INDIAN SCHOOL AL WADI AL KABIR		
CLASS: XII	DEPARTMENT: SCIENCE 2026 – 2027 SUBJECT: CHEMISTRY	DATE: 08/08/2026
WORKSHEET NO: 4 WITH ANSWERS	TOPIC: ELECTROCHEMISTRY	NOTE: A4 FILE FORMAT
CLASS & SEC:	NAME OF THE STUDENT:	ROLL NO.

Objective Type Questions

1. Consider the following cell at 298 K: Mg (s) | Mg^{2+} (1·0 M) || Cu^{2+} (1·0 M) | Cu (s). How can we increase the cell's emf using the same substances?

(Feb 2026)

(A) By decreasing only the [Mg^{2+}] to 0·1 M
(B) By decreasing only the [Cu^{2+}] to 0·1 M
(C) By increasing both [Mg^{2+}] and [Cu^{2+}] to 2·0 M
(D) By increasing only the [Mg^{2+}] to 2·0 M

2. Using the data given below, find out the strongest oxidising agent.
$E^{o}Cr_2O_7^{2-}/Cr^{3+}$ = 1.33V $E^{o}MnO_4^{-}/Mn^{2+}$ = 1.51V $E^{o}Cl_2/Cl^{-}$ = 1.36V $E^{o}Cr^{3+}/Cr$ = -0.74V
(A) Cl^{-}
(B) Mn^{2+}
(C) MnO_4^{-}
(D) Cr^{3+}

3. Which of the following batteries cannot be reused?
(A) Lead storage battery (B) Ni-Cd cell (C) Mercury cell (D) Both (b) and (c)

4. Match the items given in column I with that in column II:

Column I	Column II
(a) Ω^{-1} cm^2mol^{-1}	(i) Mercury Cell
(b) $\alpha_{dissoiation}$ is low	(ii) λ_m
(c) Decreases with dilution	(iii) Weak Electrolyte
(d) Electrolyte is a paste of KOH/ZnO	(iv) Conductivity

A)(a) - (iv), (b) - (i), (c) - (ii), (d) - (iii)
B)(a) - (i), (b) - (ii), (c) - (iii), (d) - (iv)
C)(a) - (iii), (b) - (iv), (c) - (i), (d) - (ii)
D)(a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

5. What will happen during the electrolysis of an aqueous solution of $CuCl_2$ by using platinum electrodes?
(A) Cu will deposit at Anode (B) H_2 gas will be released at cathode
(C) O_2 gas will be released at anode (D) Cl_2 gas will be released at anode (Feb 2026)

6. Consider the following reaction :

$$Zn_{(s)} + Ag_2O_{(s)} + H_2O(l) \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)}$$

Given : $E^o_{Ag^+/Ag} = 0.80$ V

$E^o_{Zn^{2+}/Zn} = -0.76$ V

$1\ F = 96500\ C\ mol^{-1}$

$\Delta_r G^o$ for the above reaction is :

(A) – 301.080 kJ mol^{-1} (C) –326.070 kJ mol^{-1} (B) + 310.080 kJ mol^{-1} (D) –375.060 kJ mol^{-1} (Feb 2026)

7. Standard reduction potentials of the half reactions are given below:

$F_{2(g)} + 2e^- \longrightarrow 2F^-(aq)$; $E° = +2.85$ V

$Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-(aq)$; $E° = +1.36$ V

$Br_{2(l)} + 2e^- \longrightarrow 2Br^-(aq)$; $E° = +1.06$ V

$I_{2(s)} + 2e^- \longrightarrow 2I^-(aq)$; $E° = +0.53\ V$

The strongest oxidising and reducing agents, respectively, are:

(a) F_2 and I^- (b) Br_2 and Cl^- (c) Cl_2 and Br^- d) Cl_2 and I_2

8. On electrolysis of a very dilute aqueous solution of NaCl using platinum electrodes:

(A) H_2 gas is evolved at anode. (B) Na is produced at cathode. (C) O_2 gas is evolved at the anode.

(D) H_2 gas is evolved at cathode.

Assertion Reason type questions

(a) If both *Assertion* and *Reason* are correct and *Reason* is the correct explanation of *Assertion*.

(b) If both *Assertion* and *Reason* are correct, but *Reason* is not the correct explanation of *Assertion*.

(c) If *the assertion* is correct and *the reason* is wrong.

(d) If *the assertion* is wrong and *the reason* is correct.

9. **Assertion (A):** In a Daniell cell, if an external voltage greater than 1.10 V is applied, the current flows in the opposite direction.

Reason (R): When the external potential exceeds the cell potential, the electrochemical cell behaves like an electrolytic cell.

10. **Assertion (A):** Mercury cell does not give a steady potential.

