ELECTRIC

The space surrounding an electric charge q in which another charge q_0 experience a force of attraction or repulsion is called the electric field of the charge q.

Here, q = source charge

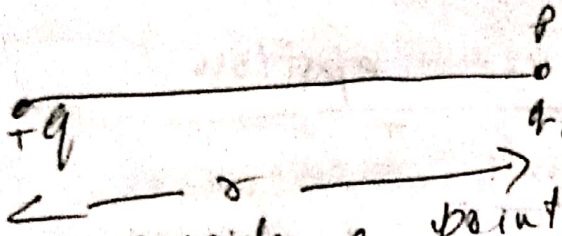
q_0 = Test charge (It should be very small)

$\therefore \vec{E} = \frac{\vec{F}}{q_0}$

Unit of electric field is NC^{-1}

Dimensional formula is $[MLT^{-3}A^{-1}]$

Electric field due to a point charge.



Let us consider a point charge +q kept at O in a medium of dielectric constant K.

Therefore the electrostatic force of repulsion experienced by test charge q_0 is $F = \frac{1}{4\pi\epsilon_0 K}\frac{qq_0}{r^2}$

$\therefore$ Intensity of electric field is

$$E = \frac{F}{q_0} = \frac{1}{4\pi\epsilon_0 K}\frac{q}{r^2}$$

$\frac{1}{4\pi\epsilon_0} = 9\times10^9$ newton metre^2/coulomb^2

In vector form

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}.$$

Intensity of electric field due to a continuous charge distribution.

(i) Linear charge distribution (One dimensional)

Here, λ = linear charge density.

$$\lambda = \frac{dq}{dl} \quad \text{or,} \quad dq = \lambda dl$$

(ii) Surface charge distribution (Two dimensional)

Surface charge density $\sigma = \frac{\text{charge}}{\text{Area}}$.

$$\sigma = \frac{dq}{ds}$$

$$\text{or,} \quad dq = \sigma ds$$

(iii) volume charge distribution (Three dimensional)

volume charge density $\rho = \frac{dq}{dV}$.

$$dq = \rho dV.$$

Electric line of force

It is an imaginary smooth curve drawn in an electric field along which a free, isolated positive charge moves.

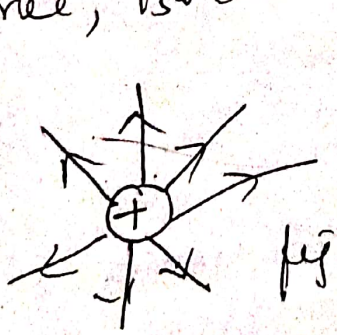


fig (1)

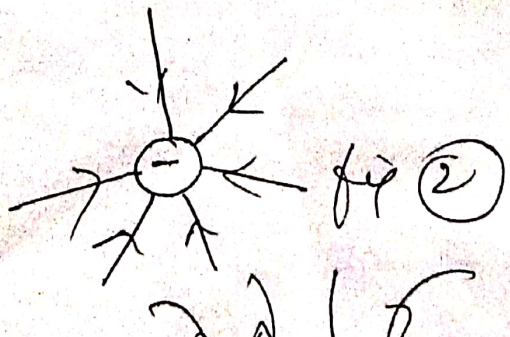


fig (2)

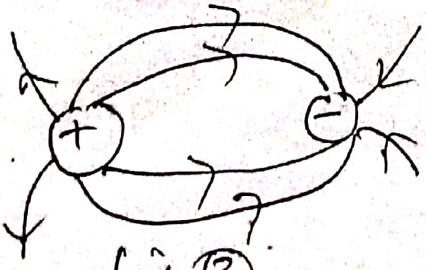


fig (3)

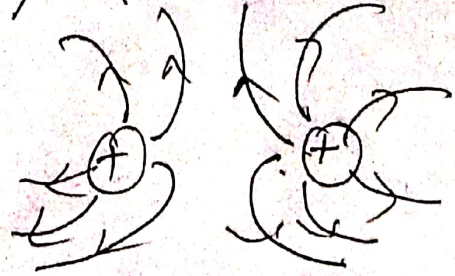


fig (4)

Properties of Electric line of force

* It originates from positive charges and terminate on negative charge
* The tangent drawn at any point gives the direction of the electric field at that point
* Two lines of Electric force do not intersect at any point as two different directions of electric field at the point of intersection is not possible
* It does not pass inside a conductor
* The lines of force are continuous, real and imaginary
* The no. of lines of force cutting unit area of the element is proportional to the strength of electric field.