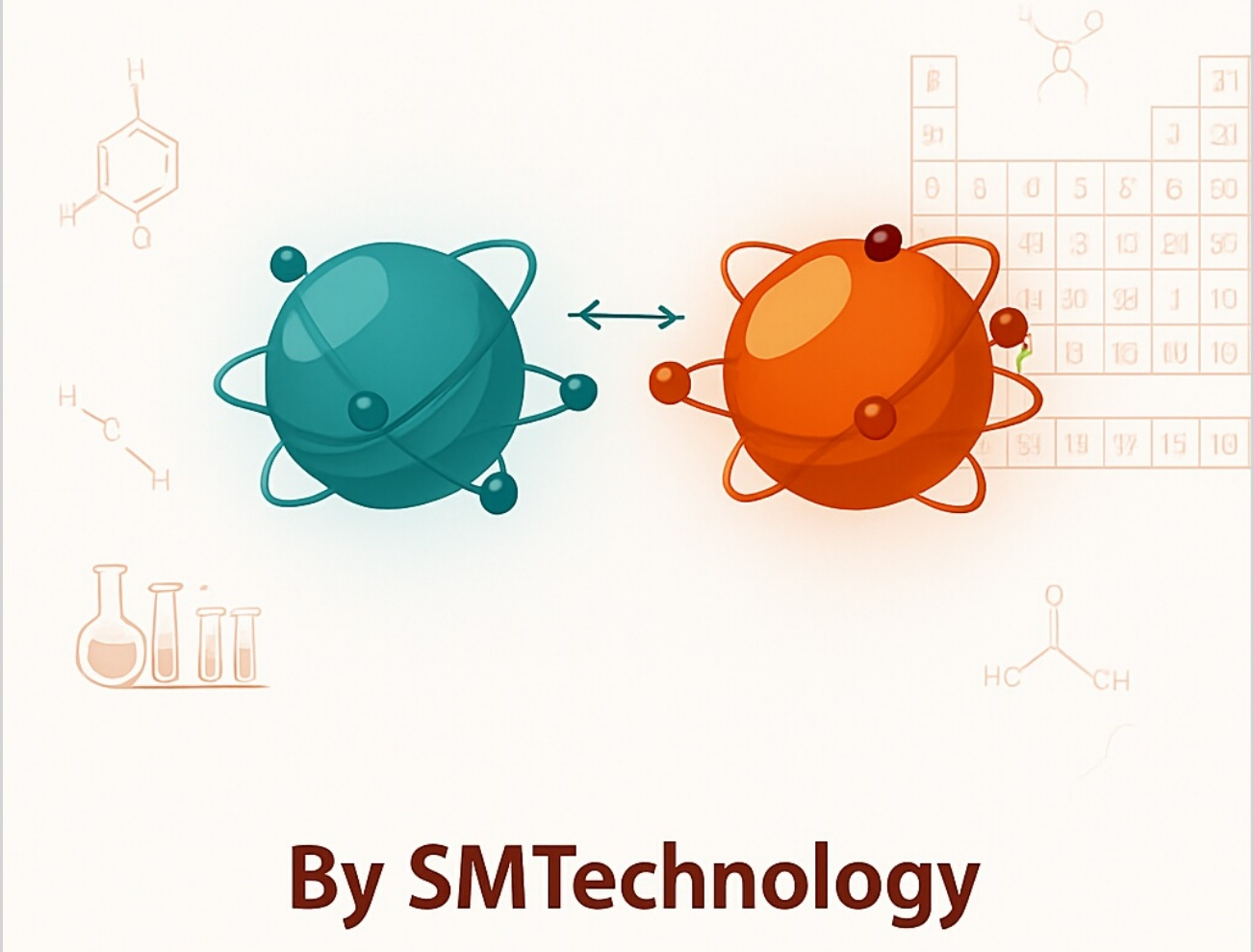
Oxidation an Reduction

Fundamentals of Redox Chemistry



By SMTechnology

Oxidation and reduction are fundamental chemical processes that always occur together in what is known as an **oxidation-reduction reaction**, or **redox reaction**. These reactions involve the transfer of electrons between two chemical species (atoms, ions, or molecules).

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1. The Definitions (Electron Transfer)

The simplest and most universally applicable way to define oxidation and reduction

is by the transfer of electrons:

- **Oxidation:** The **loss** of electrons by a chemical species.
  - When a species loses electrons, its oxidation number (or oxidation state) **increases** (becomes more positive).
  - **Mnemonic: L**oss of **E**lectrons is **O**xidation (**LEO**)
- **Reduction:** The **gain** of electrons by a chemical species.
  - When a species gains electrons, its oxidation number **decreases** (becomes more negative).
  - **Mnemonic: G**ain of **E**lectrons is **R**eduction (**GER**)

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2. Oxidation and Reduction Agents

Since oxidation and reduction must occur simultaneously, the two reacting species are given special roles:

Term	Role in Reaction	Effect on the *Other* Species	Change in Oxidation State
Oxidizing Agent (Oxidant)	Gains electrons (is **reduced**)	Causes the other species to be oxidized	Decreases
Reducing Agent (Reductant)	Loses electrons (is **oxidized**)	Causes the other species to be reduced	Increases

The oxidizing agent is reduced, and the reducing agent is oxidized.

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3. Examples of Redox Reactions

Redox reactions are common and vital to many processes in everyday life and biology:

- **Rusting of Iron:** Iron (Fe) is **oxidized** as it loses electrons and reacts with oxygen (O_2) to form iron oxide (rust). Oxygen is simultaneously **reduced**.

oxygen (O_2) to form iron(III) oxide (Fe_2O_3). Oxygen is simultaneously reduced.

$$4\ Fe\ (s) + 3\ O_2\ (g) \rightarrow 2\ Fe_2O_3\ (s)$$

- **Photosynthesis and Respiration:** These fundamental biological processes involve a complex series of redox reactions for energy transfer.
- **Batteries and Fuel Cells:** These devices rely on controlled redox reactions to generate electrical current.
- **Combustion (Fire):** The fuel is oxidized, and the oxygen is reduced.

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4. Historical Definitions (Less General)

Historically, oxidation and reduction were first defined based on oxygen and hydrogen transfer:

- **Oxidation:** Addition of oxygen or removal of hydrogen.
- **Reduction:** Removal of oxygen or addition of hydrogen.

While still true for many organic chemistry reactions, the **electron transfer** and **oxidation number** definitions are more comprehensive for all of chemistry.