IIT-JAM CHEMISTRY 2023

TEST : ELECTROCHEMISTRY

Time 00 : 60 Hour **Date : 25-08-2022**

M.M. : 35

INSTRUCTION:

1. **Attempt all the questions.**
2. **PART-A contains 10 Multiple Choice Questions (MCQ). Each question has 4 choices (a), (b), (c) and (d), for its answer, out of which ONLY ONE is correct. From Q.1 to Q.5 carries 1 Marks and Q.6 to Q.10 carries 2 Marks each.**
3. **PART-B contains 05 Multiple Select Questions(MSQ). Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE or MORE than ONE is/are correct. For each correct answer you will be awarded 2 marks.**
4. **PART-C contains 06 Numerical Answer Type (NAT) questions. Q.16 to Q.17 carry 1 Mark and Q.18 to Q.21 carries 2 Marks each. The answer of each (NAT) is a real number.**
5. **In all sections, questions not attempted will result in zero mark. In PART–A (MCQ), wrong answer will result in negative marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In PART–B (MSQ), there is no negative and no partial marking provisions. There is no negative marking in PART–C (NAT) as well.**

PART-A

Q.1 to Q.05: Carry 1 Mark each.

1. One mole of metal can be deposited when one Faraday of electricity is passed through one litre solution containing one mole of

   (a) $BaCl_2$ (b) $CuSO_4$ (c) NaCl (d) $AlCl_3$

2. When HCl is titrated conductometrically with KOH, the drastic decrease in conductance is observed due to

   (a) increase in number of Cl^- (b) Replacement of H^+ by K^+

   (c) Replacement of Cl^- by low conducting K^+ (d) Formation of weak electrolyte

3. The correct order of transport numbers of Cl^- in infinitely diluted aqueous solution of LiCl, NaCl and KCl are

   (a) $t^-(LiCl) < t^-(NaCl) < t^-(KCl)$ (b) $t^-(LiCl) < t^-(KCl) < t^-(NaCl)$

   (c) $t^-(KCl) < t^-(NaCl) < t^-(LiCl)$ (d) $t^-(KCl) = t^-(NaCl) = t^-(LiCl)$

4. Consider the following half-cells and their reduction potential

   (1) $A + e^- \longrightarrow A^-$ $E^0 = -0.24V$

   (2) $B^- + e^- \longrightarrow B^{2-}$ $E^0 = 1.25V$

(3) $C^- + 2e^- \longrightarrow C^{3-}$ $\quad E^0 = 0.68V$

(4) $D + 2e^- \longrightarrow D^{2-}$ $\quad E^0 = -1.25V$

The correct combination of two half-cells that would result in a cell with the largest potential is

(a) (1) and (2) (b) (2) and (3) (c) (1) and (4) (d) (2) and (4)

5. Standard Gibb's free energy change of the reaction

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell) \text{ is,}$$

(Given: for $2H_2O \longrightarrow O_2 + 4H + 4e^-$, $\quad E^0$ is $-1.23V$)

(a) –475 kJ (b) 475 kJ (c) 237 kJ (d) –237 kJ

Q.6 to Q.10: Carry 2 Marks each.

6. Consider the following data of molar conductance at infinite dilution at 25°C

Electrolyte	KCl	KNO_3	HCl	NaOAc	NaCl
$\Lambda_m^\infty\left(Scm^2mol^{-1}\right)$	149.9	145.0	426.2	91.0	126.5

The limiting molar conductance of acetic acid (HOAc) is (in Scm^2mol^{-1})

(a) 517.2 (b) 390.7 (c) 552.7 (d) 227.5

7. When current of 2.0 A is passed for 5 hrs through a molten salt, it deposits 22g of metal (atomic weight 177). The oxidation state of the metal ion is

(a) 1 (b) 2 (c) 3 (d) 4

8. The ionic strength of Na_2SO_4 and $Ca_3(PO_4)_2$ will be same when

(a) Molality of Na_2SO_4 is 3 times of molality of $Ca_3(PO_4)_2$

(b) Molality of Na_2SO_4 is 5 times of molality of $Ca_3(PO_4)_2$

(c) Molality of $Ca_3(PO_4)_2$ is 3 times of molality of Na_2SO_4

(d) Molality of $Ca_3(PO_4)_2$ is 5 times of molality of Na_2SO_4

9. The cell constant and resistance of the cell is 0.5 cm^{-1} and 50 ohm respectively. The equivalent conductance (in $ohm^{-1}\ cm^2\ eq^{-1}$) containing 1N solution is

(a) 10 (b) 20 (c) 0.1 (d) 0.01

10. A potential of 5.6 V is applied to two electrodes placed 9.8 cm apart, the distance travelled by ammonium ion in one hour in a dilute solution of ammonium salt is (Given: $\lambda\left(NH_4^+ = 73.4\,\Omega^{-1}cm^2mol^{-1}\right)$

(a) 1.56 cm (b) 15.6 cm (c) 156 cm (d) 186 cm

PART-B

Q.11 to Q.15: Carry 2 Marks each.

