

Answer Key

1. (D)	2. (B)	3. (D)	4. (D)	5. (A)
6. (B)	7. (C)	8. (B)	9. (B)	10. (ABC)
11. (BC)	12. (AD)	13. (ABCD)	14. (C)	15. (A)
16. (D)	17. (1144)	18. (265)	19. (3.00)	20. (4.00)
21. (B)	22. (A)q	23. (B)	24. (C)	25. (B)
26. (0571)	27. ($2 \times 10^5 \text{ dm}^3$)			

Solution

1. D is not reacted with HCl, So not easily oxidized at compare to A, B to C.
 C is reduced B as well as D, but unable to reduce A.
 So A is oxidized easily as compare to other metals.
 \therefore ability to act as easily as compare to other metals.

$$2. E_{\text{Cell}}^{\circ} = \frac{0.0591}{2} \log K_{\text{eq}}$$

$$0.003 = \frac{0.0591}{2} \log \frac{[D^+]^2}{[H^+]^2} = \frac{[D^+]}{[H^+]} = 1.123$$

$$3. E_{\text{Cr}_2\text{O}_7^{2-}|\text{Cr}^{3+}} = E_{\text{Cr}_2\text{O}_7^{2-}|\text{Cr}^{3+}}^{\circ} - \frac{0.0591}{6} \times \left(\log \frac{[\text{Cr}^{3+}]^2}{[\text{Cr}_2\text{O}_7^{2-}]} \times \frac{1}{[\text{H}^+]^{14}} \right)$$

$$E_{\text{Cr}_2\text{O}_7^{2-}|\text{Cr}^{3+}} = 1.33 - \frac{0.0591}{6} \log \frac{1}{(0.01)^{14}}$$

$$\Rightarrow 1.0542 \text{ V}$$

$$4. \text{Equivalents of } \text{CO}_2 \text{ produced} = \frac{(I \times \eta) \times t}{96500}$$

$$= \frac{0.5 \times 0.8 \times 96.5 \times 60}{96500} = 0.024$$

$$\text{Moles of } \text{CO}_2 (n = 1) \text{ produced} = 0.024$$

$$\text{moles of } \text{C}_2\text{H}_6 (n = 2) \text{ produced} = \frac{0.024}{2} = 0.012$$

$$\text{Total moles of gases produced} \Rightarrow 0.036$$

$$V_{\text{gases}} = \frac{nRT}{p} = \frac{0.036 \times 0.0821 \times 300}{(740/760)} = 0.91 \text{ litre}$$

5. Initial m moles of $\text{Cu}^{2+} = 5$;

m-eq. or m-moles of H^+ produced = $100 \times 10^{-2} = 1$

\Rightarrow m-moles of Cu^{2+} converted into

$$\text{Cu} = \frac{1}{2} = 0.5$$

m-moles of Cu^{2+} remaining in solution = $5 - 0.5 = 4.5$



and $\text{I}_2 + 2\text{Na}_2\text{S}_2\text{O}_3 \longrightarrow 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6$

m moles of Cu^{2+} remaining = m moles of $\text{Na}_2\text{S}_2\text{O}_3$

$$4.5 = 0.04 \times V$$

$\Rightarrow V = 112.5 \text{ mL}$

6. $\text{HBr} + \text{NaOH} \rightarrow \text{NaBr} + \text{H}_2\text{O}$

Initial	10	-	-	-
	Mmol			

At eq.	-	-	10	-
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Point			mmol	
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At equivalence point, the concentration of $\text{NaBr} = \frac{10}{100} = 0.1 \text{ M}$

In mole m^{-3} , concentration of $\text{NaBr} = 100 \text{ mole m}^{-3}$

Now, $\lambda_m^\circ(\text{NaBr}) = \lambda_m^\circ(\text{Na}^+) + \lambda_m^\circ(\text{Br}^-) = 12 \times 10^{-13} \text{ S m}^2 \text{ mol}^{-1}$

