* Force per unit area on the surface of charged particle (conductors) :—

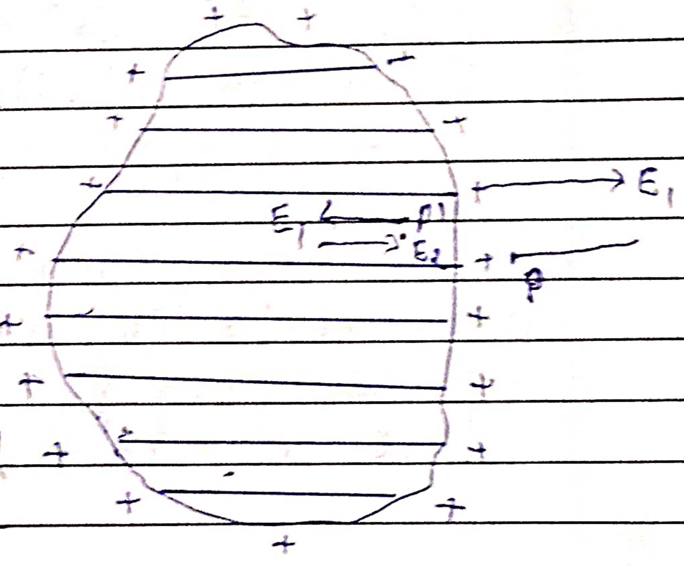
We know that the magnitude of electric field E at a point which is very close but outside the charged conductor is $E = \sigma/\epsilon_0$. However, the electric field is zero, if the point lies inside the conductor.

At any point just outside the surface of the conductor, the electric field E will be equal sum of the two fields :—

1) Field E_1 due to the charge on a very small area just in the vicinity of point P and

2) Field E_2 due to the charge on the rest of surface.

$\therefore E = E_1 + E_2$ —— (i)



Again, let the point P' be just inside the conductor as shown in fig. The electric field due to the charge on a very small area dS in the neighbourhood of the point P' is reversed which is $-E_1$, while the electric field due to the rest charge remains unchanged in direction and it is E_2. Thus, the resultant field at P' is $E_2 - E_1$. Since the point P' lies inside the conductors, the resultant field at P' must be zero.

$\therefore E_2 - E_1 = 0$

$\Rightarrow E_1 = E_2$ —— (ii)

$\therefore$ from eqn (i), we get,

$E_1 = E_2 = \frac{E}{2} = \frac{\sigma}{2\epsilon_0}$ N/C

Where σ is the surface density of charge. Now the charge on the surface immediately close to P is $\sigma \cdot dS$. Therefore, the total force experienced by this charge due to the charge on the rest surface is given by

$$F = \sigma \cdot dS \cdot E_2$$

because E_2 the field due to the rest charge.

$$\therefore F = \sigma \cdot dS \times \frac{\sigma}{2\epsilon_0} = \frac{\sigma^2 \cdot dS}{2\epsilon_0} = \frac{\sigma^2 \cdot dS}{2\epsilon_0} \text{ Newton}$$

Since the mechanical force per unit area is called pressure, hence

$$P = \frac{F}{dS} = \frac{\sigma^2}{2\epsilon_0} \, N/m^2 \quad \text{--- (iii)}$$

$$\because E = \frac{\sigma}{\epsilon_0}$$

$$\therefore \sigma^2 = \epsilon_0^2 E^2$$

From eqn (iii), we get,

$$P = \frac{1}{2} \epsilon_0 E^2 \, N/m^2 \quad \text{--- (iv)}$$

This force is directed along the outward normal to the surface. Thus, the surface of the charged conductor is always under stress or electrostatic pressure acts outwards.