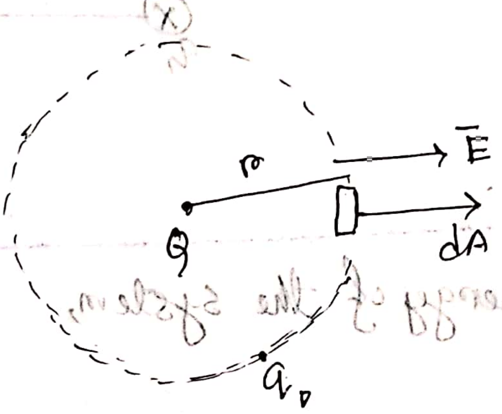
Relation or equating between Gauss' law and Coulomb's law:



$$\text{flux} = \oint \bar{E}\cdot d\bar{A}$$

$$= \oint E\,dA$$

$$= E\oint dA$$

$$= E\cdot 4\pi r^2$$

$$Q_{enc} = Q$$

Applying Gauss law,

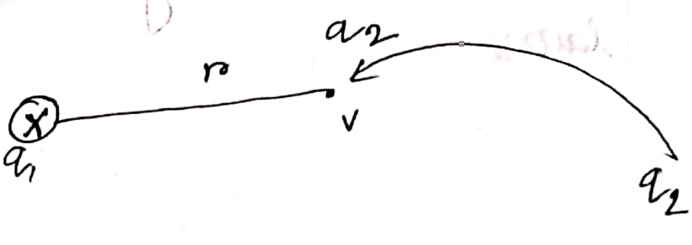
$$\epsilon_0 \oint E\,dA = Q_{enc}$$

$$\Rightarrow E = \frac{Q}{4\pi\epsilon_0 r^2}$$

Force on charge q_0, $F = q_0 E$

$$= \frac{q_0 Q}{4\pi\epsilon_0 r^2}$$

$$V = \frac{q_1}{4\pi\epsilon_0 r}$$



$$W = q_2 V = U.$$

Potential energy of the system,

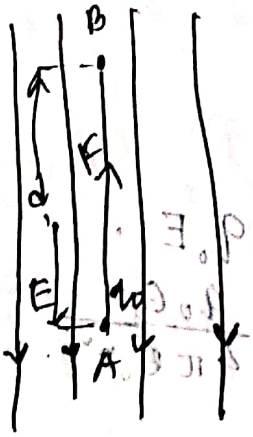
$$U = Vq_2$$

$$U = \frac{q q_2}{4\pi\epsilon_0 r},$$

Unit, $U \to J$.

$V \to$ volt / JC^{-1}.

Electric field and Electric potential:



uniform

$$F = q_0 E.$$

work done, to move q_0 from A to B

$$W = F.d$$

$$= q_0 E.d$$

work done per unite charge,

$$\frac{W}{q_0} = Ed.$$

$$\Rightarrow V_B - V_A = Ed.$$

$$\Rightarrow V = Ed.$$

CT-1

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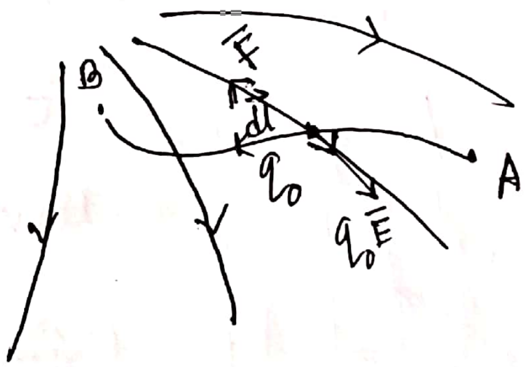
Electric flux
Electric field } 2 chapter.

