Engineering Daily 23 [Set 03] EV

Electrochemistry

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. At 25°C, the distance between the two electrodes of a conductivity cell is 1.5 cm and the cross-sectional area of each is 2.5 cm^2. When the cell is filled with a solution containing 40 g of KCl per litre, its resistance is 6.5 Ω. What is the equivalent conductivity of that solution?

(A) 92.31 $\Omega^{-1}cm^2(g\text{-}eqv)^{-1}$

(B) 171.92 $\Omega^{-1}cm^2(g\text{-}eqv)^{-1}$

(C) 128.94 $\Omega^{-1}cm^2(g\text{-}eqv)^{-1}$

(D) 76.41 $\Omega^{-1}cm^2(g\text{-}eqv)^{-1}$

2. At infinite dilution, the ionic conductivities of the cation and the anion of a univalent salt are 73.5 $\Omega^{-1}cm^2mol^{-1}$ and 76.3 $\Omega^{-1}cm^2mol^{-1}$ respectively. The molar conductivity of the salt will be—

(A) 74.9 $\Omega^{-1}cm^2mol^{-1}$ (B) 299.6 $\Omega^{-1}cm^2mol^{-1}$

(C) 149.8 $\Omega^{-1}cm^2mol^{-1}$ (D) 2.8 $\Omega^{-1}cm^2mol^{-1}$

3. On dilution, the equivalent conductivity of which compound increases at the greatest rate?

(A) $NaNO_3$ (B) C_2H_5OH

(C) CH_3COOH (D) KCl

4. The correct order of equivalent conductivity of $LiNO_3$, $NaNO_3$ and KNO_3 at infinite dilution is—

(A) $NaNO_3 > KNO_3 > LiNO_3$

(B) $LiNO_3 > KNO_3 > NaNO_3$

(C) $KNO_3 > NaNO_3 > LiNO_3$

(D) $LiNO_3 > NaNO_3 > KNO_3$

5. When an aqueous solution of potassium sulphate is electrolysed using platinum electrodes, the products formed at the cathode and the anode respectively are —

(A) H_2 and O_2 (B) H_2 and SO_2

(C) K and $S_2O_8^{2-}$ (D) K and O_2

6. Which of the following are produced when concentrated KCl solution is electrolysed?
(i) Cl_2 gas
(ii) H_2 gas
(iii) O_2 gas
(iv) KOH(aq)
Which of the following is correct?

(A) ii, iii and iv (B) i, ii and iv

(C) ii and iii (D) i and iii

7. Which of the following salts can be used in the salt bridge of an electrochemical cell?

(A) $CuSO_4$ (B) Na_2CO_3

(C) KCl (D) $AgNO_3$

8. Addition of which of the following metals to a $CuSO_4$ solution will not give solid copper?

(A) Fe(s) (B) Ag(s) (C) Mg(s) (D) Zn(s)

9. How many grams of aluminium will be deposited when 6 F of electricity is passed through an $Al_2(SO_4)_3$ solution?

(A) 27 g (B) 162 g (C) 108 g (D) 54 g

10. How many grams of Cr will be deposited at the cathode when 4.5 F of electricity is passed through a chromium sulphate solution? (Cr = 52)

(A) 52 g (B) 78 g (C) 117 g (D) 39 g

11. What mass of Cr will be deposited at the cathode when a current of 6 A flows through a $Cr_2(SO_4)_3$ solution for 25 min? (Cr = 52)

(A) 4.850 g (B) 2.425 g (C) 1.617 g (D) 0.808 g

12. What mass of silver will be deposited when a current of 0.3 A is passed through an aqueous solution of silver nitrate for 40 min? (Ag = 108)

(A) 0.537 g (B) 0.806 g

(C) 0.403 g (D) 1.612 g

13. To gold-plate 8 chains made of a cheap metal, a current of 6.0 A is passed for 12 minutes through a gold salt (Au^{3+}) solution using a gold anode. If the price of every 10 g of gold is Tk. 60000, what is the cost of the gold used per chain? (Au = 196.97)

(A) Tk. 2939 (B) Tk. 1653

(C) Tk. 2204 (D) Tk. 1102

14. A current of 0.25 A is passed through a $CuSO_4$ solution for 3000 s. How many copper atoms are deposited on the electrode?

