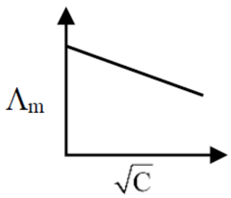
KAATAR NEET 2026

Physical Chemistry By Amit Mahajan Sir

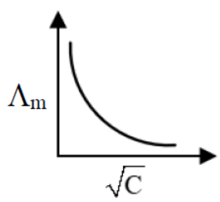
Electrochemistry

Q1 Which of the following curve represents the variation of Λ_m with $\sqrt{C}$ for $AgNO_3$?

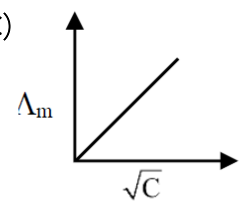
(A)



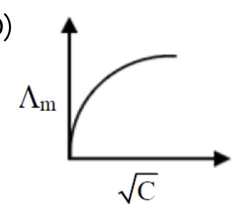
(B)



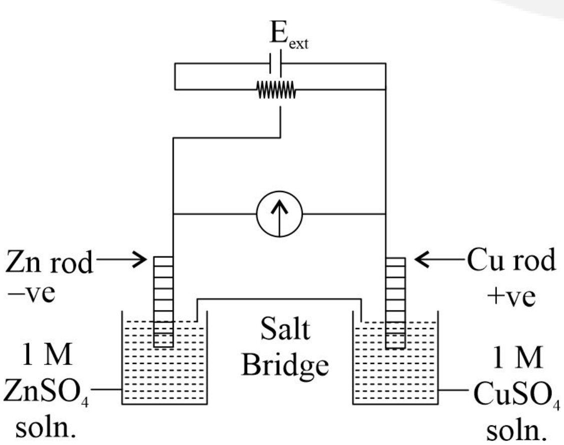
(C)



(D)



Q2



$$E^0_{Cu^{2+}|Cu} = +0.34\ V$$

$$E^0_{Zn^{2+}|Zn} = -0.76\ V$$

Identify the **incorrect** statment from the option below for the above cell.

(A) If $E_{ext} < 1.1$ V, Zn dissolves at anode and Cu deposits at cathode

(B) If $E_{ext} = 1.1$ V, no flow of e^- or current occurs

(C) If $E_{ext} > 1.1$ V, e^- flow from Cu to Zn

(D) If $E_{ext} > 1.1$ V, Zn dissolve at Zn electrode and Cu deposits at Cu electrode.

Q3 **Statements-I:** Unit of specific conductivity is $ohm^{-1}cm^{-1}$.

Statements-II: Specific conductivity of strong electrolytes decreases on dilution.

(A) Both the statements are correct.

(B) Statement I is correct but statement II is incorrect

(C) Statement I is false but statement II is correct.

(D) Both the statements are incorrect.

Q4 To observe the effect of concentration on the conductivity, electrolytes of different natures are taken in two vessels A and B; A contains weak electrolyte, e.g., NH_4OH and B contains strong electrolyte, e.g., NaCl. In both containers, the concentration of respective electrolyte is increased and the molar conductivity is observed:

(A) In A conductivity increases, in B conductivity decrease

(B)

In A conductivity decreases while, in B conductivity increases

(C) In both A and B, molar conductivity increases

(D) In both A and B, molar conductivity decreases

Q5 Plotting $1/\Lambda_m$ against $c\Lambda_m$ for aqueous solutions of a monobasic weak acid (HX) resulted in a straight line with y-axis intercept of P and slope of S. The ratio P/S is

[Λ_m= molar conductivity

$\Lambda_m°$= limiting molar conductivity

C = molar concentration

K_a = dissociation constant of HX]

(A) $\mathrm{K_a}\Lambda_\mathrm{m}{}^\circ$

(B) $\mathrm{K_a}\Lambda_\mathrm{m}{}^\circ/2$

(C) $2\ \mathrm{K_a}\Lambda_\mathrm{m}{}^\circ$

(D) $1/(\mathrm{K_a}\Lambda_\mathrm{m}{}^\circ)$

Q6 If x is specific resistance of the electrolyte solution and y is the molarity of the solution, then Λ_m is given by [x is in ohm. cm & Λ_m in Ω^{-1} cm^2mol^{-1}]

(A) $\frac{1000x}{y}$ (B) $1000\frac{x}{y}$

(C) $\frac{1000}{xy}$ (D) $\frac{xy}{1000}$

Q7 For the following cell,

$Zn(s)|ZnSO_4\,(aq)\|CuSO_4(aq)|Cu(s)$

when the concentration of Zn^{2+} is 10 times the concentration of Cu^{2+}, the expression for ΔG (in J mol^{-1}) is

[F is Faraday constant; R is gas constant;

T is temperature; E° (cell) = 1.1 V]

(A) 2.303RT + 11F

(B) 1.1 F

(C) 2.303RT–2.2F

(D) –2.2 F

Q8 Molar conductances of $BaCl_2$, H_2SO_4 and HCl at infinite dilutions are x_1, x_2 and x_3, respectively. Equivalent conductance of $BaSO_4$ at infinite dilution will be :

(A) $\frac{[x_1+x_2-x_3]}{2}$ (B) $\frac{[x_1-x_2-x_3]}{2}$

(C) $2(x_1+x_2-2x_3)$ (D) $\frac{[x_1+x_2-2x_3]}{2}$

Q9 **Statement-I:** At Infinite dilution, each ion makes definite contribution to conductance of an electrolyte whatever be the nature of the other ion of the electrolyte.

Statement-II: At infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte

(A) Both the statements are correct.

(B) Statement I is correct but statement II is false

(C) Statement I is false but statement II is correct.

(D) Both the statements are false.

Q10 Molar conductance of 0.1 M acetic acid is 7 ohm^{-1} cm^2 mol^{-1}. If the molar conductance of acetic acid at infinite dilution is 380.8 ohm^{-1} cm^2 mol^{-1}, the value of dissociation constant will be :

(A) 2.26×10^{-5} mol dm^{-3}

(B) 1.66×10^{-3} mol dm^{-1}

(C) 1.66×10^{-2} mol dm^{-3}

(D) 3.442×10^{-5} mol dm^{-3}

Q11 Match List-I with List-II.

