CASE STUDY BASED QUESTIONS
ELECTROCHEMISTRY
XII SCIENCE

Case I : Read the passage given below and answer the following questions from 53 to 57. The study of the conductivity of electrolyte solutions is important for the development of electrochemical devices , for the characterisation ofthe dissociation equilibrium ofweak electrolytes and for the fundamental understanding ofcharge transport by ions. The conductivity of electrolyte is measured for electrolyte solution with concentrations in the range of 10-3 to 10-1 mol L-l as solution in this range of concentrations can be easily prepared. The molar conductivity (Am) of strong electrolyte solutions can be nicely fit by Kohlrausch equation.

$\Lambda_m = \Lambda_m^\circ - K\sqrt{C}$ ...(1

Where, Λ_m° is th is the molar conductivity at infinite dilution and C is the concentration of the solution. K is an empirical proportionality constant to be obtained from the experiment. The molar conductivity of weak electrolytes, on the other hand, is dependent on the degree of dissociation of the electrolyte. At the limit of very dilute solution, the Ostwald dilution law is expected to be followed,

$$\frac{1}{} = \frac{1}{} + \frac{\Lambda_m}{} \frac{C_A}{}$$

...(ii) Am AO (AOm)2 Kd

where, CA is the analytical concentration of the electrolyte and Kd is dissociation constant. The molar conductivity at infinite dilution can be decomposed into the contributions of each ion. A" = + v_X^0_ ...(iii) Where, and R_ are the ionic conductivities of positive and negative ions, respectively and v+ and v- are their stoichiometric coefficients in the salt molecular formula.

Q-1 Which statement about the term infinite dilution is correct?

(a) Infinite dilution refers to hypothetical situation when the ions are infinitely far apart.

(b) The molar conductivity at infinite dilution of NaCl can be measured directly in solution.

(c) Infinite dilution is applicable only to strong electrolytes.

(d) Infinite dilution refers to a real situation when the ions are infinitely far apart.

Q-2 Which ofthe following is a strong electrolyte in aqueous solution?

(a) HN02 (b) HCN

(c) NH3 (d) HCI

Q-3 Which of the following is a weak electrolyte in aqueous solution? (a) K2S04 (b) Na3P04

(c) NaOH (d) H2S03

Q-4. Ifthe molar conductivities at infinite dilution for Nal, CH3COONa and (CH3COO)2Mg are 12.69, 9.10 and 18.78 S cm^2 mol-I respectively at 25 ^{0}C, then the molar conductivity of Mg12 at infinite dilution is

(a) 25.96 S cm^2 , mol-I (b) 390.5 S cm^2 mol-I

(c) 189.0 S cm^2 mol-I

(d) 3.89 x 10-2 S cm^2 mol-I

Q-5.5hich ofthe following is the correct order of molar ionic conductivities of the following ions in aqueous solutions?

(a) $Li^+ < Na^+ < K^+ < Rb^+$

(b) $Li^+ > Na^+ > K^+ > Rb^+$

(c) $Rb^+ < Na^+ < Li^+ < K^+$

(d) $Li^+ < Rb^+ < Na^+ < K^+$

$$Fe^{2+} + Ce^{4+} \rightleftharpoons Ce^{3+} + Fe^{3+}$$

(Given: $E^\circ_{Ce^{4+}/Ce^{3+}} = 1.44$ V and $E^\circ_{Fe^{3+}/Fe^{2+}}$ en:

Case Il : Read the passage given below and answer the following questions from 58 to 62. The electrochemical cell shown below is concentration cell.

M I M^{2+} (saturated solution of a sparingly soluble

salt, MX_2)$\|M^{2+}$ (0.001 mol dm^{-3})$|M$

The emf of the cell depends on the difference in concentrations ofM^{2} • ions at the two electrodes. The emf of the cell at 298 K is 0.059 V.

Q-6 The solubility product (Ksp, m01 ^{3} dm-9) of MX2 at 298 K based on the information available for the given concentration cell is (take 2.303 x R x 298/F = 0.059)

(a) 2 x 10-15 (b) 4 x 10-15

(c) 3 x 10-12 (d) 1 x 10-12

Q-7. The value of AG (in kJ mol-I) for the given cell is (take 1 F = 96500 C mol-I) (a) 3.7 (b) -3.7

(c) 10.5 (d) -11.4

(a) 7.6 x 10 ^{12} (b) 6.5 x 10 ^{10} Q-8 The solubility product ofa saturated solution ofAg2Cr04 in water at 298 K ifthe emf ofthe cell AglAg+ (satd. Ag2Cr04 soln) llAg+ (0.1 M)lAg is 0.164 V at 298 K, is

(c) 5.2 x 109 (d) 3.4 x 10 ^{12}

(a) 3.359 x 10 ^{12} m01^3 13

(b) 2.287 x 10-12 m01^3 13

(c) 1.158 x 10-12 m01^3 13

(d) 4.135 x 10 ^{12} m01^3 13

Q-9 To calculate the standard emf of the cell, which of the following options is correct if E^O is reduction potential values? (a) emf E ^{O}cathode

(b) emf=E anode cathode

(C) emf = E ^{O}anode + E ^{O}cathode

(d) None of these

Case Ill : Read the passage given below and answer the following questions.

