ELECTROSTATICS

- **Solution Electrostatic force and electrostatic field:**
- * Introduction: when a glass rod is rubbed with silk or an ebonite rod is rubbed with flannel, these acquire a power to attract light bodies such as small pieces of paper. The agency which gives this attracting power is called <u>'electricity</u>'. The bodies which acquire this power are said to be <u>electrified or charged</u>.



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- <u>Electric charge:</u> Electric charge is something possessed by material objects due to which electrical and other related effects are produced.
- * <u>Charging by Induction:</u> A body may be charged by putting it in contact with another charged body either directly or by means of a conductor.

Charging a Single Sphere by Induction



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- Quantisation of electric charge: The fact that all observable charges are always some integral multiples of elementary charge e(= ± 1.6 x 10⁻¹⁹ C) is known as quantisation of charge.
- Any charge q, no matter what is its origin, is given by:

 $q = \pm ne$ where n = 1, 2, 3,

- * A charge q equal to, say, 1.735e or -507.9e or $\sqrt{2e}$ is an impossibility.
- * The total electric charge of a body is equal to the algebraic sum of all the electric charges located anywhere on the body.

<u>CHARGE</u>	<u>MASS</u>
It has an important role in electromagnetism.	It has an important role in gravitation.
It can be positive, negative or zero.	It is always positive.
The electric charge is independent of the velocity of the body.	According to special theory of relativity, the mass of a body increases with the increase in velocity of the body.
Charge is quantised.	Quantisation of mass is yet to be established.
The force between two charges may be attractive or repulsive.	The gravitational force between two masses is always attractive.
It may not exist without mass.	It may exist without any net charge.

* <u>Coulomb's law</u>: The electrostatic force of interaction between two point electric charges is directly proportional to the product of the charges, inversely proportional to the square of the distance between them and along the straight line joining the two charges.





- <u>Electric field:</u> There is a region of space around a charge or a system of charges within which other charged particles experience electrostatic forces. This region is known as an electric field.
- * <u>Electric field strength:</u> The electric field strength at a point in an electric field is the force acting per unit positive test charge placed at that point, without disturbing the source charge or the configuration of source charges producing the electric field.





- * Electric lines of force (Electric field lines):
- An electric line of force is an imaginary straight or curved path along which a positive test charge is supposed to move when free to do so in an electric field.
- **Solution** Electric lines of force are discontinuous.
- Two electric lines of force never cross each other.



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- The lines of force start from positive charge and end on negative charge.
- The lines of force possess longitudinal tension i.e., they tend to contract longitudinally or lengthwise.
- * The lines of force exert lateral pressure on one another, i.e., they tend to repel each other.



* <u>Electric Dipole:</u>

- Electric dipole is a pair of equal and opposite point charges separated by a very small distance.
- The electric field produced by a dipole is known as dipole field.

	$\vec{p} = q\vec{d}$		•
			\Rightarrow
<	d	>	

* Conductors, Capacitance and Dielectrics:

- Introduction: Materials can be broadly put into two categories- conductors and insulators.
- * <u>Conductors</u>: Those substances which easily conduct electricity are called conductors. For example, silver, mercury, aluminium, copper, iron, salt solutions such as copper sulphate solution, human body, earth etc.



- * A conductor contains a large number of free electrons.
- * <u>Insulators:</u> Those substances which do not have free electrons are unable to conduct electricity and are known as insulators. For example, glass, rubber, ebonite, wood, paraffin wax, paper, mica etc.



- When there is no current inside or on the surface of the conductor, then the conductor is said to be in the static situation in which the free charges distribute themselves in such a way that the <u>electrostatic field is zero</u> everywhere inside the conductor.
- Electrostatic field must be normal to the surface of a charged conductor at every point.
- * The interior of a conductor can have no excess charge in the static situation.
- * Electrostatic potential is constant throughout the volume of the conductor and has the same value (as inside) on its surface.

Capacitor and capacitance

Capacitor:



A parallel plate capacitor consists of two conducting plates parallel to each other and separated by a distance which is small compared with the linear dimensions of the plates.

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- A capacitor is used eliminate sparking when a circuit containing inductance is suddenly opened.
- A variable capacitor is one in which the effective area of the plates can be adjusted.
- The capacitance of a conductor is said to be one farad if one coulomb of charge is sufficient to raise its potential through one volt.
- * The capacitance of a parallel plate capacitor is directly proportional to the area of the plates and inversely proportional to their separation.



- * <u>Combination of capacitors:</u>
- An equivalent capacitor is a single capacitor is a single capacitor that has the same capacitance as the actual combination of capacitors.
- Capacitors are said to be connected in series between two points if it is possible to proceed from one point to the other point along only one path.



- When a number of capacitors are connected in series, the reciprocal of the equivalent capacitance equals the sum of the individual capacitances.
- Capacitors are said to be connected in parallel between two points if it is possible to proceed from one point to another point along different paths.



VAN DE GRAAFF GENERATOR

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Section through the Van de Graaff generator.

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