(A) 2.340×10^{21} (B) 1.170×10^{21}

(C) 4.680×10^{21} (D) 2.340×10^{20}

15. What mass of copper will be deposited at the cathode when a current of 4 A is passed through a $CuSO_4$ solution for 90 min? (Cu = 63.5)

(A) 5.922 g (B) 7.107 g

(C) 14.214 g (D) 3.553 g

16. What will be the cell potential (e.m.f) of the half-cell $Zn \mid ZnCl_2(0.2\ M)$ at 27°C? [$E^0_{Zn/Zn^{2+}} = 0.758$ V]

(A) 0.7580 V (B) 0.7788 V

(C) 0.7996 V (D) 0.7372 V

17. How many electrons are needed to convert 18 g of Al^{3+} ions into metallic Al?

(A) 6.022×10^{23} (B) 1.204×10^{24}

(C) 4.015×10^{23} (D) 3.613×10^{24}

18. How many coulombs of electricity are needed to extract 30 g of calcium metal from molten $CaCl_2$ by electrolysis? (Ca = 40)

(A) 289500 C (B) 96500 C

(C) 72375 C (D) 144750 C

19. When a current of 0.25 A is passed for 40 min, 0.198 g of copper is deposited. What is the electrochemical equivalent of copper?

(A) 6.60×10^{-7} kgC^{-1} (B) 3.30×10^{-7} kgC^{-1}

(C) 1.65×10^{-7} kgC^{-1} (D) 3.30×10^{-4} kgC^{-1}

20. When a current of 0.30 ampere is passed through a silver nitrate solution for 12 minutes, 0.2417 g of silver is deposited at the cathode. What mass of silver will be deposited at the cathode when a current of 0.15 ampere is passed through another silver nitrate solution for 40 minutes?

(A) 0.4029 g (B) 0.8058 g

(C) 0.1450 g (D) 0.2014 g

21. How many seconds will it take to reduce 120 mL of 0.15 M $Fe_2(SO_4)_3$ solution completely to $FeSO_4$ by passing a current of 1.5 A?

(A) 2316 s (B) 4632 s (C) 1158 s (D) 3474 s

22. For how long must a current of 2.5 ampere be passed through a zinc sulphate solution to deposit 3.27 g of zinc? (Zn = 65.4)

(A) 32.17 min (B) 64.33 min

(C) 53.61 min (D) 128.67 min

23. For how long must a current of 2 ampere be passed through dilute sulphuric acid to produce 500 mL of H_2 gas at standard temperature and pressure?

(A) 29.92 min (B) 17.95 min

(C) 71.80 min (D) 35.90 min

24. In a fuel cell, H_2 and O_2 react to produce electrical energy. For how long must 67.2 L of H_2 (at STP) be oxidised so that the average current produced is 1200 A?

(A) 241.3 s (B) 321.7 s

(C) 965.0 s (D) 482.5 s

25. The same quantity of electricity is passed through $AgNO_3$ and $CuSO_4$ solutions. If 2.16 g of Ag is deposited at the cathode, how many grams of Cu will be deposited? (Ag = 108, Cu = 63.5)

(A) 0.635 g (B) 3.674 g

(C) 1.270 g (D) 0.318 g

26. A current of 3 A is passed for 6 minutes 30 seconds through 200 mL of 1.0 M aqueous $CuSO_4$ using Pt electrodes. If the effective efficiency of the current is 80%, what will be the pH of the solution after electrolysis? (Volume remains unchanged)

(A) 1.31 (B) 1.01 (C) 2.31 (D) 1.61

27. What is the standard cell potential E^0_{cell} of the cell $Ni \mid Ni^{2+} \parallel Ag^+ \mid Ag$, where $E^0_{Ni^{2+}/Ni} = -0.25$ V and $E^0_{Ag^+/Ag} = +0.80$ V?

(A) −1.05 V (B) −0.55 V

(C) 1.05 V (D) 0.55 V

28. A galvanic cell is represented as $Zn \mid Zn^{2+}(10^{-6}\ M) \parallel Cu^{2+}(0.01\ M) \mid Cu$. If the standard emf of the cell at 25°C is $E^0 = 1.1$ V, what is E?