Nernst equation relates the reduction potential of an electrochemical reaction to the standard potential and activities of the chemical species undergoing oxidation and reduction. Let us consider the reaction, nM For this reaction, the electrode potential measured with respect to standard hydrogen electrode can be given as

$$-\frac{RT}{}\ln\frac{[M]}{}$$

(M"+/M) 1M) nF [M"+1

In the following questions (Q. No. 10 to 14), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices on the basis of the above passage.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

Q-10 Assertion : For concentration cell, zn(s) Zn

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For spontaneous cell reaction, Cl < C2

RT C2

Reason : For concentration cell, Ecell — —log—

For spontaneous reaction, Ecell = +ve so, C2 > Cl.

Q-11Assertion : For the cell reaction, Zn(s) + Cu^2(+ Zn^2 (+aq) + Cuts) voltmeter gives zero reading at equilibrium. Reason : At the equilibrium, there is no change in concentration of Cu^2 + and Zn^2+ ions.

Q-12Assertion : The Nernst equation gives the concentration dependence of emf of the cell. Reason : In a cell, current flows from cathode to anode.

Q-13Assertion : Increase in the concentration of copper half cell in a cell, increases the emf ofthe cell.

Reason : $E_{cell} = E^{\circ}_{cell} - \frac{0.059}{2}\log\frac{[Cu^{2+}]}{[Zn^{2+}]}$

Q-14Assertion : Electrode potential for the electrode Mn*/Mn with concentration is given by the expression under STP conditions.

$$E = E^{\circ} + \frac{0.059}{n}\log[Mn+1$$

Reason : STP conditions require the temperature to be 273 K.

Case IV : Read the passage given below and answer the following questions from 11 to 15

The concentration of potassium ions inside a biological cell is at least twenty times higher

$$Zn^{2+}_{(aq)} \| Zn^{2+}_{(aq)}$$

C_1 C_2

than the outside. The resulting potential difference across the cell is important in several processes such as transmission of nerve impulses and maintaining the ion balance. A simple model for such a concentration cell involving a metal M is

0.05 molar) llM+(aq; 1

Q-11For the above cell,

(a) $E_{cell} = 0 ; \Delta G > 0$ (b) $E_{cell} > 0 ; \Delta G < 0$

(c) $E_{cell} < 0 ; \Delta G > 0$ (d) $E_{cell} > 0 ; \Delta G = 0$

Q-12 If the 0.05 molar solution ofM+ is replaced by a 0.0025 molar solution, then the magnitude of the cell potential would be

(a) 130 mV (b) 185 mV

(c) 154 mV (d) 600 rnV

Q-13 The value of equilibrium constant for a feasible cell reaction is ____?

Q-14 What is the emf of the cell when the cell reaction attains equilibrium?

Q-15 The potential of an electrode change with change in
(a) concentration of ions in solution
(b) position of electrodes (c) voltage of the cell (d) all of these.

Case V : Read the passage given below and answer the following questions from 16 to 18

All chemical reactions involve interaction of atoms and molecules. A large number of atoms/ molecules are present in a few gram of any chemical compound varying with their atomic/ molecular masses. To handle such large number conveniently, the mole concept was introduced. All electrochemical cell reactions are also based on mole concept. For example, a 4.0 molar aqueous solution of NaCl is prepared and 500 mL of this solution is electrolysed. This leads to the evolution of chlorine gas at one of the electrode. The amount of products formed can be calculated by using mole concept.

Q-16 The total number of moles of chlorine gas evolved is (a) 0.5 (b) 1.0
(c) 1.5 (d) 1.9

Q-17 If cathode is a Hg electrode, then the maximum weight of amalgam formed from this solution is

(Given : Atomic mass of Na = 23u and Hg = 200.59 u)

(a) 300 g (b) 446 g

(c) 396 g (d) 296 g

Q-18 In electrolysis of aqueous NaCl solution when Pt electrode is taken, then which gas is liberated at cathode?

Q-19 What will be the change in PH of solution ?