## EXERCISE-01 CHECK YOUR GRASP

SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. If a spoon of copper metal is placed in a solution of ferrous sulphate :-

(A) Cu will precipitate out
(B) iron will precipitate
(C) Cu and Fe will precipitate
(D) no reaction will take place

2. During discharge of a lead storage cell the density of sulphuric acid in the cell :-

(A) increasing
(B) decreasing
(C) remains unchanged
(D) initially increases but decreases subsequently

3. Which of the following represents the reduction potential of silver wire dipped into 0.1 M $AgNO_3$ solution at 25 C :-

(A) $E_{red}$
(B) $(E_{red} + 0.059)$
(C) $(E_{ox} - 0.059)$
(D) $(E_{red} - 0.059)$

4. If the solution of the $CuSO_4$ in which copper rod is immersed is diluted to 10 times, the electrode reduction potential. (T = 298 K) :-

(A) increases by 0.030 volt
(B) decreases by 0.030 volt
(C) increases by 0.059 volt
(D) decreases by 0.0059 volt

5. The oxidation potential of a hydrogen electrode at pH = 1 is (T = 298 K) :-

(A) 0.059 volt
(B) 0 volt
(C) –0.059 volt
(D) 0.59 volt

6. The electrode potential becomes equal to standard electrode potential when reactants and products concentration ratio is :-

(A) equal to 1
(B) greater than 1
(C) less than 1
(D) none of the above

7. The reduction potential values are given below

$Al^{3+} / Al = -1.67$ volt, $Mg^{2+} / Mg = -2.34$ volt $Cu^{2+} / Cu = +0.34$ volt

$I_2 / 2I^- = +0.53$ volt. Which one is the best reducing agent ?

(A) Al
(B) Mg
(C) Cu
(D) $I_2$

8. When iron is rusted, it is :-

(A) reduced
(B) oxidised
(C) evaporated
(D) decomposed

9. The reference electrode is made from which of the following :-

(A) $ZnCl_2$
(B) $CuSO_4$
(C) $Hg_2Cl_2$
(D) $HgCl_2$

10. Given standard electrode potentials :

$Fe^{3+} + 3e^- \longrightarrow Fe$ ; $E = -0.036$ volt

$Fe^{2+} + 2e^- \longrightarrow Fe$ ; $E = -0.440$ volt

The standard electrode potential E for

$Fe^{3+} + e^- \longrightarrow Fe^{2+}$ is :-

(A) –0.476 volt
(B) –0.404 volt
(C) 0.440 volt
(D) 0.772 volt

11. The reduction potential of a hydrogen electrode at pH 10 at 298 K is : (p = 1 atm)

(A) 0.51 volt
(B) 0 volt
(C) –0.591 volt
(D) 0.059 volt

12. The emf of the cell, $Ni|Ni^{2+}$ (1.0 M)$||Ag^+$ (1.0 M)$|Ag$[E for $Ni^{2+}/Ni = -0.25$ volt, E for $Ag^+/Ag = 0.80$ volt] is given by : [E for $Ag^+ / Ag = 0.80$ volt]

(A) –0.25 + 0.80 = 0.55 volt
(B) –0.25 – (+0.80) = –1.05 volt
(C) 0 + 0.80 – (–0.25) = + 1.05 volt
(D) –0.80 – (+0.25) = –0.55 volt

13. The position of some metals in the electrochemical series in decreasing electropositive character is given as Mg > Al > Zn > Cu > Ag. What will happen if a copper spoon is used to stir a solution of aluminium nitrate?

(A) The spoon will get coated with aluminium
(B) An alloy of aluminium and copper nitrate
(C) The solution becomes blue
(D) There is no reaction

14. E $(Ni^{2+} / Ni) = -0.25$ volt, E $(Au^{3+} / Au) = 1.50$ volt. The emf of the voltaic cell $Ni|Ni^{2+}$ (1.0 M)$||Au^{3+}$ (1.0 M)$|$ Au is :-

(A) 1.25 volt
(B) –1.75 volt
(C) 1.75 volt
(D) 4.0 volt

15. When the electric current is passed through a cell having an electrolyte, the positive ions move towards cathode and negative ions towards the anode. If the cathode is pulled out of the solution :-

(A) the positive and negative ions will move towards anode

(B) the positive ions will start moving towards the anode while negative ions will stop moving

(C) the negative ions will continue to move towards anode while positive ions will stop moving

(D) the positive and negative ions will start moving randomly

16. The oxidation potentials 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 reactions will provide maximum voltage :-

(A) $Zn + Cu^{2+} \longrightarrow Cu + Zn^{2+}$ (B) $Zn + 2Ag^{+} \longrightarrow 2Ag + Zn^{2+}$

(C) $H_2 + Cu^{2+} \longrightarrow 2H^{+} + Cu$ (D) $H_2 + Ni^{2+} \longrightarrow 2H^{+} + Ni$

17. Which one of the following will increase the voltage of the cell : (T = 298 K)

$Sn + 2\ Ag^{+} \longrightarrow Sn^{2+} + 2\ Ag$

(A) increase in the size of silver rod (B) increase in the concentration of $Sn^{+2}$ ions

(C) increase in the concentration of $Ag^{+}$ ions (D) none of the above

18. A chemist wants to produce $Cl_2$ (g) from molten NaCl. How many grams could be produced if he uses a steady current of 2 ampere for 2.5 minutes :-

(A) 3.55 g (B) 1.775 g (C) 0.110 g (D) 0.1775 g

19. Consider the reaction : (T = 298 K)

$Cl_2\ (g) + 2Br^{-}\ (aq) \longrightarrow 2Cl^{-}\ (aq) + Br_2\ (aq.)$

The emf of the cell, when $[Cl^{-}] = [Br_2] = [Br^{-}] = 0.01$ M and $Cl_2$ gas is 1 atm pressure, will be (E for the above reaction is = 0.29 volt) :-

(A) 0.54 volt (B) 0.35 volt (C) 0.24 volt (D) –0.29 volt

20. Three faradays of electricity was passed through an aqueous solution of iron (II) bromide. The mass of iron metal (at. mass 56) deposited at the cathode is :-

(A) 56 g (B) 84 g (C) 112 g (D) 168 g

21. The standard emf for the cell reaction $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$ is 1.10 volt at 25 C. The emf for the cell reaction when 0.1 M $Cu^{2+}$ and 0.1 $Zn^{2+}$ solutions are used at 25 C is :-

(A) 1.10 volt (B) 0.110 volt (C) –1.10 volt (D) –0.110 volt

22. Three moles of electrons are passed through three solutions in succession containing $AgNO_3$, $CuSO_4$ and $AuCl_3$ respectively. The molar ratio of amounts of cations reduced at cathode will be :-

(A) 1 : 2 : 3 (B) 2 : 1 : 3 (C) 3 : 2 : 1 (D) 6 : 3 : 2

23. The emf of the cell involving the following reaction, $2\ Ag^{+} + H_2 \longrightarrow 2\ Ag + 2H^{+}$ is 0.80 volt. The standard oxidation potential of silver electrode is :-

(A) –0.80 volt (B) 0.80 volt (C) 0.40 volt (D) –0.40 volt

24. For the electrochemical cell, $M|M^{+}||X^{-}|X$, $E_{M^{+}/M} = 0.44$ V and $E_{X/X^{-}} = 0.33$ V. From this data we can deduce that :-

(A) $M + X \longrightarrow M^{+} + X^{-}$ is the spontaneous reaction

(B) $M^{+} + X^{-} \longrightarrow M + X$ is the spontaneous reaction

(C) $E_{cell} = 0.77$ V

(D) $E_{cell} = -0.77$ V

25. For the net cell reaction of the cell $Zn(s)|Zn^{2+}||Cd^{2+}|Cd(s)$ $\Delta G$ in kilojoules at 25 C is ($E_{cell} = 0.360$ V):-

(A) 112.5 (B) 69.47 (C) –34.73 (D) –69.47

26. How many faradays are required to reduce one mol of $MnO_4^{-}$ to $Mn^{2+}$:-

(A) 1 (B) 2 (C) 3 (D) 5

27. $Cu^{+} + e^{-} \longrightarrow Cu$, E = $x_1$ volt ;

$Cu^{2+} + 2e^{-} \longrightarrow Cu$, E = $x_2$ volt, then for

$Cu^{2+} + e^{-} \longrightarrow Cu^{+}$, E (volt) will be :

(A) $x_1 - 2x_2$ (B) $x_1 + 2x_2$ (C) $x_1 - x_2$ (D) $2x_2 - x_1$

**28.** $Zn|Zn^{2+}(C_1)||Zn^{2+}(C_2)|Zn$. for this cell $\Delta G$ is negative if :-

(A) $C_1 = C_2$ (B) $C_1 > C_2$ (C) $C_2 > C_1$ (D) None

**29.** $Pt\left|\begin{array}{c}H_2\\(p_1)\end{array}\right|\left|\begin{array}{c}H^+\\(1M)\end{array}\right|\left|\begin{array}{c}H^+\\(1M)\end{array}\right|\left|\begin{array}{c}H_2\\(p_2)\end{array}\right|Pt$ (where $p_1$ and $p_2$ are pressure) cell reaction will be spontaneous if :-

(A) $p_1 = p_2$ (B) $p_1 > p_2$ (C) $p_2 > p_1$ (D) $p_1 = 1$ atm

**30.** $Pt\left|\begin{array}{c}(H_2)\\1\,atm\end{array}\right|pH = 2 \,||\, pH = 3\left|\begin{array}{c}(H_2)Pt\\1\,atm\end{array}\right.$ . The cell reaction for the given cell is :-

(A) spontaneous (B) non-spontaneous (C) equilibrium (D) none is correct

**31.** $M^{2+} + 2e \longrightarrow M$. 0.275 g of metal M is deposited at the cathode due to passage of 1A of current for 965 s. Hence atomic weight of the metal M is :-

(A) 27.5 (B) 55.0 (C) 110.0 (D) 13.75

**32.** In an electrochemical cell that function as a voltaic cell :-

(A) electrons move from the cathode to the anode

(B) electrons move through a salt-bridge

(C) electrons can move either from the cathode to the anode or from the anode to the cathode

(D) reduction occurs at the cathode

**33.** A certain metal salt solution is electrolysed in series with a silver coulometer. The weight of silver and the metal deposited are 0.5094 g and 0.2653 g. Calculate the valency of the metal if its atomic weight is nearly that of silver.

(A) .1 (B) 2 (C) 3 (D) 4

**34.** The cell Pt ($H_2$) (1 atm) $|H^+$ (pH = ?), $I^-$ (a = 1) AgI(s), Ag has emf, $E_{298\,K} = 0$. The electrode potential for the reaction $AgI + e^- \rightarrow Ag + I^{\Theta}$ is –0.151 volt. Calculate the pH value :-

(A) 3.37 (B) 5.26 (C) 2.56 (D) 4.62

**35.** Using the information in the preceding problem, calculate the solubility product of AgI in water at 25 C [$E_{(Ag^+,Ag)}$ = +0.799 volt] :-

(A) 1.97 $10^{-17}$ (B) 7.91 $10^{-17}$ (C) 1.79 $10^{-17}$ (D) 9.17 $10^{-17}$

**36.** If same quantity of electricity is passed through CuCl and $CuSO_4$, the ratio of the weights of Cu deposited from $CuSO_4$ and CuCl is :-

(A) 2 : 1 (B) 1 : 2 (C) 1 : 1 (D) 4 : 1

**37.** For $Zn^{2+}$/ Zn, E = –0.76 V, for $Ag^+$ / Ag, E = 0.799 V. The correct statement is :-

(A) the reaction Zn getting reduced Ag getting oxidized is spontaneous

(B) Zn undergoes reduction and Ag is oxidized

(C) Zn undergoes oxidation and $Ag^+$ gets reduced

(D) No suitable answer

**38.** The oxidation potential of a hydrogen electrode at pH = 10 and $P_{H_2} = 1$ is :-

(A) 0.51 V (B) 0.00 V (C) + 0.59 V (D) 0.059 V

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CHECK YOUR GRASP **ANSWER KEY** EXERCISE -1

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | D | B | D | B | A | A | B | B | C | D | C | C | D | C | D |
| Que. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Ans. | B | C | C | B | B | A | D | A | B | D | D | D | C | B | B |
| Que. | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | | | | | | | |
| Ans. | B | D | B | C | B | B | C | C | | | | | | | |

## EXERCISE–02 BRAIN TEASERS

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

**1.** What a lead storage is discharged :-

(A) $PbSO_4$ is formed (B) Pb is formed (C) $SO_2$ is consumed (D) $H_2SO_4$ is consumed

**2.** The standard emf of the cell, Cd (s)|$CdCl_2$ (aq) (0.1 M)||AgCl (s)|Ag (s) in which the cell reaction is, Cd (s) + 2 AgCl (s) $\longrightarrow$ 2 Ag (s) + $Cd^{+2}$ (aq) + $2Cl^-$ (aq) is 0.6915 V at 0 C and 0.6753 V at 25 C. The $\Delta H$ of the reaction at 25 C is :-

