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Electrostates

Hand Notes For JEE Mains, Advance, NEET UG, Class 11 & 12 etc…

Hand Notes

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ELECTROSTATES

Properties of charges –

- Basic property of matter
- charge without mass can not exist whereas mass without charge can exist.
- * quantization of charge – charge on a body can only exist in the form of 'e'

$$\boxed{q = ne} \quad (n = \text{integer})$$

- * charge is additive in nature

$$\boxed{q_{net} = q_1 - q_2 + q_3 - q_4}$$

$q_1, -q_2$
$q_3, -q_4$

- * conservation of charge – charge on an isolated system can neither be created nor, destroyed.
  Total charge of a system = const.

NOTE → ⊕ ← ⊕ → , ⊖ ← ⊖ → , ⊕ → ← ⊖

- Minimum possible charge $e = 1.6 \times 10^{-19}$ C (quanta)
- Exception of quantisation –

quark → up $(+\frac{2e}{3})$
quark → down $(-\frac{e}{3})$

$2U + 1D = 1$ particle
$2(+\frac{2e}{3}) + 1(-\frac{e}{3}) = +e$
$1U + 2D = 1$ neutron
$(\frac{2e}{3}) + 2(-\frac{e}{3}) = \text{zero}$

- quark particle don't exist independly, so quantisation is still correct.
- ** If quark particle would exist even then quantisation would be valid quanta will be $(e/3)$.
- In a conductor charge is distributed at outer surface only while in non-conductor charge is distributed inside the surface.

METHOD OF CHARGING –

|i| → Friction –
⊕ve ⇒ Glass Rod, Dry hair, cat skin, Wool.
⊖ve ⇒ Silk, comb, Ebonite, plastic/Amber.
Ex → cloud charging, charging of oil drop in Miliken oil drop experiment.

|ii| → conduction –
* For ⊕ve charge will move [High → Low]
* ⊖ve charge will move [Low → High]
*NOTE ⇒ *In conduction total charge of system is re-distributed in the ratio of radius for making potential same.
* After conduction potential become same while charges will differ.

|iii| → Induction – takes place in facing layer only.

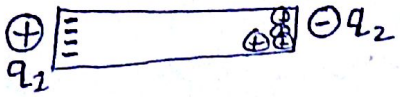
$$\left[q_{Induced} = q_{Inducing}\left(1 - \frac{1}{\varepsilon_r}\right)\right] \quad (\varepsilon_r \rightarrow \text{dielectric const. of body})$$

* For metal $(\varepsilon_r = \infty) \rightarrow q_{induced} = q_{inducing}$
* For Non-metal $(\varepsilon_r \neq \infty) \rightarrow q_{induced} < q_{inducing}$.
Imp * Best Method of charging.

NOTE ⇒ * Induction affect the distribution of charge not the magnitude of charge.
* There will be attraction b/w neutral charge body.
* There will be attraction b/w body having charge of same nature provided that magnitude of charges will be different.
* Sure test of charging is repulsion not attraction.

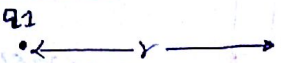
Ex → How will the force on q_1 will change if an insulated Rod is kept b/w them as shown?

Ans → Force will ↑



COULOMB'S LAW -

* It is not affected by pressure of any other charge
* It follow newton reaction.

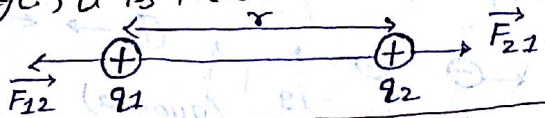


$$F = \frac{Kq_1q_2}{r^2}$$

$K = 9 \times 10^9$ (MKS)
$K = 1$ (CGS)

$F \propto \frac{1}{r^2}$, $F \propto \frac{q_1q_2}{r^2}$

* If the distance in discussion is very large as compared with the dimension of charge, it is treated as point charge.



$$|\vec{F_{21}}| = |\vec{F_{12}}| = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{q_1q_2}{r^2}$$

ϵ_0 → permitivity of vaccum or, free space $= 8.85 \times 10^{-12} \frac{C^2}{N-m^2}$

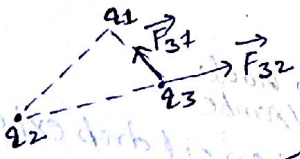
$$K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9$$

III NOTE * If the charges are kept in some other medium, permitivity $= \epsilon_0\epsilon_r$

ϵ_r = Relative permitivity or, dielectric const. of medium will ↓

$$|\vec{F_{net}}| = \left(\frac{1}{4\pi\epsilon_0\epsilon_r}\right)\frac{q_1q_2}{r^2}$$

* coulomb's law follow principle of superposition.



$$\vec{F_{3net}} = \vec{F_{31}} + \vec{F_{32}}$$

AIIMS * PERMITIVITY [E] → ϵ_0, E, ϵ_r

- Permitivity of vaccume (ϵ_0) ⇒ $\epsilon_0 = 8.85 \times 10^{-12}\ C^2/N \times m^2$
- Permitity of medium
  Absolute permitivity of medium (E)
  unit → $C^2/N \times m^2$
- $\epsilon_r = \frac{E}{\epsilon_0}$

$1 \le \epsilon_r < \infty$

$(\epsilon_r)_{air} = 1$
$(\epsilon_r)_{metal} = \infty$

$$F_{vacume} = \frac{1}{4\pi\epsilon_0} \times \frac{q_1q_2}{r^2}$$

$$F_{medium} = \frac{1}{4\pi\epsilon_0\epsilon_r} \times \frac{q_1q_2}{r^2}$$

$\therefore F_{medium} = \frac{F_{vacume}}{\epsilon_r}$ ∵ $\epsilon_r > 1$

⇒ $F_{net} < F_{vacume}$