Chapter#21 (Razdaan)

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بتا دیتے ہو سب کو

Coulombs Law: → point charges → stationary charges

- lose electrons → becomes positively charged
- when we rub glass rod (or anyother) they (it) loses electrons and become positively charged.
- F = +ve (repulsive) | F = −ve (attraction)

Conductors: → materials in which significant number of electrons are free to move. e.g. metals

Insulators: → electrons are not free to move. e.g rubber, plastic, glass

Semi-conductors: → materials that are intermediate b/w conductors & insulators. e.g. silicon, germanium (in comp. chips).

Super-conductors: → materials that are perfect conductors, allowing charge to move without any hindrance.

mobile electrons = conduction electrons

Coulomb's Law: $\vec{F} = k\dfrac{|q_1||q_2|}{r^2}\hat{r} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{|q_1||q_2|}{r^2}\hat{r}$

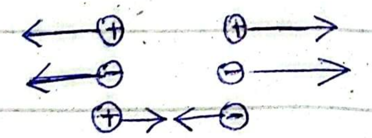
$k = 9 \times 10^{9}\ N.m^2/C^2$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$

$|q_1|.|q_2|$ = product of magnitude of charges

if $q_1 = -e$ we will take $q_1 = e$ in collombs Law (i.e only positive)

- if multiple electrostatic forces act on a particle, then net force is the vector sum (not the scalar sum) of individual forces. → $\vec{F}_{net} = \vec{F}_{12} + \cdots \vec{F}_{1n}$
  → $\vec{F}_{net} = \vec{F}_{12} + \vec{F}_{13} + \vec{F}_{14} + \vec{F}_{15} + \cdots + \vec{F}_{1n}$
- always draw force vector with tail on particle.



- Gravitational force = alway attractive force
- Electrostatic force = may be either attractive or repulsive depending upon signs of charges.
- $I = \dfrac{\Delta Q}{\Delta t}$

Shell theory →
- charge particle outside shell with charge uniformly distributed on its surface is attracted or repelleled.
- charge particle inside shell with charge uniformly distributed on its surface has no net force acting ~~due~~ on it due to shell.

Charge is Quantized:

$$q = ne,\quad Q = ne \quad \rightarrow n = \pm 1, \pm 2, \ldots$$

→ $e = 1.602 \times 10^{-19}\ C$

Particle	Charge
Electron	$-e$
Proton	$+e$
Neutron	0

- $q_{total} = q_A + q_B$
- when two identical spheres touch each other, charge redistributes equally.
- equilateral triangle $= 60^\circ$

Conservation of Charge:
↳ net charge of any isolated system is conserved.

- When charges appart:

Then $F = \frac{k|q_1 q_2|}{r^2}$

- When charges touch and the separate:

then charge redistributes equally.

→ $F = \frac{k\left|\left(\frac{q_1+q_2}{2}\right)\left(\frac{q_1+q_2}{2}\right)\right|}{r^2}$ → charges addition mean with sign then بعد میں magnitude of charges کرنا

$\left.\begin{matrix} +q \\ -q \end{matrix}\right\} \to +, -$ سے pata lagta k ya attract ہو ga repel

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- e is elementary charge.
- $Q = ne$
  - ↳ When finding n → n cannot be -ve
  - → when finding Q → Q can be -ve
  - → Q → +ve only in Coulombs force.
  - ↳ Q is -ve or +ve depends on that the particle is proton or electron.
    - ↳ electron → -ve
    - proton → +ve

Electric Field:

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

- Electric field vector → must be tangent to the field lines
- closer spacing = large magnitude of E·F and vice versa.

E·F due to charged particle:

↳ $\vec{E} = \frac{k|q|}{r^2} \cdot \hat{r}$

Enet is the vector sum (vector sum) of individual electric fields.

Electric field due to dipole:

Electric dipole consists of two equal & opposite charges i.e

$+q$ & $-q$

separated by small distance $2a$ or simply d.

a = distance from center of charge to dipole centre

d = full separation b/w charges.

