

Lecture Notes on Electrochemical Cells

1. Electrochemical Cells

Electrochemical cells are devices that convert chemical energy into electrical energy or vice versa through redox reactions. They consist of two electrodes (anode and cathode) immersed in an electrolyte solution, where oxidation and reduction reactions occur separately.

Types of Electrochemical Cells

1. **Galvanic (Voltaic) Cells** – Generate electrical energy from spontaneous chemical reactions.
 2. **Electrolytic Cells** – Consume electrical energy to drive non-spontaneous chemical reactions.
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2. Galvanic (Voltaic) Cells

A **Galvanic cell** is an electrochemical cell that generates electricity from spontaneous redox reactions.

Basic Features of a Galvanic Cell

- **Two Half-Cells:** Each consists of an electrode dipped in its respective ion solution.
 - **Electrodes:**
 - **Anode** (negative electrode) → Oxidation occurs.
 - **Cathode** (positive electrode) → Reduction occurs.
 - **Salt Bridge:** Maintains electrical neutrality by allowing ion flow between solutions.
 - **External Circuit:** Allows electron flow from anode to cathode.
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3. Construction of a Galvanic Cell

A typical **Daniell Cell** (Zn-Cu cell) consists of:

- **Zinc electrode** in ZnSO_4 solution (anode).
- **Copper electrode** in CuSO_4 solution (cathode).
- **Salt Bridge** (e.g., KCl or NaNO_3) to complete the circuit and balance ion movement.

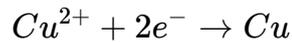
Working Principle

- **At Anode (Oxidation):**



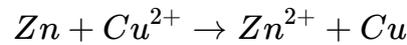
- Zinc loses electrons and dissolves into solution.

- **At Cathode (Reduction):**



- Copper ions gain electrons and deposit as metallic Cu.

Overall Reaction:



The cell generates an **emf (electromotive force)**, measured as **1.10V**.

4. Representation of Electrochemical Cells

An electrochemical cell is represented as:



For the **Daniell Cell (Zn-Cu Cell)**:



- **Single vertical line (|):** Represents a phase boundary (solid to liquid).
 - **Double vertical line (||):** Represents the salt bridge.
 - **Anode is written on the left, cathode on the right.**
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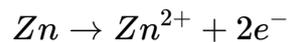
5. Half-Cell Reactions

Each electrochemical reaction consists of two half-reactions:

Oxidation Half-Reaction (Anode):



Example for Zn:



Reduction Half-Reaction (Cathode):



Example for Cu:



The sum of both half-reactions gives the overall reaction of the cell.

These principles form the basis of **electrochemical cells** and their practical applications in batteries, fuel cells, and corrosion studies.