	List-I		List-II
(A)	$Cd(s)+2Ni(OH)_3(s)\rightarrow CdO(s) + 2Ni(OH)_2(s)+H_2O(l)$	(I)	Primary battery
(B)	$Zn(Hg) + HgO(s) \rightarrow ZnO(s) + Hg(l)$	(II)	Discharging of secondary battery
(C)	$2PbSO_4(s) + 2H_2O(l)\rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4(aq)$	(III)	Fuel cell
(D)	$2H_2\,(g) + O_2(g) \rightarrow 2H_2O(l)$	(IV)	Charging of secondary

			battery

Choose the **correct** answer from the options given below

(A) A-(I), B-(II), C-(III), D-(IV)
(B) A-(IV), B-(I), C-(II), D-(III)
(C) A-(II), B-(I), C-(IV), D-(III)
(D) A-(II), B-(I), C-(III), D-(IV)

Q12 The standard EMF for the cell reaction:
$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
is 1.10 volts at 25°C. The EMF of the cell reaction when 0.1 M Cu^{2+} and 0.1 M Zn^{2+} solutions are used at 25°C is :
(A) 1.10 V (B) 1.041 V
(C) –1.10 V (D) –1.041 V

Q13 Consider the following four electrodes:
P = Cu^{2+}(0.0001M)/Cu(s)
Q = Cu^{2+}(0.1M)/Cu(s)
R = Cu^{2+}(0.01M)/Cu(s)
S = Cu^{2+}(0.001M)/Cu(s)
If the standard electrode potential of Cu^{2+}/Cu is +0.34V, the reduction potentials (in volts) of the above electrodes follow the order:
(A) P > S > R > Q
(B) S > R > Q > P
(C) R > S > Q > P
(D) Q > R > S > P

Q14 For the following E∘ values of half cells :
(i) $A^{2-} \rightarrow A^{3-} + e^-$; E° = 1.5V
(ii) $B^+ + e^- \rightarrow B$; E° = 0.5V
(iii) $C^{2+} + e^- \rightarrow C^+$; E° = 0.5V
(iv) $D \rightarrow D^{2+} + 2e^-$; E° = –1.15V
What combination of two half cells would result in a cell with the largest potential?
(A) (i) and (iii) (B) (i) and (iv)
(C) (ii) and (iv) (D) (iii) and (iv)

Q15 The potential of the cell containing two hydrogen electrodes as shown below:
$Pt, H_{2(g)} | H^+_{(aq.)}(10^{-8}M) || H_{(aq.)}(0.001M) | H_{2(g)}$, Pt is :
(A) –0.295V (B) –0.0591V
(C) 0.295V (D) 0.0591V

Q16 In a concentration cell the same metal electrodes are present in both the anode and the cathode compartments, but at different concentrations. Calculate the emf of a cell containing 0.040 M Cr^{3+} in one compartment and 1.0 M Cr^{3+} in the other if Cr electrodes are used in both.
(A) 0.028V (B) 0.249V
(C) 0.083V (D) 0.125V

Q17 The electrode oxidation potential of electrode $M(s) \rightarrow M^{n+}(aq)(2M) + ne^-$ at 298K is E_1. When temperature (in °C) is doubled and concentration is made half, then the electrode potential becomes E_2. Which of the following represents the correct relationship between E_1 and E_2?
(A) $E_1 > E_2$
(B) $E_1 < E_2$
(C) $E_1 = E_2$
(D) Cann't be predicted

Q18 The EMF of a concentration cell consisting of two zinc electrodes, one dipping into 4 M sol. of zinc sulphate and the other into 16 M sol. of the same salt at 25°C is
(A) 0.0125V (B) 0.0250V
(C) 0.0178V (D) 0.0356V

Q19 The EMF of the cell: $Zn|Zn^{2+}(0.01M)||Fe^{2+}(0.001M)|Fe$ at 298K is 0.2905V, then the value of equilibrium constant for the cell reaction at 298K is:
(A) $e^{\frac{0.32}{0.0295}}$ (B) $10^{\frac{0.32}{0.0295}}$
(C) $10^{\frac{0.26}{0.0295}}$ (D) $10^{\frac{0.32}{0.0591}}$

Q20 The cell in which the following reaction occurs:
$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$

has E°(cell) = 0.236V at 298K. Find the value of the standard Gibbs energy and the equilibrium constant of the cell reaction.

(A) $\Delta rG^{\ominus} = -45.54$ kJ mol^{-1}, $K_c = 9.62\times10^7$

(B) $\Delta rG^{\ominus} = -55.54$ kJ mol^{-1}, $K_c = 7.62\times10^7$

(C) $\Delta rG^{\ominus} = -80.54$ kJ mol^{-1}, $K_c = 3.62\times10^7$

(D) $\Delta rG^{\ominus} = -10.54$ kJ mol^{-1}, $K_c = 1.62\times10^7$

Q21 Assuming that hydrogen behaves as an ideal gas, what is the EMF of the cell at 25°C if $P_1 = 600$ mm and $P_2 = 420$ mm:
$Pt|H_2(P_1)|HCl|H_2(P_2)|Pt$? [Given: 2.303 RT/F = 0.06, log7 = 0.85]

(A) –0.0045 V

(B) –0.01 V

(C) +0.0045 V

(D) +0.0015 V

Q22 3 Faradays of electricity are passed through molten Al_2O_3, aqueous solution of $CuSO_4$ and molten NaCl taken in three different electrolytic cells. The amount of Al, Cu and Na deposited at the cathodes will be in the ratio of :

(A) 1 mole : 2 mole : 3 mole

(B) 1 mole : 1.5 mole : 3 mole

(C) 3 mole : 2 mole : 1 mole

(D) 1 mole : 1.5 mole : 2 mole

Q23 The standard electrode potential E° and its temperature coefficient (dE°/dT) for a cell are 2V and -5×10^{-4} V K^{-1} at 300 K respectively.
The cell reaction is
$Zn(s)+Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
The standard reaction enthalpy ($\Delta_rH°$) at 300 K in kJ mol^{-1} is,
[Use R=8JK^{-1}mol^{-1} and F=96,000Cmol^{-1}]

(A) 206.4 (B) –384.0

(C) –412.8 (D) 192.0

Q24 After electrolysis of a sodium chloride solution with inert electrodes for a certain period of time, 600 mL of the solution was left, which was found to be 1 N in NaOH. During the same period time, 31.75 g of copper was deposited in the copper voltmeter in series with the electrolytic cell. Calculate the percentage yield of NaOH obtained (in %).

