

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

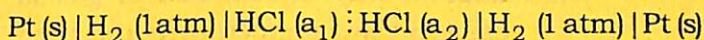
$$\text{Pt(s)} | \text{H}_2(\text{g}) | \text{H}^+(\text{c}_1) || \text{H}^+(\text{c}_2) | \text{H}_2(\text{g}) | \text{Pt(s)}$$
- (g) Calculate the value of pK_a of the acid whose dissociation constant is 2.0×10^{-5} .

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



Or

Write short notes on dry cell and lead storage battery. $2\frac{1}{2} \times 2 = 5$

- (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 $1.88 \times 10^{-3} \text{ m}$. Calculate the transport number of Na^+ ion.

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- (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

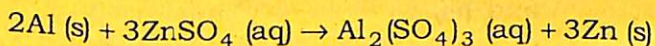
- (iv) Discuss in brief about the Debye-Hückel theory of strong electrolyte leading to Debye-Hückel-Onsager equation.

5

- (v) Calculate the mean ionic activity coefficient of 0.01 M Na_2SO_4 solution in water at 298 K .

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



Given :

$$E_{\text{Al}^{3+}|\text{Al}}^\circ = -1.66 \text{ V and } E_{\text{Zn}^{2+}|\text{Zn}}^\circ = -0.76 \text{ V}$$

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