SNS COLLEGE OF TECHNOLOGY

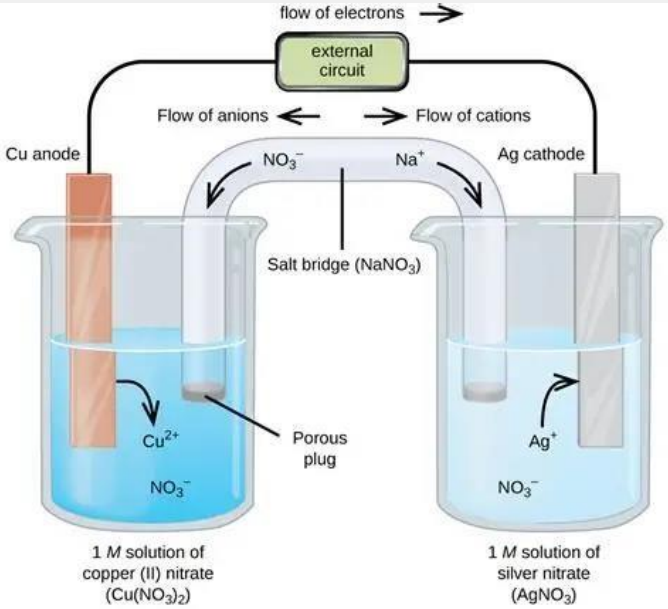
AN AUTONOMOUS INSTITUTION

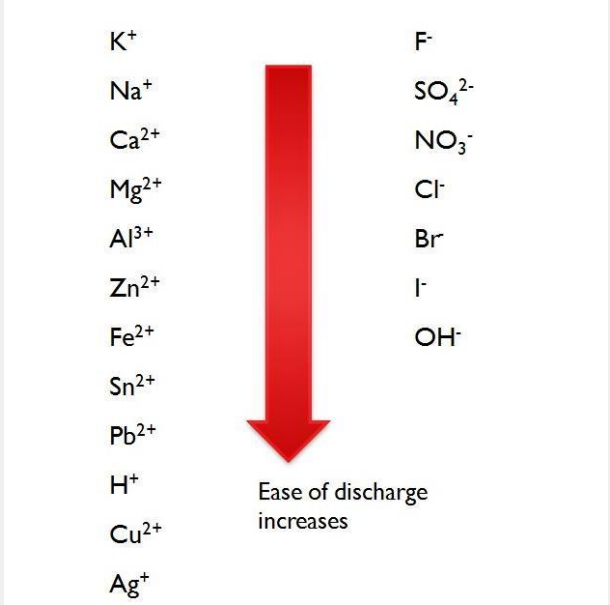
Coimbatore – 641035

23CHT101-ENGINEERING CHEMISTRY

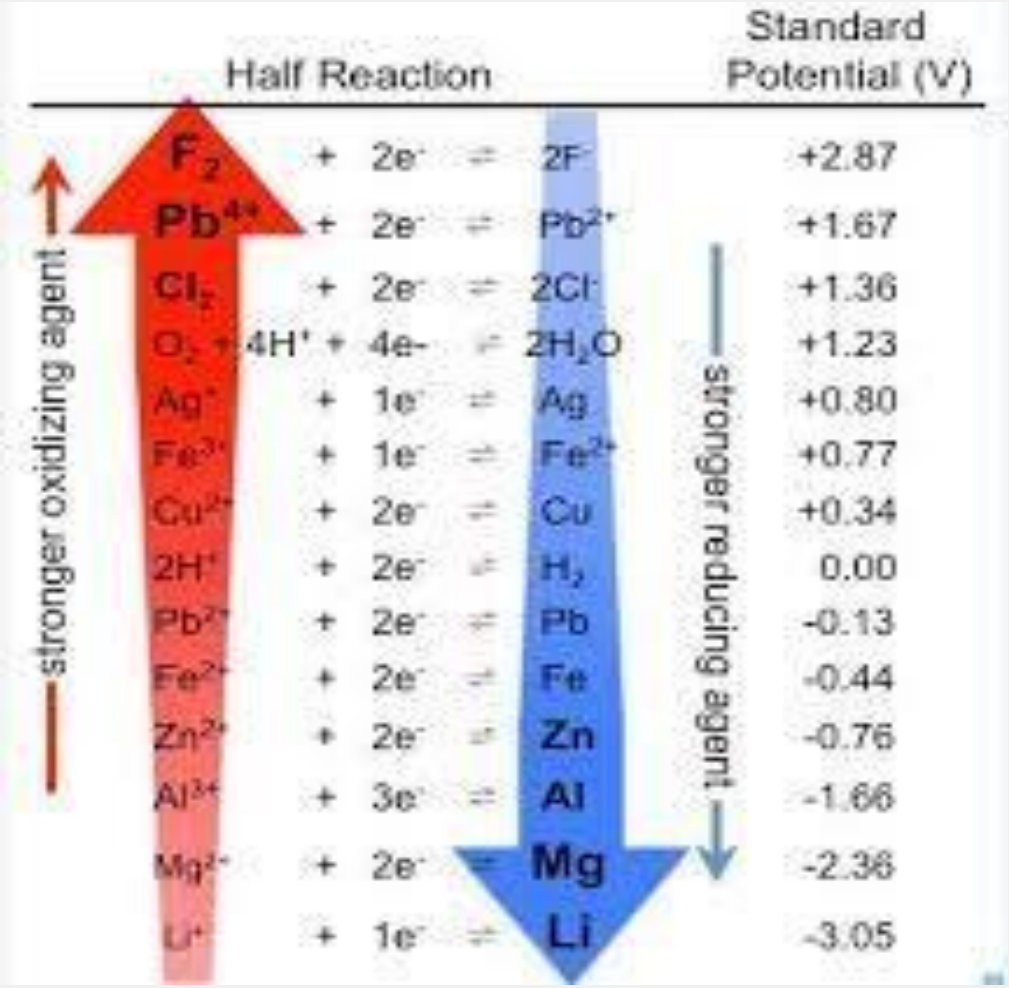
UNIT 1 – ELECTROCHEMISTRY

1.4. ELECTROCHEMICAL SERIES & ITS APPLICATIONS





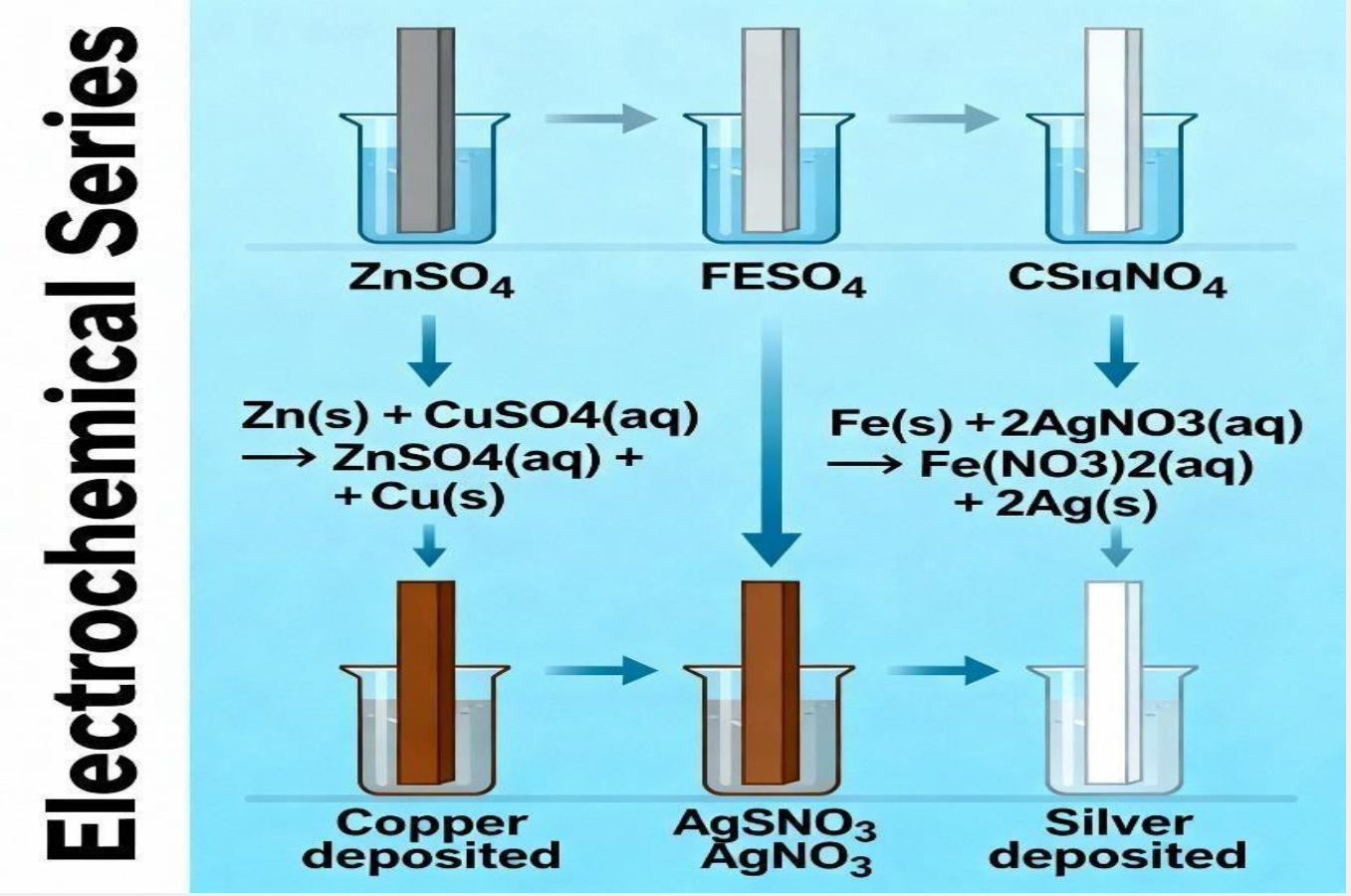
RECALL


Half Reaction
Standard Potential (V)
stronger oxidizing agent
stronger reducing agent
F2 + 2e- ⇌ 2F- +2.87
Pb4+ + 2e- ⇌ Pb2+ +1.67
Cl2 + 2e- ⇌ 2Cl- +1.36
O2 + 4H+ + 4e- ⇌ 2H2O +1.23
Ag+ + 1e- ⇌ Ag +0.80