(A) 60 (B) 20

(C) 40 (D) 80

Q25 Calculate the electricity that would be required to reduce 12.3 g of nitrobenzene to aniline, if the current efficiency for the process is 50 percent. If the potential drop across the cell is 3.0 volt, how much energy will be consumed?

(A) 0.6 F, 252 kJ

(B) 1.2 F, 380.5 kJ

(C) 1.2 F, 347.4 kJ

(D) 0.6 F, 351.2 kJ

Q26 An electric current of 100 amperes is passed through a molten liquid of sodium chloride for 5 hours. Calculate the volume of chlorine gas liberated at the electrode at STP.

(A) 210.5L (B) 200L

(C) 211L (D) 208.91L

Q27 The Zn acts as sacrificial or cathodic protection to prevent rusting of iron because :

(A) $\overset{\circ}{E}_{OP}$ of Zn $<$ $\overset{\circ}{E}_{OP}$ of Fe

(B) $\overset{\circ}{E}_{OP}$ of Zn $>$ $\overset{\circ}{E}_{OP}$ of Fe

(C) $\overset{\circ}{E}_{OP}$ of Zn $=$ $\overset{\circ}{E}_{OP}$ of Fe

(D) Zn is cheaper than iron

Q28 Among the following cells:
Leclanche cell (I), Nickel-cadmium cell (II), Lead storage battery (III), Mercury cell (IV) primary cells are :

(A) I and II (B) I and III

(C) II and III (D) I and IV

Q29

Statement-I : Fuel cells are continuously run as long as fuels are supplied.
Statement-II : Fuel cells are used to provide power and drinking water to astronauts in space programme.
(A) Both the statements are correct.
(B) Statements-I is true but statement-II is incorrect.
(C) Statement-I is false but statement-II is correct.
(D) Both the statement are incorrect.

Q30 Which of the following is incorrect for fuel cells?
(A) They generate direct current.
(B) They are highly efficient.
(C) The noise level is very high.
(D) The emission level is much below the permissible level.

Q31 Consider the following statements regarding galvanic cells:

1. In a Daniell cell, electrons flow from copper to zinc when the circuit is closed.
2. A salt bridge completes the electrical circuit and maintains charge neutrality.
3. Oxidation occurs at the anode, which is negatively charged in a galvanic cell.
4. When the EMF of the Daniell cell is +1.10 V the reaction stops at together and no current flows through cell.
5. A galvanic cell converts electrical energy into chemical energy.

Which of the above statements are correct?
(A) 2, 3, and 4 (B) 1, 2, and 5
(C) 2, 3, and 5 (D) 3, 4, and5

Q32 Analyse the following statements about standard electrode potentials:

1. Standard electrode potential is measured under I atm pressure of H_2 gas and 1 M concentrations of H^+ ions.
2. A more positive standard electrode potential implies greater tendency to lose electrons.
3. Standard hydrogen electrode is arbitrarily assigned a potential of zero volts.
4. The standard EMF of a cell can be calculated as the difference between cathode and anode standard reduction potentials.
5. An electrode with negative E° value acts as an anode in a galvanic cell.

Which statements are true?
(A) 1, 3, 4, and 5
(B) 2, 3, and 5
(C) 1, 2, 4 and 5
(D) 1, 3 and 4

Q33 Examine the following statements regarding fuel cells and batteries:

1. Dry cell is a type of rechargeable battery used in household electronics.
2. Mercury cell provides nearly constant voltage during its operation.
3. Lead storage batteries can be recharged by reversing the cell reaction.
4. Fuel cells continuously convert chemical energy into electrical energy.
5. In hydrogen-oxygen fuel cell, only water is produced as a by product.

Which of the above are correct?
(A) 2, 3, 4, and 5 (B) 1, 3, and 4
(C) 2, 4, and 5 (D) 1, 2, and 3

Q34 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A: Molar conductivity of a weak electrolyte increases rapidly with dilution.
Reason R: Weak electrolytes dissociate completely at all concentrations.

In the light of the above statements, choose the **correct** answer from the options given below:

(A) A is true but R is false.

(B) A is false but R is true.

(C) Both A and R are true and R is the correct explanation of A.

(D) Both A and R are true but R is NOT the correct explanation of A.

Q35 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: The standard EMF of a cell is positive if the redox reaction is spontaneous under standard conditions.

Reason R: A positive EMF corresponds to a negative standard Gibbs free energy change.

In the light of the above statements, choose the **correct** answer from the options given below:

(A) A is true but R is false.

(B) A is false but R is true.

(C) Both A and R are true and R is the correct explanation of A.

(D) Both A and R are true but R is NOT the correct explanation of A.

Q36 Given below are two statements:

Statement I: Conductivity of an electrolyte solution increases with increasing dilution due to more number of ions per unit volume.

Statement II: When the conductivity approaches zero, the molar conductivity is known as limiting molar conductivity.

In the light of the above statements, choose the *most appropriate* answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct.

(D) Both Statement I and Statement II are incorrect.

Q37 Given below are two statements:

Statement I: Limiting molar conductivity of H^+ is more than Ca^{2+} in water at 298 K.

Statement II: Molar conductivity is given by the expression $\Lambda_m = \kappa \times C$.

In the light of the above statements, choose the *most appropriate* answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct.

(D) Both Statement I and Statement II are incorrect.

Q38 Match List-I with List-II:

	List-I		List-II
A.	Cu^{2+}/Cu	I.	+0.34 V
B.	Zn^{2+}/Zn	II.	−0.76 V
C.	Li^+/Li	III.	Highest reducing power
D.	F_2/F^-	IV.	+2.87 V

Choose the **correct** answer from the options given below:

(A) A-III, B-II, C-I, D-IV

(B) A-IV, B-III, C-II, D-I

(C) A-II, B-III, C-IV, D-I

(D) A-I, B-II, C-III, D-IV

Q39 Match List-I with List-II:

List-I	List-II

A.	Conductivity (κ) definition	I.	Inverse of resistivity
B.	Molar Conductivity (Λ_m)	II.	κ / c
C.	Units of κ	III.	S m^{-1}
D.	Limiting Molar Conductivity	IV.	Value at infinite dilution

Choose the **correct** answer from the options given below:

