Electric Charges and Fields

1.Charge : charge is the property associated with matters due to which it produces and experiences electrical and magnetic effect.

1.1.Quantization :

Charge is always in the form of an integral multiple of electronic charge and never its fraction.

$$q=\pm ne$$

where n is an integer an $e=1.602176634 \times 10^{-19}$

1.2.conservation of charge :

net charge of an isolated physical system always remains constant .charge neither be created nor be destroyed.

2.Coulomb's Law: it states that the electrostatic force of the attraction or repulsion between two stationary point charges is given by

$$F = k\frac{q_1 q_2}{r^2}$$ *Inverse Square Law*

k = Coulomb's Constant = $9.0\text{x}10^9\ \text{Nm}^2/\text{C}^2$

q_1 = charge on mass 1

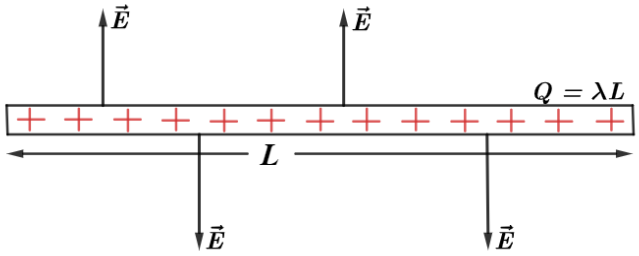
q_2 = charge on mass 2

r = the distance between the two charges

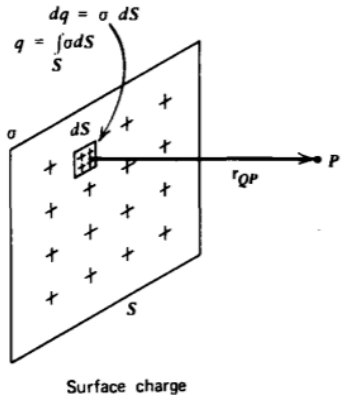
3.Electrostatic force due to continous charge distribution

The region in which charges are closely spaced is said to have continous distribution of the charge .it is of three types:

3.1.Linear charge distribution:

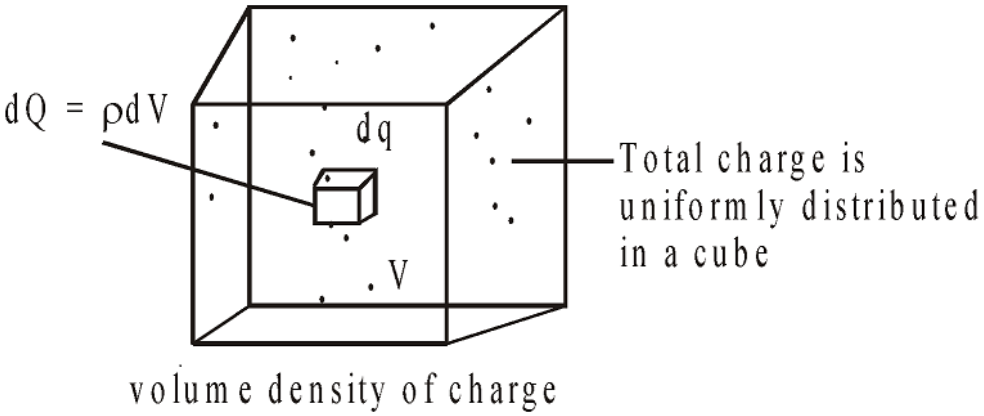


3.2.Surface charge distribution :



