CBSE 12th Chemistry
Chapter - 03 (Electrochemistry)
Unsolved Important Questions

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SECTION – A

(Each question in this section carry 1 mark)

Q.1. Express the relation between the conductivity and the molar conductivity of a solution.

Q.2. Write the equation showing the relationship between equivalent and concentrate of a strong electrolyte.

Q.3. Name the method used for refining of copper metal.

SECTION - B

(Each question in this section carry 2 marks)

Q.4. From the given cells:
Lead storage cell, mercury cell, fuel cell and Dry cell.
Answer the following:
(i) Which cell is used in hearing aids?
(ii) Which cell was used in Apollo space programme?
(iii) Which cell is used in automobiles and inverters?
(iv) Which cell does not have long life?

Q.5. Which of the following pairs, will have greater conduction?

(i) 0.1 Acetic acid solutions or IM acetic acid solution.

(ii) 0.1 M NaCl Solution at 25^0C and 0.1 M NaCl solution at 50^oC

Q.6. The chemistry of corrosion of iron is essentially an electrochemical phenomenon. Explain the reactions occurring during the corrosion of iron in the atmosphere?

Q.7. Determine the values of the equilibrium constant (K_C) and ΔG^o for the following reaction:

$$Ni(s) + 2Ag^+(aq) \longrightarrow Ni^{2+}(aq) + 2Ag(s), E^o = 1.05\ V\ (1F = 96500\ C\ mol^{-1})$$

Q.8. **(a) Following reactions occur at cathode during the electrolysis of aqueous silver chloride solution:**

$$Ag^+(aq) + e^- \longrightarrow Ag(s) E^o = +0.80V$$

$$H^+(aq) + e^- \longrightarrow \frac{1}{2}H_2(g)\ E^o = 0.00V$$

On the basis of their standard reduction electrode potential (E^o) values, which reaction is feasible at the cathode and why?

(b) Define limiting molar conductivity. Why conductivity of an electrolyte solution decreases with the decrease in concentration?

Q.9. **Calculate the degree of dissociation (α) of acetic acid if its molar conductivity (Λ_m) is $39.05\ S\ cm^2\ mol^{-1}$.**
Given $\lambda^\circ(H^+) = 349.6\ S\ cm^2\ mol^{-1}$ and $\lambda^\circ(CH_3COO^-) = 40.9\ S\ cm^2\ mol^{-1}$

Q.10. **The resistance of a conductivity cell containing 0.001 M KCl solution at 298 K is 1500 Ω. What is the cell constant if the conductivity of 0.001 M KCl solution at 298 K is $0.146 \times 10^{-3}\ S\ cm^{-1}$?**

Q.11. **Consider the reaction:**
$Cr_2O_7^{2-} + 14\ H^+ + 6e^- \longrightarrow 2Cr^{3+} + 8H_2O$.
What is the quantity of electricity in coulombs need to reduce 1 mol of $Cr_2O_7^{2-}$?

Q.12. **What type of cell is a lead storage battery? Write the anode and the cathode reactions and the overall cell reaction occurring in the use of a lead storage?**

Q13. **Two half-cell reaction of an electrochemical cell are given below:**

$$MnO_4^- + 8H^+(aq) + 5e^-, \longrightarrow Mn^{2+}(aq) + 4H_2O\ (l),$$

$$E^0 = +1.51V Sn^{2+}(aq) Sn^{4+}(aq) + 2e^-, E^0 = +0.51V$$

Construct the redox equation from the two half-cell reactions and predict if this reaction favors formation of reactions or product shown in the equation.

Q.14. **A solution of $CuSo_4$ is electrolyzed for 10 minutes with a current of 1.5 amperes. What is the mass of copper deposited at the cathode?**

Q.15. **Express the relation among the cell constant, the resistance of the solution in the cell the conductivity of the solution. How in the conductivity of a solution related to its molar conductivity?**

Q.16. Given that the standard electrode potentials (E^0) of metals are:

$K^+/K = -2.93V, Ag^+/Ag = 0.80V, Cu^{2+}/Cu = 0.34V,$
$Mg^{2+}/Mg = -2.37V, Cr^{3+}/Cr = -0.74V, Fe^{2+}/Fe = -0.44V.$

Arrange these metals in an increasing order of their reducing power.

