TREND

WRITERS

CHAPTER - 1

Electric Charge and field -

1. Electricity - Electricity is the energy due to which substance have the property of attracting the light bodies.

2. Charge bodies - ~~the~~ bodies which have the property of attracting the light bodies are said to be charged or Electrified.

3. Static Electricity - If the electricity so produced is keept stationary. it is called static electricity.

4. fractional Electricity - The Electricity produced on rubbing ~~the~~ the two objects which Each other is called frictional electricity.

5. Charge - It is physical property of metter that cause ~~property~~ of it to express force when place in electromagnatic field.
S.I unit of charge is coulomb It is denoted by c.
The value of charge - 1.6×10^{-23} C.

Charge are two kinds -

1. Positive charge - when glass rod rubbed with silk charge on glass rod is called positive charge.
The ~~bodies~~ body which losses Electron to the another body becomes positive charge.

2. Negative charge - The body which gains electrons from other body becomes negatively charge.
when Ebonite rod ruffed with furr the charge on ebonite rod is called negative charge.

Conductor - Materials that allow electricity to pass through them are called Conductor they have large number of free electricity.

Ex - Silver, copper, aluminium, human body.

Materials that do not allow electricity to pass through them are called insulator they have very small no. of free electrons.
Ex - wood, rubber, glass, ebonite..

• Method of charging -

1. By conduction - In charging by conduction if charge body is touched within uncharged body so that the uncharged body get same kind of charge from the charged body by sharing on separation of two body they have same kind of charge.

2. By Induction - In the process of ~~induct~~ Induction an opposite charge is induce on the nearer end the similar charge on the further end of uncharged conductor. In the presence of a charge body near by it thus in electrostatic gained by the charged body but separation of charges take place.

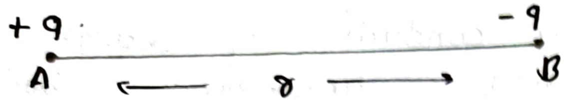
Conservation of charge - The charge can neither be created nor it can destroyed this is the law of conservation of charge.
Ex - when a glass rod is rubbed with silk the amount of positive charge gain by the glass rod is equal to the amount of negative charge gain by the silk.

Quantization of charge - Quantization of charge states that the charge on ~~the~~ a body is an integral or adject multiple of the elementary charge.

$Q = \pm Ne$ where $N = 1, 2, 3, 4$

thus on a charged body total charge can be $\pm e$, $\pm 2e$, $\pm 3e$ nobody can have a charge $1.5e$ or $0.9e$, $-1.2e$.

Coulomb's law - The force of attraction of charges is proportional between two point to the product of the magnitude of two charges & inversely proportional to the square of the distance between them.



$F \propto q_1 q_2$ —(I)

$F \propto \frac{1}{r^2}$ — (II)

by eq (I) and (II)

$F \propto \frac{q_1 q_2}{r^2}$

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

$F = \frac{1}{4\pi \varepsilon_0} \frac{q_1 q_2}{r^2}$

$F = 9 \times 10^9 \frac{q_1 q_2}{r^2}$ newton.

Unit Charge - If the force of attraction or repulsion between two point charge is 9×10^9 and 1 m is the distance between them than the charge is called unit charge.

$F = 9 \times 10^9$ N/m², $q_1 q_2 = q$, $r = 1$ m

$9 \times 10^9 = 9 \times 10^9 \frac{q_1 q_2}{1^2}$

$q^2 = 1$

$q = \pm 1$

Limitation of Coulombs law -

It is true only for points charge

This is to for charges at rest.

This is to for long rang distance.

Compare Electrostatic and Gravitational force.

Electrostatic

- It is active even in vacuum.
- It obeys the inverse square law.
- It is conservative.
- It is central force.

Dissimilarities -

- It is much stronger.
- It is affected by the presence of medium.

Gravitational

- It is active even in vacuum.
- It obeys the inverse square law.
- It is conservative.
- It is central force.
- It is not stronger.
- It is unaffected by the presence of medium.

Permittivity - The ability of a substance to store electrical energy in a electric field.

Electric field - The region around an electric charge in which the electric charge in which the electric effect can be experienced is called the electric field.

Intensity of electric field - The force acting on a unit positive charge placed at any point in electric field. It is a vector quantity.