Reason(R): In the cell reaction of the mercury cell, ions are not involved in the solution.

11. **Assertion (A):** For a spontaneous reaction in an electrochemical cell, the standard cell potential E^0must be positive.

Reason (R): The Gibbs free energy change ΔG^o is related to cell potential by the equation $\Delta\ G^0 = -nFE^0$cell

Short Answer Type Questions(2M)

12. (a) Name any two materials other than hydrogen that can be used as fuel in fuel cells.

(b) Define molar conductivity.

13. How many coulombs, in terms of Faradays, are required to produce?

(i) 20.0 g of Ca from molten $CaCl_2$

(ii) 40.0 g of Al from molten Al_2O_3

14. A student sets up a Galvanic cell: Cu(s) | Cu^{2+}(aq) || Ag^{+}(aq) | Ag(s). If the student adds a significant amount of distilled water to the half-cell, how will the cell potential be affected? Justify your answer using the Nernst equation.

15. Using E values of X and Y given below, predict which is better for coating the surface of Iron to prevent corrosion and why?

Given: $E^\circ_{X^{2+}/X} = -2.36$ V

$E^\circ_{Y^{2+}/Y} = -0.14$ V

$E^\circ_{Fe^{2+}/Fe} = -0.44$ V

16. State Kohlrausch's law and mention its applications.

17. In a laboratory experiment, a student measures the molar conductivity of KCl and CH_3COOH as they are diluted. The student observes that for one electrolyte, the increase is slow, while for the other, it is sharp. Identify which electrolyte shows which behaviour and explain why.

18. Using Kohlrausch's law of independent migration of ions, calculate the limiting molar conductivity (Λ^0_m) for Calcium Chloride (Given: $\lambda^0(Ca^{2+}) = 119.0\ \mathrm{S\ cm^2\ mol^{-1}}$ and $\lambda^0(Cl^-) = 76.3\ \mathrm{S\ cm^2\ mol^{-1}}$.

Short Answer Type Questions(3M)

19.(a) Calculate emf of the following cell at 298 K :

Sn | Sn^{2+} (0.001 M) || H^+ (0.01 M) | $H_{2(g)}$ (1 bar) | $Pt_{(s)}$

Given : $E^o_{Sn^{2+}/Sn} = -0.14$ V,

$E^o_{H^+/H_2} = 0.00$ V [log 10 = 1]

20. (a) What advantage do the fuel cells have over primary and secondary batteries?

(b) Write the cell reaction of a lead storage battery when it is discharged

21. State Kohlrausch's law of independent migration of ions. With the help of a curve, explain why it is not easy to determine Λ°_m for weak electrolytes by extrapolating the concentration molar conductivity curve, as it is for strong electrolytes. (Feb 2026)

22. Calculate the EMF of the cell for the reaction

$Mg(s) + 2Ag^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + 2Ag_{(S)}$

Given: $E^0 Mg^{2+}/Mg = -2.37V$ $E^0 Ag^+/Ag = -0.80V$ $[Mg^{2+}] = 0.001M$; $[Ag^+] = 0.0001$ M $\log 10^5 = 5$

Case study-based Questions (4 marks)

23. Read the passage given below and answer the following questions:

Electrochemistry is the study of the relationship between chemical energy and electrical energy. Many spontaneously occurring chemical reactions liberate electrical energy. In electrolysis, electrical energy is converted directly into chemical energy. The product of an electrolytic reaction depends on the nature of the material being electrolysed and the type of electrode used. Oxidising and reducing species present in the electrolytic cell and their standard electrode potential also affect the products of electrolysis. Electrolysis plays an important role in most people's daily lives, whether it is for the manufacturing of aluminium, electroplating of metals, or the synthesis of chemical compounds. Michael Faraday was the first scientist to propose two laws to explain the quantitative aspects of electrolysis, popularly known as Faraday's laws of electrolysis. Faraday's laws of electrolysis provide a basis for mathematical analysis of the mass deposited at electrodes and the amount of charge passed through them. Faraday's laws are fundamental in various applications, including electroplating, metal extraction, battery technology and chemical synthesis. These laws also help in environmental monitoring and in various chemistry experiments.

Answer the following questions:

(a) Predict the products of electrolysis in each of the following:
 (i) An aqueous solution of $CuCl_2$ with platinum electrodes.
 (ii) A concentrated solution of H_2SO4 with platinum electrodes. How much charge in faraday is required for the reduction of 1 mol of Ag^+ to Ag?
(b) (i) How much charge in faraday is required for the reduction of 1 mol of Ag^+ to Ag?
(c) State Faraday's second law of electrolysis.
(d) The following reactions occur at the anode during the electrolysis of aqueous sodium chloride solution:

$$Cl^-(aq) \longrightarrow \frac{1}{2}Cl_2(g) + e^- \quad E^o_{(cell)} = 1{\cdot}36\text{ V} \qquad (I)$$

$$2H_2O\,(l) \longrightarrow O_2\,(g) + 4H^+\,(aq) + 4e^- \quad E^o_{(cell)} = 1{\cdot}23\text{ V} \qquad (II)$$

Which reaction is feasible at the anode and why?

