

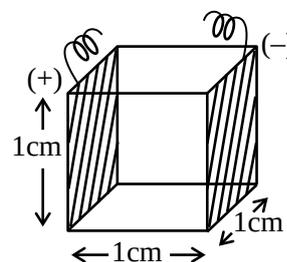
ELECTROCHEMISTRY

- The mass of silver (Molar mass of Ag : 108 gmol^{-1}) displaced by a quantity of electricity which displaces 5600 mL of O_2 at S.T.P. will be _____g.
- Which of the following statements is not correct about rusting of iron?
 - Coating of iron surface by tin prevents rusting, even if the tin coating is peeling off.
 - When pH lies above 9 or 10, rusting of iron does not take place.
 - Dissolved acidic oxides SO_2 , NO_2 in water act as catalyst in the process of rusting.
 - Rusting of iron is envisaged as setting up of electrochemical cell on the surface of iron object.
- The hydrogen electrode is dipped in a solution of pH = 3 at 25°C . The potential of the electrode will be $-\text{_____} \times 10^{-2} \text{ V}$.

$$\left(\frac{2.303RT}{F} = 0.059 \text{ V} \right)$$
- The mass of zinc produced by the electrolysis of zinc sulphate solution with a steady current of 0.015 A for 15 minutes is $\text{_____} \times 10^4 \text{ g}$. (Atomic mass of zinc = 65.4 amu)
- A constant current was passed through a solution of AuCl_4^- ion between gold electrodes. After a period of 10.0 minutes, the increase in mass of cathode was 1.314 g. The total charge passed through the solution is $\text{_____} \times 10^2 \text{ F}$. (Given atomic mass of Au = 197)
- Reduction potential of ions are given below:
 ClO_4^- IO_4^- BrO_4^-
 $E^\circ = 1.19\text{V}$ $E^\circ = 1.65\text{V}$ $E^\circ = 1.74\text{V}$
 The correct order of their oxidising power is:
 - $\text{ClO}_4^- > \text{IO}_4^- > \text{BrO}_4^-$
 - $\text{BrO}_4^- > \text{IO}_4^- > \text{ClO}_4^-$
 - $\text{BrO}_4^- > \text{ClO}_4^- > \text{IO}_4^-$
 - $\text{IO}_4^- > \text{BrO}_4^- > \text{ClO}_4^-$
- Identify the factor from the following that does not affect electrolytic conductance of a solution.
 - The nature of the electrolyte added.
 - The nature of the electrode used.
 - Concentration of the electrolyte.
 - The nature of solvent used.
- One Faraday of electricity liberates $x \times 10^{-1}$ gram atom of copper from copper sulphate, x is _____.
- The values of conductivity of some materials at 298.15 K in Sm^{-1} are $2.1 \cdot 10^3$, $1.0 \cdot 10^{-16}$, $1.2 \cdot 10$, 3.91, $1.5 \cdot 10^{-2}$, $1 \cdot 10^{-7}$, $1.0 \cdot 10^3$. The number of conductors among the materials is _____.
- The potential for the given half cell at 298K is $(-)\text{_____} \times 10^{-2} \text{ V}$.
 $2\text{H}^+_{(\text{aq})} + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$
 $[\text{H}^+] = 1\text{M}$, $P_{\text{H}_2} = 2 \text{ atm}$
 (Given: $2.303 \text{ RT/F} = 0.06 \text{ V}$, $\log 2 = 0.3$)
- The amount of electricity in Coulomb required for the oxidation of 1 mol of H_2O to O_2 is $\text{_____} \times 10^5 \text{ C}$.
- Consider the following redox reaction :
 $\text{MnO}_4^- + \text{H}^+ + \text{H}_2\text{C}_2\text{O}_4 \rightleftharpoons \text{Mn}^{2+} + \text{H}_2\text{O} + \text{CO}_2$
 The standard reduction potentials are given as below (E°_{red})
 $E^\circ_{\text{MnO}_4^-/\text{Mn}^{2+}} = +1.51\text{V}$
 $E^\circ_{\text{CO}_2/\text{H}_2\text{C}_2\text{O}_4} = -0.49\text{V}$
 If the equilibrium constant of the above reaction is given as $K_{\text{eq}} = 10^x$, then the value of $x = \text{_____}$ (nearest integer)
- What pressure (bar) of H_2 would be required to make emf of hydrogen electrode zero in pure water at 25°C ?
 - 10^{-14}
 - 10^{-7}
 - 1
 - 0.5

