Uva Wellassa University, Sri Lanka
BTech. Science and Technology
End Semester Examination- Semester 1
December –2008

SCT 233-1 Physical Chemistry I

Answer Four (04) questions only. All questions carry equal marks.
No. of questions: Six (06)
Scientific calculators are allowed **Time: One (01) hour**

Universal gas constant, R= 8.314 J K^{-1}mol^{-1}
Faraday constant 1F = 96500 C mol^{-1}

At 298 K

a) $RT = 2.4790\ kJ\ mol^{-1}$
b) $^{RT}/_{F} = 29.693\ mV$
c) $2.303\,^{RT}/_{F} = 59\ mV$

$ln\ (x) = 2.303\ log_{10}\ (x)$

1. The gas phase reaction of Fluorine atoms with bromine follows a stoicheometric equation

$$F + Br_2 \rightarrow FBr + Br$$

Following concentration of Br_2 were observed as a function of time at 298 K, when the fluorine atom concentration $[F] = 4 \times 10^{-9}$ mol dm^{-3}

Time / ms	0	0.7	1.3	2.7	3.9
$[Br_2]/10^{-10}$ mol dm^{-3}	1.00	0.66	0.48	0.22	0.11

i. Show that the reaction is first order with respect to $[Br_2]$ (20 marks)

ii. Given that the reaction is also first order with respect to *[F]*, calculate the overall second order rate constant. (05 marks)

2. a. Define following terms:

i. Reaction rate (02 Marks)

ii. Overall order of a reaction (02 Marks)

b. Flowing biochemical reaction scheme given

$$E + S \underset{k_r}{\overset{k_f}{\rightleftharpoons}} [ES] \xrightarrow{k_P} P + E$$

i. Identify the terms in the Michaelis - Menten equation for enzyme catalyzed reaction:

$$v = \frac{k_P[E]_O}{1 + K_M \frac{1}{[S]_0}}$$

(01 Marks)

ii. Deduce a rate equation when $[S]_0$ is very large.

(03 Marks)

c. The reactant A is converted into product D via an intermediate C using the following series of elementary reactions.

$$A_{(g)} + 2B_{(g)} \overset{k_1}{\rightarrow} 2\,C_{(g)} \quad (1)$$

$$2C_{(g)} \overset{k_{-1}}{\rightarrow} 2\,A_{(g)} + 2B_{(g)} \quad (2)$$

$$C_{(g)} \overset{k_2}{\rightarrow} D_{(g)} \quad (3)$$

i. Write down the rate equation for each reaction. State the order of the reaction (1) with respect to *[A]*.

(08 Marks)

ii. Derive a rate equation for the formation of *[D]*

(10 Marks)

3. The standard electromotive force (emf) of the cell

$$Zn_{(s)}|Zn^{2+}_{(aq)}||Fe^{2+}_{(aq)}, Fe^{3+}_{(aq)}|Pt_{(s)}$$

is 1.53 V at 298 K and 1.55 V at 323 K.

a. Draw a schematic diagram of the cell.

(05 Marks)

b. Write down the equation for the cell reaction.

(08 Marks)

c. Calculate $\Delta_r G^\theta$, $\Delta_r H^\theta$, $\Delta_r S^\theta$ for the cell at 323 K

Given: $\Delta_r G = \Delta_r H - T\Delta_r S$

$$\left(\frac{\partial \Delta_r G}{\partial T}\right)_p = -\Delta_r S$$

(12 Marks)

4. a. Define the terms conductance, conductivity and molar conductivity as applied to electrolyte solution.

(06 Marks)

b. The resistance of a conductivity cell filled with a 0.10 mol dm^{-3} aqueous KCl solution is 9.49 S^{-1} at 25 °C, when filled with 0.10 mol dm^{-3} aqueous solution of a weak acid HA is 21.96 S^{-1} at the same temperature. Given that the conductivity of 0.10 mol dm^{-3} aqueous KCl solution is 0.141 S m^{-1} at 25 °C. Calculate the molar conductivity of weak acid solution at the above temperature. State any assumptions you made.

(19 Marks)

5. a. What is Mobility?

(03 Marks)

b. What are the factors that affect the mobility of an ion in an aqueous solution?

(03 Marks)

c. The mobility of Li^+ is smaller than Na^+ion in water, briefly explain.

(06 Marks)

d. H^+ has the highest mobility in an aqueous solution, briefly explain.

(07 Marks)

e. The mobility of Li^+ ion in aqueous solution is 4.01×10^{-8} $m^2\ s^{-1}V^{-1}$ at 25°C. The potential difference between two electrodes placed in the solution is 12.0 V. If the electrodes are 1.00 cm apart, what is the drift speed of the ion?

(06 Marks)

6. a. State Kohlrausch's law for Strong electrolyte solutions.

(05 Marks)

b. Identify terms in the following equation for weak electrolyte solution

$$\frac{1}{\Lambda} = \frac{1}{\Lambda^{\infty}} + \frac{1}{K(\Lambda^{\infty})^2 c^{\theta}} \Lambda c$$

(05 Marks)

c. The conductance of a saturated $AgCl_{(aq)}$ solution at 25 °C is 6.80×10^{-5} S and the conductance of 0.10 mol dm^{-3} $KCl_{(aq)}$ solution is 6.49×10^{-1} S. The conductance of water used to prepare these solutions is 5.01×10^{-6} S at the same temperature. Given that, at 25 °C, the limiting molar conductivities of $Ag^+_{(aq)}$ and $Cl^-_{(aq)}$ are 6.19 mS m^2 mol^{-1} and 7.64 mS m^2 mol^{-1}, respectively, and the conductivity of 0.10 mol dm^{-3} $KCl_{(aq)}$ solution is 1.289 S m^{-1}. Calculate the solubility product constant of AgCl in water at 25 °C.

(15 Marks)