Dr. S. K. Yadav
email: sunil.phy30@gmail.com

Classical Electrostatics: Static charges create static electric fields.

Classical magnetostatics: steadily moving charges create static magnetic field

Classical Electrodynamics: Accelerating charges create changing fields
(Maxwell Equations)

Classical means here — Macroscopic theory

Coulomb's law:

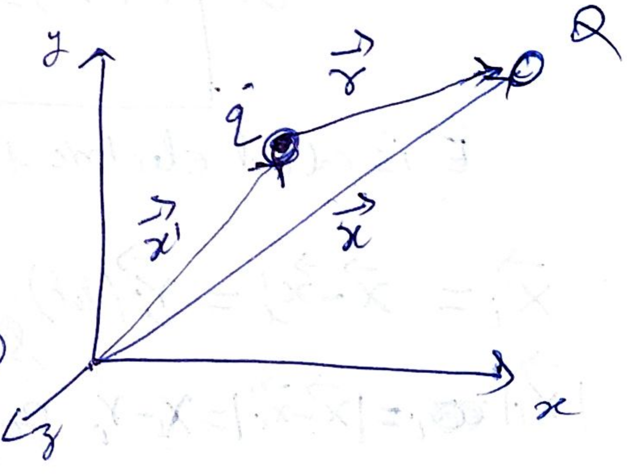
Force $(F) \propto qQ$

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

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

or $\vec{F} \propto \frac{qQ}{r^2}\hat{r}$

$$\boxed{\vec{r} = \vec{x} - \vec{x}'}$$



or $$\boxed{\vec{F} = k\frac{qQ}{r^2}\hat{r}} \quad \text{— (1)}$$

$k = \frac{1}{4\pi\epsilon_0}$ (In SI unit)
(in free space)

Coulomb's law

$$\vec{F} = k\,\frac{qQ}{r^2}\,\frac{\vec{r}}{r}$$

or

$$\vec{F} = k\,\frac{qQ\,\vec{r}}{r^3} \quad \text{—— (2)}$$

$$\vec{r} = \vec{x} - \vec{x}', \qquad r = |\vec{r}| = |\vec{x} - \vec{x}'|$$

Eq. (1) & (2) both are same.

$$\vec{F} = Q\cdot\vec{E} = Q\cdot k\,\frac{q\,\vec{r}}{r^3}$$

$$\vec{E} = k\,\frac{q\,\vec{r}}{r^3} \quad \text{or} \quad \vec{E} = k\,\frac{q\,(\vec{x} - \vec{x}')}{|\vec{x} - \vec{x}'|^3}$$

For n point charges $\{q_i\} = q_1, q_2, \dots q_n$

$$\vec{E} = k\sum_{i=1}^{n} q_i\,\frac{(\vec{x} - \vec{x}_i)}{|\vec{x} - \vec{x}_i|^3}$$

Note: ~~Before~~ (i) Since electric field is a vector field, it is defined at every point in space and therefore can be written in terms of spatial coordinates.

(ii) Force is not a field of vectors. This is the force felt at the point of particular charge q_i.

Before moving to notion of ~~char~~ continuous charge distribution we review here the Dirac Delta function.