ELECTROCHEMISTRY

14. One of the commonly used electrode is calomel electrode. Under which of the following categories calomel electrode comes ?
- (1) Metal – Insoluble Salt – Anion electrodes
 - (2) Oxidation – Reduction electrodes
 - (3) Gas – Ion electrodes
 - (4) Metal ion – Metal electrodes
15. Fuel cell, using hydrogen and oxygen as fuels,
- A. has been used in spaceship
 - B. has as efficiency of 40% to produce electricity
 - C. uses aluminium as catalysts
 - D. is eco-friendly
 - E. is actually a type of Galvanic cell only
- (1) A, B, C only (2) A, B, D only
 - (3) A, B, D, E only (4) A, D, E only
16. For a strong electrolyte, a plot of molar conductivity against $(\text{concentration})^{1/2}$ is a straight line, with a negative slope, the correct unit for the slope is
- (1) $\text{S cm}^2 \text{ mol}^{-3/2} \text{ L}^{1/2}$
 - (2) $\text{S cm}^2 \text{ mol}^{-1} \text{ L}^{1/2}$
 - (3) $\text{S cm}^2 \text{ mol}^{-3/2} \text{ L}$
 - (4) $\text{S cm}^2 \text{ mol}^{-3/2} \text{ L}^{-1/2}$
17. The reaction at cathode in the cells commonly used in clocks involves.
- (1) reduction of Mn from +4 to +3
 - (2) oxidation of Mn from +3 to +4
 - (3) reduction of Mn from +7 to +2
 - (4) oxidation of Mn from +2 to +7
18. Molar ionic conductivities of divalent cation and anion are $57 \text{ S cm}^2 \text{ mol}^{-1}$ and $73 \text{ S cm}^2 \text{ mol}^{-1}$ respectively. The molar conductivity of solution of an electrolyte with the above cation and anion will be :
- (1) $65 \text{ S cm}^2 \text{ mol}^{-1}$ (2) $130 \text{ S cm}^2 \text{ mol}^{-1}$
 - (3) $187 \text{ S cm}^2 \text{ mol}^{-1}$ (4) $260 \text{ S cm}^2 \text{ mol}^{-1}$
19. The quantity of silver deposited when one coulomb charge is passed through AgNO_3 solution:
- (1) 0.1 g atom of silver
 - (2) 1 chemical equivalent of silver
 - (3) 1 g of silver
 - (4) 1 electrochemical equivalent of silver
20. For the electro chemical cell
- $$\text{M}|\text{M}^{2+}||\text{X}|\text{X}^{2-}$$
- If $E^0_{(\text{M}^{2+}/\text{M})} = 0.46 \text{ V}$ and $E^0_{(\text{X}/\text{X}^{2-})} = 0.34 \text{ V}$.
- Which of the following is **correct** ?
- (1) $E_{\text{cell}} = -0.80 \text{ V}$
 - (2) $\text{M} + \text{X} \rightarrow \text{M}^{2+} + \text{X}^{2-}$ is a spontaneous reaction
 - (3) $\text{M}^{2+} + \text{X}^{2-} \rightarrow \text{M} + \text{X}$ is a spontaneous reaction
 - (4) $E_{\text{cell}} = 0.80 \text{ V}$
21. A conductivity cell with two electrodes (dark side) are half filled with infinitely dilute aqueous solution of a weak electrolyte. If volume is doubled by adding more water at constant temperature, the molar conductivity of the cell will-



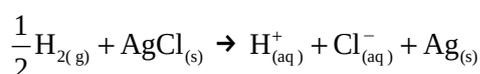
- (1) increase sharply
- (2) remain same or can not be measured accurately
- (3) decrease sharply
- (4) depend upon type of electrolyte

22. The emf of cell $\text{Tl} \left| \text{Tl}^+ \right|_{(0.001\text{M})} \left| \text{Cu}^{2+} \right|_{(0.01\text{M})} \text{Cu}$ is 0.83 V at

