বিদ্যাসাগর বিশ্ববিদ্যালয়

VIDYASAGAR UNIVERSITY

Question Paper

B.Sc. Honours Examinations 2021

(Under CBCS Pattern)

Semester - III

Subject: CHEMISTRY

Paper: C-5 T & P

Physical Chemistry - II

Full Marks : 60 (Theory-40 + Practical-20)

Time : 3 Hours

Candiates are required to give their answer in their own words as far as practicable.

The figures in the margin indicate full marks.

THEORY (Marks : 40)

Group - A

Answer any **three** questions : 12×3=36

1. (a) What is fugacity? Mention its unit.

   (b) Define specific conductance and molar conductance.

   (c) If two operators $\hat{\alpha}$ and $\hat{\beta}$ are Hermitian, then find out the condition when $\hat{\alpha}\hat{\beta}$ will be Hermitian.

(d) For a gaseous reaction, A(g) + 2B(g) $\rightarrow$ 2C(g) + D(g), the equilibrium constant $K_P = 0.694$ at 27°C. Calculate K_C at 25°C for the reaction $C(g) + \frac{1}{2}D(g) \rightarrow \frac{1}{2}A(g) + B(g)$. 3+3+3+3

2. (a) Calculate the average energy of a free particle of mass 'm' confined to move in one dimensional box of length 'a'.

(b) The results of measurement of equivalent conductance at infinite dilution in $S\ cm^2\ equiv^{-1}$ at 25°C for the following pair of electrolytes were found as :

Electrolyte	$\wedge_o$	Electrolyte	$\wedge_o$	Electrolyte	$\wedge_o$
KCl	149.9	KNO_3	145.6	KOH	271.6
LiCl	115.5	$LiNO_3$	110.1	LiOH	236.7

Generalize the results in the form of a law and state how this law can be used in determining the equivalent conductance of a weak electrolyte at infinite dilution.

(c) State Le-Chatelier principle and explain its significance.

(d) Show that : $\Delta S_{mix} = -nR\Sigma X_i \ln Xi$ 3+4+3+2

3. (a) Explain how degree of dissociation is determined at constant pressure.

(b) Calculate $\mu - \mu^0$ for one mole of an ideal gas at 25°C and 400 mm of Hg.

(c) A moving boundary experiment is done to measure the transference number of Na^+ in a 0.007 (M) NaCl solution. The boundary moves 7.3 cm in 24 minutes 50 seconds using a current of 1.00×10^{-3} amperes. Calculate t_+. [Given cross-sectional area = $0.125\ cm^2$]

(d) Derive Poiseuille's equation. 3+2+3+4

4. (a) Derive van't Hoff isotherm.

(b) At 20°C, pure water with an absolute viscosity of 0.01009 dyne-s-cm^{-2} required 102.2 second to flow through the capillary of an Ostwald viscometer. At 20°C, toluene required 68.9 s. If density of water and toluene be 0.998 and 0.866g/cc respectively, calculate the viscosity of toluene.

(c) What are the criteria of well-behaved function?

(d) Explain the variation of specific conductance with concentration.

(e) What are orthonormal set of wave function? 3+3+2+2+2

5. (a) Calculate the normalization constant A of the wave function of a harmonic oscillator in the $v = 1$ level, $\psi_1 = Axe^{\frac{ax^2}{z}}$. (Given : $\int_0^\infty x^2 e^{-ax^2} = \frac{1}{4}\sqrt{\frac{\pi}{a}}$)

(b) Evaluate $< p_x{}^2 >$ for the ground state of 1-D S. H. O.

(c) Can the zero point energy of a particle in a box be zero? Answer with reason.

(d) What is meant by precise value in quantum mechanics?

(e) What is free particle? 3+3+2+2+2

6. (a) A solution of acetone and chloroform at a given temperature having mole-fraction of chloroform is 0.2, the partial vapour pressure of chloroform and acetone are 35 mm and 270 mm respectively. In pure state vapour pressure of chloroform and acetone are 345 mm and 293 mm respectively at the same temperature. Calculate activity and activity coefficient of chloroform.

(b) Define transport number. Explain the effect of temperature on transport number.

(c) Phosgene is put into a 2 L vessel and then heated so that it is partially decomposed as —

$$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$$

At equilibrium, $[COCl_2] = 0.40(M)$. After addition of more $COCl_2$ to the vessel, when the equilibrium is re-established, $[COCl_2] = 1.6(M)$. What happens to concentration of CO ?

(d) A steel ball of density 7.90 g/cc and 4mm diameter required 55 sec to fall a distance of 1 meter through a liquid of density 1.10 g/cc. Calculate the viscosity of the liquid.

3+3+3+3

Group - B

7. Answer any **two** questions : 2×2=4

(a) Define ionic mobility and mention its unit.

(b) What are linear operators? Give example.

(c) How would you prove that chemical equilibrium is dynamic is nature.

(d) Show that : $\left(\frac{\partial G}{\partial n_i}\right)_{T,\, P,\, n_f(i \neq j)} = \left(\frac{\partial H}{\partial n_i}\right)_{S,\, P,\, n_f(i \neq j)}$

PRACTICAL (Marks : 20)

Paper : C-5 P

Group - A

Answer any ***one*** question : 15 × 1 = 15

1. Write the physico-chemical principle for Conductometric titration. 15

2. Write the procedure for the determination of viscosity of unknown liquid with respect to water. 15

3. Write the principle and methodology for the Study of saponification reaction conductometrically. 15

Group - B

Answer any ***one*** question : 5 × 1 = 5

4. How is K_a of weak acid determined conductometrically ? 5

5. State and explain Nernst distribution law. Write its limitation. 5

6. Draw and explain conductometric titration curve of oxalic acid vs. sodium hydroxide. 5