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Class 12 - Chemistry
ELECTROCHEMISTRY 2

Maximum Marks: 100 **Time Allowed: 2 hours**

Section A

1. What are fuel cells? Why we need these types of fuel cells? Explain with an example. **3**

2. Write the Nernst equation and calculate the emf of the following cell at 298 K **3**

   Cu(s)|Cu^{2+}(0.130M)||Ag$^+$(1.00 $\times$ 10^{-4}M)|Ag(s)

   Given: $E^0_{Cu^+/cu} = +0.34V$ and $E^0_{Ag^+/Ag} = +0.80V$

3. Define conductivity and molar conductivity for solution of an electrolyte. Discuss their variation with concentration. **3**

4. For the cell: **3**

   $$Zn(s)|Zn^{2+}(2M)||Cu^{2+}(0.5)|Cu(s)$$

   i. Write equation for each half-reaction.

   ii. Calculate the cell potential at $25^0\ C$. Given:

   $$E^{\Theta}_{(Zn^{2+}/Zn)} = -0.764V,\ E^{\Theta}_{(Cu^{2+}/Cu)} = 0.34V$$

5. Conductivity of 0.00241 M acetic acid is $7.896 \times 10^{-5} S\ cm^{-1}$. Calculate its molar conductivity. If λ^0_m for acetic acid is 390.5 S cm^{2}mol^{-1}. What is its dissociation constant? **3**

6. Write the cell reaction which occur in the lead storage battery **3**

   i. When the battery is in use

   ii. When the battery is on charging.

7. Calculate the equilibrium constant for the reaction at T=298 K. **3**

   $$Fe(s) + Cd^{2+}(aq) \rightarrow\ Fe^{2+}(aq) + Cd(s)$$

   $$\left[\text{Given, E}^{\Theta}_{Cd^{2+}/cd} = -0.40V, E^{\Theta}_{Fe^{2+}/Fe} = -0.44V\right]$$

8. Write the chemical equation for all the steps involved in the rusting of iron. Give any one method to prevent rusting of iron. **3**

9. Calculate the emf of the cell **3**

$$Mg(s)|Mg^{+2}(0.1M)||Cu^{+2}(1 \times 10^{-3}M|Cu(s))$$

Given, $E^{\ominus}_{Cu^{2+}/Cu} = +0.34V, E^{\ominus}_{Mg^{+2}/Mg} = -2.37V)$

10. Zinc rod is dipped in 0.1 M solution of $ZnSO_4$ **3**

The salt is 95% dissociated at is dilution at 298 K . Calculate the electrode potential. Given:
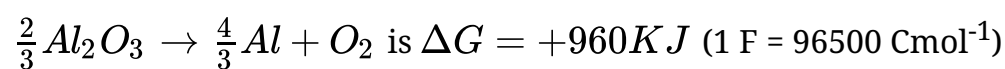
$E^0(Zn^{2+}/Zn)$ = -0.76

11. What type of a cell is the lead storage battery? Write the anode and cathode   **3** reactions and the overall reaction occurring in a lead storage battery while operating.

12. How is 'ohm' expressed in terms of dimensions in SI unit? How do you arrive at   **3** this conversion?

13. What is the difference between Galvanic cell (Electrochemical cell) and Electrolytic   **3** cell.

14. Estimate the minimum potential difference needed to reduce Al_2O_3 at 500°C. The   **3** free energy charge for the decomposition reaction.

$\frac{2}{3}Al_2O_3 \rightarrow \frac{4}{3}Al + O_2$ is $\Delta G = +960KJ$ (1 F = 96500 Cmol^{-1})

15. The E^0 values at 298 K corresponding to the following two reduction electrodes   **3** processes are:

  i. Cu^+/Cu = +0.52V

  ii. Cu^{2+}/Cu^+ = +0.16V

Formulae the galvanic cell for their combination. What will be the cell potential? Calculate the $\Delta_r G^0$ for the cell reaction. (1 F = 96500 C mol^{-1})

16. What is understood by a normal hydrogen electrode? Give its significance?   **3**

17. How much time would it take in minutes to deposit 1.18 g of metallic copper on a   **3** metal object when a current of 2.0 A is passed through the electrolytic cell containing Cu^{2+} ions?

[Cu = 63.5g/mol, 1F = 96, 500C mol^{-1}]

18. How much copper is deposited on the cathode of an electrolytic cell if a current of   **3** 5 ampere is passed through a solution of copper sulphate for 45 minutes?

