Coulomb's Law & Electric Field

charge → charge on any body defined by Numbers of e^- or protons.

Electrons rooms in orbit & Protons & Neutrons remain in neuclius.

आवेश की मात्रा e^- पर = 1.6×10^{-19} कूलॉम

Coulomb's law

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

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

F → स्थिर वैद्युत बल

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

$A = \frac{1}{4\pi\varepsilon_0}$ (नियतांक)

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

$\varepsilon = \varepsilon_0$ — नियतांक

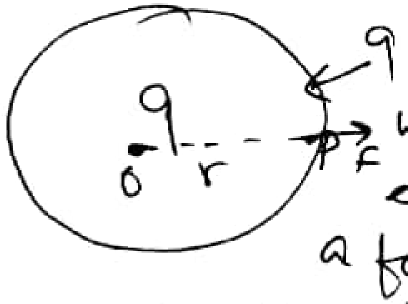
ε ↓ माध्यम की वैद्युत शीलता

परावैद्युतांक $K = \frac{\varepsilon}{\varepsilon_0}$

$$\varepsilon_0 K = \varepsilon$$

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

Electric Field



$q_0 \rightarrow$ test charge

$\rightarrow$ while test charge brings near electric charge (q), it experiences a force of attraction or repulsion. This attraction or Repulsion is being experienced due to electric field q.

$E = \frac{F}{q_0}$ E $\rightarrow$ Intensity of Electric Field

F $\rightarrow$ Force acted on P(+q_0)

Unit of Electric Intensity = N/q

Electric Potential Difference

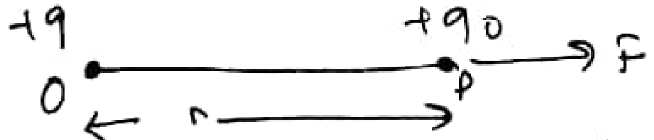
किसी दिये हुए आवेश के वैद्युत क्षेत्र में किसी परीक्षण आवेश को एक बिन्दु से दूसरे बिन्दु तक लाने में किया गया कार्य तथा परीक्षण आवेश के मान के अनुपात को उन दो बिन्दुओं के बीच वैद्युत विभवान्तर कहते हैं। $V_A - V_B = \frac{W}{q_0}$

$V_A - V_B = W/q_0$

वैद्युत विभव → वैद्युत क्षेत्र में किसी बिन्दु पर वैद्युत विभव किसी परीक्षण आवेश को अनन्त से उस बिन्दु तक लाने में किये गये कार्य तथा परीक्षण आवेश के मान के बराबर होता।

Electric Field Intensity Due to a Point charge (3)

~~किसी बिन्दु आवेश के कारण किसी बिन्दु पर विभव~~



According to coulomb's law

$$F = \frac{1}{4\pi\epsilon_0 K} \frac{q q_0}{r^2} \quad \text{—(1)}$$

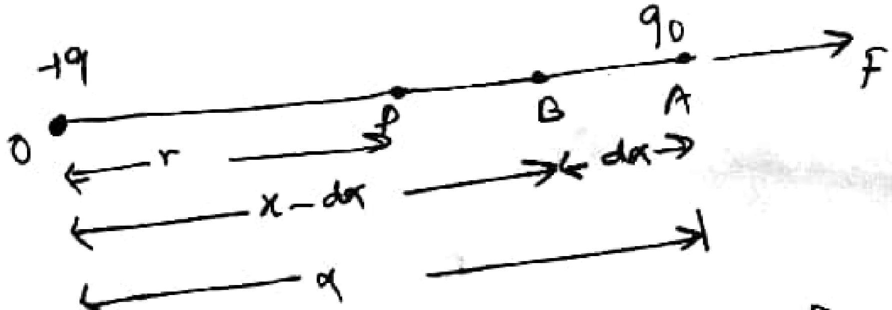
Therefore the intensity of electric field at 'P'

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

$$E q_0 = \frac{1}{4\pi\epsilon_0 K} \frac{q q_0}{r^2}$$

$$\boxed{E = \frac{1}{4\pi\epsilon_0 K} \frac{q}{r^2}}$$

किसी बिन्दु आवेश के कारण किसी बिन्दु पर विभव



→ +q आवेश के कारण परीक्षण आवेश पर आरोपित बल (x दूरी)

$$F = \frac{1}{4\pi\epsilon_0 K} \frac{q q_0}{x^2}$$

→ परीक्षण आवेश को A से B तक -dx चलने के लिए आवश्यक कार्य

$$dW = F \times d = \frac{1}{4\pi\epsilon_0 K} \frac{q q_0}{x^2} \times -dx \text{ जूल}$$