24. A Galvanic cell is made up of two electrodes anode and cathode, i.e., two half cells. One of these electrodes must have a higher electrode potential (higher tendency to lose electrons) than the other electrode. As a result of this potential difference, the electrons flow from an electrode at a higher potential to the electrode at a lower potential. There is a difference between electromotive force and potential difference.

(i) Molten NaCl conducts electricity due to the presence of :

a) Free electrons b) Free molecules c) Free ions d) Atoms of Na and Cl

(ii) In a galvanic cell

(a) the flow of electrons is from anode (negative zinc electrode) towards cathode (positive copper electrode)

(b) the flow of electrons is from cathode (positive copper electrode) towards anode (negative zinc electrode)

(c) the electric current flows from anode to cathode.

(d) The electrons are transferred from the oxidizing agent to the reducing agent.

(iii) The $E°$ for half-cell $Fe/Fe^{2+}$and$Cu/Cu^{2+}$are−0.44 V and+0.32 V respectively, then

a) Cu^{2+} oxidises Fe b) Cu oxidises Fe c) Cu reduces Fe^{2+} d) Cu^{2+} oxidises Fe^{2+}

(iv) Which of the following expressions is correct?
a) $\Delta G° = - nFE^0$cell
b) $\Delta G° = + nFE^0$cell
c) $\Delta G° = -2.303\ RT\ nFE^0$cell
d) $\Delta G° = -nF\ \log Kc$

<u>Long Answer Type Questions(5M)</u>

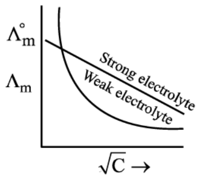
25. (a) The conductivity of 0.1 mol L^{-1} solution of NaCl is 1.06×10^{-2} S cm^{-1}. Calculate its molar conductivity and degree of dissociation. $\lambda°_{Na^+}$ = 50.1 S cm^2 mol^{-1} $\lambda°_{Cl^-}$ = 76.5 S cm^2 mol^{-1}
 (b) (i) The following cell reaction occurs in a galvanic cell:
 $2Ag^+_{(aq)} + Zn_{(s)} \longrightarrow 2Ag_{(s)} + Zn^{2+}_{(aq)}$ $E°_{(cell)} = +1.56$ V Predict the direction of flow of current.
 (ii) Differentiate between a primary battery and a secondary battery. (Feb 2026)
26. 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?

$Sn(s) + 2Cu^{2+}(aq) \longrightarrow Sn^{2+}(aq) + 2Cu(s)$

Answers

1.	(A) By decreasing only the $[Mg^{2+}]$ to 0·1 M
2.	(C) MnO_4^-
3.	(C) Mercury cell
4.	D)(a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)
5.	(D) Cl_2 gas will be released at anode
6.	(A) – 301.080 kJ mol^{-1}
7.	(A) F_2 and I^-
8.	(D) H_2 gas is evolved at cathode.
9.	**(A)** Both A and R are true, and R is the correct explanation of A
10	(D) *Assertion* is wrong and *Reason* is correct
11	**(A)** Both A and R are true, and R is the correct explanation of A
12	(a) Methane and Methanol (b) Conductivity of a solution at a given concentration is the conductance of the volume V of solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length.
13	(i) $Ca^{2+} + 2e^- \longrightarrow Ca$ (40g) Electricity required for production of 40g of Ca = 2F Electricity required for production of 20g of Ca = 1F or 96500C (ii) $Al^{3+} + 3e^- \longrightarrow Al$(27g) Electricity required for production of 27g of Al = 3F Electricity required for production of 40g of Al= 3F x40 /27 = 4.4F or 4288888.9C
14	Adding water to the half-cell decreases the concentration of Cu^{2+}. According to the Nernst equation: $E_{cell} = E^0_{cell}-(0.059/2\{\log[Cu^{2+}]/[Ag^+]^2\}$. E_{cell} value increases
15	X is better for coating the surface of iron to prevent corrosion because it has a more negative standard electrode potential and will act as a sacrificial anode, protecting the iron from oxidation.
16	Kohlrausch's law – At infinite dilution the molar conductivity of an electrolyte is sum of the molar conductivities of individual ions. (i). To find the limiting molar conductivity of weak electrolyte (ii).to find degree of dissociation (iii).to find ionization constant
17	KCl, a strong electrolyte, shows a **slow increase** because it is already fully dissociated; the increase is due to decreased inter-ionic attractions. CH_3COOH (weak electrolyte) shows a **sharp increase** because dilution increases the degree of dissociation.
18	: $\Lambda^0_m(CaCl_2) = \lambda^0(Ca^{2+}) + 2\lambda^0(Cl^-)$ $\Lambda^0_m = 119.0 + 2(76.3)$ = $119.0 + 152.6 = 271.6$ S cm^2 mol^{-1}