Q.17. Two half-reaction of an electrochemical cell are given below:

$$MnO_4^-(aq) + 8\,H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4\,H_2O\,(l),\ E^0 = +1.51\ V,$$
$$Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq) + 2\,e^-,\ E^0 = +0.15^V$$

Construct redox equation and predict if the recon is reactant or product favored.

Q.18. Express the relation among cell constant, resistance of the solution in the cell and conductivity of the solution. How is molar conductivity of a solution related to its conductivity?

Q.19. The molar conductivity of a 1.5 M solution of an electrolyte is found to be 138.9 S $cm^2 mol^{-1}$. Calculate the conductivity of this solution.

Q.20. Calculate the equilibrium constant, K for the reaction at 298 K,

$$Zn(s) + \quad Cu^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Cu(s)$$

Given: $E^0_{Zn^{2+}/Zn} = -0.76\ V$, $E^0_{Cu^{2+}/Cu} = +0.34\ V$.

Q.21. State Kohlrausch law of independent migration of ions. Why does the conductivity of a solution decrease with dilution?

Q.22. Calculate the time to deposit 1.27g of copper at cathode when a current of 2A was passed through the solution of $CuSO_4$

$(Molar\ mass\ of\ Cu = 63.5g\ mol^{-1}, 1F = 96500\ C\ mol^{-1})$.

Q.23. Write the name of the cell which is generally used in hearing aids. Write the reactions taking place at the anode and the cathode of this cell.

Q.24. Depict the galvanic cell in which the reaction

$$2Zn(s) + 2Ag^{+}(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$$

Take place. Further, show.
(i) Which of the electrodes is negatively charged?
(ii) the carries of the current in the cell.
(iii) individual reaction at each electrode.

SECTION C

(Each question in this section carry 3 marks)

Q.25. Calculate emf of the following cell at 25℃ : $Fe|Fe^{2+}\ (0.001\ M)||H^{+}(0.01M)|H_2(g)$ $(1\ bar)|Pt(s)E^{o}(Fe^{2+}|Fe) = -0.44\ V\ E^{o}(H^{+}|H_2) = 0.00V.$

Q.26. (a) Calculate the mass of Ag deposited at cathode when a current of 2 amperes was passed through a solution of $AgNO_3$ for 15 minutes.
(Given: Molar mass of Ag $= 108\ g\ mol^{-1}$ lF $= 96500\ C\ mol^{-1}$)
(b) Define fuel cell.

Q.27. Depict the galvanic cell in which the reaction

$$2Zn(s) + 2Ag^{+}(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$$

Take place. Further, show.
(i) Which of the electrodes is negatively charged?
(ii) the carries of the current in the cell.
(iii) individual reaction at each electrode.

Q.28. Calculate the emf of the following cell at.
$25^0C: Ag(s)|Ag^{+}(10^{-3}M||Cu^{2+}(10^{-1}\ M)|Cu(s)$ Give
$E^0{}_{Cell} = -0.46\ V\ and\ log\ 10^n = n$

Q.29. (a) Calculate E^0_{cell} for the following reaction at 298 K: $2\ Al(s) + 3Cu^{2+}\ (0.01\ M) \rightarrow 2Al^{3+}\ (0.01\ M) + 3Cu(s)$
$Given:\ E_{cell} = 1.98\ V$
(b) Using the E^0 values of A and B, predict which is better for coating the surface of iron $[E^0\ (Fe^{2+}/Fe) = -0.44\ V]$ to prevent corrosion and why?
$Given: E^0\ (A^{2+}/A) = 2.37V: E^0(B^{2+}/B) = 0.14V.$

