Electrostatics: What is Electrostatics: Conductors, Insulators, and Semiconductors (For CBSE, ICSE, IAS, NET, NRA 2022)

Title: Electrostatics

What is Electrostatics?

- Electrostatics, as the name implies, is the study of stationary electric charges.
- Study of stationary electric charges at rest is known as electrostatics. An electroscope is used to detect the charge on a body
- A rod of plastic rubbed with fur or a rod of glass rubbed with silk will attract small pieces of paper and is said to be electrically charged.
- Pith ball electroscope is used to detect a charge and to know the nature of the charge.
- The charge on plastic rubbed with fur is defined as negative, and the charge on glass rubbed with silk is defined as positive.
- Gold leaf electroscope which was invented by Bennet detects a charge and the nature of the charge and determines the quantity of the charge.
- Charge is conserved.
- A neutral object has no net charge.
- If the plastic rod and fur are initially neutral, when the rod becomes charged by the fur, a negative charge is transferred from the fur to the rod.
- Net negative charge on the rod is equal to the net positive charge on the fur.

Conductors, Insulators, and Semiconductors

- A body in which electric charge can easily flow through is called **conductor** (e. g. metals) .
- A **conductor** is a material through which electric charges can easily flow.

- A body in which electric charge cannot flow is called **insulator** or **dielectric**. (E. g. glass, wool, rubber, plastic, etc.) An **insulator** is a material through which electric charges do not move easily, if at all
- Substances which are intermediate between conductors and insulators are called **semiconductors**. (e. g. silicon, germanium, etc)
- An **electroscope** is a simple device used to indicate the existence of charge.
- **Dielectric Strength**: It is the minimum field intensity that should be applied to break down the insulating property of insulator.

Surface Charge Density (Σ)

- The charge per unit area of a conductor is defined as surface charge density

$$\sigma = q \times A = \text{total charge area}$$

- When $A = 1\ m^2$ then, $\sigma = q$.
- Its unit is coulomb/meter and its dimensions are ATL^{-2} .
- It is used in the formula for the charged disc, charged conductor and an infinite sheet of charge etc.
- Surface Charge Density depends on the shape of the conductor and presence of other conductors and insulators in the vicinity of the conductor.

Electric Flux

- The number of electric lines of force crossing a surface normal to the area gives electric flux ϕ_E
- Electric flux through elementary area ds is defined as the scalar product of area and field.

$$\phi_E = \text{EScos}\,\theta$$

$$\text{Or}, \phi_E = \int \vec{E} \times d\vec{s}$$

$$\phi_E = \int E \times \text{ds}$$

Electric Potential (V)

- An electric potential at a point in a field is the amount of work done in bringing a unit + ve charge from infinity to the point.
- It is equal to the Electric potential energy of unit + ve charge at that point.
- It is a scalar

- S. I unit is volt

Equipotential Surface

- A surface on which all points are at the same potential.
- Electric field is perpendicular to the equipotential surface
- Work done in moving a charge on the equipotential surface is zero.

Electron Volt

This is the unit of energy in particle physics and is represented as eV.

$$1\ \text{eV} = 1.6 \times (10)^{(-19)}\ J$$

Charged Particle in Electric Field

- When a positive test charge is fired in the direction of an electric field
- It accelerates,
- Its kinetic energy increases and hence
- Its potential energy decreases.