Now, $\lambda_m^\circ(\text{S m}^2 \text{ mol}^{-1}) = \frac{K(\text{sm}^{-1})}{C(\text{mol m}^{-3})}$

$$12 \times 10^{-3} = \frac{k}{100}$$

$$K = 1.2 \text{ m}^{-1}$$

7. For strong electrolytes,

$$\lambda_m = \lambda_m^\circ - A\sqrt{C}$$

$$282 = \lambda_m^\circ - A(0.4) \quad \dots\dots(1)$$

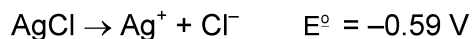
$$240 = \lambda_m^\circ - A \quad \dots\dots(2)$$

Substituting the value of λ_m° from equation (2) to equation (1),

$$282 = \lambda_m^\circ - 0.4(\lambda_m^\circ - 240)$$

$$\lambda_m^\circ = 310$$

8. $\text{AgCl} + \text{e}^- \rightarrow \text{Ag} + \text{Cl}^- \quad E^\circ = 0.2 \text{ V}$
 $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^- \quad E^\circ = -0.79 \text{ V}$



$$E^\circ = \frac{0.059}{n} \log K \Rightarrow -0.59 = \frac{0.059}{1} \log K_{\text{SP}}$$

$$K_{\text{SP}} = 10^{-10}$$

Now solubility of AgCl in 0.1 M AgNO₃

$$S(S + 0.1) = 10^{-10} \Rightarrow S = 10^{-9} \text{ mol/L}$$

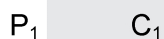
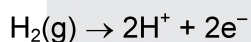
Hence, 1 mole dissolves in 10⁹ L solution.

Hence, in 10⁶ L amount that dissolve is 1 mmol.

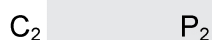
9. The concentration of Fe³⁺ decreases due to conversion to Fe⁺².

10. (ABC)

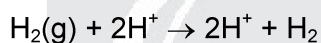
11. At Anode



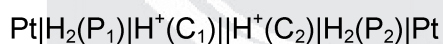
At Cathode



Net:



$$E_{\text{cell}} = \frac{-0.0591}{2} \log \frac{(\text{H}^+)_{\text{LHS}}^2 (\text{P}_{\text{H}_2})_{\text{RHS}}}{(\text{H}^+)_{\text{RHS}}^2 (\text{P}_{\text{H}_2})_{\text{LHS}}}$$



So, here $[\text{H}^+]_{\text{LHS}} = x_1$, $[\text{H}^+]_{\text{RHS}} = x_2$

12. Substance with More positive value of E° has more tendency to get reduced.

13. Refer theory of corrosion

14. Equivalent of Zn²⁺ produced = 0.1 or Moles of Zn²⁺ = $\frac{0.1}{2} \Rightarrow 0.05$

+ve charge increases in first compartment so due to interaction and maintain electrical neutrality Zn²⁺ move toward II compartment and NO₃⁻ move towards first compartment.

Solution is always electrically neutral so charge of 1 Zn²⁺ is neutralized by 2NO₃⁻.

$$\therefore [\text{Zn}^{2+}] \text{ in first compartment} = 1 + \frac{0.05}{2} = 1.025 \text{ M}$$

15. Equivalent of Zn^{2+} produced = 0.1 or Moles of $\text{Zn}^{2+} = \frac{0.1}{2} \Rightarrow 0.05$

+ve charge increases in first compartment so due to interaction and maintain electrical neutrality Zn^{2+} move toward II compartment and NO_3^- move towards first compartment.

Solution is always electrically neutral so charge of 1 Zn^{2+} is neutralized by 2NO_3^- .

$$\therefore [\text{Zn}^{2+}] \text{ in first compartment} = 1 + \frac{0.05}{2} = 1.025\text{M}$$

$$\text{Concentration of } \text{NO}_3^- \text{ in second compartment} = 1 - 0.05 = 0.95\text{ M}$$

16. In third compartment moles of Cu^{2+} reduced = $\frac{0.05}{2} = 0.025$

Relatively -ve charge increased so SO_4^{2-} and Na^+ move toward opposite direction to maintain electrical neutrality

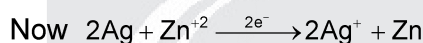
$$[\text{SO}_4^{2-}]_{\text{remaining}} = 1 - \frac{0.025}{2} \Rightarrow 0.975\text{M}$$