Q.30. **(a) The conductivity of $0.001\ mol\ L^{-1}$ solution of CH_3COOH is $3.905 \times 10^{-5}\ S\ cm^{-1}$. Calculate its molar conductivity and degree of dissociation (α). Given: $\lambda^o(H^+) = 349.6\ S\ cm^2\ mol^{-1}$ and $\lambda^o(CH_3COO^-) = 40.9\ S\ cm^2\ mol^{-1}$**

Q.31. **(a) The cell in which the following reaction occurs:**

$$2Fe^{3+}\ (aq)\ +\ 2I^-\ (aq)\ \rightarrow\ 2Fe^{2+}\ (aq)\ +\ I_2(s)$$

Has E°_{cell}= 0.236 V at 298 K. Calculate the standard Gibbs energy of the cell reaction. (Given: 1F = 96,500 C mol^{-1})

(b) How many electrons flow through a metallic wire if a current of 0.5 A is passed for 2 hours? (Given 1 F = 96,500 C mol^{-1})

Q.32. **Conductivity of $2.5 \times 10^{-4} M$ Methanoic acid is $5.25 \times 10^{-5} S\ cm^{-1}$ Calculate its molar conductivity and degree of dissociation. Given: $\lambda^\circ(H^+)349.5 cm^2 mol^{-1}$ and $\lambda^\circ(HCOO^-) = 50.5 cm^2 mol^{-1}$**

Q.33. **The electrical resistance of a column of 0.05 M, NaOH solution of diameter 1 cm and length 50cm is $5.55 \text{x} 10^3$ohm.**
Calculate its resistivity, conductivity and molar conductivity.

Q.34. **(a) Calculate $\Delta_r G^\circ$ for the reaction Mg(s) + $Cu^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Cu(s)$**

Given: $E^\circ_{cell} = +2.71V, 1\ F = 96500\ C\ mol^{-1}$

(b) Name the type of cell which was used in Apollo space program for providing electrical power.

SECTION D

(Each question in this section carry 5 marks)

Q.35. **Conductivity of 0.00241 M acetic acid solution is 7.896×10^{-5} S cm^{-1}. Calculate its molar Conductivity in this solution. If $\wedge^o_M$ for acetic acid be 390.5 S cm^{2}mol^{-1}, what would be its dissociation constant?**

Q.36. **Three electrolytic cells A, B and C containing solutions of zinc sulphate, silver nitrate and copper sulphate, respectively are connected in series. A steady current of 1.5 ampere was passed through them until 1.45 g of silver were deposited at the cathode of cell B. How long did the current flow? What mass of copper and what mass of zinc were deposited in the concerned cells? (Atomic masses of Ag = 108, Zn = 65.4, Cu = 63.5)**

Q.37. **(a) Define molar conductivity of a substance and describe how for weak and strong electrolytes, molar conductivity changes with concentration of solute. How is such change explained?**

(b) A voltaic cell is set up at 25^0C with the following half cells:
Ag* (0.001 M) | Ag and $Cu^{2+}(0.10\ M)|\ Cu$
What would be the voltage of this cell? ($E^0_{cell} = 0.46\ V$)

Q.38. **(a) State the relationship amongst cell constant of a cell, resistance of the solution in the cell and conductivity of the solution. How is its solution? How is molor conductivity of a solute related to conductivity of its solution?**

(b) A voltaic cell is set up at 25^0C with the following half-cells:
$Al\ |\ Al^{3+}\ (0.001\ M)\ and\ Ni\ |\ Ni^{2+}\ (O.50\ M)$
Calculate the cell voltage [$E^0_{Ni^{2+}|Ni} = -0.25\ V, E^0_{Al^3|Al} = -1.66\ V$]

Q.39. **(a) State Kohlrausch law of independent migration of ions. Write an expression for the molar conductivity of acetic acid at infinite dilution according to Kohlrausch law.**

(b) Calculate: $\Lambda^0{}_m\ for\ acetic\ acid$

Given that: $\Lambda^0{}_m(\text{HCl}) = 426\ \text{S}\ cm^2\ mol^{-1}$

$\Lambda^0{}_m(\text{NaCl}) = 126\ \text{S}\ cm^2\ mol^{-1}$

$\Lambda^0{}_m(CH_3COONa) = 91\ \text{S}\ cm^2\ mol^{-1}$

Q.40. **(a) Write the anode and cathode reactions and the overall reaction occurring in a lead storage battery.**

(b) A copper-silver cell is set up. The copper ion concentrations is 0.10 M. The concentration of silver ion is not known. The cell potential when measured was 0.422 V. Determine the concentration of silver ions in the cell.

