NDA-CDS 1 2025

GS

LIVE

PHYSICS

ELECTRICITY

CLASS 1

NAVJYOTI SIR

SSBCrack
EXAMS

ELECTRICITY - I

(Static Electricity)

WHAT WILL WE STUDY ?

- Charges and Static Electricity
- Coulomb's Law of Electrostatics
- Electric Field
- Electric Potential and Potential Difference
- Capacitance

CHARGE

- Charge is that property of an object by virtue of which it apply electrostatic force of interaction on other objects.
- Charges are of two types (i) Positive charge (ii) Negative charge
- Like charges repel and unlike charges attract each other.

BASIC PROPERTIES OF CHARGE

- **Additivity of Charge**

  If a system consists of n charges $q_1, q_2, q_3 \ldots\ldots\ldots q_n$, then the total charge of the system will be $q_1 + q_2 + q_3 + q_4 + \ldots\ldots + q_n$.

- **Quantisation of Charge :** Charge on any object can be an integer multiple of a smallest charge (e).

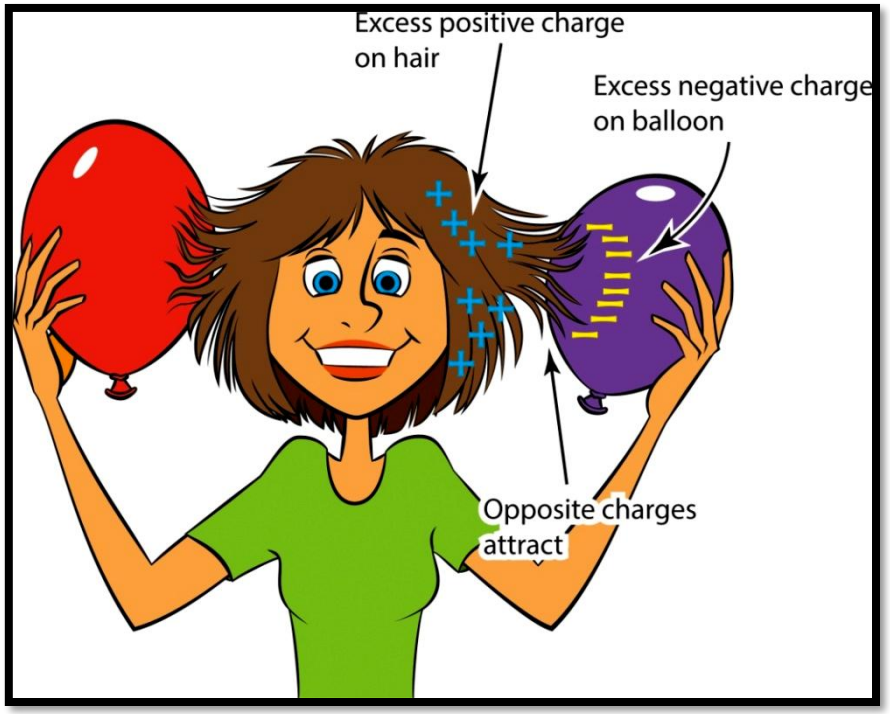
$$Q = \pm ne$$

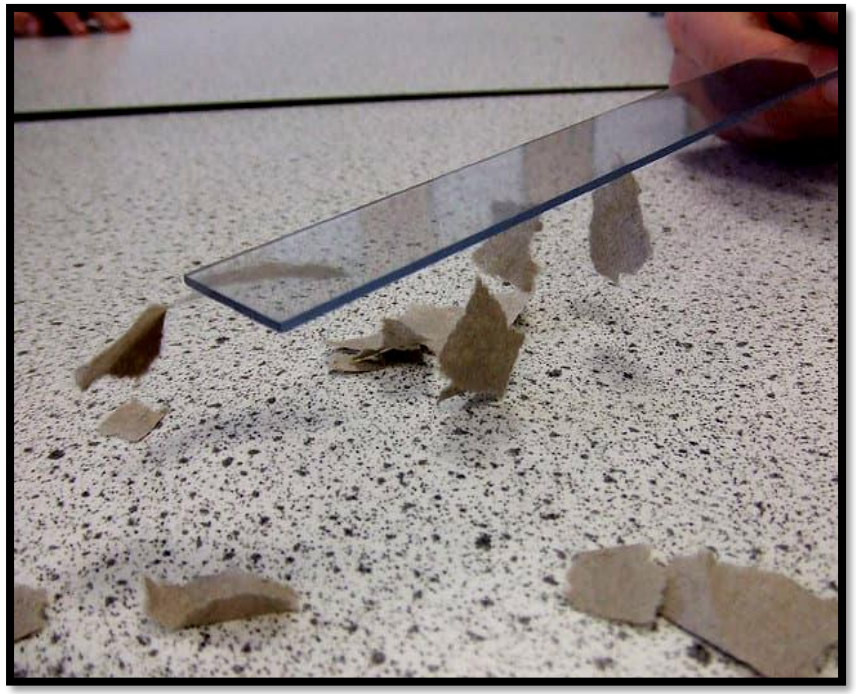
where, $n = 1, 2, 3, \ldots$ and $e = 1.6 \times 10^{-19}$ C.

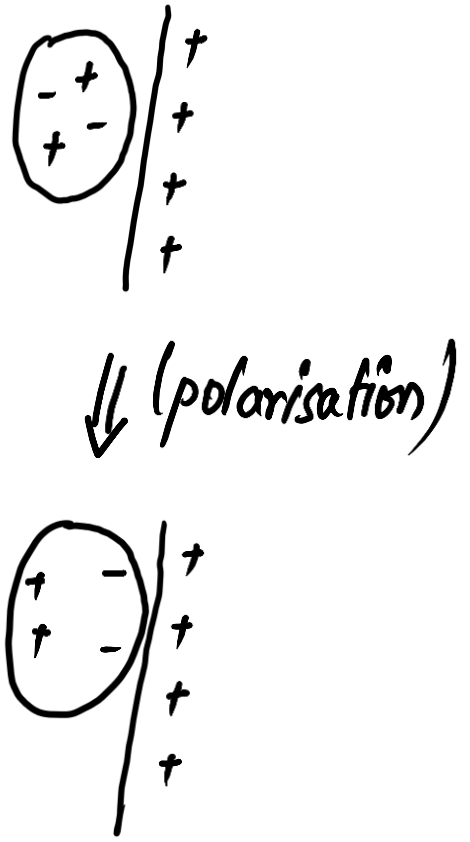
Coulombs (Unit of charge)

- **Conservation of Charge :** Charge can neither be created nor be destroyed but can be transferred from one object to another object.

STATIC ELECTRICITY







- A charged body attracts lighter neutral body.
- During any process, the net electric charge of an isolated system remains constant.

Coulomb's Law

- **The force of interaction between any two-point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.**

Magnitude of electric force,

$$F_e = \frac{K|q_1 q_2|}{r^2}$$

$K = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \ Nm^2C^{-2}$

(depends on medium in which charges are present)

