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**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 :  $1 \times 7 = 7$

(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 ?

Contd.

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

(i)  $1 \times 10^{-7} (\text{mol L}^{-1})^2$

(ii)  $2 \times 10^{-14} (\text{mol/L})^2$

(iii)  $1 \times 10^{-14} \text{ mol}^2 \text{ L}^{-2}$

(iv)  $1 \times 10^{-7} \text{ mol}^2 \text{ dm}^{-6}$

(Choose the correct answer)

(f) Write two categories of electrochemical cell.

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



(Choose the correct answer)

2. Answer following questions :  $2 \times 4 = 8$

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

(b) A perfectly cubical conductivity cell holds  $0.94 \text{ cm}^3$  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 :  $5 \times 3 = 15$

(a) Discuss the Arrhenius 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)  $\text{HCl}$  vs  $\text{NaOH}$

(ii)  $\text{CH}_3\text{COOH}$  vs  $\text{NaOH}$

(iii)  $\text{HCl}$  vs  $\text{NH}_4\text{OH}$

(iv)  $\text{CH}_3\text{COOH}$  vs  $\text{NH}_4\text{OH}$

- (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
- $$Zn | Zn^{2+}(aq) || Fe^{3+}(aq) | Fe^{2+} | Pt^-$$
- (e) Briefly explain Gouy's method for the measurement of magnetic susceptibility.

4. Answer **any three** questions from the following :  $10 \times 3 = 30$

(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 =  $0.88 \text{ cm}^{-1}$ )

(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  $\text{NaOH}$ ,  $\text{NaCl}$  and  $\text{BaCl}_2$  the molar ionic conductance at infinite dilution are  $248.1 \times 10^{-4}$ ,  $126.5 \times 10^{-4}$  and  $280.0 \times 10^{-4}$   $\text{S m}^2 \text{mol}^{-1}$  respectively. Calculate  $\Lambda_m^\circ$  for  $\text{Ba}(\text{OH})_2$ .

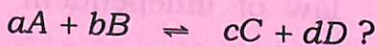
(iii) Illustrate the application of Kohlrausch's law.  $5+2+3=10$

(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



- (iii) Calculate the equilibrium constant of the cell reaction



occurring in the  $Zn - Ag$  cell at  $25^\circ C$  when  $[Zn^{2+}] = 0.10M$  and  $[Ag^+] = 10M$ . 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 :

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

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

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

$$4+(2 \times 3)=10$$

- (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 =  $1.6 \times 10^{-19} C$

Actual dipole moment =

$3.44 \times 10^{-30}$  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 covalent bonds.

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

$$2+2+2+2=10$$