Electric field due to point charge

$\vec{E} = \frac{\vec{F}}{q_0}$ charge $F = \frac{1}{4\pi\epsilon_0} \frac{q\,q_0}{r^2}$

[illegible]

Electric field strength

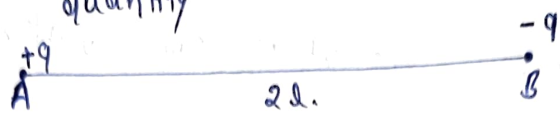
$E = \frac{F}{q_0}$

[illegible]

$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r^2}$ [illegible]

Electric dipole - If there are two equal but opp[illegible] charge at a small distance this system is called an electric dipole.

Dipole movement - The product of value of either charge and distance between of two charges is called dipole momvement. It is denoted by p. It is a vectors quantity.



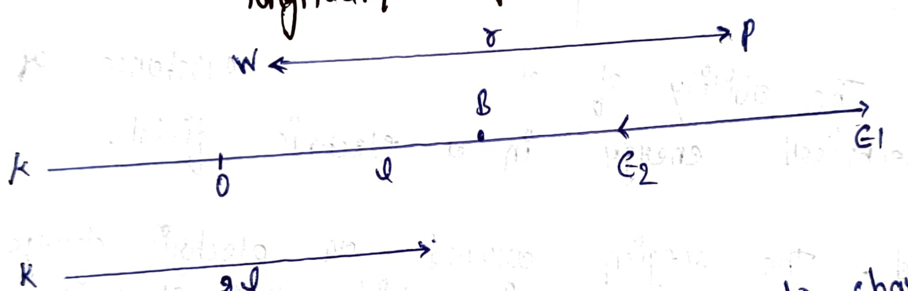
$p = q \times 2l$

S.I. unit = C X M

D.F = $[M^0 L^1 T^1 A^2]$

Ex- H_2O, NH_3, HCL etc.

- Electric field due to an electric dipole in end on position
  Case longitudinal position.



Electric field intensity at the point p due to charge +q

$E_1 = \frac{1}{4\pi \varepsilon_0 K} \frac{q}{BP^2}$ [K = 1]

$E_1 = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-l)^2}$

Electric field intensity at the point p due to charge -q

$E_2 = \frac{1}{4\pi \varepsilon_0 K} \frac{q}{AP^2}$

$E_2 = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+l)^2}$

Total Electric field intensity.

$E = E_1 - E_2$

$= \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-l)^2} - \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+l)^2}$

$$= \frac{q}{4\pi \varepsilon_0} \left[\frac{1}{(r-l)^2} - \frac{1}{(r+l)^2} \right]$$

$$= \frac{q}{4\pi \varepsilon_0} \left[\frac{(r+l)^2 - (r-l)^2}{(r^2-l^2)^2} \right]$$

$$= \frac{q}{4\pi \varepsilon_0} \left[\frac{r^2 + l^2 + 2rl - (r^2 + l^2 + 2rl)}{(r^2 - l^2)^2} \right]$$

$$= \frac{q}{4\pi \varepsilon_0} \left[\frac{r^2 + l^2 + 2rl - r^2 - l^2 + 2rl}{(r^2 - l^2)^2} \right]$$

$$= \frac{q}{4\pi \varepsilon_0} \frac{4rl}{(r^2 - l^2)^2}$$

$$= \frac{1}{4\pi \varepsilon_0} \frac{4qrl}{(r^2 - l^2)^2}$$

$$= \frac{1}{4\pi \varepsilon_0} \frac{2r \cdot 2ql}{(r^2 - l^2)^2}$$

$$= \frac{1}{4\pi \varepsilon_0} \frac{2pr}{(r^2 - l^2)^2}$$

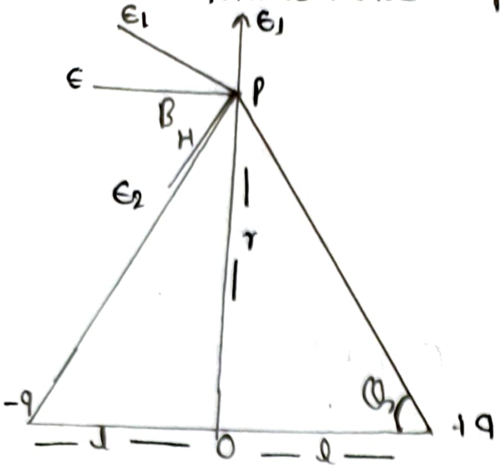
$= d <<< r$

$$= \frac{1}{4\pi \varepsilon_0} \frac{2pr}{(r^2)^2}$$

$$E = \frac{1}{4\pi \varepsilon_0} \frac{2pr}{r^4}$$

$$E = \frac{1}{4\pi \varepsilon_0} \frac{2p}{r^3} \quad N/C$$

Electric field due to a dipole in broad side on or transverse position.



