ASSIGNMENTS

OBJECTIVE QUESTIONS

LEVEL – I

Q.1 For the cell, Zn(s) $|Zn^{2+}||$ $Cu^{2+}|$ Cu(s), the standard cell voltage, E^0_{cell} is 1.10 V. When a cell using these reagents was prepared in the lab, the measured cell voltage was 0.98 V. One possible explanation for the observed voltage is :

(A) there were 2.00 mole of Cu^{2+} but only 1.00 mol of Zn^{2+}

(B) the Zn electrode had twice the surface of the Cu electrode

(C) the $[Zn^{2+}]$ was larger than the $[Cu^{2+}]$

(D) the volume of the Zn^{2+} solution was larger than the volume of the Cu^{2+} solution.

Q.2 Number of electrons lost during electrolysis of 0.355 g of Cl^- is :

(A) 0.01 (B) 0.01 N_0 (C) 0.02 N_0 (D) $\frac{0.01}{2N_0}$

Q.3 1 mol of electrons passes through each of the solution of $AgNO_3$, $CuSO_4$ and $AlCl_3$ when Ag, Cu and Al are deposited . Their molar ratio will be :

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

Q.4 Assume that during electrolysis of $AgNO_3$, only H_2O is electrolysed and O_2 is formed as :

$$2H_2O \longrightarrow 4H^+ + O_2 + 4e^-$$

O_2 formed at NTP due to passage of 2 amperes of current for 965 s is :

(A) 0.112 L (B) 0.224 L (C) 11.2 L (D) 22.4 L

Q.5 A conducting wire carries a current of 0.965 ampere. Rate of flow of electrons per second at a given point is :

(A) 1×10^{-5} N_0 (B) N_0 (C) 0.965 N_0 (D) $\frac{N_0}{0.965}$

Q.6 A quantity of electrical charge that brings about the deposition of 4.5 g Al from Al^{3+} at the cathode will also produce the following volume (STP) of $H_2(g)$ from H^+ at the cathode :

(A) 44.8 L (B) 22.4 L (C) 11.2 L (D) 5.6 L

Q.7 Consider the given data :

	Half cell reaction	E^o
1.	$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1.33 V
2.	$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0.74 V
3.	$Cu^+ + e^- \rightleftharpoons Cu$	+ 0.52 V
4.	$Cu^{2+} + 2e^- \rightleftharpoons Cu$	0.34 V

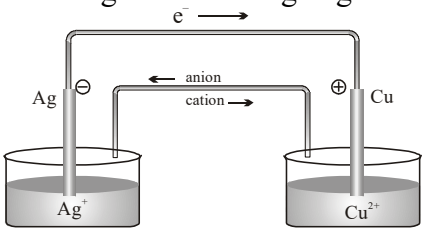
E^o for the reaction , $2Cr(s) + 3Cu^{2+}(aq) \rightleftharpoons 2Cr^{3+} + 3Cu$ is :

(A) – 1.08 V (B) – 0.70 V (C) 1.08 V (D) 2.50 V

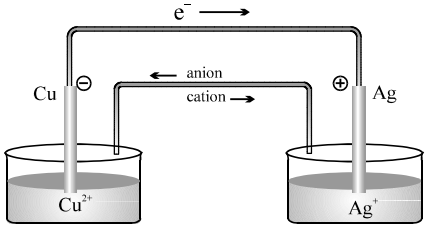
Q.8 For a cell reaction , $2Ag^+ + Cu \longrightarrow Cu^{+2} + 2Ag$

schematic diagram indicating migration of cation, anion and electrons is :

(A)



(B)



(C) both (A) and (B) (D) none of these

Q.9 Consider the following equations for a cell reaction

$A + B \rightleftharpoons C + D$ $\quad E^o = x$ volt, $K_{eq} = K_1$

$2A + 2B \rightleftharpoons 2C + 2D$ $\quad E^o = y$ volt, $K_{eq} = K_2$ then :

(A) $x = y, K_1 = K_2$ (B) $x = 2y, K_1 = 2K_2$ (C) $x = y, K_1^2 = K_2$ (D) $x^2 = y, K_1^2 = K_2$

Q.10 For the cell $Hg \mid Hg_2Cl_2 \mid Cl^-$ (0.1 M) $\| Cl^-$(0.01 M) $\mid Pt(Cl_2)$, E° is 1.10 V . Hence , E is :

(A) 1.1591 V (B) – 1.1591 V (C) 1.0409 V (D) – 1.0409 V

Q.11 When has maximum potential for the half-cell reaction ?