(A) A-I, B-II, C-III, D-IV

(B) A-I, B-IV, C-III, D-II

(C) A-II, B-I, C-IV, D-III

(D) A-IV, B-II, C-I, D-III

Q40 The mass of silver (Ag = 108 g/mol) displaces by a quantity of electricity which displaces 560 mL of O_2 at STP will be :

(A) 108 g (B) 10.8 g

(C) 54 g (D) 5.4 g

Q41 Write the cell representation for the following cell:

$\frac{1}{2}H_2(g) + AgCl(s) \rightleftharpoons H^+(aq) + Cl^-(aq) + Ag(s)$

(A) Pt $|H_2(g)|$ KCl(aq) $|AgCl(s)|$ Ag(s)

(B) Pt $|H_2(g)|$ HCl(aq) $|AgCl(s)|$ Ag(s)

(C) Pt $|H_2(g)|$ KCl(aq) $|AgCl(s)|$ Ag(s)

(D) Pt $|H_2(g)|$ HCl(aq) $|AgCl(aq)|$ Ag(s)

Q42 Consider the following:

$Cr^{3+} + 3e^- \rightarrow Cr(s)$ E° = –0.74 V

$Ca^{2+} + 2e^- \rightarrow Ca(s)$ E° = –2.87 V

$Na^+ + e^- \rightarrow Na(s)$ E° = –2.74 V

$Ni^{2+} + 2e^- \rightarrow Ni(s)$; E° = –0.25 V

The reducing power of the metal increasing in the order

(A) Ca < Cr < Na < Ni

(B) Ni < Cr < Na < Ca

(C) Cr < Na < Ni < Ca

(D) Ca < Na < Cr < Ni

Q43 We are given with followin cell reaction:

$2H^+ + 2e^- \rightarrow H_2$

$P_{H_2} = 4\,\text{atm}$

$[H^+] = 1\,\text{M}$

$\left(\frac{2.303\,RT}{F} = 0.06\right) (\log 4 = 0.6)$

If E_{cell} for reaction is given by $-x \times 10^{-2}$ V, find out x.

(A) 9 (B) 1.8

(C) 18 (D) 0.9

Q44 Correct equation to show change in molar conductivity with respect to concentration for a strong electrolyte among the following option is, if the symbols carry their usual meaning:

(A) $\Lambda^2{}_m C - K_a \Lambda_m{}^{\circ 2} + K_a \Lambda_m \Lambda^\circ{}_m = 0$

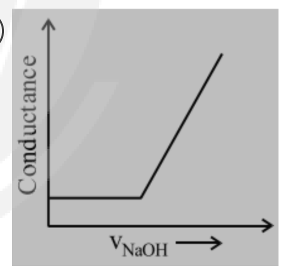
(B) $\Lambda_m + \Lambda_m^0 + AC^{\frac{1}{2}} = 0$

(C) $\Lambda_m - \Lambda_m^0 + AC^{\frac{1}{2}} = 0$

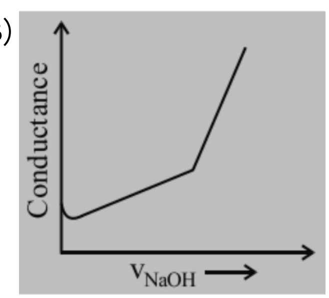
(D) $\Lambda^2{}_m C + K_a \Lambda_m{}^{\circ 2} + K_a \Lambda_m \Lambda^\circ{}_m = 0$

Q45 Choose the **correct** representation of conductometric titration of HCl vs NaOH.

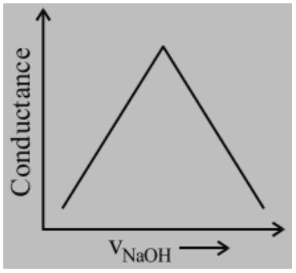
(A)



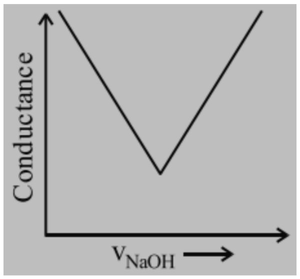
(B)



(C)



(D)



Q46 The decreasing order of electrical conductivity of the following aqueous solution is:

(A) 0.1 M Formic acid
(B) 0.1 M Acetic acid
(C) 0.1 M Benzoic acid
(D) 0.1 Phenol

(A) (A) > (B) > (D) > (C)
(B) (A) > (C) > (B) > (D)
(C) (C) > (B) > (D) > (A)
(D) (C) > (A) > (B) > (D)

Q47 What pressure (bar) of H_2 would be required to make emf of hydrogen electrode zero in pure water at 25°C?

(A) 10^{-14} (B) 10^{-7}
(C) 1 (D) 0.5

Q48 Identify the factor from the following that does not affect electrolytic conductance of a solution.

(A) The nature of the electrolyte added.
(B) The nature of the electrode used.
(C) Concentration of the electrolyte.
(D) The nature of solvent used.

Q49 The oxidation potential of Zn, Cu, Ag, H_2 and Ni are 0.76, −0.34, −0.80, 0.00, 0.25 Volt respectively. Which of the following reaction will provide maximum voltage?

(A) $Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$
(B) $Zn + 2Ag^{+} \rightarrow 2Ag + Zn^{2+}$
(C) $H_2 + Cu^{2+} \rightarrow 2H^{+} + Cu$
(D) $H_2 + 2Ag^{+} \rightarrow 2Ag + Zn^{2+}$

Q50 The metals that are employed in the battery industries are

A. Fe
B. Mn
C. Ni
D. Cr
E. Cd

Choose the **correct** answer from the options given below:

(A) B, C and E only
(B) A, B, C, D and E
(C) A, B, C and D only
(D) B, D and E only

Q51 You are given three electrolytes: NaCl, $CaCl_2$, and $AlCl_3$, all at the same molar concentration. The molar conductivities are measured under identical conditions. Which of the following statements is **correct**?

(A) $AlCl_3$ will have the lowest molar conductivity due to lower ionic mobility of Al^{3+}
(B) NaCl will show the highest molar conductivity due to complete dissociation.
(C) $CaCl_2$ will show higher conductivity than NaCl because it produces more ions per mole.
(D) All three will show identical conductivities since the concentration is the same.

Q52 When a galvanic cell operates until equilibrium is reached, which of the following is necessarily **true**?

(A) The concentrations of all ions in both half-cells are equal.

(B) The cell continues to produce a steady voltage.

(C) The Gibbs free energy of the system is positive.

