Frictional Electricity: The property acquired by substances on rubbing due to which they attract light objects is called frictional electricity. Since the charge acquired by the substance is not in motion, it is also called static electricity.

Electric charge: is the intrinsic property of a particle which gives rise to electric force between various objects. It is a scalar quality. SI unit of charge is coulomb (C) . The magnitude of charge of a proton or electron is 1.6×10^{-19} C

Electro statics: is the study of charges at rest. Many appliances are based on the principles of electrostatics like Electrostatic loud speaker, Xerox machines, laser printer.

There are two kinds of charges- positive (+) and negative (-). Like charges repel and unlike charges attract.

When amber rod is rubbed with wool, the charged acquired by it was called resinous (-) and the charge acquired by glass rod when rubbed with silk was called vitreous (+). Benjamin Franklin coined the name positive and negative to the two kinds of charges.

Tribo-electric series: different substances can be arranged in a series in such a manner that if any two of them are rubbed, the one occurring earlier in the series acquires positive charge.

Electronic Theory of Frictional Electricity: (Origin of frictional electricity)

Frictional electricity is caused by the transfer of electrons from one object to the other. The body which gains electrons gets negative charge and the body which loses electrons gets positive charge.

All substances are made up of atoms and an atom as a whole is neutral as it contains equal amount positive (protons) and negative (electrons) charges. So, when electrons are lost, the net charge on it is positive; and when electrons are gained, the net charge will be negative.

Conductors are substances through which charges can flow easily. They contain a large no. of free electrons. Eg.; metals, acids, alkalis, solutions of ionic compounds.

Insulators are substances which do not allow charges to flow through them. They don not contain any free electron. E.g.; wood, plastic, mica.

Conductors held in hand cannot be charged by rubbing. (That is why they were called non-electric substances in the beginning) .They can acquire charge if provided with insulating handles and rubbed without touching the metallic body.

Earthing (grounding) is the process of creating an electrical contact between the body and the earth. In electrical appliances, the metallic body is earthed so as to avoid shocks due to faulty wiring or wear and tear. A green wire is used in house hold wiring to indicate the earth wire.

Electrostatic induction is the phenomenon of temporary electrification of a conductor in which opposite charges appears at its closer end and similar charges at its farther end in the presence of a charged body near it.

Charging by contact is done by bringing a charged body in physical contact with uncharged body. Here charges are shared between the two bodies and the body gets similar charge as that of the original charged body. The charge on the original charged body is reduced as a result of charging by conduction.

In charging by induction the body can be charged with opposite charge by using earthing the conductor with the original charged body near by. The magnitude of charge on the original charged body does not change.

Electroscope is a device used to detect the presence of charge on a body and also to find the nature of charge.

Additivity of charge: The total charge on a system is the algebraic sum of all the individual charges. The charges are to be added by including the sign (+ or -) of the charge.

Quantization of charge:

The charge present in any body is always an integral multiple of a fundamental charge; the charge of an electron (1.6×10^{-19}C)

Mathematically, **q=ne** where n is an integer (0, ±1, ±2, ...)

The quantization of charge is verified in Faradays laws of electrolysis and Millikan's oil drop experiment. The Principle of quantization can be ignored in macroscopic charges.

Conservation of charge:

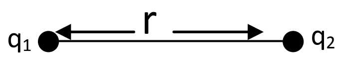
The total charge in an isolated system remains constant. The net charge can neither be created nor be destroyed in isolation.

DIFFERENCES BETWEEN CHARGE AND MASS

Charge	**Mass**
Charges may be + or -	Mass is always (taken) positive
Charge is quantized	Quantization of mass is not yet established
Charge is conserved	Mass alone is not conserved
Electric force between charges can be attractive or repulsive.	Gravitational force between masses is always attractive
Charge cannot exist without mass	Mass can exist without a net charge

Coulomb's law

Coulomb's law states that the force of attraction or repulsion between two point charges at rest is directly proportional to the magnitude of charges and inversely proportional to the square of distance between them and the force acts along the line joining the two charges.



