Contents

Condition for coloumb's law

- The **coloumb's** law is valid under following **considerations** :
  - The **charges** are *stationary* .
  - The **charges** in consideration are point charges.
    - The **radius** is negligible compared to the distance of *separation*

Structures satisfying the condition of applicability of coloumb's law

- **Coloumb's law** is *satisfied* by conducting **spheres.**
  - **Charge** is distributed at the conducting sphere.
  - This **charge** appears to originate from the *center* of the **spheres.**
  - The **charge** at the center behaves as a **point** charge.

Couloumb's law

- The expression for **coloumb's** law is given by:

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

- In CGS system:
    - k = 1
- In MKS system:
    - k = 9×10^9

Value of k

- The term k is expressed as:

$$k = \frac{1}{4\pi\epsilon_0}$$

- ϵ_0 = $8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$
- The term ϵ_0 is the **permitivitty** of **free space** .
- The **electrostatic force** in *air* and *vacuum* are equal.
- **Air** is not considered as a medium.
- **Electrostatic force** at medium of ϵ is given by:

$$F_{medium} = \frac{1}{4\pi\epsilon} \frac{q_1 q_2}{r^2}$$

Relative Permitivitty

- **Relative Permitivitty** expresses the *number* of times the **permitivitty** of a *medium* is greater than that of **air.**

$$\epsilon_r = \frac{\epsilon}{\epsilon_0}$$

- **Relative Permitivitty** is also termed as **dielectric constant** .

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

- The force in a medium of **relative** permitivitty ϵ_r is given by:

$$F_{medium} = \frac{F_{air}}{\epsilon_r}$$

Analysis of relative permitivitty

- The value of **relative permitivitty** only lies in between :

$$1 < \epsilon_r \leq \infty$$

- The value of **relative permitivitty** of metals is **infinity** .

Physical Meaning of Permitivitty

- **Current** is opposed by a conductor **maintained** at a **constant** *p.d.* .
- This **opposition** is called **resistance** .
- **Electric Force** set up by an **electric field** is opposed by **medium** .
- The **greater** the permittivity the **less** *lines of electric* force can pass through the **medium** .

Electrostatic Shielding

- **Metals** having **infinite** relative permittivity completely block **electrostatic** force.
- This **effect** is called **electrostatic shielding.**

Cases of sphere.

- If **two** spheres of same charges are *considered* :

$$F < k\frac{q_1 q_2}{r^2}$$

- If **two** spheres of opposite charges are *considered* :

$$F > k\frac{q_1 q_2}{r^2}$$

- These cases **charges** are not present exactly at the **center.**
- Change in **magnitude** of **radius** is seen.

Partial Medium

- The **electrostatic** *force* experienced at a *partial medium* of *thickness* t is:

$$F_{p.medium} = \frac{q_1 q_2}{4\pi\epsilon_0[(r-t) + \sqrt{\epsilon_r} \times t]^2}$$