



### Electrochemical series (emf series)

A series in which elements are arranged in the ascending (increasing) order of their standard reduction potential with respect to hydrogen scale is called emf series.

Half reaction	$E^{\ominus}/V$
$\text{Li}^+ (\text{aq}) + e^- \rightarrow \text{Li} (\text{s})$	-3,03
$\text{Ca}^{2+} (\text{aq}) + 2e^- \rightarrow \text{Ca} (\text{s})$	-2,87
$\text{Al}^{3+} (\text{aq}) + 3e^- \rightarrow \text{Al} (\text{s})$	-1,66
$\text{Zn}^{2+} (\text{aq}) + 2e^- \rightarrow \text{Zn} (\text{s})$	-0,76
$\text{Pb}^{2+} (\text{aq}) + 2e^- \rightarrow \text{Pb} (\text{s})$	-0,13
$2\text{H}^+ (\text{aq}) + 2e^- \rightarrow \text{H}_2 (\text{g})$	0,00
$\text{Cu}^{2+} (\text{aq}) + 2e^- \rightarrow \text{Cu} (\text{s})$	+0,34
$\text{Ag}^+ (\text{aq}) + e^- \rightarrow \text{Ag} (\text{s})$	+0,80

#### Application / Significance of electrochemical series

##### (i) Relative ease of oxidation or reduction

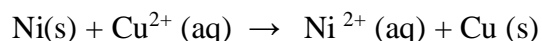
➤ The metals which lie above hydrogen in the series undergo spontaneous oxidation and the metals which lie below SHE undergo reduction spontaneously (ie. Acts as Anodes and Cathodes respectively)

➤ The metals which lie above hydrogen are good reducing agents and which lies below hydrogen will act as good oxidizing agents

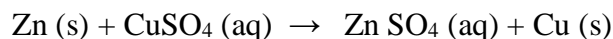
##### (ii) Replacement tendency

➤ The metal lying above in emf series displaces the metal lying below it from an electrolyte of the later.

**Example 1:** Ni spatula cannot be used to stir copper sulphate solution due to the following reaction

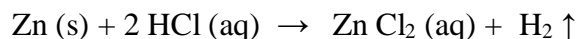


**Example 2:** when zinc is dipped in copper sulphate solution copper gets deposited (displaced)



##### (iii) Liberation of Hydrogen

➤ The metal with negative reduction potential will displace  $\text{H}_2$  from an acid solution



Hence acids cannot be stored in galvanized steel containers.

For the same reason galvanized steels are not used to store food stuffs containing vinegar. (Vinegar is used as food preservative-vinegar is acetic acid)

##### (iv) Calculation of equilibrium constant ( $K_{eq}$ )



$$-\Delta G^{\circ} = n F E^{\circ}$$

$$-\Delta G^{\circ} = 2.303 RT \log K(\text{eq})$$

$$\text{Therefore, } \log K = \frac{nFE^{\circ}}{2.303RT}$$

$$\log K = E^{\circ}/0.0591$$

#### (v) Calculation of Standard emf of the cell

$$E_{\text{Cell}} = E_{\text{Cathode}} - E_{\text{anode}}$$

(if both reduction potentials are considered)

#### (vi) Predicting the spontaneity of cell reaction

- Spontaneity of the redox reaction can be predicted from the emf value of complete cell reaction.
- If the value of  $E_{\text{cell}}$  is **positive**, the reaction is **feasible**.  $G$  will be negative ( i.e. it is an electrochemical cell)
- If the value of  $E_{\text{cell}}$  is **negative**, the reaction is **not feasible**.  $G$  will be positive ( i.e. it is an electrolytic cell).