Mathematically,

$F = \frac{kq_1q_2}{r^2}$ Where k is the electrostatic constant (or Coulomb constant.)

$$k = \frac{1}{4\pi\varepsilon_0} = 9x10^9\ Nm^2C^{-2}$$

ε_0 is the permittivity of free space (vacuum) and its value is 8.85 x $10^{-12}C^2N^{-1}m^{-2}$

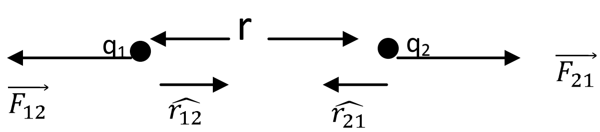
Define unit charge (OR) Define one coulomb.

From the Coulomb's law formula, if $q_1=q_2=1$ C and r = 1 m, then F=9 x 10^9N in vacuum.

Therefore, *one coulomb is defined as that charge which when kept in vacuum at a distance of 1 m from an equal and similar charge, repels it with a force of 9 x 10^9N.*

Coulomb's law in vector form

If F_{12} is the force on q_1 due to q_2 (q_1 and q_2 are positive charges) then the direction of force is from q_2 to q_1, ie; along $\widehat{r_{21}}$



Therefore, $\overrightarrow{F_{12}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^2}\widehat{r_{21}}$

$$\overrightarrow{F_{12}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^2}\frac{\overrightarrow{r_{21}}}{r}$$

$$\overrightarrow{F_{12}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^3}\overrightarrow{r_{21}}$$

Similarly, $\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^2}\widehat{r_{12}}$

$$\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^3}\overrightarrow{r_{12}}$$

Coulomb's law in terms of position vectors

Let $\overrightarrow{r_1}$ be the position vector of q_1 and $\overrightarrow{r_2}$ be the position vector of q_2, Then,

$$\overrightarrow{F_{12}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^3}(\overrightarrow{r_1} - \overrightarrow{r_2})$$

$$\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^3}(\overrightarrow{r_2} - \overrightarrow{r_1})$$

Electric Permittivity of a medium is the property of the medium which determines the force between two point charges inside the medium.

Force between two point charges in vacuum,

$$F_{vac} = \frac{1}{4\pi\varepsilon_0}\frac{q_1\,q_2}{r^2}$$

In a medium, $F_{med} = \frac{1}{4\pi\varepsilon}\frac{q_1\,q_2}{r^2}$; where ε is the absolute permittivity of the medium

$$\frac{F_{vac}}{F_{med}} = \frac{\varepsilon}{\varepsilon_0} = \varepsilon_r$$

ε_r is called the relative permittivity of the medium. (Also called **Dielectric Constant** K of the medium

The relative permittivity of a medium is defined as the ratio of the force between two point charges in vacuum at certain separation to the force between the same two charges at the same separation inside the medium.

Principle of Superposition

When a number of charges are interacting, the net force on any one of the charge is the vector sum of forces due to individual charges.

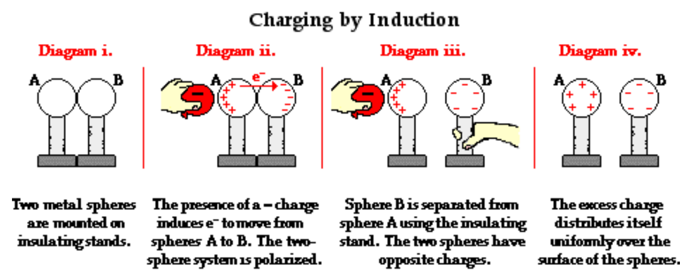
$$\overrightarrow{F_1} = \overrightarrow{F_{12}} + \overrightarrow{F_{13}} + \overrightarrow{F_{14}} + \ldots\ldots$$

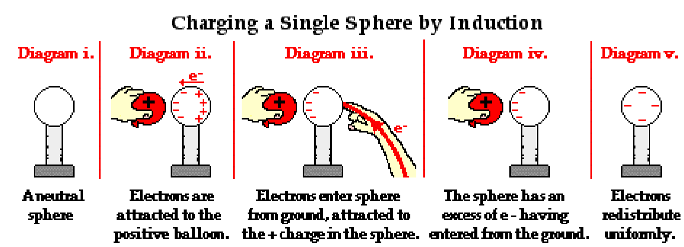
The presence of a third charge does not affect the force between any two charges.

****

Q. How does a charged body attract an uncharged body?

A. Induction precedes attraction. The charged body induces opposite charge at the near end and like charge at the far end. Then the nearby opposite charges attract each other.





Q. Why the special Tyres of aircrafts are made conducting?

Q. Why some chains are hung touching the ground from the metallic body of vehicles carrying inflammable materials?