ToppersNotes

CBSE

CLASS-XII

PHYSICS

PART - I

Sierra Innovations Pvt. Ltd.

Physics I

Contents **Page No**

ELECTROSTATICS

Electric Charges and Field

* **Electrostatics :**
The branch of physics which deals with the study of charges which are at rest.

* **current electricity :**
The branch of physics which deals with the study of charges which are in motion.

* **Charge :**
Property of matter by virtue of which it show some electrical effects is known as charge.

charges are produced due to transfer of electrons
charges are of two types :

Positive charge	negative charge
glass rod	Silk cloth
Fur	Ebonite Rod / Rubber
Dry Hair	Comb

* **Difference b/w charge and mass :**

	Charge	Mass
①	It may be positive or negative	It is always positive and never be negative.
②	Force b/w two charges are given by columbs	Force b/w two mass particles are given by

* where m_0 is rest mass
If $v = 0$
$$m = m_0$$

Electrostatic force	Newton's gravitation law.
(3) charge cannot exist without mass	Mass can exist without charge.
(4) Force b/w two charges may be attractive or repulsive in nature.	Force b/w 2 masses is always attractive in nature.
(5) Quantised Quantity	Non-Quantised Quantity.
(6) charge is not a relative quant	Mass is a relative quantity.

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

* Columb's law of Electrostatics :

According to columb's electrostatic law. If two points charges are placed at distance r than the force b/w two particles is given by.

q_1 —— r —— q_2

$$F \propto q_1 q_2$$

$$F \propto \frac{1}{r^2}$$

$$F \propto \frac{q_1 q_2}{r^2}$$

$$F = \frac{k q_1 q_2}{r^2}$$

k = Electrostatic constant

$$k = 9 \times 10^9 \ \frac{Nm^2}{c^2}$$

charge on e^- = 1.6×10^{-19} C
Mass of e^- = 9.1×10^{-31} kg

$$\vec{F} = \pm k \frac{q_1 q_2}{r^2} \hat{r}$$

+ → Repulsive force
− → attractive force

"According to coulumb, electrostatic force b/w two point charges is directly proportionals to the product of magnitude of charges and inversely proportionals to the square of their distance".

$\therefore$ $F = \frac{k q_1 q_2}{r^2}$ $\qquad$ $k = 9 \times 10^9 \ \frac{Nm^2}{c^2}$

$\Rightarrow k = \frac{Fr^2}{q_1 q_2} = \frac{Nm^2}{c^2}$

Dimension : $\frac{[M^1 L^1 T^{-2}][L^1]^2}{[A^1 T^1]^2}$

$= \frac{M^1 L^3 T^{-2}}{A^2 T^2} = [M^1 L^3 T^{-4} A^{-2}]$

★ Electrostatic constant :

If $q_1 = q_2 = 1$ unit

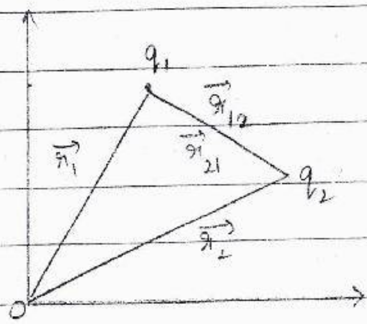
and $r = 1$ unit

then $\boxed{K = F}$

"Electrostatic constant is given by electrostatic force b/w two unit charge particles seperated by unit distance".

* Two charge system:

Consider two charges q_1 and q_2 having position vector $\vec{r_1}$ & $\vec{r_2}$



Force on q_1 due to q_2

$$F_{12} = \pm \frac{k q_1 q_2}{|\vec{r_{21}}|^2} \hat{r}_{21}$$

$$F_{12} = \pm \frac{k q_1 q_2}{|\vec{r_{21}}|^2} \times \frac{\vec{r_{21}}}{|\vec{r_{21}}|}$$

$$F_{12} = \pm \frac{k q_1 q_2}{|\vec{r_{21}}|^3} \times \vec{r_{21}}$$

∵ By triangle law of vector addition

$$\vec{r_2} + \vec{r_{21}} = \vec{r_1}$$

$$\vec{r_{21}} = \vec{r_1} - \vec{r_2}$$

$$\therefore F_{12} = \pm \frac{k q_1 q_2 \times \vec{r_{21}}}{|\vec{r_{21}}|^3}$$

$$\boxed{F_{12} = \pm \frac{k q_1 q_2}{|\vec{r_1} - \vec{r_2}|^3} \times (\vec{r_1} - \vec{r_2})}$$