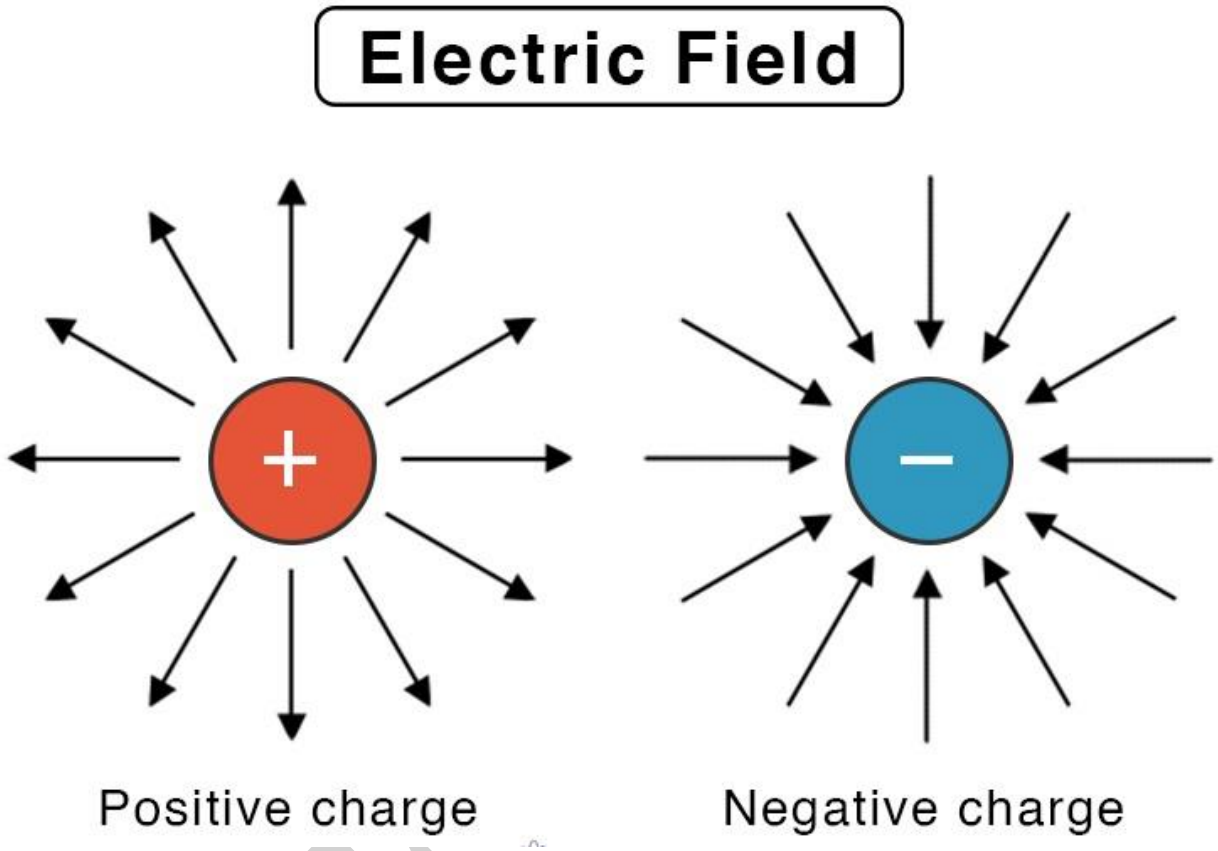
Surface charge

3.3.Volume charge distribution :



volume density of charge

4.Electric field : The region or the space around a charged body with in which it influence can be fell is called electric field .



5.Electric field intensity:

The electric field intensity at any point due to source charge is defined as the force experienced per unit positive test charge placed at that point without disturbing the source charge it is expressed as;

$$\text{Electric field:} \quad \vec{E} = \frac{\vec{F}}{q} = \frac{1}{4\pi\epsilon_0} \frac{q_i}{r^2} \hat{r}_i \qquad \text{newtons/coulomb}$$

Where $\hat{r}_i$ are unit vectors indicating the line between each q_i and q.

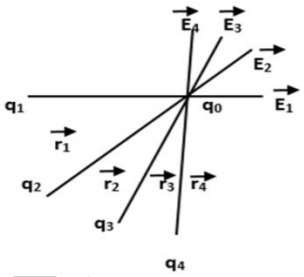
SI unit of electric field intensity is N/C and it is a vector quantity.

5.1.Electric field intensity due to point charge :

The electric field intensity at point p is ,

$$|E| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

5.2.Electric field intensity due to system of charges:



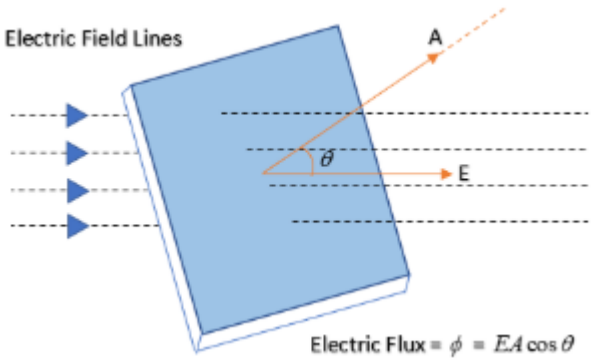
$$\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \text{----} + \vec{E}_n$$

Electric field intensity is ;

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{i=n} \frac{q_i}{r_i^2} \hat{r}$$

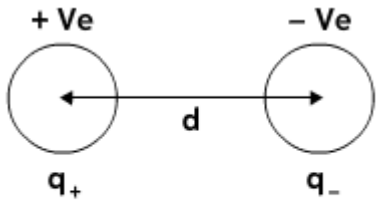
6.Electric flux:

The number of electric field lines passing through certain area is called an electric flux.



7.Electric dipole :

Two and equal charges(q) are separated by a small distance(d) constitute an electric dipole many of the atom molecule are dipoles.



∴ Dipole moment

$\mu = q \times d$

i.electric dipole moment, $\mu = q \times d$

ii. dipole moment is a vector quantity and it is directed from negative to positive charge .

iii. unit of dipole moment is coulomb meter (Cm).

iv. dimension of dipole moment [ATL].

8.Gauss law : Electric flux through any surface enclosing charge equal to Q/ε_0 where Q is the net charge enclosed by the surface.

$$\int \mathbf{E} \cdot d\mathbf{A} = Q/\varepsilon_0$$

Where,

- **E** is the electric field vector
- Q is the enclosed electric charge
- ε_0 is the electric permittivity of free space
- **A** is the outward pointing normal area vector