Fe3+ + 1e- ⇌ Fe2+ +0.77
Cu2+ + 2e- ⇌ Cu +0.34
2H+ + 2e- ⇌ H2 0.00
Pb2+ + 2e- ⇌ Pb -0.13
Fe2+ + 2e- ⇌ Fe -0.44
Zn2+ + 2e- ⇌ Zn -0.76
Al3+ + 3e- ⇌ Al -1.66
Mg2+ + 2e- ⇌ Mg -2.36
Li+ + 1e- ⇌ Li -3.05

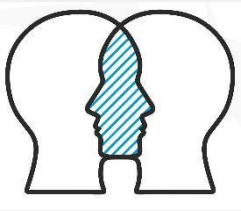
- EMF SERIES
- Applications of EMF SERIES

Electrode	Half-Cell Reaction	E° (V)
F_2/F^-	$F_2 + 2e^- \rightarrow 2F^-$	+2.87
Cl_2/Cl^-	$Cl_2 + 2e^- \rightarrow 2Cl^-$	+1.36
O_2/H_2O	$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	+1.23
Cu^{2+}/Cu	$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34
H^+/H_2	$2H^+ + 2e^- \rightarrow H_2$	0.00
Fe^{2+}/Fe	$Fe^{2+} + 2e^- \rightarrow Fe$	-0.44
Zn^{2+}/Zn	$Zn^{2+} + 2e^- \rightarrow Zn$	-0.76
Na^+/Na	$Na^+ + e^- \rightarrow Na$	-2.71
Li^+/Li	$Li^+ + e^- \rightarrow Li$	-3.04
K^+/K	$K^+ + e^- \rightarrow K$	-2.93

ELECTROCHEMICAL SERIES/ EMF SERIES

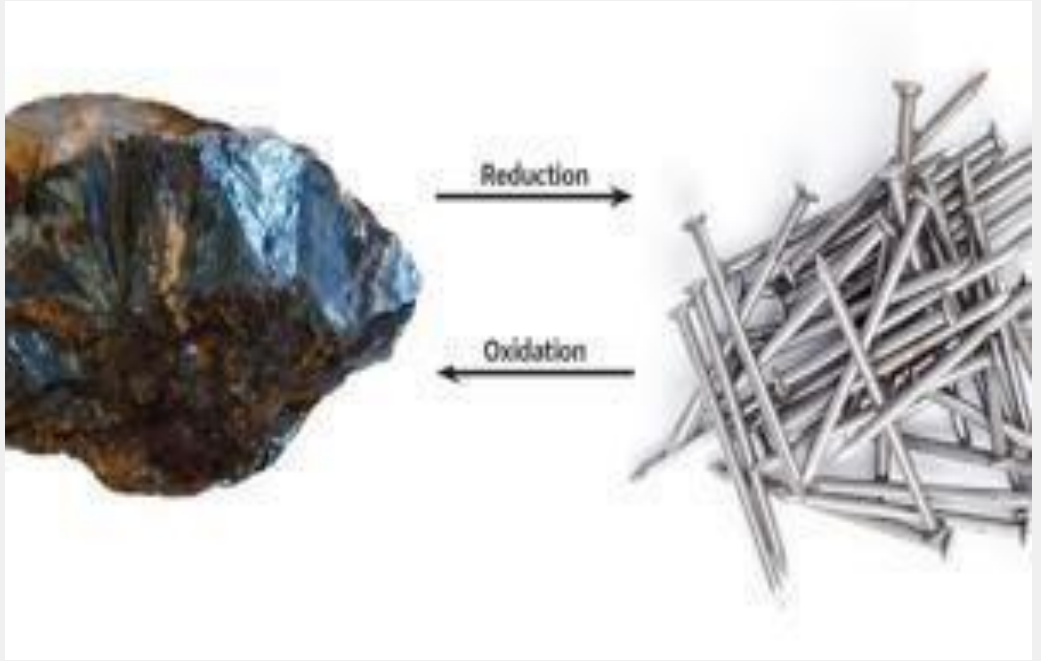


ELECTROCHEMICAL SERIES/EMF SERIES



DT-Empathize

- It helps us **predict real chemical reactions**
- Whether a metal will corrode?
- How batteries work?
- How to extract metals from ores?
  EMF series becomes less of a burden and more of a shortcut.