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

(A) 1.0 M HCl (B) a solution having pH4 (C) pure water (D) 1.0 M NaOH

Q.12 For the half-cell given below ,

$Pt(H_2)$ (1 atm) $\mid$ pH = 2 , cell potential is :

(A) 0.0591 V (B) 0.0295 V (C) 0.1182 V (D) 0.00 V

Q.13 For the cell prepared from electrode A and B ;

Electrode A : $Cr_2O_7^{2-} \mid Cr^{3+}$, $E^o_{red} = + 1.33$ V and electrode B ; $Fe^{3+} \mid Fe^{2+}$, $E^o_{red} = 0.77$ V.

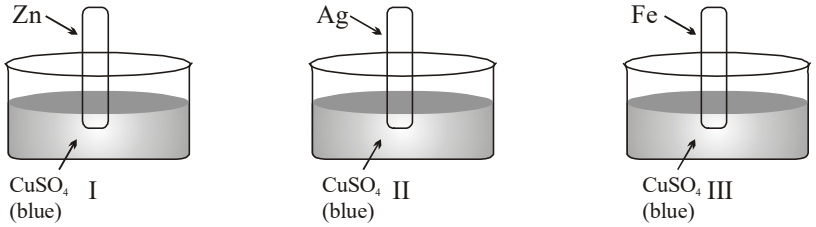
Which of the following statements are correct ?

(A) the electrons will flow from B to A when connection are made

(B) the emf of the cell will be 0.56 V

(C) A will be positive electrode (D) none of these

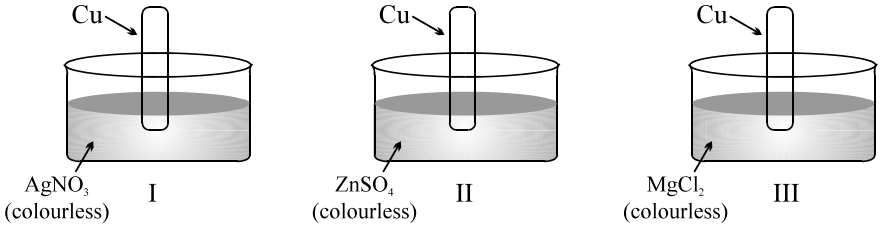
Q.14 Consider following sets



Blue colour solutions changes to colourless (or fades) in :

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

Q.15 Consider following sets



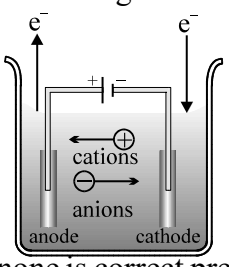
Colourless solution changes to blue coloured solution in :

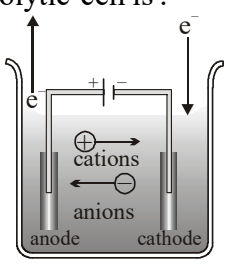
(A) I (B) II (C) III (D) I, III

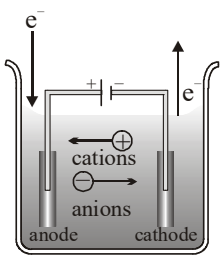
Q.16 When a dilute aqueous Li_2SO_4 solution is electrolysed , the products formed at the anode and cathode , respectively, are :

(A) S and Li (B) O_2 and Li (C) SO_2 and H_2 (D) O_2 and H_2

Q.17 Schematic diagram of an electrolytic-cell is :

(A) 

(B) 

(C) 

(D) none is correct presentation

LEVEL – II

Q.1 If $E^{o}_{Fe2+/Fe}$ is x_1, $E^{o}_{Fe3+/Fe}$ is x_2, then $E^{o}_{Fe3+/Fe2+}$ will be :
(A) $3x_2 - 2x_1$ (B) $x_2 - x_1$ (C) $x_2 + x_1$ (D) $2x_1 + 3x_2$

Q.2 $\Delta G = \Delta H - T\Delta S$ and $\Delta G = \Delta H + T\left[\frac{d(\Delta G)}{dT}\right]_p$ then $\left(\frac{dE_{cell}}{dT}\right)$ is :

(A) $\frac{\Delta S}{nF}$ (B) $\frac{nE}{\Delta S}$ (C) $-nFE_{cell}$ (D) $+nFE_{cell}$

