2018

CHEMISTRY

[Honours]

PAPER – IV

Full Marks : 45

Time : 2 hours

The figures in the right hand margin indicate marks

[NEW SYLLABUS]

GROUP – A

Answer any **one** questions :   15 × 1

1. (a) Show that wave function

$$\psi_1 = \sin\frac{\pi x}{a} \quad \text{and} \quad \psi_2 = \cos\frac{\pi x}{a}$$

are orthogonal in the interval $0 < x < a$.   2

(Turn Over)

(2)

(b) A beam of X-ray is scattered by $45°$ from the beam of direction, the scattered X-ray has a wavelength 2.2 pm. What is the wavelength of X-ray in the direction of beam ? 2

(c) Define chemical potential of a substance in a mixture. Show that

$$\left(\frac{\partial \mu i}{\partial p}\right)_{T,nj} = \overline{V}_i .$$

$1 + 2$

(d) At $25°C$ the specific conductance of a saturated solution of AgBr after substracting that of water is 1.174×10^{-7} ohm^{-1} cm^{-1}. The ionic mobilities of Ag$^+$ and Br$^-$ are 6.4×10^{-4} and 8.1×10^{-4} cm^2 sec^{-1} volt^{-1}. Calculate solubility product of AgBr at $25°C$. 4

(e) Derive the expression of liquid junction potential for the following concentration cell with transference

Ag(s)|AgCl(s)|ZnCl$_2$(a_1)|ZnCl$_2$(a_2)|AgCl(s)|Ag(s)

$(a_1 > a_2)$. 4
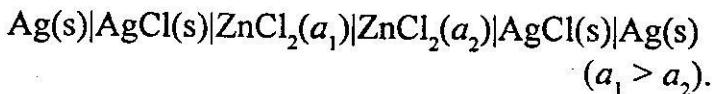
2. (a) Find the commutator $[\hat{A}, \hat{B}]$ where

$$\hat{A} = \left(\frac{d}{dx} + x\right) \text{ and } \hat{B} = \left(\frac{d}{dx} - x\right).$$ 3

(b) A sample is either glucose or sucrose. How will you confirm the sample by osmotic pressure measurement ?   3

(c) Give example of a chemical cell with one electrolyte. Write the cell reaction and the expression of e.m.f of the cell.   1 + 1 + 1

(d) ΔG^o value of a reaction is positive. Can the reaction be spontaneous ? Comment.   2

(e) At 700 K, for the gaseous reaction $H_2(g) + I_2(g) = 2\,HI(g)$, equilibrium constant $K = 55$. If in a container 5 moles of HI, 2 moles of H_2 and 1 mole of I_2 are taken at 700 K, in which direction the reaction will occur and what will be the equilibrium composition ?   2 + 2

(4)

GROUP – B

Answer any two questions from the following : 10×2

3. (a) Derive the Gibbs Duhem relation
$$\Sigma nid\mu i = 0. \qquad 3$$

(b) Define cryoscopic constant of a solvent. Find its value for H_2O. $1 + 1$

(c) Calculate the freezing temperature of water if the pressure be increased by 1 atm., given $l_f = 80$ cal gm^{-1}

$$\rho_{ice} = 0.9163 \text{ gm/c.c.}$$

$$\rho_{H_2O(l)} = 0.9998 \text{ gm/c.c at } 0^{\circ}C. \qquad 4$$

(d) What is the S.I. unit of specific conductance and molar conductance ?   1

4. (a) Discuss the effect of addition of an inert gas to the equilibrium of the following reaction.   3

$$3H_2 + N_2 \rightleftharpoons 2NH_3$$
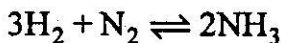
(b) Show that $\dfrac{d^2}{dx^2}$ is a Hermitian operator.   3

(c) Calculate pH of 10^{-8} (N) NaOH solution at $25°C$.   3

(d) Give example of an electrode concentration cell.   1

5. (a) Draw and explain conductometric titration curve of $AgNO_3$ solution by HCl.   2

(b) Why resistance instead of conductance is not plotted against volume of titre added during conductometric titration ?   2

(c) Define isotonic solution.
The osmotic pressure of a sample of blood is 7 atm at $37°C$. Find the percentage strength of the sodium chloride solution that is isotonic with the blood at this temperature.   1 + 3

(d) If ΔL is the uncertaity in the angular momentum of a particle and $\Delta\theta$ is the uncertainty in angular position, show that $\Delta L \cdot \Delta\theta \geq \hbar/2$.   2

(6)

6. (a) Define abnormal transport number with an example. 2

(b) With the help of vapour pressure *vs.* temperature plot explain the reasons of depression of freezing point of a solution. 2

(c) Derive the expression for pH range of an acid base indicator. 3

(d) At what minimum value of pH a ppt. of $Mg(OH)_2$ form in a 0·001(M) solution of $Mg(NO_3)_2$? Ksp of $Mg(OH)_2$ at experimental temperature = 6×10^{-12}. 3

GROUP — C

7. Answer any **five** questions : 2×5

(a) Solubility of AgCl in 0·1 (M) KNO_3 solution is higher than that of water. Explain.

(b) Calculate the entropy of mixing if 6gm H_2 gas is mixed with 8 gm He gas at 27°C.

(*Continued*)

(c) Show that $\psi(x) = \exp(i\hbar x)$ is an eigen function of the x component linear momentum operator p_x. What is its eigenvalue ?

(d) Quinhydrone electrode cannot be used above pH 8. Explain the statement.

(e) For the reaction
$$SO_2(g) + {}_1O_2(g) \rightleftharpoons SO_3(g)$$
$K_p = 1\cdot7 \times 10^{12}$ at $\overline{3}00°C$. Calculate K_p for $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ at same temperature.

(f) Represent the cell where following reaction will occur

$$2FeCl_3 + SnCl_2 = 2FeCl_2 + SnCl_4$$
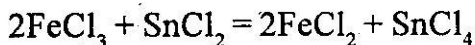
What is the standard e.m.f of the cell at $25°C$?

At $25°C$ $E°_{Sn^{4+}/Sn^{2+}} = 0\cdot15V$

$$E°_{Fe^{4+}/Fe^{2+}} = 0\cdot77V$$

(g) Define Vant Hoff's factor. How it is related with degree of association?

(h) Ammonium acetate solution acts as buffer. Explain.