(A) –176 kJ (B) –234.7 kJ (C) +123.5 kJ (D) –167.26 kJ

**3.** A current of 2.68 A is passed for one hour through an aqueous solution of $CuSO_4$ using copper electrodes. Select the correct statement (s) from the following :-

(A) increase in mass of cathode = 3.174 g

(B) decrease in mass of anode = 3.174 g

(C) no change in masses of electrodes

(D) the ratio between the change of masses of cathode and anode is 1 : 2

**4.** Any redox reaction would occur spontaneously, if :-

(A) the free energy change ($\Delta G$) is negative (B) the ($\Delta G$) is positive

(C) the cell e.m.f. (E ) is negative (D) the cell e.m.f. is positive

**5.** Fe is reacted with 1.0 M HCl. E for Fe/$Fe^{2+}$ = +0.34 volt. The correct observation (s) regarding this reaction is / are :-

(A) Fe will be oxidised to $Fe^{2+}$

(B) $Fe^{2+}$ will be reduced to Fe

(C) since e.m.f. is positive, the reaction shall occur

(D) since e.m.f. is positive, the reaction shall not occur

**6.** An acidic solution of copper (II) sulphate containing some contaminations of zinc and iron (II) ions was electrolysed till all the copper is deposited. If electrolysis is further continued for sometime, the product liberated at cathode is :-

(A) Fe (B) Zn (C) $H_2$ (D) Alloy of Zn and Fe

**7.** A current of 9.65 ampere is passed through the aqueous solution NaCl using suitable electrodes for 1000 s. The amount of NaOH formed during electrolysis is :-

(A) 2.0 g (B) 4.0 g (C) 6.0 g (D) 8.0 g

**8.** The potential of the Daniel cell, $\mathrm{Zn}\left|\begin{matrix}ZnSO_4\\(1M)\end{matrix}\right|\,\left|\begin{matrix}CuSO_4\\(1M)\end{matrix}\right|\mathrm{Cu}$ was reported by Buckbee, Surdzial and Metz as

$E = 1.1028 - 0.641 \quad 10^{-3}\,T + 0.72 \quad 10^{-5}\,T^2$, where T is the celsius temperature. Calculate $\Delta S$ for the cell reaction at 25 C :-

(A) –45.32 EU (B) –34.52 EU (C) –25.43 EU (D) –54.23 EU

**9.** Using the data in the preceding problem, calculate the equilibrium constant of the reaction at 25 C.

$$Zn + Cu^{++} \rightleftharpoons Zn^{++} + Cu,\ K = \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

(A) $8.314 \quad 10^{24}$ (B) $4.831 \quad 10^{31}$ (C) $8.314 \quad 10^{36}$ (D) $4.831 \quad 10^{44}$

**10.** The standard electrode potential (reduction) of $Ag^+$|Ag is 0.800 V at 25 C. Its electrode potential in a solution containing $10^{-3}$ M ion of $Ag^+$ ions is :-

(A) 0.623 V (B) –0.977 V (C) 0.892 V (D) 1.246 V

**11.** The number of faradays required to produce one mole of water from hydrogen - oxygen fuel cell containing aqueous alkali as electrolyte is :-

(A) 1 (B) 3 (C) 2 (D) 4

**12.** The solubility product of silver iodide is 8.3  $10^{-17}$ and the standard potential (reduction) of Ag, $Ag^+$ electrode is +0.800 volts at 25 C. The standard potential of Ag, AgI / $I^-$ electrode (reduction) from these data is :-

(A) –0.30 V (B) +0.15 V (C) +0.10 V (D) –0.15 V

**13.** The standard electrode potentials (reduction) of $Pt/Fe^{3+}$, $Fe^{+2}$ and $Pt/Sn^{4+}$, $Sn^{+2}$ are +0.77 V and 0.15 V respectively at 25 C. The standard EMF of the reaction $Sn^{4+} + 2\,Fe^{2+} \longrightarrow Sn^{2+} + 2Fe^{3+}$ is :-

(A) –0.62 V (B) –0.92 V (C) +0.31 V (D) +0.85 V

**14.** The standard reduction potential E  of the following systems are :-

| | System | E (volts) |
|---|---|---|
| (i) | $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ | 1.51 |
| (ii) | $Sn^{4+} + 2e^- \longrightarrow Sn^{2+}$ | 0.15 |
| (iii) | $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$ | 1.33 |
| (iv) | $Ce^{4+} + e^- \longrightarrow Ce^{3+}$1.61 | |

The oxidising power of the various species decreases in the order :

(A) $Ce^{4+} > Cr_2O_7^{2-} > Sn^{4+} > MnO_4^-$ (B) $Ce^{4+} > MnO_4^- > Cr_2O_7^{2-} > Sn^{4+}$

(C) $Cr_2O_7^{2-} > Sn^{4+} > Ce^{4+} > MnO_4^-$ (D) $MnO_4^- > Ce^{4+} > Sn^{4+} > Cr_2O_7^{2-}$

**15.** The e.m.f. of the following cell

Ni(s) / $NiSO_4$ (1.0 M) || $H^+$ (1.0 M)|$H_2$ (1 atm), Pt at 25 C is 0.236 V. The electrical energy which can be produced is :-

(A) 22.73 kJ (B) 45.55 kJ (C) 19.30 kJ (D) 23.60 kJ

**16.** The reduction potential of a hydrogen electrode at pH = 10, at 25 C is :-

(A) –0.59 V (B) –0.0591 V (C) zero (D) –0.591 V

**17.** The reduction potential of a half-cell consisting of a Pt electrode immersed in 1.5 M $Fe^{2+}$ and 0.015 M $Fe^{3+}$ solution at 25 C is ( $E^0_{Fe^{3+}/Fe^{2+}} = 0.770$ V) :

(A) 0.652 V (B) 0.88 V (C) 0.710 V (D) 0.850 V

**18.** Consider the cell $\begin{array}{c} H_2(Pt) \\ 1atm \end{array}\left|\begin{array}{c} H_3O^+(aq) \\ pH = 5.5 \end{array}\right|\left|\begin{array}{c} Ag^+ \\ xM \end{array}\right|$ Ag. The measured EMF of the cell is 1.023 V. What is the value of x ?

$E^0_{Ag^+,\,Ag} = +\,0.799$ V. [T = 25 C]

(A) 2  $10^{-2}$ M (B) 2  $10^{-3}$ M (C) 1.5  $10^{-3}$ M (D) 1.5  $10^{-2}$ M

**19.** $Hg_2Cl_2$ is produced by the electrolytic reduction of $Hg^{2+}$ ion in presence of $Cl^-$ ion is $2Hg^{2+} + 2Cl^- + 2e^{\ominus} \rightarrow Hg_2Cl_2$. Calculate the current required to have a rate production of 44 g per hour of $Hg_2Cl_2$ . [Atomic weight of Hg = 200.6] :-

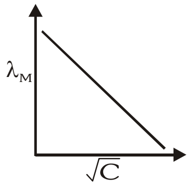
(A) 5 ampere (B) 4 ampere

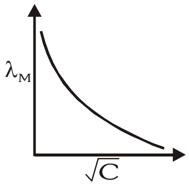
(C) 6.5 ampere (D) 3.5 ampere

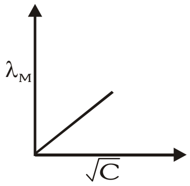
**20.** The ionization constant of a weak electrolyte is 25  $10^{-6}$ while the equivalent conductance of its 0.01 M solution is 19.6 S $cm^2$ $eq^{-1}$. The equivalent conductance of the electrolyte at infinite dilution (in S $cm^2$ $eq^{-1}$) will be :-

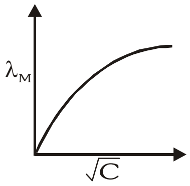
(A) 250 (B) 196 (C) 392 (D) 384

**21.** Which of the following curve represents the variation of $\lambda_M$ with $\sqrt{C}$ for $AgNO_3$ ?

(A)


(B)


(C)


(D)


**22.** Four moles of electrons were transferred from anode to cathode in an experiment on electrolysis of water. The total volume of the two gases (dry and at STP) produced will be approximately (in litres) :-

(A) 22.4 (B) 44.8 (C) 67.2 (D) 89.4

**23.** Equivalent conductance of $BaCl_2$, $H_2SO_4$ & HCl at infinite dilution are $A_{\infty}^{1}$, $A_{\infty}^{2}$ & $A_{\infty}^{3}$ respectively. Equivalent conductance of $BaSO_4$ solution is :

(A) $A_{\infty}^{1} + A_{\infty}^{2} - 2\ A_{\infty}^{3}$
(B) $A_{\infty}^{1} + A_{\infty}^{2} + A_{\infty}^{3}$
(C) $A_{\infty}^{1} + A_{\infty}^{2} - A_{\infty}^{3}$
(D) $A_{\infty}^{1} - A_{\infty}^{2} + A_{\infty}^{3}$

**24.** Salts of A (atomic weight = 7), B (atomic weight = 27) and C (atomic weight = 48) were electrolysed under identical conditions using the same quantity of electricity. It was found that when 2.1 g of A was deposited, the weights of B and C deposited were 2.7g and 7.2 g. The valencies of A, B and C respectively are :-

(A) 3, 1 and 2 (B) 1, 3 and 2 (C) 3, 1 and 3 (D) 2, 3 and 2

**25.** During electrolysis of an aqueous solution of $CuSO_4$ using copper electrodes, if 2.5 g of Cu is deposited at cathod, then at anode :-

(A) 890 mL of $Cl_2$ at STP is liberated
(B) 445 mL of $O_2$ at STP is liberated
(C) 2.5 g of copper is deposited
(D) a decrease of 2.5 g of mass takes place

**26.** The cost at 5 paise/KWH of operating an electric motor for 8 hours which takes 15 amp at 110 V is :-

(A) Rs. 66 (B) 66 paise (C) 37 paise (D) Rs. 6.60

**27.** When an aqueous solution of lithium chloride is electrolysed using graphite electrodes :-

(A) $Cl_2$ is liberated at the anode
(B) Li is deposited at the cathode
(C) as the current flows, pH of the solution around the cathode remains constant
(D) as the current flows, pH of the solution around the cathode decreases

**28.** A silver wire dipped in 0.1 M HCl solution saturated with AgCl develops a potential of –0.25 V. If $E_{Ag/Ag^+} = -0.799$ V, the $K_{sp}$ of AgCl in pure water will be :-

(A) $2.95\quad 10^{-11}$ (B) $5.1\quad 10^{-11}$ (C) $3.95\quad 10^{-11}$ (D) $1.95\quad 10^{-11}$

**29.** Consider the reaction of extraction of gold from its ore

$$Au + 2CN^- (aq.) + \frac{1}{4}O_2\ (g) + \frac{1}{2}H_2O \longrightarrow Au(CN)_2^- + OH^-$$

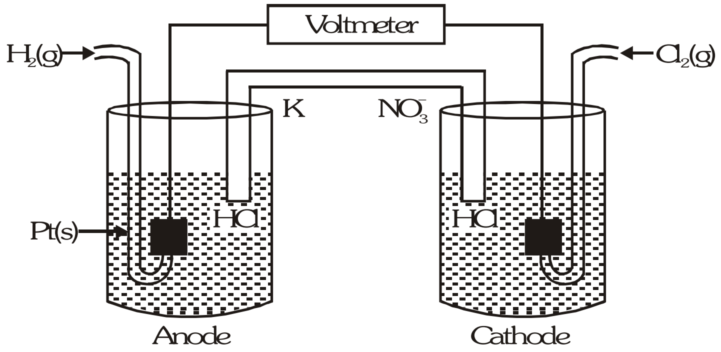
Use the following data to calculate $\Delta G$ for the reaction

$K_f\ \{Au(CN)_2^-\} = X$

$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ : E = + 0.41 volt
$Au^{3+} + 3e^- \longrightarrow Au$ : E = + 1.5 volt
$Au^{3+} + 2e^- \longrightarrow Au^+$ : E = + 1.4 volt

(A) $-RT \ln X + 1.29\ F$
(B) $-RT \ln X - 2.11\ F$
(C) $-RT \ln \frac{1}{X} + 2.11\ F$
(D) $-RT \ln X - 1.29\ F$

**30.** Consider the following Galvanic cell :-



By what value the cell voltage when concentration of ions in anodic and cathodic compartments both increased by factor of 10 at 298 K.

(A) +0.0591 (B) –0.0591 (C) –0.1182 (D) 0

**31.** For the fuel cell reaction $2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$ ; $\Delta_f H_{298}(H_2O, \ell) = -285.5$ kJ/mol

What is $\Delta S_{298}$ for the given fuel cell reaction ?