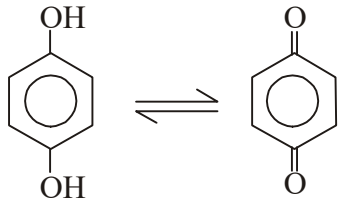
Q.3 $Zn + Cu^{2+}(aq) \rightleftharpoons Cu + Zn^{2+}(aq)$

Reaction quotient is $Q = \frac{[Zn^{2+}]}{[Cu^{2+}]}$. Variation of E_{cell} with log Q is of the type with OA = 1.10 V. E_{cell} will be 1.159 V when :

(A) $\frac{[Cu^{2+}]}{[Zn^{2+}]} = 0.01$ (B) $\frac{[Zn^{2+}]}{[Cu^{2+}]} = 0.01$ (C) $\frac{[Zn^{2+}]}{[Cu^{2+}]} = 0.1$ (D) $\frac{[Zn^{2+}]}{[Cu^{2+}]} = 1$

Q.4 $Cu^{2+} + 2e \longrightarrow Cu$. For this graph between log (Cu^{2+}) versus E_{red} is a straight line of intercept 0.34 V then electrode potential of the half-cell Cu/Cu^{2+} (0.1 M) will be :

(A) $0.34 + \frac{0.0591}{2}$ (B) $-0.34 - \frac{0.0591}{2}$ (C) 0.34 (D) $-0.34 + \frac{0.0591}{2}$

Q.5 For the half cell ,  $+ 2H^{+} + 2e^{-}$. $E^{0} = 1.30$ V

At pH = 2 , electrode potential is :
(A) 1.36V (B) 1.30 V (C) 1.42 V (D) 1.20 V

Q.6 In acidic medium MnO_4^- is an oxidising agent . $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$. If H^+ ion concentration is doubled, electrode potential of the half-cell $MnO_4^-, Mn^{2+}/Pt$ will :
(A) increase by 28.46 mV (B) decrease by 28.46 mV
(C) increase by 142.3 mV (D) decrease by 142.30 mV

Q.7 100 mL of a buffer of 1 M NH_3(aq) and 1 M NH_4^+ (aq) are placed in two voltaic cells separately . A current of 1.5 A is passed through both cells for 20 minutes . If electrolysis of water only takes place

$2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ (RHS)

$2H_2O \longrightarrow 4H^+ + O_2 + 4e^-$ (LHS)

then pH of the :
(A) LHS half cell will increase (B) RHS half-cell will increase
(C) both half-cells will increase (D) both half-cells will decrease

Q.8 1 g equivalent of Na metal is formed from electrolysis of fused NaCl. Number of mol of Al from fused Na_3AlF_6 will be :
(A) 1 (B) 3 (C) 1/3 (D) 2

Q.9 Electrode potentials of the given half-cells :

$Pt(H_2) \mid H^+ (C_1)$; $Pt(Cl_2) \mid Cl^- (C_2)$; $Ag \mid Ag^+(C_3)$

p_1 p_2

(I) (II) (III)

(A) will increase on increasing C_1, C_2 & C_3 (B) will decrease on increasing C_1, C_2 & C_3

(C) both (A) and (B) (D) none of these

Q.10 In the following electrochemical cell : $\underset{(-)}{Zn} \mid Zn^{+2} \parallel \underset{(+)}{H^+} \mid Pt(H_2)$; $E^o_{cell} = E_{cell}$.

This will be when :

(A) $[Zn^{2+}] = [H^+] = 1M$ and $p_{H2} = 1atm$

(B) $[Zn^{2+}] = 0.01$ M, $[H^+] = 0.1$ M and $p_{H2} = 1atm$

(C) $[Zn^{2+}] = 1$ M, $[H^+] = 0.1$ M and $p_{H2} = 0.01$ atm

(D) all of the above

Q.11 If the Pb^{2+} concentration is maintained at 1.0 M, what is the $[Cu^{2+}]$ when the cell potential drops to zero ? $E^o_{cell} = 0.473$ V , $Pb \mid Pb^{2+}$ (1.0 M) $\parallel Cu^{2+}$ (1.0×10^{-4} M) $\mid Cu(s)$

(A) 1×10^{-16} M (B) 1×10^{16}M (C) 1.0×10^{-14} M (D) 1.0×10^{14} M

Q.12 $Pt(H_2) \mid 0.01M\ H^+ \parallel 0.1M\ H^+ \mid Pt(H_2)$. If $E_{cell} = 0.00$ V , than $\frac{x}{y}$ is :

x atm y atm

(A) 100 (B) 10 (C) 0.01 (D) 0.1

Q.13 For the half-cell given , $Pt(H_2) \mid pH = 2$, cell potential is :

1 atm

(A) 0.0591 V (B) 0.0295 V (C) 0.1182 V (D) 0.00 V

Q.14 For the cell prepared from electrode A and B ;

Electrode A : $Cr_2O_7^{2-} \mid Cr^{3+}$, $E^o_{red} = +1.33$ V and electrode B ; $Fe^{3+} \mid Fe^{2+}$, $E^o_{red} = 0.77$ V.

