Chapter-4: Electrochemistry

Ques. ▶ 1 i. $E^0_{A^{2+}(aq)/A(s)} = 0.20$ Volt
ii. $E^0_{B^{2+}(aq)/B(s)} = -0.62$ Volt
iii. $E^0_{X^{2+}(aq)/X(s)} = -0.80$ Volt

[All Board-18]

a. What is Chiral Carbon? 1
b. Why $KMnO_4$ is a secondary standard substance? 2
c. Calculate the electromotive force of cell formed between (i) and (ii) half electrode. 3
d. Which metal container of A and X is suitable for storing B^{2+} solution? Give mathematical explanation. 4

Answer to the question no. 1

a The Carbon that is attached to four different atoms or group of atoms is called Chiral Carbon.

b The substances which are not readily available in pure and dry condition, react with air or slowly decompose by light, concentration of solution slowly changes are called secondary standard substance.

i. Concentration of $KMnO_4$ slowly change when kept even in air tight volumetric flask: $KMnO_4$ decomposes to MnO_2.
ii. In presence of sunlight, $KMnO_4$ oxidizes water to O_2.
iii. $KMnO_4$ dissociates in presence of living system.

From the above explanation we can say $KMnO_4$ is a secondary standard substance.

c The (i) and (ii) half cell in the stem are–

$E^0_{A^{2+}/A} = 0.20$ Volt

and, $E^0_{B^{2+}/B} = -0.62$ Volt

or, $E^0_{B/B^{2+}} = 0.62$ Volt

Here, the reduction potential of A is 0.20 Volt which is greater than readuction potential of B 0.62 V. We know, the half cell which has higher reduction potential acts as cathode and whcih has lower reductiion potential as anode. So, in this case (i) and (ii) electrode are cathode and anode respectively.

∴ Complete cell reaction,

Reduction (Cathode)

$$B + A^{2+} \longrightarrow B^{2+} + A$$

Oxidation (Anode)

Electromotive force of complete cell,

$E^0_{cell} = E^0_{cathode(red)} - E^0_{anode(red)}$

$E^0_{cell} = E^0_{anode(ox)} + E^0_{cathode(red)}$

$[E_{(oxi)} = -E_{(red)}]$ As oxidation and reduction potential is same but opposite sign]

$= E^0_{B/B^{2+}} + E^0_{A^{2+}/A}$
$= (0.62 + 0.20)$ Volt
$= 0.82$ Volt

∴ Electromotive force of cell is 0.82 Volt

d It should consider two factors to keep a solution in a container.

i. Container must be anode
ii. Reaction will not be spontaneous

The probable reaction when B^{2+} solution kept in A container.

$B^{2+} + A \longrightarrow B + A^{2+}$

Total e.m.f of cell,

$E^0_{cell} = E^0_{ox} + E^0_{red}$
$= E^0_{A/A^{2+}} + E^0_{B^{2+}/B}$
$= -0.20 + (-0.62)$
$= -0.82$ V

Given,
$E^0_{A/A^{2+}} = -0.20$V
$E^0_{B^{2+}/B} = -0.62$V

Again, if B^{2+} solution kept in X container,

$B^{2+} + X \longrightarrow B + X^{2+}$

Total e.m.f of cell in case of X container,

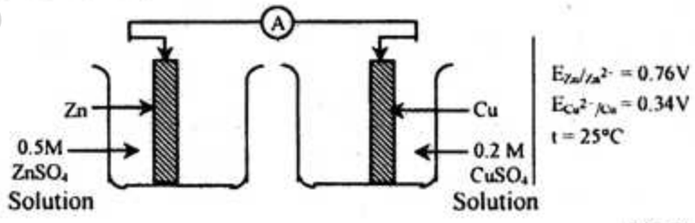
$E^0_{cell} = E^0_{ox} + E^0_{red}$
$= E^0_{X/X^{2+}} + E^0_{B^{2+}/B}$
$= 0.80 + (-0.62)$
$= 0.80 - 0.62$
$= 0.18$V

Here,
$E^0_{X/X^{2+}} = +0.80$V
$E^0_{B^{2+}/B} = -0.62$V

From the above explanation, as electromotive force is negative in A container, so reaction will not occur spontaneously. So B^{2+} solution can be kept in A container. On the other hand, electromotive force is positive in X container. So reaction will occur spontaneously.

So it is safe and rational to keep B^{2+} in A container.

Ques. ▶ 2



[D.B. 17]

a. What is reference electrode? 1
b. Why is annealing done in glass? 2
c. Calculate the electromotive force of cell in the stem. 3
d. Is there any limitation in producing large amount of electricity from the cell? Give your opinion. 4

Answer to the question no. 2

a The electrode of known potential by which the unknown potential of one electrode can be known is called reference electrode.

b Annealing is necessary for glass preparation. If annealing is not done in glass it can not withstand heat and break within sometimes.

Because without annealing glass can not withstand change of heat and stress. Annealing makes the glass smooth. So glass becomes heat and stress stable. So annealing is necessary for glass.

c In the stem, oxidation potential of zinc electrode is 0.76 V and reduction potential of Cu electrode is 0.34 V, that means oxidation potential is –0.34 V. So oxidation potential of zinc is greater than oxidation potential of Cu electrode. So zinc acts as anode and Cu acts as cathode.

Oxidation half reaction: $Zn(s) - 2e^- \rightarrow Zn^{2+}(aq)$

Reduction half reaction: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

The complete cell reaction is–

$$Zn(s) + Cu^{2+}(aq) \overset{2e^-}{\rightleftharpoons} Zn^{2+}(aq) + Cu(s)$$

Nernst equation of cell is–

$$E_{cell} = E^0_{cell} - \frac{2.303RT}{nF} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

$$= (E_{Zn/Zn^{2+}} + E_{Cu^{2+}/Cu}) - \frac{2.303 \times 8.314 \times 298}{2 \times 96500} \log \frac{(0.5)}{(0.25)}$$

$$= (0.76 + 0.34) - 8.89 \times 10^{-3}$$

$$= 1.09 \text{ V}$$

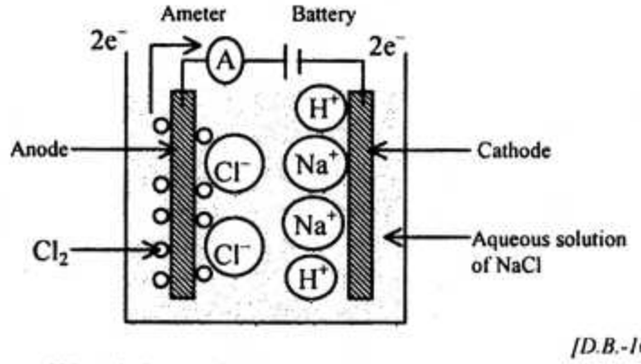
Here,
$E_{Zn/Zn^{2+}} = 0.76V$
$E_{Cu^{2+}/Cu} = 0.34V$
$R = 8.314 \text{ JK}^{-1}\text{mol}^{-1}$
$T = 298K$
$n = 2$
$F = 96500 \text{ C}$
$[Zn^{2+}] = 0.5 \text{ M}$
$[Cu^{2+}] = 0.2 \text{ M}$

∴ Electromotive force of the cell is 1.09 V

d As there is no salt bridge used in the electrochemical cell, so it is not possible to get continuous electric flow from this electrochemical cell.

In the stem, the oxidation potential of Zinc electrode is higher, so it will act as anode. Zinc will be oxidized and concentration of Zn^{2+} will increase. As a result weight of Zn plate will decrease. On the other hand, the reduction potential of Cu is higher, so it will act as cathode electrode and reduced to Cu. It will deposit Cu to Cu electrode. It will decrease the concentration of Cu^{2+} in solution. So concentration of SO_4^{2-} will increase in solution. Salt bridge provides sufficient ion to the anode and cathode solution which maintain electrical neutrality. As a result, the cell can produce electricity for long time. But there is no salt bridge in the stem cell. As a result Zn^{2+} concentration will increase at anode and Cu^{2+} concentration will decrease at cathode. It will hamper 'Redox' reaction. So electricity production will be stopped after sometime.

Ques. ▶3



[D.B.-16]

a. What is hexamine? 1
b. Why does $CHCl_3$ store in brown colored bottle? 2
c. If $CaCl_2$ was used in the experiment of the stem: what would have produced? Show using cell reactions. 3
d. Write the process by which the base is produced in the solution of the stem and explain the chemical reaction that occurred in the electrolytic cell. 4

Answer to the question no. 3

a Hexamine is hexamethelene tetraammine $(CH_2)_6N_4$. Which is a heterocyclic organic compound.

b $CHCl_3$ stores in brown colored bottle. Because in presence of sunlight chloroform oxidizes and produce toxic phosgene gas ($COCl_2$).

$$CHCl_3 + \frac{1}{2}O_2 \xrightarrow{\text{Sunlight}} \underset{\text{Phosgene gas}}{COCl_2} + HCl$$

Phosgene gas is harmful for health. So $CHCl_3$ stores in brown colored bottle.

c In aqueous solution $CaCl_2$ dissolves and produces Ca^{2+} and Cl^-. During electrolysis of aqueous solution H_2 will produce at cathode and Cl_2 will produce at anode.

$2H_2O(aq) + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$ [Reduction in cathode]

$2Cl^-(aq) \longrightarrow Cl_2(g) + 2e^-$ [Oxidation in anode]

$2H_2O(aq) + 2Cl^-(aq) \longrightarrow H_2(g) + Cl_2(g) + 2OH^-(aq)$

In this case, Ca^{2+} does not reduce to calcium. It acts as spectator ion.

From the value of reduction potential we see electrolysis of water should produce oxygen at anode. But Cl_2 is produced at anode because concentration of Cl^- is higher than OH^- in the solution.

d In the stem cell electrolysis of NaCl is shown. In aqueous solution NaCl, it ionizes to Na^+ and Cl^-. Water also ionizes to H^+ and OH^-

$$NaCl \longrightarrow Na^+ + Cl^-$$
$$H_2O \rightleftharpoons H^+ + OH^-$$

As reduction potential of H^+ is higher than Na^+, so H^+ reduced to $H_2(g)$ at cathode. On the other hand Cl^- oxidizes at anode to produce Cl_2 gas due to its high concentration.

Oxidation : $2Cl^- \longrightarrow Cl_2 + 2e^-$

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

In solution, Na^+ and OH^- will react to produce NaOH.

$Na^+ + OH^- \longrightarrow NaOH.$

In this case, oxidation occurs at anode and reduction occurs at cathode. So redox reaction occurs at electrolytic cell.

Ques. ▶4 The oxidation petential of some metal is given below :

(i) $A(s)/A^{2+}(aq) = +0.40V$
(ii) $B(s)/B^{3+}(aq) = +1.66V$
(iii) $P(s)/P^{2+}(aq) = +0.44V$

[R.B. 17]

a. What is electrophile? 1
b. Explain whether a particle of 120 nm size is a nano particle or not. 2
c. Determine the total cell petential when solution (i) and solution (ii) are conneceted by salt bridge. 3
d. Which container between A & B will be safe to keep solution (iii) explain with reactivity order. 4

Answer to the question no. 4

a The reagents that attack carbonion or electron dense substances and accept electron during reaction are called electrophiles.

b The particles of which size is vary from 1 to 100 nm are nano particles. The particle with 120 nm size is not a nano particle because it's size does not lie between 1 to 100 nm. But the particle with 120 nm size lie in range of very fine particles (100–2500 nm). So, the particle with 120 nm size is not a nano-particle.

c When solution (i) and solutions (ii) are connected by a salt bridge following electrochemical cell is produced.

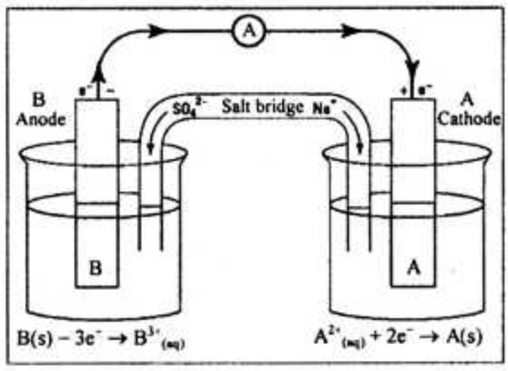


Diagram: Electrochemical cell

Given, $A(s)/A^{2+}(aq) = +0.40\ V$
$B(s)/B^{3+}(aq) = +1.66V$

As oxidation potential of A/A^{2+} is less than oxidation potential of B/B^{3+}, oxidation occurs at B/B^{3+} electrode and reduction occurs at A/A^{2+} electrode.

Oxidation half reaction : $B(s) - 3e^- \longrightarrow B^{3+}(aq)$; $E^0_{B/B^{3+}} = 1.66V$

Reduction half reaction : $A^{2+}(aq) + 2e^- \longrightarrow A(s)$; $E^0_{A^{2+}/A} = -0.40V$

Cell reaction : $B(s) + A^{2+}(aq) \rightarrow B^{3+}(aq) + A(s)$; $E^0_{cell} = +1.26\ V$

So, cell potential will be 1.26 V.

d It should consider two matters to keep solution in a container.

i. less Container must be anode.
ii. Reaction will not occur spontaneously when container is anode.

Now, in case of A container,

$$E^0_{cell} = E^0_{ox} + E^0_{red}$$
$$= E^0_{A/A^{2+}} + E^0_{P^{2+}/P}$$
$$= 0.40 + (-0.44)$$
$$= -0.04$$

Given,
$E^0_{A/A^{2+}} = 0.40V$
$E^0_{P^{2+}/P} = -0.44V$

In case of B container,

$$E^0_{cell} = E^0_{ox} + E^0_{red}$$
$$= E^0_{B/B^{3+}} + E^0_{p^{2+}/P}$$
$$= +1.66 + (-0.44)$$
$$= 1.22$$

Here,
$E^0_{B/B^{3+}} = +1.66V$
$E^0_{p^{2+}/P} = -0.44V$

From the above calculation, electromotive force of cell in case of A container is negative. So reaction does not occur spontaneously. So A container does not corrode. On the other hand, electromotive force at B container is positive. So reaction will occur spontaneously. The container will corrode in presence of solution (iii). So it is safe to use A container to keep solution (iii).

Ques. ▶5 $Al(s), Al^{3+}(aq) \parallel Sn^{2+}(aq), Sn(s)$

$E^0_{Al^{3+}/Al} = -1.66(V)$ and $E^0_{Sn^{2+}/Sn} = -0.14(V)$

[R.B.-2016]

a. What is Charle's Law? 1
b. Find out the oxidation number of central atom of $HClO_4$. 2
c. Concentration of Sn^{2+} is 0.15 M and Al^{3+} is 0.25 M. Find the electromotive force of cell. 3
d. Describe the method of conduction of electricity in the stem. 4

Answer to the question no. 5

a At constant pressure, the volume of a given mass of gas is directly proportional to the absolute temperature.

b Central atom of $HClO_4$ is Cl. Let oxidation number of Cl be X.

$\therefore (+1) + x + (-2) \times 4 = 0$
$\Rightarrow +1 + x - 8 = 0$
$\Rightarrow x - 7 = 0$
$\therefore x = +7$

Oxidation number of central atom Cl is +7.

c In the stem, the complete cell diagram is,

$$Al(s), Al^{3+}(aq) \| Sn^{2+}(aq), Sn(s)$$

So, complete cell reaction is,

$$2Al + 3Sn^{2+} \xrightarrow{6e^-} 2Al^{3+} + 3Sn$$

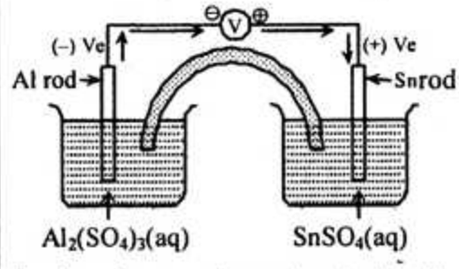
According to Nernst equation,

$$E_{cell} = E^0_{cell} - \frac{2.303RT}{nF} \log \frac{[Al^{3+}]^2}{[Sn^{2+}]^3}$$
$$= E^0_{(Al/Al^{3+})} + E^0_{(Sn^{2+}/Sn)} - \frac{2.303RT}{nF} \log \frac{[Al^{3+}]^2}{[Sn^{2+}]^3}$$
$$= (1.66V) + (-0.14V) - \frac{2.303 \times 8.314 \times 298}{6 \times 96500} \times \log \frac{[0.25]^2}{[0.15]^3}$$
$$= (1.52 - 0.00985 \times \log 18.52)\ V$$
$$= (1.52 - 0.00985 \times 1.27)\ V$$
$$= 1.507\ V$$

Here,
$R = 8.314\ JK^{-1}\ mol^{-1}$
$T = 298\ K$
$n = 6$
$F = 96500\ C$
$E_{cell} = ?$
$E^0_{Al/Al^{3+}} = 1.66V$
$E^0_{(Sn^{2+}/Sn)} = -0.14V$

$\therefore$ Electromotive force of cell is 1.507 V.

d The cell diagram can be represented as follow–



In the above, electrochemical cell, Al rod is dipped into $Al_2(SO_4)_3$ solution which acts as anode.

In $SnSO_4$ solution Sn acts as cathode. Anode and cathode are connected to positive and negative end respectively of the voltameter. In this case, the container that contains $Al_2(SO_4)_3$ is called anode and the container that contains $SnSO_4$ solution is called cathode. Anode and cathode solution connects by a salt bridge. Now, in anode Al donates 3 electrons and enters the solution as Al^{3+}.

Anodic reaction : $Al(s) - 3e^- \longrightarrow Al^{3+}(aq)$ [oxidation]

The electrons produce in anode pass through the wire to cathode. This increases electron density at cathode. On the other hand in cathode container Sn^{2+} from $SnSO_4$ solution accepts electron and deposit as Sn on the Sn rod.

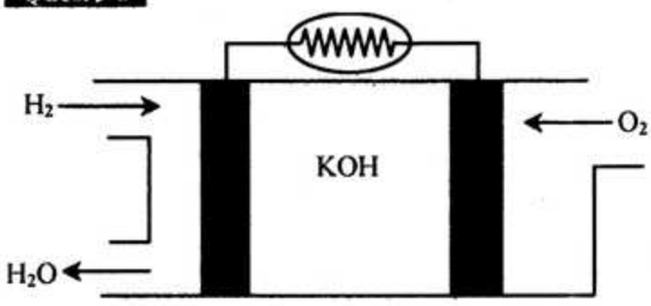
Cathode reaction : $Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$ [reduction]

From the above explanation we see, concentration of Al^{3+} in anode and concentration of SO_4^{2-} in cathode will be increased.

Salt bridge provides necessary ions to neutralize Al^{3+} and SO_4^{2-}. In this way, by neutralizing excess ions salt bridge helps in continuous electron flow.

So in the above electrochemical cell, redox reaction occurs and electrons flow from anode to cathode and electricity flows from cathode to anode.

Ques. ▶6



[Dj.B. 17]

a. What is mineral tanning? 1

b. Show that, semimolar solution is a standard solution. 2

c. Write down the anode, cathode and complete reaction of the cell. 3

d. Will the cell be economical inspite of being eco-friendly? Give rational explanation of your answer. 4

Answer to the question no. 6

a The process which uses mineral salts (Cr salt) to cross link with colagen (main constituent of leather) and produces a soft, pliable lether is called mineral tanning.

b We know, the solution which concentration is known is a standard solution. The concentration of semimolar solution is 0.5 m. Which we know. So semimolar solution is a standard solution. For example, molecular weight of Na_2CO_3 is 106. So $(\frac{1}{2} \times$ gram molecolar weight) or $\frac{106}{2} = 53$ g. If 53 g Na_2CO_3 is dissolved in 1000 mL solution then the concentration of solution will be 0.5 M. As we know the concentration of semimolar solution, so semimolar solution is a standard solution.

c In the stem cell, pure hydrogen and oxygen are used as fuel. Energy proudces through redox reaction between hydrogen and oxygen. Hydrogen oxidizes at the anode.

Anode reaction (oxidation) : $2H_2(g) + 4OH^-(aq) \rightarrow 4H_2O(l) + 4e^-$

Reaction at the anode liberates water and electrons. The electrons pass through the external circuit and readuce oxygen.

Cathode reaction (Reduction) : $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-$

Complete cell reaction : $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

d In the stem, the cell is hydrogen-oxygen fuel cell. The cell is not only eco-friendly but also economical for following characteristics.

i. High efficiency than any other diesel or gas engines.

ii. The cell is very environment friendly. It is very safe and economical to produce electricity through this cell. It's main products are heat and water. As a result, no green house gas or pollutant produces during electricity production.

iii. It uses renewable energy.

iv. It is transportable. So it can be used in spacecraft.

v. It does not need sound pollution.

vi. It does not need recharging.

vii. It's efficiency is upto 70–75% which is greater than any other cell.

viii. Maintenance is very easy.

ix. It is possible to decrease dependency on fossil fuel by using it in vehicles.

x. It emits less amount of heat at low temperature. So it is more suitable for short time use.

For above characteristics hydrogen-oxygen fuel cell is environment friendly and economical.

