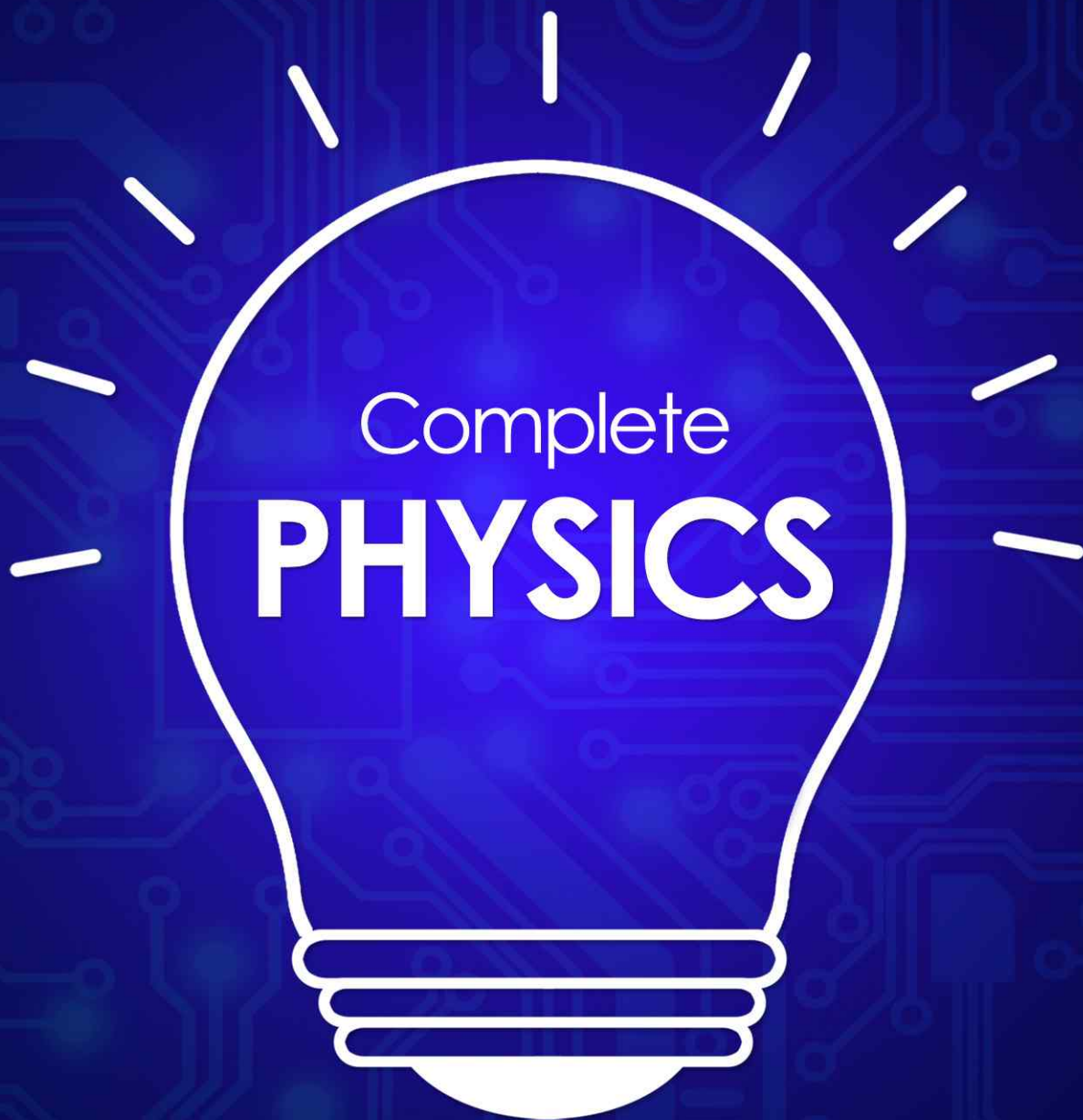




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Electrostatics-I

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01. Introduction

Electrostatics, deals with the study of charges in rest. These stationary charges occurs due to friction of two insulating bodies, therefore it is often called frictional electricity.

Important points

- (i) Gravitational force is the weakest while nuclear force is the strongest force of the nature
- (ii) Nuclear force does not depend upon charge, it acts equally between proton-proton, proton neutron and neutron-neutron.
- (iii) There are weak forces acting in β -degradation in radio-activity.
- (iv) A stationary charge produces electric field while a moving charge produce electric as well as magnetic field.
- (v) Moving charge produce electric field as well as magnetic field but does not radiate energy while uniform acceleration.
- (vi) Accelerated charge produce electric field as well as magnetic field and radiate energy.

02. Charge

Property of a substance by virtue of which it can repel or attract another charged substance.

Charges are of two types

- (a) **Positive charge** : Lesser number of electrons than number of protons.
- (b) **Negative charge** : More number of electrons than number of protons

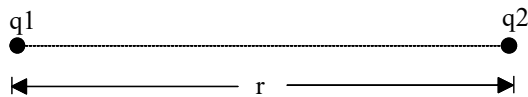
Important Points : Only, electron is responsible for a substance to be charged and not the proton.

Properties of Charge

- (i) Like charges repel while unlike charges attract each other.
- (ii) Charge is quantized in nature i.e. The magnitude of charge possessed by different objects is always and integral multiple of charge of electron (or proton) i.e. $q = \pm ne$ where $n = 1, 2, 3, \dots$
- (iii) The minimum possible charge that can exist in nature is the charge of electron which has a magnitude of $e = 1.60207 \times 10^{-19}$ coulomb. This is also known as quantum of charge or fundamental charge.
- (iv) In an isolated system the algebraic sum of total charge remains constant. This is the law of 'Conservation of charge'.

03. Coulomb's Law

The force of attraction or repulsion between two stationary point charges is directly proportional to the product of charges and inversely proportional to the square of distance between them. This force acts along the line joining the two. If q_1 & q_2 are charges in consideration r , the distance between them and F , the force acting between them



Then, $F \propto q_1 q_2$

$$F \propto 1/r^2$$

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

$$\Rightarrow F = K \frac{q_1 q_2}{r^2}, \text{ where } k = \text{constant.}$$

$$K = \frac{1}{4\pi\epsilon_0\epsilon_r} = \frac{9 \times 10^9}{\epsilon_r} \text{ Nm}^2\text{C}^{-2}$$

where,

ϵ_0 = Electric permittivity of vacuum or air

$$= 8.85 \times 10^{-12} \text{ C}^2\text{N}^{-1}\text{m}^{-2} \text{ and}$$

K or ϵ_r = Relative permittivity or Dielectric constant or Specific inductive capacity

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

[Newton's law for particles is analogous to coulomb's law for rest charge. The difference is that Newton's law gives attraction force while coulomb's law gives attraction as well as repulsion force]

- NOTE** (i) Coulomb's law is applicable to point charges only. But it can be applied for distributed charges also
- (ii) This law is valid only for stationary charges and cannot be applied for moving charges.
- (iii) This law is valid only if the distance between two charges is not less than 10^{-15} m

Direction

Direction of the force acting between two charges depends upon their nature and it is along the line joining two charges.