(D) The EMF of the cell becomes zero and Q = K.

Q53 The EMF of the Galvanic cell under standard conditions is 0.50 V. Calculate the standard Gibbs energy change ($\Delta G°$) of the cell reaction. (Take F = 96500 C mol^{-1} and n = 2)

(A) –212.3 kJ mol^{-1}

(B) –106.2 kJ mol^{-1}

(C) –96.5 kJ mol^{-1}

(D) –118.0 kJ mol^{-1}

Q54 A solution of 0.02 M KCl has a resistance of 520 Ω using a conductivity cell with cell constant 1.29 cm^{-1}. Find the conductivity.

(A) 0.00248 S cm^{-1}

(B) 0.248 S cm^{-1}

(C) 0.00248 S m^{-1}

(D) 0.129 S cm^{-1}

Q55 In a cell: Zn(s) I Zn^{2+} (1 M) II Cu^{2+} (x M) | Cu(s), the EMF is observed to be 1.25 V. If E° cell is 1.10 V, what can be inferred about the value of x?

(A) x = 1.0 (B) x > 1.0

(C) x < 1.0 (D) x = 0.0

Q56 A hydrogen electrode is placed in a solution of unknown pH. The electrode potential is measured to be -0.177 V. What is the pH of the solution at 298 K?

(A) 3.00 (B) 10.00

(C) 12.00 (D) 7.00

Q57 A student prepares 100 mL of 0.001 M $BaCl_2$ and measures its conductivity as 1.0 × 10^{-4} S cm^{-1}. If she accidentally adds 50 mL of distilled water, what is the expected change in:

(i) conductivity (κ)

(ii) molar conductivity (Λ_m)?

(A) κ and Λ_m both decrease

(B) κ decreases, Λ_m increases

(C) κ increases, Λ_m decreases

(D) κ constant, Λ_m increases

Q58 Electrolysis of aqueous $CuSO_4$ with copper electrodes maintains constant Cu^{2+} concentration. This is because:

(A) Water is preferentially reduced over Cu^{2+}

(B) Cu^{2+} is both consumed and regenerated at identical rates

(C) The electrode potential of Cu^{2+} changes rapidly

(D) Cu atoms migrate from cathode to anode

Q59 The standard cell potential of $\mathrm{Zn}(s)\,|\,\mathrm{Zn}^{2+}_{(aq)}\,||\,\mathrm{Cu}^{2+}_{(aq)}\,|\,\mathrm{Cu}(s)$ cell is 1.10 V. The magnitude of the maximum work obtained by this cell will be:

(A) 106.15 kJ (B) 212.30 kJ

(C) 318.45 kJ (D) 424.60 kJ

Q60 During electrolysis of aqueous NaCl, the expected cathodic product is:

(A) Sodium metal due to its low standard reduction potential

(B) Hydrogen gas due to its more positive reduction potential than Na^+

(C) Sodium hydroxide due to direct reduction of NaOH

(D) Water due to its higher conductivity

Answer Key

Q1	(A)
Q2	(D)
Q3	(A)
Q4	(D)
Q5	(A)
Q6	(C)
Q7	(C)
Q8	(D)
Q9	(C)
Q10	(D)
Q11	(C)
Q12	(A)
Q13	(D)
Q14	(B)
Q15	(C)
Q16	(A)
Q17	(B)
Q18	(C)
Q19	(B)
Q20	(A)
Q21	(C)
Q22	(B)
Q23	(C)
Q24	(A)
Q25	(C)
Q26	(D)
Q27	(B)
Q28	(D)
Q29	(A)
Q30	(C)
Q31	(A)
Q32	(A)
Q33	(A)
Q34	(A)
Q35	(C)
Q36	(D)
Q37	(A)
Q38	(D)
Q39	(A)
Q40	(B)
Q41	(B)
Q42	(B)
Q43	(B)
Q44	(C)
Q45	(D)
Q46	(B)
Q47	(A)
Q48	(B)
Q49	(B)
Q50	(A)
Q51	(C)
Q52	(D)
Q53	(C)
Q54	(A)

Q55 (B)

Q56 (A)

Q57 (B)

Q58 (B)

Q59 (B)

Q60 (B)

Hints & Solutions

Q1 Text Solution:

$AgNO_3$ is a strong electrolyte. For strong electrolytes, Kohlrausch's Law gives the relation:

$\Lambda_m = \Lambda_m{}^\circ - K\sqrt{C}$

This implies that Λ_m decreases linearly with $\sqrt{C}$.

Q2 Text Solution:

$E^\circ_{cell} = E^\circ_{Cu^{2+}/Cu} - E^\circ_{Zn^{2+}/Zn} = 1.1V$

So, if E_{ext} = 1.1V, no e^- will flow.

At E_{ext} > 1.1V, cell act as electrolytic cell and electron will flow from Cu to Zn.

At E_{ext} < 1.1V, cell act as electrochemical cell, so Zn dissolves at anode and Cu at Cathode.

Q3 Text Solution:

Both statements are correct.

Q4 Text Solution:

Molar conductivity decreases with increasing concentration for both weak and strong electrolytes.

Q5 Text Solution:

Since $\alpha = \frac{\Lambda_m}{\Lambda_0}$

Also, $K_a = \frac{C\alpha^2}{1-\alpha} \Rightarrow K_a\left(1-\alpha\right) = C\alpha^2$

$\Rightarrow K_a\left(1 - \frac{\Lambda_m}{\Lambda_0}\right) = C\left(\frac{\Lambda_m}{\Lambda_0}\right)^2$

$\Rightarrow K_a - \frac{\Lambda_m K_a}{\Lambda_0} = \frac{C\Lambda_m^2}{(\Lambda_0)^2}$

Divide by 'Λ_m'

$\Rightarrow \frac{K_a}{\Lambda_m} = \frac{C\Lambda_m}{(\Lambda_0)^2} + \frac{K_a}{\Lambda_0}$

$\Rightarrow \frac{1}{\Lambda_m} = \frac{C\Lambda_m}{K_a(\Lambda_0)^2} + \frac{1}{\Lambda_0}$

The plot of $\frac{1}{\Lambda_m}$ vs $C\Lambda_m$ has slope $= \frac{1}{K_a(\Lambda_0)^2} = S$ and, y -intercept = $= \frac{1}{\Lambda_0} = P$