APPLICATIONS OF EMF SERIES

To calculate standard emf of the cell

The standard emf of a cell E^0 can be calculated if the std. electrode potential values are known

$$E^0_{cell} = E^0_{RHE} - E^0_{LHE}$$

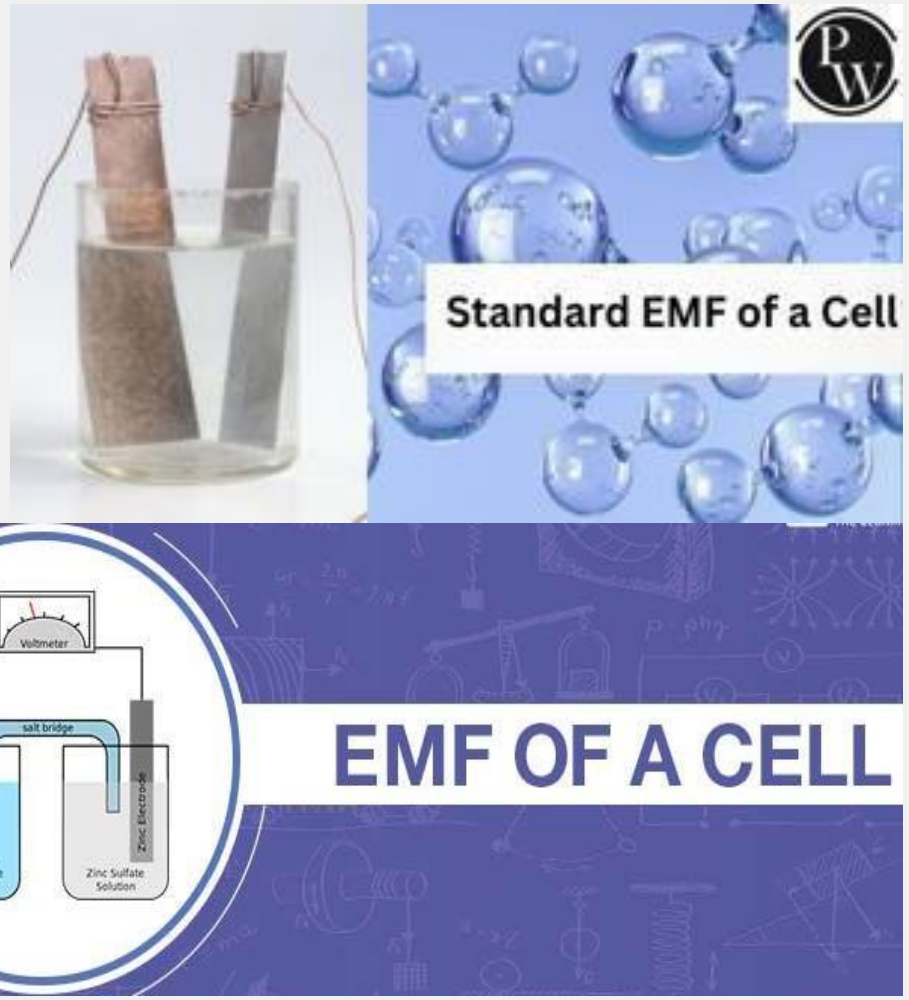
$$E^0_{cell} = E^0\ R - E^0\ L$$

Standard free energy change of a cell reaction:

