UNIT-01

(A) Electrostatic

Electrostatic :-

It is the branch of physics which deals with charge which is at rest.

i.e Pure Electrostatic.

→ Charge is at rest ⟶ displacement = 0

Velocity = 0

accl^n = 0

Charge :—

→ Charge is the fundamental characteristics property of elementary particles of matter.

→ Charge is a scalar quantity.

→ It may be +ve, or −ve or zero.

→ Charge is quantized in nature.

→ Charge is conserved quantity.

~~Coulomb's law~~

→ Two like charges repel eachother.

→ Two unlike charges attract eachother.

SI unit :— Coulomb.

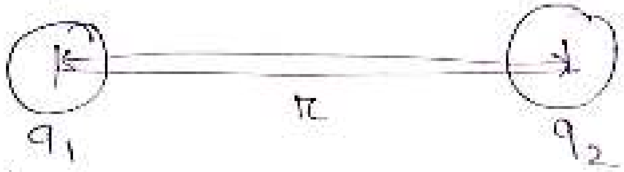
CGS — Stat Coulomb.

$$\boxed{1\,C = 3\times10^{9}\,st\cdot C}$$

Coulomb's law —

— According to Coulomb's law the magnitude of electrostatic force of attraction or repulsion between two charges are directly proporsnal to the product of the magnitude of charges and inversely proparsnal to the square of the distance between them.

i.e (explanation) :—



let $|\vec{F}|$ be the magnitude of electrostatic force. let q_1 and q_2 be the two charges separated by distance r.

$$F \propto q_1 q_2 \quad \text{—— (1)}$$

$$F \propto \frac{1}{r^2} \quad \text{—— (2)}$$

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

$$\Rightarrow \boxed{F = K\frac{q_1 q_2}{r^2}} \quad \text{—— (3)}$$

K = proparsnality Constant.

07 → Coulomb's law is only true for point charge.

Facts about Coulomb's interaction :—

→ Applicable for point charge only

→ Coulomb's force between two charges is mutual interaction.

→ It is applicable only when charge is at rest.

→ Coulomb's force is independent from ~~any~~ presence of any other charge present in the neighbourhood of two charges.

→ The direction of force depends upon the relative orientation of charge.

→ It is a central force.

→ It is conservative in nature.

→ It depends upon magnitude & distance betwe[en] two charges.

→ It depends upon nature of medium.

Now K.

① In CGS >

$K = \frac{1}{K_1}$, K_1 is called dielectric constant of the medium.

for free space, $\boxed{K=1}$

$\boxed{F = \frac{q_1 q_2}{K_1 \cdot r^2}}$, for any medium

$\boxed{F = \frac{q_1 q_2}{r^2}}$, for vaccume or free space. $K=1$

② In SI >

$K = \frac{1}{4\pi\varepsilon}$ ε = permitivity of medium.

$K = \frac{1}{4\pi\varepsilon_0}$ ε_0 = permitivity of free space.

$F = \frac{1}{4\pi\varepsilon} \cdot \frac{q_1 q_2}{r^2}$ for any medium.

$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$ for vaccume / free space.

Relative permitivity >

$\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$. i.e R.P is the ratio between permitivity of medium to that with permitivity of free space.

Again $\varepsilon = \frac{q_1 q_2}{4\pi r^2 \cdot F}$

unit of ε : $C^2 N^{-1} m^{-2}$

D.F : $\varepsilon = \dfrac{[AT]^2}{[MLT^{-2}][L^2]}$

$= [M^{-1} L^{-3} T^4 A^2]$

$\varepsilon_0 = 8.854 \times 10^{-12}$ SI unit.

$K \approx 9 \times 10^9$

ads

Dielectric Constract :— K_1

It is defined as ratio between force between 2 charges separated by some distance in air to the force between two charges separated by some distance in any other medium

$$K_1 = \frac{F_{air}}{F_{medium}} = \frac{\frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}}{\frac{1}{4\pi\varepsilon} \cdot \frac{q_1 q_2}{r^2}}$$

$$\Rightarrow \boxed{k_1 = \varepsilon/\varepsilon_0 = \varepsilon_r}$$

It has no dimention

Electric field :—

It is defined as the space, surraunding the charge within which it can influence othere charges.

Electric field intensity ($\vec{E}$): —

Electric field intensity at a point ~~which in~~ within an electric field is defined as the force experienced by a unit +ve charge placed at that point.

$$\boxed{\begin{aligned} \vec{E} &= \vec{F}/{+q} \\ \vec{F} &= \frac{kQ}{r^2} \end{aligned}}$$

Electric lines of force: —

It is an imaginary line, which may be straight or curved within which a unit +ve charge would move.

Property

1. They originate from a +ve charge and terminate at -ve charge.
2. They are continous curve having tendency of contraction along their length.
3. The tangent at any point to the lines of force indicates the direction of the electric field at that point
4. They always normal to the surface of charged body.

