Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 Level First Semester Examination – Sep/Oct 2015
SCT 331-3 Material Chemistry I

Uva Wellassa University

Instructions to candidates
Duration: Three (03) hours
Number of questions: Six (06)
Answer All Questions
Mark allocation: 100 mark

1. a. List three experiments that can be used to measure rates of reaction. Briefly explain each using appropriate diagrams where necessary. (03 mark)

b. The varaiation in the partial pressure of azoethane with time was followed at 600 K is given below. Assume blow reaction as an elementary reaction.

$$C_2H_5N_2C_2H_5(g) \rightarrow C_2H_5\text{-}C_2H_5(g) + N_2(g)$$

t/s	0	1000	2000	3000	4000
P/Pa	10.9	7.63	5.32	3.71	2.59

i. Write the rate expression for the above reaction. (01 mark)
ii. Derive the integrated rate law for the above reaction. (03 mark)
iii. Rearrange the integrated rate law in the format , y=mx + c and identify x and y axis. (02 mark)
iv. Plot the graph according to the equation in 1.b.iii, and calculate the rate constant of the reaction. (05 mark)
v. Calculate half life of this reaction. (02 mark)
vi. If the reaction is stopped after consumption of 90% of the starting material, calculate the time taken up to 90% conversion of starting material. (04 mark)

2. a. Explain main diffrences between stepwise polymerization versus chain polymerization. (05 mark)

b. In an alternative method, Nylone 66 can be synthesized by self polymerization as shown below.

$$H_2N\text{-}(CH_2)_5\text{-}COOH + H_2N\text{-}(CH_2)_5\text{-}COOH \rightarrow \text{-}HN\text{-}[(CH_2)_5\text{-}COO\text{-}NH]_n\text{-}(CH_2)_5\text{-}COO\text{-}$$

i. Write the rate expression for the above reaction. (02 mark)
ii. Show that $[A] = [A]_o / (1 + kt[A]_o)$
where [A] = concentration of monomers at time t = t, $[A]_o$ is the concentration of monomers at time t = 0. (03 mark)

31

iii. The average number of monomer units in a polymer is given by <n>,where

$<n> = [A]/[A]_o$.

Calculate the average number of monomer units after one hour of reaction, where the rate constant is 5.0×10^{-3} $mol^{-1}dm^3s^{-1}$ and the initial monomer concentration is 1.0 $moldm^{-3}$.

(05 mark)

3. Consider following redox reaction taking place during silver metal coating on metal jewellary.

$$Cu\ (s) + 2\ Ag^{2+}\ (aq) \rightleftharpoons Cu^{2+}(aq) + 2\ Ag(s)$$

a. Write the cell in standard notation. (02 mark)

b. Write oxidation and reduction half reactions. (03 mark)

c. Using Nernst equation, show that equilibrium constant for the above reaction(Keq) is given by the following eqation. Show steps clearly when deriving this expression.

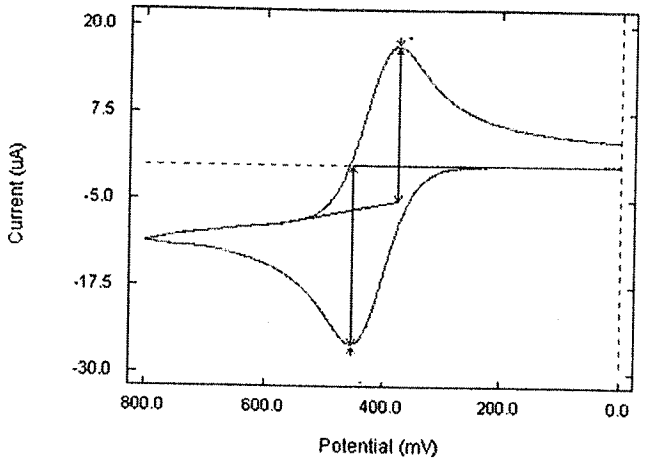
$\log K_{eq} = 2\ (E^{o}_{Ag+/Ag} - E^{o}_{Cu2+/Cu})/0.0592$ (04 mark)

d. Calculate the equilibrium constant using standard electrode potentiols given below.