($Given\ E^0Ag^+/Ag = +0.80\ V, E^0Cu^{2+}/Cu = +0.34V$)

Q.41. **(a) What type of a battery is the lead storage battery? Write the anode and the cathode reactions and the overall reaction occurring in lead storage battery when current is drawn from it.**

(b) In the button cell, widely used in watches, the following reaction takes place

$$Zn_{(s)} + Ag_2O_{(s)} + H_2O_{(l)} \longrightarrow Zn^{2+}\ (aq) + 2\ Ag_{(s)} + 2\ OH^-_{(aq)}$$

Determine E^0 and ΔG^0 for the reaction.

(Given: $E^0{}_{Ag^+/Ag} = +\ 0.80V, E^0_{\frac{zn^{2+}}{zn}} = -0.76\ V$)

Q.42. **(a) Define molar conductivity of a solution and explain how molar conductivity changes with change in concentration of solution for a weak and a strong electrolyte.**

(b) The resistance of conductivity cell containing 0.001 M KCl solution at 298 K is 1500Ω. What is the cell constant if the conductivity of 0.001 M KCI solution at 298 K is $0.146 \times |10^{-3}\ S\ Cm^{-1}$?

Q.43. **(a) Define the following terms:**

(i) Limiting molar conductivity,

(ii) Fuel cell

(b) Resistance of a conductivity cell filled with $0.1\ mol\ L^{-1}KCl$ solution is 100 w. If the resistance of the same cell when filled with $0.02\ mol\ L^{-1}KCl$ solution is 520 W. Calculate the conductivity and molar conductivity of $0.02\ mol\ L^{-1}KCl$ solution. The conductivity of$0.1\ mol\ L^{-1}\ KCl$ solution is:
$1.29 \times 10^{-1}\ W^{-1}cm^{-1}$.

Q.44. **(a) State faraday's first law of electrolysis. How much charge in terms of Faraday's required for the reduction of 1mol of Cu^{2+} to Cu.**

(b) Calculate emf of the following cell at

$298\ K : Mg\ (s)\left|\ Mg^{2+}(0.1\ M)\right|\left|Cu^{2+}(0.001)\right|\ Cu(s)$

$\left[Given\ E^{0}_{cell} = +2.71V, 1\ F = 96500\ C\ mol^{-1}\right]$.

Q.45. **(a) What type of a battery is lead storage battery? Write the anode and cathode reactions and the overall cell reaction occurring in the operation of a lead storage battery.**
(b) Calculate the potential for half-cell containing

$0.10M\ \ K_2Cr_2O_7(aq)\ \ MCr^{3+}(aq)\ and\ 1.0 \times 10^{-4}M\ H^{+}(aq)$

The half-cell reaction is

$Cr_2O_7^{2-}(aq) + 14H^{+}(aq) + 6e^{-} \longrightarrow 2Cr^{3+}(aq) + 7H_2O\ (l)$,

And the standard electrode potential is given $E^{0} = 1.33\ V$.

Q.46. **(a) How many moles of mercury will be produced by electrolyzing 1.0M Hg $(NO_3)_2$ solution with a current of 2.00 A for 3 hours? [Hg $(NO_3)_2 = 200.6 mol^{-1}$]**

(b) A voltaic cell is set up at 25^0C with the following half-cells $Al^{3+}(0.001M)$ and $Ni^{2+}(0.50M)$. Write an equation for the reaction that occurs when the cell generates an electric current and determine the cell potential.

$(Given: E^{0}_{\frac{Ni^{2+}}{Ni}} = 25^0, E^{0}_{Al^{3+}/Ai} = -1.66V)$

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