Electric Force & Field

Electric Charge

Definition:

Charge is the property associated with matter due to which it produces and experiences electrical and magnetic effects.

Type:

There exists two types of charges in nature

(i) Positive charge

(ii) Negative charge

Properties of charge

(i) **Charge is transferable:** If a charged body is put in contact with an uncharged body, uncharged body becomes charged due to transfer of electrons from one body to the other.

(ii) **Charge is always associated with mass**, *i.e.*, charge can not exist without mass though mass can exist without charge.

(iii) **Charge is conserved:** Charge can neither be created nor be destroyed.

(iv) **Quantization of charge:** When a physical quantity can have only discrete values rather than any value, the quantity is said to be quantized. The smallest charge that can exist in nature is the charge of an electron. If the charge of an electron ($= 1.6 \times 10^{-19} C$) is taken as elementary unit *i.e.* quanta of charge the charge on any body will be some integral multiple of *e i.e*,

$\boxed{Q = \pm ne}$ with $n = 1, 2, 3....$

Methods of Charging

A body can be charged by following methods:

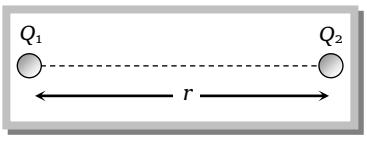
(1) **By friction**

(2) **By electrostatic induction**

(3) **Charging by conduction**

Coulomb's Law

If two stationary and point charges Q_1 and Q_2 are kept at a distance *r*, then it is found that force of attraction or repulsion between them is



$F \propto \frac{Q_1 Q_2}{r^2}$ *i.e.*,

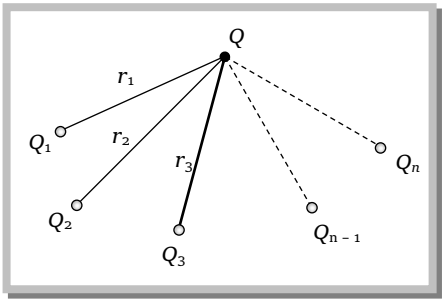
$F = \frac{kQ_1Q_2}{r^2}$; (*k* = Proportionality constant) for air $k = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \frac{N - m^2}{C^2}$

Vector form of coulomb's law:

Vector form of Coulomb's law is $\vec{F}_{12} = K.\frac{q_1 q_2}{r^3}\vec{r}_{12} = K.\frac{q_1 q_2}{r^2}\hat{r}_{12}$, where $\hat{r}_{12}$ is the unit vector from first charge to second charge along the line joining the two charges.

Principle of superposition:

According to the principle of super position, total force acting on a given charge due to number of charges is the vector sum of the individual forces acting on that charge due to all the charges.



Consider number of charge $Q_1, Q_2, Q_3 \ldots$ are applying force on a charge Q

Net force on Q will be

$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \ldots\ldots\ldots + \vec{F}_{n-1} + \vec{F}_n$

Electrical Field

Thus space around a charge in which another charged particle experiences a force is said to have electrical field in it.

Electric field intensity $(\vec{E})$**:**

The electric field intensity at any point is defined as the force experienced by a unit positive charge placed at that point. $\vec{E} = \frac{\vec{F}}{q_0}$

Where $q_0 \to 0$ so that presence of this charge may not affect the source charge Q and its electric field is not changed, therefore expression for electric field intensity can be better written as $\vec{E} = \underset{q_0 \to 0}{Lim}\ \frac{\vec{F}}{q_0}$

Super position of electric field:

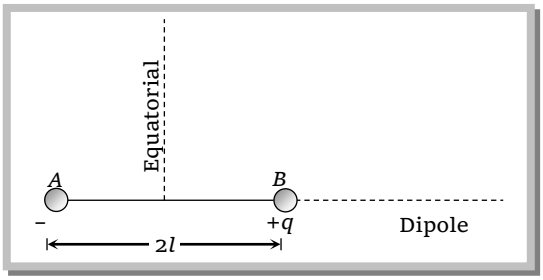
The resultant electric field at any point is equal to the vector sum of electric fields at that point due to various charges.

$\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \ldots$

Electric Dipole

General information:

System of two equal and opposite charges separated by a small fixed distance is called a dipole.



Dipole axis:

Line joining negative charge to positive charge of a dipole is called its axis. It may also be termed as its longitudinal axis.

Equatorial axis:

Perpendicular bisector of the dipole is called its equatorial or transverse axis as it is perpendicular to length.

Dipole length:

The distance between two charges is known as dipole length ($L = 2l$)

Dipole moment:

It is a quantity which gives information about the strength of dipole. It is a vector quantity and is directed from negative charge to positive charge along the axis. It is denoted as $\vec{p}$ and is defined as the product of the magnitude of either of the charge and the dipole length.

i.e. $\vec{p} = q(2\vec{l})$

Link for detail study:

https://drive.google.com/file/d/0B8hXbvn1ab-BTHBWZWltTU5jUXc/view