17. $K_a = \frac{C\alpha}{1-\alpha} \Rightarrow \frac{1}{6} = \frac{\alpha^2}{1-\alpha}$

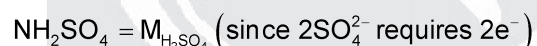
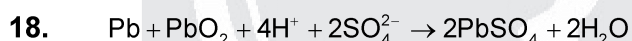
$$\Rightarrow \alpha = \frac{-1 \pm \sqrt{(1)^2 + 4 \times 6 \times 1}}{12} = \frac{-1 \pm \sqrt{1+24}}{12} = \frac{1}{3}$$

$$\therefore [\text{IO}_3] = 1 \times \frac{1}{3} = \frac{1}{3}\text{M}$$

$$\Rightarrow [\text{Ag}^+] = \frac{3 \times 10^{-8}}{\frac{1}{3}} = 9 \times 10^{-8}\text{M}$$



$$\text{Give } E = -1.56 + \frac{0.059}{2} \log \frac{1}{(9 \times 10^{-8})^2} = -1.144\text{V} = -1144\text{mV}$$



i.e., Normality = Molarity

$$\text{Now, } M_1(\text{H}_2\text{SO}_4) \text{ before electrolysis} = \frac{39 \times 1.294 \times 1000}{98 \times 100} = 5.15$$

$$M_2(\text{H}_2\text{SO}_4) \text{ after electrolysis} = \frac{20 \times 1.139 \times 1000}{98 \times 100} = 2.325$$

$$\text{Now, moles of } \text{H}_2\text{SO}_4 \text{ before electrolysis} = 5.15 \times 3.5 = 18.025$$

$$\text{Moles of } \text{H}_2\text{SO}_4 \text{ after electrolysis} = 2.235 \times 3.5 = 8.1375$$

\therefore Molos of equivalents of H_2SO_4 used

$$\text{Weight of } \text{H}_2\text{SO}_4 \text{ used up} = 3.5 \times (1.294 \times 0.39 - 1.139 \times 0.2) \times 1000\text{g} = 969\text{g}$$

$$\text{Equivalences of } \text{H}_2\text{SO}_4 = 1 \times 969 / 98$$

$$\text{Ampere hour} = 1 \times 969 / 98 \times 96500 / 3600 = 265$$

$$19. \quad \Lambda = \frac{K}{C} \times 1000 = \frac{2.19 \times 10^{-4}}{0.1} \times 1000 = 2.19 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\alpha = \frac{\Lambda}{\Lambda_0} = \frac{2.19}{400} = 5.475 \times 10^{-3}$$

$$K_\alpha = \frac{C\alpha^2}{1-\alpha} = \frac{0.1(5.475 \times 10^{-3})^2}{1-5.475 \times 10^{-3}} = 2.99 \times 10^{-6}$$

$$20. \quad \Lambda_M^\infty(\text{MA}) = \Lambda_M^\infty(\text{HCl}) + \Lambda_M^\infty(\text{NaA}) - \Lambda_M^\infty(\text{NaCl})$$

$$= 425 + 100 - 125 - 400 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\text{pH} = 4, [\text{H}^+] = 10^{-4} = \alpha C$$

$$\alpha = \frac{\Lambda_m}{\Lambda_m^\infty} = \frac{200}{400} = 0.5;$$

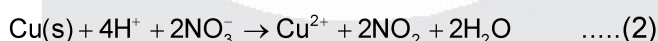
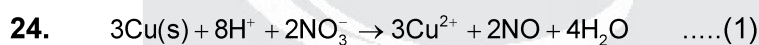
$$K_a = \frac{(C\alpha) \cdot \alpha}{(1-\alpha)} = \frac{10^{-4}(0.5)}{(1-0.5)} = 10^{-4}; \text{p}K_a = 4$$