298 K. It could be increased by :

- (1) increasing concentration of Tl ions
- (2) increasing concentration of both Tl^+ and Cu^{2+} ions
- (3) decreasing concentration of both Tl^+ and Cu^{2+} ions
- (4) increasing concentration of Cu^{2+} ions

23. The reaction ;

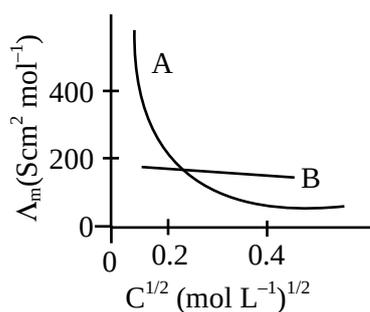


occurs in which of the following galvanic cell :

- (1) $\text{Pt} \left| \text{H}_{2(\text{g})} \right| \text{HCl}_{(\text{soln.})} \left| \text{AgCl}_{(\text{s})} \right| \text{Ag}$
- (2) $\text{Pt} \left| \text{H}_{2(\text{g})} \right| \text{HCl}_{(\text{soln.})} \left| \text{AgNO}_{3(\text{aq})} \right| \text{Ag}$
- (3) $\text{Pt} \left| \text{H}_{2(\text{g})} \right| \text{KCl}_{(\text{soln.})} \left| \text{AgCl}_{(\text{s})} \right| \text{Ag}$
- (4) $\text{Ag} \left| \text{AgCl}_{(\text{s})} \right| \text{KCl}_{(\text{soln.})} \left| \text{AgNO}_{3(\text{aq.})} \right| \text{Ag}$

24. The molar conductivity for electrolytes A and B are plotted against $C^{1/2}$ as shown below.

Electrolytes A and B respectively are :

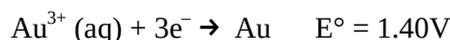


A

B

- (1) Weak electrolyte weak electrolyte
- (2) Strong electrolyte strong electrolyte
- (3) Weak electrolyte strong electrolyte
- (4) Strong electrolyte weak electrolyte

25. The standard reduction potentials at 298 K for the following half cells are given below :



Consider the given electrochemical reactions,

The number of metal(s) which will be oxidized by $\text{Cr}_2\text{O}_7^{2-}$, in aqueous solution is _____.

26. Match List-I with List-II.

LIST-I (Cell)		LIST-II (Use/Property/Reaction)	
A.	Leclanche cell	I.	Converts energy of combustion into electrical energy
B.	Ni-Cd cell	II.	Does not involve any ion in solution and is used in hearing aids
C.	Fuel cell	III.	Rechargeable
D.	Mercury cell	IV.	Reaction at anode $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$

Choose the correct answer from the options given below:

- (1) A-I, B-II, C-III, D-IV
- (2) A-III, B-I, C-IV, D-II
- (3) A-IV, B-III, C-I, D-II
- (4) A-II, B-III, C-IV, D-I

27. Which out of the following is a correct equation to show change in molar conductivity with respect to concentration for a weak electrolyte, if the symbols carry their usual meaning :

$$(1) \Lambda_m^2 C - K_a \Lambda_m^{\circ 2} + K_a \Lambda_m \Lambda_m^\circ = 0$$

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

$$(3) \Lambda_m - \Lambda_m^\circ - AC^{\frac{1}{2}} = 0$$

$$(4) \Lambda_m^2 C + K_a \Lambda_m^{\circ 2} - K_a \Lambda_m \Lambda_m^\circ = 0$$

SOLUTIONS
1. Ans. NTA (108)
Allen (107 or 108)
Sol. Eq. of Ag = Eq. of O₂

Let x gm silver displaced,

$$\frac{x \cdot 1}{108} = \frac{5.6}{22.7} \cdot 4$$

(Molar volume of gas at STP = 22.7 lit)

$$x = 106.57 \text{ gm}$$

Ans. 107

OR

as per old STP data, molar volume = 22.4 lit

$$\frac{x \cdot 1}{108} = \frac{5.6}{22.4} \cdot 4, x = 108 \text{ gm.}$$

2. Ans. (1)
Sol. As tin coating is peeled off, then iron is exposed to atmosphere.

3. Ans. (18)
Sol. $2\text{H}_{(\text{aq.})}^+ + 2\text{e}^- \rightarrow \text{H}_{2(\text{g})}$

$$E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.059}{2} \log \frac{P_{\text{H}_2}}{[\text{H}^+]^2}$$