अतः परीक्षण आवेश को अनन्त से बिन्दु P तक लाने में किया गया कार्य — (5)

$$W_{\infty P} = \int_{x=\infty}^{x=r} dW$$

$$W_{\infty P} = \int_{\infty}^{r} -\frac{1}{4\pi\epsilon_0 K}\frac{qq_0}{x^2}\,dx$$

$$= \frac{1}{4\pi\epsilon_0 K} qq_0 \int_{\infty}^{r} -\frac{dx}{x^2}$$

$$= \frac{qq_0}{4\pi\epsilon_0 K}\left|\frac{1}{x}\right|_{\infty}^{r}$$

$$W_{\infty P} = \frac{qq_0}{4\pi\epsilon_0 K}\left|\frac{1}{r}-\frac{1}{\infty}\right|$$

$$W_{\infty P} = \frac{qq_0}{4\pi\epsilon_0 r} \text{ जूल}$$

अतः एकांक धन आवेश को अनन्त से P तक लाने में किया गया कार्य

विद्युत विभव $V = \frac{W_{\infty P}}{q_0} = \frac{qq_0}{4\pi\epsilon_0 r \times q_0}$

$$= \frac{q}{4\pi\epsilon_0 r} \text{ जूल}$$

$$\boxed{V = \frac{1}{4\pi\epsilon_0 K}\cdot\frac{q}{r}}$$

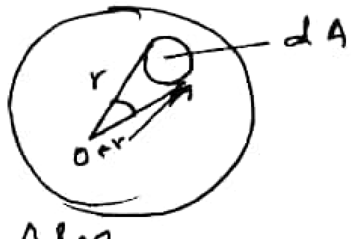
—o—

Electric Flux & Gauss Theorem –

$\hat{n}$ unit vector, $\vec{A} = \hat{n} A$

Area Vector

Solid Angle.



Radius = r
Area = dA
centre 'O'

Solid Angle is an angle which is made by the ~~spherical surf~~ Area of the S.S on the centre of the its sphere.

ज्यामितीय क्षेत्रफल $\propto r^2$ (त्रिज्या)

Area (Spherical) $dA \propto r^2$ ✓

$dA \propto r^2$

$\frac{dA}{r^2}$ = Constant ✓

$\frac{dA}{r^2} = d\omega$

~~Ratio of dA and~~

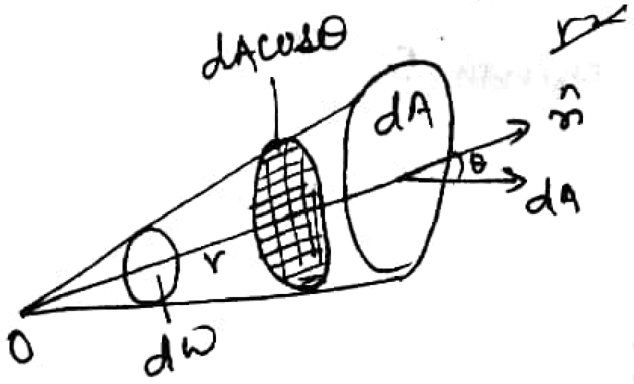
$$d\omega = \frac{dA}{r^2} \quad \text{—(1)}$$

Unit of Solid Angle – Steradian ✓

If $dA = r^2$ ∴ $d\omega = 1$ ✓

Total Surface Area of sphere(A) = $4\pi r^2$

So $d\omega = \frac{4\pi r^2}{r^2} = 4\pi$ Steradians



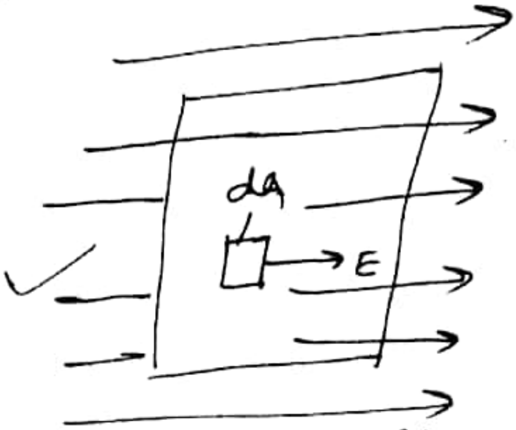
Let consider dA is at r from 'O'.
$\hat{n}$ & dA angle θ
$dA\cos\theta$ is the shade shown of dA.

