What is physics?

Physics is one of the most Scientific discipline of fundamental Sciences.
Its main goal is to understand the existance, working and behaviour of our universe.
It provides the basic laws and theories to study and understand the universe in an organized way.
Physics deals with the study of matter, energy and their mutual interaction.
That means matter and energy are the main Characters in physics.
what is matter and energy?
Matter is defined as all those things which have mass and occupy physical space are called matter.
Matter is usually measured in kilograms and moles.
There are four kinds of state of matter.
. solid . liquid . gas . Plasma
Energy is defined as the ability of a body to do work is called energy.
For Energy it usuly measure in Joules, electron volt Calories etc.

You are surrounded by devices that depend on the physics of electromagnetism, which is the combination of electric and magnetic phenomena. This physics is at the root of computers, television, radio, telecommunications, household lighting, and even the ability of food wrap to cling to a container. This physics is also the basis of the natural world. Not only does it hold together all the atoms and molecules in the world, it also produces lightning, auroras, and rainbows.

Electrostatics:- The branch of Physics which deals with electric effect of static charge is called electrostatics

Electric charge:

Charge of a material body or particle is the intrinsic property (natural property) due to which it produces and experiences electrical and magnetic effects Some of naturally charged particles are electron, proton, α-particle etc.

~~The terms Positive or~~

TYPES OF CHARGES

(1) POSITIVE CHARGE:- It is the deficiency of electrons compared to Protons If an electron is removed from an atom then atom is said to be positively charge. A charge atom is called ion.

(2) NEGATIVE CHARGE: It is the excess of electrons compared to protons.

UNIT OF CHARGE: Charge is derived physical quantity. Charge is measured in Coulomb in SI unit. In practice, we use mC (10^{-3}C), μC (10^{-6}C) nC (10^{-9}C) etc.

CGS unit of charge = electrostatic unit = esu.
(centi ← Gram, second) 1 Coulomb = 3×10^{9} esu of charge.

SPECIFIC CHARGE:-

It is defined as the ratio of charge and its mass is (q/m)

PROPERTIES OF CHARGE :-

(1) CHARGE IS A SCALAR QUANTITY.

(2) CHARGE IS TRANSFERABLE: charging implies transfer of charge (electrons) from one body to another body.

(3) CHARGE IS CONSERVED: In an isolated system, total charge (sum of positive and negative) remains constant.

EXAMPLES OF CHARGE CONSERVATION.

(i) $e^- + e^+ \longrightarrow \gamma + \gamma$ (Pair annihilation)

$(-1) + 1 \longrightarrow 0 + 0$

$0 \longrightarrow 0$

(ii) $\pi^0 \longrightarrow \gamma + \gamma$ (neutral π-meson decays)

(iii) $\gamma \longrightarrow e^+ + e^-$ (Pair Production)

$0 \longrightarrow +1 - 1$

$0 \longrightarrow 0$

(4) CHARGE IS QUANTIZED:- Charge on any body always exist in integral multiples of a fundamental unit of electric charge (e). ($1e = 1.6 \times 10^{-19} C$). So charge on anybody $Q = \pm ne$ where n is the integer and e is the charge of on an electron $(0, 1, 2, 3, \ldots)$

i.e. it is possible to find a particle having zero, $\pm 1e$, $\pm 6e$ charge but it is impossible to find a particle posessing charge equal to $3.5\bar{7}e$, $-5.\bar{4}e$ $16.3e$ etc. (But ~~a new theory~~ According to a new theory the existence of particles of charge $\pm \frac{1}{3}e$ and $\pm \frac{2}{3}e$ hass been postulated. These particles are called quarks)

(5) Like point charges repel each other while unlike point charges attract each other.

(6) A charged body may attract a neutral body or an oppositely charged body but it always repel a similar charged body.

(7) Charge is always associated with mass, i.e. charge cannot exist without mass though mass can exist without charge. Particles such as photon (γ) or neutrino (ν) which have no (rest) mass can never have a charge. (neutral atom has no charge but it has mass)

(8) CHARGE IS RELATIVISTICALLY INVARIANT

Charge on a body does not change whatever be its speed, while the mass of a body depends on its speed and increase with increase in speed. ($E = mc^2$)

(9) A charge at rest produces only electric field around itself, a charge having uniform motion produces electric field as well as magnetic field around itself while a charge having accelerated motion emits electromagnetic radiation.