$$= 0 - 0.059 \times 3$$

$$= -0.177 \text{ volts.} = -17.7 \times 10^{-2} \text{ V.}$$

4. Ans. (45.75) or (46)
Sol. $\text{Zn}^{+2} + 2\text{e}^- \rightarrow \text{Zn}$

$$W = Z \times i \times t$$

$$= \frac{65.4}{2 \cdot 96500} \cdot 0.015 \cdot 15 \cdot 60$$

$$= 45.75 \cdot 10^{-4} \text{ gm}$$

5. Ans. (2)
Sol. $\frac{W}{E} = \frac{ch}{1F}$

$$\frac{1.314}{\frac{197}{3}} = \frac{Q}{1F}$$

$$Q = 2 \times 10^{-2} \text{ F}$$

6. Ans. (2)
Sol. Higher the value of ⊖ve SRP (Std. reduction potential) more is tendency to undergo reduction, so better is oxidising power of reactant.

$$\text{Hence, ox. Power:- } \text{BrO}_4^- > \text{IO}_4^- > \text{ClO}_4^-$$

7. Ans. (2)
Sol. Conductivity of electrolytic cell is affected by concentration of electrolyte, nature of electrolyte and nature of solvent.

8. Ans. (5)
Sol. $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$

$$2 \text{ Faraday} \rightarrow 1 \text{ mol Cu}$$

$$1 \text{ Faraday} \rightarrow 0.5 \text{ mol Cu deposit}$$

$$0.5 \text{ mol} = 0.5 \text{ g atom} = 5 \times 10^{-1}$$

$$x = 5$$

9. Ans. (4)
Sol:- Conductivity (S m⁻¹)

$$\left. \begin{array}{l} 2.1 \cdot 10^3 \\ 1.2 \cdot 10^3 \\ 3.91 \\ 1 \cdot 10^3 \end{array} \right\} \text{conductors at 298.15 K}$$

$$1 \cdot 10^{-16} \text{ Insulator at 298.15 K}$$

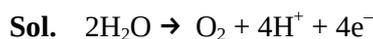
$$\left. \begin{array}{l} 1.5 \cdot 10^{-2} \\ 1 \cdot 10^{-7} \end{array} \right\} \text{Semiconductor at 298.15 K}$$

Therefore number of conductors is 4.

10. Ans. (1)
Sol. $E = E_{\text{H}^+/\text{H}_2}^0 - \frac{0.06}{2} \log \frac{P_{\text{H}_2}}{[\text{H}^+]^2}$

$$E = 0.00 - \frac{0.06}{2} \log \frac{2}{[1]^2}$$

$$E = -0.03 \cdot 0.3 = -0.9 \cdot 10^{-2} \text{ V}$$

11. Ans. (2)


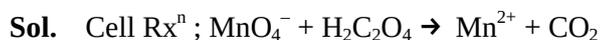
$$\frac{W}{E} = \frac{Q}{96500}$$

$$\text{mole} \times n\text{-factor} = \frac{Q}{96500}$$

$$1 \times 2 = \frac{Q}{96500}$$

$$Q = 2 \times 96500 \text{ C}$$

$$= 1.93 \times 10^5 \text{ C}$$

12. Ans. NTA (338)
Allen (338 or 339)


$$E_{\text{cell}}^{\circ} = E_{\text{OP}}^{\circ} \text{ of anode} + E_{\text{RP}}^{\circ} \text{ of cathode}$$

$$= 0.49 + 1.51 = 2.00\text{V}$$

At equilibrium

$$E_{\text{cell}} = 0,$$

$$E_{\text{cell}}^{\circ} = \frac{0.059}{n} \log K$$

$$\left(\text{As per NCERT } \frac{RT}{F} = 0.059 \text{ But } \frac{RT}{F} = 0.0591\right)$$

can also be taken.)

