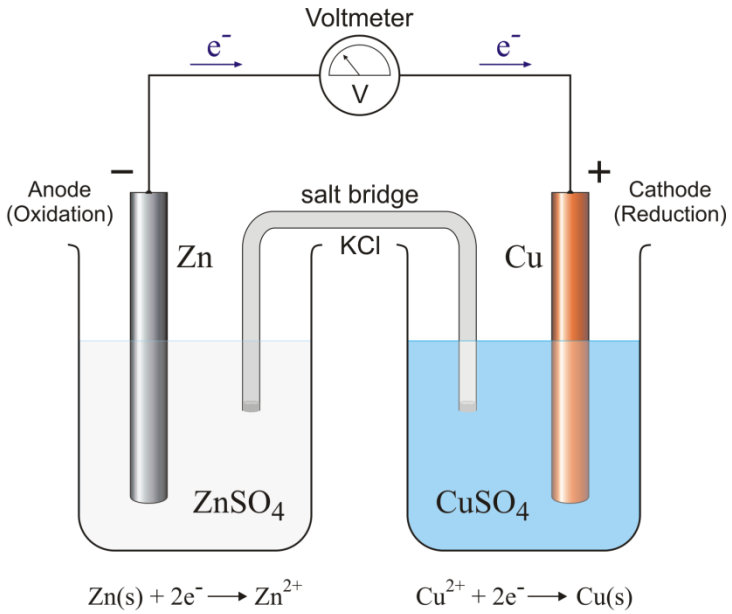
Electrochemical cells

Electrochemical cells are devices that convert chemical energy into electrical energy and vice versa. They consist of two electrodes (usually made of different materials) immersed in an electrolyte solution. These cells play a fundamental role in various applications, including batteries, fuel cells, and electroplating.

There are two main types of electrochemical cells: galvanic (voltaic) cells and electrolytic cells.

1. Galvanic (Voltaic) Cells:
    - These cells are spontaneous and generate electrical energy from chemical reactions. They are commonly found in batteries.
    - Galvanic cells consist of two half-cells: one with an anode (where oxidation occurs) and the other with a cathode (where reduction occurs).
    - Electrons flow from the anode to the cathode through an external circuit, creating an electric current.
    - The chemical reactions at the electrodes release or absorb energy, which can be used to power devices.

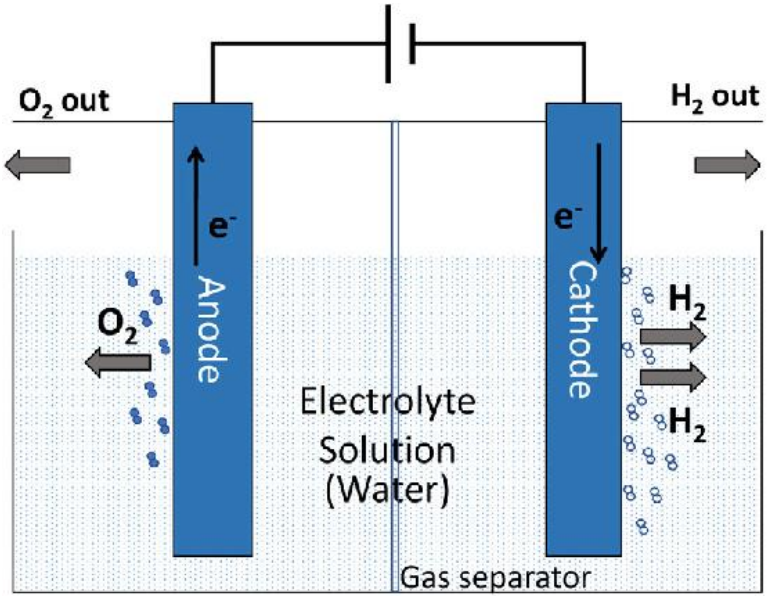


$$Zn(s) \mid ZnSO_4(aq) \mid\mid CuSO_4(aq) \mid Cu(s)$$

2. Electrolytic Cells:

    - These cells are non-spontaneous and require an external electrical energy source to drive a chemical reaction.
    - Electrolytic cells are commonly used in processes such as electroplating and water electrolysis.
    - In an electrolytic cell, the anode is typically connected to the positive terminal of an external power supply, and the cathode is connected to the negative terminal.
    - The external energy input causes a non-spontaneous chemical reaction to occur, often leading to the deposition of metals or the splitting of water into hydrogen and oxygen.

The electrolysis of water is a chemical process that uses electricity to break water (H_2O) into its constituent elements, hydrogen (H_2) and oxygen (O_2). This process occurs in an electrolytic cell, typically using two electrodes and an electrolyte solution.



Here are the balanced chemical equations for the electrolysis of water:

At the anode (positive electrode):

$4OH^- \rightarrow 2H_2O+O_2(g) + 4e^-$

At the cathode (negative electrode):

$4H^+ + 4e^- \rightarrow 2H_2(g)$

Overall reaction for the electrolysis of water:

$4OH^- + 4H^+ \rightarrow 2H_2O + O_2(g) + 2H_2(g)$

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

In the overall reaction, you can see that water (H_2O) is split into hydrogen gas (H_2) at the cathode and oxygen gas (O_2) at the anode. This process is very important because it allows for the production of hydrogen and oxygen gases, which have numerous industrial and scientific applications, such as fuel for hydrogen fuel cells and gas for rocket propulsion.

Key components of electrochemical cells include:

- Anode: The electrode where oxidation (loss of electrons) takes place. It is usually labeled as the negative electrode in a galvanic cell.
- Cathode: The electrode where reduction (gain of electrons) takes place. It is typically labeled as the positive electrode in a galvanic cell.
- Electrolyte: A solution or medium that allows the flow of ions between the two electrodes. It is essential for completing the electrical circuit and maintaining charge neutrality.
- Salt Bridge (in galvanic cells): A component that allows ions to move between the two half-cells, maintaining electrical neutrality.

Some common examples of electrochemical cells include the lead-acid battery in cars, lithium-ion batteries in electronic devices, and hydrogen fuel cells in vehicles. These cells have diverse applications and play a crucial role in modern technology by providing portable power sources, facilitating chemical reactions, and contributing to clean energy solutions.