P —— +q

$E_1 = \frac{1}{4\pi\varepsilon_0 k} \frac{q}{BP^2}$ [k = 1]

$E_2 = \frac{1}{4\pi\varepsilon_0 k} \frac{q}{AP^2}$ (k = 1)

$AP^2 = BP^2 = r^2 + l^2$

$AP = BP = \sqrt{r^2 + l^2}$

$E = E_1 \cos\theta = E_2 \cos\theta$

$\cos\theta = \frac{B}{H} = \frac{l}{\sqrt{r^2+l^2}}$

∵ $[E_1 = E_2]$ AP = BP

$E = E_1 \cos\theta + E_1 \cos\theta$

$= 2E_1 \cos\theta$

$= 2 \times \frac{1}{4\pi\varepsilon_0} = \frac{q}{(r^2+l^2)} \cdot \frac{l}{\sqrt{r^2+l^2}}$

$= 2 \frac{1}{4\pi\varepsilon_0} \frac{ql}{(r^2+l^2)(r^2+l^2)^{1/2}}$

$= 2 \frac{1}{4\pi\varepsilon_0} \frac{2ql}{(r^2+l^2)^{3/2}}$

$= \frac{1}{4\pi\varepsilon_0} \frac{p}{(r^2+l^2)^{3/4}}$

$l <<< r$

$= \frac{1}{4\pi\varepsilon_0} \frac{p}{(r^2)^{3/2}}$

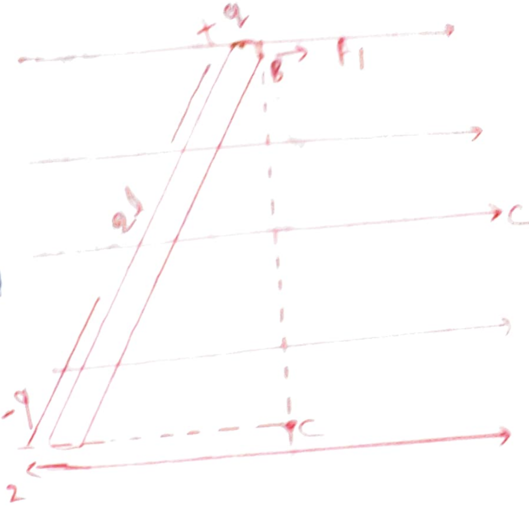
$= \frac{1}{4\pi\varepsilon_0} \frac{p}{r^3}$

3. force and Torque on a Dipole in a uniform electric field -

τ = one force × perpendicular distance between two forces

$= qE \times BC$

$F = qE$



$\frac{P}{H} = \sin\theta$

$\frac{BC}{2l} = \sin\theta \Rightarrow BC = 2l\sin\theta$

$\tau = qE \times 2l \sin\theta$

$\tau = PE \sin\theta.$

a. work done in turning a dipole -

$\tau = PE\sin\theta$

dipole $\rightarrow 0° \rightarrow \theta$

$W = \int_0^\theta PE \sin\theta \, d\theta$

$W = PE_1 \int_0^\theta \sin\theta \, d\theta$

* work done in turning a dipole in an electric fi-

$W = PE[-\cos\theta]_0^\theta$

$W = PE[-\cos\theta - (-\cos]$

$W = PE[-\cos\theta + 1]$

$W = PE[1 - \cos\theta]$

Cause (1) $\theta = 90°$

$W = PE(1 - \cos 90) = PE$

$(1-1) = 0$

Cause (2) $\theta = 180°$

$W = PE[1 - \cos 180°] = PE[1 - (-1)]$

$= 2PE.$

Potential energy of dipole - $\angle \theta = \pi/2 \to \theta$

$\tau = pE \sin\theta$

$dw = \tau\, d\theta$

$= pE \sin\theta\, d\theta$

$w = \int_{\pi/2}^{\theta} pE \sin\theta\, d\theta$

$U = pE \int_{\pi/2}^{\theta} \sin\theta\, d\theta$

$= pE [-\cos\theta]_{\pi/2}^{\theta}$

$= pE [-\cos\theta - (-\cos\pi/2)]$

$= pE [-\cos\theta + 1]$

$= pE [1 - \cos\theta]$

Causes (1)

$\theta = 90°$

$U = pE [1 - \cos 90°]$

$pE [1 - 1]$

$= 0$

Causes (2)

$\theta = 180°$

$U = pE [1 - \cos 180]$

$= pE [1 - (-1)]$

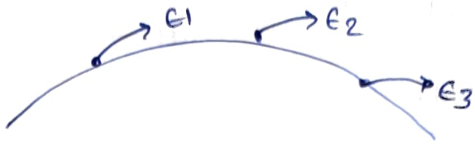
$= 2pE$

1. Linear charge density - If the charge is distributed continuously on a linear conductor the charge on its unit length is called the linear charge density. It is expressed by the letter λ. Its unit is $\frac{\text{Coulomb}}{\text{meter}}$ $\frac{C}{m}$

2. Surface charge density - If charge is distributed on the surface of the conductor then charge on unit area of conductor is called the ~~If~~ It is denoted by sigma.

