PLASMA:

If we increase the temp. of a gas above a certain value, the K.E of the atoms grows to such an extent that the collision of two atoms may split them up into electrons and positively charge ions. Generally plasma can be assumed to be a mixture of three components, free electrons, positive ions and neutral atoms. The particle interact between themselves through columb electrostatics forces.

Plasma is known as forth state of matter. The ionsphere is a plasma envelope surrounding the earth atmosphere. The Sun and Stars can be regarded as a lumps of hot plasma.

Quasi Neutrallity of plasma: One of the distinctive property of plasma is its Quasi neutrallity. The electric forces which bind the opposite charges in plasma provide for its Quasi neutrallity. Quasi neutrallity means the tendency to balance +ve and −ve Space charge in each microscopic volume element. For a given temp. and concentration Quasi-neutrallity is described by a charecteristic linear parameter δ. Let x represent the linear size of the volume element under consideration. If $x \gg \delta$ the concentrations of opposite charges in this volume are equal i.e. neutrallity is maintained. If $x \ll \delta$ the separation of charges has no significance on the motion of the particles and the neutrallity is isolated. The electric field is screened off at a distance δ.

The charecteristic lineare parameter or Charecteristic length 'δ' can be calculated in the following way:
Let us suppose that the charges are completely separated in a volume element with its linear size δ.
The p.E of the charged particles in this volume element; is of the order of the energy of the thermal motion i.e KT where T is plasma temperature.
Let $\vec{E}$ be the intensity of the electric field within that volume element.
Applying poission's equation:

$$\nabla^2 V = \nabla \cdot \nabla V = \frac{-\rho}{\epsilon_0}$$

ρ = charge density in that volume element
& V = electric potential. ∇V = Grad V = $-\vec{E}$

$$\therefore \nabla \cdot (-\vec{E}) = -\frac{\rho}{\epsilon_0} \quad \text{or} \quad \boxed{\nabla \cdot \vec{E} = \rho/\epsilon_0} \text{ --- } (1)$$

Since δ is the order of the linear size of the volume element

$$\nabla \cdot \vec{E} \simeq \frac{E}{\delta} \text{ --- } (2)$$

Let N_0 be the no. of charged particles per unit volume in that volume element.

$$\therefore \boxed{\rho = N_0 e}$$

Equating (1) and (2):

$$\frac{E}{\delta} = \frac{N_0 e}{\epsilon_0} \text{ --- } (3)$$

$$\text{or} \quad E = \frac{N_0 e \delta}{\epsilon_0}$$

Hence plasma potential 'V' in that element of volume is $V = E\delta$

putting eq^n ③:

$$V = E\delta = \frac{N_0 e \delta^2}{\epsilon_0} \quad \text{—— (4)}$$

The potential energy of a particle in that volume element

$$U = eV \simeq \frac{N_0 e^2 \delta^2}{\epsilon_0}$$ which is of the order of KT

$$\therefore \frac{N_0 e^2 \delta^2}{\epsilon_0} \simeq KT \quad \text{—— (5)}$$

from eq^n ⑤ we get: $$\delta = \left[\frac{\epsilon_0 KT}{N_0 e^2}\right]^{1/2} \quad \text{—— (6)}$$