Ques. ▶7 $X/X^{2+}(0.15M) \parallel Y^+(0.2M)/Y$

$E^0_{Y^+/Y} = +0.80V$, $E^0_{X^{2+}/X} = -0.14V$

Temperature = 298 K [Dj.B. 17]

a. What TDS? 1

b. Describe the effects of Chromium on human body. 2

c. Determine the potential of the stem cell. 3

d. Explain how chemical energy converts to electrical energy of the stem cell. 4

Answer to the question no. 7

a TDS (Total Dissolved Solid) means the total amount of dissolved solid substances in water.

b Chromium associates in food chain through soil and water. Through food chain Chromium enters into human body. In human body Cr^{6+} absorbed extensively than Cr^{3+}. Absorbed Cr^{6+} associates with haemoglobin in erythocytes. Cr^{6+} toxicity causes itching, skin problems, Liver and Kidney disease, Cancers and many other symptoms. The Cr industry labours suffer from bronchitis. It is known as Chromic Chromate Ling. It's not only responsible for Cancer but also causes inborn problems.

c In the stem,

$E^0_{Y^+/Y} = +0.80V$ or, $E^0_{Y/Y^+} = -0.80V$

$E^0_{X^{2+}/X} = -0.14V$ or, $E^0_{X/X^{2+}} = 0.14V$

Here, between X and Y electrode, oxidation potential X is higher than Y. So X electrode will act as anode and Y electrode will act as cathode. So complete cell reaction is–

$$X + 2Y^+ \xrightarrow{2e^-} X^{2+} + 2Y$$

We know, according to Nernst equation,

$$E_{cell} = E^0_{cell} - \frac{2.303RT}{nF} \log \frac{[X^{2+}]}{[Y^+]^2}$$

$$= E^0_{X/X^{2+}} + E^0_{Y^+/Y} - \frac{2.303 \times 8.314 \times 298}{2 \times 96500} \log \frac{(0.15)}{(0.2)^2}$$

$$= 0.14 + 0.80 - 0.017$$

$$= 0.923V$$

Here,
n = 2
F = 96500 C
$R = 8.314 JK^{-1} mol^{-1}$
T = 298 K
$[X^{2+}] = 0.15$ M
$[Y^+] = 0.2$ M
$E_{cell} = ?$

So the potential of cell 0.923V.

d The cell which converts chemical energy to electrical energy is called electrochemical cell.

The cell is, $X/X^{2+} \parallel Y^+/Y$.

Here X electrode is anode and Y electrode is cathode. When both electrodes connect by a wire, electrons will move from X electrode to Y electrode. In this case Y electrode is positive

and X electrode is negative or anode. X atom from X plates donates electrons and enters into solution as X^{2+}.

$X(s) \longrightarrow X^{2+}(aq) + 2e$ (oxidation)

The electrons move through the wire to Y electrode.

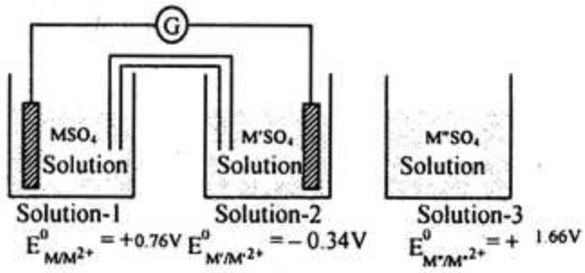
$2Y^{+}(aq) + 2e^{-} \longrightarrow 2Y(s)$ (reduction)

Complete cell reaction is–

$X(s) + 2Y^{+}(aq) \longrightarrow X^{2+}(aq) + 2Y(s)$

So, redox reaction occurs in cell. It creates movement of electron which produce electricity flow.

Ques. ▶8



[Dj.B. 16]

a. What is primary standard substance? 1

b. Write down the carboxyl group identification test in organic compound. 2

c. Find out cell potential of the cell. 3

d. Can solution-3 be kept in place of solution-2? Explain mathematically. 4

Answer to the question no. 8

a The substances which are readily available in the pure and dry state, concentration of solution does not change for prolonged period of time are called primary standard substances.

b In a test tube; 2–3 cm^3 $NaHCO_3$ solution is taken and carboxyl group containing compound is added to it. A CO_2 bubble is produced which changes the lime water.

$$R-\overset{O}{\overset{\|}{C}}-OH + NaHCO_3 \longrightarrow R-COONa + H_2O + CO_2\uparrow$$

$$Ca(OH)_2 + CO_2 \longrightarrow \underbrace{CaCO_3 + H_2O}$$

(Lime water) (Turbid lime water)

This reaction is used to identify carboxyl (–COOH) group.

c Geven, $E^{0}_{M/M^{2+}} = +0.76$ V & $E^{0}_{M'/M'^{2+}} = -0.34$ V.

From the value of oxidation potential we see, oxidation potential of M is greater than oxidation potential of M'.

So, M electrode will act as anode and M' electrode will act as cathode.

We know,

cell petential, $E_{cell} = E^{0}_{ox(anode)} + E^{0}_{red(cathode)}$
$= E^{0}_{M/M^{2+}} + E^{0}_{M'^{2+}/M'}$
$= (0.76 + 0.34)$ Volt
$= 1.1$ Volt

$E^{0}_{M/M^{2+}} = +0.76$ V
$E^{0}_{M'/M'^{2+}} = -0.34$ V
$\Rightarrow E^{0}_{M'^{2+}/M'} = 0.34$ V

∴ cell ptential of the cell is 1.1 Volt.

d In the stem, if solution-3 is kept in place of solution-2. The metal plate at solution-1 will act as anode and metal plate at solution-3 will act as cathode.

Because, as oxidation potential of M" is higher than M.' So in M" SO_4 solution M' will act as cathode.

∴ Cell ptential,

$E^{0}_{cell} = E^{0}_{ox} + E^{0}_{red}$
$= E^{0}_{M/M^{2+}} + E^{0}_{M"^{2+}/M"}$
$= 0.76 - 1.66$
$= -0.90$ V

Here,
$E^{0}_{M"/M"^{2+}} = +1.66$ V
$E^{0}_{M"^{2+}/M"} = -1.66$ V
$E^{0}_{M/M^{2+}} = 0.76$ V

As $E^{\circ}_{cell} < 0$, So cell reaction will not occur spontaneously. The cell will not produce electricity. So slution-3 can not be kept in place of solution-2.

Ques. ▶9 Fe/Fe^{++} (0.13 M) || Ag^{+} (0.0004 M)/Ag

$T = 25°C$; $E^{0}_{Fe^{++}/Fe} = -0.44$ V

$E^{0}_{Ag^{+}/Ag} = +0.80$ V

[C.B. 17]

a. What is Carbanion? 1

b. Why ETP is used in industry? 2

c. Find out the electromotive force of the cell. 3

d. What differences will be observed between two cells which are produced by connecting standard hydrogen electrode with the stem half cell separately? Explain with diagram. 4

Answer to the question no. 9

a Negative carbon containing organic ion is known as Carbanion.

b ETP stands for Effluent Treatment Plant. In present world, water is polluted by textile and dyeing, leather, paper pulp, cement, steel etc. industrial waste. The pollutants are organic or inorganic. To purify the polluted water and to make it reusable ETP is used in industry.

c From the stem, we get–

$E^{0}_{Fe^{++}/Fe} = -0.44$ V or, $E^{0}_{Fe/Fe^{++}} = +0.44$ V

And, $E^{0}_{Ag^{+}/Ag} = +0.80$ or, $E^{0}_{Ag/Ag^{+}} = -0.80$ V

The oxidation potential of Fe electrode is higher than the oxidation potential of Ag electrode. So, Fe electrode will act as anode and Ag electrode will act as cathode.

The complete cell reaction is–

$$Fe(s) + 2Ag^{+}(aq) \xrightarrow{2e^{-}} Fe^{++}(aq) + 2Ag(s)$$

According to Nernst equation,

$$E_{cell} = E^{0}_{cell} - \frac{2.303RT}{nF}\log\frac{[Fe^{++}]}{[Ag^{+}]^{2}}$$

$$= E^{\circ}_{Fe/Fe^{++}} + E^{\circ}_{Ag^{+}/Ag} - \frac{2.303 \times 8.314 \times 298}{2 \times 96500}\log\frac{(0.13)}{(0.0004)^{2}}$$

$= 0.44 + 0.80 - 0.17$
$= 1.07$ V

here,
Molar gas constant,
$R = 8.314 JK^{-1} mol^{-1}$
Temperature, $T = 298K$
$n = 2$
Faraday's constant,
$F = 96500$ C
$[Fe^{++}] = 0.13$ M
$[Ag^{+}] = 0.0004$ M
Electromotive force,
$E_{cell} = ?$

∴ Electromotive force of the cell is 1.07 V.

d In the stem, the half electrodes are–

Fe/Fe^{2+} (0.13M) and

Ag^+ (0.0004M)/Ag

When Fe/Fe^{++} (0.13M) half cell connects to standard hydrogen electrode, the complete cell will be–

$Fe/Fe^{++}(0.13M) \parallel H^+(1M)/H_2$

The complete reaction is–

$$Fe + 2H^+ \xrightarrow{2e^-} Fe^{2+} + H_2$$

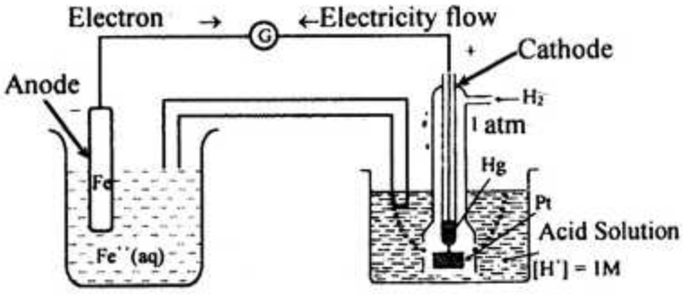


Diagram : Electrochemical cell of standard hydrogen electrode and $Fe/Fe^{++}(0.13M)$ electrode.

According to Nernst equation,

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log\frac{[Fe^{++}]}{[H^+]^2}$$

$$= E^\circ_{Fe/Fe^{++}} + E^\circ_{H^+/H_2}$$

$$- \frac{2.303 \times 8.314 \times 298}{2 \times 96500}\log\frac{[0.13]}{[1]^2}$$

$$= 0.44 + 0 + 0.026$$

$$= 0.466V$$

Here,
$[Fe^{++}] = 0.13M$
$[H^+] = 1M$
$R = 8.314\ JK^{-1}mol^{-1}$
$n = 2$
Faraday constant,
$F = 96500\ C$
$T = 298\ K$

Again, when standard hydrogen electrode adds to Ag^+(0.0004 M) / Ag half cell, the complete cell will be–

$H_2/H^+(1M) \parallel Ag^+(0.0004M)/Ag$

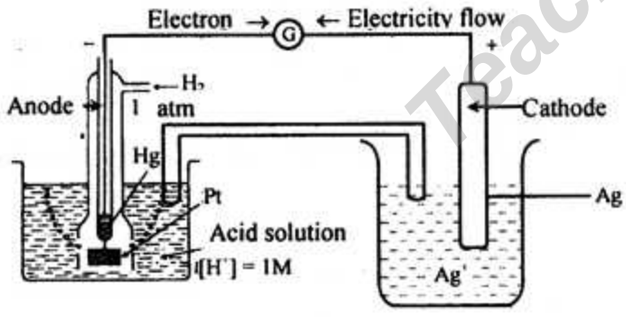


Diagram : Electrochemical cell of standard hydrogen electrode and $Ag^+(0.0004M)/Ag$ electrode.

According to Nernst equation,

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log\frac{[H^+]}{[Ag^+]}$$

$$= E^\circ_{H_2/H^+} + E^\circ_{Ag^+/Ag} - \frac{2.303 \times 8.314 \times 298}{1 \times 96500} \times$$

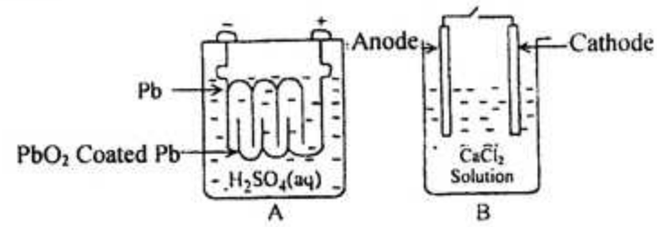
$$\log\left(\frac{1}{0.0004}\right) = 0 + 0.80 - 0.2$$

$$= 0.6V$$

Here,
$[H^+] = 1\ M$
$[Ag^+] = 0.0004\ M$
$R = 8.314\ JK^-mol^{-1}$
$T = 298\ K$
$n = 1$
$F = 96500\ C$

So, electromotive force of 1st cell is 0.466 V and electromotive force of 2nd cell is 0.6 V. In 1st cell anode is iron electrode and cathode is hydrogen electrode. In 2nd cell anode is hydrogen electrode and cathode is silver electrode. In 1st cell electricity flows from hydrogen electrode to iron electrode, in 2nd cell electricity flows from silver electrode to hydrogen electrode.

Ques. ▶ 10



[C.B. 17]

a. What is decarboxylation reaction? 1

b. Propane and Methane are homologous. Explain 2

c. Calculate how much amount of element will be deposited if 5 amp electricity pass through B cell for 5 minutes? 3

d. Show the charging and discharging reaction of A cell and describe the working mechanism of the cell. 4

Answer to the question no. 10

a The reaction which produces paraffin from salt of fatty acid in presence of soda lime is called decarboxylation.

b Propane ($CH_3CH_2CH_3$) and Methane (CH_4) are homologous. Because there is only difference of two methylene ($-CH_2$) group between propane and and methane. Both are in alkane homologous series. General formula of both compounds is C_nH_{2n+2}. If n =1 then the compound is CH_4, and if n= 3 then the compound is propane ($CH_3CH_2CH_3$). So methane and propane are in same homologous series.

c When electricity pass though B cell, Ca^{2+} from the solution reduced to Ca and deposit at cathode.

$$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$$

We, know,
$W = ZIt$
$$= \frac{40 \times 5 \times 600}{2 \times 96500}$$
$$= 0.621g$$

Here,
time, $t = 10\ min = (10 \times 60)sec$
$= 600\ sec$
Electric flow, $I = 5\ amp$
Electrochemical equivalent of Ca, $Z = \frac{40}{2 \times 96500}\ g\ Coul^{-1}$
Deposited Ca, $W = ?$

∴ 0.621g calcium will be deposited at cathode.

d In the stem, A cell is lead storage battery.

Charging reaction of lead storage battery :

Anode reaction :

$$PbSO_4(s) + H^+(aq) + 2e^- \rightarrow Pb(s) + H_2SO_4(aq)$$

Cathode reaction :

$$PbSO_4(s) + 2H_2O(l) \rightarrow PbO_2(s) + H_2SO_4(aq) + 3H^+(aq) + 2e^-$$

Discharging reaction of lead storage battery :

Anode reaction : $Pb(s) + H_2SO_4\ (aq) \rightarrow PbSO_4(s) + 2H^+(aq) + 2e^-$

Cathode reaction : $PbO_2(s) + H_2SO_4\ (aq) + 3H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

Complete reaction :

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \underset{\text{Charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} 2PbSO_4(s) + 2H_2O\ (l)$$

Mechanism of continuous functioning of lead storage battery :

H_2SO_4 is used during use of electricity. When battery is charged, water with H_2SO_4 is electrolyzed.

$$H_2O(l) \longrightarrow \frac{1}{2}H_2(g) + O_2(g)$$

Due to liberating of $H_2(g)$ and $O_2(g)$ amount of water in battery decreases.

Therefore, water is to be added to the battery cell to keep constant its specific gravity which is 1.2, otherwise its function of efficiency will be hampered.

Ques. ▶ 11

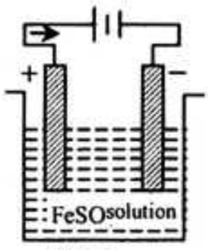


Fig: 1

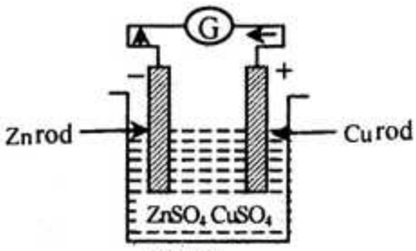


Fig: 2

[C.B. 2016]

a. What is plasticity? 1

b. How do heavy metals enter into human body? 2

c. If 50 A current is passed in figure 1 for 10 minutes how much metal will be deposited at cathode. 3

d. Though figure-1 and figure-2 both are cells but their processes of transformation of energy is different Explain. 4

Answer to the question no. 11

a Plasticity describes the deformation of a (solid) material undergoing non-reversible changes of shape in response to applied forces.

b Cows, goats etc. eat grass, plants and leaves of plants. Again human being eat fruits, vegetables, meats and milk of animals. Through this process food energy transfarred to human body from the plants. This process is known as food chain. Heavy metals such as As, Cr, Pb, Cd, Hg are associated with food chain by different ways. Through food chain these heavy metals enter into human body and causes toxicity.

c In figure-1, electrolysis of $FeSO_4$ is shown. During electrolysis of $FeSO_4$, Fe is deposited at cathode by following reaction —

$$Fe^{2+} + 2e^- \longrightarrow Fe \text{ (Deposit as metal at cathode)}$$
$$2F \quad 1 \text{ mol}$$

We know,
$W = ZIt$
$= \frac{55.85}{2 \times 96500} \times 50 \times 600$
$= 8.681$ g

Here,
electricity, $I = 50A$
time, $t = 10$ min
$= (10 \times 60)$ sec
$= 600$ sec
Electrochemical equivalent,
$Z = \frac{55.85}{2 \times 96500}$
Depsited weight, $W = ?$

$\therefore$ 8.681g Fe will be deposited at cathode.

d In the stem, the cell of figure-1 is an electrolytic cell and the cell of figure-2 is an electrochemical cell. Though both are cell but energy transformation is completely different.

In firure-1 there is a battery which is the source of electromotive force. So in this cell electricity pass from circuit to the solution which causes electrolysis. As a result Fe^{2+} reduced to Fe at cathode.

$$Fe^{2+} + 2e^- \longrightarrow Fe \text{ (cathode)}$$

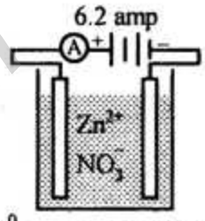
So in figure-1 cell, the source of electromotive force is added to the circuit. On the other hand, in figure-2 there are two electrode attached to the circuit but there is no battery.

Reaction in the cell is the source of electromotive force. In this cell, Zn plate act as anode which donates electron and enters into the solution as Zn^{2+}. The electrons pass through the wire to the cathode which are taken by Cu^{2+} at cathode. Due to this electron flow electricity is produced.

$$Zn - 2e^- \longrightarrow Zn^{2+} \text{ (oxidation in anode)}$$
$$Cu^{2+} + 2e^- \longrightarrow Cu \text{ (reduction in cathode)}$$

From the above explanation we see, in first cell chemical reaction occurs due to electric supply and in second cell electricity is produced due to chemical reaction.

Ques. ▶ 12



$E^0_{Zn^{2+}/Zn} = -0.76V$; $E^0_{M^{2+}/M} = -0.126V$ [C.B. 17]

a. What is TDS? 1

b. Why does leather need to be tanned. 2

c. To increase cathode weight by 1g how much time of electric supply is needed through the solution? 3

d. Justify the probability of storing the electrolytic solution in M container for longer period of time. 4

Answer to the question no. 12

a TDS (Total Dissolved Solid) means the total amount of solid substances that dissolved in water.

b The leather of living animals are soft and elastic which is rigid. But the leather of dead animals will rot in wet state and become hard and brittle at dry state. Tanning is the process of treating skins and hides of animals to produce leather.

Tanning is necessary for leather because if the raw hide is not tanned, it will rot and putrefy.

So to prevent rotting and brittleness tanning is necessary for leather.

c When electricity is passed through the solution Zn^{2+} will be deposited at cathode as Zn. The deposited Zn will increase the weight of cathode.

$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$ [Deposited in cathode]

We know,
$W = ZIt$
$\Rightarrow t = \frac{W}{ZI}$
$\Rightarrow t = \frac{1 \times 2 \times 96500}{65.5 \times 6.2}$
$= 475.25$ sec

Electrochemical equivalent of Zn,
$Z = \frac{65.5}{2 \times 96500}$ g Coul^{-1}
Electricity, $I = 6.2$ amp
deposited weight, $W = 1$g
time, $t = ?$

So if electricity pass through the solution for 475.25 sec then the weight of cathode will be increase by 1g.

d To store the stem solution in M container it should consider two mathers —

i. M container must be anode.
ii. Whether the reaction occurs spontaneously or not.