Given : $O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(\ell)$ E = 1.23 V

(A) –0.322 J/K (B) –0.635 kJ/K (C) 3.51 kJ/K (D) –0.322 kJ/K

**32.** The resistance of 0.5 M solution of an electrolyte in a cell was found to be 50 Ω. If the electrodes in the cell are 2.2 cm apart and have an area of 4.4 $cm^2$ then the molar conductivity (in S $m^2$ $mol^{-1}$) of the solution is :-

(A) 0.2 (B) 0.02 (C) 0.002 (D) none of these

**33.** The dissociation constant of n-butyric acid is 1.6 $10^{-5}$ and the molar conductivity at infinite dilution is 380 $10^{-4}$ $Sm^2mol^{-1}$. The specific conductance of the 0.01 M acid solution is :-

(A) 1.52 $10^{-5}$ $Sm^{-1}$ (B) 1.52 $10^{-2}$ $Sm^{-1}$ (C) 1.52 $10^{-3}$ $Sm^{-1}$ (D) none

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BRAIN TEASERS **ANSWER KEY** EXERCISE -2

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | A,D | D | A,B | A,D | A,C | C | B | D | C | A | C | D | A | B | B |
| Que. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Ans. | D | A | A | A | C | A | C | C | B | D | B | A | B | A | C |
| Que. | 31 | 32 | 33 | | | | | | | | | | | | |
| Ans. | D | C | B | | | | | | | | | | | | |

# EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

1. Compounds of active metals (Zn, Na, Mg) are reducible by $H_2$ whereas those of noble metals (Cu, Ag, Au) are not reducible.
2. The mass of a substance deposited on the cathode or anode during electrolysis is given by $w = \frac{EIt}{F}$.
3. Faraday's second law of electrolysis is related to the equivalent mass of the electrolyte.
4. Equivalent conductance at infinite dilution of salt AB is equal to the sum of equivalent conductances of ions, $A^+$ and $B^-$ at infinite dilution.
5. The standard reaction potential of $Cl^-|AgCl|Ag$ half-cell is related to that of $Ag^+|Ag$ half-cell through the expression $E_{Ag^+|Ag} = E_{Cl^-|AgCl|Ag} + \frac{RT}{F}\text{In}K_{SP}(AgCl)$.
6. The cell potential is given by $E_{cell} = E_{RP(cathode)} - E_{RP(anode)}$
7. In a galvanic cell, the half-cell with higher reduction potential acts as a reducing agent.
8. In an electrode concentration cell, the cell reaction $Zn(c_1) \longrightarrow Zn(c_2)$ will be spontaneous if $c_1 > c_2$.
9. The redox reaction involved in galvanic cell is a non-spontaneous process.

FILL IN THE BLANKS

1. A dilute solution of sulphuric acid during electrolysis liberate .................... gas at anode.
2. Among metals .................... is the strongest reducing agents in aqueous solutions.
3. Lead is able to displace silver from $AgNO_3$ solution because its standard oxidation potential is .................... than that of silver.
4. Coulomb refers to .................... of electricity while ampere refers to .................... at which it flows.
5. During electrolysis of aqueous solution of $CuSO_4$ using Pt electrodes the product at anode is .................. .
6. The quantity of electricity required for complete reduction of 0.5 mole of $MnO_4^-$ to $Mn^{2+}$ is .................. C.
7. $\lambda_{eq}$ normality = .................... .
8. The presence of electrolytes .................... the rate of corrosion.
9. The more negative the standard potential, the .................... is its ability to displace hydrogen from acids.
10. In the calomel half-cell, the reduction reaction to be considered is .................... .

MATCH THE COLUMN

**Match the items of column I to those of column I :**

1.

| | Column-I | | Column-II |
|---|---|---|---|
| (A) | Cell constant | (p) | $E^0_{cathode} + E^0_{anode}$ |
| (B) | Anode | (q) | $\ell/A$ |
| (C) | Conductance | (r) | Mass of product deposited by 1 coulomb of electricity. |
| (D) | Electrochemical equivalent | (s) | $(Resistance)^{-1}$ |
| (E) | $E^0_{cell}$ | (u) | Involve oxidation |

2.

| | Column-I | | Column-II |
|---|---|---|---|
| (A) | Cathode | (p) | Primary cell |
| (B) | 1 Coulomb | (q) | Secondary cell |
| (C) | Dry cell | (r) | 6.24 $10^{18}$ electrones |
| (D) | Lead strong cell | (s) | Concentration cell |
| (E) | $Zn\|Zn^{2+}(0.01M)\|\|Zn^{2+}(0.1M)\|Zn$ | (u) | Positive terminal of electrochemical cell |

3.

| Column-I | | Column-II | |
|---|---|---|---|
| (A) | Electrolytic cell | (p) | $-\Delta G$ |
| (B) | $nFE^0_{Cell}$ | (q) | Concentration cell |
| (C) | $E_{cell} = \frac{0.059}{n} \log \frac{C_{cathode}}{C_{anode}}$ | (r) | 96500 Coulombs |
| (D) | Diffusion of ions | (s) | Device converting electrical energy into chemical energy |
| (E) | 1 Faraday | (u) | Salt bridge |

4.

| Column-I | | Column-II | |
|---|---|---|---|
| (A) | Conductance | (p) | $Cm^{-1}$ |
| (B) | Specific conductance | (q) | $Ohm^{-1}\, cm^2\, mol^{-1}$ |
| (C) | Cell constant | (r) | $Ohm^{-1}$ |
| (D) | Equivalent conductance | (s) | $Ohm^{-1}\, cm^{-1}$ |
| (E) | Molar conductance | (u) | $Ohm^{-1}\, cm^2$ equivalent$^{-1}$ |

## ASSERTION & REASON

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

1. **Statement-I :** In electrolysis, the quantity of electricity needed for depositing 1 mole of silver is different from that required for 1 mole of copper.

**Because**

**Statement-II :** The molecular weights of silver and copper are different.

2. **Statement-I :** Equivalent conductance of all electrolytes decreases with increasing concentration.

**Because**

**Statement-II :** Lesser number of ions are available per gram equivalent at higher concentration.

3. **Statement-I :** If an aqueous solution of NaCl is electrolysed, the product obtained at the cathode is $H_2$ gas and not Na.

**Because**

**Statement-II :** Gases are liberated faster than the metals.

4. **Statement-I :** Molar conductivity of a weak electrolyte at infinite dilution cannot be determined experimentally.

**Because**

**Statement-II :** Kohlrausch law help to find the molar conductivity of a weak electrolyte at infinite dilution.

5. **Statement-I :** Gold chloride ($AuCl_3$) solution cannot be stored in a vessel made of copper, iron, nickel, chromium, zinc or tin.

**Because**

**Statement-II :** Gold is very precious metal.

6. **Statement-I :** In the Daniel cell, if concentration of $Cu^{2+}$ and $Zn^{2+}$ ions are doubled, the emf of the cell will not change.

**Because**

**Statement-II :** If the concentration of ions in contact with the metals is doubled, the electrode potential is doubled.

7. **Statement-I :** $H_2 + O_2$ fuel cell gives a constant voltage throughout its life.

**Because**

**Statement-II :** In this fuel cell, $H_2$ reacts with $OH^-$ ions, yet the overall concentration of $OH^-$ ions does not change.

8. **Statement-I :** Blocks of magnesium are often stapped to steel hulls of ocean going ships.

**Because**

**Statement-II :** Magnesium causes cathodic protection of iron.

9. **Statement-I :** Absolute value of $E^0_{red}$ of an electrode cannot be determined.

**Because**

**Statement-II :** Neither oxidation nor reduction can take place alone.

## COMPREHENSION BASED QUESTIONS

### Comprehension # 1

Copper reduces $NO_3^-$ into NO and $NO_2$ depending upon conc. of $HNO_3$ in solution. Assuming $[Cu^{2+}] = 0.1$ M, and $P_{NO} = P_{NO_2} = 10^{-3}$ atm and using given data answer the following questions :

$E_{Cu^{2+}/Cu} = +0.34$ volt ; $E^\circ_{NO_3^-/NO} = +0.96$ volt

$E^\circ_{NO_3^-/NO_2} = +0.79$ volt ; at 298 K $\frac{RT}{F}(2.303) = 0.06$ volt

1. $E_{Cell}$ for reduction of $NO_3^- \longrightarrow NO$ by Cu(s), when $[HNO_3] = 1$ M is [At T = 298]

(A) ~0.61 (B) ~0.71 (C) ~0.51 (D) ~0.81

2. At what $HNO_3$ concentration thermodynamic tendency for reduction of $NO_3^-$ into NO and $NO_2$ by copper is same ?

(A) $10^{1.23}$ M (B) $10^{0.56}$ M (C) $10^{0.66}$ M (D) $10^{0.12}$ M

### Comprehension # 2

Accidentally chewing on a stray fragment of aluminium foil can causes a sharp tooth pain if the aluminium comes in contact with an amalgam filling. The filling, an alloy of silver, tin and mercury, acts as the cathode of a tiny galvanic cell, the aluminium behaves as the anode, and saliva serves as the electrolyte. When the aluminium and the filling come in contact, an electric current passage from the aluminium to the filling which is sensed by a nerve in the tooth. Aluminium is oxidized at the anode, and $O_2$ gas is reduced to water at the cathode.

$E^\circ_{Al^{3+}/Al} = -1.66$ V, $E^\circ_{O_2,H^+/H_2O} = 1.23$ V

1. Net reaction taking place when amalgam is in contact with aluminium foil :

(A) $Al + O_2 + OH^- \rightarrow Al(OH^-) + H_2O$

(B) $4Al + 3O_2 + 12H^+ \rightarrow 4Al^{3+} + 6H_2O$

(C) $4Al + 3O_2 \rightarrow 4Al_2O_3$

(D) $2H_2 + O_2 \rightarrow 2H_2O$

2. Standard E.M.F. experienced by the person with dental filling is :

(A) +2.89 V (B) –2.89 V (C) –0.93 V (D) +0.43 V

3. The standard reduction potential of the reaction,

$$H_2O + e^- \rightarrow \frac{1}{2}H_2 + OH^- \text{ at } 298 \text{ K is :}$$

(A) $E = \frac{RT}{2F}\ln K_w$

(B) $E = \frac{RT}{F}\ln\left[P_{H_2}\right]^{1/2}[OH^-]$

(C) $E = \frac{RT}{F}\ln\frac{\left[P_{H_2}\right]^{1/2}}{[H^+]}$

(D) $E = \frac{RT}{F}\ln K_w$

---

MISCELLANEOUS TYPE QUESTION

## ANSWER KEY

EXERCISE -3

- ***True / False***

1. F 2. T 3. T 4. T 5. F 6. T 7. F
8. T 9. F

- ***Fill in the Blanks***

1. $O_2$ 2. Lithium 3. Higher 4. Amount, rate
5. Oxygen 6. 2.5 96500 C 7. κ $10^3$ 8. Increases
9. Greater 10. $Hg_2Cl_2$ (s) + $2e^- \rightarrow$ 2Hg (ℓ) + $2Cl^-$ (aq)

- ***Match the Column***

1. A - (q), B - (u), C - (s), D - (r), E - (p)
2. A - (u), B - (r), C - (p), D - (q), E - (s)
3. A - (s), B - (p), C - (q), D - (u), E - (r)
4. A - (r), B - (s), C - (p), D - (u), E - (r)

- ***Assertion - Reason Questions***

1. B 2. C 3. C 4. B 5. B 6. C
7. A 8. A 9. A

- ***Comprehension Based Questions***

Comprehension # 1:
1. (B) 2. (C)
Comprehension # 2:
1. (A) 2. (C) 3. (A)
Comprehension # 3:
1. (B) 2. (A) 3. (D)

# EXERCISE–04 [A] CONCEPTUAL SUBJECTIVE EXERCISE

1. The resistance of a N/10 KCl solution is 245 ohms. Calculate the specific conductance and the equivalent conductance of the solution if the electrodes in the cell are 4 cm apart and each having an area of 7.0 sq. cm.

2. The resistance of a solution 'A' is 50 ohms and that of solution 'B' is 100 ohms, both solutions being taken in the same conductivity cell. If equal volumes of solution A and B are mixed , what will be the resistance of the mixture using the same cell. (Assume that there is no increase in the degree of dissociation of A and B on mixing.)

3. In a conductivity cell the two platinum electrodes, each of area 10 sq. cm. are fixed 1.5 cm apart. The cell contained 0.05 N solution of a salt. If the two electrodes are just half dipped into the solution which has a resistance of 50 ohms, find equivalent conductance of the salt solution.