$$2 = \frac{0.059}{10} \log K$$

$$\log K = 338.98$$

13. Ans. (1)


$$E = E^{\circ} - \frac{0.059}{n} \log \frac{P_{\text{H}_2}}{[\text{H}^+]^2}$$

$$0 = 0 - \frac{0.059}{2} \log \frac{P_{\text{H}_2}}{(10^{-7})^2}$$

$$\log \frac{P_{\text{H}_2}}{(10^{-7})^2} = 0$$

$$\frac{P_{\text{H}_2}}{10^{-14}} = 1$$

$$P_{\text{H}_2} = 10^{-14} \text{ bar}$$

14. Ans. (1)
Sol. Theory based

15. Ans. (4)
Sol. Fuel cell is used in spaceship and it is type of galvanic cell.

16. Ans. (1)

Sol. $\Lambda_m = \Lambda \frac{\rho}{m} \quad A \sqrt{C}$

Units of $A \sqrt{C} = \text{S cm}^2 \text{ mole}^{-1}$

Units of $A = \text{S cm}^2 \text{ mole}^{-3/2} \text{ L}^{1/2}$

17. Ans. (1)
Sol. In the cathode reaction manganese (Mn) is reduced from the +4 oxidation state to the +3 state.

18. Ans. (2)

Sol. $\Lambda_C^{+2} = 57 \text{ S cm}^2 \text{ mol}^{-1}$

$$\Lambda_A^{-2} = 73 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\Lambda_{\text{Solution}} = \lambda_C^{+2} + \Lambda_A^{-2}$$

$$= 57 + 73 = 130$$

19. Ans. (4)
Sol. $W = ZIt$

$$W = ZQ$$

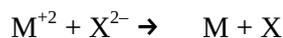
$$Q = \frac{W}{Z}$$

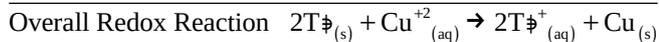
$$W = ZQ = (\text{electrochemical equivalent})$$

20. Ans. (3)


$$E_{\text{cell}}^{\circ} = E_{\text{M/M}^{+2}}^{\circ} + E_{\text{X/X}^{2-}}^{\circ}$$

$$= -0.46 + 0.34 = -0.12\text{V}$$

 As E_{cell}° is negative so anode becomes cathode and cathode become anode. Spontaneous reaction will be

21. Ans. (2)
Sol. Solution is already infinitely dilute, hence no change in molar conductivity upon addition of water.

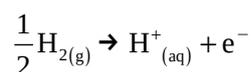
ELECTROCHEMISTRY
22. Ans. (4)
Sol.


$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{2} \log \frac{[\text{T}\ddot{\Phi}^+]^2}{[\text{Cu}^{+2}]}$$

E_{cell} increases by increasing concentration of $[\text{Cu}^{+2}]$ ions.

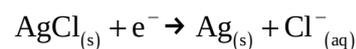
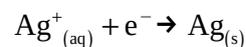
23. Ans. NTA (1)
Allen (3)
Sol. Anodic half cell

Gas – gas ion electrode

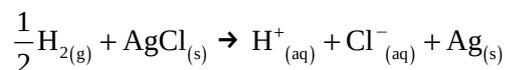


Cathodic Reaction

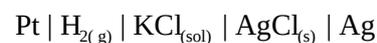
Metal-metal insoluble salt anion electrode



Overall redox reaction



Cell Representation


24. Ans. (3)
Sol. A \rightarrow Weak electrolyte

 B \rightarrow Strong electrolyte

25. Ans. (3)
Sol. Fe, Ni, Ag will be oxidized due to lower S.R.P.

26. Ans. (3)
Sol. A-IV, B-III, C-I, D-II

27. Ans. (1)
Sol. $\text{HA}_{(aq)} \rightleftharpoons \text{H}^+_{(aq)} + \text{A}^-_{(aq)}$

$$K_a = \frac{\alpha^2 C}{1 - \alpha}$$

$$\alpha^2 C + K_a \alpha - K_a = 0$$

$$\left(\frac{\lambda_m}{\lambda_m^\infty} \right)^2 C + K_a \frac{\lambda_m}{\lambda_m^\infty} - K_a = 0$$

$$\lambda_m^2 C + K_a \lambda_m \lambda_m^\infty - K_a (\lambda_m^\infty)^2 = 0$$