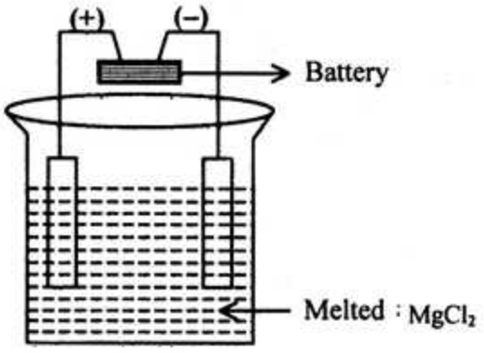
Given, $E^0_{M^{2+}/M} = -0.126V$
or, $E^0_{M/M^{2+}} = 0.126V$
and, $E^0_{Zn^{2+}/Zn} = -0.76V$

The probable reaction is–
$M(s) + Zn^{2+}(aq) \longrightarrow M^{2+}(aq) + Zn(s)$

Electromotive force of cell, $E_{cell} = E^0_{M/M^{2+}} + E^0_{Zn^{2+}/Zn}$
$= 0.126 + (-0.76)$
$= 0.126 - 0.76$
$= -0.634\ V$

As $E_{cell} < 0$, So reaction will not occur spontaneously. The container will not corrode. So it is possible to store the solution in M container for long time.

Ques. ▶ 13



[Ctg.B. 16]

a. What is Nano Particle? 1
b. Write down the Vander Waal's equation for 64 g oxygen. 2
c. Write the reaction occurr Melted anode of the cell of the stem. 3
d. Write down the reasons behind the necessity of electricity flow in the reaction that occurs in the cell of the stem. 4

Answer to the question no. 13

a The microscopic substances, of which sizes vary from 1 to 100 nm are called Nano-particles.

b The Vander Wall's equation is–

$$\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$$

For 64g O_2, $n = \frac{W}{M} = \frac{64}{32} = 2$

So for 64g oxygen, the equation will be –

$$\left(P + \frac{2^2a}{V^2}\right)(V - 2b) = 2RT$$

or, $$\left(P + \frac{4a}{V^2}\right)(V - 2b) = 2RT$$

c In the stem cell, the electrolyte is melted $MgCl_2$.

So there is only one cation and one anion in the solution. If aqueous solution of $MgCl_2$ is used then there will be more than one anions and cations. Because dissociation of water produces H^+ and OH^-. At that time, during electrolysis oxidation and reduction of ions will depend on the nature of ion, concentration of ion and position of ion in reactivity series. As $MgCl_2$ is melted, so there will be only negative Cl^- ion.

Chloride ion will be shifted to anode and oxidized to Cl_2 gas.

$MgCl_2(l) \rightleftharpoons Mg^{2+}(l) + 2Cl^-(l)$

Oxidation : $2Cl^-(l) \longrightarrow Cl_2(g) + 2e^-$(Anode reaction)

d The cell which converts electrical energy to chemical energy is called electrolytic cell. The cell in the stem is an electrolytic cell, because there is a battery as a source of energy in the stem cell.

So the redox reaction occurs in electrolytic cell is not spontaneous. Redox reaction depends on electricity flow from the battery. Electric flow dissociates $MgCl_2$ then the ions participate in redox reaction.

$$MgCl_2(l) \rightleftharpoons Mg^{2+}(l) + 2Cl^-(l)$$

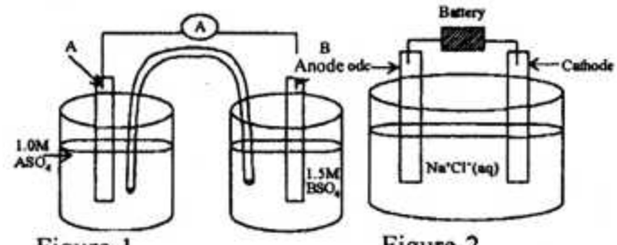
Oxidation in anode : $2Cl^-(l) \longrightarrow Cl_2(g) + 2e^-$

Reduction in cathode : $Mg(l)^{2+} + 2e^- \longrightarrow Mg(s)$

Redox reaction will be continued until the electric flow from the battery is stopped.

From the above explantion we can conclude that, electric supply is essential for the electrolytic cell reaction.

Ques. ▶ 14



$E_{A/A^{2+}} = +1.18V$, $E_{B^{2+}/B} = +0.34V$

[S.B 17]

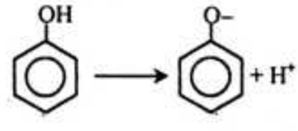
a. What is peptide bond? 1
b. Why Phenol is acidic? 2
c. Determine the electromotive force of figure-1 cell. 3
d. Explain the difference between figure-1 and figure-2 cell with cell reactions. 4

Answer to the question no. 14

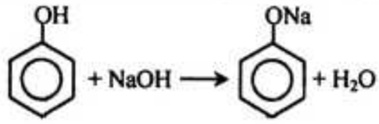
a The amide bond which is produced between carboxyl group of one amino acid and amino group of another amino acid is called peptide bond.

b Phenol is acidic. Because Benzene ring attracts the bond electron pair to the ring.

As a result O–H bond becomes weak. So Phenol can easily donate proton to form stable phenate ion.



Moreover phenol reacts with NaOH to form salt and water.



So phenol is acidic.

c In case of figure-1 cell, given,

$E_{A/A^{2+}} = +1.18$ V or, $E_{A^{2+}/A} = -1.18$V

And, $E_{B^{2+}/B} = +0.34$ V

As reduction potential of B^{2+}/B is higher than A^{2+}/A, so B will act as cathode and A will act as anode.

The complete cell reaction of the figure-1 cell is,

$$A(s) + B^{2+}(aq) \xrightarrow{2e^-} A^{2+}(aq) + B(s)$$

$E^0_{cell} = E_{A/A^{2+}} + E_{B^{2+}/B} = 1.18 + 0.34 = 1.52$ V.

According to Nernst equation,

$$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[A^{2+}]}{[B^{2+}]}$$

$$= 1.52 - \frac{0.0592}{2} \log \frac{1.0}{1.5}$$

$$= 1.525 \text{ V}$$

Here,
n = 2
$[A^{2+}] = 1.0$ M
$[B^{2+}] = 1.5$ M

So the electromotive force of the cell 1 is 1.525 V.

d In the stem, the figure-1 and figure-2 cell are electrochemical and electrolytic cell respectively. The differences between both cells are given below:

Electrochemical cell	Elctrolytic cell
i. The cell which converts chemical energy to electrical energy is called electrochemical cell or Galvanic cell.	i. The cell which converts electrical energy to chemical energy is called electrolytic cell.
ii. It produces electrical energy.	ii. It uses electrical energy.
iii. No need of battery in external circuit.	iii. It needs battery as a source of electromotive force.
iv. Anode is negative and Cathode is positive in electrochemical cell.	iv. Anode is positive and Cathode is negative in electrolytic cell.
v. Two electrodes are dipped in two different electrolyte solution.	v. Two electrodes are dipped in a same electrolyte solution.
vi. Redox reaction is spontaneous.	vi. Redox reaction is not spontaneous.
vii. Oxidation half reaction (Anode) : $A(s) \rightarrow A^{2+}(aq) + 2e^-$ Reduction half reaction (Cathode) : $B^{2+}(aq) + 2e^- \rightarrow B(s)$ Complete reaction : $A(s) + B^{2+}(aq) \rightarrow A^{2+}(aq) + B(s)$ A→ strong reducing agent B→ strong oxidizing agent	vii. Oxidation half reaction (Anode) : $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ Reduction half reaction (Cathode) : $2Na^+(aq) + 2e^- \rightarrow 2Na(s)$ Complete reaction : $2Cl^-(aq) + 2Na^+(aq) \rightarrow Cl_2(g) + 2Na(s)$

Ques. ▶ 15

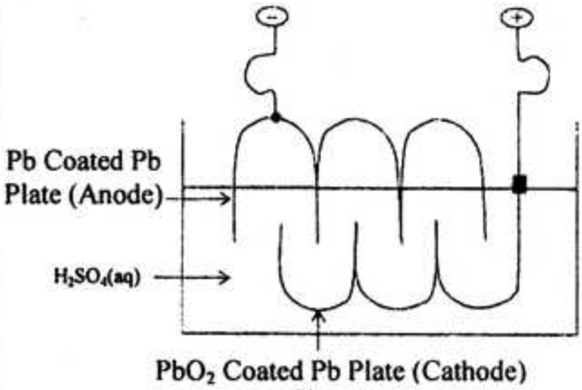


Figure : A

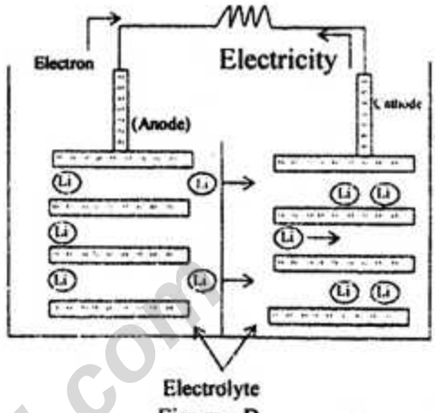


Figure : B

[S.B. 17]

a. What is CFC? 1

b. Electrolysis is a redox reaction. Explain. 2

c. Explain charging, discharging and cell reaction of B cell. 3

d. Explain advantages and disadvantage of A and B cell. 4

Answer to the question no. 15

a CFC are the Chloro fluoro derivatives of methane (CH_4) and ethane.

b Electrolysis is a redox reaction because during electrolysis oxidation occurs at anode and reduction occurs at cathode. In melted NaCl solution there is Na^+ and Cl^- ion. When electricity is passed through the cell, Cl^- ion donates electron at anode and Na^+ accepts electron at cathode.

Anodic reaction : $Cl^- - e^- \rightarrow \frac{1}{2}Cl_2$ (oxidation)

Cathodic reaction : $Na^+ + e^- \rightarrow Na$ (reduction)

So electrolysis is a redox reaction.

c In the stem, B cell is a lithium ion battery. Here, the charging, discharging and complete cell reaction are explained.

Charging and discharging:

In lithium ion battery, the process of charging and discharging is completed through movement of electron and Li^+ to the anode and cathode. Discharging and charging both are completely inverse process. During charging Li^+ liberates from the cathodic $LiCoO_2$ which passes through the electrolyte and membrane and neutralize at anode. During discharging Li^+ liberates from graphite anode which passes through electrolyte and membrane and neutralize at cathode. For this battery,

Reaction of positive electrode :

$LiCoO_2 \rightleftharpoons Li_{(1-n)}CoO_2 + nLi^+ + ne^-$

Reaction of negative electrode :

$nLi^+ + ne^- + C \rightleftharpoons nLiC$

Complete reaction :

$Li^+ + e^- + LiCoO_2 \rightarrow Li_2O + CoO$

When charging exceeds 5.2 Volts then,
$LiCoO_2 \rightarrow Li^+ + CoO_2 + e^-$.

In this case, ion exchange occurs between Co^{3+} and Co^{4+} which produces electron.

During charging : $Co^{3+} \rightarrow Co^{4+} + e$

Durring discharging : $Co^{4+} + e \rightarrow Co^{3+}$

d In the stem, the cells of figure-A and figure-B are lead storage battery and lithium ion battery respectively. The advantages and disadvantages of both cells are described below.

Lead storage bettery :

Advantages : Internal resistance of lead storage battery is low. So it provides high electric supply. Lead acid storage battery is rechargeable. Density of H_2SO_4 is 1.29 gcm^{-3} in a fully charged lead storage battery. Decrease density of H_2SO_4 indicates the decrease of charge level. Lead storage battery is readily available and low price battery.

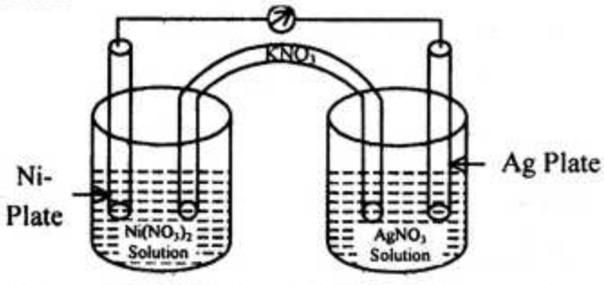
Disadvantages : 36–38%(w/v) H_2SO_4 is used in lead storage battery. It causes burn in the skin. During recharging H_2SO_4 gas is evaluated. Which is expelled out. So during recharging it should not be kept near any fire or flame. The weight of lead storage battery is upto 30–60 pounds. So it is difficult to transport. It also causes lead poisoning and pollutes soil.

Lithium ion battery :

Advantages : It is lighter than lead and nickel battery. It is widely used in motor vehicles. It has longer lifespan than lead and Ni battery. So it does not mix with soil as waste widely. Voltage of lithium battery is higher than any other battery.

Disadvantages : It is not rechargeable. So after one time use it becomes waste. It cannot be replaced from electronic devices. When the battery leaks, it produces fire in electric devices. Friction and collisions among Lithium battery produces hazardous gas. It degrades in presence of water vapor and produces hydrogen gas.

Ques. ▶ 16



Standard reduction potential of Nickel, Silver and Zinc are –0.25V, + 0.799V and –0.76V respectively.

[S.B,J.B-16]

a. What is acid rain? 1
b. What is gypsum used in cement production? 2
c. Write down the half cell reaction and complete reaction of the cell of the stem. 3
d. Evaluate mathematically whether the solution of anode can be preserved in the zinc container. 4

Answer to the question no. 16

a If the pH of rain water is below 5.6 then the rain is called acid rain.

b In presence of gypsum ($CaSO_4.2H_2O$) setting of cement occurs slowly. Because gypsum reacts with tricalcium aluminate to produce insoluble calcium sulfoaluminate.

So amount of tricalcium silicate decreases. Tricalium aluminate causes rapid setting of cement. For this reason, in presence of gypsum, cement can not set rapidly.

$3\,CaO.Al_2O_3 + 3(CaSO_4.2H_2O) + 2H_2O \rightarrow 3CaO.\,Al_2O_3.\,3CaSO_4.2H_2O + 6H_2O$

Though it needs long time for setting but after several weeks it creates a rigid and strong structure.

c The cell in the stem is an electrochemical cell. In cell–

Reduction potential of Ni is = – 0.25 V

Reduction potential of Ag is = + 0.799 V

So oxidation potential of Ni is higher than oxidation potential of Ag. So Ni will act as anode and Ag will act as cathode. In anode Ni donates two electrons and enters in solution as Ni^{2+}.

Half cell reaction in anode : $Ni \rightarrow Ni^{2+} + 2e^-$

In cathode Ag^+ accepts one electron and deposit on cathode as Ag.

Half cell reaction in cathode : $2Ag^+ + 2e^- \rightarrow 2Ag$

So complete cell reaction is: $2Ag^+ + Ni \xrightarrow{2e^-} 2Ag + Ni^{2+}$

d In the stem, the solution of anode is $Ni(NO_3)_2$. If it is kept in zinc container then zinc would be anode.

Standard reduction potential of Zinc : –0.76 V

Standard oxidation potential of Zinc : 0.76 V

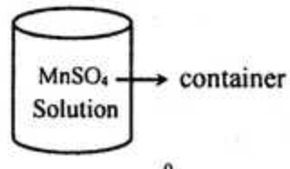
And, Standard reduction potential of Ni = –0.25 V

∴ Cell potential,

$E_{cell} = E_{OX} + E_{Red}$
$= 0.76 + (-0.25)$
$= (0.76 - 0.25)V$
$= 0.51V$

Here, E_{cell} is positive. So cell reaction will occur spontaneously. As a result Zinc container will corrode in presence of $Ni(NO_3)_2$. So $Ni(NO_3)_2$ solution can not be preserved in Zinc container.

Ques. ▶ 17



Given, $E^0_{Mn/Mn^{2+}} = 1.18$ V and $E^0_{Al/Al^{3+}} = +1.66$V

[J.B. 17]

a. What is diazotization? 1
b. Why Alkyne-1 is acidic? 2
c. Write down the cell reaction occurred in Al container. 3
d. Explain whether the Al container will be perforated or not after some days. 4

Answer to the question no. 17

a Diazotization is the reaction in which primary aromatic amine produces diazonium salt in presence of $NaNO_2$ and inorganic acid at 0.5°C.

b Alkyne-1 (R–C≡CH) is acidic.

Because carbon atoms of Alkyne-1 is SP hybridized. In SP hybridization the ratio of S and P is 1 : 1. As ratio of small S orbital is higher in SP hybridization, the bond electrons of C–H shift to the carbon nucleus. As a result, the bond of hydrogen became weak. For this reason Alkyne-1 can easily donate proton by breaking C–H bond. So Alkyne-1 is acidic.

c In the stem, $MnSO_4$ solution is kept in Al container.

Here, $E^0_{Mn/Mn^{2+}} = +1.18V$

And, $E^0_{Al/Al^{3+}} = +1.66V$

We know, the electrode which has higher oxidation potential in a cell acts as anode. And which has lower oxidation potential acts as cathode.

Oxidation potential of Al is higher than oxidation potential of Mn. So Al will act as anode and Mn will act as cathode. Al donates 3 electrons and enters in solution as Al^{3+}.

Anode half reaction : $Al - 3e^- \rightarrow Al^{3+}$ [oxidation]

On the other hand, Mn^{2+} accepts two electrons and deposit on container as Mn.

Cathode half reaction : $Mn^{2+} + 2e^- \longrightarrow Mn$ [reduction]

Complete cell reaction is–

$$2Al + 3Mn^{2+} \xrightarrow{6e^-} 2Al^{3+} + 3Mn$$

d In the stem, $MnSO_4$ solution is kept in Al container. The container will be perforated when it will act as anode.

If Al is anode, then the probable reaction will be–

$$Al + Mn^{2+} \longrightarrow Al^{3+} + Mn$$

We know,

Cell potential,

$E^0_{cell} = E^0_{ox(anode)} + E^0_{red(cathode)}$

$= \{1.66 + (-1.18)\}V$

$= (1.66 - 1.18)\ V$

$= 0.48\ V$

Given,

$E^0_{Mn/Mn^{2+}} = +1.18V$

or, $E^0_{Mn^{2+}/Mn} = -1.18V$

and, $E^0_{Al/Al^{3+}} = +1.66V$

Cell potential, $E^0_{cell} > 0$, So the reaction is spontaneous. So Al atom will be oxidized and will enter into solution. So when $MnSO_4$ solution is kept in Al container, the container will be perforated.

Ques. ▶ 18 (i) Potassium Chlorate $\xrightarrow{\Delta}$ A(g) + KCl(s)

(ii) $Zn(s) + H_2SO_4\ (dil) \longrightarrow B(g) + ZnSO_4$

[J.B. 17]

a. What is Carbocation? 1

b. Why it is not possible to twist 0.50 nm long Copper wire? 2

c. How much amount of reactant is needed to produce 0.07g A in the stem? 3

d. What will be the nature of cell formed by A and B gas? Explain. 4

Answer to the question no. 18

a Positive carbon containing organic ion is known as Carbocation.

b 0.50 nm long (Actually diameter is 0.50 nm) Copper wire is smaller than nano-particle. Size of nano-particles vary among 1 to 100 nm. Nano-particles do not show the properties of normal state particles.

Usually Copper wire are easily twisted when its diameter is greater than 50 nm. But if diameter is 0.50 nm then the wire becomes very hard. Because the wire consists of lots of nano-particles. So it can not be twisted.

c The complete reaction (i) in the stem is–

$$\underset{245g}{2KClO_3} \xrightarrow{\Delta} \underset{3\times32g}{\underset{A}{3O_2(g)}} + 2KCl\ (s)$$

To produce, 3×32 g O_2, $KClO_3$ needed = 245 g

" " 1g O_2, $KClO_3$ " $= \frac{245}{3\times32}$ g

" " 0.07g O_2, $KClO_3$ " $= \frac{245\times0.07}{3\times32}$ g

$= 0.1801$ g

So, to produce 0.07g A, 0.1801 g $KClO_3$ is needed.

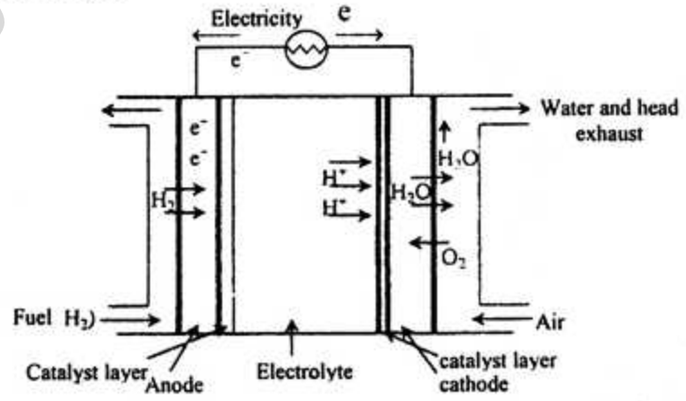
d The complete reaction (ii) in the stem is–

$$Zn(s) + H_2SO_4\ (dil) \longrightarrow H_2(g) + ZnSO_4$$

It is possible to produce electrical energy by using A and B that means oxygen and hydrogen gas. The cell is known as hydrogen fuel cell. Here hydrogen is used as fuel.

There are 3 parts in hydrogen fuel cell– Andoe, Cathode and electrolyte.

Ni coated semi-permeable graphite is used as anode anod Ni, NiO coated graphite is used as cathode. Heated KOH is used as electrolyte.



