NERNST EQUATION :

Consider the following electrode reaction.

$$M^{n+}_{aq} \longrightarrow M + ne^-$$

The emf of a reversible cell can be measured by free energy change (ΔG) of a reaction takes place in the reversible cell. If the reaction involves the transfer of 'n' electrons, 'F' faradays of electricity will flow and E is the emf of the cell, then the total electrical energy produced by the cell is given by following equation

$$-\Delta G = (-)nFE \quad \ldots\ldots (1)$$

where $-\Delta G$ is decrease in free energy change.

In other way,

$$\Delta G^\circ = -nFE^\circ \text{ (or) } (-)\Delta G^\circ = nFE^\circ \quad \ldots (2)$$

where $-\Delta G^\circ$ is Standard free energy change and E_0 is the Standard emf of a cell.

For a reversible reaction, the interrelationship of free energy change and equilibrium Constant (K) is given by

$$-\Delta G = -\Delta G^\circ + RT \ln K \quad \ldots\ldots (3)$$

$$\Delta G = (-)RT \ln K + RT \ln \frac{[\text{product}]}{[\text{reactant}]} \longrightarrow ① \quad 4$$

But $\Delta G^\circ = (-)RT \ln K$ — ② 5

Sub ② in ① 5 in 4

$$\Delta G = \Delta G^\circ + RT \ln \frac{[\text{product}]}{[\text{reactant}]} \quad ③ \quad 6$$

where n is the number of elections
f is the Faraday = 96,500 coulombs of electricity
E° is the standard potential

Sub the equation 4 & 5

$$(-)nfE = (-)nfE^\circ + RT \ln \frac{[product]}{[rectant]}$$

Rearranging the above equation.

$$E_{red} = E^\circ_{red} - RT \ln \frac{[product]}{[rectant]}$$

$$E_{red} = E^\circ_{red} - \frac{RT}{nf} \ln \frac{[M]}{[M^{n+}]}$$

$[M] = 1$ for the solid metal.

$$E_{red} = E^\circ_{red} - \frac{RT}{nf} \ln \frac{1}{[M^{n+}]}$$

The above Equation may be written as,

$$E = E^\circ + \frac{RT}{nf} \ln [M^{n+}]$$

where $R = 8.314\ J/K/mole$, $T = 298^\circ C$, $f = 96500$ Coulombs.

Sub the value of R, T, and f.

$$\boxed{E_{red} = E^\circ_{red} + \frac{0.0591}{n} \ln [M^{n+}]}$$

The above equation is known as Nernst Equation.

For reduction reaction $E_{red} = E^\circ_{red} + \frac{0.0591}{n} \ln [M^{n+}]$

For oxidation reaction,

$$M \rightleftharpoons M^{n+} + ne$$

$$\boxed{E_{oxd} = E^\circ_{oxi} - \frac{0.0591}{n} \ln [M^{n+}].}$$

Application of Nernst Equation:

* Corrosion tendency of metals can be predicted.
* It is used to calculate the EMF of a cell.
* p^H of a solution can be calculated by measuring the emf.
* Nernst Equation is used to calculate electrode potential of unknown metal.
* Concentration of the rectant can be calculated using the electrode potential