4. A big irregular shaped vessel contained water, the sp. conductance of which was 2.56 $10^{-5}$ mho cm$^{-1}$. 500g of NaCl was then added to the water and the specific conductance after the addition of NaCl, was found to be 3.10 $10^{-5}$ mho cm$^{-1}$. Find the capacity of the vessel if it is fulfilled with water. ($\lambda_\infty$NaCl = 149.9)

5. The equivalent conductance of 0.10 N solution of $MgCl_2$ is 97.1 mho cm$^2$ eq$^{-1}$. A cell with electrodes that are 1.50 cm$^2$ in surface are and 0.50 cm apart is filled with 0.1N $MgCl_2$ solution. How much current will flow when the potential difference between the electrodes is 5 volts?

6. At 18 C the mobilities of $NH_4^+$ and $ClO_4^-$ ions are 6.6 $10^{-4}$ and 5.7 $10^{-4}$ cm$^2$ volt$^{-1}$ sec$^{-1}$ at infinite dilution. Calculate equivalent conductance of ammonium chlorate solution.

7. For $H^+$ and $Na^+$ the values of $\lambda^\infty$ are 349.8 and 50.11. Calculate the mobilities of these ions and their velocities if they are in a cell in which the electrodes are 5 cm apart and to which a potential of 2 volts is applied.

8. The equivalent conductance of an infinitely dilute solution $NH_4Cl$ is 150 and the ionic conductances of $OH^-$ and $Cl^-$ ions are 198 and 76 respectively. What will be the equivalent conductance of the solution of $NH_4OH$ at infinite dilution. If the equivalent conductance of a 0.01 N solution $NH_4OH$ is 9.6, what will be its degree of dissociation?

9. Calculate the dissociation constant of water at 25 C from the following data.

   Specific conductance of $H_2O$ = 5.8 $10^{-8}$ mho cm$^{-1}$, $\lambda^\infty_{H^+}$ = 350.0 and $\lambda^\infty_{OH^-}$ = 198.0 mho cm$^2$

10. Calculate $K_a$ of acetic acid if its 0.05 N solution has equivalent conductance of 7.36 mho cm$^2$ at 25 C. ($\lambda^\infty_{CH_3COOH}$ = 390.70)

11. The sp. cond. of a saturated solution of AgCl at 25 C after substracting the sp. conductance of conductivity of water is 2.28 $10^{-6}$ mho cm$^{-1}$. Find the solubility product of AgCl at 25 C. ($\lambda^\infty_{AgCl}$ = 138.3 mho cm$^2$)

12. The specific conductance of a N/10 KCl solution at 18 C is 1.12 $10^{-2}$ mho cm$^{-1}$. The resistance of the solution contained in the cell is found to be 65 ohms. Calculate the cell constant.

13. When a solution of conductance 1.342 mho m$^{-1}$ was placed in a conductivity cell with parallel electrodes, the resistance was found to be 170.5 ohm. The area of the electrodes is 1.86 $10^{-4}$ sq.meter. Calculate the distance between the two electrodes in meter.

**14.** The resistance of two electrolytes X and Y were found to be 45 and 100 respectively when equal volumes of both the solutions were taken in the same cell in two different experiments. If equal volumes of these solutions are mixed in the same cell, what will be the conductance of the mixture?

**15.** The resistance of an aqueous solution containing 0.624 g of $CuSO_4$. $5H_2O$ per 100 cm$^3$ of the solution in a conductance cell of cell constant 153.7 per meter is 520 ohms at 298 K. Calculate the molar conductivity. ($CuSO_4$ . $5H_2O$ = 249.5)

**16.** Given the equivalent conductance of sodium butyrate, sodium chloride and hydrogen chloride as 83, 127 and 426 mho cm$^2$ at 25 C respectively. Calculate the equivalent conductance of butyric acid at infinite dilution.

**17.** For 0.0128 N solution of acetic acid at 25 C, equivalent conductance of the solution is 1.4 mho cm$^3$ eq$^{-1}$ and $\lambda^{\infty}$ = 391 mho cm$^2$ eq$^{-1}$. Calculate dissociation constant ($K_a$) of acetic acid.

**18.** The specific conductance at 25 C of a saturated solution of $SrSO_4$ is 1.482 $10^{-4}$ ohm$^{-1}$ cm$^{-1}$ while that of water used is 1.5 $10^{-6}$ mho cm$^{-1}$. Determine at 25 C the solubility in g per litre of $SrSO_4$ in water. Molar ionic conductance of $Sr^{2+}$ and $SO_4^{2-}$ ions at infinite dilution are 59.46 and 79.8 ohm$^{-1}$ cm$^2$ mole$^{-1}$ respectively. [Sr = 87.6, S = 32, O = 16]

**19.** Specific conductance of pure water at 25 C is 0.58 $10^{-7}$ mho cm$^{-1}$. Calculate ionic product of water ($K_W$) if ionic conductances of $H^+$ and $OH^-$ ions at infinite dilution are 350 and 198 mho cm$^2$ respectively at 25 C.

**20.** How long a current of 3A has to be passed through a solution of $AgNO_3$, to coat a metal surface of 80 cm$^2$ with 5μm thick layer? Density of silver = 10.8 g/cm$^3$.

**21.** 3A current was passed through an aqueous solution of an unknown salt of Pd for 1 hr. 2.977 g of $Pd^{+n}$ was deposited at cathode. Find n.

**22.** 50 mL of 0.1 M $CuSO_4$ solution is electrolysed with a current of 0.965 A for a period of 200 sec. The reactions at electrodes are :

Cathode : $Cu^{2+} + 2e^- \rightarrow Cu(s)$ Anode : $2H_2O \rightarrow O_2 + 4H^+ + 4e$.

Assuming no change in volume during electrolysis, calculate the molar concentration of $Cu^{2+}$, $H^+$ and $SO_4^{2-}$ at the end of electrolysis.

**23.** A metal is known to form fluoride $MF_2$. When 10 A of electricity is passed through a molten salt for 330 sec., 1.95 g of metal is deposited. Find the atomic weight of M. What will be the quantity electricity required to deposit the same mass of Cu form $CuSO_4$?

**24.** An electric current is passed through electrolytic cells in series one containing $Ag(NO_3)$ (aq.) and other $H_2SO_4$ (aq.) What volume of $O_2$ measured at 25 C and 750 mm Hg pressure would be liberated from $H_2SO_4$ if

(a) one mole of $Ag^+$ is deposited from $AgNO_3$ solution

(b) 8 $10^{22}$ ions of $Ag^+$ are deposited from $AgNO_3$ solution.

**25.** Cd amalgam is prepared by electrolysis of a solution $CdCl_2$ using a mercury cathode. How long should a current of 5A be passed in order to prepare 12 % Cd-Hg amalgam on a cathode of 2g, Hg (atomic weight of Cd = 112.4)

**26.** After electrolysis of NaCl solution with inert electrodes for a certain period of time, 600 mL of the solution was left. Which was found to be 1N in NaOH. During the same time, 31.75 g of Cu deposited in the copper voltameter in series with the electrolytic cell. Calculate the percentage yield of NaOH obtained.

**27.** During the discharge of a lead storage battery, the density of sulphuric acid fell from 1.294 to 1.139 g.mL$^{-1}$. $H_2SO_4$ of density 1.294 gmL$^{-1}$ is 39% and that of density 1.139 g.mL$^{-1}$ is 20% by weight.

The battery holds 3.5 L of acid and the volume practically remains constant during discharge. Calculate the number of ampere hours for which the battery must have been used. The discharging and charging reactions are.

$Pb + SO_4^{2-} \rightarrow PbSO_4 + 2e^-$ (charging)

$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O$ (discharging)

**28.** The e.m.f. of the cell obtained by combining Zn and Cu electrode of a Daniel cell with N calomel electrode in two different arrangements are 1.083 V and 0.018 V respectively at 25 C. If the standard reduction potential of N calomel electrode is 0.28 V find the emf of Daniel cell.

**29.** Same quantity of electricity is being used to liberate iodine (at anode) and a metal x (at cathode). The mass of x liberated is 0.617 g and the iodine liberated is completely reduced by 46.3 cc of 0.124 M sodium thiosulphate. Find the equivalent mass of metal x.

**30.** 100 mL $CuSO_4$ (aq) was electrolyzed using inert electrodes by passing 0.965 A till the pH of the resulting solution was 1. The solution after electrolysis was neutralized, treated with excess KI and titrated with 0.04 M $Na_2S_2O_3$. Volume of $Na_2S_2O_3$ required was 35 mL. Assuming no volume change during electrolysis, calculate :

(a) duration of electrolysis if current efficiency is 80 %

(b) initial concentration (M) of $CuSO_4$.

**31.** A current of 3.7 A is passed for 6 hrs between Pt electrodes in 0.5 L of 2M solution of $Ni(NO_3)_2$. What will be the molarity of solution at the end of electrolysis ?

**32.** Calculate the EMF of a Daniel cell when the concentration of $ZnSO_4$ and $CuSO_4$ are 0.001 M and 0.1 M respectively. The standard potential of the cell is 1.1 V.

**33.** EMF of the cell $Zn|ZnSO_4(a = 0.2)||ZnSO_4(a_2)|Zn$ is –0.0088 V at 25 C. Calculate the value of $a_2$.

**34.** The EMF of the cell $M|M^{n+}$ (0.02 M)$||H^+$(1 M)$|H_2$ (g) (1 atm), Pt at 25 C is 0.81 V. Calculate the valency of the metal if the standard oxidation potential of the metal is 0.76 V.

**35.** Equinormal solution of two weak acids, HA ($pK_a$ = 3) and HB ($pK_a$ = 5) are each placed in contact with standard hydrogen electrode at 25 C. When a cell is constructed by interconnecting them through a salt bridge find the e.m.f. of the cell.

**36.** In two vessels each containing 500 mL water, 0.5 m mol of aniline ($K_b = 10^{-9}$) and 25 m mol of HCl are added separately. Two hydrogen electrodes are constructed using these solutions. Calculate the emf of cell made by connecting them appropriately.

**37.** The emf of the cell $Ag|AgI|KI$ (0.05 M)$||AgNO_3$(0.05 M)$|Ag$ is 0.788 V. Calculate the solubility product of AgI.

**38.** The cell Pt, $H_2$ (1 atm)$|H^+$ (pH = x)$||$ Normal calomel Electrode has an EMF of 0.67 V at 25 C. Calculate the pH of the solution. The oxidation potential of the calomel electrode on hydrogen scale is –0.28 V.

**39.** Estimate the cell potential of a Daniel cell having 1.0 M $Zn^{++}$ and originally having 1.0 M $Cu^{++}$ after sufficient $NH_3$ has been added to the cathode compartment to make $NH_3$ concentration 2.0 M. Given $K_f$ for $[Cu(NH_3)_4]^{2+} = 1 \quad 10^{12}$, E for the reaction, $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$ is 1.1 V.

**40.** Consider the cell $Ag|AgBr(s)|Br^-||AgCl(s)|Cl^-|Ag$ at 25 C. The solubility product constants of AgBr & AgCl are respectively $5 \quad 10^{-13}$ & $1 \quad 10^{-10}$. For what ratio of the concentration of $Br^-$ & $Cl^-$ ions would the em.f. of the cell be zero?

**41.** The $pK_{sp}$ of AgI is 16.07. If the E value for $Ag^+/Ag$ is 0.7991 V, find the E for the half cell reaction

$AgI\ (s) + e^- \longrightarrow Ag + I^-$

**42.** Voltage of the cell Pt, $H_2$ (1 atm)|HOCN ($1.3 \quad 10^{-3}$ M)||$Ag^+$(0.8 M)|Ag(s) is 0.982 V. Calculate the $K_a$ for HOCN. Neglect $[H^+]$ because of oxidation of $H_2$(g).

$Ag^+ + e^- \longrightarrow Ag\ (s) = 0.8$ V

**43.** The standard oxidation potential of Zn referred to SHE is 0.76 V and that of Cu is –0.34 V at 25 C. When excess of Zn is added to $CuSO_4$, Zn displaces $Cu^{2+}$ till equilibrium is reached. What is the ratio of $Zn^{2+}$ to $Cu^{2+}$ ions at equilibrium?

**44.** The standard reduction potential values, E ($Bi^{3+}$/Bi) and E ($Cu^{2+}$ / Cu) are 0.226 V and 0.344 V respectively. A mixture of salts of bismuth and copper at unit concentration each is electrolysed at 25 C. To what value can $[Cu^{2+}]$ be brought down before bismuth starts to deposit, in electrolysis.

**45.** Calculate the potential of an indicator electrode versus the standard hydrogen electrode, which originally contained 0.1 M $MnO_4^-$ and 0.8 M $H^+$ and which was treated with $Fe^{2+}$ necessary to reduce 90% of the $MnO_4^-$ to $Mn^{2+}$.