Force on q_2 due to q_1

$$F_{21} = \pm k \frac{q_1 q_2}{|\vec{r}_{12}|^2} \hat{r}_{12}$$

$$\left\{ \hat{r}_{12} = \frac{\vec{r}_{12}}{|\vec{r}_{12}|} \right\}$$

$$F_{21} = \pm k \frac{q_1 q_2}{|\vec{r}_{12}|^3} \times \vec{r}_{12}$$

From triangle law of vector Addition.

$$\vec{r}_1 + \vec{r}_{12} = \vec{r}_2$$

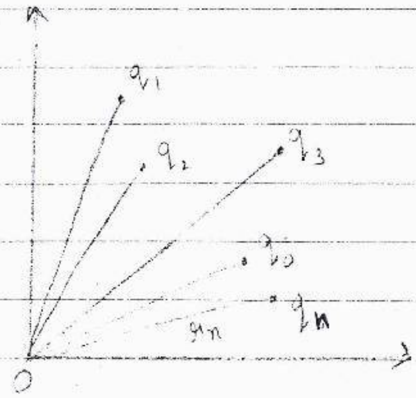
$$\vec{r}_{12} = \vec{r}_2 - \vec{r}_1$$

So,

$$\boxed{F_{21} = \pm k \frac{q_1 q_2}{|\vec{r}_2 - \vec{r}_1|^3} \times (\vec{r}_2 - \vec{r}_1)}$$

★ n-charge system :

Consider n-charges having magnitude $q_1, q_2, \ldots q_n$ having position vector $\vec{r}_1, \vec{r}_2, \ldots \vec{r}_n$. Let a test charge q_0 placed at $\vec{r}_0$.



Force on test charge due to system of charges

$$\vec{F} = \vec{F}_{01} + \vec{F}_{02} + \vec{F}_{03} - - - - - \vec{F}_{0n}$$

$$\vec{F} = \pm k \frac{q_0 q_1}{|\vec{r}_{10}|^2} \hat{r}_{10} \pm k \frac{q_0 q_2}{|\vec{r}_{20}|^2} \hat{r}_{20} \pm - - - - \pm k \frac{q_0 q_n}{|\vec{r}_{n0}|^2} \hat{r}_{n0}$$

$$\boxed{\vec{F} = \pm k q_0 \sum_{i \neq j = 1}^{n} \frac{q_i \hat{r}_{i0}}{|\vec{r}_{i0}|^2}}$$

$$\vec{F} = \pm k\, q_0 \sum_{i=1}^{n} \frac{q_i\, \vec{r}_{i0}}{|\vec{r}_{i0}|^3}$$

$$\boxed{\vec{F} = \pm k q_0 \sum_{i=1}^{n} \frac{q_i\,(\vec{r}_0 - \vec{r}_i)}{|\vec{r}_0 - \vec{r}_i|^3}}$$

$$\because \vec{r}_{21} = \vec{r}_1 - \vec{r}_2$$
$$\vec{r}_{12} = \vec{r}_2 - \vec{r}_1$$

★ Super Position of Force :

"Force applied on a test charge is due to n- charge system is algebric sum of force applied by the individual charges on the test charge"

$$\vec{F} = \vec{F}_{01} + \vec{F}_{02} + \vec{F}_{03} + \text{-----} + \vec{F}_{0n}$$

DEFINITIONS :

① Electric Field :

Area around a charge particle in which other charge particle experience a force is known as electric field.

② Electric field intensity :

Force on unit test charge is known as electric field intensity.

$$\vec{E} = \lim_{q_0 \to 0} \frac{\vec{F}}{q_0}$$

$$\vec{E} = \frac{\vec{F}}{q}$$