Hydrogen is passed through the anode. Where hydrogen produces proton and electons.

Anode reaction (oxidation) : $H_2 \rightarrow 2H^+ + 2e^-$; $E^0 = 0\ V$

Protons pass through the electrolyte membrane to the cathode. Electrons flow to the external circuit from anode to cathode. As a result electricity is produced. At that time oxygen passes through the cathode. In cathode oxygen reacts with proton and electrons to form water.

Cathode reaction (reduction) :

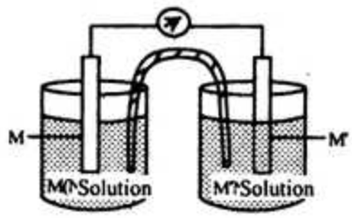
$\frac{1}{2}O_2(g) + 2H^+ + 2e^- \rightarrow H_2O(l)$;

$E^0 = 1.229\ V$

Complete reaction :

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$; $E^0 = 1.229\ V$

Ques. ▶ 19



$E^0_{M^{2+}/M} = -0.25V$, $E^0_{M'^{+}/M'} = +0.799V$ And, $E^0_{Zn^{2+}/Zn} = -0.76V$

[B.B. 17]

a. What is conjugated base? 1

b. Why does lactic acid show optical isomerism? 2

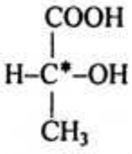
c. Write down the cell reaction of the stem cell and determine e.m.f. 3

d. Explain mathematically whether anode solution can be reserved in zinc container? 4

Answer to the question no. 19

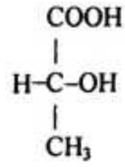
a The base which is produced by releasing a proton from an acid is called conjugated base of that acid.

b The structural formula of Lactic Acid is–

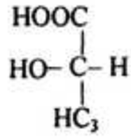


* = Chiral Carbon.

Central carbon atom of lactic acid is a Chiral carbon. And Chiral carbon containing organic compounds show optical isomerism.



d-lactic acid



l-lactic acid

d-isomer rotates polarized light to right direction and *l*-isomer rotates polarized light to left direction. So lactic acid shows optical isomerism.

c Given,

$E^0_{M^{2+}/M} = -0.25$ V or, $E^0_{M/M^{2+}} = 0.25$ V

And, $E^0_{M'^{+}/M'} = +0.799$ V

As reduction potential of $E^0_{M^{2+}/M}$ is smaller than reduction potential of $E_{M'^{+}/M'}$, so oxidation will occur in $E^0_{M^{2+}/M}$ and reduction will occur in $E_{M'^{+}/M'}$ electrode.

Oxidation half reaction : $M(s) - 2e^- \rightarrow M^{2+}(aq)$ (anode)

Reduction half reaction : $2M'^{+}(aq) + 2e^- \rightarrow 2M'(s)$ (cathode)

Complete reaction : $M(s) + 2M'^{+}(aq) \rightarrow M^{2+}(aq) + 2M'(s)$

Now,

$$\text{e.m.f} = E^0_{M/M^{2+}} + M^0_{M'^{+}/M'}$$
$$= 0.25 + 0.799$$
$$= 1.049 \text{ V}$$

So, e.m.f of the cell is 1.049 V.

! From the answer of C, anode electrode is $E^0_{M^{2+}/M}$ and the solution is $M(NO_3)_2$. Now to preserve $M(NO_3)_2$ solution in zinc container it should consider two factors–

(i) Whether the zinc container is anode or not.

(ii) Whether the reaction is spontaneous or not.

Given,

$E^0_{M^{2+}/M} = -0.25$ V

And, $E^0_{Zn^{2+}/zn} = -0.76$ V or, $E^0_{Zn/zn^{2+}} = 0.76$ V

The complete cell reaction is–

$Zn(s) + M^{2+}(aq) \longrightarrow Zn^{2+}(aq) + M(s)$

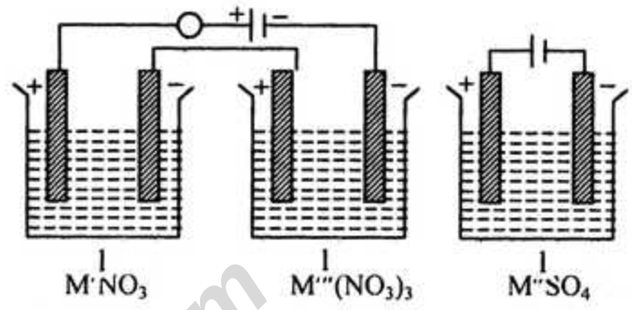
Cell potential, $E_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{M^{2+}/M}(s)$

$= 0.76 + (-0.25)$

$= 0.51$V

As $E_{cell} > 0$, so reaction will be spontaneous. Zn container will be corroded. So $M(NO_3)_2$ solution can not be preserved in zinc container.

Ques. ▶ 20



[Atomic mass, M' = 108, M'' = 63.5 And, M''' = 52]

[B.B. 16]

a. What is diazotization? 1

b. Methyl amine is more basic than aniline. Explain. 2

c. pH of $M''SO_4$ solution is less than 7. Explain. 3

d. If 50 C of electricity is supplied through 1 and 2 no cell, different amounts of compounds are accumulated in different electrodes. Explain the reason. 4

Answer to the question no. 20

a Diazotization is the reaction in which primary aromatic amine produces diazonium salt in presence of $NaNO_2$ and inorganic acid at 0–5°C.

b Lone pair electron of nitrogen in aniline partially coalesce with delocalized electrons of benzene ring. As a result, lone pair electron of nitrogen is attracted by benzene ring. This decreases the chance of forming coordinate covalent bond with proton. For this reason, aniline is a weak base. On the other hand, in methyl amine, methyl group increases the electron density of nitrogen. So methyl amine can easily accept proton from water. For this reason methyl amine is more basic than aniline.

c Atomic mass of M'' is 63.5. So M'' is copper. So solution-3 is $CuSO_4$. $CuSO_4$ is the salt of weak base $Cu(OH)_2$ and strong acid H_2SO_4. First it dissolves in water and forms ions. Subsequently Cu^{2+} reacts with water and increases concentration of H_3O^+.

$$CuSO_4(s) \xrightarrow{H_2O} Cu^{2+}(aq) + SO_4^{2-}(aq)$$

$$Cu^{2+}(aq) + 4H_2O(l) \rightleftharpoons Cu(OH)_2(aq) + 2H_3O^+(aq)$$

As a result concentration of proton (H_3O^+) increases, so aqueous solution of $CuSO_4$ is acidic and pH of the solution is less than 7.

d Atomic mass of M' is 108. So M' is Ag. 1 no solution is $AgNO_3$ solution. Atomic mass of M'' is 52. So M''' is Cr. 2 No solution is $Cr(NO_3)_3$. 50 C charge is supplied in both cells.

According to Faraday's 2nd law,

When the same quantity of electricity is passed through different electrolytes, the masses of different ions liberated at the electrodes are directly proportional to their chemical equivalents.

Electrochemical equivalent of, Ag, $Z_1 = \frac{108}{1 \times 96500}$

$= 1.12 \times 10^{-3}\ gc^{-1}$

Electrochemical equivalent of, Cr, $Z_2 = \frac{52}{3 \times 96500}$

$= 1.8 \times 10^{-4} gC^{-1}$

According to Faraday's 1st law,

deposited weight of Ag,

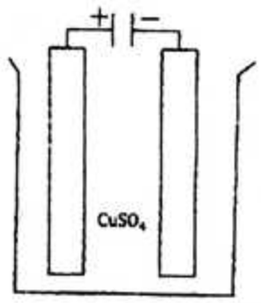
$W_1 = Z_1Q = 1.12 \times 10^{-3} \times 50 \times t = 0.056 \times t$

Again, deposited weight of Cr,

$W_2 = Z_2Q = 1.8 \times 10^{-4} \times 50 \times t = 0.009 \times t$

From the calculated value we can conclude that, deposited weight of Ag is higher. It is due to their different chemical equivalent.

Ques. ▶ 21



[RAJUK Uttara Model College, Dhaka]

a. What is recycling? 1

b. What is iodimetry? Explain. 2

c. If 0.25A current is passed through a solution of stem for 30 minutes, then what amount of copper will be deposited at cathode? [Cu = 63.5] 3

d. Does the solution of stem can be kept in zinc vessel? Analyze mathematically. Where, $E°_{Zn/Zn^{2+}} = +0.76V$ and $E°_{Cu/Cu^{2+}} = -0.34V$ 4

Answer to the question no. 21

a Recycling is the process of converting used or old materials into usable materials.

b Iodimetry is a titration process; in which a strong or weak acid is reduced by idoine solution in presence of an indicator.

$Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$

The determination of concentration of $Na_2S_2O_3$ solution by using standard I_2 solution is an iodimetric titration.

c Similar to the question no– 11(c).

d In the stem cell, there is $CuSO_4$ solution. When a solution is kept in a container it should consider two matters, such as –

i) Whether the container is anode or not

ii) Whether the reaction is spontaneous or not.

When $CuSO_4$ solution is kept in Zn container, the probable reaction is –

$Zn_{(s)} + CuSO_{4(aq)} \longrightarrow ZnSO_{4(s)} + Cu_{(s)}$

The cell e.m.f will be,

$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{Cu^{2+}/Cu}$

$= 0.76 + 0.34$

$= 1.1\ V$

Here,

$E^0_{Zn/Zn^{2+}} = 0.76V$

$E^0_{Cu/Cu^{2+}} = -0.34V$

Or, $E^0_{Cu^{2+}/Cu} = 0.34V$

$E^0_{cell} = ?$

As the value of cell is positive, so the reaction will occur spontaneously. As a result Zn container will be corroded. For this reason the stem solution can not be kept in Zinc vessel.

Ques. ▶ 22 Read the stem:

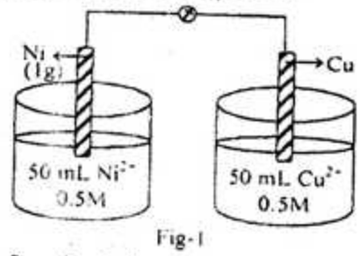


Fig-1

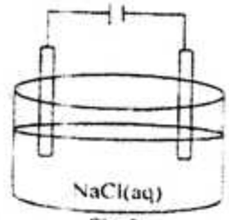


Fig-2

[Notre Dame College, Dhaka]

a. What is LNG? 1

b. Glass is exceedingly cooled liquid— explain. 2

c. Find the concentration of left electrode solution of fig.-1 after using the cell. 3

d. Compare the electric processes of given setups in fig.-1 and 2. 4

Answer to the question no. 22

a LNG stands for liquefied natural gas. LNG is natural gas that has been cooled down to liquid form for ease and safety of non pressurized storage or transport.

b Glass is called exceedingly (supper cooled) liquid because it does not form a crystalline structure, but instead forms an amorphous solid that allows molecules in the material to continue to move. Glass does not form crystalline solid when its liquid form cooled. For this reason glass is called exceedingly cooled liquid.

c In figure-1 cell the complete cell reaction is.

$Ni_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Ni^{+2+}_{(aq)} + Cu_{(s)}$

1mol Nickel is oxidized by 1 mol Cu^{2+}

Here,

Mole no of Cu^{2+}

$n = VS$

$= 0.05 \times 0.5$

$= 0.025$ mol

Fore, Cu^{2+} solution

Volume = 50 mL

$= \frac{50}{1000}$ L

$= 0.05$ L

Concentration, S = 0.5 M

Again, Mole no. of Ni^{2+}

$n = VS$

$= 0.05 \times 0.5$

$= 0.025$ mol

For, Ni^{2+} solution

Volume = 50 mL = 0.05 L

Concentration, S = 0.5 M

Mole no . of Ni rod is –

$n = \frac{W}{M}$

$= \frac{1}{58.7}$

$= 0.017$ mol

Weight, W = 1g

atomic mass, M = 58.7

$Ni_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Ni^{2+}_{(aq)} + Cu_{(s)}$

1 mol Ni is oxidized by 1 mol Cu^{2+}

So.0.017 mol Ni will be oxidized by 0.017 mol Cu^{2+}. It will produces 0.017 mol Ni^{2+}.

$\therefore$ Total Ni^{2+} in solution, = (0.025 + 0.017) mol

= 0.042 mol

Now, n = VS

$\Rightarrow 0.042 = 0.05 \times S$

$\Rightarrow S = \frac{0.042}{005}$

= 0.84 M

So, the concentration of left electrode after using the cell will be 0.84 M.

d In the stem, the figure-1 is an electrochemical cell and figure-2 is an electrolytic cell. The process of energy transformation of both gas two electrodes are attached to external circuit. There is no battery in figure-1 cell spontaneous chemical reaction is the source of electromotive force in figure–1 Ni is oxidized by donating electron at anode and Cu^{2+} will be reduced by accepting electrons. The movement of electrons from anode to cathode creates flow electricity.

Anode reaction :

$$Ni_{(s)} \longrightarrow Ni^{2+}_{(aq)} + 2e^- \text{ (oxidation)}$$

Cathode reaction :

$$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)} \text{ (reduction)}$$

So in electrochemical cell, Chemical energy is converted to electrical energy.

On the other hand, Figure-2 is an electrolytic cell. There is a battery in figure-2 cell which is the source of electromotive force. When electricity is passed through the figure-2 solution electrolysis of NaCl occurs. The proton will be reduced at cathode and Chloride ion (Cl^-) will be oxidized at cathode.

$$NaCl_{(aq)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

$$H_2O \longrightarrow H^+_{(aq)} + OH^-_{(aq)}$$

Reduction at cathode;

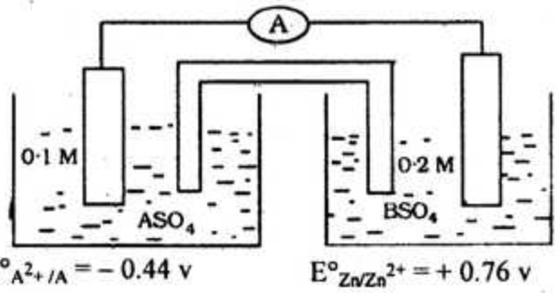
$$2H^+ + e^- \longrightarrow H_{2(g)}$$

Oxidation at cathode,

$$2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e^-$$

So in figure-2 cell electrical energy is converted to chemical energy.

Ques. ▶ 23



$E^\circ_{A^{2+}/A} = -0.44$ v $\quad E^\circ_{Zn/Zn^{2+}} = +0.76$ v

$E^\circ_{B^{2+}/B} = -0.34$ v

[Ideal School and College, Motijheel, Dhaka]

a. What is electo chemical equivalent? 1

b. Ethanal is homologue of propanal— explain it. 2

c. Calculate the EMF of the cell of the stem. 3

d. Is it possible to preserve the cathode solution in Zinc container. 4

Answer to the question no. 23

a Electrochemical equivalent is the amount of substance that is deposited due to pass of 1C charge through solution of electrolyte during electrolysis.

b Ethanol (CH_3CHO) and propanal (CH_3CH_2CHO) are homologous because both has aldehyde (–CHO) functional group. The general formula of both Compound is $C_nH_{2n+1}CHO$ [n = 1 for ethanol and n = 2 for propanal]

And there is a difference of $-CH_2-$ group between two compounds. Ethanol and propanal can be prepared by oxidation of 1° alcohol.

For above reasons, ethanol is homologous of proanal.

c In the stem, The reduction potential of $E^0_{B^{2+}|B} = 0.34$ V is higher than reduction potential of $E^\circ_{A^{2+}/A} = -0.44$v. So $E^\circ_{B^{2+}/A}$ will act as Cathode and $E^\circ_{A^{2+}/A}$ will act as anode.

The complete$_{cell}$ is –

$A/A^{2+}(0.1M) \| B^{2+}(.2M)/B$

The complete cell is

$A + BSO_4 \longrightarrow ASO_4 + B$

According to Nernst equation,

$$E_{Cell} = E^\circ_{cell} - \frac{0.0592}{n} \log \frac{[A^{2+}]}{[B^{2+}]}$$

$$= (E^\circ_{A/A^{2+}} + E^\circ_{B^{2+}/B}) - \frac{0.0592}{n} \log \frac{[A^{2+}]}{[B^{2+}]}$$

$$= (0.44 + 0.34) - \frac{0.0592}{2} \log \frac{0.1}{0.2}$$

$= 0.78 - (-8.91 \times 10^{-3})$

= 0.7889 V

Here,

$E^\circ_{A^{2+}/A} = -0.44$ V

or, $E^\circ_{A/A^{2+}} = 0.44$V

$E^\circ_{B^{2+}/B} = 0.34$V

$[A^{2+}] = 0.1$M

$[B^{2+}] = 0.2$ M

n = 2

$E_{cell} = ?$

$\therefore$ The EMF of the cell of the given stem is 0.7889V.

d In the stem, the cathode solution is BSO_4. When a solution is preserved in a container it should consider two matters such as-

i) Whether the container is anode or not

ii) Whether the reaction is spontaneous or not.

If BSO_4 solution is preserved in Zn Container, the probable reaction is–

$$Zn_{(s)} + BSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + B_{(S)}$$

We know,

$$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{B^{2+}/B}$$

$$= (0.76 + 0.34)\ V$$

$$= 1.1V$$

Here, $E^0_{Zn/Zn^{2+}} = 0.76$V

$E^0_{B^{2+}/B} = 0.34$ V

$E^0_{cell} = ?$

As $E^0_{cell} > 0$, so the reaction will occur spontaneously. As a result Zinc container will be corroded. So it is not suitable to preserve BSO_4 in Zinc Container.

Ques. ▶ 24 A nickel rod is dipped into a $NiSO_4$ solution and a silver rod is dipped into a Ag_2SO_4 solution. These two rod are connected by a wire through a potentiometer. Standard reduction of nickel, silver and zinc are 0.25V, + 0. 799V and – 0.76V respectively. *[St. Joseph School & College, Dhaka]*

a. What is electrode? 1
b. Why does acid mixed water conducts electricity? 2
c. Write down half cell reactions and cell reaction of the cell mentioned in the stem. 3
d. Will the anode solution be kept in a container of zinc? Explain mathematically. 4

Answer to the question no. 24

a An electrode is a conductor through which electricity enters or leaves an object.

b Pure distilled is non-conductor of electricity. If few drops of acids is added to water, the compounds separate into individual ions and having that small number of ions increase conductivity astronomically. When electromotive force is applied to it, H_2 and O_2 are produced at cathode and anode respectively. So due to movement of ions acid mixed water is electrolytic conductor.

Reduction at cathode :

$$2H^+ + 2e^- \longrightarrow H_2\,(g)$$

Oxidation at cathode:

$$4OH^- \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$$

c The standard reduction potential of nickel and silver is – 0.25V and + 0.799 V respectively. The standard reduction potential of silver is higher than nickel. So silver electrode will act as cathode and nickel electrode will act as anode.

Oxidation half reaction :

$$Ni_{(s)} \longrightarrow Ni^{2+} + 2e^- \quad \ldots\ldots\ldots\ldots (i)$$

Reduction half reaction :

$$2Ag^+_{(aq)} + 2e^- \longrightarrow 2Ag_{(s)} \quad \ldots\ldots\ldots\ldots (ii)$$

The complete cell reaction is

$$Ni_{(s)} + 2Ag^+ \longrightarrow Ni^{2+}_{(aq)} + 2Ag_{(s)}$$

$$Ni_{(s)} + Ag_2SO_{4(aq)} \longrightarrow NiSO_{4(aq)} + 2\,Ag_{(s)}$$

The complete cell is : $Ni_{(s)}/Ni^{2+}_{(aq)} \,\|\, Ag^+_{(aq)} / Ag_{(s)}$

d In the stem, the anode solution is $NiSO_4$. When a solution is kept in a container, it should be considered two matters, it Such as-

i) Whether the container is anode or not.

ii) Whether the reaction is spontaneous or not.

When $NiSO_4$ solution is kept in zinc Container, the probable reaction is–

$$NiSO_{4(aq)} + Zn_{(s)} \longrightarrow ZnSO_{4(aq)} + Ni_{(s)}$$

We know,

$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{Ni^{2+}/Ni}$
$= 0.76 + (-0.25)$
$= 0.76 - 0.25$
$= 0.51$ V

Here, $E^0_{Zn^+/Zn} = -0.76$ V
$E^0_{Zn/Zn^{2+}} = 0.76$ V
$E^0_{Ni^{2+}/Ni} = -0.25$ V
$E^0_{cell} = ?$

As $E^0_{cell} > 0$, so the reaction will occur spontaneously. As a result zinc container will be corroded. So zinc container is not possible to keep anode solution of the stem.