11. Consider the following reaction and choose the correct options

$$2HNO_3(aq) + Cu(s) + 2H^+(aq) \longrightarrow 2NO_2(g) + Cu^{2+}(g) + 2H_2O(\ell)$$

(a) H^+ is the oxidising agent (b) Cu is the reducing agent

(c) HNO_3 is the oxidising agent (d) H^+ is the reducing agent.

12. The emf of the following cell is 0.22V, $Ag(s)|AgCl(s)|KCl(1M)||H^+(1M)|H_2(g)(1\,atm)|Pt$ which of the following will decrease the emf of the cell
(a) Increasing pressure of $H_2(g)$ from 1 atm to 2 atm
(b) Incrasing H^+ concentration in cathodic compartment
(c) Decreasing KCl concentration in anodic compartment
(d) Increasing Cl^- concentration in anodic compartment

13. Choose the correct option.
(a) Ionic mobility of Na^+ is greater than that of K^+
(b) Molar conductance increases on dilution
(c) Specific conductance decreases on dilution
(d) Transport number of Na^+ in NaOH is less than that of in NaCl

14. For 0.01 molal aqueous solution of $ZnSO_4$ at 25°C, the correct statements is/are
(a) $\log \gamma_{\pm} = -0.407$
(b) The mean activity coefficients increases when concentration increases to 0.1 molal.
(c) The mean activity coefficient increases by replacing $ZnSO_4$ to $Al_2(SO_4)_3$.
(d) For very dilute solution of $ZnSO_4$ $\gamma_{\pm}$ approaches to unity

15. Choose the correct option(s).
(a) Cathode has negative polarity in electrolytic cell
(b) Anode has negative polarity in galvanic cell
(c) Oxidation occurs at negative electrode in electrolytic cell
(d) Oxidation occurs at positive electrode in galvanic cell

PART-C

Q.16 to Q.17: Carry 1 Mark each.

16. The standard potential of a cell is 2.0 V at 298K. The equilibrium constant of the following net cell reaction at 298K is 10^x.

$$2MnO_4^- + 6H^+ + 5H_2C_2O_4 \longrightarrow 2Mn^{2+} + 8H_2O + 10CO_2$$

The value of x is _____(Round off to nearest integer)

$\left(\text{Given}: \frac{2.303RT}{F} = 0.059 \text{ at } 298K\right)$

17. The mean molality $(m_{\pm})$ of 0.01021 molal aquous solution of $ZnCl_2$ is _____mol/kg. (Round off to three decimal places).

Q.18 to Q.21: Carry 2 Marks each.

18. Ionic strength of 0.25 m $Ca_3(PO_4)_2$ is _____(Round off to two decimal places)

19. The molar conductance at infinite dilution of Ag^+ is 61.92×10^{-4} S.mol^{-1}m^2 at 25°C. The ionic mobility of Ag+ ion will be _____$\times10^{-8}$ m^{2}V^{-1}sec^{-1}. (Given: 1F = 96485 C) (Round off to two decimal places)

20. At 25°C, the specific conductance of a 0.01 M aqueous solution of acetic acid is 0.163 mSm^{-1}. The molar conductance at infinite dilution is 390×10^{-4} Sm^{2}mol^{-1}. The degree of dissociation of acid is _____% (Round off to three decimal places)

21. If $E^0_{Au^{3+}|Au^+} = -0.29$ V and $E^0_{Fe^{3+}|Fe^{2+}} = 0.77$ V, then E^0 for the reaction

$$2Fe^{2+}(aq) + Au^{3+}(aq) \longrightarrow 2Fe^{3+}(aq) + Au^+(aq)$$

is _____V. (Round off to two decimal places)

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PART - A

1. (c)	2. (b)	3. (c)	4. (d)	5. (a)	6. (b)	7. (c)
8. (b)	9. (a)	10. (a)				

PART - B

11. (b,c)	12. (a,c)	13. (b,c,d)	14. (a, d)	15. (a,b)

PART - C

16. (339)	17. (0.015 to 0.017)	18. (3.74 to 3.76)
19. (6.40 to 6.43)	20. (0.039 to 0.044)	21. (-1.07 to -1.05)