	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**DEPARTMENT: SCIENCE 2022-23** **SUBJECT: CHEMISTRY**	**Date of completion:** **I week of November 2022**
Worksheet No: 03 with answers	**TOPIC: ELECTROCHEMISTRY**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT	**CLASS & SEC:**	**ROLL NO.**

SOLVED QUESTION ANSWERS

Q.1 **Differences between metallic and electrolytic conduction**

A

Metallic conduction	Electrolytic conduction
1. Metallic conduction is carried by the movement of electrons.	Electrolytic conduction is carried by the movement of ions.
2. It involves no change in the chemical properties of the conductor.	It involves the decomposition of the electrolyte as a result of the chemical reaction.
3. It does not involve the transfer of any matter.	It involves the transfer of matter as ions.
4. Metallic conduction **decreases** with increase in temperature.	Electrolytic conduction **increases** with increase in temperature.

Q.2 **What are the two types of electrolytes? Give two examples for each.**

A Strong electrolytes. The electrolytes which are almost completely dissociated into ions in solution are called strong electrolytes. For example, NaCl, KCl

Weak electrolytes. The electrolytes which do not ionise completely in solution are called weak electrolytes. For example, CH_3COOH, HCN

Q.3 **The resistance of a conductivity cell containing 0.001 M KCl solution at 298 K is 1500 ohm. What is the cell constant if the conductivity of 0.001 M KCI solution at 298 K is 0.146×10^{-3} Scm^{-1}?**

A

$$\text{Conductivity, } \kappa = 0.146 \times 10^{-3} \text{ S cm}^{-1}$$

$$\text{Resistance, R} = 1500 \text{ ohm}$$

$$\text{Cell constant} = \frac{\text{Conductivity, } (\kappa)}{\text{Conductance (G)}}$$

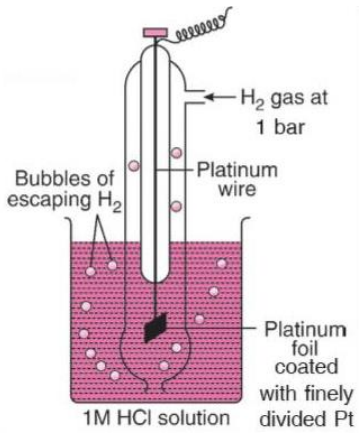
$$= \text{Conductivity } (\kappa) \times \text{Resistance (R)}$$

$$\therefore \quad \text{Cell constant} = 0.146 \times 10^{-3} \text{ ohm}^{-1} \text{ cm}^{-1} \times 1500 \text{ ohm}$$

$$= \mathbf{0.219 \text{ cm}^{-1}.}$$

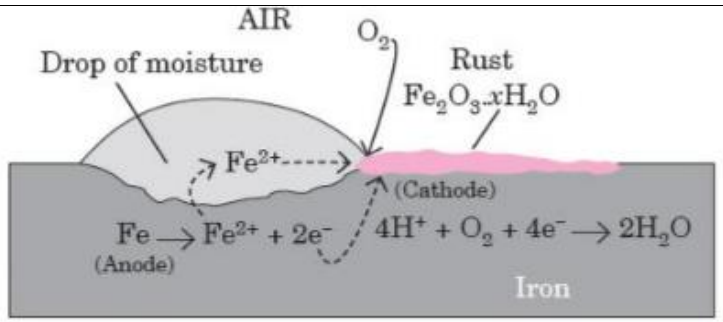
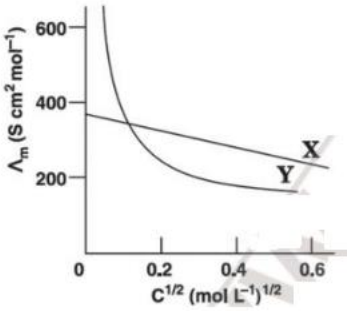
Q.4 **The conductivity of 0.20 M KCl solution at 298 K is 0.025 Scm^{-1}. Calculate its molar conductivity.**

