

"ELECTROSTATICS" Unit-I

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"The branch of Physics which deals with electricity at rest is called electrostatics."

Electro → electricity, statics → at rest.

Principle of Electrostatics:-

Electrostatics works on the principle of electric charge which can be transferred from one body to another by rubbing them together.

We know that the substances are electrically neutral because no. of revolving electrons around the nucleus of atom is equal to number of protons in the nucleus.

Electric charge:-

"It is the property of matter by virtue of which electrical, magnetic and some other related effects can be produced in the body."

Electric charge is denoted by 'q'. It is a derived physical quantity.

[Fe is a strong & Al is a weak magnetic substance]

Expression for electric charge:-

$$q = I \cdot t$$

where I = electric current.

t = time.

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Units of q:
of $I = 1A$ $t = 1s$
then $q = 1A \times 1s = 1C$

Definition of 1 Coulomb:
Electric charge is said to be 1 Coulomb when a current of 1 Ampere passes through a conductor in 1 second.
Dimensional formula: $[M^0 L^0 T^1 A^1] = [A^1 T^1]$

Q. If any substance is electrically neutral. How charge developed on it after rubbing with suitable material? Explain.

Ans. We know that atom consists of a +vely charged central core called the nucleus. The negatively charged electrons revolve round the nucleus in fixed orbits. The no. of revolving electrons is equal to the no. of protons in the nucleus. So, atom is electrically neutral.

Binding energy: It is the energy required to release an electron from the orbit of an atom.

- Those electrons which revolve round the nucleus in the outermost orbit of the atom have least binding energy and as such they are called as free electrons.
- The free electrons reside on the surface of the substance.
- These free electrons can be removed by rubbing or even due to resistance of air.

→ When the free electrons gets removed from the atom, there is decrease in the no. of revolving electrons than the protons. So the atom becomes a +ve ion.

This is how electric charge is developed in a substance by rubbing. This is called frictional electricity.

Benjamin Franklin, a famous physicist showed for the first time that there are two kinds of electric charge. → +ve charge and -ve charge.

Examples:- 1) When a glass rod is rubbed with silk cloth it gets +vely charged & silk cloth gets -vely charged.

Reason:- A glass rod has excess of free electrons while silk cloth is deficit of free electrons. After rubbing, some free electrons from glass rod get transferred to silk cloth. The glass rod becomes +vely charged due to loss of free e^s. The silk cloth becomes -vely charged due to gain of free electrons.

2) When an ebonite rod is rubbed with fur it gets -vely charged & fur gets +vely charged.

Table showing two suitable materials when rubbed together become charged:-

<u>+vely charged substances</u>	when Rubbed with	<u>-vely charged substances</u>
Glass rod	→	Silk cloth
Fur	→	Ebonite rod.
Dry Hair	→	Plastic scale/comb
Wool	→	Plastic rod
Woolen cloth.	→	Plastic bag.

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Contain appliances that use Principles of electrostatics are:-

Microphones, Cathode ray tubes (CRT), capacitors used in TV, radio computers, etc. spraying paints, Van de Graaf generator, etc.

Theory of Electric charges

- 1) Franklin's Theory.
- 2) Symmer's Theory.
- 3) Electronic theory.

1) Franklin's Theory:-

Franklin suggested that the substances contain electrical fluids in normal state. When they are rubbed together the substance which gains this fluid becomes positively charged and the substance which loses this fluid becomes -vely charged.

However this theory is now outdated.

2) Symmer's Theory:-

Symmer - considered that the substances contain two types of electrical fluids. When they are rubbed together the substance which gains this fluid or we can say that if the electrical fluid is transferred to this substance it becomes positively charged. On the other

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hand if the electrical fluid is transferred from the substance that loses it becomes -vely charged. This theory was also later on discarded.

3) Electronic Theory:-

According to this theory atom consists of +vely charged centre core called nucleus and -vely charged electrons revolving round the nucleus in fixed orbits. The free electrons revolve in the outermost orbit of the atom and can be easily removed by rubbing or brushing. When two substances are rubbed together transfer of free electrons takes place.

The substance which loses free electrons becomes +vely charged and the substance which gains electrons becomes -vely charged.

Q → It is seen that a plastic comb rubbed with dry hair attracts bits of paper. After sometime the bits of paper are repelled by it. Explain why?

Ans Plastic Comb has excess of free electrons. Some of these free electrons are transferred to dry hair after rubbing. The comb gets -vely charged. When it is brought near bits of paper, +ve charge is induced in the bits and they get attracted to the comb. After contact, -ve charge is conducted on the bits due to which they get repelled and move away from the comb.

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