Which of the following statements are correct ?

(A) the electrons will flow from B to A when connection are made

(B) the emf of the cell will be 0.56 V

(C) A will be positive electrode (D) none of these

Q.15 During discharging of lead-storage acid battery following reaction takes place :

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

If 2.5 amp of current is drawn for 965 minutes, H_2SO_4 consumed is :

(A) 0.75 mol (B) 3.00 mol (C) 1.50 mol (D) 4.50 mol

Q.16 Following behaves as S.H.E. at a pressure $Pt, H_2 \mid H_2O$:

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

LEVEL – III

Q.1 Which of the following statements is correct for ionic mobility ?
(A) It depends upon the voltage across the electrodes
(B) Lower the voltage, higher is the velocity.
(C) Ionic velocity per unit electric field strength is constant.
(D) All of these

Q.2 Which of the following units is correctly matched ?
(A) SI unit of conductivity (k) $\longrightarrow$ siemens per meter (Sm^{-1})
(B) SI units of molar conductivity $\rightarrow$ siemens squared per mol ($S\ m^2\ mol^{-1}$)
(C) SI unit of ionic mobility $\longrightarrow$ $m\ V^{-1}S^{-1}$
(D) All of these

Q.3 According to Grotthuss model :
(A) there is no coordinated motion of a proton along a chain of water molecules.
(B) there is a rapid hoping between neighbouring sites of water molecules.
(C) the system $H^+(H_2O)_4$ has low activation energy
(D) none of these

Q.4 Oxygen and hydrogen gas are produced at the anode and cathode during the electrolysis of dilute aqueous solutions of :
(A) Na_2SO_4 (B) $AgNO_3$ (C) H_2SO_4 (D) NaOH

Q.5 Which of the following statements are correct ?
(A) The electrolysis of aqueous NaCl produces hydrogen gas at the cathode and chlorine gas at the anode.
(B) The electrolysis of a dilute solution of sodium fluoride produces oxygen gas at the anode and O_2 gas at the cathode.
(C) The electrolysis of concentrated sulphuric acid produces SO_2 gas at the anode and O_2 gas at the cathode.
(D) After the electrolysis of aqueous sodium sulphate, the solution becomes acidic.

Q.6 Which of the following cell reactions correctly represent the electrolysis of water ?
(A) $2H^+ + 2e \longrightarrow H_2(g)$ (B) $2H_2O + 2e \longrightarrow H_2(g) + 2(OH^-)$
(C) $4(OH^-) \longrightarrow 2H_2O + O_2(g) + 4e$ (D) $2H_2O \longrightarrow O2(g) + 4H^+ + 4e$

Q.7 Which of the following statements are correct ?
(A) The electrolysis of concentrated H_2SO_4 at 0–5ºC using a Pt electrode produces $H_2S_2O_8$.
(B) The electrolysis of a brine solution produces $NaClO_3$ and NaClO.
(C) The electrolysis of a $CuSO_4$ solution using Pt electrodes causes the liberation of O_2 at the anode and the deposition of copper at the cathode
(D) All electrolytic reactions are redox reactions.

Q.8 How much charge must be supplied to a cell for the electrolytic production of 245 g $NaClO_4$ from $NaClO_3$? Because of a side reaction, the anode efficiency for the desired reaction is 60 % ?
(A) 6.43×10^5 C (B) 6.67 F (C) 6.43×106C (D) 66.67 F

Q.9 In an electrochemical process , a slat bridge is used :
(A) to maintain electroneutrality in each solution
(B) to complete the circuit so that current can flow
(C) as an oxidizing agent
(D) as a colour indicator

Q.10 Consider the cell :

$Cd(s) \mid Cd^{2+}(1.0M) \parallel Cu^{2+}(1.0M) \mid Cu(s)$

If we wish to make a cell with a more positive voltage using the same substances, we should