n = number of electrons involved in cell reaction,

F = 96500 coulombs

E^o = Standard emf of the cell



STUDY THE RELATIVE CASE OF OXIDATION OR REDUCTION OF ELEMENTS

- Metal ion with higher reduction potential

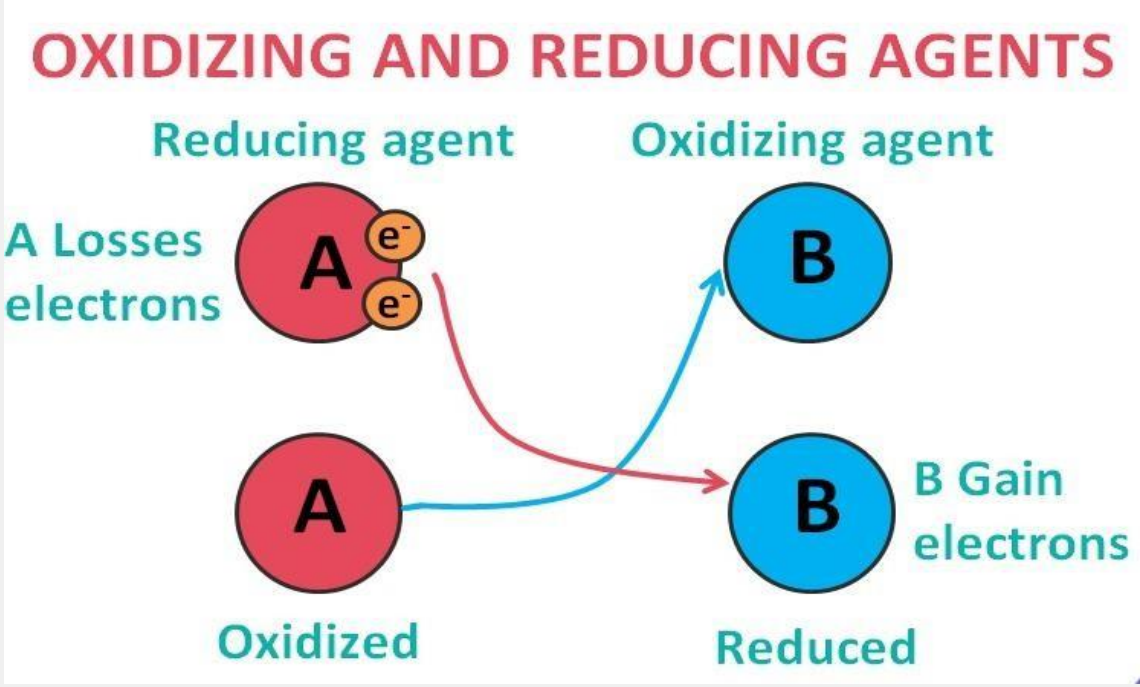
  greater tendency to undergo reduction

- Metal ion with lower reduction potential

  greater tendency to oxidation

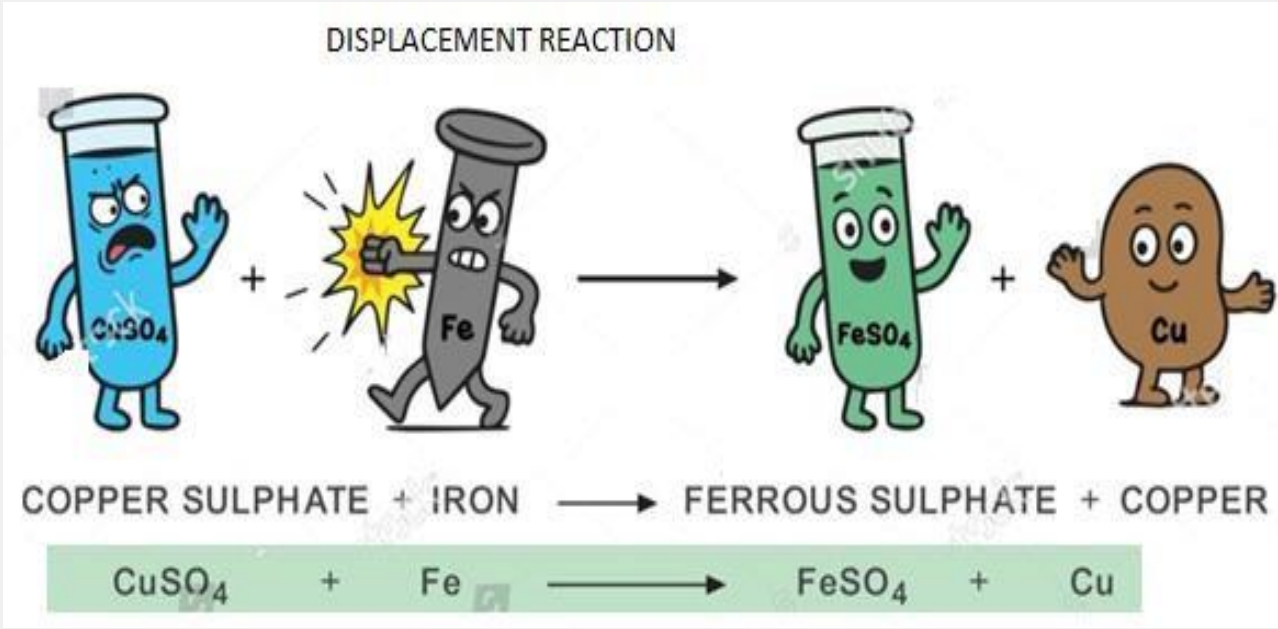
Ex: F_2 - higher positive value (+2.87 V)
higher tendency towards reduction.

Li - highest negative value (–3.01 V)
higher tendency towards oxidation.



Replacement or displacement tendency of one element by the other

Metals with a lower reduction potential
Greater tendency to replace another metal
which has higher reduction potential.



