3 (Sem–4/CBCS) CHE HC3

2023

CHEMISTRY

(Honours Core)

Paper : CHE–HC–4036

(Physical Chemistry–IV)

Full Marks : 60

Time : Three hours

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

1. Answer the following questions : 1×7=7

   (a) What weight of AlF_3 salt be dissolved in 100 *ml* of solution so as to make the solution containing 1 *eq/L* ?

   (b) Define equivalent conductance.

   (c) What is cell constant ?

   (d) What is transport number ?

(e) Ionic product of water at $25^{\circ}C$ is approximately equal to

(i) $1\times10^{-7}\left(molL^{-1}\right)^2$

(ii) $2\times10^{-14}(mol/L)^2$

(iii) $1\times10^{-14}\ mol^2\ L^{-2}$

(iv) $1\times10^{-7}\ mol^2\ dm^{-6}$

(Choose the correct answer)

(f) Write *two* categories of electrochemical cell.

(g) Which of the following hydrogen halides has most polar bond ?

(i) *HF*

(ii) *HBr*

(iii) *HCl*

(iv) *HI*

(Choose the correct answer)

2. Answer following questions : 2×4=8

(a) Find the relationship between molar conductance and specific conductance in SI unit.

(b) A perfectly cubical conductivity cell holds 0.94 cm^3 of a solution between its electrodes. Determine its cell constants.

(c) What is relaxation effect ?

(d) Write precisely on potentiometric titration.

3. Answer ***any three*** questions from the following : 5×3=15

(a) Discuss the Arhenius theory of electrolytic dissociation. Give evidence in support of the dissociation theory. 3+2=5

(b) Write the principle of conductometric titrations. Discuss the characteristics of curves obtained in the titration of *any two* given below : 1+(2+2)=5

(i) *HCl* vs *NaOH*

(ii) CH_3COOH vs *NaOH*

(iii) *HCl* vs NH_4OH

(iv) CH_3COOH vs NH_4OH

(c) (i) What is ionic mobility ? What is the effect of temperature on ionic mobility ? 2

(ii) A potential of 12·0 volts was applied to two electrodes placed 20 *cm* apart. A dilute solution of NH_4Cl was placed between the electrodes when NH_4^+ is found to cover a distance of 1.6 *cm* in one hour. What is the mobility of NH_4^+ ion ? 3

(d) (i) Derive a mathematical relation between the electrical energy of reversible galvanic cell and in free energy of the cell reaction. 3

(ii) What is half cell reaction ? Write the half cell reaction of the following cell : 2

$$Zn|\,Zn^{2+}(aq)\,||\,Fe^{3+}(aq)|\,Fe^{2+}\,|\,Pl^{-}$$

(e) Briefly explain Gouy's method for the measurement of magnetic susceptibility.

4. Answer ***any three*** questions from the following : 10×3=30

(a) (i) How can you measure electrolytic conductance, specific conductance, equivalent conductance and molar conductance ? Write the unit of cell constant (K) in SI unit.

(ii) The resistance of 0.01 *M* solution of an electrolyte was found to be 210 ohm at 25 °*C*. Calculate the molar conductance of the solution at 25 °*C*.
(Given : cell constant = 0.88 cm^{-1})

(iii) Specific conductance of an electrolyte solution decreases with dilution. Explain.

5+3+2=10

(b) (i) State and explain the Kohlrausch's law of independent migration of ions.

(ii) For the strong electrolytes $NaOH$, $NaCl$ and $BaCl_2$ the molar ionic conductance at infinite dilution are 248.1×10^{-4}, 126.5×10^{-4} and 280.0×10^{-4} $S\ m^2\ mol^{-1}$ respectively. Calculate $\wedge_m^o$ for $Ba(OH)_2$.

(iii) Illustrate the application of Kohlrausch's law. 5+2+3=10

(c) (i) Illustrate how the solubility product of a sparingly soluble salt can be determined with the help of conductance measurement.

(ii) What is Ostwald dilution law ? Write its verification, importance and limitations. 5+5=10

(d) (i) Find the mean ionic activity of a uni-univalent electrolyte.

(ii) How can you calculate the equilibrium constant of a cell reaction of the type

$aA + bB \rightleftharpoons cC + dD$?

(iii) Calculate the equilibrium constant of the cell reaction

$$2Ag^+ + Zn \rightleftharpoons 2Ag + Z_n^{2+}$$

occurring in the $Zn-Ag$ cell at 25 °C when $\left[Z_n^{2+}\right] = 0.10M$ and $\left[Ag^+\right] = 10M$. The EMF of the cell is found to be 1.62 volts. 2+5+3=10

(e) (i) State and explain the Nernst equation.

(ii) Find out whether Zn and Ag would react with dilute H_2SO_4 acid or not.

Given :

$E_{el}^o = 0$ for $2H^+, H_2(g); Pt$

$E_{el}^o = -0.76\ V$ for $Zn^{2+}; Zn$

$E_{el}^o = +0.80\ V$ for $Ag^+; Ag$

4+(2×3)=10

(f) (i) How can you apply the dipole moment of a molecule to study its molecular structure ?

(ii) Find the percentage of ionic character of *HCl* molecule using SI unit.

Given :

Internuclear distance (r) = 127 *pm*

Electronic charge = $1.6 \times .0^{-19} C$

Actual dipole moment = 3.44×10^{-30} coulomb metre.

(iii) How can you distinguish diamagnetic substances and paramagnetic substances depending on the behaviour in a magnetic field ?

(iv) Explain polar and nonpolar convalent bonds.

(v) Explain the variation of molar polarization with temperature.

2+2+2+2+2=10