Ques. ▶ 25 $X(s)/X^+_{(aq)}\,[0.01M]//Y^{2+}_{(aq)}\,[0.02M]/Y_{(s)}$
here, $E^\circ_{X/X^+} = +0.799$V and $E^\circ_{Y/Y^{2+}} = 2.87$V
[atomic mass of Br = 79.9]
[Bangladesh International School and College, Dhaka]

a. What is titration? 1
b. What is racemic mixture optically inactive? 2
c. 1.26F electricity is passed through solution of YBr_2: then what is the amount of molecules accumulated at anode? 3
d. Is there any change in *e.m.f* in case of given reaction and opposite reaction? Analyse mathematically. 4

Answer to the question no. 25

a Titration is the quantitative chemical analysis that is used to determine the concentration of an identified analyte.

b Recemic mixture is the equimolar mixture of two enantiomers. It is actually the equimolar mixture of d and *l* isomer. Racemic mixture is optically inactive. Because we know, d isomer rotates the polarized light to right direction and *l* isomer rotates the polarized light to left direction. The extant of rotation is same for both isomers. The relative rotation of d lactic acid is + 2.24° and relative rotation of *l* lactic acid is – 2.24°. The rotation of d*l* mixture is zero. So racemic mixture is optically inactive.

c In YBr_2 solution, the compound will be dissociated as follow –

$$YBr_{2(aq)} \longrightarrow Y^{2+}_{(aq)} + 2Br^-_{(aq)}$$

When current is passed through the solution Y^{2+} will be reduced at cathode and Br^- will be oxidized at anode.

The reaction at anode is –

$$2Br^- \longrightarrow Br_2 + 2e^-$$
$$1\text{ mol} \quad 2F$$

2F current flow will liberate 1 mol Br_2

1 F " " " " $\frac{1}{2}$ mol Br_2

1.26 F " " " " $\frac{1.26}{2}$ "

$= 0.63$ mol Br_2

$\therefore$ 1 mol Br_2 contains 6.02×10^{23} molecules

$\therefore$ 0.63 mol Br_2 " $6.02 \times 10^{23} \times 0.63$ "

$= 3.79449 \times 10^{23}$ "

$\therefore$ 3.79449×10^{23} molecules will be accumulated at anode.

d The given cell diagram is –

$X_{(s)}/X^+_{(aq)}\,[0.01M] \,//\, Y^{2+}_{(aq)}(0.02M)/\, Y_{(s)}$

The complete cell reaction is :

$$2X_{(s)} + Y^{2+}_{(aq)} \longrightarrow 2X^{2+}_{(aq)} + Y_{(s)}$$

According to reaction, X is anode and Y is cathode.

According to Nernst equation, We get,

$$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[X^+]^2}{[Y^{2+}]}$$

$$= (E^0_{X/X^+} + E^0_{Y^{2+}/Y}) - \frac{0.0592}{2} \log \frac{[X^+]^2}{[Y^{2+}]}$$

$$= 0.799 + (-2.87) - \frac{0.0592}{2} \log \frac{(0.01)^2}{0.02}$$

Here,
$E^0_{X/X^+} = 0.799$V
$E^0_{Y/Y^{2+}} = 2.87$ V
or, $E^0_{Y^{2+}/Y} = -2.87$ V
$[X^+] = 0.01$M
$[Y^{2+}] = 0.02$M
$n = 2$,
$E_{cell} = ?$

$= -2.071 - (-0.06811)$

$= -2,071 + 0.06811$

$= -2.0029V$

∴ The emf of the given cell is – 2.0029V

If the reaction is opposite the cell is –

$Y_{(s)}/Y^{+}_{(aq)}\ [0.02M] \parallel X^{+}_{(aq)}(0.01)/\ X_{(s)}$

The complete cell reaction is

$Y_{(s)} + 2X^{2+}_{(aq)} \longrightarrow Y^{2+}_{(aq)} + 2X_{(s)}$

According to Nernst equation,

We get,

$$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Y^{2+}]}{[X^{+}]^2}$$

$$= (E^0_{Y/Y^{2+}} + E^0_{X+/X}) - \frac{0.0592}{2} \log \frac{0.02}{(0.01)^2}$$

$= (2.87 - 0.799) - 0.06811$

$= 2.071 - 0.06811$

$= 2.0029$ V

Here,

$E^0_{X/X^{+}} = 0.799V$

or, $E^0_{X^{2+}/X} = -0.799V$

$E^0_{Y/Y^{2+}} = 2.87$ V

$n = 2$,

$[Y^{2+}] = 0.02M$

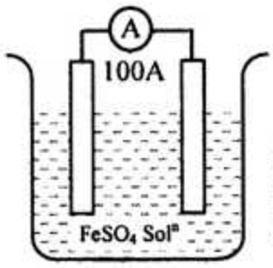
$[X^{+}] = 0.01M$

$E_{cell} = ?$

So if reaction is opposite the emf is 2,0029 V.

From the above analysis the value of emf is same but the sign is opposite.

Ques. ▶ 26



$E^0_{Cu^{2+}/Cu} = 0.34V$

$E_{Fe/Fe^{2+}} = +0.44V$

$E^0_{Zn/Zn^{2+}} = +0.76V$

[College of Development Alternative (CODA), Dhaka]

a. What is oxidation No? 1

b. Convent the 0.15M H_2SO_4 solution in terms of ppm. 2

c. Which amount of metal will be deposited at the cathode with in 20 minutes? 3

d. The solution of the stem can be preserved in Zinc or coper container? — Explain mathematically. 4

Answer to the question no. 26

a Oxidation number is the charged that assigned to an element which represent the number of electrons lost (positive charge) or number of electrons gained (negative charged).

b Here,

The concentration = 0.15 mol/L

$$= \frac{0.15 \text{ mol}}{L}$$

$$= \frac{0.15 \times 98g}{L}$$

[Molecular weight of H_2SO_4 is 98]

$$= \frac{0.15 \times 98 \times 1000 \text{ mg}}{L}$$

$= 14700\ mgL^{-1}$

$= 14700$ ppm.

∴ The concentration is 1400 ppm.

c In the stem, there is $FeSO_4$ solution. $FeSO_4$ will be dissociated to produce $Fe^{2+}_{(aq)}$ and $SO^{2-}_{4\,(aq)}$ when electricity is passed through the solution, $Fe^{2+}_{(aq)}$ will be shifted to cathode and reduced to Fe. As a result Fe metal will be deposited at cathode.

Cathode reaction,

From Faraday's 1st law we get,

$$W = ZIt$$

$$= \frac{55.85}{96500 \times 2} \times 100 \times 20 \times 60$$

$= 34.73g$

Here,

Flow of electricity, I = 100A

time, t = 20 min

$= (20 \times 60)$ sec

Electrochemical equivalent,

$$Z = \frac{55.85}{96500 \times 2}$$

Deposited weight, W = ?

So, 34.73g Fe will be deposited at the cathode within 20 minutes.

d When a solution is preserved in a container it should consider two matters.

i) Whether the container is anode or not.

ii) Whether the reaction is spontaneous or not.

For Zinc container, the probable reaction is—

$FeSO_{4(aq)} + Zn_{(s)} \longrightarrow ZnSO_{4(aq)} + Fe_{(S)}$

We know,

$E^{\circ}_{cell} = E^{\circ}_{Zn/Zn^{2+}} + E^{\circ}_{Fe^{2+}/Fe}$

$= 0.76 + (-0.44)$

$= 0.76 - 0.44$

$= 0.32V$

Here,

$E^{\circ}_{Fe/Fe^{2+}} = 0.44V$

$E^{\circ}_{Fe^{2+}/Fe} = -0.44V$

$E^{\circ}_{Zn/Zn^{2+}} = 0.76V$

As $E^{\circ}_{cell} > 0$. So reaction will occur sponotaneously. As a result Zinc container will be corroded. The solution can not be preserved in zinc container.

Again,

For Cu contain, the probable reaction is—

$Cu_{(S)} + FeSO_{4(aq)} \longrightarrow CuSO_{4(aq)} + Fe_{(S)}$

We know,

$E^{\circ}_{cell} = E^{\circ}_{Cu/Cu^{2+}} + E^{\circ}_{Fe^{2+}/Fe}$

$= -0.34 + (-0.44)$

$= -0.34 - 0.44$

$= -0.78V$

Here,

$E^{\circ}_{Cu^{2+}/Cu} = 0.34V$

$E^{\circ}_{Cu/Cu^{2+}} = -0.34V$

$E^{\circ}_{Fe/Fe^{2+}} = 0.44V$

$E^{\circ}_{Fe^{2+}/Fe} = -0.44V$

$E^{\circ}_{cell} = ?$

As $E^{\circ}_{cell} < 0$, so reaction will not occur spontaneously. Coper container is suitable to preserve steam solution.

Ques. ▶ 27 In a laboratory demonstrator said to keep nickel salt in a Cooper container but by mistake lab attendant kept it in zinc container. Oxidation potential of Ni and Zn are + 0.25V and + 0.76V respectively. *[Daffodil International College, Dhaka]*

a. What is salt bridge? 1

b. What does mean by electro chemical equivalent of Ag is $0.00118C^{-1}$? 2

c. How much gm of metal will be deposited if 0.1A of electricity passed by 60 min. 3

d. Analyze whether the salt can be kept in zinc container long time? 4

Answer to the question no. 27

a Salt bridge is an inverted U shapes glass tube containing an inert electrolyte (saturated) solution of KCl, KNO_3, NH_4NO_3) which controls the ionic balance between anode and cathode.

b Electrochemical equivalent is the amount of substance deposited due to flow of 1C electricity during electrolysis. Electrochemical equivalent of Ag is 0.001118 gC^{-1} means 0.001118g silver is deposited at cathode due flow of 1C electricity during electrolysis of Ag solution.

c During electrolysis of nickel salt Ni^{2+} will be shifted to cathode and reduced to Ni.

Cathode reaction : $Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(S)}$.

From Faraday's 1st law

We get,

$W = ZIt$

$= \frac{58.7}{96500 \times 2} \times 0.1 \times 60 \times 60$

$= 0.1095g$

Here,

Flow of electricity, $I = 0.1A$

time, $t = 60$ min

$= (60 \times 60)$ sec

Electrochemical equivalent of Nickel,

$Z = \frac{58.7}{96500 \times 2}$

Deposited metai, W= ?

∴ 0.1095g metal will be deposited.

d When a salt is kept in container, it should consider two matters.

i) Whether the container is anode or not.

ii) Whether the reaction is spontaneous or not.

If Nickel salt is kept in zinc container, the probable reaction is— $Zn_{(S)} + Ni^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Ni_{(S)}$.

We know,

$E^\circ_{cell} = E^\circ_{Zn/Zn^{2+}} + E^\circ_{Ni^{2+}/Ni}$

$= 0.76 + (-0.25)$

$= (0.76 - 0.25)$

$= 0.51V$

Here,

$E^\circ_{Ni/Ni^{2+}} = 0.25V$

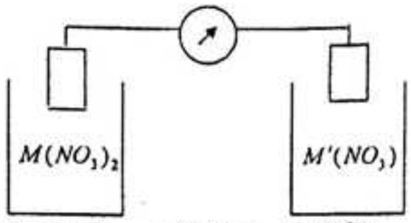
$E^\circ_{Ni^{2+}/Ni} = -0.25V$

$E^\circ_{Zn/Zn^{2+}} = 0.76V$

$E^\circ_{cell} = ?$

As E°_{cell} is positive, so spontaneous reaction will be occurred. As a result zinc container will react with Nickel salt. So it is not possible to keep the salt in the zinc container for long time.

Ques. ▶ 28



$E^\circ_{M^{2+}/M} = -0.25V$, $E^\circ_{M'^{+}/M'} = +0.799V$ and $E^\circ_{Zn^{2+}/Zn} = 0.76V$

[Millennium Scholastic School & College, Bogura]

a. What is green chemistry? 1

b. Why is CH_4 called paraffin? 2

c. What is the electromotive force in given stem? 3

d. Is it possible to keep the solution of Anode container in Zinc pot? Analyze mathematically. 4

Answer to the question no. 28

a Green chemistry is an area of chemistry and chemical engineering that focuses on the designing of products and processes that minimize the use and generation of hazardous substances.

b Paraffin means little or no attraction CH_4 (alkane) is called paraffin. In CH_4 molecule central carbon atom is sp^3 hybridized. There is only sigma bond between carbon and hydrogen. Sigma bond is strong and high energy is needed to break it.

As a result CH_4 does not react with acid, base or any other general reagents. So methanol (CH_4) is called paraffin.

c In the stem the cell is an electrochemical cell, According to stem cell, M/M^{2+} electrode is anode and M'/M'^{+} electrode is cathode.

The cell reaction is

$M_{(s)} + 2M'NO_{3(aq)} \rightarrow M(NO_3)_{2(aq)} + 2M'_{(s)}$

$E^0_{cell} = E^0_{M/M^{2+}} + E^0_{M'^{+}/M'}$

$= (0.25 + 0.799)$ V

$= 1.049$ V

∴ Electromotive force of the cell is 1.049 V

Here, $E^0_{M^{2+}/M} = -0.25V$

$E^0_{M/M^{2+}} = 0.25V$

$\Rightarrow E^0_{M'^{+}/M'} = 0.799V$

$E^0_{cell} = ?$

d In the stem, there is $M(NO_3)_2$ solution. To keep a solution to a container if should consider two matters.

i) Whether the container is anode or not

ii) Whether the reaction is spontaneous or not.

The probable reaction when anode solution is kept in Zinc pot is.

$Zn + M(NO_3)_2 \rightarrow Zn(NO_3)_2 + M^{2+}$

We know,

$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{M^{2+}/M}$

$= 0.76 + (-0.25)$

$= 0.76 - 0.25$

$= 0.51$ V

Here,

$E^0_{M^{2+}/M} = -0.25V$

$E^0_{Zn^{2+}/Zn} = -0.76V$

$E^0_{Zn/Zn^{+2}} = 0.76V$

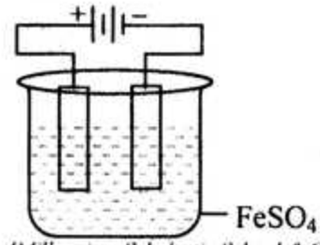
As $E^0_{cell} > 0$, So the reaction will occur spontaneously. As a result Zinc pot will be corroded. So it is not possible to keep Anode solution to Zinc pot.

Ques. ▶ 29 Standard electrode potentials of same metals and cell diagram are —

i. $E^\circ_{Cu/Cu^2} = -0.34V$

ii. $E^\circ_{Fe/Fe^{2+}} = 0.44V$

iii. $E_{Zn/Zn^{2+}} = 0.74V$



[Millennium Scholastic School & College, Bogura]

a. What is nano particle? 1

b. Why ETP is used in industry? 2

c. How much gm of metal will deposit to cathode when 250A current is passed for 40 minutes? 3

d. Which one is suitable to keep the solution of stem in the pot and copper pot-analyze. 4

Answer to the question no. 29

a The microscopic particle which size varies among 1 – 100 nm is Called nano-particle.

b ETP stands for effluent treatment plant. In present world Water is polluted by textile and dyeing, leather, pulp paper, Cements, Steel etc. industrial waste. There is organic and inorganic pollutants in waste water. ETP helps in removing contaminants from waste, water and industrial effluent, water that are used by industry ETP makes waste water to reusable water. For this reason ETP is used in industry.

c In $FeSO_4$solution, $FeSO_4$ dissociates to $Fe^{2+}_{(aq)}$ and $SO_4^{2-}{}_{(aq)}$.

When current is passed through the solution. Fe^{2+} moves to cathode and reduced to Fe metal.

$FeSO_{4(aq)} \longrightarrow Fe^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$

Cathode reaction : $Fe^{2+}_{(aq)} + 2e^- \longrightarrow Fe_{(s)}$

According to Faraday's 1st law,
$W = ZIt$
$= \frac{55.85}{96500 \times 2} \times 250 \times 2400$
$= 176.63$ g
The deposited mass of iron is 176.63 g.

Here,
Current, I = 250A
Time, t = 40 min = (40 × 60) s
= 2400 sec
Electrochemical equivalent,
$Z = \frac{55.85}{96500 \times 2}$
Deposited weight, w = ?

d In the stem cell, there is $FeSO_4$ solution. To preserve a solution in a container it should consider two matters.

i) Whether the container is anode or not

ii) Whether the reaction is spontaneous or not.

For Zinc container, the probable reaction is–

$Zn_{(s)} + FeSO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + Fe_{(s)}$

$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{Fe^{2+}/Fe}$
$= 0.74 + (-0.44)$
$= (0.74 - 0.44)$ V
$= 0.30$ V

Here,
$E^0_{Zn^+/Zn} = 0.74$V
$E^0_{Fe/Fe^{2+}} = 0.44$V
$E^0_{Fe^{2+}/Fe} = -0.44$V
$E^0_{cell} = ?$

As $E^0_{cell} > 0$, So the reaction will occur spontaneously.

As a result Zinc pot will be corroded. So zinc pot is not suitable to keep the stem solution.

For Copper pot

The probable reaction is

$Cu_{(s)} + FeSO_{4(aq)} \longrightarrow CuSO_{4(aq)} + Fe_{(s)}$

$E^0_{cell} = E^0_{Cu/Cu^{2+}} + E^0_{Fe^{2+}/Fe}$
$= 0.34 + (-0.44)$
$= -0.34 - 0.44$
$= -0.78$ V

Here, $E^0_{Cu/Cu^{2+}} = 0.34$V
$E^0_{Fe/Fe^{2+}} = 0.44$V
$E^0_{Fe^{2+}/Fe} = -0.44$V
$E^0_{cell} = ?$

As the cell potential is negative.
So the reaction will not occur spontaneously. For this reason, Copper pot is suitable to keep stem solution.

Ques. ▶ 30 $Al(S) \mid Al^{3+}(aq) \parallel Sn^{2+}(aq) \mid Sn(s)$

$E_{0Al^{3+}/Al} = -1.66$(V)

$E_{0Sn^{2+}/Sn} = -0.14$(V)

[The Millennium stars School and College, Rungpur]

a. What is CFC? 1

b. How does chromium effect on human health? 2

c. The concentration of Sn^{2+} and Al^{+3} are 0.15 M and 0.25M respectively. Determine the electromotive force of the cell. 3

d. How will you explain electric conductivity when above data complete a cell? Analyze. 4

Answer to the question no. 30

a CFC: CFC means Chlorofluorocarbon derived from methane (CH_4) and ethane.

b Chromium is a heavy metal. Different industries e.g tanning industry emit chromium containing waste. Chromium associates is human body through food chain. The effects of chromium on human body are chromium affects the respiratory system, digestive system and immune system of body Cr(vi) act as carcinogen in human body. chromium prevents the synthesis of hemoglobin. It causes anemia. It is also responsible for asthma.

c Given

$E_{0\,Al^{3+}/Al} = -1.66$ V

$E_{0Sn^{2+}/Sn} = -0.14$ V

The cell is $Al_{(s)}/Al^{3+}_{(aq)} \parallel Sn^{2+}(aq) / Sn_{(S)}$

From the cell, Al is oxidized to Al^{3+} and Sn^{2+} is reduced to Sn. So Al electrode will be anode and Sn electrode will be cathode.

The complete reaction of the cell is –

$3Al_{(s)} + 3Sn^{2+}_{(aq)} \longrightarrow 3Sn_{(s)} + 2Al^{3+}_{(aq)}$ According to Nernst equation.

$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Al^{3+}]^2}{[Sn^{2+}]^3}$

$= (E^0_{Ox} + E^0_{red}) - \frac{0.0592}{n} \log \frac{[Al^{3+}]^2}{[Sn^{2+}]^3}$

$= [1.66 + (-.014) - \frac{0.0592}{n} \log \frac{(0.25)^2}{(0.15)^3}$

$= 1.52 - \frac{0.0592}{n} \times 1.2676$

$= (1.52 - 0.01250)$ v

$= 1.5075$ v

Here,
$E_0\,Al^{3+}_{(aq)}/Al_{(s)} = -1.66$ V
$E_0 Al_{(s)}/Al^{3+}_{(aq)} = 1.66$ V
$E_0 Sn^{2+} / Sn_{(s)} = -0.14$ V
$[Sn^{2+}] = 0.15$ M
$[Al^{3+}] = 0.25$ M
$n = 6$
$E_{cell} = ?$

∴ Electromotive force of the cell is 1.5675 v.

d The cell diagram of the stem cell is

$Al_{(s)}/Al^{3+}_{(aq)} \parallel Sn^{2+}_{(aq)}/Sn_{(s)}$

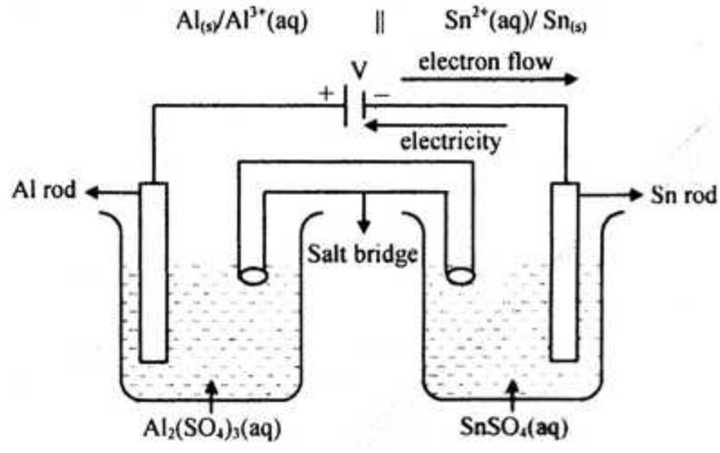


Diagram : Electrochemical Cell

In the above electrochemical cell, Aluminum electrode acts as anode which is dipped into $Al_2(SO_4)_3$ solution. And Sn electrode act as cathode which is dipped into $SnSO_4$ solution. Anode is Connected with the negative end and positive end of the voltammeter.