Relation between E and V (non-uniform field):

$$\overline{F} = -q_0\overline{E}.$$



Work done to move q_0 charge from A to B

$$W_{AB} = \int_A^B \overline{F}\cdot d\overline{l}$$

$$= -\int_A^B q_0 \bar{E}\cdot d\bar{l}$$

$$W_{AB} = -q_0 \int_A^B \vec{E}\cdot d\vec{l}$$

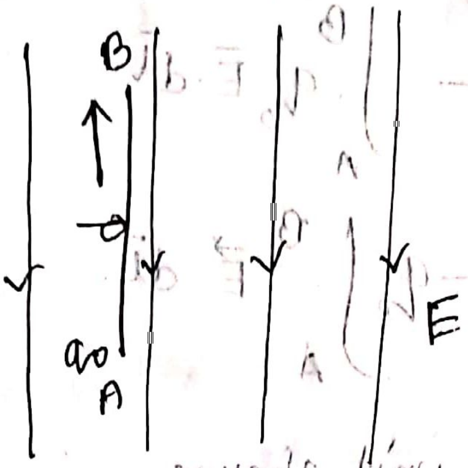
Work done per unit charge,

$$\frac{W_{AB}}{q_0} = -\int_A^B \bar{E}\cdot d\bar{l}$$

$$W_B - W_A = V_B - V_A = -\int_A^B \bar{E}\, d\bar{l}$$

If $A \to \infty$, $V_A = 0$.

$$V = -\int_{\infty}^{B} \vec{E}\cdot d\bar{l}$$



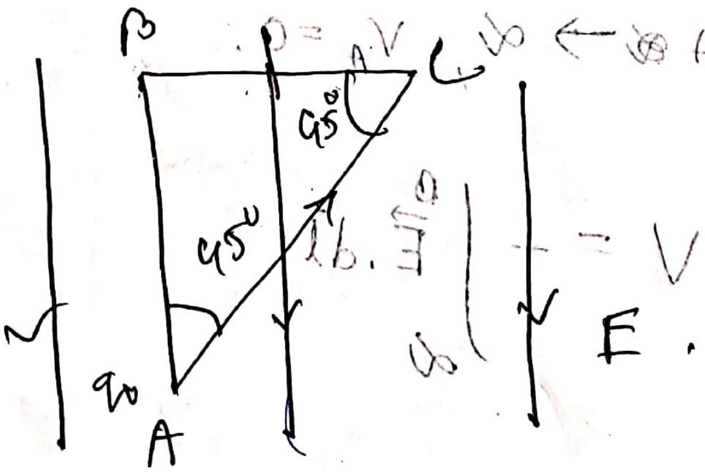
$V = Ed$

$$V_B - V_A = -\int_A^B \bar{E}\cdot d\bar{l}$$

$$\cos 0 = \frac{d}{\cdot}$$

$$= -E\int_A^B \cos\theta\, d\bar{l}$$

$$V_B - V_A = Ed.$$



$$V_C - V_A = -\int_A^C \bar{E}\cdot d\bar{l}, \quad = -\int_A^C E\,dl \cos 135^\circ$$

$$= -E\int_A^C dl\left(-\tfrac{1}{\sqrt{2}}\right)$$

$$= \cdot\,\bar{b}$$

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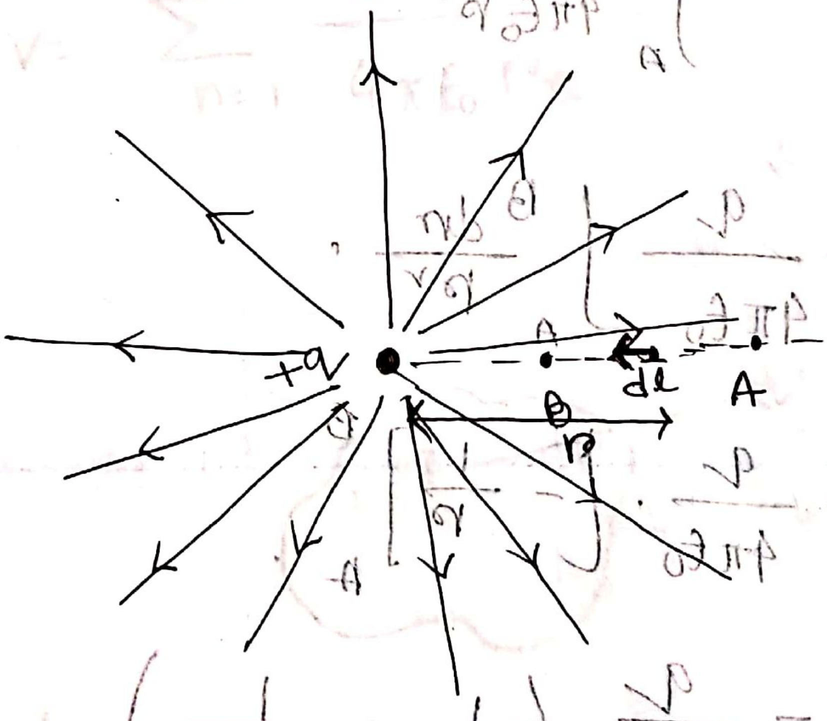
$$= \frac{E}{\sqrt{2}} \int_A^C dl = \frac{E}{\sqrt{2}} d\sqrt{2} \Big|_A^C = Ed.$$

