



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, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

Faraday constant $1F = 96500 \text{ C mol}^{-1}$

At 298 K

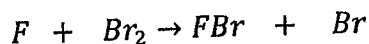
a) $RT = 2.4790 \text{ kJ mol}^{-1}$

b) $RT/F = 29.693 \text{ mV}$

c) $2.303 RT/F = 59 \text{ mV}$

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

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

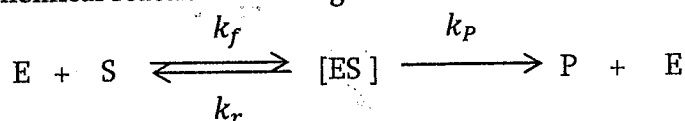


Following concentration of Br_2 were observed as a function of time at 298 K, when the fluorine atom concentration $[F] = 4 \times 10^{-9} \text{ mol dm}^{-3}$

Time / ms	0	0.7	1.3	2.7	3.9
$[Br_2]/10^{-10} \text{ mol dm}^{-3}$	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



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

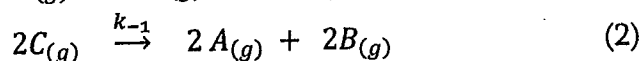
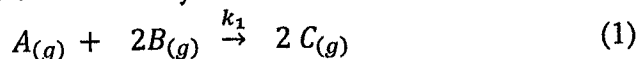
$$v = \frac{k_p [E]_0}{1 + K_M \frac{1}{[S]_0}}$$

(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.



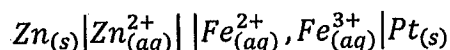
- i. Write down the rate equation for each reaction. State the order of the reaction (1) with respect to $[A]$.

(08 Marks)

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

(10 Marks)

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



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

$$\text{Given: } \Delta_r G = \Delta_r H - T\Delta_r S$$

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

(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 $4.01 \times 10^{-8} \text{ m}^2 \text{ s}^{-1} \text{ V}^{-1}$ 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 $\text{AgCl}_{(\text{aq})}$ solution at 25°C is $6.80 \times 10^{-5} \text{ S}$ and the conductance of $0.10 \text{ mol dm}^{-3} \text{ KCl}_{(\text{aq})}$ solution is $6.49 \times 10^{-1} \text{ S}$. The conductance of water used to prepare these solutions is $5.01 \times 10^{-6} \text{ S}$ at the same temperature. Given that, at 25°C , the limiting molar conductivities of $\text{Ag}^+_{(\text{aq})}$ and $\text{Cl}^-_{(\text{aq})}$ are $6.19 \text{ mS m}^2 \text{ mol}^{-1}$ and $7.64 \text{ mS m}^2 \text{ mol}^{-1}$, respectively, and the conductivity of $0.10 \text{ mol dm}^{-3} \text{ KCl}_{(\text{aq})}$ solution is 1.289 S m^{-1} . Calculate the solubility product constant of AgCl in water at 25°C .

(15 Marks)