Salt bridge is used to control the ionic balance between anode and cathode solution.

In anode, Aluminium donates 3 elections to form $Al^{3+}(aq)$ which enters into the solution.

Anode reaction :

$Al_{(s)} \longrightarrow Al^{3+}(aq) + 3e^-$(Oxidation)

The electrons pass through the wire to the cathode. In cathode Sn^{2+} accept the electrons to reduce to Sn(s)

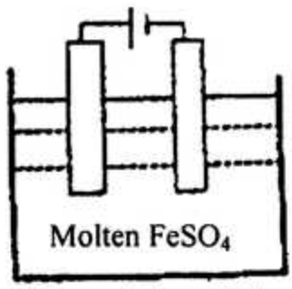
Cathode reaction :

$Sn^{2+}(aq) + 2e^- \longrightarrow Sn^{(s)}$ [Reduction]

Due to movement of electons from Anode to cathode electric conductivity is produced from Cathode to Anode.

Sufficient posivtive and negative charges diffuse to cathode and anode respectively to continue electrons flow.
So, from the above explantion we can conclude that, in the stem cell electric conductivity is produced due to spontaneous redox rection.

Ques. ▶ 31 Observe the following figure and answer the related questions:



Given that 2A current is passed through the electrolyte for 10 minutes. *[Cantonment English School and College, Chattogram]*

a. What is Lucas reagent? 1
b. 'BOD of a sample of water is 10ppm'. Explain. 2
c. Calculate the amount of 'Fe' deposited at cathode. 3
d. Which of the vessels between 'Zn' & 'Sn' will be suitable to store the electrolyte of the stem? Analyze mathematically.

[Given, $E°_{Fe^{2+}/Fe} = -0.44V$, $E°_{Zn^{2+}/Zn} = -0.76V$, $E°_{Sn^{+2}/Sn} = -0.14V$] 4

Answer to the question no. 31

a Lucas reagent is the mixture of concentrated hydrochloric acid (HCl) with anhydrous ($ZnCl_2$)

b BOD stands for "Biochemical Oxygen Demand". It is the amount of oxygen needed to oxidize biodegradable organic pollutants present in water, BOD of water sample is 100ppm means 10 mg oxygen is needed to oxidize organic pollutants (biodegradable) present in 1 L water sample.

c In the stem cell, electrolysis of molten $FeSO_4$ is shown. In molten $FeSO_4$ solution there is Fe^{2+} and SO_4^{2-} ion. During electrolysis Fe^{2+} reduced to Fe by taking electrons at Cathode.

$FeSO_{4(l)} \longrightarrow Fe^{2+}_{(l)} + SO_4^{2-}{}_{(l)}$

Cathode reaction : $Fe^{2+}_{(l)} + 2e^- \longrightarrow Fe_{(l)}$

According to Faraday's 1st law, deposited weight,

$W = ZIt$

$= \frac{55.85}{96500 \times 2} \times 2 \times 600$

$= 0.34725$ g

$\therefore$ 0.34725 g Fe will be deposited at cathode.

Here,
Current, I = 2A
Time, t = 10 min = (10 × 60) s
= 600 sec
Electrochemical equivalent,
$Z = \frac{55.85}{96500 \times 2}$
Deposited weight, w = ?

d To store electrolyte in a container it should consider two matters. Such as-

i) Whether the container is anode or not

ii) Whether the reaction is spontaneous or not. .

For Zn container, the probable reaction is-

$Zn_{(s)} + Fe^{2+}_{(aq)} \longrightarrow Fe_{(s)} + Zn^{2+}_{(aq)}$

$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{Fe^{2+}/Fe}$
$= 0.76 - 0.44$
$= 0.32$ V

Here,
$E^0_{Fe^{2+}/Fe} = -0.44V$
$E^0_{Zn^{2+}/Zn} = -0.76V$
$\Rightarrow E^0_{Zn/Zn^{2+}} = 0.76V$

For Sn container, the probable reaction is,

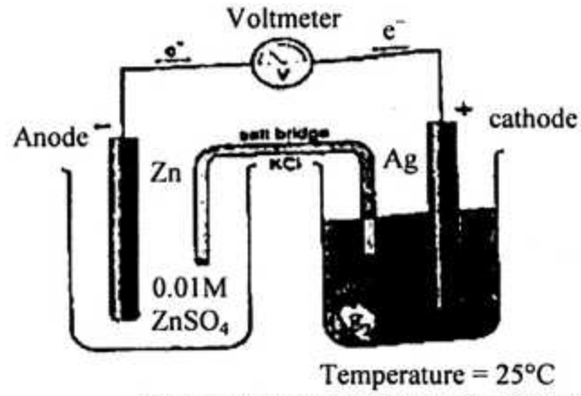
$Sn_{(s)} + Fe^{2+}_{(aq)} \longrightarrow Sn^{2+}_{(aq)} + Fe_{(s)}$

$E^0_{cell} = E^0_{Sn/Sn^{2+}} + E^0_{Fe^{2+}/Fe}$
$= 0.14 + (-0.44)$
$= 0.14 - 0.44$
$= -0.30$ v

Here,
$E^0_{Fe^{2+}/Fe} = -0.44V$
$E^0_{Sn^{2+}/Sn} = -0.14V$
$\Rightarrow E^0_{Sn/Sn^{2+}} = 0.14V$

As E°_{Cell} for Zn container is positive. So reaction will occur spontaneously in Zinc container. As a result Zn will be corrided. So it's not possible to store electrolyte in Zinc container.
On the other hand, E^0_{cell} for Sn container is negative. So reaction will not occur spontaneously. Hence Sn container is suitable for storn storing electrolyte.

Ques. ▶ 32



Temperature = 25°C

[Cantonment English School and College, Chattogram]

a. What is CFC? 1
b. Propyne is acidic. Explain. 2
c. Write the cell diagram of the given cell. 3
d. Is the given cell spontaneous? Analyze mathematically. 4

Answer to the question no. 32

a CFC : CFC stands for Chlorofluro Carbon derived from methane and ethane.

b Propyne ($CH_3 - C \equiv CH$) is acidic. Because 1 no carbon atom Propyne is sp hybridized. In SP hybridization the ratio of s and p is 1 : 1. As ratio of small s orbital is higher in sp hybridization the bond hydrogen becomes weak. For this reason propyne easily donates proton of 1 no carbon by breaking C – H bond. So Propyne is acidic.

c In the stem, cell diagram, Zn electrode attaches with the negative end of the volatmeter, So Zn electrode is anode. On the other hand, Ag electrode connects with the positive end of the volatmeter. So Ag electrode is cathode. We know, oxidation occurs at anode and reduction occurs at cathode.

Oxidation half reaction :

$Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^-$ (Anode reaction)

Oxidation half cell is : $Zn(s)/Zn^{2+}_{(aq)}$ (0.01M)

Reduction half reaction :

$2Ag^+_{(aq)} + 2e^- \longrightarrow 2Ag_{(s)}$ (Cathode reaction)

Reduction half cell: Ag^+ (0.05M)/$Ag_{(s)}$

∴ The Complete reaction is

$Zn_{(s)} + 2Ag^+_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)}$

Or, $Zn_{(s)} + Ag_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + 2Ag_{(s)}$

Complete Cell is :

$$Zn_{(s)}/Zn^{2+}_{(aq)}\ (0.01M) \parallel Ag^+_{(aq)}\ (0.05M)/Ag_{(s)}$$

d The complete cell reaction of the above cell is -

$Zn_{(s)} + 2Ag^+_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)}$

According to Nernst equation, we get,

$$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Zn^{2+}]}{[Ag^+]^2}$$

$$\Rightarrow E_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{Ag^+/Ag} - \frac{0.0592}{n} \log \frac{[Zn^{2+}]}{[Ag^+]^2}$$

$$= (0.76 + 0.80) - \frac{0.0592}{2} \log \frac{0.01}{(0.05)^2}$$

$= 1.56 - 0.0178$

$= 1.5421$ V

Here,
We know,
Oxidation potential of Zn, $E^0_{Zn/Zn^{2+}} = 0.76$v
Reduction potential of Ag,
$E^0_{Ag^+/Ag} = 0.80$ V
$[Zn^{2+}] = 0.01$M
$[Ag^+] = 0.05$M
$n = 2$, $E_{cell} = ?$

As $E_{cell} > 0$. So reaction will occur spontaneously.

Ques. ▶ 33

i. $Fe_{(s)}/Fe^{2+}_{(aq)} \parallel Cu_{(aq)}{}^{2+}/Cu_{(S)}$
ii. $Ag/Ag^+_{(aq)} \parallel Zn^{2+}/Zn$

Here, $E^\circ_{Fe/Fe^{2+}} = +0.44$V and $E^\circ_{Cu^{2+}/Cu} = 0.34$V and

$E^\circ_{Ag/Ag^+} = -0.799$V and $E^\circ_{Zn^{2+}/Zn} = -0.76$V

[Mirzapur Cadet College, Tangail]

a. What is salt-bridge? 1
b. Fuel cell is friendly to environment— Explain. 2
c. If 160 mA current is passed though the cell no. (i) for 10 minutes, then calculate the amount of deposited metal at the cathode chamber. 3
d. Cell reaction of which of the above cell occurs spontaneously?— Analyze mathematically. 4

Answer to the question no. 33

a Salt bridge is a table containing an electrolyte (typically in the form of a gel) providing electrical contact between two solution of electrochemical cell.

b Fuel cells have been widely touted as an environmentally friendly alternative to conventional fossil fuels. By oxidising molecular hydrogen, the only direct by-product of their energy generation is water, which means they could significantly reduce pollution and man-made greenhouse gases. The by products that produce through fuel cells are harmless to environment.

c Cell number (i) stated in stem is given below.

(i) $Fe_{(s)}/Fe^{2+}_{(aq)} \parallel Cu^{2+}_{(aq)}/Cu_{(S)}$

According to this cell, the cell reaction is

$Fe^{2+}_{(S)} + Cu^{2+}_{(aq)} \rightleftharpoons Fe^{2+}_{(aq)} + Cu_{(S)}$

Thus, metallic Cu(s) is deposit in the cathode of the above cell.

Here, current flow, $I = 160$ mA $= 160 \times 10^{-3}$ Amp

Flow time, $t = 10$ min $= (10 \times 60)$ sec $= 600$ sec

Electrochemical equivalent weight of Cu,

$$Z = \frac{63.5}{2 \times 96500}\ g/C = 3.29 \times 10^{-4}\ g/C$$

We have, $W = ZIt$

$\Rightarrow W_{Cu} = (3.29 \times 10^{-4} \times 160 \times 10^{-3} \times 600)$ g

$\therefore W_{Cu} = 0.016$ g

Therefore, Deposited Cu the cathode chamber 0.016 g.

d The cell reaction of cell (i) stated in stem :

(i) $Fe_{(S)} + Cu^{2+}_{(aq)} \rightleftharpoons Fe^{2+}_{(aq)} + Cu_{(S)}$

$E^\circ_{cell} = E^\circ_{Fe/Fe^{2+}} + E^\circ_{Cu^{2+}/Cu}$
$= (0.44 + 0.34)$ V $= 0.78$ V

The cell reaction of cell (ii) stated in stem :

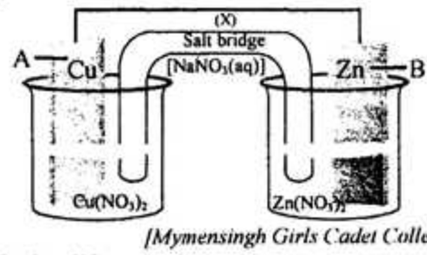
(ii) $Ag/Ag^+_{(aq)} \parallel Zn^{2+}/Zn$

Reaction : $2Ag_{(s)} + Zn^{2+}_{(aq)} \rightleftharpoons Ag^+_{(aq)} + Zn_{(S)}$

$E^\circ_{cell} = E^\circ_{Ag/Ag^+} + E^\circ_{Zn^{2+}/Zn}$
$= (-0.799 + 0.76)$ V $= -1.559$ V

E°_{cell} for cell (i) and (ii) are positive and negative respectively. So reaction of cell (i) occurs spontaneously and reaction of cell (ii) does not occurs spontaneously.

Ques. ▶ 34



[Mymensingh Girls Cadet College, Mymensingh]

a. What is fuel cell? 1
b. What is the difference between the action of metallic conductor and electrolytic conductor? 2
c. Explain the importance of X on above process. 3
d. Identify the direction of electric flow with proper reaction in above process. 4

Answer to the question no. 34

a A fuel cell is an electrochemical cell that converts the chemical energy from a fuel into electricity through an electrochemical reaction of hydrogen fuel with oxygen or another oxidizing agent.

b

Metallic conductor	Electrolytic conductor
1. The flow of electron is responsible for this conduction.	1. The movement of ions in the solution or fused electrolyte is responsible for this conduction.
2. Metallic conductor does not undergo any chemical change.	2. Electrolytic conductor undergoes chemical changes at the electrodes.
3. Metallic conduction does not involve the transfer of any matter.	3. This conduction involves the transfer of matter in the form of ions.

c The X stated in the figure of stem is salt bridge of galvanic cell. the role of salt bridge (X) explained as follows.

i. Salt bridge completes the electric circuit: The salt bridge connects the two solution of the half cells and their electrodes are connected by means of a wire. Therefore, the slat bridge completes the circuit.

ii. Salt bridge maintain electrical neutrality of two half-cell solutions : To understand the function of the salt bridge. Let us consider the cell without a salt bridge. The electrons released by the oxidation of Zn to Zn^{2+} ions will be accepted by the Cu^{2+} ions of Cu $(NO^{-}_{3})_2$ in the other half cell and the latter will be reduced to copper. This positively charged Zn^{2+} ions passed into the solution. After sometimes this result in to accumulation of extra positive charge in the solution around the anode. Similarly, due to the reduction of some Cu^{2+} ions to Cu, the solution around cathode will acquire extra negative charge due to excess of NO^{-}_{3} ions. The accumulation of positive charge around zinc rod will prevent the further flow of electrons from the zinc rod. Similarly, the accumulation of negative charge around copper electrode will prevent the flow of electrons to the copper ions. Thus, the flow of electrons will occur only momentarily and the cell will stop working. However, the accumulation of charges on the two half cells is prevented by using salt bridge, which provides a passage for the flow of the charge in the internal circuit. When the concentration of Zn^{2+} ions around anode increases, sufficient number of NO_3 ions migrate form the salt bridge to the anode of cell. Similarly, to neutralize the excess negative charge due to the additional NO_3^- ions in cathode half cell, sufficient number of Na^+ ions migrate from the salt bridge to this half cell. Thus, the salt bridge provides cations and anions to replace the ions lost or produced in the two half cells.

d The direction of electron flow will be from right to left as metioned cell in the stem. The overall process is describe below.

Here Zn plate is in contact with Zn^{2+} ions. Each of the Zinc atoms from the Zinc plate is oxidized to from Zn^{2+} ion by the loss of 2 electrons. $Zn(NO_3)_2$ Solution).

$$Zn \longrightarrow Zn^{++} + 2e$$

Zn^{++} ions thus produced pass into the solution and the electrons left by them flow away from the zinc plate (since temporarily electrons are generated of the zinc electrode, it is referred to as negative electrode) to the copper plate.

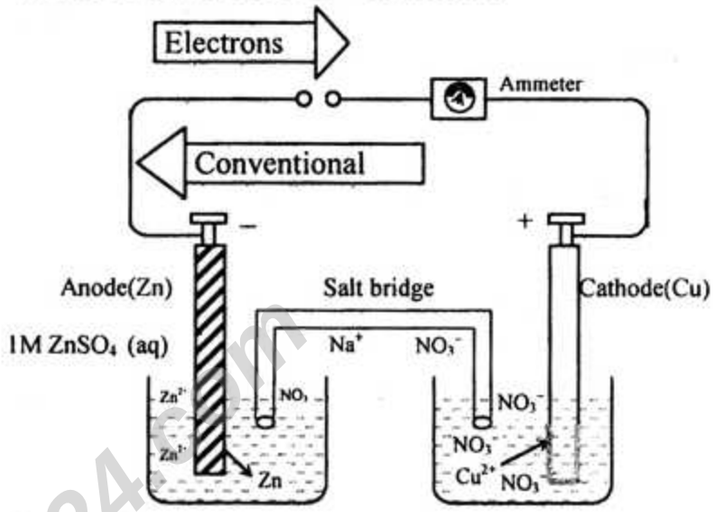
The copper plate is in contact with Cu^{++} ions $Cu(NO_3)_2$ solution). Here each Cu^{++} ion accepts two electrons coming from zinc plate and are deposited on the copper plate as metallic copper.

$$Cu^{++} + 2e \longrightarrow Cu$$

The flow of electrons from zinc plate to copper plate is responsible for the generation of current by cell. The overall chemical reaction is,

$$Zn + Cu^{++} \longrightarrow Zn^{++} + Cu$$

The liberation of electrical energy is attributed to the above overall chemical reaction taking place in the cell. As the reaction proceeds, the zinc plate decreases in weight, copper plate increases in weight, concentration of Cu^{++} ion decreases while the concentration of Zn^{++} ion increase.



Ques. ▶ 35

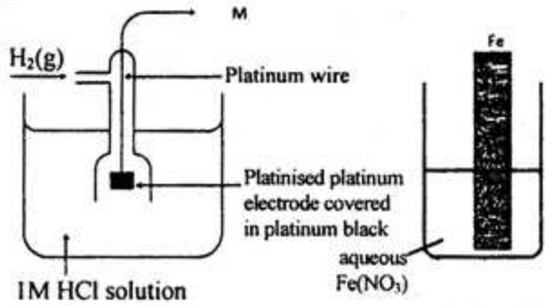


Figure-1 Figure-2

Here, $E^{\circ}_{(ox)} = +0.44V$

[Mymensingh Girls Cadet College, Mymensingh]

a. What is electromotive force? 1

b. Why is anode called oxidizing electrode? 2

c. How colud you explain the reason of creating electrode potential over Fe in figure-2? 3

d. Do you think the mentioned electrodes will produce a spontaneous electrochemical cell? If so, how could you describe its function? 4

Answer to the question no. 35

a Electromotive force (emf) is defined as the potential deference in charge between two points in a circuit that tends to give rise to an electric current.

b The anode is the electrode where oxidation (loss of electrons) takes place, in a galvanic cell, it is the negative electrode, as when oxidation occurs, electrons are left behind on the electrode. The anode is also the electrode where metal atoms give up their electrons to the metal and go into solution.

Thus, the oxidation always take place at anode, therefore the anode is called oxidizing electrode.

In Galvanic cell Zn is oxidized at anode: $Zn(s) \rightarrow Zn^{2+} + 2e^-$ (oxidation)

c According to the figure–2 stated in stem, there is an electrode where Fe in dipped into $Fe(NO_3)_2$ solution.

When a metal is immersed in a solution containing its own ion, then it losses its outermost electron to create M+ ions and equilibrium is established.

$$M \rightleftharpoons M^{n+} + ne^-$$

Thus Fe metal goes into solution my giving Fe^{2+} ion.

$Fe(s) \rightleftharpoons Fe^{2+} + 2e^-$, This is oxidation and as a result the metal will become negatively charged. As a result, a potential deference is developed when Fe metal in contact with $Fe(NO_3)_2$ solution.

d According to he stem, the cell will be formed as follows.

$$Fe/Fe^{2+} \| H^+/H_2, Pt$$

$$\text{Cell reaction : } Fe + 2H^+ \rightleftharpoons Fe^{2+} + H_2$$

$$E^\circ = E^\circ_{Fe/Fe^{2+}} + E^\circ_{2H^+/H_2}$$

$$= +0.44 + 0$$

$$= +0.44 \text{ V}$$

As E° is +ve, then the electrodes produce a spontaneous electrochemical cell.

The metallic iron donate electron and produces Fe^{2+} ion. The electron goes cathode through outer circuit. The H^+ in H_2–cell accept this upcoming electrons and produced H_2 gas spontaneously. Therefore a electron flow is maintained from anode to cathode through the circuit.

