**Electrochemistry and Electrochemical Cells**

[FlexBooks® 2.0](https://flexbooks.ck12.org/flexbooks)  >  [CK-12 Chemistry For High School](https://flexbooks.ck12.org/cbook/ck-12-chemistry-flexbook-2.0)  >  23.2 Electrochemical Reaction

Metal exposed to the outside elements will usually corrode if not protected. The [corrosion](https://www.ck12.org/c/chemistry/corrosion?referrer=crossref) process is a series of redox reactions involving the metal of the sculpture. In some situations, the [metals](https://www.ck12.org/c/physical-science/metals?referrer=crossref) are deliberately left unprotected so that the surface will undergo changes that may enhance the aesthetic value of the work.

**Electrochemical Reactions**

[Chemical reactions](https://www.ck12.org/c/college-biology/chemical-reactions?referrer=crossref) either absorb or release [energy](https://www.ck12.org/c/physical-science/energy?referrer=crossref). REDOX reactions involve the exchange (movement) of electrons, so for REDOX reactions this energy can be released or absorbed as electrical energy. Electrochemistry is a branch of chemistry that deals with the interconversion of chemical [energy](https://www.ck12.org/c/physical-science/energy?referrer=crossref) and electrical energy. Electrochemistry has many common applications in everyday life. All sorts of [batteries](https://www.ck12.org/c/chemistry/batteries?referrer=crossref), from those used to power a flashlight to a calculator to an automobile, rely on [chemical reactions](https://www.ck12.org/c/college-biology/chemical-reactions?referrer=crossref) to generate electricity. Electricity is used to plate objects with decorative [metals](https://www.ck12.org/c/physical-science/metals?referrer=crossref) like gold or chromium. Electrochemistry is important in the transmission of [nerve impulses](https://www.ck12.org/c/college-biology/nerve-impulses?referrer=crossref) in biological systems. Redox chemistry, the transfer of electrons, is behind all electrochemical processes.

When a strip of zinc metal is placed into a blue [solution](https://www.ck12.org/c/physical-science/solution?referrer=crossref) of copper (II) sulphate (Figure [below](https://flexbooks.ck12.org/cbook/ck-12-chemistry-flexbook-2.0/section/23.1/primary/lesson/direct-redox-reactions-chem#x-ck12-OTgwNDUtMTM2ODc0MjM3NC0wMi05NC1DLUludENoLTA1LTA3LTAxLUNvcHBlci1TdWxmYXRl)), a reaction immediately begins as the zinc strip begins to darken. If left in the [solution](https://www.ck12.org/c/physical-science/solution?referrer=crossref) for a longer period, the zinc will gradually decay due to oxidation to zinc ions. At the same time, the copper (II) ions from the solution are reduced to copper metal, which causes the blue copper (II) sulphate [solution](https://www.ck12.org/c/physical-science/solution?referrer=crossref) to become colourless.

The process that occurs in this redox reaction is shown below as two separate half-reactions, which can then be combined into the full redox reaction.

Oxidation:  Zn(s) → Zn2+(aq) + 2e− Reduction:  Cu2+(aq) + 2e− → Cu(s)

Full Reaction: Zn(s) + Cu2+(aq) → Zn2+(aq) + Cu(s)

This reaction occurs spontaneously. Why? Discuss in terms of availability of electrons and relative electronegativity.

However, no reaction will occur if a strip of copper metal is placed into a solution of zinc ions, because the zinc ions are not able to oxidize the copper. In other words, such a reaction is non-spontaneous.

The reaction of zinc metal with copper (II) ions is a spontaneous redox reaction. The electrons that are transferred in the reaction go directly from the Zn atoms on the surface of the strip to the Cu2+ ions in the area of the [solution](https://www.ck12.org/c/physical-science/solution?referrer=crossref) right next to the zinc strip.

Electricity on the other hand, requires the passage of electrons through a conducting medium, such as a wire, in order to do work. This work could be lighting a light bulb, powering a refrigerator, or heating a house. When the redox reaction is directly between two substances in contact, those electrons cannot be made to do work as they do not travel through a wire, but are directly transferred from one substance to another.

To create an electric current, we must separate the oxidation process from the reduction process and force the electrons to move from one place to another through an external wire. That is the key to the structure of the electrochemical cell.

An **electrochemical cell** is any device that converts chemical [energy](https://www.ck12.org/c/physical-science/energy?referrer=crossref) into electrical energy (spontaneous REDOX reactions), or the opposite – forces electrical energy into a system to create chemical change (non-spontaneous REDOX reactions). An electrochemical cell which generates converts chemical energy into electricity is known as a GALVANIC cell (these make up our batteries). An electrochemical cell which uses electricity to create chemical change is called an electrolytic cell.

Four basic components make up a Galvanic cell

* Two [solution](https://www.ck12.org/c/physical-science/solution?referrer=crossref)s where the two half reactions occur – these are called **half cells**. The half reactions generally take place in [aqueous](https://www.ck12.org/c/biology/water?referrer=crossref) solution (there are some exceptions) to facilitate [electron](https://www.ck12.org/c/physical-science/electron?referrer=crossref) and [ion](https://www.ck12.org/c/physical-science/ion?referrer=crossref) movement. If the REDOX reaction is spontaneous, the oxidation and reduction half reactions are separated (into two half cells) from each other so there can be no direct exchange of electrons.
* A conductor (usually a metal wire) which connects one half cell to the other. This conductor is external to the solutions and allows the electrons being exchanged to travel from one half cell to the other.
* Electrodes that sit within the solution. The surface of the electrodes is where the oxidation and reduction half reactions actually occur. The electrode where the oxidation half reaction occurs is called the **Anode**; the electrode where the reduction half reaction occurs is called the **Cathode**.
* A **Salt** **Bridge** connecting the two solutions. The salt bridge allows ions to travel and distribute electric charge electrons move.