A	$\Lambda_m = \frac{\kappa \times 1000}{C}$ $\kappa = 0.025\ S\ cm^{-1}$, $C = 0.20\ M$ $\Lambda_m = \mathbf{125.0\ S\ cm^2\ mol^{-1}}$.
Q.5	**A conductivity cell when filled with 0.01 M KCl has a resistance of 745 Ω at 25°C. When the same cell was filled with an aqueous solution of 0.005 M $CaCl_2$, solution the resistance was 874 Ω. Calculate** **(i) Conductivity of solution** **(ii) Molar conductivity of solution. [Conductivity of 0.01 M KCI =0.141Sm^{-1}]**
A	**HINT:** Cell constant = $R \times \kappa$ Conductivity, $\kappa = \frac{\text{Cell constant}}{R}$ $\Lambda_m = \frac{\kappa \times 1000}{C}$
Q.6	**The molar conductivities at infinite dilution for Nal, CH_3COONa and $(CH_3COO)_2Mg$ are 12.69, 9.10 and 18.78 $Scm^2\ mol^{-1}$ respectively at 25°C. What is the molar conductivity of MgI_2 at infinite dilution?**
A	$\Lambda^\circ(MgI_2) = \Lambda^\circ[(CH_3COO)_2Mg] + 2\Lambda^\circ(NaI) - 2\Lambda^\circ(CH_3COONa)$ $\Lambda^\circ(MgI_2) = 18.78 + 2(12.69) - 2(9.10)$ $= 25.96$ **$Scm^2\ mol^{-1}$**
Q.7	**Conductivity of 0.00241 M acetic acid is 7.896×10^{-5} Scm^{-1}. Calculate its molar conductivity and if Λ^0 for acetic acid is 390.5 Scm^2mol^{-1} What is its dissociation constant ?**
A	$\Lambda = \frac{\kappa \times 1000}{M}$ $\Lambda = \frac{7.896 \times 10^{-5} \times 1000}{0.00241}$ $= 32.76\ S\ cm^2\ mol^{-1}$ $\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{32.76}{390.5} = 0.0839$ $K = \frac{C\alpha^2}{(1-\alpha)} = \frac{0.00241 \times (0.0839)^2}{(1-0.0839)}$ $= \mathbf{1.85 \times 10^{-5}}$.
Q.8	**a.Which will have greater molar conductivity?** **i. Solution containing 1 mol of KCl in 200 ml or 1 mol of KCl in 500 ml.** **ii. Solution containing 1 mol of LiCl in 500 ml or 1 mol of KCl in 500 ml.** **b. Write an expression for molar conductivity of $Al_2(SO_4)_3$ at infinite dilution in terms of their ionic molar conductivities. (hint: strong electrolytes, dissociation into ions)**

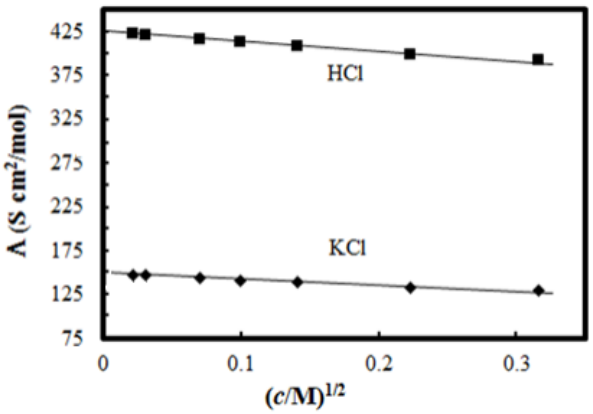
Q.9	**a. Identify the reference electrode shown.** **b. Write the anodic and cathodic reactions involved.** **c. Using this reference electrode, how will you find the standard electrode potential of the zinc electrode?** 
A	**a. Standard hydrogen electrode.** **b.** *If S.H.E. acts as anode* $H_2(g) \longrightarrow 2H^+ + 2e^-$ *If S.H.E. acts as cathode* $2H^+ + 2e^- \longrightarrow H_2(g)$ **c.** $E^\ominus_{cell} = E^\ominus_C - E^\ominus_A$ $= E^\ominus(H^+\mid H_2) - E^\ominus(Zn^{2+}\mid Zn)$ $0.76 = 0 - E^\ominus(Zn^{2+}\mid Zn)$ $E^\ominus(Zn^{2+}\mid Zn) = -0.76\ V$
Q.10	**In a simple electrochemical cell, which is in the standard state, the half cell reactions with their appropriate reduction potentials are :** $Pb^{2+}(aq) + 2e^- \longrightarrow Pb(s);\quad (E^\ominus = -0.13\ V)$ $Ag^+(aq) + e^- \longrightarrow Ag(s);\quad (E^\ominus = +0.80\ V)$ **(a) What ts the cell reaction for the cell?** **(b) Calculate the e.m.f. of the cell.**
A	$2Ag^+(aq) + Pb(s) \longrightarrow 2Ag(s) + Pb^{2+}(aq)$ The cell may be represented as : $Pb \mid Pb^{2+} \parallel Ag^+ \mid Ag$ $E^\ominus_{cell} = E^\ominus(\text{cathode}) - E^\ominus(\text{anode})$ $= 0.80 - (-0.13) = \mathbf{0.93\ V.}$