$V_C - V_B = 0$. $[\because \theta = 90°.]$

$\therefore V_B - V_A = 0 + Ed$

$= Ed.$

Electric potential due to a point charge:



$V_B - V_A = ?$

$V_B - V_A = \vec{E} \cdot \vec{dl}$

$= E\, dl \cos 180°$

$= -E\, dl = E\, dr.$

And $dl = -dr$.

$$V_B - V_A = -\int_A^B E\, dr$$

We know, for point charge,

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

$$\therefore V_B - V_A = -\int_A^B \frac{q}{4\pi\epsilon_0 r^2} \cdot dr.$$

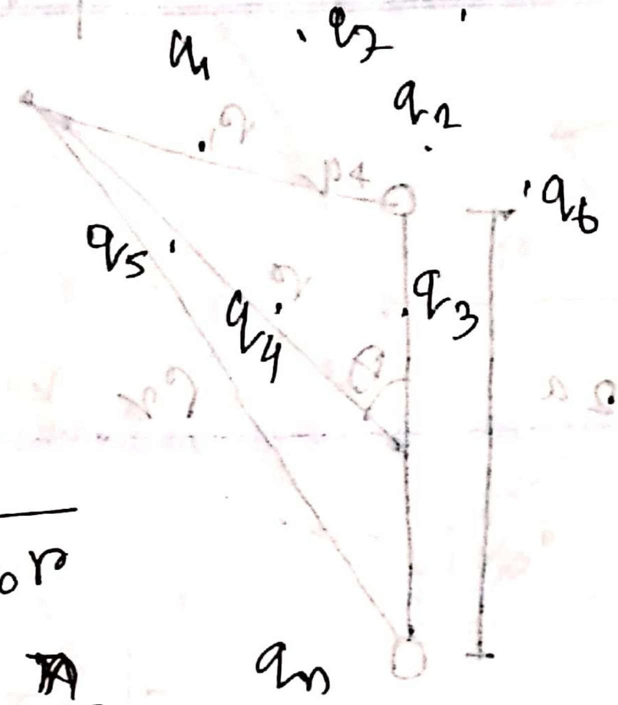
$$= -\frac{q}{4\pi\epsilon_0}\int_A^B \frac{dr}{r^2}.$$

$$= -\frac{q}{4\pi\epsilon_0} \cdot \left[-\frac{1}{r}\right]_A^B.$$

$$V_B - V_A = -\frac{q}{4\pi\epsilon_0}\left(-\frac{1}{r_B} + \frac{1}{r_A}\right).$$