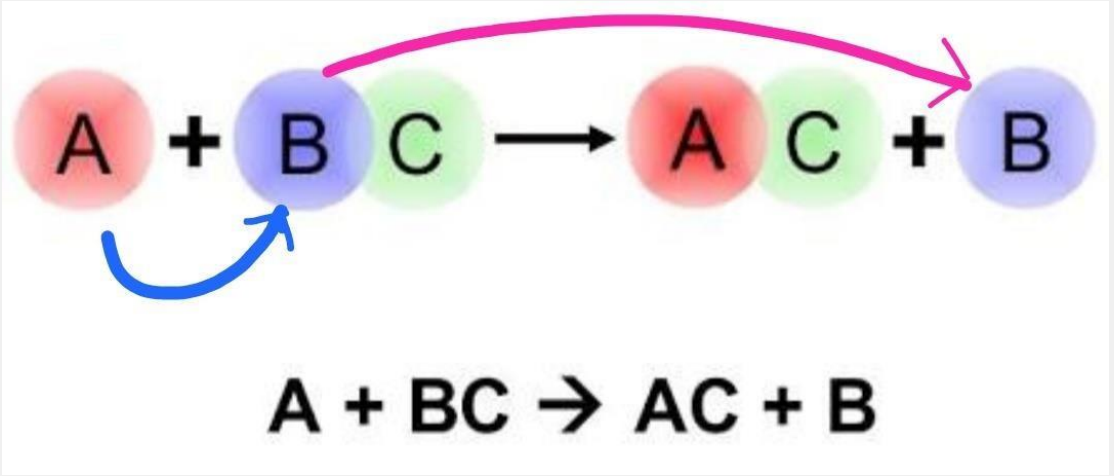
Ex: Reduction potential of zinc (–0.76 V)

is lower than copper (0.34 V).

Zinc displaces copper from its salt

solution.

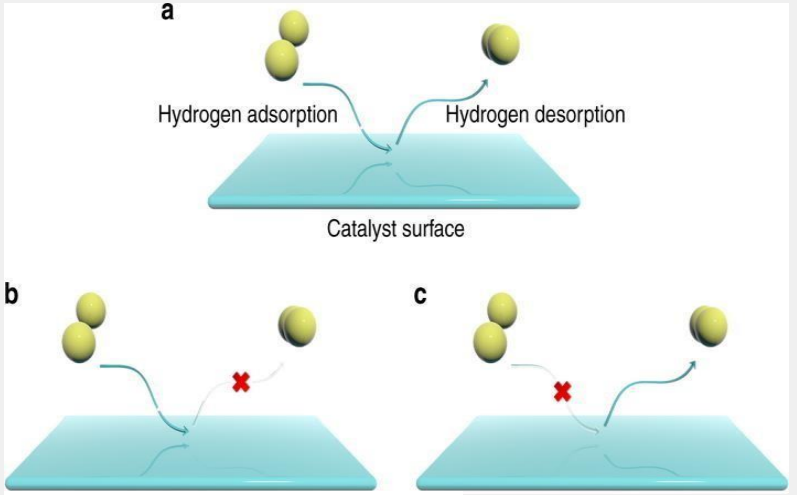
$$Zn + CuSO_4 \leftrightarrow ZnSO_4 + Cu.$$

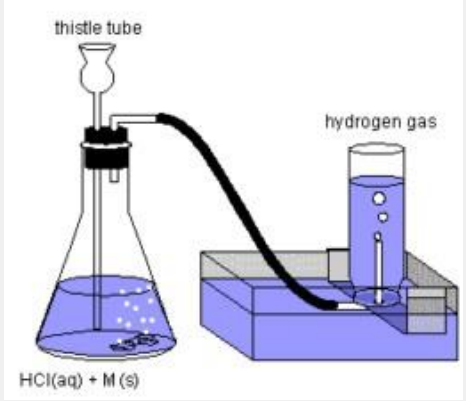


DISPLACEMENT BEHAVIOR OF HYDROGEN

- Metals with negative reduction potential displaces the hydrogen from acid solution.

- $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
  - $E^0\ Zn^{2+}/\ Zn = -\ 0.76\ V$





- Metal with positive reduction potential does not displace the hydrogen from an acid solution.

