Static Electricity

Electric Charge

- Types of charges:
  - Neutrons
  - Protons
  - Electrons

- If electrons are removed , the atom becomes positively charged . - If electrons are added , the atom becomes negatively charged . - If the number of negative and positive charges are equal , the object is electrically neutral - An atom that is charged is called an ion

- The law of conservation of charge is one of the fundamental laws of Physics
  - The net charge of a closed system remains unchanged.
  - The net charge of a system is the algebraic sum of the charges while taking into consideration the positive and negative signs of the charges.

Interaction Between Charges

- Like charges repel
- Unlike charges attract

Measuring Electric Charges

- The SI unit of electric charge is the coulomb (C).
- The amount of charge carried by an electron is $1.6 \times 10^{-19} C$

Electrical Insulators and Conductors

- Objects around us can be classified into two broad categories:

1. electrical insulators
2. electrical conductors

	electrical insulators	**electrical conductors**
motion of charged particles	charged particles (electrons) are not free to move about	charged particles (electrons) are free to move about
ability to conduct electricity	low	high
method of charging	by friction (e.g. rubbing)	by induction

	electrical insulators	electrical conductors
examples	glass, perspex, silk wool	copper, steel, fluids with mobile charged particles

Electrostatic by Friction

- Some materials like silk and glass, gain static charges when they are rubbed together

Example:

- When the glass rod and silk cloth are rubbed together, electrons move from the glass rod to the silk cloth.
- The glass rod loses electrons and becomes positively charged.
- The silk cloth gains electrons and becomes negatively charged.
- The electrons transferred are not able to move freely in the silk cloth.
- They remain at the surface where the silk cloth was rubbed.
- Materials in which the electrons do not move freely are called insulators.
- Insulators are charged by friction (e.g. rubbing)
- Different materials have different affinities to electrons. Some attract electrons weakly, while others attract electrons strongly.

Electrostatic Charging by Induction

- Conductors cannot be charged by friction because mobile electrons can be easily transferred to and away from conductors.
- Metallic conductors can be charged by induction in which a conductor is charged without contact with the charging body.

Method 1: Charging two metal

1. Two metal spheres (conductors) on insulating stands are placed side by side.

- They are touching each other.

2. A negatively-charged rod is brought near, but not touching, sphere A. Like charges repel.

- Electrons in both spheres A and B are repelled to the far end of sphere B.
- sphere A has excess positive charges,
- while sphere B has excess negative charges.

3. While holding the negatively charged rod in place (near sphere A), move sphere B away from sphere A.

4. The charged rod is removed.

- Sphere A is now positively charged and sphere B negatively charged.
- Spheres A and B have an equal number of opposite charges.
- Both spheres have been charged by induction.

5. When the charged rod is removed *before* the two spheres are moved apart,

- The electrons will be redistributed in sphere A and B and both will become neutral again.

Method 2: Charging a single conductor by induction

1. A positively charged rod is brought near, but not touching, a metal conductor on insulating stand.

- The electrons in the conductor are drawn (attracted) towards the end near the positively-charged rod.

2. Without removing the positively-charged rod, the positively charged end of the conductor is earthed by touching it with a person's hand.

- Free electrons move from earth to the conductor through the person.
- This neutralises the positive charges on the end of the conductor.

> 🔰 Earthing is a process which a conducting path is connected from a conductor to earth. This allows electrons to either flow into or out of the conductor. Earth refers to a large body of charge that remains electrically neutral regardless of the amount of charge that is added or removed from it.

5. When the charged rod is removed before the earthing process is stopped,

- The excess electrons in the conductor will flow to the earth and discharging occurs. The conductor will then become electrically neutral.

Neutralising/Discharging a Charged Insulator

- A charged object is neutralised by discharging the excess charges on it.

Discharging through heating

- The heat from the flame ionises the surrounding air particles.
- For a positively-charged glass rod, the ions neutralise the excess charges on the glass rod.

Discharging due to humid conditions

- Water molecules in air are electrical conductors
- For a negatively charged insulator, excess charges are transferred to the water molecule.

Neutralising / Discharging a Charged Conductor

- A charged conductor can be discharged through earthing
- When we earth a charged conductor, we provide a path (usually lower resistance and connected to the earth) for

- excess electrons to flow away from the charged conductor, or
- electrons to flow to the charged conductor if it has excess positive charges