(A) increase $[Cd^{2+}]$ as well as $[Cu^{2+}]$ to 2.0 M (B) reduce only $[Cd^{2+}]$ to 0.1 M

(C) decrease $[Cd^{2+}]$ as well as $[Cu^{2+}]$ to 0.1 M (D) increase only $[Cu^{2+}]$ to 2.0 M

Q.11 A concentration cell is a galvanic cell in which :

(A) the electrode material and the solutions in both half-cells are composed of the same substances

(B) only the concentrations of the two solutions differ

(C) $\Delta E^0_{cell} = 0$

(D) the Nernst equation reduces to $\Delta E_{cell} = -\left(\frac{0.0592}{n}\right) \log Q$ at 25ºC

Q.12 Which of the following statements are correct ?

(A) A reaction is spontaneous from left to right if $K_{eq} > Q$, in which case $\Delta E_{cell} > 0$.

(B) A reaction occurs from right to left if $K_{eq} < Q$, in which case $\Delta E_{cell} < 0$.

(C) If the system is at equilibrium, no net reaction occurs.

(D) ΔE_{cell} is temperature-independent.

Q.13 Which of the following are concentration cells ?

(A) $\underset{p_1}{PtH_2\ g} \mid \underset{(m)}{HCl} \mid \underset{p_2}{H_2(g)}, Pt$ (B) $\underset{a_1}{Cd,(Hg)} \mid \underset{(m)}{Cd^{2+}} \mid \underset{a_2}{(Hg)}, Cd$

(C) $Zn(s) \mid \underset{m_1}{Zn^{2+}} \parallel \underset{m_2}{Cu^{2+}} \mid Cu$ (D) $Ag(s), AgCl(s) \mid \underset{m}{HCl} \parallel \underset{m}{HCl} \mid AgCl(s), Ag(s)$

Q.14 $Pb(s) \mid \underset{\text{saturated solution}}{PbSO_4} \mid \underset{\text{saturated solution}}{PbI_2} \mid Pb(s)$

Which of the following expressions represent the emf of the above cell at 25 ºC ?

(A) $E = \frac{0.0592}{2} \log \frac{(a_{pb^{2+}})_2}{(a_{pb^{2+}})_1}$ (B) $E = \frac{0.0592}{2} \log \frac{(a_{pb^{2+}})_1}{(a_{pb^{2+}})_2}$

(C) $E = \frac{0.0592}{2} \log \frac{[K_{sp}(PbI_2)]^{1/3}}{[K_{sp}(PbSO_4)]^{1/2}}$ (D) $E = \frac{0.0592}{2} \log \frac{K_{sp}(PbI_2)}{K_{sp}(PbSO_4)}$

Q.15 Which of the following represent electrodes of the second king ?

(A) $Ag(s) \mid AgCl(s), Cl^-$ (B) $Cu(s) \mid CuSO_4(aq), SO_4^{2-}$

(C) $Hg(1) \mid Hg_2Cl_2(s), Cl^-$ (D) $Pb(s) + PbSO_4(s), SO_4^{2-}$

LEVEL – IV

Q.1 Match the following :

	Column I		**Column II**
(i)	Faraday's first law	(a)	96500 C
(ii)	One Faraday	(b)	$w = Z \times I \times t$
(iii)	Cell constant	(c)	$\frac{1}{\text{Resistance}}$
(iv)	Conductivity	(d)	$\frac{K \times 1000}{C}$
(v)	Molar conductivity	(e)	l/A

(A) i-a, ii-b, iii-c, iv-e, v-d (B) i-b, ii-a, iii-e, iv-c, v-d
(C) i-a, ii-b, iii-e, iv-d, v-c (D) i-b, ii-a, iii-d, iv-c, v-e

Q.2 Match the following :

	Column I		**Column II**
(i)	Cell constant	(a)	Ω cm
(ii)	λ_m	(b)	cm^{-1}
(iii)	λ_{eq}	(c)	$S\ cm^{-1}$
(iv)	k	(d)	$S\ cm^2\ mol^{-1}$
(v)	ρ	(e)	$S\ m^2\ eq^{-1}$

(A) i-b, ii-d, iii-e, iv-c, v-a (B) i-a, ii-d, iii-c, iv-e, v-b
(C) i-d, ii-b, iii-a, iv-c, v-e (D) i-b, ii-d, iii-a, iv-e, v-c

Q.3 Match the following :