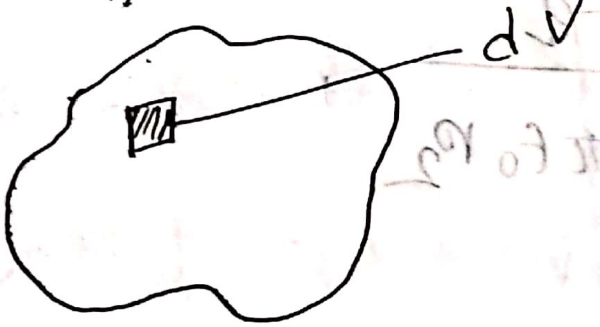
When, $A \rightarrow \infty$, $V_A = 0$

$$V = \frac{q}{4\pi\epsilon_0 r}$$



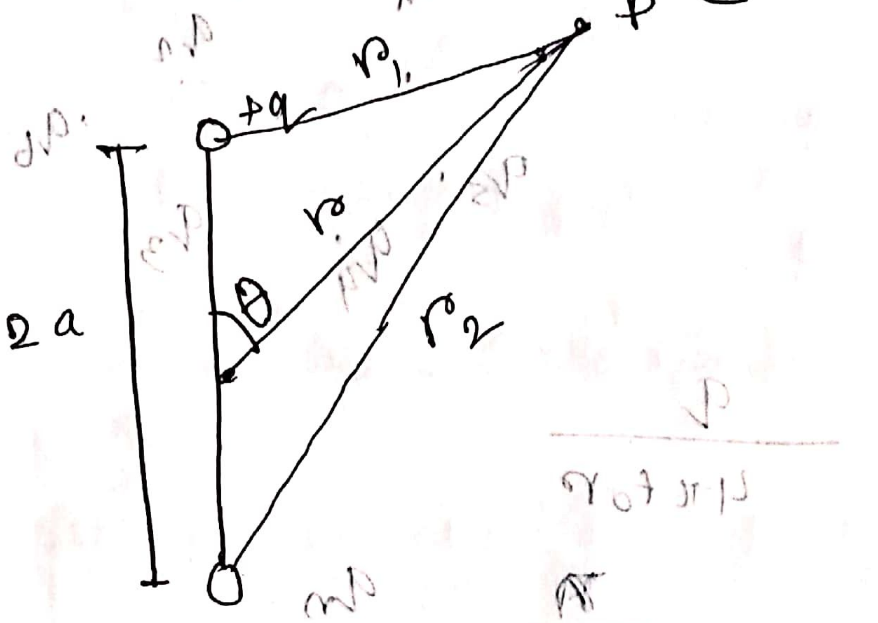
$$V = \frac{q}{4\pi\epsilon_0 r}$$

Here, $V = \sum_{n=1}^{n} \frac{q_n}{4\pi\epsilon_0 r_n}$



$$V = \int dV.$$

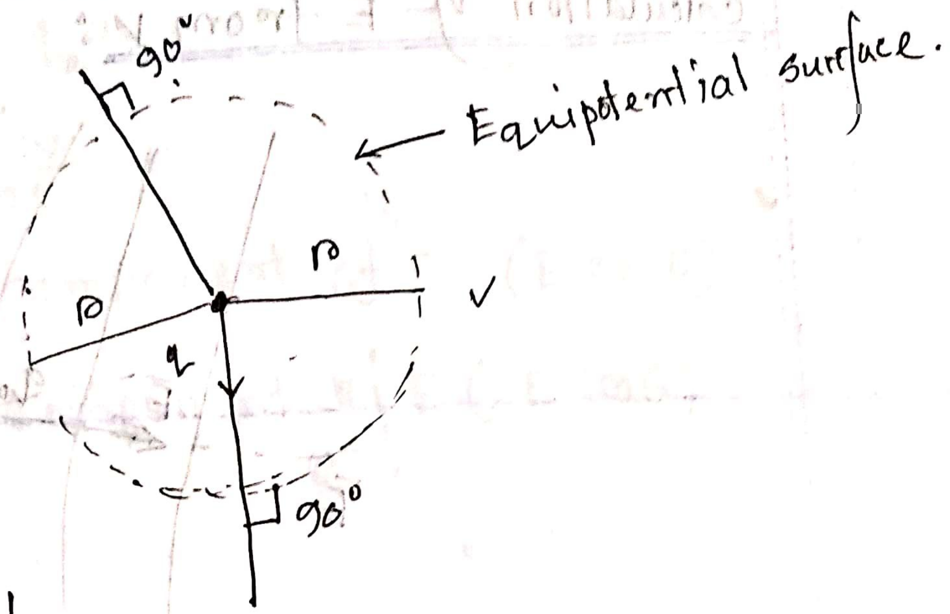
Electric potential due to dipole :

