

Electrochemical series

Electrochemical series

- Electrochemical series (also sometimes referred to as activity series) is a list that describes the arrangement of elements in order of their increasing electrode potential values.
- The series has been established by measuring the potential of various electrodes versus standard hydrogen electrode (SHE).
- In electrochemical series, the electrodes (metals and non-metals) in contact with their ions are arranged on the basis of the values of their standard reduction or oxidation potentials.
- Standard electrode potential is obtained by measuring the voltage when the half cell is connected to the standard hydrogen electrode under standard conditions.

	Half Reaction	Standard Potential (V)
	F₂ + 2e ⁻ ⇌ 2F ⁻	+2.87
	Pb⁴⁺ + 2e ⁻ ⇌ Pb²⁺	+1.67
	Cl₂ + 2e ⁻ ⇌ 2Cl ⁻	+1.36
	O ₂ + 4H ⁺ + 4e ⁻ ⇌ 2H ₂ O	+1.23
	Ag ⁺ + 1e ⁻ ⇌ Ag	+0.80
	Fe ³⁺ + 1e ⁻ ⇌ Fe ²⁺	+0.77
	Cu ²⁺ + 2e ⁻ ⇌ Cu	+0.34
	2H ⁺ + 2e ⁻ ⇌ H ₂	0.00
	Pb ²⁺ + 2e ⁻ ⇌ Pb	-0.13
	Fe ²⁺ + 2e ⁻ ⇌ Fe	-0.44
	Zn ²⁺ + 2e ⁻ ⇌ Zn	-0.76
	Al ³⁺ + 3e ⁻ ⇌ Al	-1.66
	Mg ²⁺ + 2e ⁻ ⇌ Mg	-2.36
	Li ⁺ + 1e ⁻ ⇌ Li	-3.05

↑ stronger oxidizing agent

↓ stronger reducing agent

Characteristics of Electrochemical Series

- The substances which are stronger reducing agents than hydrogen are placed above hydrogen in the series and have negative values of standard reduction potentials.
- All those substances which have positive values of reduction potentials and placed below hydrogen in the series are weaker reducing agents than hydrogen.
- The substances which are stronger oxidizing agents than hydrogen ion are placed below hydrogen in the series.
- The metals on the top (having high negative values of standard reduction potentials) have the tendency to lose electrons readily. These are active metals.
- The activity of metals decreases from top to bottom. The non-metals on the bottom (having high positive values of standard reduction potentials).
- The activity of non-metals increases from top to bottom

Applications of Electrochemical Series

Reactivity of Metals

- The activity of the metal depends on its tendency to lose electron or electrons, i.e., tendency to form cation (M^{n+}). This tendency depends on the magnitude of standard reduction potential.
- The metal which has high negative value (or smaller positive value) of standard reduction potential readily loses the electron or electrons and is converted into cation. Such a metal is said to be chemically active.
- The chemical reactivity of metals decreases from top to bottom in the series.
- The metal higher in the series is more active than the metal lower in the series. For

example,

- Alkali metals and alkaline earth metals having high negative values of standard reduction potentials are chemically active. These react with cold water and evolve hydrogen. These readily dissolve in acids forming corresponding salts and combine with those substances which accept electrons.
- Metals like Fe, Pb, Sn, Ni, Co, etc., which lie a little down in the series do not react with cold water but react with steam to evolve hydrogen.
- Metals like Cu, Ag and Au which lie below hydrogen are less reactive and do not evolve hydrogen from water.

Electropositive Character of Metals:

- The electropositive character also depends on the tendency to lose electron or electrons.
- Like reactivity, the electropositive character of metals decreases from top to bottom in the electrochemical series.

On the basis of standard reduction potential values, metals are divided into three groups

1. **Strongly electropositive metals:** Metals having standard reduction potential near about -2.0 volt or more negative like alkali metals, alkaline earth metals are strongly electropositive in nature.
2. **Moderately electropositive metals:** Metals having values of reduction potentials between 0.0 and about -2.0 volt are moderately electropositive. Al, Zn, Fe, Ni, Co, etc., belong to this group.
3. **Weakly electropositive metals:** The metals which are below hydrogen and possess positive values of reduction potentials are weakly electropositive metals. Cu, Hg, Ag, etc., belong to this group.