$MnO_4^- + 8H^+ + 5e \longrightarrow Mn^{2+} + H_2O$, E = 1.51 V,

**46.** $K_d$ for dissociation of $[Ag(NH_3)_2]^+$ into $Ag^+$ and $NH_3$ is $6 \quad 10^{-8}$. Calculate E for the following half reaction;

$Ag\ (NH_3)_2^+ + e^- \longrightarrow Ag + 2NH_3$

Given $Ag^+ + e^- \longrightarrow Ag$, E = 0.799 V

**47.** The overall formation constant for the reaction of 6 mole of $CN^-$ with cobalt (II) is $1 \quad 10^{19}$. The standard reduction potential for the reaction $[Co(CN)_6]^{3-} + e^- \longrightarrow Co(CN)_6^{4-}$ is –0.83 V. Calculate the formation constant of $[Co(CN)_6]^{3-}$.

Given $Co^{3+} + e^- \longrightarrow Co^{2+}$ ; E = 1.82 V

**48.** Calculate the e.m.f. of the cell

Pt|$H_2$|(1.0 atm)|$CH_3COOH$ (0.1 M)||$NH_3$(aq, 0.01 M)|$H_2$ (1.0 atm)|Pt

$K_a(CH_3COOH) = 1.8 \quad 10^{-5}$, $K_b$, $(NH_3) = 1.8 \quad 10^{-5}$.

**49.** An external current source giving a current of 5.0 A was joined with Daniel cell arrangement opposing the normal current flow and was removed after 10 hrs. Before passing the current the LHE and RHE contained 1L each of 1M $Zn^{2+}$ and $Cu^{2+}$ respectively. Find the EMF supplied by the Daniel cell after removal of the external current source. E of $Zn^{2+}$/Zn and $Cu^{2+}$/Cu at 25 C is –0.76 and +0.34 V respectively.

**50.** Calculate the equilibrium constant for the reaction :

$3Sn\ (s) + 2Cr_2O_7^{2-} + 28\ H^+ \longrightarrow 3\ Sn^{+4} + 4Cr^{3+} + 14H_2O$

E for $Sn/Sn^{2+}$ = 0.136 V E for $Sn^{2+}/Sn^{4+}$ = –0.154 V

E for $Cr_2O_7^{2-}/Cr^{3+}$ = 1.33 V

**51.** Calculate the voltage E, of the cell at 25 C

Mn(s)|Mn($OH_2$)(s)|$Mn^{2+}$(x M), $OH^-$ ($1.00 \quad 10^{-4}$ M)||$Cu^{2+}$ (0.675 M)|Cu(s)

given that $K_{sp} = 1.9 \quad 10^{-13}$ for $Mn(OH)_2$ (s) E ($Mn^{2+}$/Mn) = –1.18 V, E ($Cu^{+2}$/Cu) = +0.34 V

**52.** Calculate the voltage E, of the cell

Ag(s) $AgIO_3$(s)|$Ag^+$ (x M), $HIO_3$ (0.300 M)||$Zn^{2+}$ (0.175 M)|Zn (s) if $K_{SP}$ = 3.02 $10^{-8}$ for $AgIO_3$ (s) and $K_a$ = 0.162 for $HIO_3$, E $(Zn^{+2}/Zn)$ = –0.76 V, E $(Ag/Ag^+)$ = –0.8 V)

**53.** The voltage of the cell

$Pb(s)|PbSO_4(s)|NaHSO_4$ (0.600 M)$||Pb^{2+}$(2.50 $10^{-5}$ M)|Pb (s)

is E = +0.061 V. Calculates $K_2 = [H^+]\,[SO_4^{2-}]/[HSO_4^-]$, the dissociation constant for $HSO_4^-$.

Given $Pb(s) + SO_4^{2-} \rightarrow PbSO_4 + 2e^-$ (E = 0.356 V), E $(Pb^{2+}/Pb)$ = –0.126 V.

**54.** The voltage of the cell

$Zn(s)|Zn(CN)_4^{2-}$ (0.450 M), $CN^-$ (2.65 $10^{-3}$ M)$||Zn^{2+}$(3.84 $10^{-4}$ M)|Zn(s) is E = +0.099 V. Calculate the constant $K_f$ for $Zn^{2+} + 4CN^- \rightarrow Zn(CN)_4^{2-}$, the only $Zn^{2+}$ + $CN^-$ complex reaction of importance.

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CONCEPTUAL SUBJECTIVE EXERCISE

## ANSWER KEY

EXERCISE-4(A)

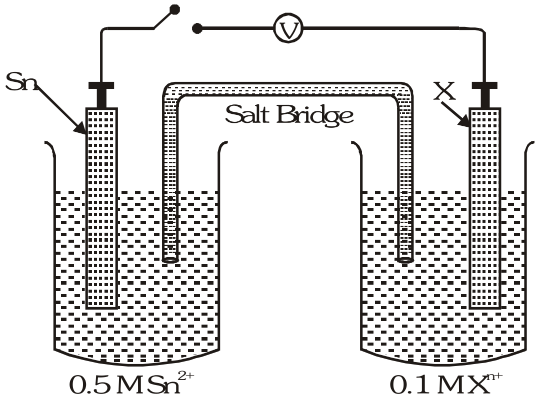
**1.** 2.332 $10^{-3}$mho $cm^{-1}$, 23.32 mho $cm^2 eq^{-1}$
**2.** R = 66.67 ohms
**3.** 120 mho $cm^2$ $eq^{-1}$
**4.** V = 2.34 $10^8$ cc
**5.** 0.1456 amp
**6.** 118.67 mho $cm^2$ $eq^{-1}$
**7.** $\mu\, H^+$ = 3.62 $10^{-3}$ $cm^2$ $volt^{-1}$ $sec^{-1}$, $\mu_{Na}$ = 5.20 $10^{-4}$ $cm^2$ $volt^{-1}$ $sec^{-1}$
velocity of $H^+$ = 1.45 $10^{-3}$ cm $sec^{-1}$, velocity of $Na^+$ = 2.08 $10^{-4}$ cm $sec^{-1}$
**8.** 272, 0.0353
**9.** 1.8 $10^{-16}$mole/litre
**10.** 1.76 $10^{-5}$ mole/litre
**11.** 2.70 $10^{-10}$(mole/litre)$^2$
**12.** 0.728 $cm^{-1}$
**13.** 4.25 $10^{-2}$metres
**14.** 0.016 mho
**15.** 118.2 mho $cm^2 mol^{-1}$
**16.** 382 mho $cm^2$ $eq^{-1}$
**17.** 1.6 $10^{-7}$
**18.** 0.1934 g/L
**19.** 1 $10^{-14}$ (mole/litre)$^2$
**20.** t = 128.66 sec
**21.** n = 4
**22.** $Cu^{2+}$ = 0.08M, $H^+$ = 0.04M, $SO_4^{2-}$ = 0.1M
**23.** A=114, Q=5926.8C
**24.** (a) $V(O_2)$=6.2 L, (b) $V(O_2)$=0.824L
**25.** t = 93.65 sec
**26.** $\eta$ = 60%
**27.** 265 Amp. hr.
**28.** E = 1.1 V
**29.** Eq.wt = 107.468
**30.** 1250 S, 0.064 M
**31.** 1.172 M
**32.** E = 1.159 V
**33.** $a_2$ = 0.1006 M
**34.** n = 2
**35.** E = 0.059 V
**36.** E = 0.395 V
**37.** $K_{SP}$ = 1.16 $10^{-16}$
**38.** pH = 6.61
**39.** E = 0.71 V
**40.** $[Br^-] : [Cl^-]$ = 1 : 200
**41.** E = –0.149 V
**42.** $K_a$ = 6.74 $10^{-4}$
**43.** $[Zn^{2+}]/[Cu^{2+}]$=1.941 $10^{37}$
**44.** $[Cu^{2+}]$ = $10^{-4}$ M
**45.** 1.39 V
**46.** 0.373 V
**47.** $K_f$ = 8.28 $10^{63}$
**48.** –0.46 V
**49.** 1.143 V
**50.** K = $10^{268}$
**51.** 1.66 V
**52.** –1.188 V
**53.** 1.06 $10^{-2}$
**54.** 5.4 $10^{16}$

# EXERCISE–04 [B] BRAIN STORMING SUBJECTIVE EXERCISE

1. The e.m.f. of cell : $H_2$(g)|Buffer||Normal calomal electrode is 0.6885 V at 40 C when the barometric pressure is 725 mm of Hg. What is the pH of the solution. $E_{calomal}$ = 0.28.

2. A direct current of 1.25 A was passed through 200 mL of 0.25 M $Fe_2(SO_4)_3$ solution for a period of 1.1 hour. The resulting solution in cathode chamber was analyzed by titrating against acidic $KMnO_4$ solution. 25 mL permaganate solution was required to reach the end point. Determine molarity of $KMnO_4$ solution.

3. An electrochemical cell is constructed with an open switch as shown below :



When the switch is closed, mass of tin-electrode increases. If E ($Sn^{2+}$ / Sn) = –0.14 V and for E ($X^{n+}$ / X) = – 0.78 V and initial emf of the cell is 0.65 V, determine n and indicate the direction of electron flow in the external circuit.

4. 10 g fairly concentrated solution of $CuSO_4$ is electrolyzed using 0.01 F of electricity. Calculate :

(a) The weight of resulting solution

(b) Equivalents of acid or alkali in the solution.

5. One of the methods of preparation of per disulphuric acid, $H_2S_2O_8$, involve electrolytic oxidation of $H_2SO_4$ at anode ($2H_2SO_4 \longrightarrow H_2S_2O_8 + 2H^+ + 2e^-$) with oxygen and hydrogen as by - products. In such an electrolysis, 9.722 L of $H_2$ and 2.35 L of $O_2$ were generated at STP. What is the weight of $H_2S_2O_8$ formed?

6. Assume that impure copper contains only iron, silver and a gold as impurities. After passage of 140 A, for 482.5 sec, of the mass of the anode decreased by 22.260 g and the cathode increased in mass by 22.011 g. Estimate the % iron and % copper originally present.

7. For the galvanic cell : Ag|AgCl(s)|KCl(0.2 M)||KBr(0.001 M)|AgBr(s)|Ag,

Calculate the EMF generated and assign correct polarity to each electrode for a spontaneous process after taking into account the cell reaction at 25 C.

[$K_{sp(AgCl)}$ = 2.8 $10^{-10}$ ; $K_{sp(AgBr)}$ = 3.3 $10^{-13}$]

8. An aqueous solution of NaCl on electrolysis gives $H_{2(g)}$, $Cl_{2(g)}$ and NaOH according to the reaction :

$$2Cl^-_{(aq)} + 2H_2O \rightleftharpoons 2OH^-_{(aq)} + H_{2(g)} + Cl_{2(g)}$$

A direct current of 25 amperes with a current efficiency of 62% is passed through 20 liters of NaCl solution (20% by weight). Write down the reactions taking place at the anode and the cathode. How long will it take to produce 1 kg of $Cl_2$? What will be the molarity of the solution with respect to hydroxide ion? (Assume no loss due to evaporation).

**9.** An acidic solution of $Cu^{2+}$ salt containing 0.4 of $Cu^{2+}$ is electrolyzed until all the copper is deposited. The electrolysis is continued for seven more minutes with the volume of solution kept at 100 mL and the current at 1.2 amp. Calculate the volume of gases evolved at NTP during the entire electrolysis.

**10.** In the refining of silver by electrolytic method what will be the weight of 100 g Ag anode if 5 ampere current is passed for 2 hours? Purity of silver is 95% by weight.

**11.** Hydrogen peroxide can be prepared by successive reactions :

$2NH_4HSO_4 \rightarrow H_2 + (NH_4)_2S_2O_8$

$(NH_4)_2S_2O_8 + 2H_2O \rightarrow 2NH_4HSO_4 + H_2O_2$

The first reaction is an electrolytic reaction the second is steam distillation. What amount of current would have to be used in first reaction to produce enough intermediate to yield 100 g pure $H_2O_2$ per hour? Assume 50% anode current efficiency.

**12.** Dal lake has water 8.2  $10^{12}$ litre approximately. A power reactor produces electricity at the rate of 1.5  $10^{6}$ coulomb per second at an appropriate voltage. How many years would it take to electrolyse the lake?

**13.** Determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride in M/32 solution of salt at 298 K from the following cell data at 298 K.

$Pt|H_2(1\ atm)|H^+(1\ M)||\ M/32\ C_6H_5NH_3Cl|H_2(1\ atm)|Pt$ ; $E_{cell} = -0.188$ V.

**14.** The emf of the cell, $Pt|H_2(1\ atm)|H^+(0.1\ M,\ 30\ mL)||\ Ag^+\ (0.8\ M)\ Ag$ is 0.9 V. Calculate the emf when 40 mL of 0.05 M NaOH is added.

**15.** A dilute aqueous solution of KCl was placed between two electrodes 10 cm apart, across which a potential of 6 volt was applied. How far would the $K^+$ ion move in 2 hours at 25 C? Ionic conductance of $K^+$ ion at infinite dilution at 25 C is 73.52 $ohm^{-1}\ cm^2\ mole^{-1}$?

