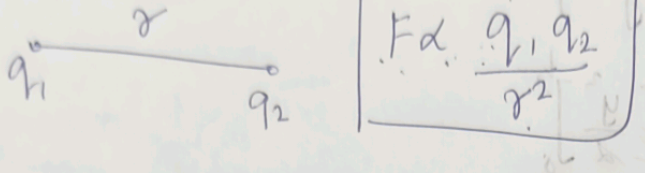
UNIT- II

Electrostatics

Coulomb's law

* **Statement** -

(mag & charge) ↑F (characteristics)



→ The force of attraction (or) repulsion between any two point charges is.

dist ↓ F ↑
dist ↑ F ↓

- directly proportional to the product of two charges ($F \propto q_1 q_2$).
- inversely proportional to the square of the distance between the charges. $\left(F \propto \frac{1}{r^2}\right)$

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

$$F = \frac{q_1 q_2}{4\pi\varepsilon r^2} \text{ ; Newtons}$$

$\frac{1}{4\pi\varepsilon}$ = proportional constant

where ε → dielectric constant (or) permittivity

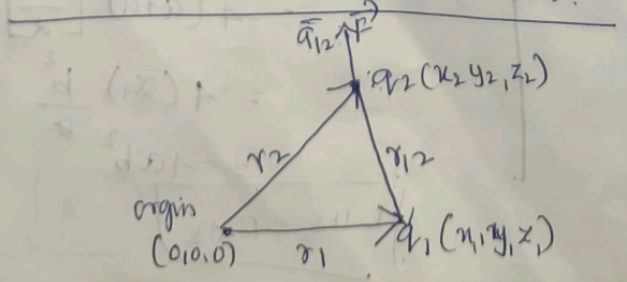
$$\varepsilon = \varepsilon_0 \varepsilon_r$$

$\varepsilon_0 = 8.854 \times 10^{-12}$ F/m

ε_r = relative permittivity of the particular conductive medium

air → $\varepsilon_r \Rightarrow 1$.

* Coulomb's law in vector form:



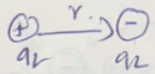
Vector form of Coulomb's law

$$\vec{F} = \frac{q_1 q_2}{4\pi\varepsilon \vec{r}_{12}^{\,2}} \cdot \vec{q}_{12}$$

$\vec{a}_{12}$ → unit vector in the direction of r_{12}

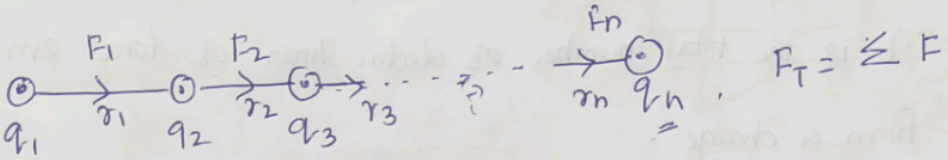
$$\vec{a}_{12} = \frac{\bar{r}_2 - \bar{r}_1}{|r_2 - r_1|} \quad ; \quad r_{12} = |r_2 - r_1|$$

* Principle of Superposition:



→ Consider a system of 'n' point charges.

$q_1, q_2 \ldots q_n$ at distance $r_1, r_2 \ldots r_n$ respectively.



$F_T = \sum F$

→ The force on n^{th} charge is given by vector sum of all the individual forces → superposition principle.

→ The force F_i on the i^{th} charge is given as.

$$\vec{F}_i = \sum_{j=1}^{n} \frac{q_i q_j}{4\pi\varepsilon_0 r_{ij}^2} \times \vec{a}_{ij}$$

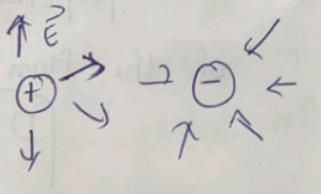
$\therefore [\, i \neq j \,]$

$q_i \neq q_j$

Electrostatics → Static Electric field

→ It is the study of charge at rest condition

→ $\vec{E}$ is produced by the stationary charge.



* Characteristics of E:

→ Electric field lines (or) Electric flux (ψ)

→ Electric flux density (D)

→ Electric field Intensity (E)

→ Electric Potential (V)