(5) Two lines of force never intersect eachother because, if it happen they we get 2 direction of Electric field at a perticular point which is impossible.

(6) They touch the surface of spherical Conductore perpendicularly.

(7) Unit +ve charge produce 4π lines of force.

(8) The no of lines of force per unit area is directly proposnal to the strength of the field

Electric field potential :—

Electric field potential at a point within an electric field is defined as the amount of workdone in bringing a unit +ve charge from infinite to that point.

$$V = W/+q.$$

SI unit :— Volt. $1V = \frac{1 \text{ Joule}}{1 \text{ Coulomb}}$

CGS :— Statvolt $1sv = \frac{1 \text{ erg}}{1 \text{ st. volt}}.$

$$\boxed{1V = \frac{1}{300} \text{ st} \cdot V}$$

$$V = [ML^2T^{-3}A^{-1}]$$

Potential difference :—

The difference of potential between any 2 point is called potential difference.

$$\Delta V = K'Q\left[\frac{1}{r_2} - \frac{1}{r_1}\right], \quad r_1 > r_2. \Rightarrow V_1 < V_B$$

or we can defined it as workdone in moving a unit +ve charge from one point to another with in electric field.

Capacity —

$$Q \propto V$$

$$Q = CV$$

$$\Rightarrow \boxed{C = Q/V}$$

C : Capacity of Conductor.

if V = 1 unit then $\boxed{C = Q}$

SI unit : — Farad.

$$1F = \frac{1C}{1V}$$

D.F =

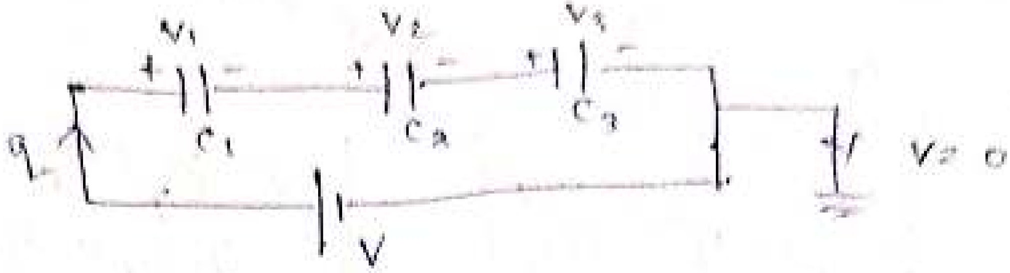
$$C = [M^{-1}L^{-2}T^{4}A^{2}]$$

CGS unit : — 1 stat. farad

$$1sF = \frac{1s \cdot C}{1s \cdot V}$$

$$\boxed{1F = 9 \times 10^{9}\ st \cdot F}$$

① Series Combination (capacitors) :—



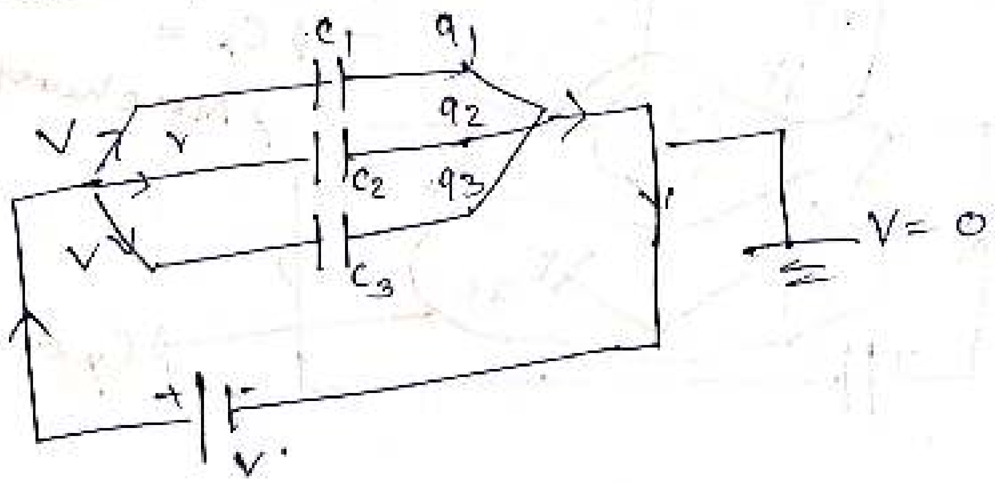
$$\boxed{\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

$$\Rightarrow C = \frac{C_1 C_2 C_3}{C_1 C_2 + C_2 C_3 + C_1 C_3}$$

$$V = V_1 + V_2 + V_3 \Rightarrow \frac{q}{C} = \frac{q}{C_1} + \frac{q}{C_2} + \frac{q}{C_3}$$