q_1 and q_2 are unlike,

$F_e < 0 \Rightarrow$ attractive force

q_1 and q_2 are like,

$F_e > 0 \Rightarrow$ repulsive force,

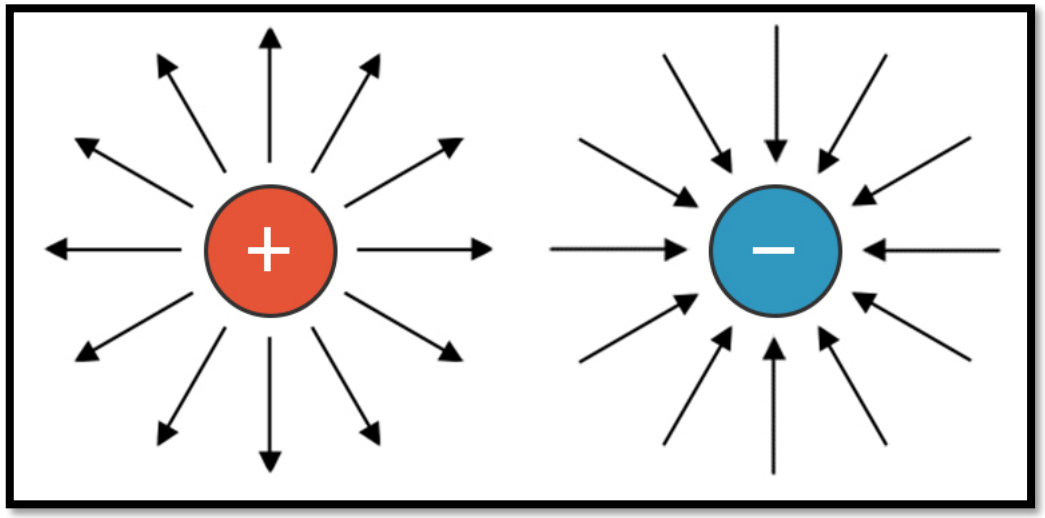
ϵ_0 – permittivity of free space

Electric Field

- The space in the surrounding of any charge in which its influence can be experienced by other charges.

$$\vec{E} = \frac{\vec{F}}{q_0}$$

$q_0 \rightarrow$ unit positive test charge,



- It is a vector quantity, and its direction is in the direction of electrostatic force acting on positive charge.
- Its SI unit is NC^{-1} or V/m. → (volt)/(metre → potential difference,

Properties of Electric Field

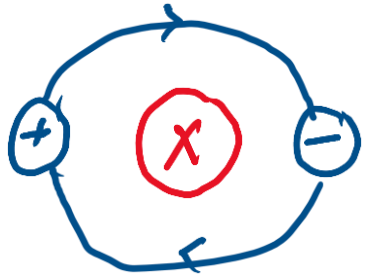
- Electric field lines start from positive charges and end at negative charges. In the case of a single charge, they may start or end at infinity.

- Tangent to any point on electric field lines shows the direction of electric field at that point.

Properties of Electric Field

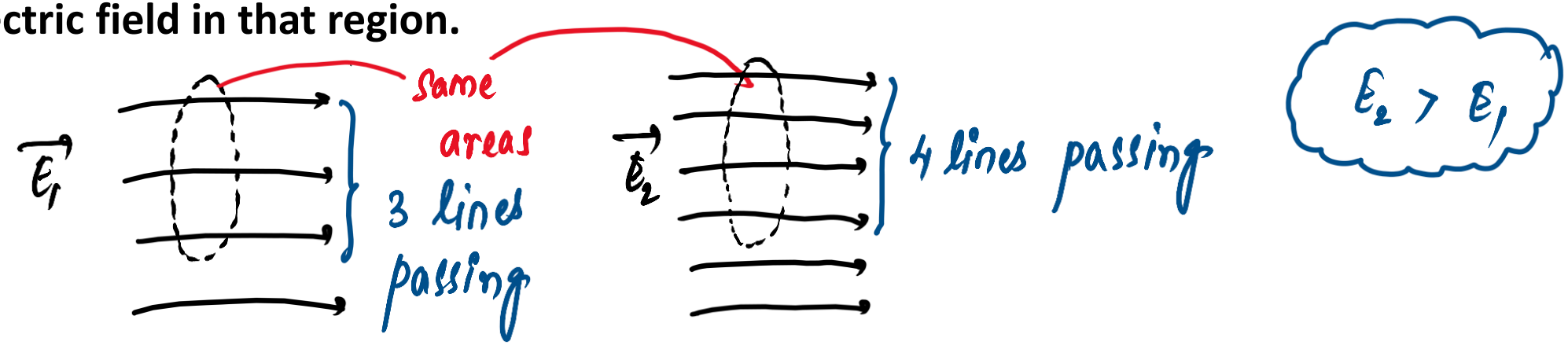
- Two field lines can never intersect each other because, if they intersect, then two tangents drawn at that point will represent two-directions of field at that point, which is not possible.

