MODULE 4 : ELECTROSTATICS

ELECTROSTATICS

Sub-topics;

1. ELECTRIC FORCE AND COULOMB'S LAW
2. ELECTRIC FIELD
3. ELECTRIC POTENTIAL
4. CAPACITANCE.

INTRODUCTION

Electrostatics – Is the branch of physics which deals with charges at the rest. The word **''ELECTROSTATICS''** means electricity at the rest. Sometimes is known as Static-Electricity.

IMPORTANCE OF ELECTROSTATICS

1. Electrostatics generation can produce high voltages such as 10 volts. Such high voltages are required for X - Ray work and nuclear bombardment.
2. We use principles of electrostatics for spray paints powder.
3. The principle of electrostatics are used to present pollution.
4. The problems of preventing sparks and breakdown of insulators in high voltage engineering are essentially electrostatic.
5. The development of lightning rod and capacitor are the outcomes of electrostatics.

FRICTIONAL ELECTRICITY

Is the electrostatic charge (ie charges at rest) developed on insulating bodies when they are rubbed against each other. When two objects rubbing with each other, there is transferring of electric charges. When two objects rubs each other exerts a force and this force is known as ''Electric force''

ELECTRIC FORCE- Is the force experienced on the charged bodies or electric charges.

ELECTRIC CHARGE - Is the charges acquired by the body due to the deficiency or excess of electrons from the normal due to the share.

Electric charge- Is the charge(s) acquired by the body when two bodies rubbing each other which may be either positive or negative charges.

TYPES OF ELECTRIC CHARGES

(i) Positive charge.

(ii) Negative charge.

POSITIVE CHARGE - Is the charge which possessed by the body after rubbing having defficiency of the electrons.

NEGATIVE CHARGE - Is the charge which possessed by the body after rubbing having efficiency of the electrons. Fig.

The name of the object, which acquires	
POSITIVE CHARGE	NEGATIVE CHARGE
Glass rod	Silk cloth
Fur or cat skin	Ebonite rod
Woolen cloth	Amber
Woolen cloth	Plastic object

PROPERTIES OF ELECTRIC CHARGES

1. Like charges repel each other and unlike charges attract each other.
2. The magnitude of elementary is negative or positive charge is same and is equal to 1.6×10^{-19}C.
3. The force between charges varies as the inverse square of their separation.
4. The charge is quantized ie equal to $\pm ne$ where n is an integer and $e = 1.6 \times 10^{-19}$C.
5. The electric charge of a system is always conserved.
6. Electric charge is a scalar quantity.
7. The magnitude of a charge on a body is independent of the speed of the body.

CONSERVATION OF ELECTRICC CHARGES

This is the property that the total charges on an isolated system remains constant.

LAW OF CONSERVATION OF THE ELECTRIC CHARGES

State that" The algebraic sum of positive and negative charges in an isolated system remain always remain constant". In other words, the net charge of isolated system remain unaltered.
The following examples explain the law of conservation of charge;-

1. In all nuclear transformations, the proton number is found to remain unchanged.

   $${}^{1}_{0}n + {}^{235}_{92}u \rightarrow {}^{141}_{56}Ba + {}_{36}kr^{92} + 3{}^{1}_{0}n + E$$

   E = energy

   Proton number before fission = 0 + 92 = 92

   Proton number after fission

   = 56 + 36 + 3(0) = 92

   Thus, net charge (proton number) is same before and after the nuclear fission of ^{235}U

2. When a glass rod is rubbed with silk, negative charges appear on the silk while an equal amount of positive charges appears on the glass rod. Then, the net charges on the glass – rod system is remains equal to zero both before and after rubbing. Hence electric charges are conserved.

QUANTIZATION OF CHARGE

The magnitude of charge on a proton or an electron($e = 1.6 \times 10^{-19}C$) is called ''elementary charge''. Since protons and electrons are the only charged particles constituting the matter, the charge on an object must be integral multiple of ±e.

Mathematically, the charge on any object must always be equal to

$q = \pm ne$, [n = 1, 2, 3,-------]

''Quantization of electric charge''

Refers that the electric charge of an object is an integral multiple of the fundamental charge.ie The charges carried by the body is not fraction.

CONDUCTOR - Is the substance which possessing the electric charge(s) **Examples:** Copper, Iron, Zinc, aluminium, etc

INSULATOR (BAD CONDUCTOR)

Is the substance which does not possessing the electric charges. **Examples:** Rubber, Cotton, dry piece of wood, waxy, etc

CHARGING - Is the process of electrifying body.

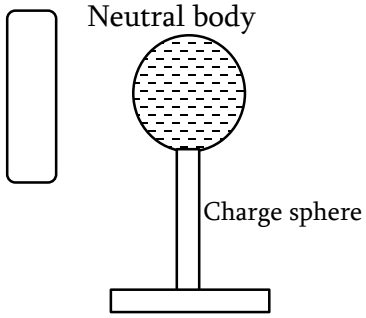
METHOD OF CHARGING

1. Rubbing (Friction) method
2. Shaining method
3. Electrostatic Induction
4. Corona discharge method

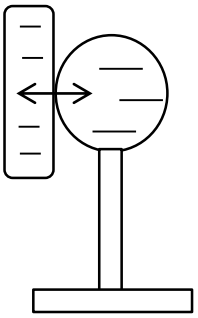
1. RUBBING(FRICTION) METHOD

When two objects are rubbed together electrons moves form one body to another body, so that both objects becomes charged.

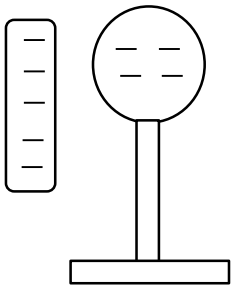
(i)



(ii) On contact and rubbing process



(iii) After rubbing



Conclusion: After rubbing a neutral body on charged sphere. The body will possessing the negative charges and they fly apart from each other since they contain similar charges of equal amount. The sign carried by the charged body can be tested by using Gold Leaf Electroscope.

Note that: Rubbing process can be occurred for the two possible cases:-

(i) For two charged bodies.
(ii) For a charged body and neutral body

(i) Keeping the charged rod nearby, touch the body with fore finger or corrected to the Earth.
(ii) Remove the finger first and then the charged rod.
(iii) The body is now charged with a charge opposite to that present on the charging rod