Q.11	**A copper wire is dipped in silver nitrate solution in beaker A and a silver wire is dipped in a solution of copper sulphate kept in beaker B. Ifthe standard electrode potential for $Cu^{2+} + 2e^- \longrightarrow Cu$ is + 0.34 V** **$Ag^+ + e^- \longrightarrow Ag$ is 0.80 V** **Predict in which beaker the ions present will get reduced ?**
A	HINT: lower E^0 value acts as an anode, whereas the higher E^0 value acts as a cathode.
Q.12	**Zine rod is dipped in 0.1M solution of $ZnSO_4$. The salt is 95% dissociated at this dilution at 298 K. Calculate the electrode potential given that $E^0 (Zn^{2+} \mid Zn)$ = — 0.76 V.**
A	The electrode reaction is : $Zn^{2+} + 2e^- \rightleftharpoons Zn(s)$ According to Nernst equation, at 298 K $E(Zn^{2+} \mid Zn) = E^{\ominus}(Zn^{2+} \mid Zn) - \frac{0.059}{n} \log \frac{[Zn]}{[Zn^{2+}(aq)]}$ $E^{\ominus}(Zn^{2+} \mid Zn) = -0.76$ V, $[Zn] = 1$, $[Zn^{2+}(aq)] = 0.1 \times 95/100 = 0.095$ M $E(Zn^{2+} \mid Zn) = -0.76 - \frac{0.059}{n} \log \frac{1}{0.095}$ $= -0.76 - 0.03 = -$ **0.79V.** n=2 log 1 = 0 log 10.53 = 1.0224
Q.13	**Write the Nernst equation and calculate the e.m.f. of the following cell at 298 K:** *Cu(s) | Cu^{2+} (0.130 M) || Ag^+ (1.0 × 10^{-4} M)) | Ag (s)* *Given :* $E^{\ominus}_{(Cu^{2+} \mid Cu)} = +0.34$V and $E^{\ominus}_{(Ag^+ \mid Ag)} = +0.80$V
A	$E_{cell} = E^{\ominus}_{cell} - \frac{0.059}{2} \log \frac{[Cu^{2+}]}{[Ag^+]^2}$ $E^{\ominus} = E^{\ominus}_{(Ag^+ \mid Ag)} - E^{\ominus}_{(Cu^{2+} \mid Cu)}$ $= 0.80 - 0.34 = 0.46$ V $E_{cell} = 0.46 - \frac{0.059}{2} \log \frac{(0.130)}{(1.0 \times 10^{-4})^2}$ $= 0.46 - \frac{0.059}{2} \log 1.30 \times 10^7$ $= 0.46 - 0.21$ $=$ **0.25 V.** log 7 = 7 log10 log10 = 1 log 1.3 = 0.1139
Q.14	**Calculate the e.m.f. of the following cell:** $Cd \mid Cd^{2+}(0.01M) \parallel H^+(0.02M) \mid Pt, H_2(0.8\ atm)$ *Given :* $E^{\circ}(Cd^{2+} \mid Cd) = -0.40$ V

A	The cell reaction is : $Cd(s) + 2H^+(aq) \longrightarrow Cd^{2+}(aq) + H_2(g)$ $E = E^\circ - \frac{0.059}{2}\log\frac{[Cd^{2+}]\times p(H_2)}{[H^+]^2}$ $E = E^\circ(H^+ \mid \frac{1}{2}H_2) - E^\circ(Cd^{2+} \mid Cd)$ $= 0 - (-0.40) = 0.40\ V$ $E = 0.40 - \frac{0.059}{2}\log\frac{(0.01)\times 0.8}{(0.02)^2}$ $= 0.40 - \frac{0.059}{2}\times 1.3010$ $= 0.40 - 0.04$ **= 0.36 V**
Q.15	**Calculate the value of the equilibrium constant for the following cell reaction :** $4Br^- + O_2 + 4H^+ \longrightarrow 2Br_2 + 2H_2O$ **Given that E^0cell= 0.16 V. Comment on the reaction.**
A	$\log K_C = \frac{nE^\circ_{cell}}{0.0591}$ $E^\circ_{cell} = 0.16\ V, \quad n = 4$ $\log K_C = \frac{(4)\times(0.16\ V)}{(0.0591\ V)}$ K_C = Antilog **10.847** **Kc = 7.03 x 10^{10}**
Q.16	*Determine the values of equilibrium constant (K_c) and ΔG° for the following reaction :* *$Ni(s) + 2Ag^+(aq) \longrightarrow Ni^{2+}(aq) + 2Ag(s)$, $E = 1.05V$* *($1F = 96500\ C\ mol^{-1}$)*
A	**hint:** **(i)** ΔG° **= — 202.650 kJ** **(ii) Kc = 2.82 x 10^{35}**
Q.17	Refer to the diagram and explain the electrochemical cell set up in the process of corrosion.

