation

$$CH_3COOCH_3 + H_2O \xrightarrow{H^+} CH_3OH + CH_3COOH$$

Given that the rate constant for the reaction at 25^{0}C is $1.26\times10^{-4}\,s^{-1}$

i) What is the order of the reaction. [1 mark]

ii) What is the half-life of the reaction and how long will it take for 65% of the methyl acetate to react? [6 marks]

3) a) The concentration of NaCl in a solution that also contains $Cu(NO_3)_2$ is 0.0083 *m*, if the ionic strength of the solution is 0.015*m*, what are the concentrations of copper and nitrate ions? [5 marks]

b) If a reaction has a rate constant of 2.40×10^{-3} sec^{-1} at 273 K and 2.65×10^{-3} sec^{-1} at 298 K, what is the activation energy of the reaction? [5 marks]

4) a) With the aid of examples, explain the difference between a weak and a strong electrolyte. [4 marks]

b) A standard solution of KCl with a conductivity of $1.063\times10^{-6}\,Sm^{-1}$ at 298 K was used to calibrate a conductivity cell and a resistance of 4.22 Ω was measured. The same cell was filled with a solution of HCl, and a resistance of 1.033 Ω was measured. Calculate the conductivity of the HCl solution. [6 marks]

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SECTION B

1) The data below shows the molar conductivities of sodium acetate as a function of concentration in aqueous solution at 298 K. From the data, is sodium acetate a strong or weak electrolyte and what is the value of Λ_m° ? [20 marks]

Concentration (M)	Λ_m (S m^2 mol^{-1})
0.0005	0.00892
0.001	0.00885
0.005	0.00857
0.01	0.00838
0.02	0.00812
0.05	0.00769

2) The composition of a liquid-phase reaction, 2A→B, was followed by a spectrophotometric method with the following results.

t (min)	*[B]* (mol/L)
0	0
10	0.089
20	0.153
30	0.200
40	0.230

a) What are the conditions required for a reaction to be monitored by spectrophotometric methods. [2 marks]

b) Determine the order of the reaction and the rate constant, thus write the rate law in the form of $rate = k[A]^n$. [18 marks]

3) a) Discuss the importance of the wave particle duality in quantum chemistry [4 marks]

b) What do you understand by the term quantization of energy? Explain how the principle of quantization of energy forms the basis of spectrometry.[4 marks]

c) For the electrochemical cell represented as:

$$Pt(s)\,|\,H_2(g, f = 1.00bar)\,|\,HCl(\text{aq, m})\,|\,AgCl(s)\,|\,Ag(s)$$

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(i) Write down the half-cell reactions in the cell above. [3 marks]

(ii) How does the value of the cell potential vary as HCl concentration is varied from 0.01 *m*, to 0.001 *m,* to 0.01 *m?* [9 marks]

4) Enzyme catalyzed reactions can be represented as $E + S \underset{-k_1}{\overset{k_1}{\rightleftarrows}} ES \xrightarrow{k_2} P + E$

d) An enzyme is a homogenous catalyst. Explain what is a homogeneous catalyst and, using a potential energy diagram, describe how a catalyst increases the rate of a chemical reaction. [6 marks]

e) Identify indermediate(s) and the catalyst in the above equation and, using steady state approximation, show that the rate equation, rate = $\left(\frac{k_2 k_1 [S][E]}{k_{-1} + k_2} \right)$ can be obtained by using either the reactant or the product. [14 marks]

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