DIGITAL EDUCATION
MARTCOST

INTERMEDIATE

Electro states

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'

$$Q = ne \quad (n = \text{Integer})$$

*– charge is additive in nature

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

$$Q_{net} = q_1 - q_2 + q_3 - q_4$$

*– conservation of charge – charge on an isolated system can neither be created nor, distroyed.
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}) = $ zero

- quark particle dont exist indepently, 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 ⇒ silks, 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.

$$\left[Q_{Induced} = Q_{Inducing}\left(1 - \frac{1}{\varepsilon_r}\right) \right]$$ (ε_r → dielectric const. of body)

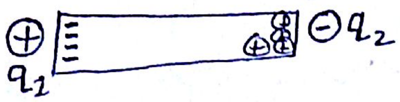
* For Metal ($\varepsilon_r = \infty$) → $Q_{induced} = Q_{inducing}$
* For Non-Metal ($\varepsilon_r \neq \infty$) → $Q_{induced} < Q_{inducing}$.

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 ↑



COLUMB'S LAW -

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

q_1 ←— r —→ q_2

$F \propto \frac{1}{r^2}$, $F \propto q_1 q_2$

$$\boxed{F = \frac{K q_1 q_2}{r^2}}$$

$K = 9 \times 10^{9}$ (MKS)

$K = 1$ (CGS)

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

$\overleftarrow{F_{12}}$ ⊕ q_1 ←— r —→ ⊕ q_2 $\overrightarrow{F_{21}}$

$$\boxed{|\vec{F}_{21}| = |\vec{F}_{12}| = \left(\frac{1}{4\pi\epsilon_0}\right)\frac{q_1 q_2}{r^2}}$$

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

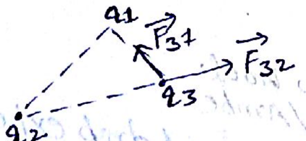
$K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^{9}$

IIT NOTE * If the charges are kept in some other medium, permitivity $= \epsilon_0 \epsilon_r$ or, dielectric const. of medium will ↓

ϵ_r = Relative permitivity

$$\boxed{|\vec{F}_{net}| = \left(\frac{1}{4\pi\epsilon_0\epsilon_r}\right)\frac{q_1 q_2}{r^2}}$$

* coulomb's law follow principle of superposition.



$$\boxed{\vec{F}_{3net} = \vec{F}_{31} + \vec{F}_{32}}$$

AIIMS * PERMITIVITY [ε] → ϵ_0, ϵ, 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 (ϵ)
  unit → $C^2/N \times m^2$
- $\epsilon_r = \frac{\epsilon}{\epsilon_0}$

$\boxed{1 \le \epsilon_r < \infty}$

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

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

$$\boxed{F_{vacume} = \frac{1}{4\pi\epsilon_0} \times \frac{q_1 q_2}{r^2}}$$

$$\boxed{F_{medium} = \frac{1}{4\pi\epsilon_0\epsilon_r} \times \frac{q_1 q_2}{r^2}}$$

$\therefore \boxed{F_{medium} = \frac{F_{vacume}}{\epsilon_r}}$

$\because \boxed{\epsilon_r > 1}$

$\Rightarrow \boxed{F_{net} < F_{vacume}}$