Hence, $\frac{P}{S} = \frac{\frac{1}{\Lambda_0}}{\frac{1}{K_a(\Lambda_0)^2}} = K_a\Lambda_0$

Q6 Text Solution:

Specific conductivity $\kappa = \frac{1}{x}\left(\text{in S}\cdot\ \text{cm}^{-1}\right)$

Molar conductivity $\Lambda_m = \frac{\kappa\times 1000}{y}$

Final formula :

$\Lambda_m = \frac{1000}{x\cdot y}\ \left[\text{in }\Omega^{-1}\ \text{cm}^2\ \text{mol}^{-1}\right]$

Q7 Text Solution:

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

$E = E^\circ - \frac{2.303RT}{2F}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

$E = E^\circ - \frac{2.303RT}{2F}\log 10$

$E = 1.1 - \frac{2.303RT}{2F}$

Also, $\Delta G = -nEF = -2F\left(1.1 - \frac{2.303RT}{2F}\right)$

$-2.2F + 2.303RT = 2.303RT - 2.2F$

Q8 Text Solution:

$\Lambda_{\circ BaCl_2} = x_1 = \lambda_{\circ Ba^{2+}} + 2\lambda_{\circ Cl^-}$

$\Lambda_{\circ H_2SO_4} = x_2 = 2\lambda_{\circ H^+} + \lambda_{\circ SO_4^{2-}}$

$\Lambda_{\circ HCl} = x_3 = \Lambda_{\circ H^+} + \lambda_{\circ Cl^-}$

Step-by-step subtraction:

To eliminate H^+ and Cl^-:

Multiply HCl by 2: $2x_3 = 2\lambda^\circ_{H^+} + 2\lambda^\circ_{Cl^-}$

Now,

$x_1 + x_2 - 2x_3 = \lambda^\circ_{Ba^{2+}} + 2\lambda^\circ_{H^+} + \lambda^\circ_{SO_4^{2-}}$

$-\left(2\lambda^\circ_{H+} + 2\lambda^\circ_{Cl^-}\right)$

$= \lambda^\circ_{Ba^{2+}} + \lambda^\circ_{SO_4^{2-}} = \Lambda^\circ_{BaSO_4}$

Q9 Text Solution:

At infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte.

Q10 Text Solution:

$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{7}{380.8} = 0.01838$

$K_a = 0.1 \times (0.01838)$

On solving we get $K_a = 3.442 \times 10^{-5}$

Q11 Text Solution:

(A) $Cd(s)+2Ni(OH)_3(s) \longrightarrow CdO(s) +2Ni(OH)_2(s)+H_2O(l)$

Discharging of secondary battery reaction

(B) $Zn(Hg)+HgO(s) \rightarrow ZnO(s)+Hg(l)$

Primary battery cell reaction

(C) $2PbSO_4(s)+2H_2O(l) \longrightarrow Pb(s)+ PbO_2(s)+2H_2SO_4(aq)$

Charging of secondary battery reaction

(D) $2H_2(g)+O_2(g) \longrightarrow 2H_2O(l)$

Fuel cell reaction

Q12 Text Solution:

$$E_{\text{cell}} = E_{\text{cell}}{}^{\circ} - \frac{0.0591}{n} \log\left(\frac{[\mathrm{Zn}^{2+}]}{[\mathrm{Cu}^{2+}]}\right)$$

Here, n = 2

$$E_{\text{cell}} = 1.10 - \frac{0.0591}{2} \log\left(\frac{0.1}{0.1}\right) = 1.10 - 0$$

$$= 1.10 \text{ V}$$

Q13 Text Solution:

Lower $[Cu^{2+}]$ results in a lower reduction potential (since $\log[Cu^{2+}]$ becomes more negative).

The order of $[Cu^{2+}]$ is:

Q(0.1M)>R(0.01M)>S(0.001M)>P(0.0001M)

Thus, the order of reduction potentials will be the reverse of concentration (since higher concentration = higher potential):

Q14 Text Solution:

Option (A): (i) and (iii)

Cathode: (i) $A^{3-} \rightarrow A^{2-} + e^-$ ($E° = 1.5$ V)

Anode: (iii) Oxidation $C^+ \rightarrow C^{2+} + e^-$ ($E° = -0.5$ V)

E°_{cell} = 1.5 – (–0.5) = 2.0 V

Option (B): (i) and (iv)

Cathode: (i) $A^{3-} \rightarrow A^{2-} + e^-$ ($E° = 1.5$ V)

Anode: (iv) $D \rightarrow D^{2+} + 2e^-$ ($E° = -1.15$ V)

E°_{cell} = 1.5 – (–1.15) = 2.65 V

Option (C): (ii) and (iv)

Cathode: (iv) Reduction $D^{2+} + 2e^- \rightarrow D$($E° = 1.15$ V)

Anode: (ii) Oxidation $B \rightarrow B^+ + e^-$ ($E° = -0.5$ V)

E°_{cell} =1.15 – (– 0.5) = 1.65 V

Option (D): (iii) and (iv)

Cathode: (iv) Reduction $D^{2+} + 2e^- \rightarrow D$($E° = 1.15$ V)

Anode: (iii) Oxidation $C^+ \rightarrow C^{2+} + e^-$ ($E° = -0.5$ V)

E°_{cell} = 1.15 – (– 0.5) = 1.65 V

Conclusion:

The largest cell potential (2.65 V) is obtained with Option (B): (i) and (iv).

Q15 Text Solution:

$$= -\frac{0.0591}{1} \frac{\log[10^{-8}]}{[10^{-3}]}$$

$=0.0591 \log 10^{-5}$

= 0.0591×5 V = 0.295 V

Q16 Text Solution:

$$\mathrm{E_{cell}} = 0 - \frac{0.0591}{3} \log\left(\frac{0.040}{1.0}\right)$$

$$\log(0.040) \approx -1.40)$$

3. Put the log value back in:

$$\mathrm{E_{cell}} = -\frac{0.0591}{3} \times (-1.398) = \frac{0.0591 \times 1.398}{3}$$

4. Calculate the emf.

$$E_{\text{cell}} \approx \frac{0.0826}{3} = 0.0275 \text{ V} \approx 0.028 \text{ V}$$

Q17 Text Solution:

Initial Conditions (E_1):

- Temperature T_1 = 298K,
- Concentration $[M^{n+}]_1 = 2\text{M}$

The initial potential E_2 is:

$$E_1 = E^{\circ} - \frac{R \times 298}{nF} \ln 2$$

New Conditions (E_2):

