UNIT-3 : ELECTROCHEMISTRY

One mark questions:	
1. When can a Galvanic cell become an electrolytic cell?	U
2. What is limiting molar conductivity?	K
3. Why does the molar conductivity increase on decreasing the concentration of the weak electrolyte?	U
4. The value of $\wedge^0_{m(NaBr)} - \wedge^0_{m(NaCl)} \cong 1.8\ Scm^2mol^{-1}$, then calculate the value of $\wedge^0_{m(KBr)} - \wedge^0_{m(KCl)}$.	U
5. $\lambda^0_{H^+}$ and $\lambda^0_{OH^-}$ are 349.6 Scm^2mol^{-1} and 199.1 Scm^2mol^{-1} at 298 K respectively. Calculate $\wedge^0_m$ of water.	S
6. When 1F of charge is passed through 1M HCl, volume of hydrogen liberated was 11.35L at STP. What is the volume of hydrogen liberated when same quantity of electricity is passed through 1M H_2SO_4.	A
7. Differentiate between reactive and inert electrodes.	U
8. What is the role of platinum in SHE?	U
9. What is the value assigned to the electrode potential of SHE at 300K?	U
10. A galvanic cell is constructed using SHE and silver electrode . $[Ag^+]$ = 1M and E^oAg^+/Ag = +0.8V. What is the cell potential?	S
11. Given $E^0_{Ni} < E^0_{H_2}$, then between nickel and hydrogen which is more stable in reduced form?	S
12. Mention an observation made when an iron rod is dipped into 0.1M $CuSO_4$ solution?	U
13. Following are the values of E^0_{red} values of certain elements. Arrange them in the descending order of their oxidizing power. $E^0_{Mg^{+2}/Mg} = -2.36V$, $E^0_{Ni^{+2}/Ni} = -0.25V$, $E^0_{Fe^{+3}/Fe^{+2}} = 0.77V$, $E^0_{Ag^+/Ag} = +0.8V$, $E^0_{F_2/F^-} = 2.87V$	A
14. What is the electrode potential of a Daniell cell when the concentrations of copper and zinc ions are 1M each. $E^0_{Cu^{+2}/Cu} = 0.34V$, $E^0_{Zn^{+2}/Zn} = -0.76V$?	A
15. ΔG for the reaction $2X^+ + 2e^- \longrightarrow X_2$ is −84.92 kJ. What is the value of ΔG for the reaction: $X^+ + e^- \longrightarrow ½\ X_2$? [A:−42.46kJ]	A
16. Write the relationship between E^o_{cell} and equilibrium constant.	K
17. What is the major difference between a primary battery and a secondary battery?	U

18. Name one metal which can be used as sacrificial electrode to prevent rusting of iron.	A
Two mark questions:	
1. Differentiate between strong and weak electrolytes.	U
2. Define conductivity of a solution. Write its SI unit.	K
3. How does (i) conductivity (ii) molar conductivity of an electrolyte change with dilution?	U
4. The cell constant of a given cell is 0.47 cm^{-1}. The resistance of a solution taken in the cell was found to be 31.6Ω. Calculate the conductivity of the solution. [A : 0.0148S cm^{-1}]	S
5. The conductivity of 0.025 M solution of methanoic acid is 1.1525 S cm^{-1}. Calculate its molar conductivity. [A:46100 S cm^2 mol^{-1}]	S
6. State (i) Faraday's II law of electrolysis (ii) Kohlrausch law	K
7. A solution of $Ni(NO_3)_2$ is electrolysed between Pt electrodes using current of 5 amps for 20 mins. What mass of nickel is deposited at the cathode? (Molar mass of Ni=58.7 g mol^{-1}. 1F = 96487 C)	S
8. 96487C of charge is passed through both $CuSO_4$ solution and $AgNO_3$ solution. The mass of copper deposited is 32g. What would be the mass of silver deposited? (Molar mass of copper = 64gmol^{-1} and silver =108g mol^{-1}) (1F=96487C)	S
9. In electrolysis, lower the electrode potential, higher is the tendency for oxidation reaction to occur. When aqueous NaCl is electrolysed, following two reactions are possible. Which of these two is preferred and why? $Cl^-_{(aq)} \longrightarrow ½\ Cl_{2\,(g)} + e^-$ E^0_{cell} = 1.36 V $2H_2O_{(l)} \longrightarrow O_{2\,(g)} + 4H^+_{(aq)} + 4e^-$ E^0_{cell} = 1.23 V	A
10. A total of 49750C of charge was required to reduce 9.5g of M^{+3} ion to metal. Calculate the molar mass of the metal. 1F = 96500C. [A:55.28]	S
11. Calculate $\wedge^0_m$ for $CaCl_2$ given $\lambda^0_{Ca^{2+}}$ = 119.0 Scm^2mol^{-1} and $\lambda^0_{Cl^-}$ = 76.3 Scm^2mol^{-1}. [A: 271.6 Scm^2 mol^{-1}]	S
12. Write the anodic reaction occurring during the electrolysis of dilute H_2SO_4. What would be the product if higher concentration of sulphuric acid is electrolysed?	K
13. What are the conditions under which a hydrogen electrode is considered a standard hydrogen electrode?	U
14. Draw a neat labeled diagram of SHE and write its symbolic representation.	S