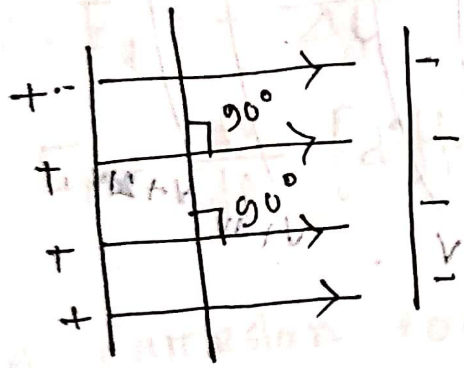


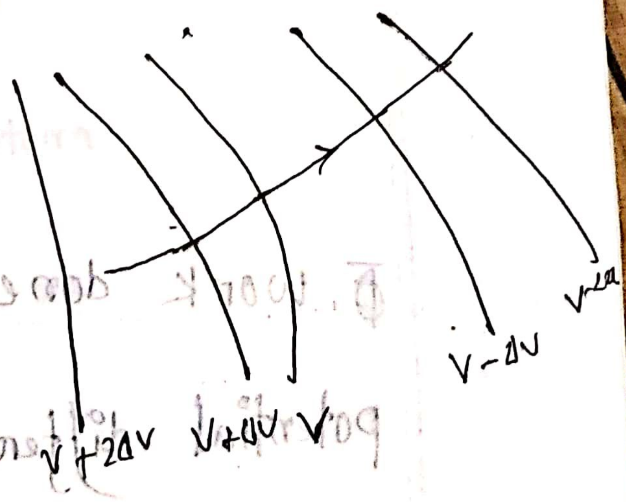
$$V_1 = \frac{q}{4\pi\epsilon_0 r_1}$$

$$V_2 = \frac{-q}{4\pi\epsilon_0 r_2}$$

$$V = \frac{p\cos\theta}{4\pi\epsilon_0 r^2}$$







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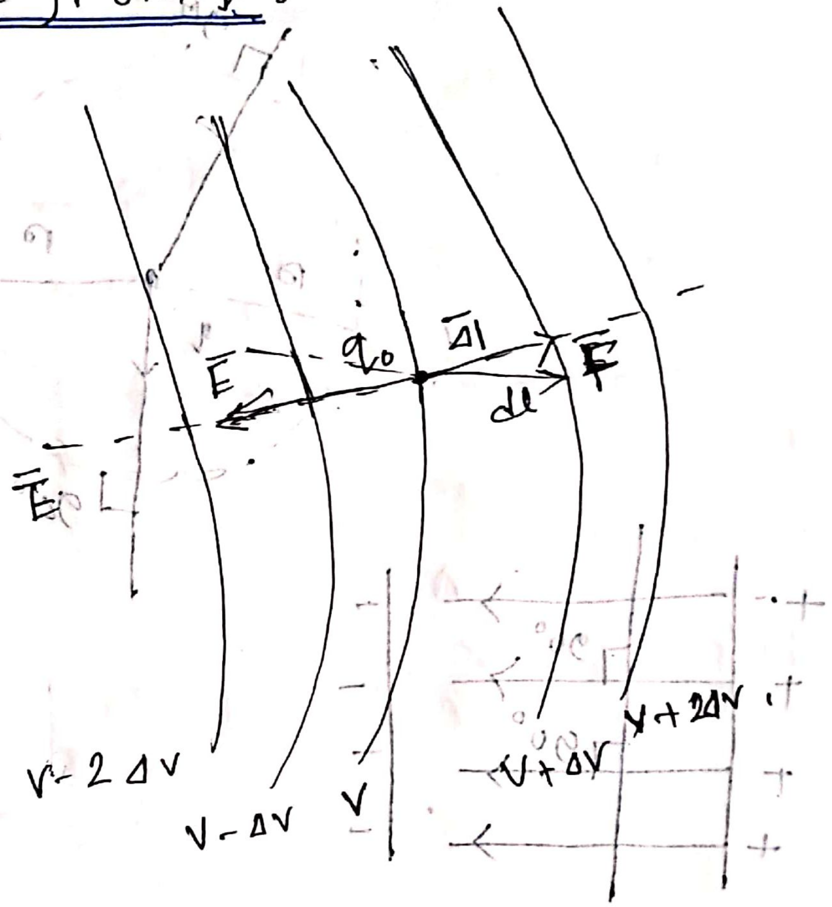
Calculation of E from V :



∴ work done to move charge q_0 through potential difference $= q_0 \Delta V$.

