



Electric Charges and fields

Charges

Positive charges

Negative charges

Like charges repel each other

Unlike charges attract each other

Properties of charge

Quantisation

$$q = ne$$

where, $n = 0, 1, 2, \dots$
 e is an charge of electron.

Additivity

$$q_{net} = \sum q_i$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

Conservation

total charge of an isolated system is constant



Coulomb's law

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

Vector form,

$$\vec{F}_{12} = K \frac{q_1 q_2}{r_{12}^2} \hat{r}_{12}$$

$$K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N-m}^2/\text{C}^2$$

$$\left[\hat{r}_{12} = \frac{\vec{r}_{12}}{r_{12}} \right]$$



Principle of Superposition,

$$\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14} + \dots + \vec{F}_{1n}$$

$$\vec{F}_1 = \frac{q_1}{4\pi\epsilon_0} \sum_{i=2}^n \frac{q_i}{r_{1i}^2} \hat{r}_{1i}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{N-m}^2$$



Electric field

$$\vec{E} = \frac{\vec{F}}{q_0}$$

$$\vec{E} = K \frac{q}{r^2}$$

or

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$

q_0 = test charge



Vector form,

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}$$



Relative Permittivity

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

ϵ_0 = Permittivity in free space
 ϵ = Permittivity in medium

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