Chapter – 4
Electrochemistry

Very Short Answer Type Questions

01. Write mathematical expression of Nernst equation for $Zn(s)\left|Zn^{2+}(aq)\right|\left|Cu^{2+}(aq)\right|Cu(s)$.

02. What is a primary cell? Give one example.

03. At infinite dilution the molar conductivities of Na^+ and SO_4^{2-} ions are 50 S cm^2 mol^{-1} and 160 S cm^2 mol^{-1} respectively. What will be the molar conductivities of sodium sulphate at infinite dilution?

04. What is the relationship between cell potential and equilibrium constant.

05. The standard reduction potential values of three metal cations X, Y and Z are +0.52, -3.03, -1.18V respectively. Arrange the corresponding metals in order of their increasing reducing power.

06. Rusting of iron is quicker in saline water than in ordinary water. Why is it so?

07. What is a secondary cell? Write two examples of it.

08. What is meant by 'limiting molar conductivity'?

09. Express the relation among the conductivity of solution in the cell, the cell constant and the resistance of solution in the cell.

10. Mercury cell is suitable for low current device like hearing aids, watches etc why ? Write the cell reaction occur at anode and cathode.

Short Answer Type Questions

11. Can a nickel spatula be used to stir a solution of copper sulphate? Support your answer with reason. $\left[E^0_{Ni^{2+}/Ni} = -0.25V, E^0_{Cu^{2+}/Cu} = +0.34V\right]$

12. Explain Kohlrausch's law of independent migration of ions. Mention one application of Kohlrausch's law.

Or

State and explain Kohlrausch law.

13. Give a brief account of corrosion and its mechanism.

14. With the help of a graph explain why it is not easy to determine Λ^0_m for a weak electrolyte by extrapolating the graph concentration-molar conductance curve as poor electrolytes.

15. Explain with the help of a diagram, the effect of change in concentration of solution on the molar conductivity of. (i) a weak elctrolyte, and (ii) a strong electrolyte.

16. Give an example of a fuel cell and write the anode and cathode reactions for it.

17. Predict the products of electrolysis obtained at the electrodes in each case when the electrodes used are platinum: (i) An aqueous solution of $AgNO_3$ (ii) An aqueous solution of H_2SO_4.

18. What is a Nickel-cadmium cell ? State one of it merit and demerit of this cell.

19. Write the cell reaction which occur in lead storage battery when the battery is charging and discharging.

20. (a) 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.

(b) Calculate the mass of Ag deposited at cathode when a current 2A was passed through a solution of $AgNO_3$ for 15 min. Given molar mass of $Ag = 108 g\ mol^{-1}$ $1F = 96500 C\ mol^{-1}$

21. (i) The cell in which the following reaction occurs $2Fe^{3+}_{(aq)} + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$ has $E^{\Theta}_{cell} = 0.236V$ at 298k. Calculate the standard Gibb's energy of the cell reaction given 1F = 96500 C.

(ii) How many electrons flow through a metallic wire of a current of 0.5 A is placed for 2 hrs. $1F = 96500\ C\ mol^{-1}$

22. For a cell, $Ag(s)|AgNO_3(0.01M)||AgNO_3(1.0M)|Ag(s)$

(a) Write the net cell reaction. (b) Calculate the e.m.f. at 25^0 C.

(c) Will the cell generate e.m.f. when the concentrations become equal?

23. How many hours does it take to reduce 3 mole of Fe^{3+} to Fe^{2+} with 2.00 A current?

(R = 8.314 K^{-1} mol^{-1} ; F = 96,500 C mol^{-1})

24. A solution of $Ni(NO_3)_2$ is electrolysed between platinum electrodes using a current of 5.0 A for 20 min, what mass of nickel will be deposited at the cathode

(Given atomic mass of Ni = 58.7 g mol^{-1}) 1F = 96500 C mol^{-1}

25. Calculate the emf for the given cell at 25^0C: $Cr_{(s)}\left|Cr^{3+}\left(0.01M\right)\right|\left|Fe^{2+}\left(1.0\,M\right)\right|Fe_{(s)}$

$\left[Given: E^0_{Cr^{3+}/Cr} = -0.74V, E^0_{Fe^{2+}/Fe} = -0.44V\right]$

26. (a) Write the cell reaction and calculate the e.m.f. of the following cell at 298 K

$\mathrm{Sn(s)\left|Sn^{2+}(0.004M)\right|\left|H^+\right|0.020M\left|H_2(g)(1bar)Pt(s)\right|}$. Given . $\mathrm{E^0_{Sn^{2+}/Sn} = -0.14V}$

(b) Give reasons :

(i) On the basis of $\mathrm{E^0}$ values, $\mathrm{O_2}$ gas should be libreated at anode but it is $\mathrm{Cl_2}$ gas which is liberated in the electroysis of aq NaCl.

