

Electrochemical Series

Introduction:

Electrochemical arrangement once in a while alluded to as movement arrangement is a rundown that portrays the course of action of components arranged by their expanding anode potential qualities. The arrangement has been set up by estimating the capability of different cathodes versus standard hydrogen terminal (SHE).

In electrochemical arrangement, the cathodes (metals and non-metals) in contact with their particles are masterminded based on the estimations of their standard decrease or oxidation possibilities. Standard terminal potential is gotten by estimating the voltage when the half-cell is associated with the standard hydrogen cathode under standard conditions.

Electropositive and Electronegative Elements:

Components (other than hydrogen) that show a more prominent propensity to lose electrons to their answer are typically sorted as electropositive. Thus, components that gain electrons are said to be electronegative. They are normally beneath the component hydrogen in the arrangement. Regardless, in the event that we take a gander at the electrochemical arrangement, we can make sense of the request in which metals will supplant each other from their salts. In this way, electropositive metals for the most part supplant hydrogen from acids.

Application of Electrochemical Series:

Sr. No.	Electrode	Reduction Half reaction Oxidising agent → Reducing agent	E ⁰ (volts)At 25
1	F ⁻ F ₂ Pt.	F ₂ + 2e ⁻ → 2F ⁻	+2.87
2	Au ⁺ Au	Au ⁺ + e ⁻ → Au	+1.68
3	Ce ⁴⁺ , Ce ³⁺ Pt.	Ce ⁴⁺ + e ⁻ → Ce ³⁺	+1.61
4	Au ³⁺ Au	Au ³⁺ + 3e ⁻ → Au	+1.50
5	Cl ⁻ Cl ₂ Pt.	Cl ₂ + 2e ⁻ → 2Cl ⁻	+1.36
6	Pt ²⁺ Pt	Pt ²⁺ + 2e ⁻ → Pt	+1.20
7	Br ⁻ Br ₂ Pt	Br ₂ + 2e ⁻ → 2Br ⁻	+1.08
8	Hg ²⁺ Hg	Hg ²⁺ + 2e ⁻ → Hg	+0.854
9	Ag ⁺ Ag	Ag ⁺ + e ⁻ → Ag	+0.799
10	Hg ₂ ²⁺ Hg	Hg ₂ ²⁺ + 2e ⁻ → Hg ₂	+0.790
11	Fe ³⁺ , Fe ²⁺ Pt.	Fe ³⁺ + e ⁻ → Fe ²⁺	+0.771
12	I ⁻ I ₂ (s) Pt	I ₂ + 2e ⁻ → 2I ⁻	+0.535
13	Cu ²⁺ Cu	Cu ²⁺ + 2e ⁻ → Cu	+0.337
14	Pt Hg Hg ₂ Cl ₂ Cl ⁻	Hg ₂ Cl ₂ + 2e ⁻ → 2Hg + 2Cl ⁻	+0.242
15	Ag AgCl(s) Cl ⁻	AgCl + e ⁻ → Ag + Cl ⁻	+0.222
16	Cu ²⁺ Cu ⁺	Cu ²⁺ + e ⁻ → Cu ⁺	+0.153
17	Sn ⁴⁺ , Sn ²⁺ Pt.	Sn ⁴⁺ + 2e ⁻ → Sn ²⁺	+0.15
18	H ⁺ H ₂ Pt.	2H ⁺ + 2e ⁻ → H ₂ (g)	0.0 (Definition)
19	Pb ²⁺ Pb	Pb ²⁺ + 2e ⁻ → Pb	-0.126
20	Su ²⁺ Su	Su ²⁺ + 2e ⁻ → Su	-0.136
21	Ni ²⁺ Ni	Ni ²⁺ + 2e ⁻ → Ni	-0.257
22	Co ²⁺ Co	Co ²⁺ + 2e ⁻ → Co	-0.280
23	Cd ²⁺ Cd	Cd ²⁺ + 2e ⁻ → Cd	-0.403
24	Fe ²⁺ Fe	Fe ²⁺ + 2e ⁻ → Fe	-0.440

1. Oxidizing and Reducing Strengths:

Electrochemical arrangement encourages us to distinguish a decent oxidizing specialist or lessening operator. All the substance showing up on the highest point of the electrochemical arrangement are a decent oxidizing operator i.e., they have positive Value of standard decrease potential though those showing up on the base of the electrochemical arrangement are a decent diminishing specialist i.e., they have a negative estimation of standard decrease potential. For Example, F₂ cathode with the standard decrease potential estimation of +2.87 is a solid oxidizing specialist and Li⁺ with standard decrease potential estimation of - 3.05 volts is a solid diminishing operator.

