Electrochemical Cell Chemistry Questions with Solutions

Q1. Out of the given options, choose which of the following is not a characteristic feature of the salt bridge?

a.) Salt bridge joins the two halves of an electrochemical cell
b.) It completes the inner circuit
c.) It is filled with a salt solution (or gel)
d.) It does not maintain the electrical neutrality of the electrolytic solutions of the half-cells

Correct Answer– (d.) It does not maintain the electrical neutrality of the electrolytic solutions of the half-cells.

Q2. In an electrochemical cell, a cathode is:

a.) always neutral
b.) always positive
c.) the electrode at which the reduction takes place
d.) always negative

Correct Answer– (c.) the electrode at which the reduction takes place.

Q3. What is the direction of flow of electrons in an electrolytic cell?

a.) Anode to cathode externally
b.) Anode to cathode internally
c.) Cathode to anode externally
d.) Cathode to the anode in the solution

Correct Answer– (a.) Anode to cathode externally

Q4. Choose which of the following that does not affect the electrode potential of an electrode?

a.) Nature of electrode
b.) The temperature of the solution
c.) Molarity of the solution
d.) Size of teh electrode

Correct Answer– (d.) Size of teh electrode

Q5. An electrochemical cell generally consists of a cathode and an anode. Choose the correct statement with respect to the cathode?

a.) Oxidation occurs at the cathode
b.) Electrons move into the cathode
c.) Usually denoted by a negative sign
d.) Is usually made up of insulating material

Correct Answer– (b.) Electrons move into the cathode.

Q6. State True or False.
An electrochemical cell can only convert electrical energy to chemical energy.

Answer. False.
An electrochemical cell can convert electrical energy to chemical energy as well as chemical energy to electrical energy. Electrochemical cells are classified into two types: galvanic cells and electrolytic cells.

Q7. Why are the saturated electrolyte solutions for the salt bridge prepared in agar-agar jelly or gelatin?

Answer. The salt bridge connects the two half-cell solutions, completing the electrochemical cell's circuit. The salt bridge electrolytes are typically prepared in agar-agar or gelatin so that they remain semi-solid and do not mix with the half-cell solutions and interfere with the electrochemical reaction.

Q8. What is a salt bridge?

Answer. A salt bridge is a device used in an electrochemical cell for connecting its oxidation and reduction half cells wherein a weak electrolyte is used. In other words, a salt bridge is a junction that connects the anodic and cathodic compartments in a cell or electrolytic solution.
The salt bridge usually consists of a strong electrolyte which is further made up of ions. For example, $AgNO_3$, KCl, etc. The main function of a salt bridge is to help maintain electrical neutrality within the internal circuit. It also helps in preventing the cell from taking its reaction to equilibrium. If salt bridges are absent or if they are not used then the reaction will likely continue and the solution in one-half electrodes will gather a negative charge.

Q9. Which of the following are the four components of an electrochemical cell?

Answer. The four components of an electrochemical cell are as follows:

- Anode - The cell compartment in which oxidation occurs.
- Cathode - The cell compartment in which reduction occurs.
- When dissolved in polar solvents such as water, an electrolyte produces ions, resulting in an electrically conducting solution.

- A salt bridge connects the oxidation and reduction halves of an electrochemical cell, completing the electrochemical circuit. It contains a saturated salt solution, such as KCl.

Q10. Calculate the standard reduction potential of Ni^{2+}|Ni electrode when the cell potential for the cell Ni | Ni^{2+} (1M)|| Cu^{2+} (1M) | Cu is 0.59 V (E° Cu^{2+}| Cu = 0.34 V).

Answer. The cell is:
Ni | Ni^{2+} (1M)|| Cu^{2+} (1M) | Cu
The e.m.f of the cell $E°_{cell} = E°_R – E°_L$
$E°_{cell}$ = E° (Cu^{2+} | Cu) – E° (Ni | Ni^{2+})
0.59 V = 0.34 – E° (Ni | Ni^{2+})
E° (Ni | Ni^{2+}) = 0.34 – 0.59 = – 0.25 V

Q11. Write the half-cell reaction and the overall cell reaction for the electrochemical cell: Zn | Zn^{2+} (1.0M) || Pb^{2+} (1.0M) | Pb
Calculate the standard e.m.f for the cell if standard electrode potential (reduction) for Pb^{2+} | Pb and Zn^{2+} | Zn electrodes are – 0.126 V and – 0.763 V respectively.

Answer. Zn electrode acts as an anode while the Pb electrode acts as a cathode. Therefore, oxidation occurs at the zinc electrode and reduction occurs at the lead electrode.
Half reactions are-
Oxidation half-reaction: $Zn \rightarrow Zn^{2+} + 2e^-$
Reduction half-reaction: $Pb^{2+} + 2e^- \rightarrow Pb$
Overall cell reaction: $Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$
$E°_{cell} = E°_R – E°_L$
$E°_{cell}$ = –0.126 – (–0.763)
$E°_{cell}$ = 0.637 V.

Q12. Explain the working principle of an electrochemical cell.

Answer. The basic working principle of an electrochemical cell is the transfer of electrons produced by a redox reaction that results in the generation of electric current. Electrons are emitted from metal electrodes. Metals oxidise when they lose electrons. However, if they gain electrons, they are reduced. As a result of such redox reactions, free energy decreases and appears as electrical energy.

Q13. How Daniel's Cell is a Galvanic cell?