	Column I				**Column II**	
	Electrolyte	Anode	Cathode		Product at cathode	at anode
(i)	Aq $CuCl_2$	Pt	Pt	(a)	Cu(s)	Cu^{++}
(ii)	Aq $CuCl_2$	Cu	Cu	(b)	Cu(s)	$Cl_2(g)$
(iii)	Aq $CuCl_2$	Cu	Ag	(c)	Cu(s)	Cu^{++}
(iv)	Aq $CuCl_2$	Ag	Cu	(d)	Cu(s)	Ag^{++}

(A) i-b, ii-d, iii-a, iv-a (B) i-a, ii-b, iii-a, iv-d
(C) i-a, ii-b, iii-a, iv-d (D) i-b, ii-a, iii-a, iv-d

Q.4 Match the following :

	Column I **Electrode**		**Column II** **Type**
(i)	Pt, H_2(1 atm) | H^+ (1M)	(a)	Secondary refrence electrode
(ii)	$Zn(s) \mid Zn^{2+} \parallel Cu^{2+} \mid Cu(s)$	(b)	Primary reference electrode
(iii)	Calomel electrode	(c)	NHE
(iv)	$Ag \mid AgCl \mid Cl^-$ (1M)	(d)	Denial cell

(A) i-bc, ii-d, iii-a, iv-a (B) i-bc, ii-a, iii-d, iv-a
(C) i-ac, ii-d, iii-b, iv-a (D) i-bc, ii-d, iii-a, iv-b

Q.5 Match the following :

	Column I		**Column II**
(i)	Salt bridge	(a)	$+ \Delta G$
(ii)	nFE	(b)	Diffusion in ions
(iii)	Corrosion	(c)	$-\Delta G$
(iv)	$Cu(s) \mid Cu^{++} \parallel Zn^{++} \mid Zn(s)$	(d)	$Fe_2O_3 \times .H_2O$

(A) i-d, ii-c, iii-b, iv-a
(B) i-c, ii-b, iii-a, iv-d
(C) i-b, ii-c, iii-d, iv-a
(D) i-a, ii-c, iii-d, iv-b

Q.6 Match the following :

	Column I		**Column II**
(i)	Loss of electron	(a)	Cathode to anode
(ii)	Gain of electron	(b)	Anode to cathode
(iii)	Flow of current	(c)	Cathode
(iv)	Flow of electron	(d)	Anode

(A) i-c, ii-c, iii-a, iv-d
(B) i-a, ii-c, iii-d, iv-c
(C) i-d, ii-c, iii-a, iv-c
(D) i-c, ii-a, iii-d, iv-c

SUBJECTIVE QUESTIONS

LEVEL – I

Q.1 Potassium chlorate is prepared by electrolysis of KCl in basic solution,

$$6OH^- + Cl^- \longrightarrow ClO_3^- + 3H_2O + 6e^-$$

If only 60 % of the current is utilised in the reaction, what time will be required to produce 10 g of $KClO_3$ using a current of 2 amp ?

Q.2 After electrolysis of a sodium chloride (NaCl) solution with inert electrodes for a certain period of time, 600 ml of the solution was left which was found to be 1 N in sodium hydroxide. During the same time 31.8 g of Cu was deposited in a Cu voltameter in series with the electrolytic cell. Calculate the percentage of theoretical yield of the sodium hydroxide obtained.

Q.3 A spoon used as a cathode is dipped in $AgNO_3$ solution and a current of 0.2 amp is passed for one hour. Calculate :

(a) How much silver plating has occurred ?

(b) How many electrons were involved in the process ?

(c) What amount of copper would have been plated under similar conditions ?

Q.4 A steady current passing through a solution of $AgNO_3$ solution deposits 0.50 g of Ag in 1 hr. Calculate the number of coulomb. What volume of hydrogen at 27°C and 750 mm pressure would the same current liberates in one hour ?

Q.5 In an electrolysis experiment, current was passed for 5 hours through two cells connected in series. The first cell contains a solution of gold and second contains $CuSO_4$ solution. 9.85 g of gold was deposited in the first cell. If the oxidation number of gold is +3, find the amount of Cu deposited on the cathode of second cell. Also calculate the magnitude of the current in ampere.

Q.6 Electric current is passed through two cells 'A' and 'B' in series. Cell 'A' contains an aqueous solution of Ag_2SO_4 and platinum electrodes. The cell 'B' contains aqueous solution of $CuSO_4$ and Cu electrodes. The current is passed till 1.6 g of oxygen is liberated at the anode of cell 'A'.