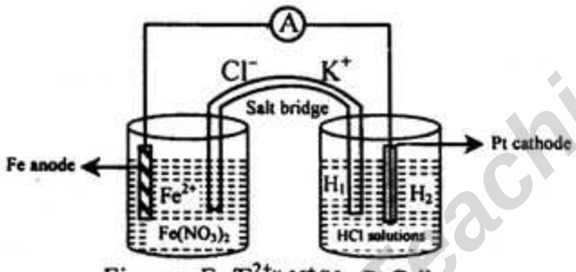


Figure : $Fe/F^{2+} \| H^+/H_2$, Pt Cell

Ques. ▶ 36 (i) $E^\circ_{A/A^{2+}} = 0.13$ V

(i) $E^\circ_{B^{2+}/B} = -0.44$ V

(iii) $E^\circ_{C^{2+}/C} = -0.14$ V

(iv) $E^\circ_{D/D^+} = -0.80$ V

(v) ACl_2 solution

[Rajshahi Cadet college, Rajshahi]

a. What is critical temperature? 1

b. Why is acidic $H_2C_2O_4$ a reductant? Explain. 2

c. Draw the cell by using (i) and (ii) mentioning cell reaction. 3

d. Can the solution of (v) be kept safe in the container mode by B, C or D? Analyze it mathematically. 4

Answer to the question no. 36

a The temperature above which a gas can not be liquefied by applying high pressure, nut the temperature at or below which a gas could be liquefied by applying pressure only is called the critical temperature of gas.

b Oxalic acid ($H_2C_2O_4$) is a strong reducing agent at acidic solution. In acidic solution $H_2C_2O_4$is oxidized to CO_2 and $2H^+$

$$\overset{+3}{H_2C_2O_4} - 2e^- \longrightarrow \overset{+4}{2CO_2} + 2H^+$$

Oxidation

The species who is oxidized in oxidation reactant is called reductant oxalic acid oxidized CO_2 therefore $H_2C_2O_4$ is reductant.

c According to the stem,

i) $E^0_{A/A^{2+}} = 0.13$ V

ii) $E^0_{B^{2+}/B} = -0.44$ V

or, $E^0_{B/B^{2+}} = +0.44$ V

As the oxidation Potential of metal B is higher than of metal A. Therefore B is oxidized and A will be reduced.

The cell notation: $B/B^{2+} \| A^{2+}/A$

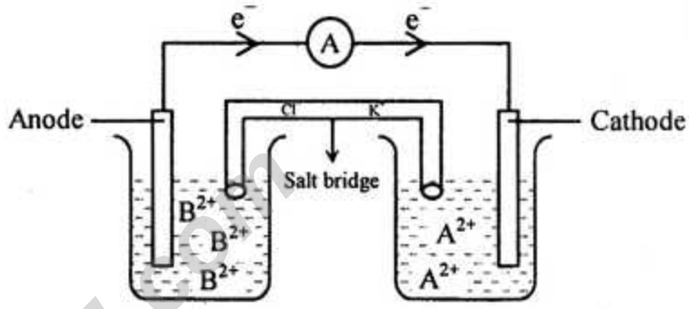


Figure : Cell of $B^{2+}/B \parallel_{A2+/A}$

d According to the stem, solution (v) is ACl_2 solution when ACl_2 solution kept in B-container, then the cell reaction occur as follows.

$$A^{2+} + B \rightleftharpoons A + B^{2+}$$

$$\therefore E^0_{Cell} = E^0_{B/B^{2+}} + E^0_{A^{2+}/A}$$

$$= +0.44 + (-0.13) \text{ Volts}$$

$$= +0.31 \text{ V}$$

When ACl_2 solution kept in C–Container, then the cell reaction:

$$A^{2+} + C \rightleftharpoons A + C^{2+}$$

$$\therefore E^0_{Cell} = E^0_{C/C^{2+}} + E^0_{A^{2+}/A}$$

$$= +0.14 + (-0.13)$$

$$= +0.01 \text{ volt}$$

When ACl_2 solution kept in D–container then the cell reaction:

$$A^{2+} + 2D \rightleftharpoons A + 2D^+$$

$$E^0_{Cell} = E^0_{D/D^+} + E^0_{A^{2+}/A}$$

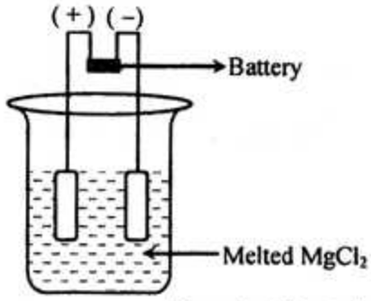
$$= -0.80 + (-.013)$$

$$= -0.93 \text{ volt}$$

When ACl_2 solution was kept into B and C container, then the E^0_{Cell} were Positive which indicate the sponteneous reaction were take place. Therefore ACl_2 was not kept into B and c–Container.

On the other hand, when $AlCl_2$ solution was kept into D - Container the E_{Cell} was negative which indicate the non-spontaneous reaction. Therefore solution of ACl_2will be kept into D-Container.

Ques. ▶ 37



[Joypurhat Girls Cadet College, Joypurhat]

a. What is nano-particle? 1
b. Write the Vander Waals equation for 64g oxygen gas. 2
c. Show the reaction occurred in anode of the stem cell. 3
d. Analyze logically the necessity of flow of electricity to occur reaction in the stem cell. 4

Answer to the question no. 37

a Nano-praticle is the smallest particle of substance where the size of particle can be from 1×10^{-9} of 1×10^{-7}m.

b The equation of Vander Waals is, $\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$

We know,

32 g O_2 = 1 mol

$\therefore$ 64 g O_2 = 2 mol

the Vander Waals equation for 64 gm O_2,

$\left(P + \frac{2^2a}{V^2}\right)(V - 2b) = 2RT$

Or, $\left(P + \frac{4a}{V^2}\right)(V - 2b) = 2RT$

Here,
P = Pressure
V = Volume
n = mol number
T = Absolute temperatures
R = Universal constant

c The above picture, we can see its a electrolytic cell where Electrical energy is converted into chemical energy. A non spontaneous chemical reaction occurs in the cell. In the cell, the aqueous solution is melted $MgCl_2$. In cathode, where negative ion donates electron and turn into gas. In anode, where positive ion takes e^- and turn into metal.

The whole reaction of above cell,

$MgCl_2(s) \longrightarrow Mg^{2+}(aq) + 2Cl^-(aq)$

Anode reaction,

$2Cl^-(aq) \longrightarrow Cl_2(g) + 2e^-$

$H_2O(l) \longrightarrow 2H^+(aq) + \frac{1}{2}O_2(g) + 2e^-$

d In aqueous solution $MgCl_2$ is almost completely dissociated to produced $Mg^{2+}(aq)$ and $Cl^-(aq)$.

So, in concentrated aqueous $MgCl_2$ solution, $Mg^{2+}(aq)$, $Cl^-(aq)$ and $H_2O(l)$ are present. As electricity (DC) is passed through the solution, probable reactions at the electrodes are as follows–

Cathode reaction,

$Mg^{2+} + 2e^- \longrightarrow Mg(s)$

$2H_2O(l) + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$

Anode recction,

$2Cl^-(aq) \longrightarrow Cl_2(g) + 2e^-$

$H_2O(l) \longrightarrow 2H^+(aq) + \frac{1}{2}O_2(g) + 2e$

In this reaction, Cl^- is Oxidised at the anode to give $Cl_2(g)$. This is due to over voltage or over potential, which is the amount of excess potential required over theoretical Potential for electron transfer at electrodes for liberation of gases like oxygen or hydrogen. If there is no flow of electricity, the $MgCl_2$ will not be dissociated and the reaction process will be stopped. The flow of electricity is the primary key of the whole function.

Ques. ▶ 38 Recently Engr. Suman Nag has joined a electronic company which produces rechargeable battery and does merchandise but the products fall behind in market. On investigation, the engineer finds out some problem, in Lead-acid storage battery. To solve the market problem Mr. Suman replaces Lead acid battery by Lithium-ion battery and then the company gains good-will. *[Joypurhat Girls Cadet College, Joypurhat]*

a. Write Nernst equation for cell potential. 1
b. 'Hydrogen-fuel cell is greener.'— Explain. 2
c. As per stem, write the construction and both cell reactions of the battery which was produced before Mr. Suman's joining. 3
d. Compare the advantages and disadvantages f the two types of batteries as per given stem. 4

Answer to the question no. 38

a Nernst equation for cell potential,

$E_{(M^{n+}/M)} = E^0_{(M^{n+}/M)} - \frac{RT}{nF}\ln\frac{[M](s)}{[M^{n+}](aq)}$

Or, $E_{(M^{n+}/M)} = E^0_{(M^{n+}/M)} - \frac{1.303\,RT}{nF}\log\frac{[M](s)}{[M^{n+}](aq)}$

Here,
$E_{(M^{n+}/M)}$ cell potential and $E^0_{(M^{n+}/M)}$ = standard
R = molar gas constant electrode potential
n = number of electricity (Faraday)
$[M^{n+}](aq)$ = molar concentration of ion.

b Hydrogen fuel cell is a greener.

Reaction at anode : $2H_2 \rightarrow 4H^+ + 4e^-$

Reaction at Cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

Overall reaction : $2H_2 + O_2 \longrightarrow 2H_2O$ $\quad E^0 = 1.23V$

The products of hydrogen fuel cell water and heat. No greenhouse gas is produced from it, Therefore environment polution is markedly reduced. This hydrogen fuel cell is environmentally friendly.

c As per stem, the battery which was produced before Mr. Suman's joining is lead-acid storge battery. The construction and both cell reactions of the battery is given below–

Each battery consists of number of voltaic cells connected in series. Three to six such cells are generally combined to get 6 to 12 volt battery. In each cell, the anode is a grid of lead packed with finely divided spongy lead and the cathode is a grid of lead.

packed with, PbO_2. The electrolyte is aqueous solution of sulphuric acid (38% by mass) having a density 1.30 gml^{-1} sulphuric acid.

When the lead plates are kept for sometimes, lead sulphate formed on them.

At the anode, lead is oxidized to Pb^{2+} ions and insoluble $PbSO_4$ is formed. At the cathode PbO_2 is reduced to Pb^{2+} ions and $PbSO_4$ is formed.

The following reactions take place in the lead storage cell:

Anode: $Pb(s) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2e^-$

Cathode : $PbO_2(s) + 4H^+ + SO_4^{2-} + 2e^- \longrightarrow PbSO_4 + 2H_2O$

Overall: $Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O$

The cell may be represented as: $Pb, PbSO_4/H_2SO_4\ (aq)/PbO_2Pb$

It is clear from the above reaction that during the working of the cell, $PbSO_4$ is formed at each electrode and sulphuric acid is used up. As a result, the concentration of H_2SO_4 decreases and the density of the solution also decrease. When the density of H_2SO_4 falls below 1.2 g ml^{-1}, the battery needs recharging.

Anode (Positive electrode connected with the source):

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

Cathode (Negative electrode connected with the source):

$PbSO_4(s) + 2e \longrightarrow Pb^-(s) + SO\ (aq)$

Overall reaction : $2PbSO_4(s) + 2H_2O \longrightarrow Pb(s) + PbO_2 + 4H^+ + 2SO_4^{2-}$.

d As per stem, the mentioned batteries are lead-acid storage battery and Lithium ion battery. Both the batteries are rechargeable. Both batteries have some advantages and disadvantages. Therefore, the advantages and the disadvantages of the two types of batteries are compared.

The advantages of lead storage Battery:

1. Low internal resistance: The internal resistance of lead storage battery is 0.001 ohms. On the other side, the internal resistance of lead storage battery which is used in clock is 100 ohms. Internal résistance of lead storage battery is very little. That's why lead storage battery is preferable for producing higher electricity. For car engine's higher electricity, lead storage battery is produced.

2. Rechargeable: Lead acid battery can recharged again and again.

3. Checking charge levels: The lead acid storage battery can be checked by measuring the density of the electrolyte with a hydrometer, as is usually done at gas stations.

4. Availability: Lead storage battery can be found with a little prize.

The disadvantages of lead-storage battery:

i. Electrolyte levels: The acid H_2SO_4 is used in lead storage battery. During the time of recharging, if any electrolyte of any cell, the general condition of H_2SO_4 level decreases, then the battery cannot be worked properly.

ii. Troubles to carry Heavy Battery: The weight of lead storage battery is 30 to 60 pound. The lead storage battery is too heavy to bear. To bear such heavy battery, the muscles of body can be harmed.

3. Environment Pollution:

Lead storage battery is used as waste. As a result, the soil of environment is polluted. If (Pb^{2+}) ion enter into Food chain people suffer from various diseases.

The advantages of Lithium battery:

i. Lightness: Lithium battery is comparatively light than any other battery. This battery is used in motor car.

ii. Pollution, Power, Durability:

The lithium battery is lasting for a long time. The amount of this wastage of battery is very little. This power of lithium battery is very high.

The disadvantages of Lithium battery

Lithium ion battery is inflammable. So, In some situation, the lithium ion battery gets very dangerous. Lithium ion battery should not be used in market.

After compares, the two types of battery, the lithium ion battery is very preferable than lead storage battery.

Ques. ▶ 39 Following the cell reaction :

$Zn/Zn^{2+} \parallel Cu^{2+}/Cu$

Concentration of Zn^{2+} & Cu^{2+} are 0.1mol/dm^3 & 0.05mol/dm^3 at 25°C

$E^0_{Zn/Zn}2+ = 0.76V$; $E^0_{Cu/Cu}2+ = -0.34V$;

[Pabna Cadet College, Pabna]

a. What is standard electrode potential? 1
b. State Faraday 1st law of electrolysis. 2
c. Compare the mention cell with hydrogen fuel cell. 3
d. Does the cell reaction take place spontaneously? Explain with your logic. 4

Answer to the question no. 39

a Standard electrode potential (E°) (Standard reduction potentials) are defined by measuring the potential relative to a standard hydrogen electrode using 1 mol solution at 25°C.

b Faraday law state that, The mass of an element liberated on an electrode during electrolysis is directly Proportional to the quantity of electricity 'Q' which passes through the solution of an electrolyte.

It is the mass or amount of a substance deposited or liberated and 'I' is the current in amperes, which passes for 't' seconds, then according to the law.

$W \propto I \times t$

Or, $W = Z \times I \times t$

c The cell stated in the stem is Galvanic cell and comparison of it with fuel cell describe as follows.

Hydrogen fuel cell :

(i) A hydrogen fuel cell is an electrochemical cell that converts the chemical energy from a fuel into electricity through an electrochemical reaction of hydrogen fuel with odygen or another oxidizing agent.

(ii) No salt bridge is used in hydrogen fuel cell.

Anode reaction : $H_2 \longrightarrow 2H^+ + 2e^-$

Figure :

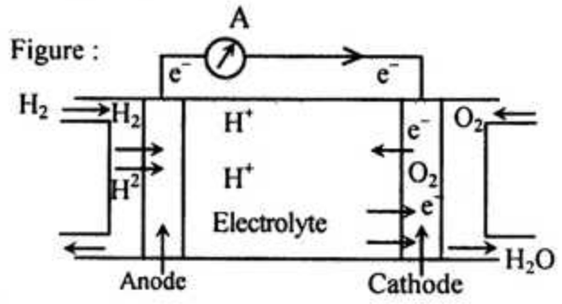


Fig : Hydrogen fuel cell

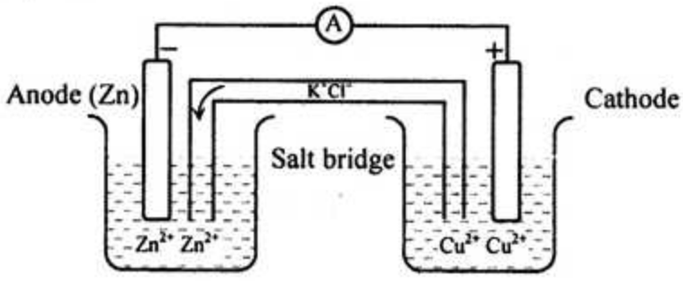
Cathode reaction : $\frac{1}{2}O_2 + 2H^+ + 2e^- \longrightarrow H_2O$

$Zn/Zn^{2+} \parallel Cu^{2+}/Cu$ (Galvanic cell):

(i) It is a one kind of galvanic cell where electricity is generate by means of chemical reaction.

(ii) Salt bridge of KCl or KNO_3 or NH_4Cl are generally used.

(iii) Figure :



Anode reaction : $Zn \longrightarrow Zn^{2+} + 2e^-$

Cathode reaction : $Cu^{2+} + 2e^- \longrightarrow Cu$

d According to the stem the cell is given below.

$Zn/Zn^{2+} \parallel Cu^{2+}/Cu$

Cell reaction : $Zn + Cu^{2+} \rightleftharpoons Zn^{2+} + Cu$

$E^0_{cell} = E^0_{Zn/Zn^{2+}} + E^0_{Cu^{2+}/Cu}$

$= (0.76 + 0.34)$ V

$= 1.10$ Volt

Here,

$E^\circ_{Zn/Zn^{2+}} = 0.76$ V

$E^\circ_{Cu/Cu^{2+}} = -0.34$ V

$E^\circ_{Cu^{2+}/Cu} = 0.34$ V

$E^\circ_{cell} = ?$

$$E_{cell} = E^0_{cell} - \frac{0.0591}{n} \log \frac{[Cu^{2+}]}{[Zn^{2+}]}$$

$$= 1.10 - \frac{0.0591}{2} \log \frac{0.05}{(0.1)}$$

$$= 1.10 - \frac{0.0591}{2} \log (-0.301)$$

$= 1.10 + 0.008895$

$= 1.1008895$

Here

$E^\circ_{cell} = 1.10$ V

$n = 2$

$E^\circ_{Cu/Cu^{2+}} = 0.34$ V

$[Cu^{2+}] = 0.05$ M

$[Zn^{2+}] = 0.1$ M

$E_{cell} = ?$

$\therefore E_{cell} = 1.1009$ Volts

As, E_{cell} = +ve, thus the above reaction occurs spontaneously.

Ques. ▶ 40 $MnSO_4$ solution ⟶ Al vessel

(Here, $E°Mn/Mn^{2+} = +1.18$V and $E°Al/Al^{3+} = +1.66$V)

[Rangpur Cadet College, Rangpur]

a. State Faraday's First law. 1

b. Zwitter ion acts both as an acid and base. Explain. 2

c. Write down the half reaction happened in Al vessel and also the cell reactions. 3

d. Analyze why the above mentioned vessel will be leaked after few days. 4

Answer to the question no. 40

a The amount of a given product liberated at an electrode during electrolysis is directly proportional to the quantity of electricity which passes through an electrolyte solution.

b In case of Zwitter ion –COOH group of amino acid loses a H^+ to become $-COO^-$. By donating a H^+, the amino acid acts as an acid. When in contact with an acid, the NH_2 group receives a H^+ ion and becomes NH_3^+. By accepting AH^+ ion, the amino acid behaves as a base. Thus zwitter ion acts both as an acid and a base.

c In the following stem, there is $MnSO_4$ in Al vessel. The reaction occurred in the vessel are mentioned below.

$Al + MnSO_4 = Al_2(SO_4)_3 + Mn$

or $Al + Mn^{2+} = Al^{3+} + Mn$

The cell diagram will be–

$Al/Al^{3+} \parallel Mn^{2+}/Mn$

Anode Cathode

Oxidation half reaction in anode : $Al - 3e^- \rightarrow Al^{3+}$ ..... × 2

Reduction half reaction in cathode: $Mn^{2+} + 2e^- \rightarrow Mn$ ..... × 3

The overall cell reaction : $2Al + 3Mn^{2+} \xrightarrow{6e^-} 2Al^{3+} + 3Mn$

d Following the stem,

$E^0_{Mn/Mn^{2+}} = +1.18$ V

$E^0_{Al/Al^{3+}} = +1.66$ V

The cell diagram obtained from-C following the stem

$Al/Al^{3+} \parallel Mn^{2+}/Mn$

anode cathode

The cell emf will be

$E^0_{cell} = E^0_{anode} + E_{cathode}$

$= E^0_{Al/Al^{3+}} + E^0_{Mn^{2+}/Mn}$

$= +1.66V + (-1.18V)$

$= +0.48V$

As the cell emf is positive, so the cell reaction will be occurred spontaneously and for this the Al vessel will be erroded or leaked as anode.

Ques. ▶ 41 Mr. Zaman is a demonstrator of Chemistry Department and Mr. Asif is a Laboratory Assistant. Mr. Zaman instructed Mr. Asif to keep Nickel salt in copper vessel but he wrongly kept it in zinc vessel. The electrode potentials of Nickel and Zinc are +0.25V and + 0.76V respectively.

[Rangpur Cadet College, Rangpur]

a. What is Racemic Mixture? 1
b. What is the concentration of 0.15 M HCl solution? 2
c. How much metal will be deposited at cathode passing 0.1A current for 60 minutes in the stem's solution of the salt? 3
d. Analyze by finding its e.m.f. whether the electrolyte will be preserved for a long time in Zn vessel or not. 4

Answer to the question no. 41

a The mixture of equal amounts of left and right-handed enantiomers is called racemic mixture.

b 0.15 M HCl solution = 0.15 mol L^{-1} HCl solution
= 0.15 × 36.5 g L^{-1} HCl solution
[1 mol HCl = 36.5 g]
= 0.15 × 36.5 × 10^3 mg L^{-1} HCl solution
= 5475 ppm concentration of HCl solution

So, in ppm unit the value of 0.15M HCl solution is 5475 ppm.

c According to the stem, nickel start to be deposited in ctahode due to the electricity passed through the salt of nickel.