**16.** 100 mL $CuSO_4$(aq) was electrolyzed using inert electrodes by passing 0.965 A till the pH of the resulting solution was 1. The solution after electrolysis was neutralized, treated with excess KI and titrated with 0.04 M $Na_2S_2O_3$. Volume of $Na_2S_2O_3$ required was 35 mL. Assuming no volume change during electrolysis, calculate :

(a) duration of electrolysis if current efficiency is 80%

(b) initial concentration (M) of $CuSO_4$

**17.** Calculate the equilibrium concentration of all ions in an ideal solution prepared by mixing 25.00 mL of 0.100 M $Tl^+$ with 25.00 mL of 0.200 M $Co^{3+}$.

E  $(Tl^+/Tl^{3+}) = -1.25$ V, E  $(Co^{3+}/Co^{2+}) = 1.84$ V

**18.** Determine at 298 for cell :

$Pt|Q,\ QH_2\ ,\ H^+||1M\ KCl|Hg_2Cl_2|Hg(l)|Pt$

(a) it's emf when pH = 5.0

(b) the pH when $E_{cell} = 0$

(c) the positive electrode when pH = 7.5

given $E_{RP(RHS)} = 0.28$, $E_{RP(LHS)} = 0.699$

**19.** At 25 C, $\Delta H_f(H_2O, l) = -56700$ J/mol and energy of ionization of $H_2O(l)$ = 19050 J/mol. What will be the reversible EMF at 25 C of the cell,

$Pt|H_2(g)(1\ atm)|H^+||\ OH^-|O_2\ (g)(1\ atm)|Pt$, if at 26 C the emf increase by 0.001158 V.

**20.** Calculate the cell potential of a cell having reaction $Ag_2S + 2e^- \rightleftharpoons 2\ Ag + S^{2-}$ in a solution buffered at pH = 3 and which is also saturated with 0.1 M $H_2S$.

For $H_2S$ : $K_1 = 10^{-8}$ and $K_2 = 1.1\quad 10^{-13}$, $K_{sp}(Ag_2S) = 2\quad 10^{-49}$, $E_{Ag^+/Ag} = 0.8$.

**21.** Calculate the solubility and solubility product of $Co_2[Fe(CN)_6]$ in water at 25 C from the following data :

Conductivity of a saturated solution of $Co_2[Fe(CN)_6]$ is $2.06\quad 10^{-6}\Omega^{-1}cm^{-1}$ and that of water used $4.1\quad 10^{-7}\ \Omega^{-1}cm^{-1}$. The ionic molar conductivities of $Co^{2+}$ and $Fe(CN)_6^{\ 4-}$ are 86.0 $\Omega^{-1}cm^2mol^{-1}$ and 444.0 $\Omega^{-1}cm^{-1}mol^{-1}$.

**22.** A sample of water from a large swimming pool has a resistance of 9200 Ω at 25 C when placed in a certain conductance cell. When filled with 0.02 M KCl solution, the cell has a resistance of 85 Ω at 25 C. 500 g of NaCl were dissolved in the pool, which was throughly stirred. A sample of this solution gave a resistance of 7600 Ω. Calculate the volume of water in the pool.

Given : Molar conductance of NaCl at that concentrations is 126.5 $\Omega^{-1}cm^2mol^{-1}$ and molar conductivity of KCl at 0.02 M is 138 $\Omega^{-1}cm^2\ mol^{-1}$.

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### BRAIN STORMING SUBJECTIVE EXERCISE ANSWER KEY EXERCISE-4(B)

| | | | |
|---|---|---|---|
| **1.** | 6.6 | **2.** | 0.41 M |
| **3.** | n = 3 & X-electrode to Sn-electrode | **4.** | final weight = 9.6 g, 0.01 eq. of acid |
| **5.** | 43.45 g | **6.** | Cu = 98.88%, Fe = 0.85% |
| **7.** | – 0.037 V | **8.** | 48.71 hour, $[OH^-]$ = 1.41 M |
| **9.** | $V(O_2)$ = 99.68 mL, $V(H_2)$ = 58.46 mL, Total vol. = 158.1 mL | | |
| **10.** | 57.5894 g | **11.** | 315.36 A |
| **12.** | 1.9 million year | **13.** | $h = 2.12\quad 10^{-2}$, $K_h = 1.43\quad 10^{-5}$ M |
| **14.** | 0.95 V | **15.** | 3.29 cm |
| **16.** | 1250 s, 0.064 M | **17.** | $Tl^+ = 10^{-8}$ , $Co^{+3} = 2\quad 10^{-8}$ |
| **18.** | (a) –0.124V (b) 7.1 (c) calomel electrode | | |
| **19.** | 0.4414 V | **20.** | –0.167 V |
| **21.** | $K_{sp} = 7.682\quad 10^{-17}$ | **22.** | $2\quad 10^5\ dm^3$ |

# EXERCISE - 05 [A] JEE-[MAINS] : PREVIOUS YEAR QUESTIONS

1. For a cell reaction involving a two-electron change, the standard e.m.f. of the cell is found to be 0.295V at 25 C. The equilibrium constant of the reaction at 25 C will be : [AIEEE-2003]

(A) 10 (B) 1 $10^{10}$ (C) 1 $10^{-10}$ (D) 29.5 $10^{-2}$

2. Standard reduction electrode potentials of three metals A, B and C are respectively + 0.5V, – 3.0V and –1.2 V. The reducing powers of these metals are : [AIEEE-2003]

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

3. For the redox reaction :

$Zn(s) + Cu^{2+}$ (0.1M) $\rightarrow Zn^{2+}$ (1M) + Cu(s) taking place in a cell,

$E_{Cell}$ is 1.10 volt. $E_{Cell}$ for the cell will be $\left(2.303\frac{RT}{F} = 0.0591\right)$ [AIEEE-2003]

(A) 1.07 volt (B) 0.82 volt (C) 2.14 volt (D) 1.80 volt

4. When during electrolysis of a solution of $AgNO_3$ 9650 coulombs of charge pass through the electroplating bath, the mass of silver deposited on the cathode will be : [AIEEE-2003]

(A) 21.6g (B) 108g (C) 1.08g (D) 10.8g

5. Consider the following $E^0$ values [AIEEE-2004]

$E^0_{Fe^{3+}/Fe^{2+}} = +\ 0.77V \qquad E^0_{Sn^{2+}/Sn} = -\ 0.14V$

Under standard conditions the potential for the reaction

$Sn(s) + 2Fe^{3+}(aq) \longrightarrow 2Fe^{2+}(aq) + Sn^{2+}(aq)$ is

(A) 0.91V (B) 1.40V (C) 1.68V (D) 0.63V

6. The standard e.m.f. of a cell, involving one electron change is found to be 0.591 V at 25 C. The equilibrium constant of the reaction is (F = 96,500C $mol^{-1}$ ; R = 8.314 $JK^{-1}$ $mol^{-1}$) [AIEEE-2004]

(A) 1.0 $10^{10}$ (B) 1.0 $10^{5}$ (C) 1.0 $10^{1}$ (D) 1.0 $10^{30}$

7. The limiting molar conductivities $\Lambda^0$ for NaCl, KBr and KCl are 126,152 and 150Scm$^2$ mol$^{-1}$ respectively. The $\Lambda^0$ for NaBr is : [AIEEE-2004]

(A) 278 S cm$^2$ mol$^{-1}$ (B) 176 S cm$^2$ mol$^{-1}$ (C) 128 S cm$^2$ mol$^{-1}$ (D) 302 S cm$^2$ mol$^{-1}$

8. In a cell that utilises the reaction

$Zn(s) + 2H^+(aq.) \longrightarrow Zn^{2+}(aq) + H_2(g)$ addition of $H_2SO_4$ to cathode compartment, will [AIEEE-2004]

(A) increase the E and shift equilibrium to the right (B) lower the E and shift equilibrium to the right

(C) lower the E and shift equilibrium to the left (D) increase the E and shift equilibrium to the left

9. The $E^0_{M^{3+}/M^{2+}}$ values for Cr, Mn, Fe and Co are –0.41, + 1.57, +0.77 and + 1.97V respectively. For which one of these metals the change in oxidation state from +2 to +3 is easiest ? [AIEEE-2004]

(A) Fe (B) Mn (C) Cr (D) Co

**10.** For a spontaneous reaction the $\Delta G$, equilibrium constant (K) and $E^0_{\text{Cell}}$ will be respectively **[AIEEE-2005]**

(A) –ve, < 1, –ve  (B) –ve, >1, –ve  (C) –ve, >1, +ve  (D) +ve, >1, –ve

**11.** Aluminium oxide may be electrolysed at 1000 C to furnish aluminium metal (At. Mass = 27 amu; 1 Faraday = 96500 Coulombs).The cathode reaction is **[AIEEE-2005]**

$A\ell^{3+} + 3e^{-} \longrightarrow A\ell^{0}$

To prepare 5.12 kg of aluminium metal by this method would require.

(A) 5.49 $10^4$ C of electric charge  (B) 5.49 $10^1$ C of electric charge

(C) 5.49 $10^7$ C of electric charge  (D) 1.83 $10^7$ C of electric charge

**12.** The highest electrical conducitivity of the following aqueous solution is of **[AIEEE-2005]**

(A) 0.1 M fluoroacetic acid  (B) 0.1 M difluoroacetic acid

(C) 0.1 M acetic acid  (D) 0.1 M chloroacetic acid

**13.**

| Electrolyte | $\Lambda^{\infty}$ (S cm$^2$ mol$^{-1}$) |
|---|---|
| KCl | 149.9 |
| $KNO_3$ | 145.0 |
| HCl | 426.2 |
| NaOAC | 91.0 |
| NaCl | 126.5 |

Calculate $\Lambda^{\infty}_{\text{HOAc}}$ using appropriate molar conductances of the electrolytes listed above at infinite dilution in $H_2O$ at 25 C **[AIEEE-2005]**

(A) 390.7  (B) 217.5  (C) 517.2  (D) 552.7

**14.** Given the data at 25 C,

$Ag + I^{-} \rightarrow AgI + e^{-}$, E = 0.152V

$Ag \rightarrow Ag^{+} + e^{-}$,  E = – 0.800 V

What is the value of log Ksp for AgI ? $\left(2.303\dfrac{RT}{F} = 0.059V\right)$ **[AIEEE 2006]**

(A) –8.12  (B) +8.612  (C) –37.83  (D) –16.13

**15.** Resistance of a conductivity cell filled with a solution of an electrolyte of concentration 0.1M is 100Ω. The conductivity of this solution is 1.29 Sm$^{-1}$. Resistance of the same cell when filled with 0.02M of the same solution is 520Ω. The molar conductivity of 0.02M solution of the electrolyte will be. **[AIEEE-2006]**

(A) 124 $10^{-4}$ Sm$^2$ mol$^{-1}$  (B) 1240 $10^{-4}$ Sm$^2$ mol$^{-1}$

(C) 1.24 $10^{4}$ Sm$^2$ mol$^{-1}$  (D) 12.4 $10^{-4}$ Sm$^2$ mol$^{-1}$

**16.** The molar conductivities $\wedge^0_{\text{NaOAc}}$ and $\wedge^0_{\text{HCl}}$ at infinite dilution in water at 25 C are 91.0 and 426.2 S cm$^2$/mol respectively. To calculate $\wedge^0_{\text{HOAc}}$ the additional value required is : **[AIEEE-2006]**

(A) KCl  (B) NaOH  (C) NaCl  (D) $H_2O$

**17.** Given $E^0_{Cr^{3+}/Cr} = -\ 0.72$ V, $E^0_{Fe^{2+}/Fe} = -\ 0.42$ V. The potential for the cell **[AIEEE-2008]**

Cr | $Cr^{3+}$ (0.1 M) || $Fe^{2+}$ (0.01 M)|Fe is

(A) 0.26 V  (B) 0.339 V  (C) – 0.339 V  (D) –0.26 V

**18.** Given : **[AIEEE-2009]**

$E^0_{Fe^{3+}/Fe} = -0.036V,\ E^0_{Fe^{2+}/Fe} = -0.439V,$

Thevalue of standard electrode potential for the change, $Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}(aq)$ will be :-

(A) 0.770 V (B) –0.270 V (C) –0.072 V (D) 0.385 V

**19.** The Gibbs energy for the decomposition of $Al_2O_3$ at 500  C is as follows : **[AIEEE-2010]**

$$\frac{2}{3}Al_2O_3 \longrightarrow \frac{4}{3}Al + O_2,\ \Delta_rG = +966\ KJ\ mol^{-1}$$

The potential difference needed for electrolytic reduction of $Al_2O_3$ at 500  C is at least :-

(A) 5.0 V (B) 4.5 V (C) 3.0 V (D) 2.5 V

**20.** The correct order of $E^{\circ}_{M^{2+}/M}$ values with negative sign for the four successive elements Cr, Mn, Fe and Co is :- **[AIEEE-2010]**