OR

(a) For the reaction $\mathrm{2AgCl(s) + H_2(g)(1atm) \rightarrow 2Ag(s) + 2H^+(0.1M) + 2Cl^-(0.1M)}$

$\mathrm{\Delta G^{\ominus} = -43600\ J/mol\ at\ 25^0C}$. Calculate the emf of the cell $\mathrm{\log 10^{-n} = -n}$

(b) Define fuel cell and write its two advantages.

27. How many moles of mercury will be produced by electrolysing 10 M $\mathrm{Hg(NO_3)_2}$ solution with a current 2Amp for 3 hours. $\mathrm{Hg(NO_3)_2 = 200.6\ gmol^{-1}}$.

Long Answer Type Questions

28. (a) Depict the galvanic cell in which the following reaction takes place.

$Zn(s) + 2Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$ Also indicate that in this cell

(i) Which electrode is negatively charged?

(ii) What are the carriers of the current in the cell?

(iii) What is the individual reaction at each electrode?

(b) Write the Nernst equation and determine the e.m.f. of the following cell at 298 K.

$Mg(s)\left|Mg^{2+}(0.001M)\right|\left|Cu^{2+}(0.0001M)\right|Cu(s)$

$Given: E^0_{Mg^{2+}/Mg} = -2.37V, E^0_{Cu^{2+}/Cu} = +0.34V$

29. (a) Define conductivity and molar conductivity for the solution of an electrolyte. How do they vary when the concentration of electrolyte in the solution increases?

(b) Three electrolyte cells A, B and C containing solution of $ZnSO_4$, $AgNO_3$ and $CuSO_4$, respectively are connected in series. A steady current of 1.5 ampere was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow? What mass of copper and of zinc were deposited? (Atomic mass : Zn = 65.4u, Ag = 108u, Cu = 63.54).

30. 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.

(Given that Λ_m^0 (HCl) = 426 S cm^2 mol^{-1}, Λ_m^0 (NaCl) = 126 S cm^2 mol^{-1} and Λ_m^0 (CH_3COONa) = 91 S cm^2 mol^{-1}.

MODEL QUESTIONS

01. Represent the galvanic cell in which the reaction, $Zn(s)+Cu^{2+}(aq)\rightarrow Zn^{2+}(aq)+Cu(s)$ takes place.

02. What is the necessity to use a salt bridge in a Galvanic cell?

03. Define electrochemical cell. What happens if external potential applied becomes greater than E^0_{cell} of electrochemical cell?

04. The standard electrode potential (E^0) for Daniell cell is +1.1V. Calculate the ΔG^0 for the reaction . $Zn(s)+Cu^{2+}(aq)\rightarrow Zn^{2+}(aq)+Cu(s)$

05. The standard electrode potential for Daniell cell is 1.1V. Calculate the standard Gibbs energy for the cell reaction. (F = 96500 C mol^{-1})

06. A zinc rod is dipped in 0.1M solution of $ZnSO_4$. The salt is 95% dissociated at this dilution at 298K. Calculate the electrode potential.. $\left[E^0_{Zn^{2+}/Zn}=-0.76V\right]$

07. Two half reactions of an electrochemical cell are given below:

$MnO_4^-(aq)+8H^+(aq)+5e^-\rightarrow Mn^{2+}(aq)+4H_2O(l)$, $E^0=+1.51V$, $Sn^{2+}(aq)\rightarrow Sn^{4+}(aq)+2e^-$, $E^0=-0.15V$. Construct the redox equation from the standard potential of the cell and predict, if the reaction is reactant favoured or product favoured.

08. 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.

09. Calculate the emf for the given cell at 25^{0}C. $Cr_{(s)}|Cr^{3+}(0.1M)||Fe^{2+}(0.01M)|Fe_{(s)}$.

Given $\left[E^0_{Cr^{3+}/Cr}=-0.74V, E^0_{Fe^{2+}/Fe}=-0.44V\right]$.

10. Formulate the galvanic cell in which the following reaction takes place.

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

(i) Which one of its electrodes is negatively charged?

(ii) The reaction taking place at each of its electrode.

(iii) The carriers of current within this cell.

11. A strip of nickel metal is placed in a 1 molar solution of $Ni(NO_3)_2$ and a strip of silver metal is placed in a one molar solution of $AgNO_3$. An electrochemical cell is created when the two solutions are connected by a salt bridge and the two strips are connected by wires to a voltmeter.

(a) Write the balanced equations for the overall reaction occurring in the cell and calculate the cell potential.

(b) Calculate the cell potential, E, at 25^0C for the cell, if the initial concentration of $Ni(NO_3)_2$ is 0.100 molar and the initial concentration of $AgNO_3$ is 1.00 molar.

$$\left[E^0_{Ni^{2+}/Ni}=-0.25V, E^0_{Ag^{+}/Ag}=0.80V, \log 10^{-1}=-1\right]$$