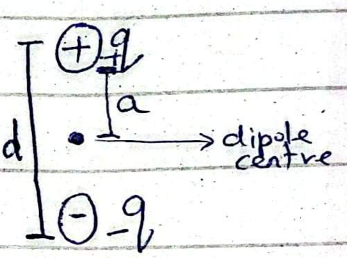
Dipole moment:

$$\vec{P} = q \times 2a$$

OR

$$\vec{P} = q \times d \checkmark$$

Concepts:



now E·F due to dipole:

$$E = \frac{1}{2\pi\epsilon_0} \cdot \frac{qd}{z^3} \quad \left(\begin{matrix} 2a = d \\ d = 2a \end{matrix}\right)$$

OR

$$E = \frac{1}{2\pi\epsilon_0} \cdot \frac{P}{z^3} \quad (\because P = qd)$$

z = distance b/w point & dipole centre

d = full separation b/w $+q$ & $-q$.

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{2P}{z^3} = k\frac{2P}{z^3} \checkmark$$

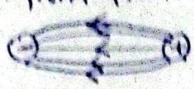
Derived by

$E = \frac{kq}{(z-(\frac{1}{2}d))^2} + \frac{kq}{(z+(\frac{1}{2}d))^2}$ $\quad E = k\frac{2qd}{z^3} \checkmark$

- Force on a point charge in an E·F:

$\boxed{F = qE}$

⊙ E·F direction
↳ from +ve to −ve

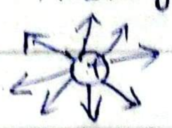


Area of cylinder $= 2\pi r L$

$E = \dfrac{\lambda}{2\pi\varepsilon_0 r L}$

⊙ unit vector notation aa jaye tu means x & y components nikalna hain

E·F Lines (+ve)
↳ radially outward



rank 17

0 16+16+32

E·F Lines (−ve)
↳ radially inward.

⊙ Electric field formulas for thin uniformly charged spherical shell. (Hollow sphere)

$r \rightarrow$ distance from center of sphere/shell to the point where E·F is to be measured (radius of gaussian surface)

$R \rightarrow$ radius of charged sphere/shell

$q(Q) \rightarrow$ Total charge enclosed on the sphere/shell

(i) $r < R \rightarrow E = 0$ (if no charge) ; if $q_{enclosed}$: $\dfrac{qr}{4\pi\varepsilon_0 R^3}$

(ii) $r \gtrsim R \rightarrow \dfrac{k\,q_{enclosed}}{r^2} = \dfrac{k\,q_{enclosed}}{R^2}$ } → for → to find E·F on the surface
↳ when r is slightly greater than R.

(iii) $r > R \rightarrow \dfrac{k\,q_{enclosed}}{r^2}$

⊙ $Q_{enclosed}$ → for 2D sphere → surface charge density.

↳ $\sigma = \dfrac{Q_{enclosed}}{A}$

$Q_{enclosed} = \sigma A$

⊙ Area → circle → πr^2
→ sphere → $4\pi r^2$
↳ cylinder →

Gauss law

$\hookrightarrow \phi = \dfrac{q_{enclosed}}{\varepsilon_0}$

$$\int E \cdot dA = \frac{q_{enclosed}}{\varepsilon_0}$$

$$E \int dA = \frac{\sigma A}{\varepsilon_0}$$

$$E \cancel{A} = \frac{\sigma \cancel{A}}{\varepsilon_0}$$

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

<u>Electric flux:</u>

$$\phi_e = \vec{E} \cdot \Delta\vec{A}$$

$$= EA\cos\theta$$

$\hookrightarrow$ angle b/w E & normal of Area

<u>Dipole</u>

$$p = qd$$

$$E_{net} = E_2 - E_1$$

$$= \frac{kq}{\left(z - \frac{d}{2}\right)^2} - \frac{kq}{\left(z + \frac{d}{2}\right)^2}$$

اس فارمولے سے dipole والے کا

فارمولا بنا ہے۔

Gauss's Law کے derivations کر laina uska notes nahi banaye maina.