- Temperature $T_2 = 2 \times 298 = 596$ K,
- Concentration $[M^{n+}]_2 = \frac{2}{2} = 1\text{M}.$

The new potential E_2 is:

$$\mathrm{E_2 = E^{\circ} - \frac{R \times 596}{nF} \ln 1}$$

Since in 1 = 0, this simplifies to:

$$\mathrm{E_2 = E^{\circ}}$$

Comparison of E_1 and E_2:

$$E_1 = E^{\circ} - \frac{R \times 298}{nF} \ln 2 \quad \text{(Negative term)}$$

$$E_2 = E^{\circ} \quad \text{(No correction term)}$$

Thus: $E_1 < E^\circ = E_2$

Q18 Text Solution:

EMF of a concentration cell:

$E_{\text{cell}} =-\frac{0.0591}{n}\log\left(\frac{\text{Lower conc.}}{\text{Higher conc.}}\right)$

Lower concentration = 4M

Higher concentration = 16 M

For Zn^{2+}/Zn, n = 2

$E_{\text{cell}} =-\frac{0.0591}{2}\log\left(\frac{4}{16}\right) =-0$

$.02955\log(0.25) = 0.02955 \times 0.602 \approx 0$

$.0178 \text{ V}$

Q19 Text Solution:

At equilibrium, use the Nernst equation:

$\log K = \frac{nE^\circ}{0.0591}$

$\log\ K = \frac{2\times0.2905}{0.0591} = \frac{0.581}{0.0591} \approx 9.83\ K$

$= 10^{9.83}$

$K = 10^{\frac{0.32}{0.0295}}$

Q20 Text Solution:

$\Delta G^\circ = -RT\ln K \Rightarrow \ln K = \frac{-\Delta G^\circ}{RT}$

$R = 8.314\ \text{J/mol}\quad \text{K},\quad T = 298\ \text{K}$

$\ln K = \frac{45538.6}{8.314\times298} \approx 18.43 \Rightarrow K = e^{18.43}$

$\approx 9.62 \times 10^7$

Q21 Text Solution:

$E = \frac{0.06}{n}\log\left(\frac{P_1}{P_2}\right)$

Given:

P_1 = 600 mm

P_2 = 420 mm

n = 2 (since $H_2 \rightleftharpoons 2H + 2e^-$)

$\frac{0.06}{2} = 0.03$

$\frac{P_1}{P_2} = \frac{600}{420} = \frac{10}{7}$

$\log\left(\frac{10}{7}\right) = \log 10 - \log 7 = 1 - 0.85 = 0$

$.15$

$E = 0.03 \times 0.15 = 0.0045\ \text{V}$

Q22 Text Solution:

Aluminum ($Al^{3+} + 3e^- \rightarrow Al$)

n=3

Moles of Al = 3/3 = 1

Copper ($Cu^{2+} + 2e^- \rightarrow Cu$)

n=2

Moles of Cu = 3/2 = 1.5

Sodium ($Na^+ + e^- \rightarrow Na$)

n=1

Moles of Na = 3/1 = 3

Final Ratio:

Al : Cu : Na = 1 : 1.5 : 3

Q23 Text Solution:

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

$+ \text{Cu}(\text{s})$

$\frac{\text{dE}^\circ}{\text{dT}} = -5 \times 10^{-4}\ \text{VK}^{-1}$

E° = 2V

T = 300K

$\Delta G^\circ = -nFE_{\text{cell}}{}^\circ = -2 \times 96500 \times 2$

=–4 × 96500

$\Delta \text{S}^\circ = \text{nF}\,\frac{\text{dE}^\circ}{\text{dT}}$

= 2 × 96500 × [–5 ×10^{-4}] = – 96.5

Now from equations:

$\Delta\text{H}^\circ = \Delta\text{G}^\circ + \text{T}\Delta\ \text{S}^\circ = -4 \times 96500$

$+ 298 \times (-96.5) = -412.8\ \text{kJ/mo}$

Q24 Text Solution:

Cu deposited = 31.75 g ⟹ 0.5 mol ⟹ 1 Faraday used

1 Faraday gives 1 mol NaOH theoretically

Actual NaOH = 1 N × 0.6 L = 0.6 mol

% Yield = (0.6 / 1) × 100 = 60%

Q25 Text Solution:

Reduction of nitrobenzene ($C_6H_5NO_2$) to aniline ($C_6H_5NH_2$) is a 6-electron process:

$\text{C}_6\text{H}_5\ \text{NO}_2 + 6e^- + 6\text{H}^+ \rightarrow \text{C}_6\text{H}_5\ \text{NH}_2$

$+ 2\text{H}_2\text{O}$

% current efficiency= $\frac{\text{charge}\quad\text{obs.}}{\text{charge}\quad\text{Theorotical}} \times 100\%$

$50\% = \frac{0.6F}{Q_T} \times 100\%$

$Q_T = \frac{0.6F\times100\%}{50\%} = 1.2F$

V = 3 volt

E = Q×V

=1.2 F×3

=1.2×96500 × 3

=347400 J

=347.4 kJ

Q26 Text Solution:

Q = i × t =100 × 5 × 3600 = 1,800,000C

Cl_2 needs 2 F⇒ Moles =1,800,000/(2 × 96500) = 9.33 mol

Volume = 9.33 × 22.4 = 208.91 L

Q27 Text Solution:

Zinc (Zn): Zn→Zn^{2+} + $2e^-$

$\mathrm{E}^{\mathrm{o}}_{\mathrm{OP}}$ = +0.76V

Iron (Fe):

Fe→Fe^{2+} +$2e^-$

$E^o_{OP} = +0.44V$

Since E^o_{OP} of Zn(+0.76 V) > E^o_{OP} of Fe (+0.44 V), Zn oxidizes more redily than Fe.

Q28 Text Solution:

A **primary cell** is a non-rechargeable battery that converts chemical energy into electrical energy through an irreversible reaction. Once discharged, it cannot be reused.

Example -: Leclanche and Mercury cell

Q29 Text Solution:

Both statements are true

Q30 Text Solution:

Their nose level is not so much high.

Q31 Text Solution:

- Electrons flow from Zinc to Copper
- Galvanic cell converts chemical energy into electrical energy.

Q32 Text Solution:

More positive E° means a greater tendency to gain electron.

Q33 Text Solution:

Dry cell are type of primay battery which become dead over a period of time.

