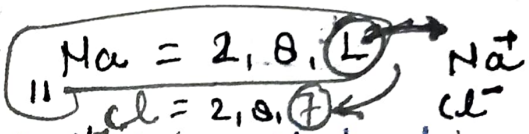
Electrostatics

Electric charge :-

1) charge is the property associated with matter due to which it produces and experiences electrical and magnetic effects.

+ve -ve S.F

2) It is known that every atom is electrically neutral, containing as many electrons as the number of protons in the nucleus.



3) Charged particles can be created by disturbing neutrality of an atom.

loss of electrons gives positive charge and gain of electrons gives negative charge.

4) Charges with the same electrical sign repel each other, and charges with opposite electrical sign attract each other.

5) Unit and dimensional formula:

S.I. unit of charge is Ampere × sec = coulomb (C)

smaller SI units, mC, μC. $1\,\mu C = 1 \times 10^{-6}\,C$

C.G.S. unit of charge is stat coulomb or electrostatic unit (e.s.u.); Electromagnetic unit of charge is → abcoulomb

$1C = 3\times10^{9}$ stat coulomb $= \frac{1}{10}$ ab coulomb.

Dimensional formula $[Q] = [AT]$.

6) charge is -

= Transferable: It can be transferred from one body to another.

Associated with mass: charge cannot exist without mass but reverse is not true. (+/- → mass)

Conserved: It can neither be created nor be destroyed. (11 Na, 17 Cl → Na^+, Cl^- → NaCl)

Invariant: Independent of velocity of charge particle.

7) Electric charge produces electric field ($\vec{E}$), magnetic field ($\vec{B}$) and electromagnetic radiations.

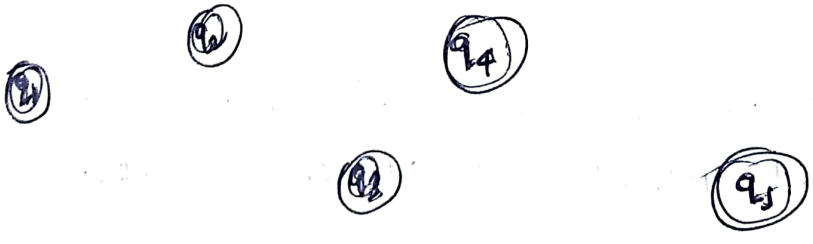
ie. $v=0$: +q, $\vec{v}=0$ → $\vec{E}$ only

$\vec{v}$ = const: +q → $\vec{E}$ & $\vec{B}$

$\vec{v}$ = variable: +q → $\vec{E}$, $\vec{B}$ & Radiates energy.

8) Charge distribution: It may be of two types

i) Discrete distribution of charge:- A system consisting of ultimate individual charges.



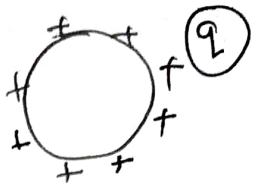
ii) Continuous distribution of charge: An amount of charge distributes uniformly or non-uniformly on a body. It is of following three types.

a) Linear charge distribution:- charge on a line.
e.g: charged straight wire, circular charged ring etc.

$\lambda = \frac{\text{charge}}{\text{length}}$ = linear charge density

S.I. unit of λ = C/m

Dimension = $[L^{-1}TA]$

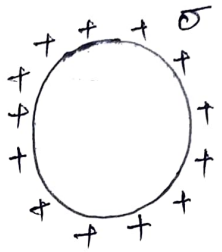


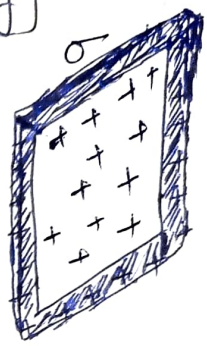
b) Surface charge distribution: charge distributed on a surface. eg. Plane sheet of charge, conducting sphere, conducting cylinder etc.

$$\sigma = \frac{\text{charge}}{\text{Area}} = \text{surface charge density}$$

S I unit → C/m^2

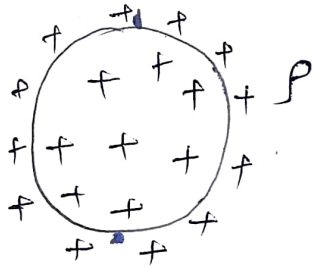
Dimension → $[L^{-2}TA]$





c) Volume charge density :- charge distributes through out the volume of the body e.g charge on a dielectric sphere etc.

$$\rho = \frac{\text{Charge}}{\text{Volume}} = \text{Volume charge density}$$



S.I. unit → C/m^3

Dimension → $[L^{-3}TA]$

g) Quantization of charge :- If the charge of an electron ($= 1.6 \times 10^{-19} C$) is taken as elementary unit ie quanta of charge, the charge on any body will be some integral multiple of e. ie.

$$Q = \pm ne, \text{ with, } n = 1, 2, 3, 4 \ldots$$

charge on a body can never be $\pm \frac{2}{3}e$, $\pm \frac{1}{2}e$ ....

$Q = \pm 1e, \pm 2e, \pm 3e, \pm 4e \ldots$

$\pm \frac{2}{3}e$, 17.5 e ✗