19	Sn(s) | Sn^{2+}(0.001M) || H^+(0.01M) | $H_{2(g)}$(1 bar) | Pt(s) $E^\circ_{cell} = 0 - (-0.14\ V) = 0.14\ V$ $E_{cell} = E^\circ_{cell} - \frac{0.059}{2} \log \frac{[Sn^{2+}]}{[H^+]^2}$ $= 0.14\ V - \frac{0.059}{2} \log \frac{(0.001)}{(0.01)^2}$ $= 0.14\ V - \frac{0.059}{2} \log 10$ $=0.14\ V - 0.0295\ V$ $= 0.1105\ V$
20	(a) Primary batteries contain a limited amount of reactants and are discharged when the reactants have been consumed. Secondary batteries can be recharged but take a long time to recharge. Fuel cell runs continuously as long as the reactants are supplied to it and products are removed continuously. When a lead storage battery is discharged then the following cell reaction takes place $Pb+PbO_2+2H_2SO_4 \rightarrow 2PbSO_4+2H_2O$
21	Limiting molar conductivity is equal to the sum of individual contributions of cation and anion.  For a weak electrolyte, on extrapolation, the curve runs parallel to the y-axis and does not intercept, unlike a strong electrolyte.
22	$E^0Cell = E^0right - E^0left = 0.80 - (-2.37\ V) = 3.17$ $= 3.17 - \frac{0.059}{2} \log \frac{[10^{-3}]}{[10^{-4}]^2}$ $= 3.17 - \frac{0.059}{2} \log 10^5$ $= 3.17 - \frac{0.059x5}{2}$ **Ecell = 3.0225 V**
23	(a) (i) Anode : Chlorine / Cl_2 / $2Cl^- \longrightarrow Cl_2 + 2e^-$ Cathode : Copper /Cu / $Cu^{2+} + 2e^- \longrightarrow Cu$ (ii) Anode : Peroxodisulphate ion / $2SO_4^{2-} \longrightarrow S_2O_8^{2-} + 2\ e^-$ Cathode: Hydrogen / $H_2(g)$ / $H_2O + 1e^- \longrightarrow \frac{1}{2} H_2(g) + OH^-$ (b) 1 Faraday (c) The amounts of different substances liberated by the same quantity of electricity passing through the electrolytic solution are proportional to their chemical equivalent weight (d) Reaction (I) is feasible and due to overpotential of oxygen.
24	(i) (c) Free ions (ii) (a) the flow of electron is from anode (negative zinc electrode) towards cathode (positive copper electrode) (iii) a) Cu^{2+} oxidises Fe (iv) a) $\Delta G^\circ = -nFE^0$cell

25	(a) $\lambda^{\circ}_{NaCl} = 50.1 + 76.5 = 126.6\ Scm^2\ mol^{-1}$ $\Lambda_m = \frac{k\ X\ 1000}{M}$ $= \frac{1.06\ X\ 10^{-2}\ X\ 1000}{0.1}$ $= 106\ Scm^2\ mol^{-1}$ $\alpha = \frac{\Lambda_m}{\Lambda_m^0}$ $\alpha = \frac{106}{126.6} = 0.8372$ or 83.72 % (b)(i) Current will flow from Silver to Zinc /cathode to anode (ii) Primary battery – the reaction occurs only once; it cannot be reused again. Secondary battery – It can be recharged and reused.
26	a. "A" is copper; metals are conductors, thus have a high value of conductivity. b. $Mg^{2+} + 2e^- \text{----}\rightarrow Mg$ 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) $Ca^{2+} + 2e\text{-----}\rightarrow Ca$ 2 F of electricity is required to produce 1 mole =40 g Ca 0.4 F electricity will produce 8 g Ca c.F = 96500C, n=2, $Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$ $E^0 = -0.14V$ $Cu^{2+}(aq) + e^- \rightarrow Cu^+(aq)$ $E^0 = 0.34\ V$ $E^o cell = E^o cathode - E^o anode$ $= 0.34 - (-0.14) = 0.48V$ $\Delta G^o = -nFE^o cell$ = -2 x96500x 0.29 = - 92640J/mol (spontaneous)

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