(A) Cr > Mn > Fe > Co (B) Mn > Cr > Fe > Co

(C) Cr > Fe > Mn > Co (D) Fe > Mn > Cr > Co

**21.** The reduction potential of hydrogen half-cell will be negative if :- **[AIEEE-2011]**

(A) $p(H_2)$ = 2 atm $[H^+]$ = 1.0 M (B) $p(H_2)$ = 2 atm and $[H^+]$ = 2.0 M

(C) $p(H_2)$ = 1 atm and $[H^+]$ = 2.0 M (D) $p(H_2)$ = 1 atm and $[H^+]$ = 1.0 M

**22.** Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is 1.3 S $m^{-1}$. If resistance of the 0.4M solution of the same electrolyte is 260 Ω, its molar conductivity is :- **[AIEEE-2011]**

(A) 6250 S $m^2$ $mol^{-1}$ (B) 6.25   $10^{-4}$ S $m^2$ $mol^{-1}$

(C) 625   $10^{-4}$ S $m^2$ $mol^{-1}$ (D) 62.5 S $m^2$ $mol^{-1}$

**23.** The standard reduction potentials for $Zn^{2+}$ / Zn, $Ni^{2+}$ / Ni and $Fe^{2+}$ / Fe are – 0.76, – 0.23 and – 0.44 V respectively. The reaction $X + Y^{+2} \rightarrow X^{2+} + Y$ will be spontaneous when **[AIEEE-2012]**

(A) X = Zn, Y = Ni (B) X = Ni, Y = Fe

(C) X = Ni, Y = Zn (D) X = Fe, Y = Zn

JEE-[MAIN] : PREVIOUS YEAR QUESTIONS **ANSWER KEY** EXERCISE -5[A]

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans | B | C | A | D | A | A | C | A | C | C | C | B | A | D | A |
| Que. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | | | | | | | |
| Ans | C | A | A | D | B | A | B | A | | | | | | | |

# EXERCISE - 05 [B] JEE-[ADVANCED] : PREVIOUS YEAR QUESTIONS

1. The standard reduction potentials of $Cu^{2+}$ / Cu and $Cu^{2+}$ / $Cu^{+}$ are 0.337 and 0.153 V respectively. The standard electrode potential of $Cu^{+}$ / Cu half cell is :- **[JEE 1997]**

(A) 0.184 V (B) 0.827 V (C) 0.521 V (D) 0.490 V

2. A standard hydrogen electrode has zero electrode potential because :- **[JEE 1997]**

(A) hydrogen is easier to oxidise (B) this electrode potential is assumed to be zero

(C) hydrogen atom has only one electron (D) hydrogen is the lowest element

3. The standard reduction potential values of the three metallic cations X, Y, Z are 0.52, –3.03, and –1.18V respectively. The order of reducing power of the corresponding metals is :- **[JEE 1998]**

(A) $Y > Z > X$ (B) $X > Y > Z$ (C) $Z > Y > X$ (D) $Z > X > Y$

4. A gas X at 1 atm is bubbled through a solution containing a mixture of 1M Y and 1M Z at 25 C. If the reduction potential of $Z > Y > X$, then :- **[JEE 1999]**

(A) Y will oxidise X and not Z (B) Y will oxidise Z and not X

(C) Y will oxidise both X and Z (D) Y will reduce both X and Z

5. For the electrochemical cell, $M|M^{+}||X^{-}|X$,E $(M^{+}/M)$ = 0.44 V and E $(X/X^{-})$ = 0.33 V. From this data, one can deduce that :- **[JEE 2000]**

(A) $M + X \longrightarrow M^{+} + X^{-}$ is the spontaneous reaction

(B) $M^{+} + X^{-} \longrightarrow M + X$ is the spontaneous reaction

(C) $E_{cell} = 0.77$ V

(D) $E_{cell} = -0.77$ V

6. The reaction,

$3\ ClO^{-}\ (aq) \longrightarrow ClO_3^{-}\ (aq) + 2\ Cl^{-}\ (aq)$

is an example of :- **[JEE 2001]**

(A) Oxidation reaction (B) Reduction reaction

(C) Disproportionation reaction (D) Decomposition reaction

7. The correct order of equivalent conductance at infinite dilution of LiCl, NaCl and KCl is:-**[JEE 2001]**

(A) LiCl > NaCl > KCl (B) KCl > NaCl > LiCl

(C) NaCl > KCl > LiCl (D) LiCl > KCl > NaCl

8. Saturated solution of $KNO_3$ is used to make salt bridge because :- **[JEE 2001]**

(A) velocity of $K^{+}$ is greater than that of $NO_3^{-}$ (B) velocity of $NO_3^{-}$ is greater than that of $K^{+}$

(C) velocities of both $K^{+}$ and $NO_3^{-}$ are nearly the same (D) $KNO_3$ is highly soluble in water

9. Standard electrode potential data are useful for understanding the suitability of an oxidant in a redox titration. Some half cell reactions and their standard potentials are given below :- **[JEE 2002]**

$MnO_4^{-}\ (aq) + 8H^{+}\ (aq) + 5e^{-} \longrightarrow Mn^{2+}\ (aq) + 4H_2O\ (l)$ ; E = 1.51 V

$CrO_7^{-}\ (aq) + 14H^{+}\ (aq) + 6e^{-} \longrightarrow 2Cr^{3+}\ (aq) + 7H_2O\ (l)$ ; E = 1.38 V

$Fe^{3+}\ (aq) + e^{-} \longrightarrow Fe^{2+}\ (aq)$ ; E = 0.77 V

$Cl_2\ (g) + 2e^{-} \longrightarrow 2Cl^{-}\ (aq)$ ; E = 1.40 V

Identify the only incorrect statement regarding quantitative estimation of aqueous $Fe(NO_3)_2$.

(A) $MnO_4^{-}$ can be used in aqueous HCl (B) $Cr_2O_7^{2-}$ can be used in aqueous HCl

(C) $MnO_4^{-}$ can be used in aqueous $H_2SO_4$ (D) $Cr_2O_7^{2-}$ can be used in aqueous $H_2SO_4$

**10.** In the electrolytic cell, flow of electrons is from :- **[JEE 2003]**

(A) Cathode to anode in solution

(B) Cathode to anode through external supply

(C) Cathode to anode through internal supply

(D) Anode to cathode through internal supply

**11.** $Zn|Zn^{2+}$(a = 0.1 M)||$Fe^{2+}$ (a = 0.01 M)|Fe. The emf of the above cell is 0.2905 V. Equilibrium constant for the cell reaction is :- **[JEE 2004]**

(A) $10^{0.32/0.591}$ (B) $10^{0.32/0.0295}$ (C) $10^{0.26/0.0295}$ (D) $e^{0.32/0.295}$

**12.** The half cell reactions for rusting of iron are : **[JEE 2000]**

$$2H^{+} + \frac{1}{2}O_2 + 2e^{-} \longrightarrow H_2O\ ;\ E = +1.23\ V,\ Fe^{2+} + 2e^{-} \longrightarrow Fe\ ;\ E = -0.44\ V$$

$\Delta G$ (in kJ) for the reaction is :

(A) –76 (B) –322 (C) –122 (D) –176

**Question No. 13 to 15 (3 question)**

Tollen's reagent is used for the detection of aldehyde when a solution of $AgNO_3$ is added to glucose with $NH_4OH$ then gluconic acid is formed.

$Ag^{+} + e^{-} \longrightarrow Ag\ ;\ E_{red} = 0.8\ V$

$C_6H_{12}O_6 + H_2O \longrightarrow C_6H_{12}O_7$ (Gluconic acid) $+ 2H^{+} + 2e^{-}\ ;\ E_{red} = -0.05\ V$

$Ag(NH_3)_2^{+} + e^{-} \longrightarrow Ag(s) + 2NH_3\ ;\ E = -0.337\ V$

[Use $2.303\ \frac{RT}{F} = 0.0592$ and $\frac{F}{RT} = 38.92$ at 298 K] **[JEE 2006]**

**13.** $2Ag^{+} + C_6H_{12}O_6 + H_2O \longrightarrow 2Ag(s) + C_6H_{12}O_7 + 2H^{+}$

Find $\ell$n K of this reaction

(A) 66.13 (B) 58.38 (C) 28.30 (D) 46.29

**14.** When ammonia is added to the solution, pH is raised to 11. Which half-cell reaction is affected by pH and by how much ?

(A) $E_{oxd}$ will increase by a factor of 0.65 from $E_{oxd}$

(B) $E_{oxd}$ will decrease by a factor of 0.65 from $E_{oxd}$

(C) $E_{red}$ will increase by a factor of 0.65 from $E_{red}$

(D) $E_{red}$ will decrease by a factor of 0.65 from $E_{red}$

**15.** Ammonia is always is added in this reaction. Which of the following must be incorrect?

(A) $NH_3$ combines with $Ag^{+}$ to form a complex

(B) $Ag(NH_3)_2^{+}$ is a weaker oxidising reagent than $Ag^{+}$

(C) In absence of $NH_3$ silver salt of gluconic acid is formed

(D) $NH_3$ has affected the standard reduction potential of glucose / gluconic acid electrode

**16.** Electrolysis of a solution of $MnSO_4$ in aqueous sulphuric acid is a method for the preparation of $MnO_2$ as per the reaction, $Mn^{2+}_{aq} + 2H_2O \rightarrow MnO_2(s) + 2H^{+}_{aq} + H_2(g)$

Passing a current of 27 A for 24 hours gives one kg of $MnO_2$. What is the value of current efficiency? Write the reaction taking place at the cathode and at the anode. **[JEE 1997]**

**17.** How many grams of silver could be plated out on a serving tray by electrolysis of a solution containing silver in +1 oxidation state for a period of 8.0 hours at a current of 8.46 Amperes? What is the area of the tray if the thickness of the silver plating is 0.00254 cm? Density of silver is 10.5 g/cm$^3$ :- **[JEE 1997]**

**18.** Calculate the equilibrium constant for the reaction

$Fe^{2+} + Ce^{4+} \rightleftharpoons Fe^{3+} + Ce^{3+}$, [given : $E^0_{Ce^{4+}/Ce^{3+}} = 1.44$ V ; $E^0_{Fe^{3+}/Fe^{2+}} = 0.68$ V] **[JEE 1997]**

**19.** Calculate the equilibrium constant for the reaction, $2Fe^{3+} + 3I^- \rightleftharpoons 2Fe^{2+} + I_3^-$. The standard reduction potentials in acidic condition are 0.77 and 0.54 V respectively for $Fe^{3+}/Fe^{2+}$ and $I_3^-/I^-$ couples :- **[JEE 1998]**

**20.** Find the solubility product of a saturated solution of $Ag_2CrO_4$ in water at 298 K if the emf of the cell $Ag|Ag^+$ (satd. $Ag_2CrO_4$ soln) $||Ag^+$ (0.1 M) | Ag is 0.164 V at 298 K :- **[JEE 1998]**

**21.** Copper sulphate solution (250 mL) was electrolysed using a platinum anode and a copper cathode. A constant current of 2 mA was passed for 16 minute it was found that after electrolysis, the concentration of the solution was reduced to 50% of its original value. Calculate the concentration of copper sulphate in the solution to begin with. **[JEE 2000]**

**22.** The following electrochemical cell has been set up :- **[JEE 2000]**

$Pt_{(I)}|Fe^{3+}, Fe^{2+} (a = 1)||Ce^{4+}, Ce^{3+} (a = 1)|Pt_{(II)}$

$E_{Fe^{3+}/Fe^{2+}} = 0.77$ V and $E_{Ce^{4+}/Ce^{3+}} = 1.61$ V

If an ammeter is connected between the two platinum electrodes. Predict the direction of flow of current. Will the current increase or decrease with time?

**23.** The standard potential of the following cell is 0.23 V at 15 C C & 0.21 V at 35 C.

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

(i) Write the cell reaction.

(ii) Calculate $\Delta H^0$, $\Delta S^0$ for the cell reaction by assuming that these quantities remain unchanged in the range 15 C to 35 C.

(iii) Calculate the solubility of AgCl in water at 25 C. Given standard reduction potential of the $Ag^+/Ag$ couples is 0.80 V at 25 C. **[JEE 2001]**

**24.** Two students use same stock solution of $ZnSO_4$ and a solution of $CuSO_4$. The e.m.f of one cell is 0.03 V higher than the other. The conc. of $CuSO_4$ in the cell with higher e.m.f value is 0.5 M. Find out the conc. of $CuSO_4$ in the other cell $\left(\frac{2.303RT}{F} = 0.06\right)$:- **[JEE 2003]**

**25.** Find the equilibrium constant at 298 K for the reaction,

$$Cu^{2+}(aq) + In^{2+}(aq) \rightleftharpoons Cu^{+}(aq) + In^{3+}(aq) \text{ c}$$

Given that :

$E^\circ_{Cu^{2+}|Cu^+} = 0.15$ V, $E^\circ_{In^{3+}|In^+} = -0.42$ V, $E^\circ_{In^{2+}|In^+} = -0.40$ V **[JEE 2000]**

**26.** (a) Calculate $\Delta G_f^0$ of the following reaction

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$

Given : $\Delta G_f^0(AgCl) = -109$ kJ/mole, $\Delta G_f^0(Cl^-) = -129$ kJ/mole, $\Delta G_f^0(Ag^+) = 77$ kJ/mole

Represent the above reaction in form of a cell

Calculate $E^0$ of the cell. Find $\log_{10}K_{SP}$ of AgCl

(b) 6.593 $10^{-2}$ g of metallic Zn (amu = 65.39) was added to 100 mL of saturated solution of AgCl.