19. Calculate the emf of the cell Mg(s) || Mg^{2+}(0.1 M) || Cu^{2+} (1 × 10^{-3} M) | Cu(s)   **3**

Given : $E^0(Cu^{2+}/Cu)$ = +0.34V

$E^0(Mg^{2+}/Mg)$ = -2.37V

20. Explain with examples the terms weak and strong electrolytes. **3**

21. How long will it take an electric current of 0.15 A to deposit all the copper from 500 ml of 0.15 M copper sulphate solution? **3**

22. Calculate the equilibrium constant for the following reaction at 298 K **3**

$$Cu(s) + Cl_2(g) \rightarrow CuCl_2(aq)$$
$$R = 8.314 JK^{-1}mol^{-1}$$
$$E^0(Cu^{2+}/Cu) = 0.34V$$
$$E^0(Cl_2/Cl^{-1}) = 1.36V$$

1F = 96500 C mol^{-1}

23. One half-cell in a voltaic cell is constructed from a silver wire dipped in silver nitrate solution of unknown concentration. The other half cell consists of a zinc electrode in a 1.0 M solution of $Zn(NO_3)_2$. A voltage of 1.48 V is measured for this-cell. Use this information to calculate the concentration of silver nitrate solution. **3**

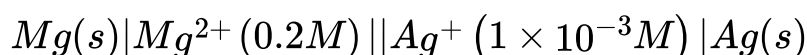$$(Given, E^{\ominus}_{Zn^{2+}/Zn} = -0.763\,V, E^{\ominus}_{Ag^+/Ag} = +0.80\,V)$$

24. What is an electrochemical series? How does it help in calculating the e.m.f of a standard cell? **3**

25. The measured resistance of a conductance cell containing $7.5 \times 10^{-3}M$ solution of KCl at 25°C was 1005 ohms. Calculate **3**

 a. specific conductance

 b. molar conductance of the solution cell constant = 1.25cm^{-1}.

26. Calculate the emf of the following cell: **3**

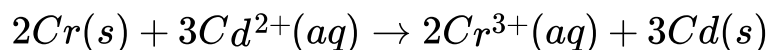$$Mg(s)|Mg^{2+}(0.2M)||Ag^+(1 \times 10^{-3}M)|Ag(s)$$
$$E^0(Ag^+/Ag) = 0.80V$$
$$E^0(Mg^{2+}/Mg) = -2.37V$$

27. Three iron sheets have been coated separately with three metals (A, B and C) whose standard electrode potentials are given below: **3**

MetaI	A	B	C	Iron

E^0_{value}	-0.46	-0.66V	- 0.20 V	- 0.44 V

28. Calculate the standard cell potential of the galvanic cell in which the following **3**

    reaction takes place.

    $2Cr(s) + 3Cd^{2+}(aq) \rightarrow 2Cr^{3+}(aq) + 3Cd(s)$

    Also calculate the ΔrG^0 value of the reaction.

    (Given $E^0(Cr^{3+}/Cr) = -0.74V$)

    $E^0(Cd^{3+}/Cd) = -0.40V$

    and F = 96500C mol^{-1}

29. For what concentration of Ag$^+$(aq) will the emf of the given cell be zero at 25^0C if **3**

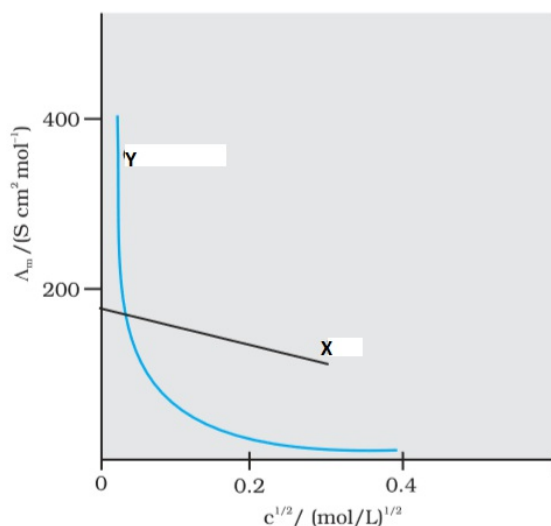   the concentration of Cu^{2+}(aq) is 0.1 M? ($E^{\ominus}_{(Ag^+/Ag)} = +0.80\ V$,

    $E^{\ominus}_{(Cu^{2+}/Cu)} = +0.34\ V$)

30. Suggest a way to determine λ^0_m value of water? **3**

31. a. What is electrochemical equivalent? **2**

     b. Calculate the cell emf and ΔG° for the cell reaction at 25^0C. Zn / Zn^{+2}(0.1M) //

         Cu^{+2}(0.01M) /Cu electrode potential for Zn is - 0.403 volt and for Cu is -0.763 volt

32. The following curve is obtained when molar conductivity, Λ_m is plotted against **2**

    the square root of concentration, C$^{1/2}$ along y and x-axis respectively for the two

    electrolytes X and Y.

     i. What can you say about the nature of these two electrolytes?

     ii. How do you account for the increase in Λ_m for the electrolytes X and Y with

          dilution?

     iii. How can you determine Λ^{∞}_m for these electrolytes?

33. a. What is Nickel Cadmium cell? State its one merit over lead storage cell. Write **2**

the overall reaction that occurs during discharging of this cell.

b. Silver is electro deposited on a metallic vessel of total surface area 900 cm^2 by passing a current of 0.5 ampere for 2 hours.

Calculate the thickness of silver deposited, given its density is 10.5gcm^{-3}. (At. mass of Ag = 108 g mol^{-1}).

34. Conductivity of 0.00241 M acetic acid is $7.896 \times 10^{-5} \, S \, cm^{-1}$. Calculate its molar conductivity. If $\Lambda^o{}_m$ for acetic acid is 390.5 S cm^2 mol^{-1}, what is its dissociation constant?   **2**

35. What do you understand by sacrificial, cathodic and barrier protection of corrosion?   **2**