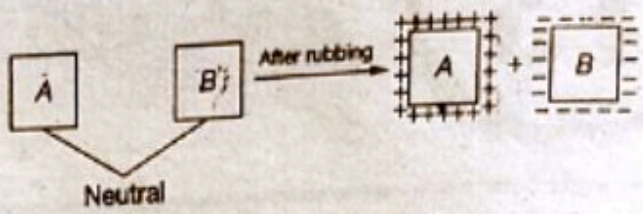
CHARGING OF A BODY:

A body can be charged by means of (a) friction (b) Conduction (c) induction (d) thermionic emission or ionization (e) photoelectric effect (f) Field emission.

no of protons = no of electrons

Charging by Friction

When a neutral body is rubbed with other neutral body (at least one of them should be insulator) then some electrons are transferred from one body to other. The body which gains electrons becomes negatively charged and other becomes positively charged.

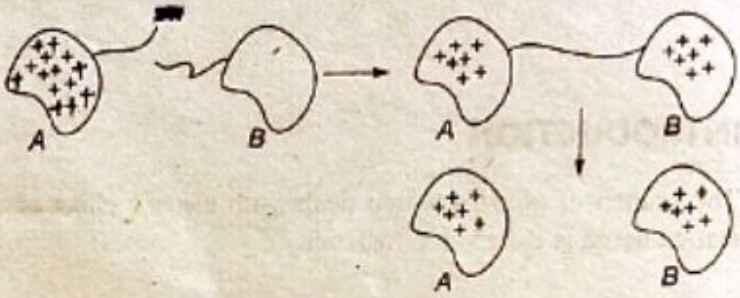


Conduction (Flow)

There are three types of material in nature

1. **Conductor:** Materials which have large number of free electrons.
2. **Insulator or Dielectric or Nonconductors:** Materials which do not have free electrons.

When a charged conductor is connected with a neutral conductor then charge flows from one body to the other body. In case of two charged conductors, charge flows from higher potential energy to lower potential energy. The charge stops flowing when the potential of the two bodies become same.



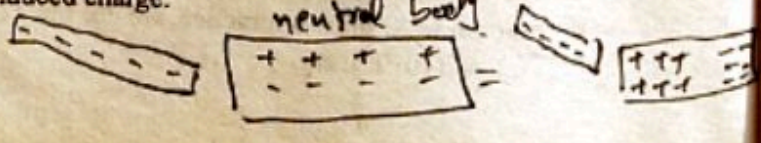
By conduction, the body acquires the same charge as the charging body.

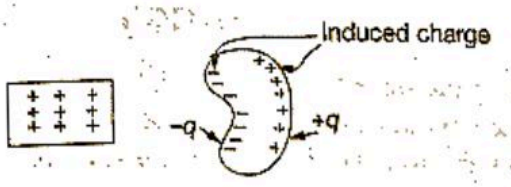
NOTE

If two identical shaped conductors kept at large distance are connected to each other, then they will have equal charges finally.

Induction

When a charged particle is taken near to neutral object, then the electrons move to one side and there is excess of electrons on that side making it negatively charged and deficiency on the other side making that side positively charged. Hence, charges appear on two sides of the body (although total charge of the body is still zero). This phenomenon is called induction and the charge produced by it is called induced charge.

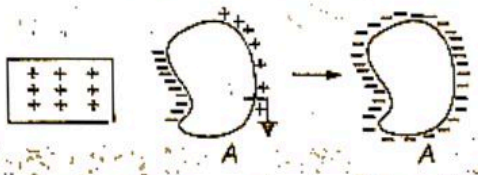




A body can be charged by induction in following two ways.

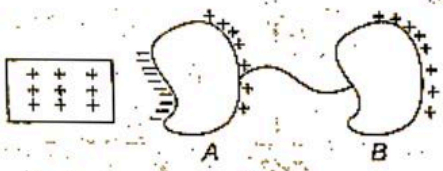
Method I:

The potential of conductor A becomes zero after earthing. To make potential zero, some electrons flow from the earth to the conductor A and now connection is removed making it negatively charged.



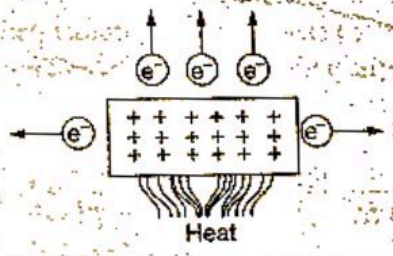
Method II:

The conductor which has induced charge on it is connected to a neutral conductor which makes the flow of charge such that their potentials become equal and now they are disconnected making the neutral conductor charged.



