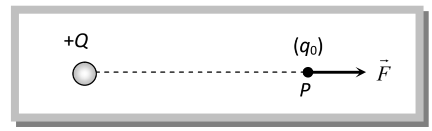
Electrical Field.

A positive charge or a negative charge is said to create its field around itself. If a charge Q_1 exerts a force on charge Q_2 placed near it, it may be stated that since Q_2 is in the field of Q_1, it experiences some force, or it may also be said that since charge Q_1 is inside the field of Q_2, it experience some force. Thus space around a charge in which another charged particle experiences a force is said to have electrical field in it.

(1) **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. $\vec{E} = \frac{\vec{F}}{q_0}$



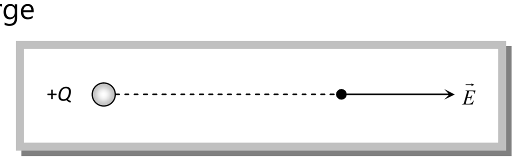
Where $q_0 \to 0$ so that presence of this charge may not affect the source charge Q and its electric field is not changed, therefore expression for electric field intensity can be better written as $\vec{E} = \lim_{q_0 \to 0} \frac{\vec{F}}{q_0}$

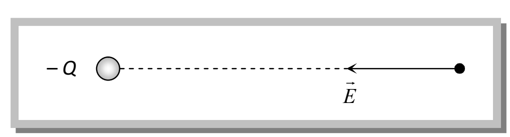
(2) **Unit and Dimensional formula:**its S.I. unit – $\frac{Newton}{coulomb} = \frac{volt}{meter} = \frac{Joule}{coulomb \times meter}$ and

C.G.S. unit – Dyne/stat coulomb.

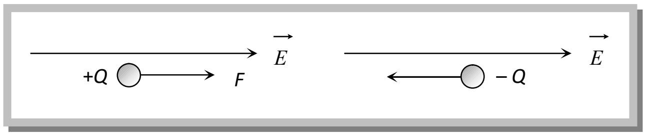
Dimension:[E] = [$MLT^{-3}A^{-1}$]

(3) **Direction of electric field:**Electric field (intensity) $\vec{E}$ is a vector quantity. Electric field due to a positive charge is always away from the charge and that due to a negative charge is always towards the charge





(4) **Relation between electric force and electric field:** In an electric field $\vec{E}$ a charge (Q) experiences a force $F = QE$. If charge is positive then force is directed in the direction of field while if charge is negative force acts on it in the opposite direction of field

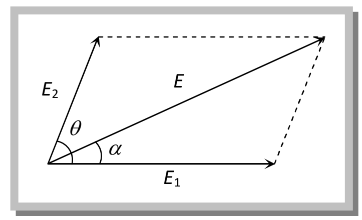


(5) **Super position of electric field** (electric field at a point due to various charges): The resultant electric field at any point is equal to the vector sum of electric fields at that point due to various charges.

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

The magnitude of the resultant of two electric fields is given by

$$E = \sqrt{E_1^2 + E_2^2 + 2E_1E_2\cos\theta}$$ and the direction is given by $$\tan\alpha = \frac{E_2\sin\theta}{E_1 + E_2\cos\theta}$$



(6) **Electric field due to continuous distribution of charge:** A system of closely spaced electric charges forms a continuous charge distribution

Continuous charge distribution		
Linear charge distribution	**Surface charge distribution**	**Volume charge distribution**
In this distribution charge	In this distribution charge	In this distribution charge

distributed on a line. For example: charge on a wire, charge on a ring etc. Relevant parameter is λ which is called linear charge density i.e., $\lambda = \frac{\text{charge}}{\text{length}}$ $\lambda = \frac{Q}{2\pi R}$	distributed on the surface. For example: Charge on a conducting sphere, charge on a sheet etc. Relevant parameter is σ which is called surface charge density i.e., $\sigma = \frac{\text{charge}}{\text{area}}$ $\sigma = \frac{Q}{4\pi R^2}$	distributed in the whole volume of the body. For example:Non conducting charged sphere. Relevant parameter is ρ which is called volume charge density i.e., $\rho = \frac{\text{charge}}{\text{volume}}$ $\rho = \frac{Q}{\frac{4}{3}\pi R^3}$

To find the field of a continuous charge distribution, we divide the charge into infinitesimal charge elements. Each infinitesimal charge element is then considered, as a point charge and electric field $\overrightarrow{dE}$ is determined due to this charge at given point. The Net field at the given point is the summation of fields of all the elements. i.e., $\vec{E} = \int \overrightarrow{dE}$