NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

PHYSICAL CHEMISTRY II FOR SCH & TTE

SCH2204

Supplementary Examination Paper

August 2015

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Dr. Stephen Majoni

INSTRUCTIONS

1. Answer ALL questions.
2. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
TOTAL	100

1. (a) The resistance of 0.01M NaCl solution at 25^0C is 200 Ohm. The cell constant of the conductivity cell is unity. Calculate the molar conductivity of the solution.

[5 marks]

(b) The limiting molar conductivities of NaCl, HCl, and C_2H_5COONa are 126.45, 426.16 and 91 S cm^2 mol^{-1} respectively. Calculate the limiting molar conductivity of C_2H_5COOH. [5 marks]

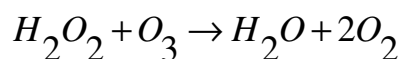(c) $Cr_2O_7^{2-}(aq) + 14H_3O^+(aq) + 6I^-(aq) \rightarrow 2Cr^{3+}(aq) + 3I_2(s) + 21H_2O(l)$
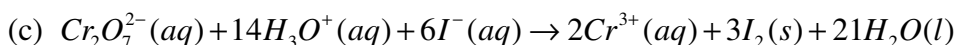
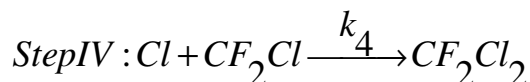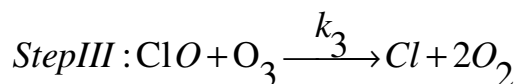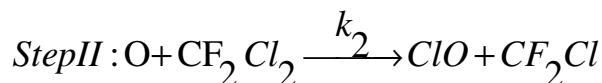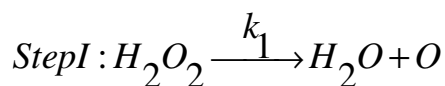The above equation represents an overall reaction for a galvanic cell.

i) Draw a line diagram for the cell and calculate the standard cell potential.

ii) At pH 0, with $[Cr_2O_7^{2-}] = 1.5$ M and $[I^-] = 0.40$ M, the cell potential is 0.87 V. Calculate the concentration of Cr^{3+}(aq) in the cell. [15 marks]

2. H_2O_2 reacts with ozone in the presence of CFCs according to the following equation:

$$H_2O_2 + O_3 \rightarrow H_2O + 2O_2$$

The following reaction mechanism has been proposed:

$$StepI: H_2O_2 \xrightarrow{k_1} H_2O + O$$
$$StepII: O + CF_2Cl_2 \xrightarrow{k_2} ClO + CF_2Cl$$
$$StepIII: ClO + O_3 \xrightarrow{k_3} Cl + 2O_2$$
$$StepIV: Cl + CF_2Cl \xrightarrow{k_4} CF_2Cl_2$$

a) With good reasoning, identify the role of the CFCs in the reaction. [5 marks]

b) Apply steady state approximation to the intermediates and give expressions for their concentrations [20 marks]

3. (a) A plot of $\ln k$ vs $\frac{1}{T}$ for a certain chemical reaction yielded a straight line with the following equation $y = -6.2 \times 10^3 x + 13.85$

Find the activation energy for the reaction [5 marks]

(b) If the activation energy for a reaction is 268 kJ mol^{-1} and the rate constant at 660 K is $8.1 \times 10^{-3} s^{-1}$ what will be the rate constant at 690 K? [8 marks]
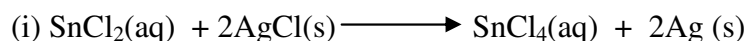
(c) The decomposition of A to produce B can be written as $A \rightarrow B$.

When the initial concentration of A is 0.012 M, the rate is 0.0018M min^{-1} and when the initial concentration of A is 0.024 M, the rate is 0.0036M min^{-1}. What is the rate law for the reaction? [6 marks]

(d) Cyclopropane, C_3H_6, is converted to its isomer propylene, when heated. The rate law is first order in cyclopropane with a rate constant of $6.0 \times 10^{-4} s^{-1}$ at 500°C. If the initial concentration of cyclopropane is 0.0226 M, what is the concentration after 899 s? [6 marks]

4. (a) Giving examples, discuss the applications of Kohlrausch's law of independent migration of ions. [10 marks]

(b) Using electrode potentials, calculate the equilibrium constants for the following reactions at 25°C.

(i) SnCl$_2$(aq) + 2AgCl(s) $\longrightarrow$ SnCl$_4$(aq) + 2Ag (s)

(ii) Hg(l) + Cu(NO$_3$)$_2$(aq) $\longrightarrow$ Cu(s) + Hg(NO$_3$)$_2$(aq) [6 marks]

(c) Derive the linearized form of the Langmuir's adsorption isotherm. [9 marks]

Useful Information

Reaction	E°/volts
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	1.36
$Cu^{2+} + 2e^- \rightleftharpoons Cu(s)$	0.339
$I_2(aq) + 2e^- \rightleftharpoons T\ 2I^-$	0.620
$Hg^{2+}(aq) + 2e^- \rightleftharpoons Hg(l)$	0.852
$AgCl(s) + e^- \rightleftharpoons Ag(s) + Cl^-$	0.222
$Ag^+ + e^- \rightleftharpoons Ag(s)$	0.799
$Sn^{2+} + 2e^- \rightleftharpoons Sn(s)$	–0141
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	0.139
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	–0.236
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.0000

End of Question Paper!!!