(i) Give equations for the reaction taking place at each electrode.

(ii) Calculate the quantities of substances deposited at the cathodes of the two cells.

Q.7 Anthrancene can be oxidised anodically to anthraquinone. What weight of anthraquinone can be produced by the passage of a current of 1 amp for 60 minutes if the current efficiency is 100 % ?

Q.8 Calculate the e.m.f. of the cell at 25°C.

$$Pt\ (H_2)\ (1\ atm)\ |\ HCl\ (pH\ 2.95)\ ||\ HCl\ (pH\ 1.47)\ |\ Pt(H_2)\ (1\ atm)$$

Q.9 Calculate the reduction potential for the following half cells at 25°C

(i) $Mg \mid Mg^{2+}\ (1 \times 10^{-4}\ M)$ $\quad E^0_{Mg\mid Mg^{2+}} = +2.36$ V

(ii) $Cl_2 \mid Cl^-\ (2 \times 10^{-5}\ M)$ $\quad E^0_{Cl_2\mid Cl^-} = +1.36$ V

(iii) $Pt \mid Fe^{2+}\ (0.1\ M),\ Fe^{3+}\ (0.01\ M)$ $\quad E^0_{Fe^{+3}\mid Fe^{+2}} = +0.77$ V

Q.10 What is K_c for the following reaction at 25° C ?

$$Cu^{2+}(aq) + Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq) + Cu(s)$$

$E^0_{Cu^{+2}\mid Cu} = 0.34$ volt, $\quad E^0_{Sn^{+4}\mid Sn^2} = 0.15$ volt

LEVEL – II

Q.1 Under standard conditions for all concentrations, the following reaction is spontaneous at 25 °C , $O_2(g) + 4H^+(aq) + 4Br^-(aq) \longrightarrow 2H_2O(l) + 2Br_2(l)$

(a) If $[H^+]$ is decreased so that the pH = 3.60, what value will E_{cell} have and will the reaction be spontaneous at this $[H^+]$?

(b) If $[H^+]$ is adjusted by adding a buffer of 0.10 M NaCNO and 0.10 M HCNO . $(K_a = 3.5 \times 10^{-4})$, what value will E_{cell} have and will the reaction be spontaneous at this $[H^+]$? $E^o_{cell} = 0.173$ V.

Q.2 The emf of the following cell is – 0.46 V

$Pt(H_2) \mid HSO_3^-(0.4\ M), SO_3^{2-}(6.4 \times 10^{-3}\ M) \parallel Zn^{2+}(0.3\ M) \mid Zn$

If $E^o_{Zn2+/Zn} = -0.76$ V . Calculate pK_a of HSO_3^-, i.e., for the equilibrium

$HSO_3^- \rightleftharpoons H^+ + SO_3^{2-}$

Q.3 At equimolar concentrations of Fe^{2+} and Fe^{3+}, what must $[Ag^+]$ be, so that the voltage of the galvanic cell made from Ag^+/Ag and Fe^{3+}/Fe^{2+} electrodes equals zero .

The reaction is : $Fe^{2+} + Ag^+ \rightleftharpoons Fe^{3+} + Ag$. Determine the equilibrium constant at 25°C for the reaction . [Given $E^o_{Ag+/Ag} = 0.799$ volt and $E^o_{Fe3+/Fe2+} = 0.771$ volt]

Q.4 The e.m.f. of the cell Ag | AgCl (s) | KCl solution | Hg_2Cl_2(s) | Hg is 0.0455 V at 298 K and the temperature co-efficient is 3.38×10^{-4} V K^{-1}. What is the reaction taking place in the cell and what are free energy , enthalpy and entropy changes at 298 K ?

Q.5 For the cell :

Pt | H_2(1 atm) | $CH_3COONa(10^{-3}\ M) \parallel NH_4Cl\ (0.01\ M) + NH_4OH\ (0.2\ M)$ | H_2 (1 atm) | Pt.

$K_a(CH_3COOH) = 1.8 \times 10^{-5}$, $K_b(NH_4OH) = 1.8 \times 10^{-5}$. In the anode neglect (H^+) from oxidation of H_2. Calculate the cell potential.

