

# ELECTROSTATICS

\* Electrostatics :- The branch of physics which deals with electric charges at rest is known as electrostatics or static electricity.

⇒ Electric charge :- It is the physical property of matter due to which it produces and experiences electrical and magnetic effects. It is carried by subatomic particles like electron  $[-e]$  and proton  $[+e]$ . Generally, charge is considered as surplus or deficit of electrons.

:: Modern Electron Theory of Electrification:  
According to Bohr atomic structure, atom is composed of three particles. They are :-

Particle	Mass	Charge
i) Electron	$9.1 \times 10^{-31} \text{ kg}$	$-1.6 \times 10^{-19} \text{ C}$
ii) Proton	$1.67 \times 10^{-27} \text{ kg}$	$+1.6 \times 10^{-19} \text{ C}$
iii) Neutron	$1.675 \times 10^{-27} \text{ kg}$	0

As we know, for an atom no. of protons = no. of electrons and charge on a proton is equal and opposite to that of an electron. So, atom as a whole is electrically neutral. The nucleus has positively charged protons where as negatively charged electrons revolve around the nucleus. Thus different substances hold electrons in outermost orbit of an atom with different strength. When two bodies are rubbed together, electrons are transferred from one body to other.

The body gaining electrons is negatively charged whereas those losing them gets positively charged.

Therefore, the transfer of electrons from one body to another is responsible for the electric charging of the body by rubbing.

## Basic properties of Electric charge :-

1) In SI unit as current is assumed to be a fundamental quantity and  $I = q/t$ , charge is a derived physical quantity with dimension  $[AT]$  and unit (ampere  $\times$  sec) called coulomb. The coulomb is related to c.g.s. units of charge through the basic relation  $1C = 3 \times 10^9$  e.s.u. or stat-coulomb.

$$1C \cdot 3 \times 10^9 = 3 \times 10^{10} \text{ e.s.u.} = 10C$$

Smallest units of charge :-

$$1 \text{ pico coulomb (pC)} = 10^{-6} C$$

$$1 \text{ nano coulomb (nC)} = 10^{-9} C$$

① Similar charges repel each other while dissimilar attract.  
2. Charge is a scalar.

3. Charge is transferable

4. Charge is always associated with mass.

5. Charge is quantised :- Existence of charges in discrete packets rather than in continuous

amount is known as quantization of charge.

According to Millikan oil drop experiment

Smallest possible amount of negative and positive charges are charges on electron is  $-e$  and that of proton is  $e$ . Thus,  $e$  is an elementary charge.

Quantization is the property of an electric charge which tells that any charged body can have charge as integral multiple of the basic charge ( $e$ )

$$\text{i.e. } q = \pm ne$$

Here  $q$  = total charge,  $n = 1, 2, 3, \dots$

\* Charge on a body can never be fraction i.e.  $\frac{2}{3}e$ .

6. Charge is conserved: - Charge can neither be created nor destroyed. It can appear or disappear simultaneously in equal quantities of positive and negative charges.

7. Accelerated charge radiates energy: - A charged particle at rest produces only electric field but in unaccelerated motion, it produces both electric and magnetic fields. If the motion is accelerated, it produces electric and magnetic field and also radiate energy in the form of electromagnetic waves.

- |                   |   |   |
|-------------------|---|---|
| (1) $\vec{V} = 0$ | (2) $\vec{V} \xrightarrow{\text{constant}}$ | (3) $\vec{V} \xrightarrow{\text{not constant}}$ |
| $\vec{E}$         | $\vec{E}$ and $\vec{B}$                     | $\vec{E}$ , $\vec{B}$ and radiates energy.      |
| (A)               | But no radiation<br>(B)                     | (C)   |

8. Charge resides on the outer surface of a conductor

9. Charge density is maximum where the radius of curvature is minimum and vice-versa. i.e.

$\sigma \propto \frac{1}{R}$ . This is why charge leaks from sharp points.



\* Lightning rods: -  $\Psi$  are made up of conductors with one of either  $\underline{\underline{\quad}}$  their ends earthed ~~with~~ while the other sharp end protects a building from lightning either by neutralising or conducting the charge of the cloud to the ground.

\* Grounding or Earthing: - The method by which charges are shared between a charged body and earth is called earthing. It ensures safety of the appliance as well as the user.

Its pictorial symbol is  $\underline{\underline{\quad}}$  or  $\text{||||}$