	
A	Hint: Write down the cell reactions involved.
Q.18	**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 a long life?**
A	(i) Mercury cell (ii) Fuel cell (iii)Lead storage cell (iv)Dry cell
Q.19	**How much charge is required for the following reduction:** **(i) 1 mol of Al^{3+} to Al.** **(ii) 1 mol of Cu^{2+} to Cu** **(iii)1 mol of MnO_4^- to Mn^{2+}** **Hint: one mol of electrons = 1F = 96487Cmol^{-1}**
Q.20	**The following curve is obtained when molar conductivity is plotted against the square root of concentration, along the 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 molar conductivity, for the electrolytes X and Y with dilution ? (iii)How can you determine the limiting molar conductivity for these electrolytes ?
A	i. Electrolyte X is a strong electrolyte and Y is a weak electrolyte. ii. Molar conductivity of X(strong electrolyte) increases slowly with dilution. This is because interionic forces of attraction decrease on dilution, although the number of

	ions remains the same. As a result, ions move more freely and hence molar conductivity increases with dilution. On the other hand, for Y (weak electrolyte), molar conductivity increases sharply with dilution. This is because, the degree of dissociation increases on dilution resulting in the greater number of ions on dilution. Hence molar conductivity increases. iii. For X, limiting molar conductivity can be obtained by extrapolation to zero concentration. For Y, limiting molar conductivity can be calculated by using Kohlrausch's law.
Q.21	For redox reaction to proceed in a cell, the e.m.f. must be (a) positive (b) negative (c) fixed (d) zero **Ans. (a)**
Q.22	The tendency of the electrodes made up of Cu, Zn and Ag to release electrons when dipped in their respective salt solutions decrease in the order: (a) Zn>Ag>Cu (b) Cu> Zn > Ag (c) Zn > Cu> Ag (d) Ag > Cu > Zn **Ans. (c)**
Q.23	The limiting molar conductivities for NaCl, KBr and KCl are 126, 152 and 150 S cm^2 mol^{-1} respectively. The limiting molar conductivity for NaBr is: (a) 278 S cm^2 mol^{-1} (b) 976 S cm^2 mol^{-1} (c) 128 S cm^2 mol^{-1} (d) 302 S cm^2 mol^{-1} **Ans. (c)**
Q. 24	Rust is a mixture of: (a) FeO and $Fe(OH)_3$ (b) FeO and $Fe(OH)_2$ (c) Fe_2O_3 and $Fe(OH)_3$ (d) Fe_3O_4 and $Fe(OH)_3$ **Ans. (c)**
Q. 25	A current is passed through two cells connected in series. The first cell contains $X(NO_3)_3(aq)$ and the second cell contains $Y(NO_3)_2(aq)$. The relative atomic masses of X and Y are in the ratio 1: 2. What is the ratio of the liberated mass of X to that of Y? (a) 3:2 (b) 1:2 (c) 1:3 (d) 3:1 (e) 2:1 **Ans. (c)**

Q.26	**In the following questions, a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the following choices:** **(a) Both Assertion and Reason are true and the Reason is the correct explanation for Assertion.** **(b) Both Assertion and Reason are true and the Reason is not the correct explanation for Assertion** **(c) Assertion is true but the Reason is false.** **(d) Both Assertion and Reason are false.** **(e) Assertion is false but Reason is true.**
a.	Assertion (A): Conductivity of all electrolytes decreases on dilution. Reason (R): On dilution number of ions per unit volume decreases. **Ans: (a)**
b.	Assertion (A): Mercury cell does not give steady potential. Reason (R): In the cell reaction, ions are not involved in the solution. **Ans: (e)**
c.	Assertion (A): Current stops flowing when $E_{cell} = 0$. Reason (R): Equilibrium of the cell reaction is attained. **Ans: (a)**
d.	Assertion (A): Copper sulphate can be stored in a zinc vessel. Reason (R): Zinc is less reactive than copper. **Ans: (d)**
Q.27 **Year** **2022**	The molar conductivity of CH_3COOH at infinite dilution is 390 Scm^2/mol. Using the graph and given information, the molar conductivity of CH_3COOK will be:  a. 100 Scm^2/mol b. 115 Scm^2/mol c. 150 Scm^2/mol d. 125 Scm^2/mol **Ans. b**