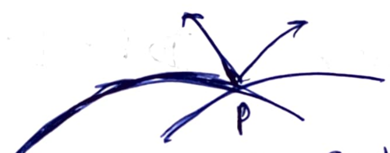
3. Volume charge density - If the charge is distributed over the entire volume of a conductor the charge is unit volume of conductor charge is unit volume of conductor is called volume charge density. It is denoted by ρ (roh). Its unit is $\frac{\text{Coulomb}}{\text{meter}^3}$ $\frac{C}{m^3}$

Electric field lines - An imaginary linear or curv draw from a point of an Electric field such that tangents to it gives the direction of the Electric field at that point.



Properties -

- They are started from positive charge to ne. charge.
- They are the open curves.
- They are not present inside the conductor.
- They are always normal to the charge surface.
- They do not intersect each other.



If two field lines intersect each other which will represent two direction of Electric field at that point which is impossible.

Difference between electric & magnatic field lines -

~~Electric~~ Electric flux - The total number of Electric field line passing through a surface in an Electric is called Electric flux. It is denoted by the latter ϕ. It is scalar quantity. It can be positive, negative, zero.

Electric field lines	Magnatic field lines.
These are the open curves.	These are the closed curves.
They are always to the charged surface.	They are not essentially normal to the surface of magnet but they can be in any direction.
They are not present inside the conductor.	They are present inside the magnet also.

dQ

$$\int d\phi = \int \vec{E} \cdot \vec{ds}$$

$$E = \frac{f}{q}$$

$$\phi = E \cdot ds \cos\theta$$

$$\phi = E \cdot ds$$

$$\phi \cdot \theta = 0^\circ$$
$$= 0$$

2. $\theta = 90^\circ$

$$\phi = 0$$

$$\theta = E \cdot ds$$

$$\frac{N}{C} \times m^2$$

S.I. Unit $= Nm^2/C$

$$Df = [ML^3T^{-3}A^{-1}]$$

Gauss Law -

$$\phi_E = \frac{Q}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$$

$$d\phi = \vec{E} \cdot \vec{ds}$$

$$\int d\phi = \int \frac{1}{4\pi\varepsilon_0} \frac{-Q}{r^2} ds$$

$$\phi = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} \int ds$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} 4\pi r^2$$

$$= \phi_E = \frac{Q}{\varepsilon_0}$$

By the gauss theorem coulomb inverse square law -

$$\phi = \int E \cdot ds$$

$$= E \int ds$$

$$= E \cdot 4\pi r^2 \quad \text{--- (I)}$$

By Gauss law

$$\phi = \frac{Q}{\varepsilon_0} \quad \text{--- (II)}$$

by Eq (I) & (II)

$$E \cdot 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$$

$$E = \frac{F}{q}$$

$$F = E \cdot q$$

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Q \cdot q}{r^2}$$

Write Electric field intensity due to uniformly charged thin spherical shell.

$$\phi = \int E ds$$

$$= E \int ds$$

$$= E \cdot 4\pi x^2 \quad \text{--- (I)}$$

$$\phi = \frac{q}{\varepsilon_0} \quad \text{--- (II)}$$

By eq (I) & (II)

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{x^2} \quad N/C$$

Cause - (1)

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

Cause - (2)

$$E = \frac{1}{4\pi\varepsilon_0} \frac{0}{r^2}$$

$$E = 0.$$

Electronic theory of origin of charge

Conductor

- A conductor allow current flow Easily through it.
- Electronic charge exists on the Surface of Conductor
- The resistance of Conductor is very low
- The thermal Conductivity (heat allowance) of a conductor is very high.
- Copper, aluminium and mercury are some conductors.
- Electrons move freely within the Conductor.

Insulator.

- Insulator don't's allow current to flow through it.
- Electronic charges are absent in insulator.
- The ristance of insulator is very high.
- The thermal conductivity of an insulator is very low.
- wood, paper, and ceramic are some Insulators.
- Electrons do not move freely within the insulator.