Amount of current, I = 0.1A

Time, t = (60 × 60)s

Electrochemical equavalent of Ni,

$$Z = \frac{\text{Gram molecular weight}}{\text{Valency of element} \times 96500\ C}$$

$$= \frac{58.7g}{2 \times 96500C}$$

$$= 3.0415 \times 10^{-4}\ g/C$$

The amount of deposited metal,

W = ZIt

$$= 3.0415 \times 10^{-4}\ g/C \times 0.1 \times 60 \times 60$$

$$= 0.1095\ gm$$

d In the following stem, if the salt of electrolytic nickel kept in Zn vessel then, the reaction can be represented as,

$Zn + Ni^{2+} = Zn^{2+} + Ni$

The cell diagram will be–

$Zn/Zn^{2+} \parallel Ni^{2+}/Ni$
Anode Cathode

Given,

$E^0_{Zn/Zn^{2+}} = +0.76\ V$

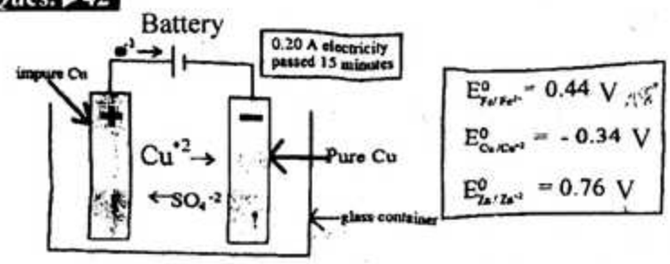
$E^0_{Ni/Ni^{2+}} = +0.25\ V$

The emf of the cell will be

$E^0_{cell} = E^0_{anode} + E^0_{cathode}$
$= E^0_{Zn/Zn^{2+}} + E^0_{Ni^{2+}/Ni}$
$= +0.76V + (-0.25V)$
$= +0.51V$

As the emf of the cell is positive, so the cell reaction will be spontaneous. That means Zn container will be corroded. Therefore, the electrolyte can not be preserved in Zn vessel within long time .

Ques. ▶ 42



[Cumilla Cadet College, Cumilla]

a. What is TDS? 1
b. Why HSO_4^- is an amphoteric substance? 2
c. Calculate what amount of metal will be deposited at stem cathode? 3
d. What happens when stem electrolyte is kept in zinc or iron container? Analyze through emf. 4

Answer to the question no. 42

a The total amount of solid substances dissolved in a water sample is called TDS (Total Dissolved Solid) of that sample.

b HSO_4^- can act as acid and base simultaneously.

As acid : HSO_4^- donates a proton (H^+) and converted to SO_4^{2-}.

$HSO_4^- \longrightarrow H^+ + SO_4^{2-}$

As base : HSO_4^- is converted to H_2SO_4 by accepting a proton (H^+)

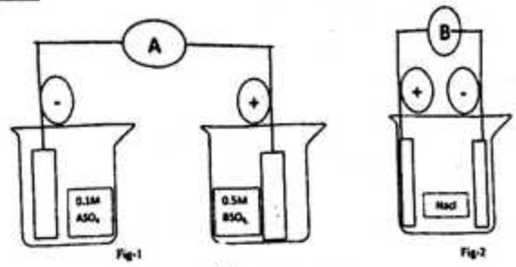
$HSO_4^- + H^+ \longrightarrow H_2SO_4$

So, HSO_4^- is called amphoteric substance due to its ability to act both as acid and base simultaneously.

c Similar to the question no.- 11(c).

d Similar to the question no.- 19(d).

Ques. ▶ 43



$A/A^{2+} = +1.18V$
$B^{2+}B = +0.34V$

[Feni girls Cadet College, Feni]

a. What is standard hydrogen electrode? 1
b. Electrolysis is a redox process. Explain it. 2
c. Calculate the e.m.f of the cell–1. 3
d. Analyse the difference between two cell in the stem. 4

Answer to the question no. 43

a When in an one molar concentration of H^+ ion containing solution, a platinised platinum is immersed and pure hydrogen gas is introduced into the solution, a particular type of electrode is formed. The electrode thus formed is called standard hydrogen electrode.

b During, the process of electrolysis the electric current is passed through an ionic compound which is either in it's molten state or dissolved in a solvent which leads to a chemical reaction.

A redox reaction is a specific type of chemical reaction in which the process of oxidation [loss of electrons] and the precess of reduction [gain in electrons] takes place simultaneously.
In the process of electrolysis, oxidation of an ion takes places at anode [the negatively charged electrode] and reduction takes place at cathode [the positively charged electrode] simultaneously. As, in a redox reaction both oxidation and reduction takes place simultaneously therefore, we can actually conclude that electrolysis is a redox reaction.

c Similar to the question 14 (c).

d Similar to the question no– 14(d).

Ques. ▶44 $Ni(s)/Ni^{2+}(0.15M) \parallel Ag^{+}(0.2M)/Ag(s)$

Here, $E°_{Ni^{2+}/Ni} = -0.25V$, $E°_{Ag^{+}/Ag} = +0.799V$ and $E°_{Cu^{2+}/Cu} = +0.34V$ *[Faujdarhat Cadet College, Chattogram]*

a. What is standard electrode potential? 1
b. Why H_2SO_4 is used in lead storage battery? 2
c. Determine electromotive force at 25°C temperature for the cell given in the stem. 3
d. Is it possible to keep the solutions of the cell in a Copper made container? Analyze. 4

Answer to the question no. 44

a In standard condition, i.e. at 25°C temperature the voltage difference created between the electrode and 1 M concentrated electrolyte is called standard electrode potential.

b In lead storage battery, the lead plate is dissolved in 30% H_2SO_4 solution. When the battery supplies electricity, Pb and PbO_2 both react with H_2SO_4 and produce $PbSO_4$.

Anode reaction : $Pb(s) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2e^-$

Cathode reaction : $PbO_2(s) + 4H_3O^+ + SO_4^{2-}(aq) + 2e^- \longrightarrow PbSO_4(s) + 2H_2O(l)$

At the time of recharge, the film of $PbSO_4$ is converted again into Pb and PbO_2 and H_2SO_4 is reproduced.

c Similar to the question no- 9(c)

d The solutions in the cell are solutions of Ni^{2+} and Ag^+.

The possibility of keeping these solutions in copper made container depends on wether they react with copper container or not.

Ni^{2+} solution in copper container :

Copper container act as anode when Ni^{2+} solution is kept in it. In this case, possible anode and cathode reactions are :

Anode reaction : $Cu - 2e^- \longrightarrow Cu^{2+}$
Cathode reaction : $Ni^{2+} + 2e^- \longrightarrow Ni$
Overall cell reaction : $Cu + Ni^{2+} \longrightarrow Cu^{2+} + Ni$
emf of the cell,

$$E°_{cell} = E°_{Cu/Cu^{2+}} + E°_{Ni^{2+}/Ni}$$
$$= -E°_{Cu/Cu^{2+}} + E°_{Ni^{2+}/Ni}$$
$$= -0.34 + -0.25$$
$$= 0.59\ V$$

$\therefore E°_{cell} < 0$

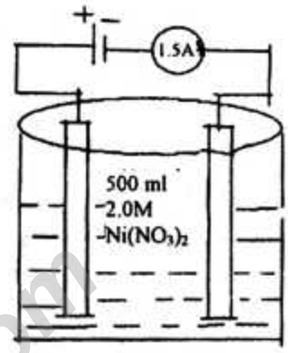
As the value of $E°_{cell}$ is negative, the reaction will not be spontaneous.
So, solutions of Ni^{2+} can be kept in copper made container.
Ag^+ solution in copper container :
Cu container act as anode when solution of Ag^+ is kept in it.
Possible anode and cathode reaction :
Anode reaction : $Cu - 2e^- \longrightarrow Cu^{2+}$
Cathode reaction : $2Ag^+ + 2e^- \longrightarrow 2Ag$
Overall cell reaction : $Cu + 2Ag^+ \longrightarrow Cu^{2+} + 2Ag$
emf of the cell,

$$E°_{cell} = E°_{Cu/Cu^{2+}} + E°_{Ag^{+}/Ag}$$
$$= -E°_{Cu^{2+}/Cu} + E°_{Ag^{+}/Ag}$$
$$= -0.34 + 0.799$$
$$= 0.459\ V$$

$\therefore E°_{cell} > 0$

As the value of $E°_{cell}$ is positive, the reaction will be occured spontaneously.
As a result, solution of Ag^+ can't be kept in Cu container.

Ques. ▶45



[Sylhet Cadet College, Sylhet]

a. What is super conductor? 1
b. What is meant by the electrochemical equivalent of Copper is 0.000329gram/ Coulomb? 2
c. If the above mentioned electric current passed through the solution for 2 hours 30 minutes then how much nickel will be deposited at cathode? (Atomic mass of Ni is 58.7) 3
d. Determine the change of the concentration Ni^{2+} ion due to passing 3F electricity in the above electrolysis. 4

Answer to the question no. 45

a A superconductor is a material that can conduct electricity or transport electrons from one atom to another with no resistance.

b The electrochemical equivalent is the amount passing for one second (i.e.) one coulomb. The electrochemical equivalent of copper is 0.00032, gm/coulomb, means when 1 coulomb of electricity passed for a second through electrolytic solution of copper, 0.00032, gm . Cu will be deposited in the electrode.

c The cell following the stem is electrolytic cell.
Given that,
Time, t = 2 h 30 min = (2 × 60 + 30) min = (150 × 60) s
Electricity, I = 1.5 A
The electrochemical equivalent of Ni,

$$Z = \frac{\text{Atomic mass expressed in gram}}{96500 \times \text{valency of element}}$$
$$= \frac{58.7\ \text{gram}}{2 \times 96500}$$
$$= 0.000304\ g/C$$

Now, the amount of Ni deposited in cathode,
$W = ZiT = 0.000304 \times 1.5\ A \times 150 \times 60\ s$
$= 4.104$ gram

d In the electrolysis of $Ni(NO_3)_2$ solution, the Ni^{2+} is reduced by the following below–

$Ni^{2+} + 2e^- \longrightarrow Ni$

$2F \qquad 1 \text{ mol} = 58.7 \text{ g Ni}$

Accoding to the equation,

2F current deposits 1 mol or 58.7 g Ni

$\therefore$ 3F current deposits $= \frac{58.7 \times 3}{2}$ g Ni

$= 88.05$ g Ni

The mole number of Ni^{2+} in electrolytic solution,

$n = \text{concentration} \times \text{volume(L)} = 2 \times \frac{500}{1000} = 1$

The mole number deposited Ni^{2+} due to

3F current $= \frac{88.05}{58.7} = 1.5$

As, 1 mol $Ni(NO_3)_2$ exists in the solution only. So it is impossible for the deposition of 1.5 mol Ni from 3F current mathematically. Therefore, the total amount of Ni will be deposited into cathode for the 3F current.

Ques. ▶ 46 Zn/Zn^{2+} (1.0M) || Ag^+(1.0M)/Ag

$E^0_{Ag/Ag^+} = -0.80V$; $E^0_{Zn/Zn^{2+}} = 0.76V$ *[Sylhet Cadet College, Sylhet]*

a. What is solution pressure? 1

b. Why salt bridge is necessary in Galvanic cell? 2

c. If the concentration of Zn^{2+} and Ag^+ in the above cell is 0.001mol/dm^3 and 0.1mol/dm^3 respectively, then calculate its cell potential at 25°C temperature. 3

d. If the right half cell is replaced by Mg^{2+} (1.0)/ Mg, then whether the reaction will occur spontaneously or not? Analyze with respect of ΔG°, ($E°_{Mg^{2+}/Mg} = -2.3V$) 4

Answer to the question no. 46

a A measure of tendency of molecules or atoms cross a bounding surface between phase and to enter into a solution is called solution pressure.

b The purpose of a salt bridge is not to move electrons from the electrolyte, rather to maintain charge balance because the electrons moving from one half cell to the other.

Without the salt bridge, the solution in the anode compartment would become positively charged and the solution in the cathode compartment would become negatively charged. Because of the charge imblance, the electrode reaction would quickly come to a half, therefore it helps to maintain the flow of electrons from the oxidation half cell to a reduction half cell.

For this reason mentioned above, salt bridge is necessary in galvanic cell.

c As the concentration of Zn^{2+} and Ag^+ in solution is 0.001 mol/dm^3 or 0.001M and 0.1 mol/dm^3 or 0.1M respectively. So, the cell will not be behaved as standard condition. Then, the Nernst equation will be used to determine the cell potential.

The cell diagram– Zn/Zn^{2+} (0.001M) || Ag^+ (0.1M)/Ag

Half oxidation reaction : $Zn - 2e^- \longrightarrow Zn^{2+}$

Half reduction reaction : $2Ag^+ + 2e^- \longrightarrow 2Ag$

The overcall cell reaction : $Zn + 2Ag^+ \xrightarrow{2e^-} Zn^{2+} + 2Ag$

In this case, n = 2

$[Ag^+] = 0.1$ M

$[Zn^{2+}] = 0.001$ M

At standard condition,

Cell potential, $E_{cell} = E^0_{Zn^{2+}/Zn} + E^0_{Ag^+/Ag}$

$= +0.76 \text{ V} + 0.80 \text{ V}$

[$\therefore E^0_{Ag/Ag^+} = -0.8V \therefore E^0_{Ag^+/Ag} = 0.8V$]

$= +1.56V$

Now, get from the Nernst equation,

$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Zn^{2+}]}{[Ag^+]^2}$

$= +1.56 - \frac{0.0592}{2} \log \frac{0.001}{(0.1)^2}$

$= +1.5896$ V

d If the right half cell following the stem is substituted by Mg^{2+}(1.0M) / Mg. Then the cell diagram will be,

Zn / Zn^{2+} (1.0M) || Mg^+ (1.0M) / Mg

As the cell behaves as standard condition,

So the cell potential will be, $E_{cell} = E^0_{Zn^{2+}/Zn} + E^0_{Mg^+/Mg}$

$= +0.76V + (-2.3V)$

$= -1.54$ V

half oxidation reaction : $Zn - 2e^- \longrightarrow Zn^{2+}$

half reduction reaction : $Mg^{2+} + 2e^- \longrightarrow Mg$

The overcall cell reaction : $Zn + Mg^{2+} \xrightarrow{2e^-} Zn^{2+} + Mg$

Only 2 electrons are exchanged in the overall cell reaction. So, n = 2

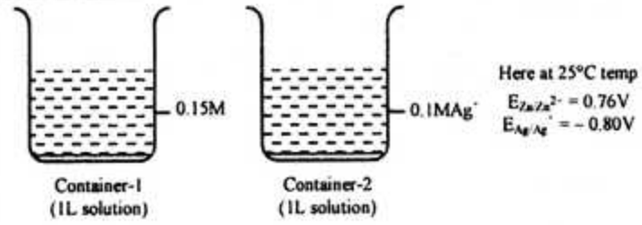
We know,

The change of Gibbs free energy,

$\Delta G° = -nF E^0_{cell} = -2 \times 95600C \times (-1.54) = +297220$ J

As ΔG° = (+ve), So, the oveall reaction for will not be occured spontaneously.

Ques. ▶ 47



[Jhenaidah Cadet College, Jhenaidah]

a. What is weak electrolyte? 1

b. Explain the charging & discharging of lithium ion battery. 2

c. What coulomb charge will be required to deposit the metal ion of container-1 completely at the electrode? Explain. 3

d. Analyze the possibility of spontaneous of electricity if the containers given in the stem are connected through a salt bridge. 4

Answer to the question no. 47

a Which compound ionized very less in solution called weak electrolyte. For example CH_3COOH.

b During discharge, lithium ions migrate through non-aqueous electrolyte and separated diaphgram from negative electrode to positive electrode & thus produce current flow. During charging, external current source is introduced so that current flow occurs in opposite direction. In this process, lithium ions migrate from positive electrode to negative electrode. Heve, lithium ions are intercalated on the porous electrode. Then reaction occured following below.

Oxidation in Anode :

$Li_xC_6\ (s) \longrightarrow xLi^+(soln) + 6C(s) + xe^-;\ E° = 3.04\ V$

Reduction in Cathode :

$Li_{1-x}CoO_6(s) + xLi^+(soln) + xe^- \longrightarrow LiCoO_2\ (s);\ E° = 0.66\ V$

The overall cell reaction :

$Li_xC_6\ (s) + Li_{1-x}CoO_2(s) \rightarrow LiCoO_2\ (s) + 6C(s);\ E°_{cell} = 3.7\ V$

In case of recharge, the cell reaction occured contrarity. For example,

$LiCoO_2\ (s) + 6C(s) \longrightarrow Li_xC_6\ (s) + Li_{1-x}CoO_6(s)$

c The mole number of Zn^{2+} in container-1

n = concentration × volume (l) = $0.15 \times 1 = 0.15$

To deposit in electrode, the reduction of Zn occured following below–

$Zn^{2+} + 2e^- \longrightarrow Zn$

1 mol 2F

To deposit needs 1 mol Zn^{2+} 2F or 2×96500 C

$\therefore$ 0.15 mol Zn^{2+} deposit needs $= \frac{2 \times 96500 \times 0.15}{1} = 28950$ C

d In the following stem, When two container connected by salt bridge to complete the cell, then cell diagram will be,

$Zn/\ Zn^{2+}\ (0.15M) \parallel Ag^+\ (1.0M)/Ag$

Half oxidation reaction : $Zn - 2e^- \longrightarrow Zn^{2+}$

Half reduction reaction : $2Ag^+ + 2e^- \longrightarrow 2Ag$

The overcall cell reaction : $Zn + 2Ag^+ \xrightarrow{2e^-} Zn^{2+} + 2Ag$

In this case, $n = 2$

$E^0_{Zn^{2+}/Zn} = +0.76$ V

$E^0_{Ag/Ag^+} = -0.80$ V

$[Ag^+] = 0.1$ M

$[Zn^{2+}] = 0.15$ M

Following the Nernst equation, the cell potential will be–

$$E_{cell} = E^0_{cell} - \frac{0.0592}{n} \log \frac{[Zn^{2+}]}{[Ag^+]^2}$$

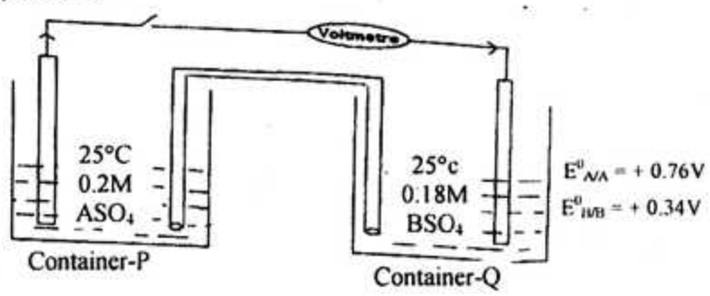
$$= E^0_{Zn/Zn^{2+}} + E^0_{Ag^+/Ag} - \frac{0.0592}{2} \log \frac{[Zn^{2+}]}{[Ag^+]^2}$$

$$= +0.76\ V + 0.80\ V - \frac{0.0592}{2} \log \frac{0.15}{(0.1)^2}$$

$$= +1.5252\ V$$

As the cell potential is positive, so the cell reaction will be occured spontaneously and the possibility of electricity would be true also.

Ques. ▶48 Observe the stem carefully and answer the following questions–



[Barisal Cadet College, Barisal]

a. What is called nano particle? 1

b. H^+/H_2, Pt is used as primary reference electrode. Explain it. 2

c. Calculate the emf of the stated cell in the stem. 3

d. If container Q is made with Ag ($E°_{Ag^+/Ag} = -0.80V$) then for preserving the cell for long time analyze your opinion. 4

Answer to the question no. 48

a The particles or substances that are 1–100 nm in size are called nano particle.

b By the universal rule, the value of standard hydrogen electrode voltage is assumed to be zero. Any electrode is meassured by the refference of it's voltage. Pure H_2 gas is operated around a platinum plate of inactive metal which is dissolved in a solution of H^+ ion at 25°C temperature and a pressure of 1 atm. Metallic platinum absorbs H_2 gas. The arctic reaction continues in the absorbed state and the electrode volt is assumed to be 0.0V.

$H_2\ (g, 1\ atm) \longrightarrow 2H^+\ (aq, 1M) + 2e^-\ ;\ E° = 0.0V$

$2H^+\ (aq, 1M) + 2e^- \longrightarrow H_2\ (g, 1\ atm)\ ;\ E° = 0.0V$

c See to the question no.- 2(c).

d If the Q-container of the stem is made of Ag,

$Ag + B^+ \longrightarrow Ag^+ + B$

The cell diagram will be, $Ag/Ag^+ \parallel B^+/B$

emf of this cell will be,

$E°_{cell} = E°_{Ag/Ag^+} + E°_{B^+/B}$

$= -0.80\ V + 0.34\ V$

$[\because E°_{Ag^+/Ag} = -0.80\ V$ and $E°_{B/B^+} = -0.34\ V]$

$= -0.46\ V$

As the value of emf is negative. So the cell reaction will not be spontaneous. As a result, the Ag made container would be intact and the cell can be stored for a very long time.