2. Calculation of Standard emf (E⁰) of Electrochemical Cell

The standard emf of the cell is the entirety of the standard decrease capability of the two half cell: decrease half-cell and oxidation half cell

$$[E^{\circ}]_{\text{cell}} = [E^{\circ}]_{\text{red}} + [E^{\circ}]_{\text{ox}}$$

By show, the standard oxidation potential is constantly communicated as far as decrease potential. In this manner, standard oxidation potential

$$(E^{\circ}_{\text{ox}}) = - \text{standard decrease potential } (E^{\circ}_{\text{red}})$$

In this manner,

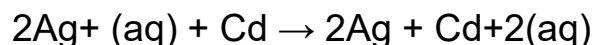
$$E^{\circ}_{\text{cell}} = (\text{standard decrease capability of decrease half-cell}) - (\text{standard decrease capability of oxidation half-cell})$$

As oxidation happens at anode and decrease happens at the cathode. Subsequently,

$$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathod}} - E^{\circ}_{\text{anode}}$$

Model:

For a response,



The standard decrease potential given are: $\text{Ag}^+/\text{Ag} = 0.80$ volt, $\text{Cd}^{2+}/\text{Cd} = -0.40$ volt

From the response, we can see that Cd misfortunes electron and Ag^+ gains. Consequently, oxidation half-cell or anode is Cd.

Utilizing the recipe,

$$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathod}} - E^{\circ}_{\text{anode}}$$

$$= 0.80 - (-0.40)$$

$$= 1.20 \text{ volt}$$

4. Predicting the Product of Electrolysis

On the off chance that, at least two kinds of positive and negative particles are available in arrangement, during electrolysis certain metal particles are released or freed at the terminals in inclination to other people. When all is said in done, in such rivalry, the particle which is a more grounded oxidizing specialist (high estimation of standard decrease potential) is released first at the cathode.

Hence, when a watery arrangement of NaCl containing Na^+ , Cl^- , H^+ and OH^- particles is electrolyzed, H^+ particle is specially kept at cathode (decrease) rather than Na^+ being diminished, this is on the grounds that decrease capability of hydrogen (0.00 volt) is higher than the decrease capability of sodium (- 2.71 volt). At the anode where oxidation happens, the anion that has lower decrease potential will be oxidized. Subsequently, OH^- with standard decrease potential 0.40 volt will be oxidized in inclination to Cl^- with standard decrease capability of 1.36 volt.

5. Reactivity of metals:

The movement of the metal relies upon its propensity to lose electron or electrons, i.e., inclination to frame activity. This propensity relies upon the greatness of standard decrease potential. The metal which has high negative worth (or littler positive estimation) of standard decrease potential promptly loses the electron or electrons and is changed over into cation. Such a metal is said to be synthetically dynamic. The synthetic reactivity of metals diminishes through and through in the arrangement. The metal higher in the arrangement is more dynamic than the metal lower in the arrangement.

For instance:

1) Alkali metals and basic earth metals having high negative estimations of standard decrease possibilities are synthetically dynamic. These respond with cold water and advance hydrogen. These promptly break up in acids shaping comparing salts and join with those substances which acknowledge electrons.

2) Metals like Fe, Pb, Sn, Ni, Co, and so forth. Which lie somewhat down in the arrangement don't respond with cold water yet respond with steam to advance hydrogen.

3) Metals like Cu, Ag and Au which lie underneath hydrogen are less responsive and don't develop hydrogen from water.

