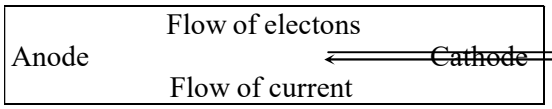
Cell potential or EMF of the cell.

(1) "The difference in potentials of the two half – cells of a cell known as **electromotive force** (emf) of the cell or cell potential."

The difference in potentials of the two half – cells of a cell arises due to the flow of electrons from anode to cathode and flow of current from cathode to anode.



(2) The emf of the cell or cell potential can be calculated from the values of electrode potentials of two the half – cells constituting the cell. The following three methods are in use:

(i) When oxidation potential of anode and reduction potential of cathode are taken into account

E^0_{cell} = Oxidation potential of anode + Reduction potential of cathode $= E^0_{\text{ox}}\,(\text{anode}) + E^0_{\text{red}}\,(\text{cathode})$

(ii) When reduction potentials of both electrodes are taken into account

$E^0_{\text{cell}} = \text{Reduction potential of cathode} - \text{Reduction potential of anode} = E^0_{\text{Cathode}} - E^0_{\text{Anode}}$
$= E^0_{\text{right}} - E^0_{\text{left}}$

(iii) When oxidation potentials of both electrodes are taken into account

E^o_{cell} = Oxidation potential of anode – Oxidation potential of cathode $= E^0_{\text{ox}}\,(\text{anode}) - E^0_{\text{ox}}\,(\text{cathode})$

3) **Difference between emf and potential difference :** The potential difference is the difference between the electrode potentials of the two electrodes of the cell under any condition while emf is the potential generated by a cell when there is zero electron flow, i.e., it draws no current. The points of difference are given below:

Emf	Potential difference
It is the potential difference between two electrodes when no current is flowing in the circuit.	It is the difference of the electrode potentials of the two electrodes when the cell is under operation.
It is the maximum voltage that the cell can deliver.	It is always less than the maximum value of voltage which the cell can deliver.
It is responsible for the steady flow of current in the cell.	It is not responsible for the steady flow of current in the cell.

(4) **Cell EMF and the spontaneity of the reaction:**

We know, $\boxed{\Delta G = -nFE_{cell}}$

(i) For a spontaneous process, ΔG is negative. Then, according to the equation for a spontaneous process, E_{cell} should be positive. Thus, the cell reaction will be spontaneous when the cell emf is positive.

(ii) For a non – spontaneous process, ΔG is positive. Then, according to equation for a non – spontaneous process, E_{cell} should be negative. Thus, the cell reaction will be non – spontaneous when the cell emf is negative.

(iii) For the process to be at equilibrium, $\Delta G = 0$. Then, according to the equation E_{cell} should be zero. Thus, the cell reaction will be at equilibrium when the cell emf is zero.These results are summarized below

Nature of reaction	ΔG(or ΔG^o)	E_{cell} (or E^o_{cell})
Spontaneous	–	+
Equilibrium	0	0
Non – spontaneous	+	–