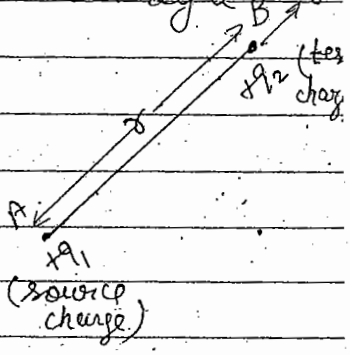
Electric field :- It is defined as (coulomb) force per unit charge

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

Suppose we have 2 charges $+q_1$ & $+q_2$ seperated by a distance r.



force on q_2 due to q_1,

$$\vec{F}_B = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \hat{r}$$

electric field at B,

$$\vec{E}_B = \frac{\vec{F}_B}{q_2}$$

source charge → due to which Ele. field is find out

Test " → at which electric field is find out

$$\boxed{q_2 = +1\,C}$$

Test charge is always of unity magnitude & it is always +ve.

* Find electric field at point B means find the force of test charge placed at B.

Direction of electric field depanands on source charge.

If source charge +ve → away

−ve → towards.

So $\boxed{\vec{F} = q\vec{E}}$

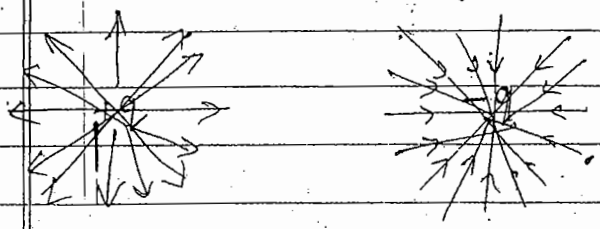
Electric Flux :- Flux = electric field X area

$$= \vec{E} \cdot \vec{A}$$

$\vec{E} \cdot \vec{A}$ = Total no. of electric field lines

Electric field lines :- It is a hypothetical concept. To find out the strength of a charge we use electric field lines concept.

from +ve charge, electric field lines diverges out, -ve charge, lines are inward

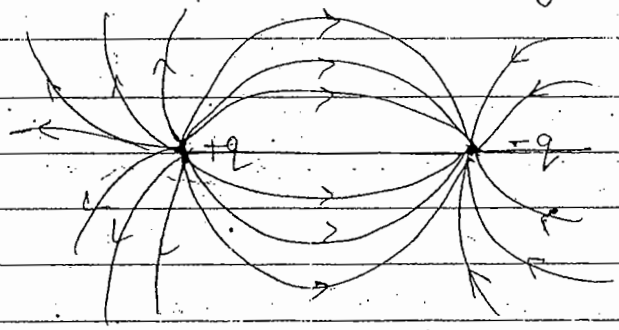


E. field lines show the dirⁿ of electric field.

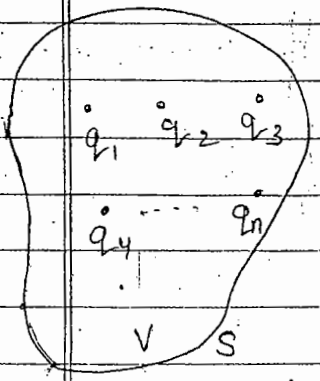
E field lines never crosses each other. If they cross, they show two dirⁿ.

E. field lines are open curves.

If two charges are placed together, then E. field lines originates at +ve charge & terminate at -ve charge.



Gauss Law :- Acc. to this law, electric flux passing through a closed surface S (is equal to charge enclose in the surface devided by ϵ_0) is $1/\epsilon_0$ times charge enclose by the surface



$$\oint \vec{E} \cdot d\vec{S} = \frac{q_{enc}}{\epsilon_0}$$

q_{enc} → charge enclosed

This is Integral form of Gauss law.

Suppose we have no. of charges in the surface then flux passing through this surface. This

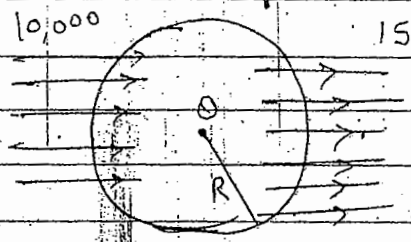
$$\oint \vec{E} \cdot d\vec{S} = \frac{\sum_{i=1}^{n} q_i}{\epsilon_0}$$

This flux is also known as net no. of electric field lines contained in the surface.

If we have some +ve charge in closed surface the electric field lines go out.

This law is valid only for closed surface of radius R

e.g. Suppose we have a sphere in this we have 10,000 electric field lines entering the surface & 15,000 electric field lines leaving the surface. Calculate the charge contained in the surface.



Net lines = 15,000 − 10,000
= 5,000

So there is a source inside the surface.

$$\oint \vec{E} \cdot d\vec{S} = \frac{q_{enc}}{\epsilon_0}$$

$$q_{enc} = \epsilon_0 \times 5000$$
$$= 5000\,\epsilon_0 \quad \text{Ans}$$

* Gauss law is always valid but not useful, it is useful only if there is symmetry in the problem (it can be spherical symmetry, cylindrical symmetry or planer symmetry).
* Gauss law can not be used to calculate the electric field if monopole moment is zero. (monopole mom → total charge)

Gauss law can be used only if "Inverse