Q.6 Consider the cell :

$Pt \mid Cu^+(aq)\ (1M), Cu^{2+}(aq)\ (1M) \parallel Fe^{3+}(aq)\ (1M), Fe^{2+}(aq)\ (1M) \mid Pt.$

Given : $E^o(Fe^{3+}/Fe) = -0.036$ V, $E^o(Cu^+/Cu) = 0.521$ V

$E^o(Fe^{2+}/Fe) = -0.440$V, $E_{cell} = 0.618$ V

Calculate the equilibrium constant for the reacion , $Cu + Cu^{2+} \rightleftharpoons 2Cu^+$

Q.7 Calculate the minimum mass of NaOH required to be added in R.H.S. to consume all the H^+ present in R.H.S. of the cell of emf + 0.701 volt at 25 °C before its use . Also report the emf of the cell after addition of NaOH .

$Zn \mid Zn^{2+} \parallel HCl \mid Pt(H_2g)$; $E^o_{Zn/Zn2+} = 0.760$ V

0.1 M 1 litre 1 atm

Q.8 A constant current flowed for 2 hours through a potassium iodide solution oxidising the iodide ion to iodine $(2I^- \longrightarrow I_2 + 2e^-)$

At the end of the experiment, the iodine was titrated with 21.75 ml of 0.0831 M sodium thiosulphate solution . $(I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-})$

What was the average rate of current flow in ampere ?

Q.9 40 ml of 0.125 M of $NiSO_4$ solution is electrolysed by a current of 0.05 amp for 40 minutes.

(i) Write equation for the reactions occurring at each electrode.

(ii) How many coulomb of electricity passed through the solution

(iii) How many grams of the product deposited on the cathode ?

(iv) How long will the same current have to pass through the solution to remove completely the metal ions from the solution ?

(v) At the end of electrolysis how many grams of the product would appear at the anode ?

Q.10 An electric current is passed through a solution of (i) silver nitrate (ii) solution of 10 g of copper sulphate ($CuSO_4.5H_2O$) crystals in 500 ml of water, platinum electrodes being used in each case. After 30 minute it was found that 1.307 g of silver has been deposited. What was the concentration of copper, expressed as grams of copper per litre in the copper sulphate solution after electrolysis ?

OBJECTIVE QUESTIONS

LEVEL – I

1. C **2.** B **3.** B **4.** A **5.** A **6.** D **7.** C
8. B **9.** C **10.** B **11.** A **12.** C **13.** AC **14.** D
15. A **16.** D **17.** B

LEVEL – II

1. A **2.** A **3.** B **4.** D **5.** C **6.** A **7.** B
8. C **9.** D **10.** D **11.** A **12.** D **13.** C **14.** AC
15. C **16.** D

LEVEL – III

1. AC **2.** AB **3.** ABC **4.** ABCD **5.** AB **6.** BC
7. ABCD **8.** AB **9.** AB **10.** BC **11.** ABCD **12.** ABC
13. ABD **14.** AC **15.** ACD

LEVEL – III

1. B **2.** A **3.** D **4.** A **5.** C **6.** C

SUBJECTIVE QUESTIONS

LEVEL – I

1. 10.95 hours **2.** 60 % **3.** 0.805g , 4.5×10^{21} , 0.237 g

4. 446.7 coulomb, 57.7 ml **5.** 4.765g , 0.8037 amp

6. (i) In cell 'A' : $2H_2O \longrightarrow O_2(g) + 4H^+ + 4e$ at anode $Ag^+ + e \longrightarrow Ag$ at cathode
In cell 'B' : $Cu \longrightarrow Cu^{2+} + 2e$ at anode $Cu^{2+} + 2e \longrightarrow Cu$ at cathode
(ii) Ag = 21.6 g ; Cu = 6.35 g

7. 1.2932 g **8.** 0.0874 volt

9. (i) – 2.4782 V (ii) 1.6377 V (iii) 0.7109 V **10.** $K_c = 2.63 \times 10^6$

LEVEL–II

1. (a) – 0.04 volt (non spontaneous) (b) – 0.03 volt (non spontaneous)

2. $K_a = 7.36 \times 10^{-11}$, $pK_a = 7.13$ **3.** $[Ag^+] = 0.34$, K = 3.0

4. $\Delta G = -8780$ J , $\Delta H = 10650$ J , $\Delta S = 65.22$ J K^{-1} **5.** $E_{cell} = -0.158$ V

6. $K = 1.72 \times 10^6$ **7.** Mass of NaOH = 1.264 gm, 0.3759 volt

8. 0.0242 amp **9.** (ii) 120 (iii) 0.037 g (iv) 19300 s (v) 0.08 g

10. 4.32 g/litre