15. Given $E^0_{Ni^{2+}/Ni} = -0.25V$, $E^0_{Cr^{3+}/Cr} = -0.74V$. Identify a stronger redox couple. Give reason.	S
16. In a cell, the reaction $Fe + 2H^+ \longrightarrow Fe^{+2} + H_2$, takes place. What happens to the emf of the cell when sulphuric acid is poured at the cathode. Give reason.	A
17. The reduction potential of Mg^{+2} and Al^{+3} are -2.37 and -1.66 volts respectively. Constructing a Galvanic cell using these electrodes, give the cell representation, and write the Nernst equation .	S
18. At which electrode will oxidation occur in a (i) Galvanic cell (ii) electrolytic cell	U
19. E^0_{Cu} = +0.3V. Copper does not dissolve in HCl but dissolves in HNO_3. Explain.	U
20. EMF of a galvanic cell is 1.05V and 193000 Coulomb of charge is passed. Calculate the reversible work done by the cell. [A: 202650J]	S
21. Write the overall cell reaction occurring in a mercury-cell. Its cell potential remains a constant value of approximately 1.35V during its life. Why?	U
22. Write the reactions occurring during discharging of lead storage battery.	K
23. What are the advantages of fuel cell over other conventional power plants in producing energy?	A
24. i) Chemically "what is rust"? ii) Write anodic reaction occurring during the rusting of iron	K
25. Give two methods for the prevention of corrosion.	A
Three mark questions	
1. What do we mean by cell constant in conductivity measurements. If the resistance of a conductivity cell filled with 0.02 M KCl solution is 520 Ω, calculate its cell constant, given $\kappa = 0.248\ Sm^{-1}$. [A: 128.96 m^{-1}]	S
2. Molar conductivity of 0.05M acetic acid solution at 298K is 7.36 Sm^2mol^{-1}. Calculate the degree of dissociation of acetic acid and also Ka. [$\lambda^0_{CH_3COOH}$ = 390.7 Sm^2mol^{-1}]. [A: 0.0188, 1.8×10^{-5}]	S
3. Predict the products of electrolysis for the following i) aqueous solution of NaCl with graphite electrodes ii) aqueous solution of $CuSO_4$ with platinum electrodes iii) aqueous solution of $AgNO_3$ with silver electrodes	A

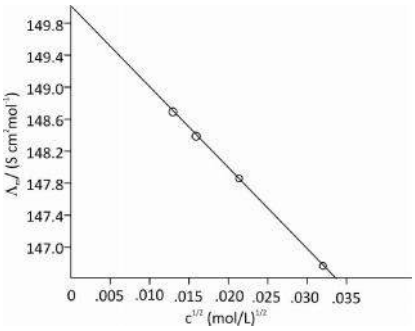
4. Electrolysis of aqueous sodium chloride solution was carried out by passing 5 A current for 3 hours. Calculate the volume of hydrogen liberated at STP, at the cathode. [1F = 96500C, molar volume of hydrogen at STP = 22,400 cm^3].

[A: 2089 cm^3] S

5. In the electrolysis of copper sulphate solution using current of 5.3A, the mass of cathode increased by 4.6g. Calculate the time taken in min for the electrolysis (molar mass of copper = $64gmol^{-1}$, 1F = 96500C)

[A: 43.6 mins] S

6. Given is the plot of Λ_m Vs $C^{½}$ for a electrolyte 'X'. What type of electrolyte is X? What does the intercept refer to? What is its value?



S

7. Name the following:
   i) The difference between the electrode potentials of two electrodes when no current is drawn through the cell
   ii) the quantity length/area of the electrode in a conductivity cell
   iii) M^{n+}/M

S

8. Using Nernst equation calculate the concentration of Sn^{+2} ions at which the single electrode potential becomes zero. Given : $E^0_{Sn^{2+}/Sn} = -0.14$ V.