Solid Angle denoted by dA on O

$$d\omega = \frac{dA\cos\theta}{r^2} = \frac{\vec{dA}\cdot\hat{n}}{r^2}$$

Electric Flux

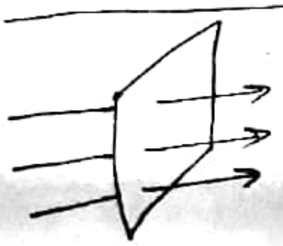
The total number of lines of force passing through the unit area of a surface is called Electric flux.



It is a scalar quantity

Flux means How many lines are passing through any surface

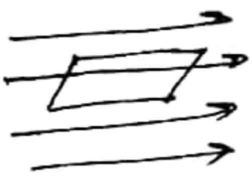
→ if lines are closer — strong
→ if lines are wider ⇒ weaker



Example of water

if we consider flow of water at any point is const. so we can multiply value of flow with the HAND SURFACE AREA. we will get flux of our hand.

$\phi_F = FA$



$\phi_f = FA = 0$ Since no water will passing through to the hand.

Area is ZERO

— x —

$\phi_E = \int_a E.dA$

Surface
- open
- closed

→ यदि वो रेखाएं बाहर जा रही तो Flux +ive

→ यदि पृष्ठ में प्रवेश कर रहीं तो Flux -ive.

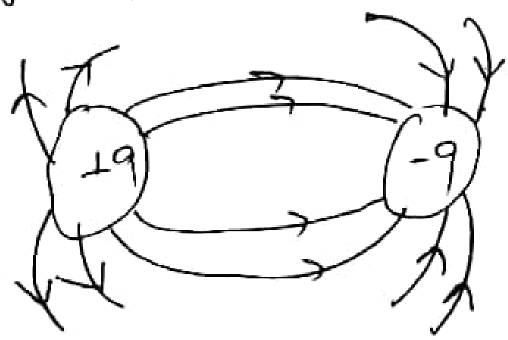
$\phi_E = EA\cos\theta$

(i) $\phi_E = 0$ $\quad \theta = 90°$

(ii) $\phi_E = EA$ $\quad \theta = 0$

Capacitance

Capacitors : It is a device which store the potential energy. It is also known as a store house of energy. Capacitor provides energy for a very short time of duration. e.g flash of camera, fan, medical equipments



Two conductors, isolated from eachother and their surroundings also. This arrangement works like a capacitor.

$1\,mF = 10^{-3}F$
$1\,\mu F = 10^{-6}F$
$1\,nF = 10^{-9}F$
$1\,pF = 10^{-12}F$

When a capacitor is charged, the conductor ~~are called~~ have equal and opposite charge of magnitude 'q'

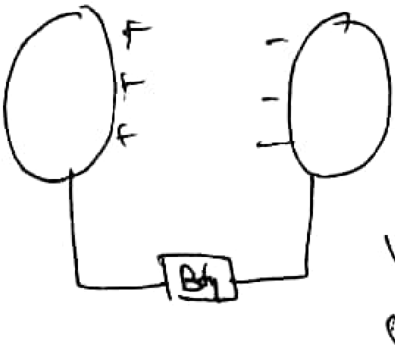
The charge of the capacitor is directly proportional to the potential difference of the capacitor

$$q \propto V$$
$$q = CV$$

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

C is a capacitance constant.

$= \frac{\text{Coloumb}}{\text{Volt}} = \text{Farad}$

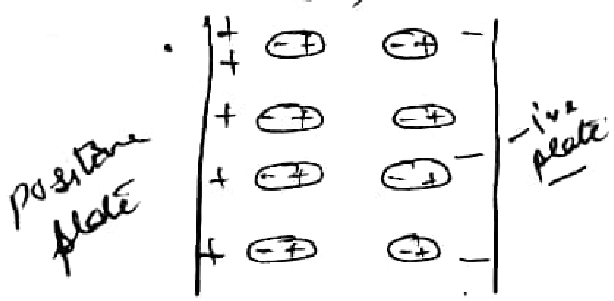


Voltage ∝ Charge

$$V \propto Q$$
$$Q \propto V$$
$$Q = CV$$
$$C = \frac{Q}{V}$$

Effect of Dielectric on Capacitor

Dielectric (परावैद्युत पदार्थ) is an insulating material such mineral oil or plastic.



Capacitance of capacitor is depend on the medium filled ~~within the~~ between the plates.

