Total No. of printed pages = 8

3 (Sem-2) CHM M1

2015

CHEMISTRY

(Major)

Theory Paper : 2.1

Full Marks – 60

Time – 2½ hours

The figures in the margin indicate full marks for the questions.

1. Answer in brief : 1×7=7

   (a) State whether a gas for which the value of van der Waals constant 'a' is zero can be liquefied or not.

   (b) Name the least ordered liquid crystal.

   (c) The molar conductance at infinite dilution of KBr is 1.5×10^{-2} S m^2 mol^{-1} and the transport number of K^+ is 0.48. What will be the ion conductance of K^+ at infinite dilution ?

   (d) Write the cell reaction that takes place in the cell

   $Pb(s) \mid Pb^{2+}(aq) \parallel SO_4^{=}(aq) \mid PbSO_4(s) \mid Pb(s)$

(e) Find how many vibrational degree of freedom H_2O possesses.

(f) State how mean free path of a gas varies with pressure.

(g) The molar conductances at infinite dilution of KCl, KNO_3 and $AgNO_3$ are 1.5×10^{-2} S m^2 mol^{-1}, 1.4×10^{-2} S m^2 mol^{-1} and 1.3×10^{-2} S m^2 mol^{-1} respectively. Find molar conductance at infinite dilution of AgCl.

2. Answer the following questions : 2×4=8

(a) Using van der Walls equation explain how the value of compressibility factor changes when

(i) van der Waals constant 'a' is negligible and

(ii) van der Waals constant 'b' is negligible.

(b) State Fick's law of diffusion. How does diffusion of gas vary with molar mass of gas ?

(c) Explain why the boiling point of water increases with increase in surrounding external pressure.

(d) The surface tension of a soap solution is 3.0×10^{-2} N m^{-1} at 298 K. Calculate the work done in blowing a soap bubble in air of radius 0.1m at the same temperature.

3. (a) Discuss about the Ostwald's viscometer method for determination of viscosity of liquid.

Or

Explain why water possesses high surface tension under normal condition.

In the stalagnometer method for the determination of surface tension of a liquid A, equal volumes of A and water gave 60 and 20 numbers of drops respectively. The density of the liquid A is 0.896 g cm^{-3} while that of water is 0.964 g cm^{-3}. If the surface tension of water is 7.28×10^{-2} N m^{-1}, find surface tension of A. 2+3=5

(b) Answer either (i) and (ii) or (iii) and (iv) :

(i) Explain why mobility of Li^+ is less than that of K^+ in aqueous medium. 2

(ii) Calculate the ionic strength of the solution obtained by mixing equal volumes of 0.01M NaCl and 0.02M $AlCl_3$ solution. 3

Or

(iii) Explain the function of salt-bridge in a Galvanic cell. State why only KCl or NH_4NO_3 is used to make salt-bridge. 2+1=3

(iv) Calculate the pH of the solution which is 0.06 M in acetic acid and 0.04 M in CH_3COONa. Given, the dissociation constant of acetic acid is 1.6×10^{-5}. 2

(c) Answer either (i) or (ii) and (iii) :

(i) Using Debye-Huckel theory discuss about the different factors that affect the speed of ion when an electric field is applied. 5

Or

(ii) Explain how a layer of Zn prevents the rusting of iron. 3

(iii) Write Galvanic cell for each of the following cell reactions :

$Sn^{2+}(aq)+Fe^{3+}(aq)\rightarrow Sn^{4+}(aq)+Fe^{2+}(aq)$;

$MnO_4^-(aq)+H^+(aq)+H_2O_2\rightarrow Mn^{2+}(aq)+H_2O+O_2(q)$. 1+1=2

4. (a) Answer either (i), (ii) and (iii) or (iv), (v) and (vi) :

(i) Using the concept of chemical potential show that the depression of freezing point of a dilute solution containing non-volatile non-electrolyte solute is proportional to the molal concentration. 5

(ii) Explain when the value of van't Hoff factor of a solution can be less than one. 2

(iii) The vapour pressure of a solution containing 6.69g Mg $(NO_3)_2$ dissolved in 100g water is 747 mm (of Hg) at 373 K. Calculate van't Hoff factor if the molar mass of $Mg(NO_3)_2$ is 148g mol^{-1}. 3

Or

(iv) Find an expression for the molal elevation constant of a solvent containing small amount of non-volatile non-electrolyte solute to form a binary solution. Use the concept of chemical potential. 5

(v) Explain why effervescence is observed when a soda water bottle is opened. 2

(vi) At 37°C the osmotic pressure of blood is 7.75×10^5 Pa. Calculate how much glucose is to be dissolved per litre for an intravenous injection so that it has the same osmotic pressure as that of blood. 3

(b) Answer (i) and (ii) or (iii) and (iv) :

(i) What do you mean by battery ? Write which material are used as the cathode and the anode of Pb-storage battery. Write how this battery is represented. Write reaction at each electrode and write the cell reaction. State whether this is a primary or secondary battery and justify your answer. 1+1+1+2+1=6

(ii) A solution of HCl was electrolysed in a Hittorf cell using Pt electrodes. The analysis of the solution from the cathode compartment before and after electrolysis indicated the masses of

HCl as 1.82×10^{-4} kg and 1.67×10^{-4} kg respectively. At the same time the mass of Ag deposited at the cathode of the coulometer in the same circuit was found to be 2.52×10^{-4} kg. Calculate the transport number of each ion. 4

Or

(iii) Write what you mean by concentration cell. Taking the example of hydrogen electrode, explain how concentration cells are classified. Explain in which type of cell liquid junction potential will be maxium. 1+3+2=6

(iv) Calculate the activity of 0.01M aqueous solution of a 2:1 electrolyte BA_2 at 25°C. 4

(c) Answer (i) and (ii) or (iii) and (iv) :

(i) Write what you mean by distribution of molecular speeds. Explain what information can be drawn from speed distribution curves. Discuss using graphical representation the effect of temperature on the distribution of molecular speeds. 2+2+2=6

(ii) Gases A and B obey van der Waals equation. The critical temperature and critical pressure of gas A are 44 K and 2.64×10^5 Pa. Again those of gas B are 304 K and 7.3×10^5 Pa respectively. Find which of the two gases has higher critical volume. 4

Or

(iii) State and explain the principle of equipartition of energy. Using this principle find the ratio between molar heat capacity at constant pressure and molar heat capacity at constant volume of a non-rigid diatomic gas. 2+4=6

(iv) The values of the van der Waals constants 'a' and 'b' for $CH_4(g)$ are 0.2283 Pa m^6 mol^{-2} and $4.28\times10^{-5}m^3$ mol^{-1} respectively. Show whether $CH_4(g)$ can be liquefied at 298 K or not. Can water vapour be liquefied at 298 K ? 3+1=4