[A: 5.55×10^6 M] S

9. Using the Nernst equation for the following cell at 298K and calculate the EMF.

$Al_{(S)} \mid Al^{+3}_{0.001M} \| Cu^{+2}_{0.0001M} \mid Cu_{(s)}$. Given $E^0_{Al^{3+}/Al} = -1.66$ V and $E^0_{Cu^{+2}/Cu} = +0.34$V

[A:1.941V] S

10. Give the cell diagram of a galvanic cell made of zinc and nickel showing the direction of flow of electrons. Write the half cell reactions. $E^0_{Ni^{2+}/Ni} = -0.25$V, $E^0_{Zn^{2+}/Zn} = -0.76$V.

S

11. For the cell $Mg_{(s)} \mid Mg^{+2}_{(aq)} \parallel Ag^{+}_{(aq)} \mid Ag_{(s)}$, calculate the EMF of the cell when the concentration of Ag^+ ions is 5 times that of concentration of Mg^{+2} ions. Given $E^0_{cell} = 3.17V$. [A : 3.211V]	S
12. Consider the following reaction; $2Fe_{(s)} + O_{2(g)} + 4H^+_{(aq)} \longrightarrow 2Fe^{+2}_{(aq)} + 2H_2O_{(l)}$ $E^0_{cell} = 1.67V$. If $[Fe^{+2}] = 10^{-3}$ M, $p_{O_2} = 0.1$ bar and pH = 3, Calculate the cell potential at 25°C. [A:1.56V]	S
13. Calculate the value of E^0_{cell} for the reaction $Fe + Cu^{+2} \longrightarrow Fe^{+2} + Cu$, if the equilibrium constant for the reaction is 2.18×10^{26}. [A : 0.7769V]	S
14. E^0_{cell} for the reaction $Sn + Cu^{+2}_{(aq)} \longrightarrow Sn^{+2}_{(aq)} + Cu$ is 0.48 V. Write the value of E^0_{cell} and calculate ΔG for the reaction $2Sn+2Cu^{+2}_{(aq)} \longrightarrow 2Sn^{+2}_{(aq)}+2Cu$. Given: 1F = 96500C. [A : 0.48V, −185280J]	S
Five mark questions:	
1. a) Name the anode, cathode and the electrolyte used in dry cell. b) $\wedge^0_m$ of sodium benzoate, hydrochloric acid, sodium chloride are 82.4, 426.2, 26.53 Sm^2mol^{-1}. Calculate $\wedge^0_m$ for benzoic acid. [A: 482.07 $Sm^2\ mol^{-1}$]	S
2. a) What are fuel cells? Write the schematic diagram of H_2–O_2 fuel cell and give the electrode reactions. b) How is molar conductivity related to conductivity?	S
3. a) Depict the galvanic cell, in which the reaction $Zn + 2Ag^+_{(aq)} \longrightarrow Zn^{+2}_{(aq)} + 2Ag$ takes place. Which of the electrode is negatively charged? Give the reaction at anode. b) How much charge in coulombs is required to reduce 1 mole of $Cr_2O_7^{-2}$ to Cr_2O_3? Given: 1F = 96500C [A: 579000 C]	S
4. Given $E^0_{Ag^+/Ag} = 0.8$ V, $E^0_{Cl_2/Cl^-} = 1.36$ V, $E^0_{Mg^{+2}/Mg} = -2.36$ V, $E^0_{Fe^{+2}/Fe} = -0.44$ V i) Identify the couple which is the a) strongest reducing agent b) strongest oxidising agent ii) Will iron displace Mg^{+2} or Ag^+ from their salt solution? iii) Calculate E^0_{cell} for : Fe ‖ Cl_2, Pt [A : 1.8 V]	S

5. a) $3Fe^{+2} + 2Ag^{+}_{(aq)} \longrightarrow 2Fe^{+3}_{(aq)} + 2Ag$ is the reaction occurring in a galvanic cell. Calculate its E^{0}_{cell} and ΔG^{0}. $E^{0}_{Fe^{+3}/Fe^{+2}} = 0.77V$, $E^{0}_{Ag^{+}/Ag} = +0.8V$ [A: 1.57V, $-303010J$]		
b) Mention any two factors which can influence the products formed at the electrodes during electrolysis?		S
6. a) For Daniell cell Zn ll Cu, E = 1.1V, when $[Zn^{+2}]$ and $[Cu^{+2}]$ are equal to 1M ; i) When does the cell potential become zero, if the cell in a circuit is closed. ii) What is observed when an external potential applied to the cell a) is equal to 1.1V b) is greater than 1.1V?		
b) Between cell potential and free energy change ,which one is an intensive property? ΔG^{0} for the reaction $Cu^{+2} + H_2 \rightleftharpoons Cu + 2H^{+}$, is -65.6×10^{3} J. Calculate the work done if the hydrogen consumed is 0.5 mole. [A: 32.8×10^{3}J]		U