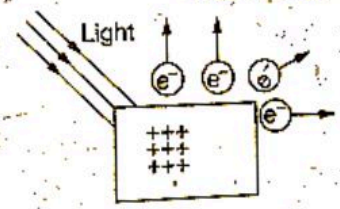
Thermionic Emission

When the metal is heated at a high temperature then some electrons of metals are ejected and the metal gets ionized. It becomes positively charged.



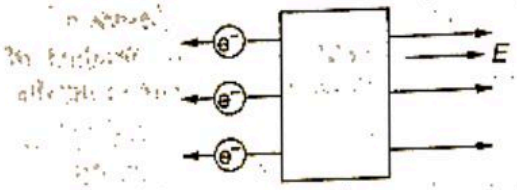
Photoelectric Effect

When light of sufficiently high frequency is incident on metal surface then some electrons come out and metal gets ionized.



Field Emission

When electric field of large magnitude is applied near the metal surface, then some electrons come out from the metal surface and hence the metal gets positively charged.



SOLVED EXAMPLES

1. Charge conservation is always valid. Is it also true for mass?

Solution:

No, mass conservation is not valid. Mass can be converted into energy.

2. What are the differences between charging by induction and charging by conduction?

Solution:

Major differences between two methods of charging are as follows

(A) In induction, two bodies are close to each other but do not touch each other while in conduction they touch each other.

(B) In induction, total charge of body remains unchanged while in conduction it changes.

(C) In induction, induced charge is always opposite in nature to that of source charge while in conduction charge on two bodies is of same nature.

3. If a glass rod is rubbed with silk, it acquires a positive charge because

(A) protons are added to it.
(B) protons are removed from it.
(C) electrons are added to it.
(D) electrons are removed from it.

Solution: (D)

4. A positively charged body A attracts a body B then charge on body B may be

(A) Positive
(B) Negative
(C) Zero
(D) Cannot say

Solution: (A, B, C)

Q How many electrons must be removed from a piece of metal to give it positive Charge of 1.0×10^{-7} C?

Sol $n = ?$ $Q = 1 \times 10^{-7}$ C

$Q = \pm ne$

$e = 1.6 \times 10^{-19}$ C

$1 \times 10^{-7}\,\text{C} = n \times 1.6 \times 10^{-19}\,\text{C}$

~~$n = 1.6 \times 10^{-19}$~~

$n = \frac{1 \times 10^{-7}}{1.6 \times 10^{19}}$

$n = 6.25 \times 10^{19-7}$

$n = 6.25 \times 10^{11}$ electrons.

Q What is the total charge on 75.0 kg of electrons?

Sol $e = -1.6 \times 10^{-19}$ C

$m = 9.31 \times 10^{-31}$ kg.

$n = \frac{75}{9.31 \times 10^{-31}}$

$Q = ?$

$Q = \pm ne$

$Q = \frac{75}{9.31 \times 10^{-31}} \times 1.6 \times 10^{-19}$ C

$Q = -1.33 \times 10^{13}$ C ... -ve sign represents ~~that~~ the charge on an electron.

ges ATOM:

The terms *positive* and *negative* refer to electric *charge*, the fundamental quantity that underlies all electrical phenomena. The positively charged particles in ordinary matter are protons, and the negatively charged particles are electrons. The attractive force between these particles causes them to lump together into incredibly small units—atoms. (Atoms also contain neutral particles called neutrons.) When two atoms get close together, the balance of attractive and repelling forces is not perfect, because electrons fly around within the volume of each atom. The atoms may then attract each other and form a molecule. In fact, all the chemical bonding forces that hold atoms together to form molecules are electrical in nature. Anyone planning to study chemistry should first know something about electrical attraction and repulsion and, before studying electrical phenomena, should know something about atoms. Here are some important facts about atoms:

1. Every atom is composed of a positively charged *nucleus* surrounded by negatively charged electrons.
2. The electrons of all atoms are identical. Each has the same quantity of negative charge and the same mass.
3. Protons and neutrons compose the nucleus. (The common form of the hydrogen atom, which has no neutron, is the only exception.) Protons are about 1800 times more massive than electrons, but they carry an amount of positive charge equal to the negative charge of electrons. Neutrons have slightly more mass than protons and have no net charge.
4. Atoms usually have as many electrons as protons, so the atom has zero *net* charge.