Q34 Text Solution:

Assertion (A): TRUE

Molar conductivity increases rapidly on dilution due to greater ionization of the weak electrolyte.

Reason (R): FALSE

The statement is incorrect. Weak electrolytes do not dissociate completely at all concentrations.

Q35 Text Solution:

Assertion (A): TRUE

A redox reaction is spontaneous under standard conditions if the EMF of the cell is positive.

Reason (R): TRUE

A positive EMF does mean ΔG° is negative, indicating spontaneity.

Q36 Text Solution:

Statement I : False

Conductivity decreases with dilution.

Statement II : False

Limiting molar conductivity is defined at infinite dilution, not when K becomes zero.

Q37 Text Solution:

Statement II is wrong.

$\Lambda = \frac{\kappa \times 1000}{\mathrm{C}}$

Statement I is correct.

Statement I compares two ions' limiting molar conductivities, which are based on ionic mobilities.

Q38 Text Solution:

A.	Cu^{2+}/Cu	I.	+0.34 V
B.	Zn^{2+}/Zn	II.	–0.76 V
C.	Li^+/Li	III.	Highest reducing power

D.	F_2/F^-	IV.	+2.87 V

Q39 Text Solution:

A.	Conductivity	I.	Inverse of resistivity
B.	Molar Conductivity	II.	$\Lambda_m = \kappa \times \frac{1000}{C}$
C.	Units of κ	III.	$S\ m^{-1}$
D.	Limiting Molar Conductivity	IV.	Value at infinite dilution

Q40 Text Solution:

$$\text{moles}_1 \times n_{f_1} = \text{moles}_2 \times n_{f_2}$$

$$\frac{W}{108} \times 1 = \frac{560}{22400} \times 4$$

W = 108 g × 0.1

= 10.8 g

Q41 Text Solution:

Cell is made up of two half cell

: Ag Cl(s)$\rightarrow$Ag(s) + Cl^-(aq)

Anode : $\frac{1}{2}H_2(g) \rightarrow H^+(aq)$

Q42 Text Solution:

Reducing power is proportional to E°

More (–) E° means more reducing power of metal.

Q43 Text Solution:

$$E_{cell} = 0 - \frac{0.06}{2}\log 4$$

$$= -0.030(0.6)$$

$$= -0.018$$

$$= -1.8 \times 10^{-2}$$

$$X = 1.8$$

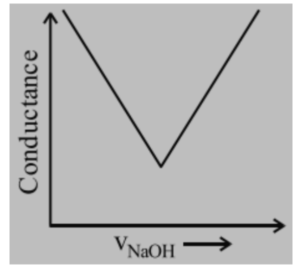
Q44 Text Solution:

For strong electrolyte

$$\Lambda_m = \Lambda_m^\circ - AC^{1/2}$$

Q45 Text Solution:

Strong acid vs strong base conductometric graph is given by;



Q46 Text Solution:

Stong acid means ions will be generated faster high ionisation leads to high conductivity.

Q47 Text Solution:

$$\frac{10^{-14}}{P_{H_2}} = 1$$

$$P_{H_2} = 10^{-14}$$

In pure water

$[H^+] = 10^{-7}$

Nernst equation at 25°C

$$E = E^\circ - \frac{0.059}{n}\log\frac{\text{pdt}}{\text{Reactant}}$$

$$0 = 0 - \frac{0.059}{2}\log\frac{(10^{-7})^2}{P_{H_2}}$$

$$\left(\frac{10^{-14}}{P_{H_2}}\right) = 1$$

$$P_{H_2} = 10^{-14}\ \text{bar}$$

Q48 Text Solution:

Nature of the electrode used.

Q49 Text Solution:

Zn + $2Ag^+ \rightarrow 2Ag + Zn^{2+}$

$E_{cell} = E_{right} - E_{left}$

= 0.8 – (–0.76)

= 1.56 V

Q50 Text Solution:

Mn, Ni and Cd are employed in battery.

Q51 Text Solution:

$CaCl_2$ will form 3 ions which NaCl will form only 2 ions.

Q52 Text Solution:

When Q = K

equilibrium is attained

$\Delta G = 0$ hence Emf = 0

Q53 Text Solution:

$\Delta G° = -nFE°$

n = 2 for Daniell cell

$\Delta G° = -2 \times 96500 \times 0.50$

= –96500 J/mol

= –96.5 kJ/mol

Q54 Text Solution:

$\kappa = GG^*$

$= \frac{1.29}{520} = 0.002485\ \mathrm{cm}^{-1}$

Q55 Text Solution:

$\mathrm{E} = \mathrm{E}^{\circ} - \frac{0.059}{n} \log \frac{1}{\mathrm{x}}$

$1.25 - 1.10 = -\frac{0.059}{2} \log \frac{1}{2}$

$= -\frac{0.15}{0.0295} = \log \frac{1}{\mathrm{x}}\ \boxed{\mathrm{x} > 1.0}$

Q56 Text Solution:

$\mathrm{E} = \mathrm{E}^{\circ} - \frac{0.059}{1} \log \frac{1}{[\mathrm{H}^{+}]}$

$-0.177 = 0 - 0.059 \log \frac{1}{[\mathrm{H}^{+}]}$

$3\ = \mathrm{pH}$

Q57 Text Solution:

Property	After Dilution	Why
Conductivity (κ)	Decreases	Fewer ions per unit volume
Molar Conductivity (Λ_{m})	Increases	κ drops, but concentration drops more

Q58 Text Solution:

Solution: For every mole of Cu^{2+} Ion reduced at the cathode, one mole is generated at the anode. The net concentration of Cu^{2+} in solution remains unchanged over time, assummg no side reactions or mass transfer limitations.

Q59 Text Solution:

$\mathrm{W} = |\Delta \mathrm{G}|$

W = 212300 J/mol = 212.3 KJ/mol

Q60 Text Solution:

In the electrolysis of aqueous sodium chloride (NaCl), we are dealing with an aqueous solution, so both Na^+ ions and H_2O molecules are available at the cathode. The reaction that occurs depends on the standard reduction potentials (E°) of the species involved:

- $Na^+ + e^- \rightarrow Na$; E° = –2.71 V
- $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$; E° = – 0.83 V

Since hydrogen ions from water have a more positive (less negative) reduction potential than sodium ions, water is reduced preferentially at the cathode to give hydrogen gas.