2013

CHEMISTRY

(Major)

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) Give the schematic plot of compressibility factor against pressure at a definite temperature to show the difference between ideal gas and real gas.

(b) Indane gas used for cooking in houses consists mainly of butane and propane. Does each of these two gases have critical temperature higher than 298 K?

(c) Out of nematic, smectic and cholesteric liquid crystal phases, state which is the most ordered one?

(d) State why liquid is less compressible than gas.

(e) Liquid crystal display consists of a liquid crystal sandwiched between two thin glass plates with provision for applying electric field. State what change occurs in the liquid crystal phase when electric field is applied.

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

$$Pt(s)\,|\,H_2(g)\,|\,H^+(c_1)\,||\,H^+(c_2)\,|\,H_2(g)\,|\,Pt(s)$$

(g) Calculate the value of pK_a of the acid whose dissociation constant is $2{\cdot}0\times10^{-5}$.

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

(a) Discuss the effect of temperature on the distribution of molecular speeds. Draw necessary graphs to show this effect.

(b) A liquid *A* has half the surface tension of the liquid *B*. Again the density of the liquid *A* is twice that of *B*. If in a capillary tube *A* rises to the height of 10 cm, what will be the rise of *B* in the same tube at the same temperature?

(c) Explain why K^+ has higher ion mobility than Li^+.

(d) Write the reaction that takes place in Ag-AgCl electrode. Also write Nernst equation for the same.

3. (a) Discuss about the Ostwald viscometer method for the determination of viscosity of a liquid. How does viscosity of a liquid vary with temperature? 4+1=5

(b) Deduce an expression for the e.m.f. of the concentration cell with transference : 5

$Pt(s) | H_2$ (1 atm) | HCl (a_1) : HCl (a_2) | H_2 (1 atm) | Pt (s)

Or

Write short notes on dry cell and lead storage battery. 2½×2=5

(c) Deduce the expressions for critical constants P_c, T_c and V_c in terms of the van der Waals constants. Can a van der Waals gas be liquefied for which the value of the van der Waals constant a is zero? 4+1=5

Or

Explain what you mean by collision cross-section. Define mean free path and find an expression for this. How does the mean free path vary with pressure? 2+2+1=5

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

(i) Deduce the equation of corresponding states. 4

(ii) Using the principle of equipartition of energy, deduce an expression for the energy of 1 mol CO_2 (g) at temperature T K. 4

(iii) Explain why liquefaction of gas is easier at low temperature and high pressure. 2

Or

(iv) Write the two main causes of deviation from ideal gas behaviour. Explain how van der Waals modified the ideal gas equation. 2+4=6

(v) Deduce an expression for the thermal conductivity of monatomic gas by using kinetic theory of gases. 4

(b) (i) Using the concept of chemical potential, prove that the elevation of boiling point of a dilute solution containing non-volatile non-electrolyte solute is proportional to the molal concentration of the solution. 5

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

(iii) 122 g of benzoic acid is dissolved in 1000 g of benzene at a definite temperature. The vapour pressure of pure benzene is 0·876 atm at that temperature. Assuming that the benzoic acid dimerises completely, calculate the vapour pressure of the solution (temperature constant). 3

(c) Answer *either (i), (ii)* and *(iii)* or *(iv), (v)* and *(vi)* :

(i) Deduce Stokes-Einstein equation relating diffusion coefficient and viscosity of the medium. 5

(ii) A moving boundary experiment was carried out with 20 mol m^{-3} NaCl solution in water. In the

experiment, a current of 0·0016 A moved the boundary through a distance of 0·06 m in 34 minutes and 30 seconds. The radius of the tube used in the experiment is $1 \cdot 88 \times 10^{-3}$ m. Calculate the transport number of Na^+ ion. 3

(iii) Calculate the ionic strength of the solution which is 0·1 *M* in KCl and 0·2 *M* in K_2SO_4. 2

Or

(iv) Discuss in brief about the Debye-Hückel theory of strong electrolyte leading to Debye-Hückel-Onsager equation. 5

(v) Calculate the mean ionic activity coefficient of 0·01 *M* Na_2SO_4 solution in water at 298 K. 3

(vi) Calculate the standard free energy change associated with the reaction

$$2Al\,(s) + 3ZnSO_4\,(aq) \rightarrow Al_2(SO_4)_3\,(aq) + 3Zn\,(s)$$

Given :

$$E^{\circ}_{Al^{3+}|Al} = -1 \cdot 66\ V \text{ and } E^{\circ}_{Zn^{2+}|Zn} = -0 \cdot 76\ V$$

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