21. (A) The reduction tendency of AuCl_4^- is more than reduction tendency of Li^+
 (B) The tendency of reduction of Zn^{2+} is more than that of Al^{3+} , while the given representation shows the reverse order, thus, the cell is non-spontaneous and $E_{\text{cell}}^0 < 0$.
 (C) For a spontaneous concentration cell, the concentration of anode compartment should be less than the concentration of cathode compartment.
 (D) The tendency of reduction of Cu^{2+} is more than that of Ni^{2+} and the given representation shows the same order, thus, the cell is spontaneous and $E_{\text{cell}}^0 > 0$. Such cells act as galvanic cells.
22. Electrolysis of dilute solution of NaCl : Water is reduced at cathode to give hydrogen gas and chloride ion is oxidized at anode (due to overpotential of oxygen) to give chlorine gas.
 Electrolysis of concentrated solution of AgNO_3 : Silver ion is reduced at cathode to deposit silver and water is oxidized at anode to give oxygen gas.

$$23. \quad \text{No. of equivalent of aluminum, } \frac{W}{E} = \frac{I \times \eta \times t}{96500}$$

$$\frac{24 \times 5}{27} \times 3 = \frac{9650 \times 0.9 \times t}{96500}$$

$$t = 148.14 \text{ sec}$$



Let concentration of HNO_3 is x so $[\text{H}^+] = x$, and $[\text{NO}_3^-] = x$

$$E_{\text{NO}_3|\text{NO}} - E_{\text{Cu}^{2+}|\text{Cu}} = E_{\text{NO}_3|\text{NO}_2} - E_{\text{Cu}^{2+}|\text{Cu}}$$

$$\text{or } E_{\text{NO}_3|\text{NO}} = E_{\text{NO}_3|\text{NO}_2}$$

$$(0.96 - 0.34) - \frac{0.06}{6} \log \frac{[\text{Cu}^{2+}]^3 (\text{P}_{\text{NO}}^2)}{[\text{NO}_3^-]^2 [\text{H}^+]^8}$$

$$= (0.79 - 0.34) - \frac{0.06}{2} \log \frac{[\text{Cu}^{2+}] (\text{P}_{\text{NO}_2})}{[\text{NO}_3^-]^2 [\text{H}^+]^4} \Rightarrow 0.62 - \frac{0.06}{6} \log \frac{10^{-9}}{x^{10}} = 0.45 - \frac{0.06}{2} \log \frac{10^{-7}}{x^6}$$

$$\log x = 0.657 = 0.66 \text{ or } x = 10^{+0.66}$$

$$25. \quad E_{\text{cell}} = \frac{0.06}{1} \log \frac{[\text{H}^+]_{\text{RHS}}}{[\text{H}^+]_{\text{LHS}}}$$

$$\text{or} \quad E_{\text{cell}} = 0.06 [(\text{pH})_{\text{LHS}} - (\text{pH})_{\text{RHS}}]$$

$$(\text{pH})_{\text{LHS}} = \text{pK}_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

$$= 4 + \log \left(\frac{1}{0.1} \right) = 5; (\text{pH})_{\text{RHS}} = 4$$

$$E_{\text{cell}} = 0.06(5 - 4) = + 0.06 \text{ V}$$

26. (0571)

27. For KCl,

$$\lambda_{\text{M}} = \frac{k \times 1000}{M} \Rightarrow 138 = \frac{k \times 1000}{0.02}$$

$$k = 2.76 \times 10^{-3} = \frac{1}{R} \left(\frac{l}{a} \right) = \frac{1}{85} \left(\frac{l}{a} \right)$$

$$(l/a) = 0.2346$$

$$\text{For } \text{H}_2\text{O} : k_{\text{H}_2\text{O}} = \frac{1}{9200} (l/a)$$

$$\text{For } \text{NaCl} : k_{\text{NaCl}} = \frac{1}{7600} (l/a)$$

$$\lambda_{\text{M}} = \frac{(k_{\text{NaCl}} - k_{\text{H}_2\text{O}}) \times 1000}{M}$$

$$126.5 = \frac{\left(\frac{1}{7600} - \frac{1}{9200} \right) \times 0.2346 \times 1000}{M}$$

$$M = 4.2438 \times 10^{-5} \text{ M} = \frac{500}{58.5 \times V} = 4.2438 \times 10^{-5}$$

$$V = 201400 \text{ V}$$

$$V = 2.014 \times 10^5 \text{ L}$$