$$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

② Parallel Combination —

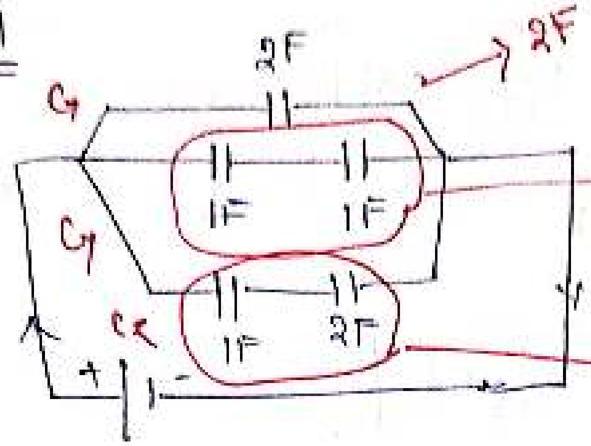


$$q = q_1 + q_2 + q_3$$

$$\Rightarrow CV = C_1 V + C_2 V + C_3 V.$$

$$\Rightarrow \boxed{C = C_1 + C_2 + C_3}$$

Ex-1



$\to 2F = C_x$

$\frac{1}{C_y} = \frac{1}{1F} + \frac{1}{1F}$

$\Rightarrow C_y = 1/2$

$\frac{1}{C_z} = \frac{1}{1} + \frac{1}{2}$

$\Rightarrow C_z = 2/3$

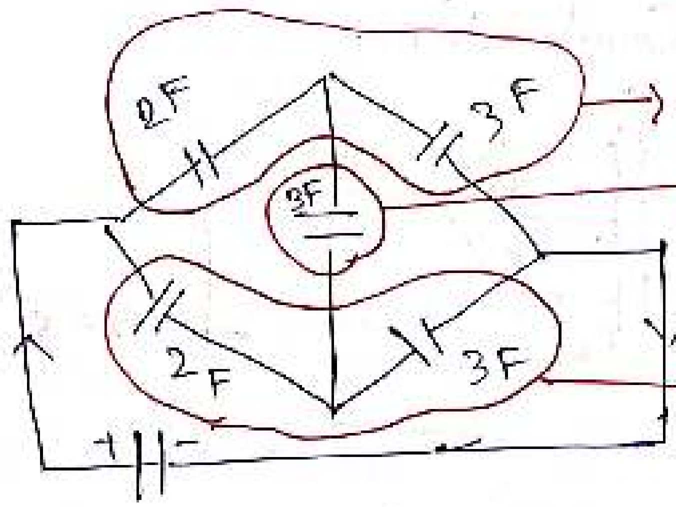
finally

$C = C_x + C_y + C_z$ (Parallal)

$C = \left(2 + 1/2 + 2/3\right) = \frac{3+4+12}{6}$

$= 19/6$ F

Ex-2



$\to C_x =$

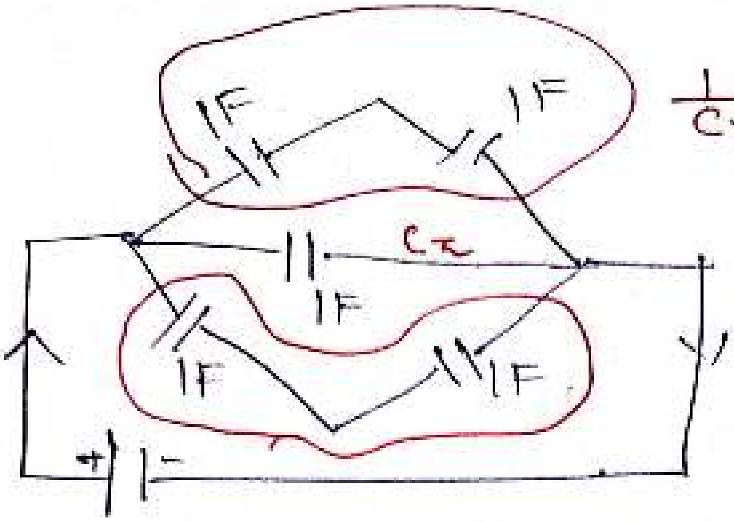
$\to$ No charege.

$\to C_y =$

$\frac{1}{C_x} = \frac{1}{2} + \frac{1}{3} \Rightarrow C_x = 6/5$

$\frac{1}{C_y} = \frac{1}{2} + \frac{1}{3} \Rightarrow C_y = 6/5$

$C = C_x + C_y = \frac{6}{5} + \frac{6}{5} = \frac{12}{5}$



$$\frac{1}{C_x} = \frac{1}{1} + \frac{1}{1} \Rightarrow C_x = 1/2$$

$$\frac{1}{C_y} = \frac{1}{1} + \frac{1}{1}$$

$$\Rightarrow C_y = 1/2$$

$$C = C_x + C_y + C_z$$

$$C = \frac{1}{2} + \frac{1}{2} + 1 = \frac{1+1+2}{2} = \frac{4}{2} = 2F$$