ELECTROSTAT
ELECTRIC CHARGES AND FIELDS

1 CHAPTER CHECKLIST

Electric Charges.
Coulomb's Law
Electrostatic Field
Electric Dipole
Electric Flux

Electric Charges

- **The physical property of matter that causes it to experience a force when placed in an electromagnetic field is called electric charge**.
- Electric charge is a scalar quantity.
- There are two kinds of charges such as positive charge and negative charge.An object can attain positive charge by loosing electrons while other can attain negative charge by gaining electrons. Charges with same sign, i.c. like charges repel each other while charges with opposite sign, i.e. unlike charges attract

Difference between Dielectrics and Conductors

- Dielectrics are non-conductors and do not have free electrons at all, while conductors have free electrons in their any volume which makes them able to pass the electricity through them.
- **METHODS OF CHARGING**
- CONDUCTION
- INDUCTION
- FRICTION

Charging by Induction

- The process of charging a neutral body by bringing a charged body nearby it without making contact between the two bodies is known as charging by induction.Figures given below are showing the sequential steps of charging a conductor permanently by using the process of charging by induction. Fig. (a)Fig. (b)Fig. (c)

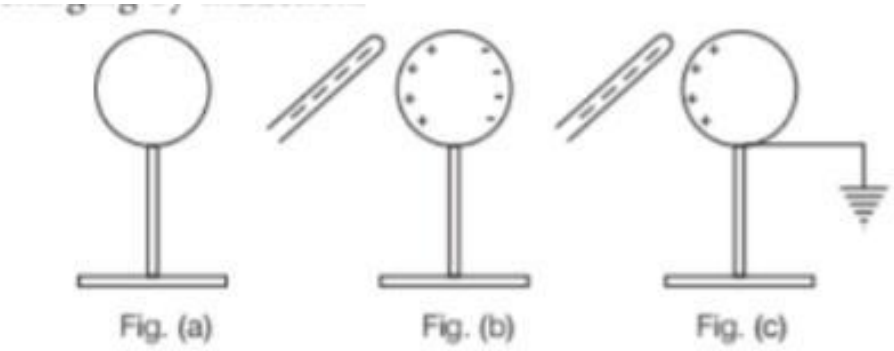

Fig. (a) Fig. (b) Fig. (c)

Using the process of charging by induction, a conductor ma

BASIC PROPERTIES OF ELECTRIC CHARGE

Some basic properties of the electric charge are discussed below

Additive Nature of Electric Charge

Electric charge is additive in nature. In general, if a system consists of n charges $q_1, q_2, q_3, \ldots, q_n$, then the total charge of the system will be $q_1 + q_2 + q_3 + \ldots + q_n$.

- **In order to calculate the net charge on a system, we have to just add algebraically, all the charges present in the system. This is known as the principle of superposition of charge.**

Conservation of Electric Charge

During any process, the net electric charge of an isolated system remains constant (i.e. conserved). In simple words, charge can neither be created nor be destroyed.

Difference between Charge AND Mass

Charge	Mass
Electric charge on a body may be positive, negative or zero.	Mass of a body is a positive quantity.
Charge carried by a body does not depend upon velocity of the body.	Mass of a body increases with its velocity as $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$, where c is velocity of light in vacuum, m is the mass of the body moving with velocity v and m_0 is rest mass of the body.
Charge is quantised.	The quantisation of mass is yet to be established.
Electric charge is always conserved.	Mass is not conserved as it can be changed into energy and *vice-versa*.
Force between charges can be either attractive or repulsive, as charges are unlike or like charges.	The gravitational force between two masses is always attractive.

Quantisation of Electric Charge

The charge on any body can be expressed as an integral multiple of basic unit of charge, i.e. charge on one electron. This phenomena is called **quantisation of electric charge.**

It can be written as $\boxed{q = \pm ne}$

where, $n = 1, 2, 3, \ldots$ is any integer, positive or negative and e is the basic unit of charge.

The SI unit of charge is called coulomb and denoted by C and its value is $e = 1.602192 \times 10^{-19}$ C or 1.6×10^{-19} C.

EXAMPLE |2| A polythene piece rubbed with wool is found to have a negative charge of 3×10^{-7} C.

(i) Estimate the number of electrons transferred from which to which?

(ii) Is there a transfer of mass from wool to polythene?

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Sol. (i) Here, $q = -3 \times 10^{-7}$ C

Charge on one electron, $e = -1.6 \times 10^{-19}$ C

$\therefore$ Number of electrons transferred from wool to polythene piece,

$$n = \frac{q}{e} = \frac{-3 \times 10^{-7}\,\text{C}}{-1.6 \times 10^{-19}\,\text{C}} = 1.875 \times 10^{12}$$

(ii) Yes, there is a transfer of mass from wool to polythene piece.

As, mass of each electron, $m_e = 9 \times 10^{-31}$ kg

$\therefore$ Mass transferred from wool to polythene,

$$m = n \times m_e = 1.875 \times 10^{12} \times 9 \times 10^{-31}\,\text{kg}$$

$$= 1.687 \times 10^{-18}\,\text{kg}$$

EXAMPLE |3| A copper slab of mass 2 g contains 2×10^{22} atoms. The charge on the nucleus of each atom is 29 *e*. What fraction of the electrons must be removed from the sphere to give it a charge of +2 μC?

Sol. Total number of electrons in the slab

$$= 29 \times 2 \times 10^{22}$$

Number of electrons removed

$$= \frac{q}{e} = \frac{2 \times 10^{-6}}{1.6 \times 10^{-19}} = 1.25 \times 10^{13}$$

$\therefore$ Fraction of electrons removed

$$= \frac{1.25 \times 10^{13}}{29 \times 2 \times 10^{22}} = 2.16 \times 10^{-11}$$