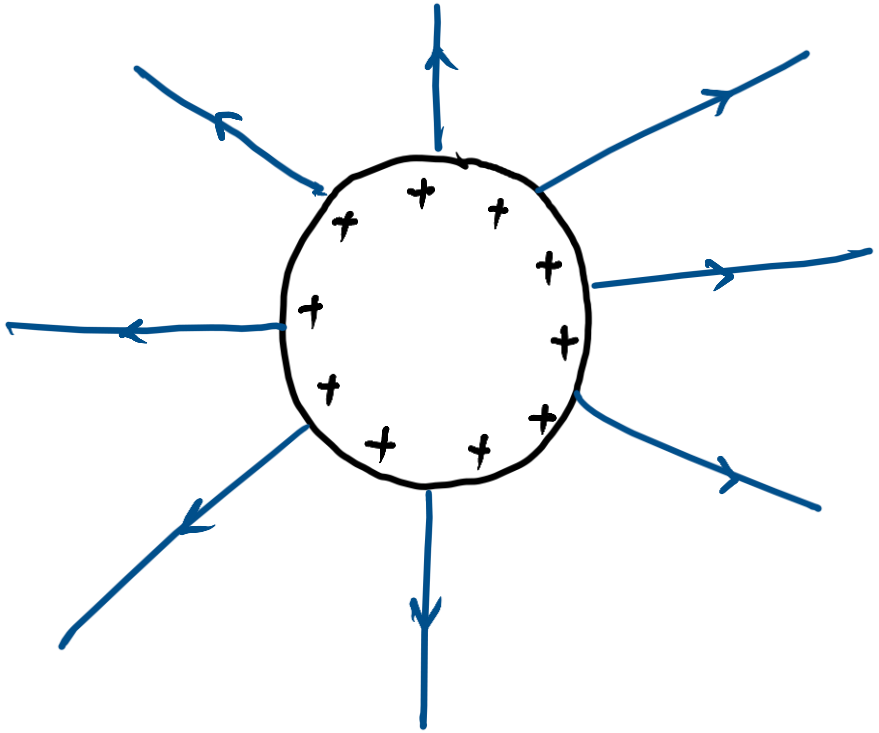
- Electric field lines do not form closed loops (because of conservative nature of electric field).



Properties of Electric Field

- The number ΔN of lines per unit cross-sectional area ΔA perpendicular to the field lines (i.e. density of lines of force) is directly proportional to the magnitude of the intensity of electric field in that region.





(Electric field lines)

(spherically charged conductor)

Electric field direction is always perpendicular from a surface.

ELECTRIC POTENTIAL

- Electric potential at any point is equal to the work done per unit positive charge in carrying it from infinity to that point in electric field.

$$V = \frac{W}{q}$$

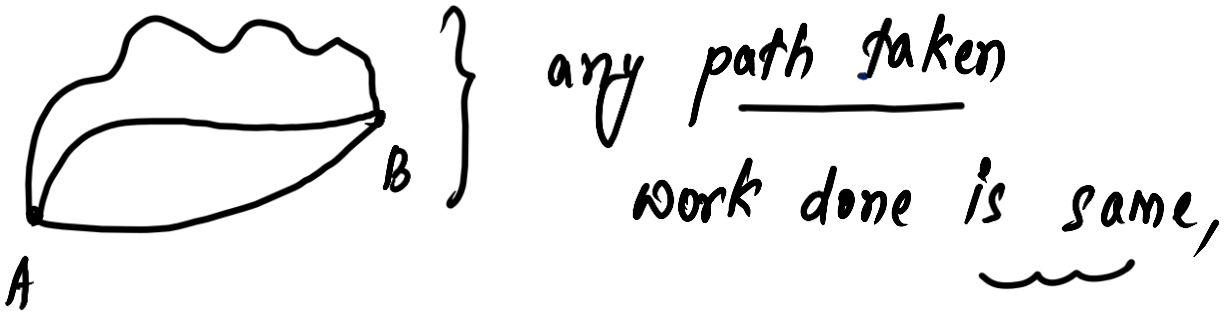
→ $\frac{\text{Work done}}{\text{Charge}}$

- It is a scalar quantity. Its SI unit is J/C or volt.