(A) 0.982 V (B) 1.041 V

(C) 1.218 V (D) 1.159 V

29. If the cell potential of $Ni(s) \mid Ni^{2+}(0.001\ M) \parallel Cu^{2+}(0.1\ M) \mid Cu(s)$ is 0.65 V, what is the standard reduction potential of the $Ni^{2+} \mid Ni$ electrode? [Given, $E^0_{Cu^{2+}/Cu} = 0.34$ V]

(A) −0.251 V (B) +0.251 V

(C) +0.369 V (D) −0.369 V

30. If the emf values of the following four cells are E_1, E_2, E_3 and E_4 respectively, which of the following orders is correct?
(i) $Zn \mid Zn^{2+}(0.01\ M) \parallel Ag^+(1\ M) \mid Ag$
(ii) $Zn \mid Zn^{2+}(1\ M) \parallel Ag^+(0.01\ M) \mid Ag$
(iii) $Zn \mid Zn^{2+}(1\ M) \parallel Ag^+(1\ M) \mid Ag$
(iv) $Zn \mid Zn^{2+}(0.001\ M) \parallel Ag^+(0.1\ M) \mid Ag$

(A) $E_2 > E_3 > E_4 > E_1$ (B) $E_4 > E_1 > E_3 > E_2$

(C) $E_1 > E_3 > E_4 > E_2$ (D) $E_1 > E_4 > E_3 > E_2$

31. The emf values of the following three galvanic cells are E_1, E_2, E_3 respectively.
(i) $Zn \mid Zn^{2+}(0.01\ M) \parallel Cu^{2+}(1\ M) \mid Cu$
(ii) $Zn \mid Zn^{2+}(1\ M) \parallel Cu^{2+}(0.1\ M) \mid Cu$
(iii) $Zn \mid Zn^{2+}(1\ M) \parallel Cu^{2+}(1\ M) \mid Cu$
Which of the following is correct?

(A) $E_1 > E_3 > E_2$ (B) $E_3 > E_1 > E_2$

(C) $E_2 > E_3 > E_1$ (D) $E_1 > E_2 > E_3$

32. If the equilibrium constant of the reaction $H_2 + Cl_2 \rightarrow 2HCl$ at 25°C is taken as $K = 10^{40}$, calculate the E^0 of the cell $Pt, H_2 \mid HCl(aq) \mid Cl_2, Pt$ at 25°C.

(A) 0.591 V (B) 2.364 V

(C) 0.000 V (D) 1.182 V

33. What is the emf of the cell $Zn \mid Zn^{2+}(0.05\ M) \parallel Ag^+(0.5\ M) \mid Ag$ at 25°C? [$E^0_{cell} = 1.56$ V]

(A) 1.619 V (B) 1.539 V

(C) 1.560 V (D) 1.581 V

34. What is the emf of the following chemical cell at 25°C?
$Pb \mid Pb^{2+}(0.5\ M) \parallel H^+(0.2\ M) \mid H_2(1\ atm), Pt$
Given, $E^0_{Pb^{2+}/Pb} = -0.14$ V

(A) 0.1311 V (B) 0.1724 V

(C) 0.1076 V (D) 0.0489 V

35. If a 1.0 M $CuSO_4$ solution is stored in a nickel vessel, which of the following statements is true? [$E^0_{Cu^{2+}/Cu} = 0.34$ V and $E^0_{Ni^{2+}/Ni} = -0.25$ V]

(A) $E^0_{cell} = -0.59$ V; the solution can be kept in a nickel vessel

(B) $E^0_{cell} = +0.09$ V; the solution can be kept in a nickel vessel

(C) $E^0_{cell} = -0.09$ V; the solution cannot be kept in a nickel vessel

(D) $E^0_{cell} = +0.59$ V; the solution cannot be kept in a nickel vessel

36. What is the emf of the following cell at 25°C?
$Fe \mid FeSO_4(0.05\,M) \parallel CuSO_4(0.5\,M) \mid Cu$
Given: $E^0_{Fe/Fe^{2+}} = 0.44$ V; $E^0_{Cu/Cu^{2+}} = -0.34$ V

(A) 0.8096 V (B) 0.1000 V

(C) 0.7504 V (D) 0.7800 V

37. What will be the emf of the half-cell $Sn \mid Sn^{2+}(0.02\,molL^{-1})$ at 35°C? (Given $E^0_{Sn/Sn^{2+}} = 0.14$ V)

(A) 0.2438 V (B) 0.1400 V

(C) 0.1919 V (D) 0.0881 V

38. A hydrogen electrode uses a 0.005 M HCl solution at 25°C. Calculate the oxidation potential of the electrode.

(A) 0.0680 V (B) −0.1360 V

(C) 0.3122 V (D) 0.1360 V

39. Find the emf of the cell $Al(s) \mid Al^{3+}(aq) \parallel Sn^{2+}(aq) \mid Sn(s)$. At 25°C the concentrations of Al^{3+} and Sn^{2+} are 0.2 M and 0.6 M respectively, and $E^0_{Al^{3+}/Al} = -1.66$ V, $E^0_{Sn^{2+}/Sn} = -0.14$ V

