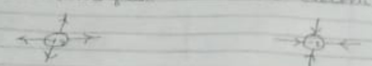
Topic Summary about electric flux

Unit in S.I. std = $\frac{N}{C} m^2$ — ELECTRIC FLUX — Formula $\phi = \vec{E} \cdot \vec{dS}$, $\phi = E\, ds \cos\theta$

+ve electric flux — -ve electric flux



Topic Dipole :

Electric Dipole A System of two equal and opposite charges which are placed very close to each other is called electric dipole

$+q$ $\vec{P}$ $-q$

$2l$

Example - ① Nature all atoms

② H_2O, HCl, NH_3

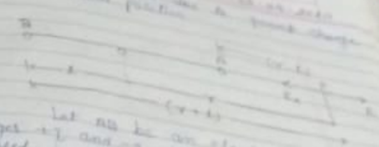
Electric Dipole Moment

Electric dipole is equal to the product of magnitude of any one charge dipole and the distance b/w the two charges

$\vec{P} = q \cdot 2\vec{l}$

S.I Unit ⇒ Coulomb × meter

Intensity of electric field due to electric dipole at end-on / axial position



Let AB be an electric dipole consisting of charges +q and -q which are 2l distance apart and placed in a medium of dielectric constant ϵ_r

We have to determine the electric field intensity at point P at a distance r from O of the dipole

Field intensity due to +q at charge P is

$$E_1 = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{q}{(AP)^2} \quad (\text{along } \vec{AP})$$

or

$$E_1 = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{q}{(r-l)^2}$$

Similarly field Intensity E_2 due to charge $-q$ at point is

$$E_2 = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{-q}{(BP)^2} \quad (\text{along } \vec{BP})$$

$$E_2 = \frac{1}{4\pi\epsilon_0\epsilon_r} \frac{-q}{(r+l)^2} \quad (\text{along } \vec{BP})$$

But E_1 and E_2 act along the same line of action and $E_1 > E_2$.

Hence the net field is

$$|\vec{E}| = |\vec{E_1}| - |\vec{E_2}|$$

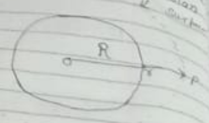
$$E = E_1 - E_2 \quad (\text{along } \vec{AP})$$

Topic: Application of Gauss' law

- Field due to a uniformly charged thin Spherical shell at point ① out side ② Inside ③ at the Center

Let σ be the uniform Surface charge density of a thin Spherical Shell of Radius R the field at any point P outside or inside Gaussian Surface

① Field outside the shell



Consider a point P outside the shell with radius r ~~to~~ To Calculate E at P we take the Gaussian Surface to be a Sphere of radius r and with Center O passing through P The electric field at each point of the Gaussian Surface electric flux passing through this Surface is

$$\phi = \int E\, dS \cos 0^\circ$$

$$= E \int dS$$

$$\phi = E \times 4\pi r^2 \quad -①$$

By Gauss law

$$\phi = \frac{1}{\varepsilon_0} \times q \quad -②$$

From eq ① and eq ②

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

$$\boxed{E = \frac{1}{4\pi\varepsilon_0} \times q/r^2} \text{ Ans} \quad -③$$

(ii) Field on the Surface

In this Case r = R put in eq ③

$$\boxed{E = \frac{1}{4\pi\varepsilon_0} \times q/R^2}$$

(iii) Field inside Surface

In this case there is no charge Inside the sphere

$$\therefore q = 0$$

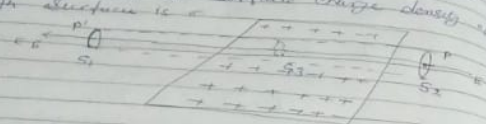
$$\boxed{E = 0}$$

*

(4)

Topic: Intensity of electric field due to infinite plane sheet of charge

Imagine a charged sheet of infinite expansion on which the surface charge density at its both surface is σ



By symmetric it is clear that the direction of E F due to charged plane sheet will be outward's and ⊥ to the both surface

Consider a point P at distance r apart from the sheet at which the intensity of electric F is to be obtained.

Now construct a cylinder by taking PP' as its axis across the plane sheet

Let the area of its circular surface is A then the cylinder will be acts as a Gaussian surface

The net charge present inside the Gaussian surface be

$$q = \sigma A$$

Since surface S_3 is ∥ to E i.e. $\phi_{S_3} = 0$

The net flux linked with the surface S_1 and S_2

$$\phi_E = \phi_{S_1} + \phi_{S_2}$$

$$= EA + EA$$

$$= 2EA \quad \text{--- (1)}$$

But according Gauss Th

$$\phi_E = \frac{q}{\varepsilon_0} = q/\varepsilon_0 \quad \text{--- (2)}$$

From eqns (1) and eqn's (2)

$$2EA = q/\varepsilon_0$$

$$E = \frac{1}{2A} \times \frac{q}{\varepsilon_0}$$

But $q = \sigma A$

$$E = \frac{1}{2\cancel{A}} \times \frac{\sigma \cancel{A}}{\varepsilon_0}$$

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$