POTENTIAL DIFFERENCE

- **The potential difference between two points A and B is equal to the work done by the external force in moving a unit positive charge against the electrostatic force from point B to A along any path between these two points.**

$$\Delta V = \frac{W_{AB}}{q}$$



ELECTRIC POTENTIAL ENERGY

- **Electric potential energy is a potential energy that results from conservative coulomb forces.**

$$U = \frac{k q_1 q_2}{r}$$

CONDUCTORS

- **Conductors are the materials through which electric charge can flow easily. Most of the metals are conductors of electric charge. Silver is the best conductor of electric charge.**

→ free electrons are responsible.

Electrically not neutral.

INSULATORS

- Insulators are the materials through which electric charge cannot flow, glass, rubber, wood etc.

→ bounded electrons → electrically neutral.

- Insulators are also called dielectrics, when an electric field is applied, induced charges appear on the surface of the dielectric. Hence, it can be said that dielectric are the insulating materials which transit electric effect without conducting.

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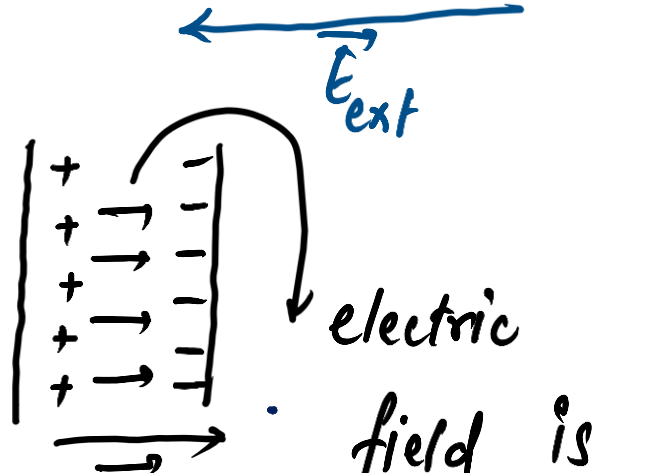


CAPACITANCE

- **Capacitance of a conductor is the amount of charge needed in order to raise the potential of the conductor by unity.**

$$\text{Capacitance} = \frac{\text{Charge}}{\text{Potential difference}} = \frac{Q}{V}$$

- **Electrical capacitance is a scalar. SI unit of capacitance is 1 farad (1F).**

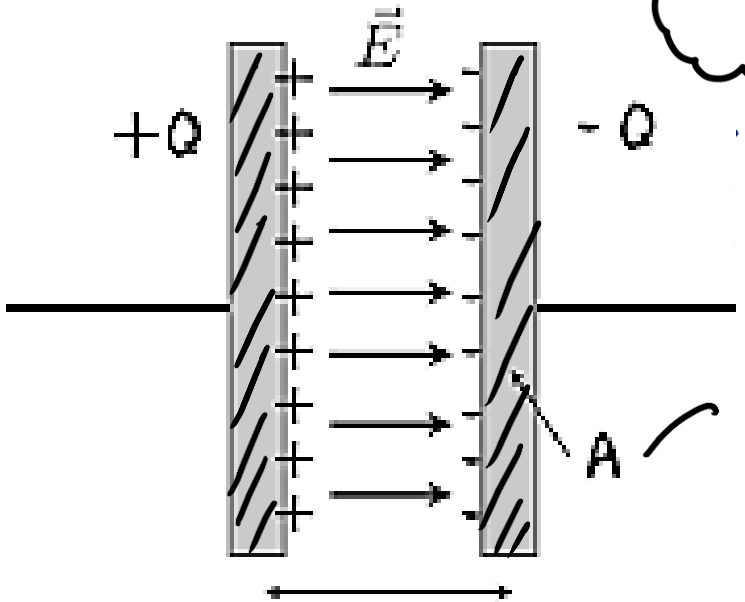
Coulomb (volt)$^{-1}$

micro-farad $\rightarrow$ $\mu F = 10^{-6} F$

CAPACITOR

- A capacitor is a device which stores electrostatic energy. (charges)
- Net charge on a capacitor is zero. However, ordinarily we talk in terms of charge on either plate of a capacitor and that is finite.

$$E = \frac{Q}{A\varepsilon_0}$$



A → Area of each plate

S → distance between plates

Energy on a capacitor = $\frac{1}{2}CV^2$ / $\frac{Q^2}{2C}$ / $\frac{1}{2}QV$

SUMMARY

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