(A) 1.520 V (B) 1.534 V

(C) 1.527 V (D) 1.513 V

40. Determine the e.m.f of the following cell at 25°C.
$Ag \mid AgNO_3(0.001\,M) \parallel AgNO_3(0.1\,M) \mid Ag$

(A) 0.0591 V (B) 0.2364 V

(C) 0.1182 V (D) −0.1182 V

41. At standard temperature, the emf of the following electrochemical cell is found to be 0.40 V. What will be the change in free energy of the cell reaction?
$Mn \mid MnSO_4(0.02\,M) \parallel Cr_2(SO_4)_3(0.01\,M) \mid Cr$

(A) $-77.2\,kJmol^{-1}$ (B) $-231.6\,kJmol^{-1}$

(C) $-115.8\,kJmol^{-1}$ (D) $+231.6\,kJmol^{-1}$

42. If the standard reduction potentials of the three electrodes $Cu^{2+} \mid Cu$, $Cu^{+} \mid Cu$ and $Cu^{2+} \mid Cu^{+}$ are E^0_1, E^0_2 and E^0_3 respectively, which of the following relations is correct?

(A) $E^0_3 = 2E^0_1 - E^0_2$ (B) $E^0_3 = E^0_1 - E^0_2$

(C) $E^0_3 = 2E^0_1 + E^0_2$ (D) $2E^0_3 = E^0_1 + E^0_2$

43. The standard reduction potentials of two half-cell reactions are given below:
$Ni^{2+} + 2e^- \rightarrow Ni,\ E^0 = -0.25$ V
$Ag^+ + e^- \rightarrow Ag,\ E^0 = +0.80$ V
What is the correct value of the standard free energy change of the reaction $Ni + 2Ag^+ \rightarrow Ni^{2+} + 2Ag$?

(A) −101.33 kJ (B) −202.65 kJ

(C) +202.65 kJ (D) −106.15 kJ

44. The reaction $Ni(s) + Cu^{2+}(aq) \rightarrow Ni^{2+}(aq) + Cu(s)$ takes place in an electrochemical cell whose E^0 = +0.59 V. What is the value of the equilibrium constant at 25°C?

(A) 9.62×10^9 (B) 1.08×10^{-20}

(C) 4.85×10^{39} (D) 9.25×10^{19}

45. The following data are given at 25°C—
$Ag + Br^- \rightarrow AgBr + e^-,\ E^0 = -0.071$ V
$Ag \rightarrow Ag^+ + e^-,\ E^0 = -0.800$ V
What is the solubility product (K_{sp}) of AgBr?

(A) 2.16×10^{12} (B) 7.48×10^{-15}

(C) 4.62×10^{-13} (D) 6.80×10^{-7}

46. If a cell reaction is non-spontaneous, the values of ΔG^0, the equilibrium constant K and E^0_{cell} under standard conditions will be, respectively—

(A) positive, < 1, negative (B) negative, > 1, positive

(C) negative, < 1, negative (D) positive, > 1, negative

47. When is the reduction potential of a hydrogen electrode negative?

(A) $P_{H_2} = 2$ atm and $[H^+] = 1$ M

(B) $P_{H_2} = 1$ atm and $[H^+] = 2$ M

(C) $P_{H_2} = 1$ atm and $[H^+] = 1$ M

(D) $P_{H_2} = 2$ atm and $[H^+] = 2$ M

48. Which of the following must be done to increase the potential of the galvanic cell based on the reaction $Ni(s) + Cu^{2+}(aq) \rightarrow Ni^{2+}(aq) + Cu(s)$?

(A) Increasing the size of the Ni rod

(B) Increasing $[Ni^{2+}]$ and $[Cu^{2+}]$ at the same rate

(C) Decreasing $[Cu^{2+}]$

(D) Decreasing $[Ni^{2+}]$

49. In a modified fuel cell, burning propane at 1 atm and 25°C gives the reaction $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$; if $\Delta G^0 = -2108\,kJmol^{-1}$, what is the standard emf of the cell?

(A) 0.546 V (B) 2.184 V

(C) 4.369 V (D) 1.092 V

50. Which substance is formed at the positive plate (anode) while a lead storage battery is being charged?

(A) Pb (B) PbO_2 (C) H_2 (D) $PbSO_4$