Answer. The best example of a galvanic cell is the Daniel cell. The Daniel cell's anode is a zinc rod dipped in a C1 concentration zinc sulphate ($ZnSO_4$) solution. The cathode is made by immersing a copper rod in the solution of copper sulphate ($CuSO_4$) of concentration C2. The Zn^{2+} and Cu^{2+} ions in the solution connect electrically either through direct contact or through a salt bridge.
The zinc electrode serves as an anode for oxidation, while the copper electrode serves as a cathode for reduction. Since electrons are produced at the zinc electrode, this electrode is abundant in electrons

and pushes them into the external circuit. The electron-deficient copper electrode, on the other hand, draws the electron from the external circuit. As a result, electrons flow from the zinc electrode to the copper electrode.

Q14. Two half cell reactions of an electrochemical cell are given below :
MnO^{4-} (aq) + $8H^+$ (aq) + $5e^-$ → Mn^{2+} (aq) + $4H_2O$ (l), E° = + 1.51 V
Sn^{2+} (aq) → $4Sn^{4+}$ (aq) + $2e^-$, E° = + 0.15 V
Construct the redox equation from the two half cell reactions and predict if this reaction favours formation of reactants or product shown in the equation.

Answer. The reactions can be represented at anode and at cathode in the following ways :
At anode (oxidation) :
Sn^{2+} (aq) → $4Sn^{4+}$ (aq) + $2e^-$] × 5 ; E° = + 0.15 V
At cathode (reduction) :
MnO^{4-} (aq) + $8H^+$ (aq) + $5e^-$ → Mn^{2+} (aq) + $4H_2O$ (l)] × 2 ; E° = + 1.51 V

The Net R × M = $2MnO^{4-}$ (aq) + $16H^+$ + $5Sn^{2+}$ → $2Mn^{2+}$ + $5Sn^{4+}$ + $8H_2O$
Now E°cell = E°cathode – E°anode
E°cell = 1.51 – 0.15 = + 1.36 V
Since, the value of E°cell is positive. It favours the formation of the product.

Q15. How an electrochemical cell is represented?

Answer. An electrochemical cell, also known as a galvanic cell, is made up of two electrodes: anode and cathode. The electrolyte solution containing these electrodes is referred to as a half cell. A cell is formed when these two half-cells are combined.

- A galvanic cell is represented by writing the anode (where oxidation takes place) on the left and the cathode (where reduction takes place) on the right.
- The anode of the cell is represented by writing the metal or solid-phase first, followed by the electrolyte (or cation of the electrolyte), whereas the cathode is represented by writing the electrolyte (or cation) first, followed by the metal and solid phase.
- Two vertical lines represent the salt bridge that connects the two half cells.

For example: Zn | Zn2+ (1M) || Cu2+ (1M)

Practise Questions on Electrochemical Cell

Q1. When equilibrium is reached inside the two half-cells of the electrochemical cells, what is the net voltage across the electrodes?

a.) > 1
b.) < 1
c.) = 0

d.) Cannot be determined

Correct Answer– (c.) = 0
At equilibrium, there is no electron transfer across the half cells. As a result, the potential difference between them is zero.

Q2. Which of the following is not a generally used electrolyte in the salt bridges used to connect the two half-cells of an electrochemical cell?

a.) NaCl
b.) KNO_3
c.) KCl
d.) $ZnSO_4$

Correct Answer– (d.) $ZnSO_4$.
$ZnSO_4$ is not a strong electrolyte. Hence, it cannot be used in the salt bridge.

Q3. What happens if the external potential applied becomes greater than $E°_{cell}$ of the electrochemical cell?

Answer. If the external potential applied becomes greater than $E°_{cell}$ of the electrochemical cell, then the reaction gets reversed.

Q4. Why does an electrochemical cell stop working after some time?

Answer. The concentration of a solution with which an electrode comes into contact determines its reduction potential. The concentration of reactants decreases as the cell works. Then, according to Le Chatelier's principle, the equilibrium will shift backwards. However, if the concentration is higher on the reactant side, the equilibrium will shift forward. When a cell works, the concentration in the anodic compartment decreases, and thus the E° cathode decreases.

Now, the cell's EMF is $E°_{cell}$ = E° (cathode) – E° (anode).

A decrease in E° cathode and an increase in E° anode means that the cell's EMF will decrease and eventually become zero, i.e., the cell will stop working after some time.

Q5. In a simple electrochemical cell, which is the standard state, the half-cell reactions with the appropriate reduction potentials are:
$Pb^{2+} + 2e^- \rightarrow Pb\ (s)$; (E°= –0.13 V)
$Ag^+ + e^- \rightarrow Ag\ (s)$; (E° = +0.80V)
a.) What is the cell reaction for the cell?
b.) Calculate the e.m.f of the cell.

Answer. The reaction potentials of the two half-cell reactions are:

$Pb^{2+} + 2e^- \rightarrow Pb(s)$; ($E° = -0.13$ V)

$Ag^+ + e^- \rightarrow Ag(s)$; ($E° = +0.80$V)

The reduction potential of Ag^+ | Ag electrode is more than that of Pb^{2+} | Pb. Therefore, the reduction will occur at the silver electrode and oxidation will occur at the lead electrode and the cell reaction will be

$2Ag^+ + Pb \rightarrow 2Ag + Pb^{2+}$

The cell may be represented as:

Pb | Pb^{2+} || Ag^+ | Ag

Therefore, $E°_{cell}$ = E° (cathode) – E° (anode)

E° = 0.80 – (–0.13) = 0.93 V.