$E^{o}_{Ag+/Ag} = 0.799$ V, $E^{o}_{Cu2+/Cu} = 0.337$ V (03 mark)

e. Is forward reaction, $Cu\ (s) + 2\ Ag^{2+}\ (aq) \rightarrow Cu^{2+}(aq) + 2\ Ag(s)$ spontaneouse or not? Show calculations. (03 mark)

4. a. Cyclic voltammetry is a technique frequently used to monitor redox processes in a given species. A typical cyclic voltammagram is illustrated below.

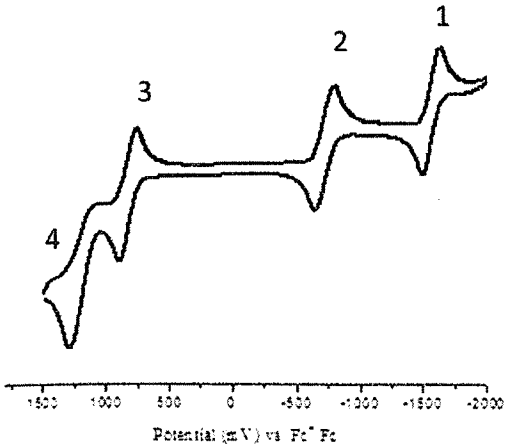


i. Copy above diaram to your answer book and mark E_{pa}, E_{pc}, I_{pa}, I_{pc}, oxidation wave, and reduction wave. (03 mark)

ii. What are the three electrodes used in cyclic voltammetry? (03 mark)

iii. Give conditions to be satisfied in order to confirm reversibility of a redox process. (04 mark)

b. In molecular based memory devices, oxidation states of a molecule can be used to store memory. Following is a cyclic voltammagram of a species with potentiol to be used as a molecular memory device.



Peak	$E_{1/2}$ (mV)	Ep_c-Ep_a (mV)	Ip_c/Ip_a
Fc^+/Fc	503	-142	0.993
1	-1559	-137	0.979
2	-708	-133	0.998
3	833	-138	0.926
4	1181	-249	

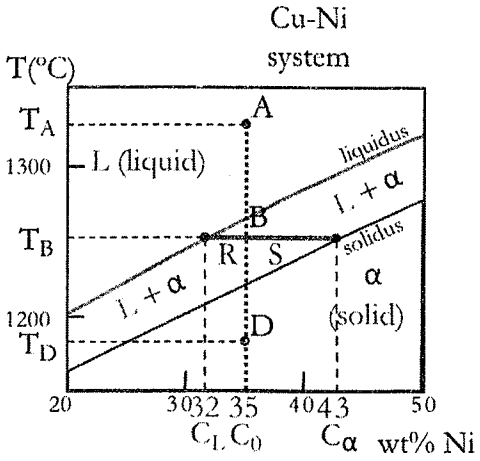
i. What is the purpose of using ferrocene (Fc^+/Fc) (03 mark)

ii. Which processes (except Fc^+/Fc) can be considered reversible and which processes can be considred irreversible? Give reasons for your choice. (04 mark)

iii. How many bits of information do you expect to store on this molecule. Give reasons. (03 mark)

5. a. Sketch the general shape of isomorphous binary phase diagram of Cu-Ni system (composition range from 0-100% Ni). The melting point of Cu is 1090 °C and the melting point of Ni is 1450 °C. (05 mark)

b. Considere a part of Cu/Ni phase diagram as shown below.



i. Determine the composition of each phase at points A,B, and D for 35% Ni at temperatures T_A = 1320 °C, T_B = 1250 °C, and T_D = 1119 °C respectively. (05 mark)

ii. If slow cooling was conducted for the above system, draw morphology changes at points A, B, and D. (05 mark)

31

6. Write short notes on following topics.

a. Advantages and disadvantages of potentiometric titrations over indicator based titrations. (05 mark)

b. Define following terms related to phase transitions. (05 mark)

i. Eutectic

ii. Eutectoid

iii. Peritectic

c. Potential energy surfaces. (05 mark)