- $E^0\ Ag / Ag^+ = +0.80\ V$

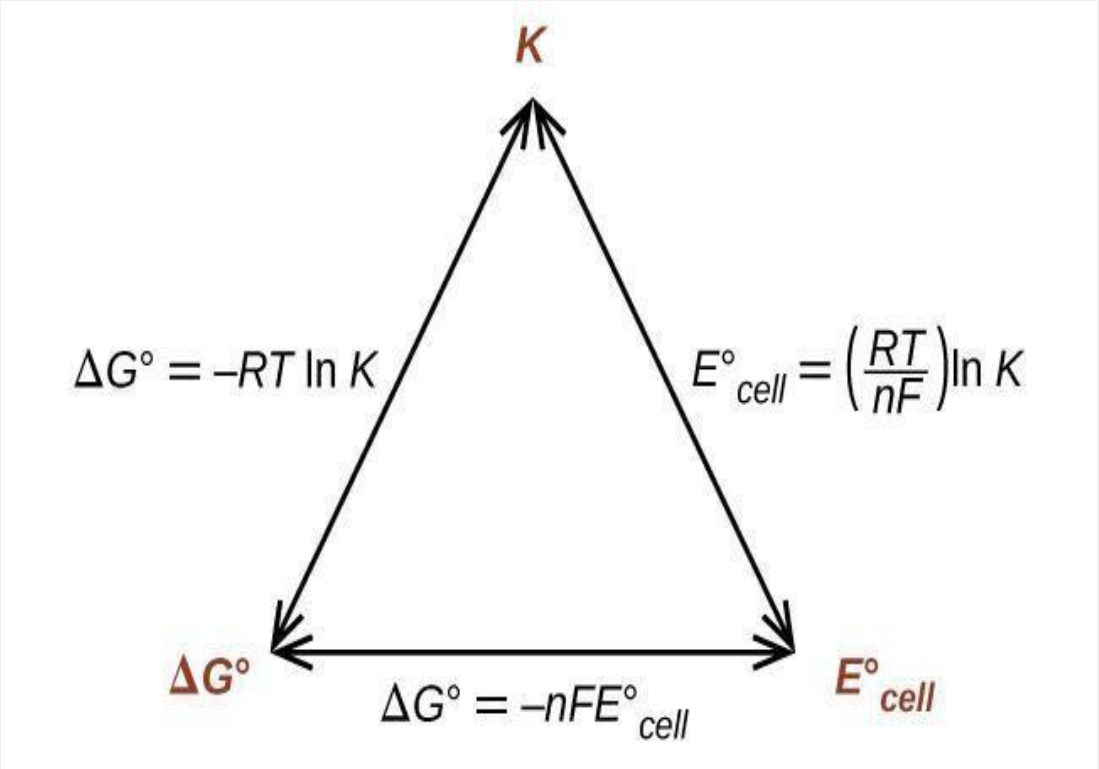
$Ag + H_2SO_4 \rightarrow$ No reaction

Positive value means Ag^+ ions are easily **reduced** to Ag metal.

Metallic Ag is not easily oxidized back to Ag^+.

CALCULATE THE EQUILIBRIUM CONSTANT OF A CELL REACTION

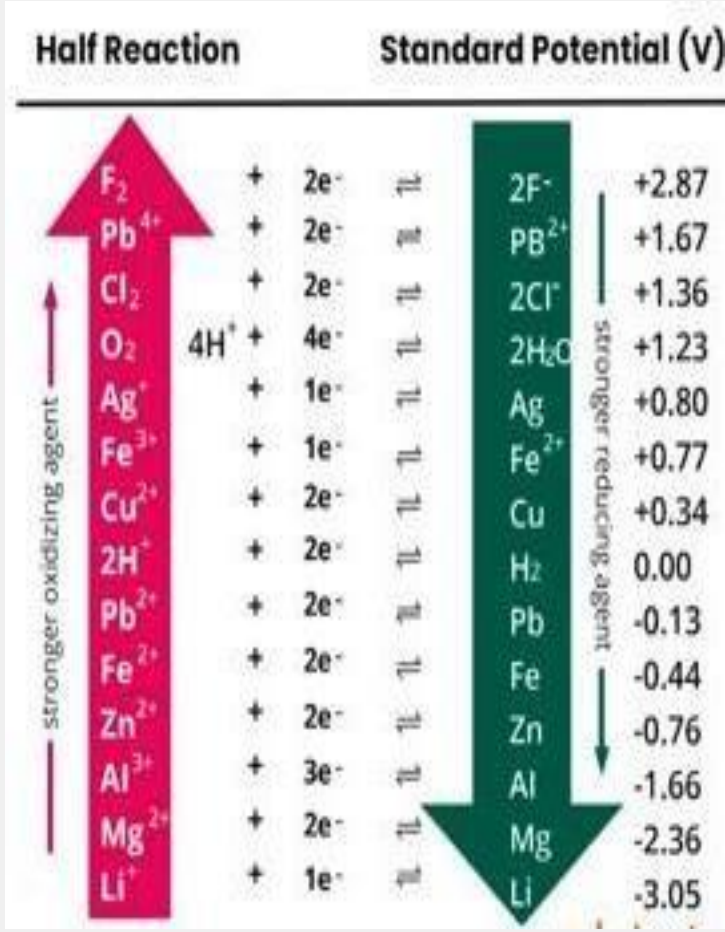
- $\Delta G^0 = -\ RT\ lnK$ .....*(1)*
- $\Delta\ G^0 = -\ nFE^0$ .....(2)
- Compare equation (1) and (2), we get,
- $nFE^o = RT lnK$
- $ln\ K = n\ FE/\ RT$
- $\log K = n\ FE^o / 2.303\ RT$
- $\log K = nE^o/ 0.0591$ ....(3)



- From the equation (3), we can calculate the equilibrium constant of a given cell reaction