Calculate $\log_{10}\dfrac{\left[Zn^{2+}\right]}{\left[Ag^{+}\right]^{2}}$, given that

$Ag^{+} + e^{-} \longrightarrow Ag \qquad E^{0} = 0.80\ V$

$Zn^{2+} + 2e^{-} \longrightarrow Zn \qquad E^{0} = -0.76\ V$

Also find how many moles of Ag will be formed ? **[JEE 2005]**

27. We have taken a saturated solution of AgBr, $K_{sp}$ of AgBr is 12 $10^{-14}$. If $10^{-7}$ mole of $AgNO_3$ are added to 1 litre of this solution find conductivity (specific conductance) of this solution in terms of $10^{-7}$ S $m^{-1}$ $mol^{-1}$. Given : $\lambda^{0}_{(Ag^{+})} = 6 \quad 10^{-3}$ S $m^{2}$ $mol^{-1}$ ; $\lambda^{0}_{(Br^{-})} = 8 \quad 10^{-3}$ S $m^{2}$ $mol^{-1}$ ; $\lambda^{0}_{(NO_3^{-})} = 7 \quad 10^{-3}$ S $m^{2}$ $mol^{-1}$ :-**[JEE 2006]**

*Question No. 28 to 30 (3 questions)*

Tollen's reagent is used for the detection of aldehyde when a solution of $AgNO_3$ is added to glucose with $NH_4OH$ then gluconic acid is formed

$Ag^{+} + e^{-} \longrightarrow Ag \qquad ; \quad E^{0}_{red} = 0.8\ V$

$C_6H_{12}O_6 + H_2O \longrightarrow C_6H_{12}O_7$ (Gluconic acid) $+ 2H^{+} + 2e^{-}$ ; $E^{0}_{red} = -\ 0.05\ V$

$Ag(NH_3)_2^{+} + e^{-} \longrightarrow Ag(s) + 2NH_3 \qquad ; \quad E^{0} = -\ 0.337\ V$

[Use $2.303\,\dfrac{RT}{F} = 0.0592$ and $\dfrac{F}{RT} = 38.92$ at 298 K] **[JEE 2006]**

28. $2Ag^{+} + C_6H_{12}O_6 + H_2O \longrightarrow 2Ag(s) + C_6H_{12}O_7 + 2H^{+}$

Find ln K of this reaction

(A) 66.13 (B) 58.38 (C) 28.30 (D) 46.29

29. When ammonia is added to the solution, pH is raised to 11. Which half-cell reaction is affected by pH and by how much?

(A) $E_{oxd}$ will increase by a factor of 0.65 from $E^{0}_{oxd}$

(B) $E_{oxd}$ will decrease by a factor of 0.65 from $E^{0}_{oxd}$

(C) $E_{red}$ will increase by a factor of 0.65 from $E^{0}_{red}$

(D) $E_{red}$ will decrease by a factor of 0.65 from $E^{0}_{red}$

30. Ammonia is always is added in this reaction. Which of the following must be incorrect?

(A) $NH_3$ combines with $Ag^{+}$ to form a complex.

(B) $Ag(NH_3)_2^{+}$ is a weaker oxidising reagent than $Ag^{+}$.

(C) In absence of $NH_3$ silver salt of gluconic acid is formed.

(D) $NH_3$ has affected the standard reduction potential of glucose/gluconic acid electrode.

### *Paragraph for Question Nos. 31 to 33 (3 questions)*

Chemical reactions involve interaction of atoms and molecules. A large number of atoms/molecules (approximately 6.023  $10^{23}$) are present in a few grams of any chemical compound varying with their atomic/molecular masses. To handle such large numbers conveniently, the mole concept was introduced. This concept has implications in diverse areas such as analytical chemistry, biochemistry, electrochemistry and radiochemistry. The following example illustrates a typical case, involving chemical/ electrochemical reaction, which requires a clear understanding of the mole concept.

A 4.0 molar aqueous solution of NaCl is prepared and 500 mL of this solution is electrolysed. This leads to the evolution of chlorine gas at one of the electrodes (atomic mass : Na = 23, Hg = 200; 1 Faraday = 96500 coulombs) **[JEE 2007]**

**31.** The total number of moles of chlorine gas evolved is

(A) 0.5 (B) 1.0 (C) 2.0 (D) 3.0

**32.** If the cathode is a Hg electrode, the maximum weight (g) of amalgam formed from this solution is

(A) 200 (B) 225 (C) 400 (D) 446

**33.** The total charge (coulombs) required for complete electrolysis is

(A) 24125 (B) 48250 (C) 96500 (D) 193000

### *Paragraph for Question Nos. 34 & 35 (2 questions)*

Redox reactions play a pivoted role in chemistry and biology. The values of standard redox potential (E ) of two half-cell reactions decide which way the reaction is expected to proceed. A simple example is a Daniel cell in which zinc goes into solution and copper gets deposited. Given below are a set of half-cell reactions (acidic medium) along with their E  (V with respect to normal hydrogen electrode) values. Using this data obtain the correct explanations to Questions 14-16.

$I_2 + 2e^- \rightarrow 2I^-$ E  = 0.54

$Cl_2 + 2e^- \rightarrow 2Cl^-$ E  = 1.36

$Mn^{3+} + e^- \rightarrow Mn^{2+}$ E  = 1.50

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ E  = 0.77

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ E  = 1.23 **[JEE 2007]**

**34.** Among the following, identify the correct statement.

(A) Chloride ion is oxidised by $O_2$ (B) $Fe^{2+}$ is oxidised by iodine

(C) Iodine ion is oxidised by chlorine (D) $Mn^{2+}$ is oxidised by chlorine

**35.** While $Fe^{3+}$ is stable, $Mn^{3+}$ is not stable in acid solution because

(A) $O_2$ oxidises $Mn^{2+}$ to $Mn^{3+}$ (B) $O_2$ oxidises both $Mn^{2+}$ to $Mn^{3+}$ and $Fe^{2+}$ to $Fe^{3+}$

(C) $Fe^{3+}$ oxidises $H_2O$ to $O_2$ (D) $Mn^{3+}$ oxidises $H_2O$ to $O_2$

**36.** Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01 mol of $H_2$ gas at the cathode is (1 Faraday = 96500 C $mol^{-1}$)

(A) 9.65  $10^4$ sec (B) 19.3  $10^4$ sec

(C) 28.95  $10^4$ sec (D) 38.6  $10^4$ sec **[JEE 2008]**

**37.** For the reaction of $NO_3$ ion in an aqueous solution, E  is +0.96 V. Values of E  for some metal ions are given below

$V^{2+}$ (aq) + 2e  → V E  = – 1.19 V

$Fe^{3+}$ (aq) + 3e  → Fe E  = – 0.04 V

$Au^{3+}$ (aq) + 3$e$ $\rightarrow$ Au E = + 1.40 V

$Hg^{2+}$ (aq) + 2$e$ $\rightarrow$ Hg E = + 0.86 V

The pair(s) of metal that is(are) oxidised by $NO_3$ in aqueous solution is(are) **[JEE 2009]**

(A) V and Hg (B) Hg and Fe (C) Fe and Au (D) Fe and V

## Paragraph for Questions 38 to 39

The concentration of potassium ions inside a biological cell is at least twenty times higher than the outside. The resulting potential difference across the cell is important in several processes such as transmission of nerve impulses and maintaining the ion balance. A simple model for such a concentration cell involving a metal M is : **[JEE 2010]**

M(s) | $M^+$(aq ; 0.05 molar) || $M^+$(aq ; 1 molar) | M(s)

For the above electrolytic cell the magnitude of the cell potential $|E_{cell}|$ = 70 mV.

**38.** For the above cell :-

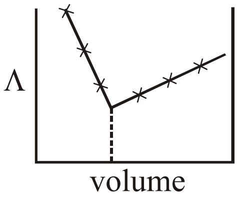
(A) $E_{cell} < 0$ ; $\Delta G > 0$ (B) $E_{cell} > 0$ ; $\Delta G < 0$

(C) $E_{cell} < 0$ ; $\Delta G^0 > 0$ (D) $E_{cell} > 0$ ; $\Delta G^0 < 0$

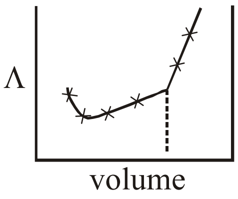
**39.** If the 0.05 molar solution of $M^+$ is replaced by a 0.0025 molar $M^+$ solution, then the magnitude of the cell potential would be :-

(A) 35 mV (B) 70 mV (C) 140 mV (D) 700 mV

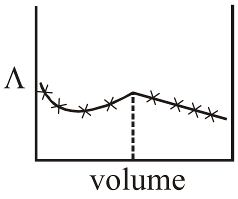
**40.** $AgNO_3$ (aq.) was added to an aqueous KCl solution gradually and the conductivity of the solution was measured. the plot of conductance ($\Lambda$) versus the volume of $AgNO_3$ is - **[JEE 2011]**



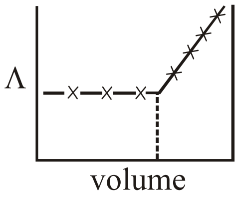
(P)



(Q)



(R)



(S)

(A) (P) (B) (Q) (C) (R) (D) (S)

**41.** Consider the following cell reaction : **[JEE 2011]**

$2Fe_{(s)}+O_{2(g)}+4H^+_{(aq)} \rightarrow 2Fe^{2+}_{(aq.)}+2H_2O(\ell)$ E = 1.67 V

At$[Fe^{2+}] = 10^{-3}$ M, $P(O_2)$ = 0.1 atm and pH = 3, the cell potential at 25 C is -

(A) 1.47 V (B) 1.77 V (C) 1.87 V (D) 1.57 V

## Paragraph for Question 42 & 43

The electrochemical cell shown below is a concentration cell. **[JEE 2012]**

M | $M^{2+}$ (saturated solution of a sparingly soluble salt, $MX_2$) | | $M^{2+}$ (0.001 mol $dm^{-3}$) | M

The emf of the cell depends on the difference in concentrations of $M^{2+}$ ions at the two electrodes. The emf of the cell at 298 K is 0.059V.

**42.** The value of $\Delta G$ (kJ $mol^{-1}$) for the given cell is (take If = 96500 C $mol^{-1}$)

(A) –5.7 (B) 5.7 (C) 11.4 (D) –11.4.

**43.** The solubility product ($K_{sp}$ ; $mol^3\ dm^{-9}$) of $MX_2$ at 298 K based on the information available for the given concentration cell is (take 2.303 R 298/F = 0.059 V)

(A) 1 $10^{-15}$ (B) 4 $10^{-15}$ (C) 1 $10^{-12}$ (D) 1 $10^{-12}$

## JEE-[MAIN] : PREVIOUS YEAR QUESTIONS ANSWER KEY EXERCISE -5[B]

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | C | B | A | A | B | C | B | C | A | C | B | B | B | A | D |

**16.** $\eta$ = 94.8% ; Cathode : $2H^+ + 2e^- \rightarrow H_2$, Anode : $Mn^{2+} \rightarrow Mn^{4+} + 2e-$

**17.** $W_{Ag}$ = 272.2 g, area = 1.02 $10^4\ cm^2$ **18.** $K_c$ = 7.6 $10^{12}$ **19.** $K_C$ = 6.26 $10^7$

**20.** $K_{sp}$ = 2.287 $10^{-12}\ M^{-3}$ **21.** 7.95 $10^{-5}$ M **22.** decrease with time

**23.** $\Delta H^0$ = –49987 J $mol^{-1}$, $\Delta S^0$ = – 96.5 J $mol^{-1}\ K^{-1}$, s = 1.47 $10^{-5}$ M **24.** 0.05

**25.** $K_C$ = $10^{10}$

**26.** (a) $E^0$ = 0.59 V, $\log_{10}K_{SP}$ = – 10 **27.** 55 S $m^{-1}$

(b) 52.8, $10^{-6}$ moles

**28.** A **29.** A **30.** D **31.** B **32.** D

**33.** D **34.** C **35.** D **36.** B **37.** A,B,D **38.** B

**39.** C **40.** D **41.** D **42.** D **43.** B