Q. 28 Year 2022	What is the molar conductance at infinite dilution for sodium chloride if the molar conductance at infinite dilution of Na^+ and Cl^- ions are 51.12×10^{-4} Scm^2/mol and 73.54×10^{-4} Scm^2/mol respectively? a. 124.66 Scm^2/mol b. 22.42 Scm^2/mol c. 198.20Scm^2/mol d. 175.78 Scm^2/mol **Ans. a**
Q. 29 Year 2022	Corrosion is an electrochemical phenomenon. The oxygen in moist air reacts as follows: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$. Write down the possible reactions for corrosion of zinc occurring at anode, cathode, and overall reaction to form a white layer of zinc hydroxide.
A	Anode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ (1/2) Cathode: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$. (1/2) Overall: $2Zn(s) + O_2(g) + 2H_2O(l) \rightarrow 2Zn^{2+}(aq) + 4OH^-(aq)$ $2Zn(s) + O_2(g) + 2H_2O(l) \rightarrow 2Zn(OH)_2$ (ppt) (1)
Q. 30 Year 2022	a. Why does the cell voltage of a mercury cell remain constant during its lifetime? b. Write the reaction occurring at anode and cathode and the products of electrolysis of aq KCl. c. What is the pH of HCl solution when the hydrogen gas electrode shows a potential of -0.59 V at standard temperature and pressure?
A	**a.** The cell potential remains constant during its life as the overall reaction does not involve any ion in solution whose concentration can change during its life time.(1) b. $KCl(aq) \rightarrow K^+(aq) + Cl^-(aq)$ cathode: $H_2O(l) + e^- \rightarrow \frac{1}{2} H_2(g) + OH^-(aq)$ (1/2) anode: $Cl^-(aq) \rightarrow \frac{1}{2} Cl_2(aq) + e^-$ (1/2) net reaction: $KCl(aq) + H_2O(l) \rightarrow K^+(aq) + OH^-(aq) + \frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g)$ (1) c. Given, potential of hydrogen gas electrode = −0.59 V Electrode reaction: $H^+ + e^- \rightarrow 0.5\ H_2$ Applying Nernst equation, $E(H^+/H_2) = E^\circ(H^+/H_2) - \frac{0.059}{n} \log \frac{[H_2]^{1/2}}{[H^+]}$ (1) $E^\circ(H^+/H_2) = 0$ V $E(H^+/H_2) = -0.59$ V $n = 1$ $[H_2] = 1$ bar $-0.59 = 0 - 0.059(-\log [H^+])$ (1/2) $-0.59 = -0.059pH$ $\therefore pH = 10$ (1/2)

Q.31 Year 2022	a. Molar conductivity of substance "A" is 5.9×10^{3} S/m and "B" is 1×10^{-16} S/m. Which of the two is most likely to be copper metal and why? b. What is the quantity of electricity in Coulombs required to produce 4.8 g of Mg from molten $MgCl_2$? How much Ca will be produced if the same amount of electricity was passed through molten $CaCl_2$? (Atomic mass of Mg = 24 u, atomic mass of Ca = 40 u). c. What is the standard free energy change for the following reaction at room temperature? Is the reaction spontaneous? $Sn(s) + 2Cu^{2+}(aq) \rightarrow Sn^{2+}(aq) + 2Cu^{+}(s)$
A	a. "A" is copper, metals are conductors thus have high value of conductivity. (1) b. $Mg^{2+} + 2e^{-} \rightarrow Mg$ 1 mole of magnesium ions gains two moles of electrons or 2F to form 1 mole of Mg 24 g Mg requires 2 F electricity 4.8 g Mg requires 2 x4.8/24 = 0.4 F = 0.4 x96500 = 38600C (1) $Ca^{2+} + 2e^{-} \rightarrow Ca$ 2 F electricity is required to produce 1 mole =40 g Ca 0.4 F electricity will produce 8 g Ca (1) c. F = 96500C, n=2, $Sn^{2+}(aq) + 2e^{-} \rightarrow Sn(s)$ –0.14V $Cu^{2+}(aq) + e^{-} \rightarrow Cu^{+}(aq)$ 0.15 V $E^{o}cell = E^{o}cathode - E^{o}anode$ $= 0.15 - (-0.14) = 0.29V$ (1) $\Delta G^{o} = -nFE^{o}_{cell}$ $= -2 \times 96500 \times 0.29 = 55970$ J/mol (1)
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