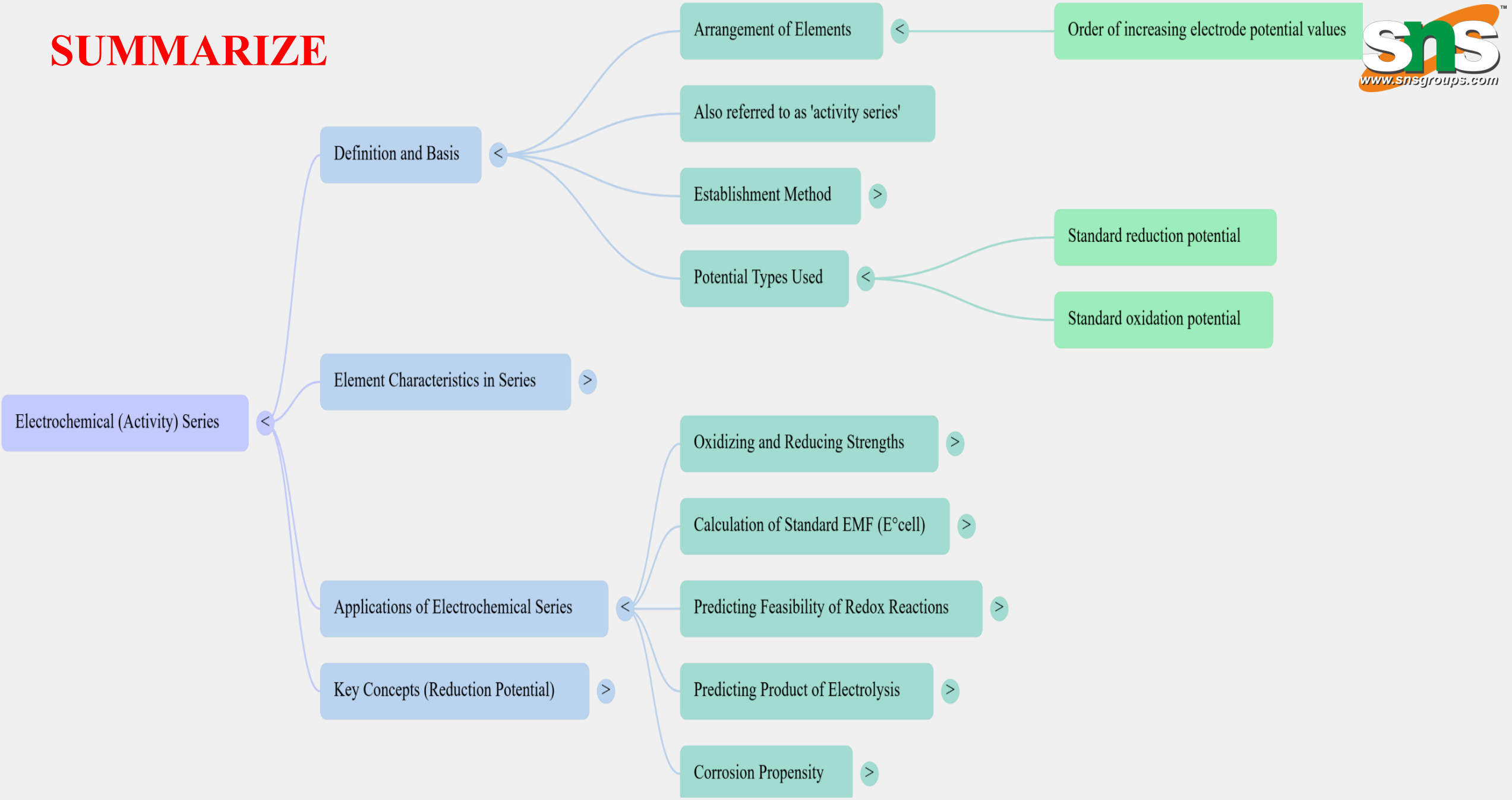
SPONTANEITY OF A CELL REACTION CAN BE PREDICTED WITH THE HELP OF ELECTROCHEMICAL SERIES

- Standard emf of a cell can calculated from EMF series.
- The relationship between change in standard free energy of the cell reaction and standard emf of the cell is given below:
- $\Delta G^{o} = - nFE^{o}$
- If E^{o} is positive, ΔG^{o} will be negative Cell reaction is spontaneous.
- If E^{o} is negative, ΔG^{o} will be positive Cell reaction is non-spontaneous (not feasible).



APPLICATIONS OF EMF SERIES

SUMMARIZE


Electrochemical (Activity) Series
Definition and Basis
Arrangement of Elements
Order of increasing electrode potential values
Also referred to as 'activity series'
Establishment Method
Potential Types Used
Standard reduction potential
Standard oxidation potential
Element Characteristics in Series
Applications of Electrochemical Series
Oxidizing and Reducing Strengths
Calculation of Standard EMF (E°cell)
Predicting Feasibility of Redox Reactions
Predicting Product of Electrolysis
Corrosion Propensity
Key Concepts (Reduction Potential)

REFERENCE

https://www.geeksforgeeks.org/chemistry/electrochemical-series/

https://satheejee.iitk.ac.in/article/chemistry/chemistry-standard-electrode-potential/

THANK YOU