6. Electropositive character of metals:

The electropositive character likewise relies upon the inclination to lose electron or electrons. Like reactivity, the electropositive character of metals diminishes start to finish in the electrochemical arrangement. Based on standard decrease potential qualities, metals are isolated into three gathering.

(1) **Strongly electropositive metals:** Metals having standard decrease potential close about 2.0 volt or progressively negative like soluble base metals, antacid earth metals are firmly electropositive in nature.

(2) **Moderately electropositive metals:** Metals having estimations of decrease possibilities among 0.0 and about 2.0 volt are decently

electropositive Al, Zn, Fe, Ni, Co, and so on., have a place with this gathering.

(3) **Weakly electropositive:** The metals which are underneath hydrogen and have positive estimations of decrease possibilities are feebly electropositive metals. Cu, Hg, Ag, and so forth. Have a place with this gathering.

7. Reducing power of metals:

Lessening nature relies upon the inclination of losing electron or electrons. More the negative decrease potential, more is the inclination to lose electron or electrons. In this way diminishing nature diminishes through and through in the electrochemical arrangement. The intensity of the diminishing specialist expands (capacity to lessen), as the standard decrease potential turns out to be increasingly negative.

8. Oxidising nature of non-metals:

Oxidizing nature relies upon the propensity to acknowledge electron or electrons. More the estimation of decrease potential, higher is the propensity to acknowledge electron or electrons. Along these lines, oxidizing nature increments through and through in the electrochemical arrangement. The quality of an oxidizing operator increments as the estimation of decrease potential turns out to be increasingly positive.

9. Thermal stability of metallic oxides:

The warm security of the metal oxide relies upon its electropositive nature. As the electro inspiration diminishes start to finish, the warm solidness of the

oxide additionally diminishes through and through. The oxides of metals having high positive decrease possibilities are not steady towards heat. The metals which come beneath copper structure flimsy oxides, i.e., these are deteriorated on warming.

10. Activity of metals from Electrochemical Series:

The electrochemical arrangement (otherwise called the movement arrangement) is a rundown of metals recorded arranged by diminishing reactivity or in the request for diminishing simplicity of oxidation. The action of the metal relies upon its propensity to lose electron or electrons, i.e., inclination to shape cation. This propensity relies upon the extent of standard decrease potential. The metal which has high negative worth (or littler positive estimation) of standard decrease potential promptly loses the electron or electrons and is changed over into cation. Such a metal is said to be artificially dynamic. The synthetic reactivity of metals diminishes start to finish in the arrangement. The metal higher in the arrangement is more dynamic than the metal lower in the arrangement.

For instance:

(1) Alkali metals and soluble earth metals having high negative estimations of standard decrease possibilities are artificially dynamic. These respond with cold water and develop hydrogen. These promptly break down in acids framing comparing salts and join with those substances which acknowledge electrons.

(2) Metals like Fe, Pb, Sn, Ni, Co, and so on., which lie somewhat down in the arrangement don't respond with cold water yet respond with steam to advance hydrogen.

(3) Metals like Cu, Ag and Au which lie underneath hydrogen are less receptive and don't develop hydrogen from water.

11. Displacement of hydrogen from dilute acids by metals:

A few metals like Fe, Zn respond with dil. acids like HCl, H₂ So₄ to free H₂ gas while a few metals like Cu, Ag don't free H₂ with dil. HCl, dil. H₂ So₄. A forecast about capacity of an offered metal to create H₂ gas by its response with weaken corrosive can be effortlessly produced using the information on electromotive arrangement. The metal which can give electrons to H⁺ particles present in weaken corrosive for decrease, advance hydrogen from weaken corrosive.

Oxidation half response will be:



While decrease half response will be:



The metal having negative estimations of decrease potential have the property of losing electrons. In this way, if decrease capability of metals is lesser than that of hydrogen, metal will supply electrons to H⁺ of acids and will free hydrogen gas. Ordinarily, antacid and basic earth metals have decrease potential lower than that of hydrogen. Be that as it may, metals whose decrease potential is higher than that of hydrogen. For instance: copper, gold, platinum, mercury and so on won't advance hydrogen from weaken acids.