$C \propto K$

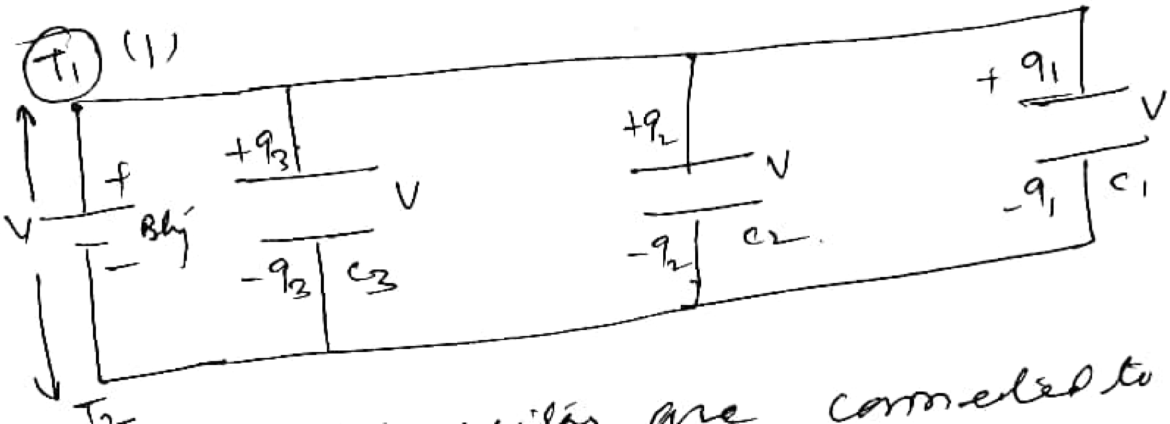
-ive electrons of the atoms seem toward +ive plate & proton or +ive seem towards -ive plate. In this process every particle of dielectric have one -ive & one +ive side. This state is known as polarized state (ध्रुवण). Resultantly Electric field between plates decreases due to dielectric and potential difference also decrease and as we know C is inversely proportional to potential difference. So capacitance of the capacitor increase $\left(C = \frac{Q}{V}\right)$

$$C \propto \frac{1}{V}$$

Types of capacitors

. Capacitors in Parallel — There are two basic combinations of capacitors -

(1)



Three capacitors are connected to a Bty. All capacitor plates connected to the Terminal T_1 will be +ive charged due to they all are connected with +ive Terminal. Due to induction (प्रेरण) other plates of the capacitors will be -ively charged at the inner side and outer side will be +ive charged.

~~P.D(V) will be same at all (three) capacitors~~

When a P.D (V) is applied across several capacitors connected in ||el, that P.D (V) is applied across each capacitors. The total charge q stored on the capacitors is the sum of the charges stored on all the capacitors.

V → same for all capacitors

$q_1 = C_1 V$ $\quad q_2 = C_2 V$ $\quad q_3 = C_3 V$

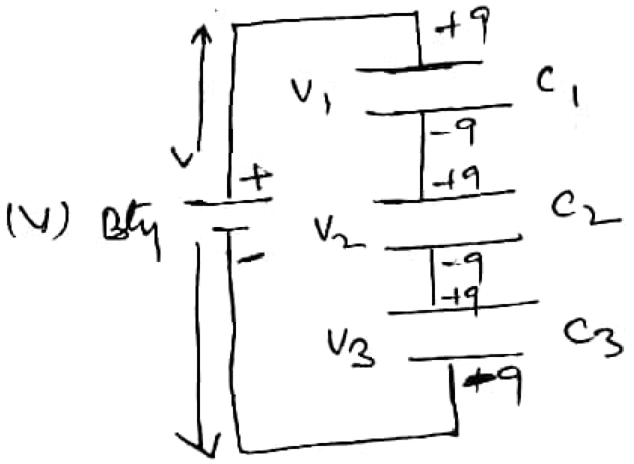
Total charge $q = q_1 + q_2 + q_3$

$$q = (C_1 + C_2 + C_3) V$$

$$\Rightarrow \frac{q}{V} = C_1 + C_2 + C_3$$

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

Capacitors in Series



'Series' means that the capacitors are wired serially one after the other and PD (V) is applied across the two terminal.

In Series, the sum of the PD $(V_1+V_2+V_3)$ across all the capacitors is equal to the applied PD (V)

$$V_1 = \frac{q}{C_1} \qquad V_2 = \frac{q}{C_2} \qquad V_3 = \frac{q}{C_3}$$

$$V = V_1 + V_2 + V_3$$

$$V = \frac{q}{C_1} + \frac{q}{C_2} + \frac{q}{C_3} = q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

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

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