In other definition, this work $= \vec{F} \cdot \Delta l$.

$$= -q_0 \vec{E} \cdot d\vec{l}$$

$$= -q_0 E \Delta l \cos(\pi - \theta)$$

$$= q_0 E \Delta l \cos\theta .$$

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$\therefore q_0 E \Delta l \cos\theta = q_0 \Delta V$.

$\Rightarrow E \cos\theta = \dfrac{\Delta V}{\Delta l}$.

$-l$ direction $\Rightarrow$ component of E. $(E\cos\theta)$.

$+l$ direction $\Rightarrow$ component of E $(-E\cos\theta)$

$$\therefore E_l = -\frac{\Delta V}{\Delta l}.$$

$$E_l = -\frac{dV}{dl} \quad \text{[differential limit]}.$$

In cartesian coordinate system.

$$E_x = -\frac{\partial V}{\partial x}.$$

$$E_y = -\frac{\partial V}{\partial y}$$

$$E_z = -\frac{\partial V}{\partial z},$$

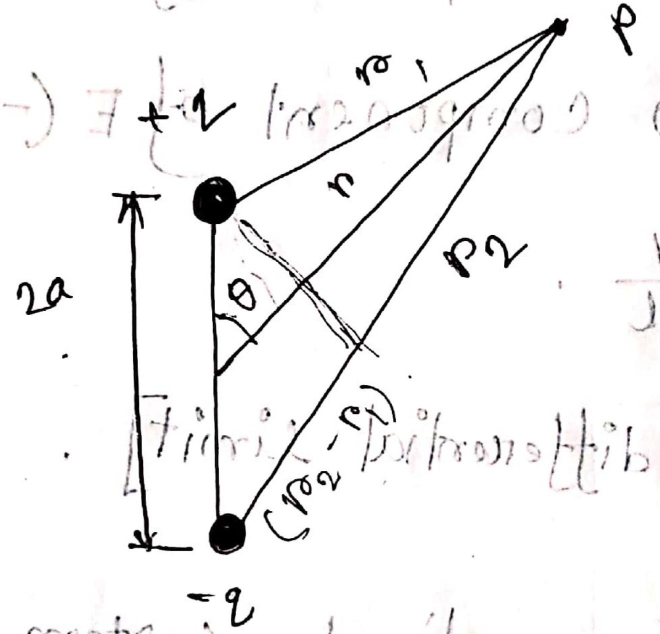
In polar coordinate system.

$$E_r = -\frac{\partial V}{\partial r}.$$

$$E_\theta = -\frac{1}{r}\cdot\frac{\partial V}{\partial \theta}$$

$$E = \sqrt{E_r^2 + E_\theta^2}$$

Electric potential due to dipole :



For $+q$,

$$V_1 = \frac{q}{4\pi\epsilon_0 r_1}$$

For $-q$,

$$V_2 = \frac{-q}{4\pi\epsilon_0 r_2}$$

$\therefore$ Net potential.

$$V = V_1 + V_2$$

$$= \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right).$$

$$= \frac{q}{4\pi\epsilon_0}\left(\frac{r_2 - r_1}{r_1 r_2}\right).$$

$r >> 2a \Rightarrow r_1 r_2 = r^2$

$r_2 - r_1 = 2a\cos\theta$.

$$\therefore V = \frac{q}{4\pi\epsilon_0}\left(\frac{2a\cos\theta}{r^2}\right).$$

$$= \frac{p\cos\theta}{4\pi\epsilon_0 r^2}.$$

when, $\theta = 0$;

$$V = \frac{p}{4\pi\epsilon_0 r^2}$$

$\theta = 180°$, $V = -\frac{p}{4\pi\epsilon_0 r^2}$.

$\theta = 90°$, $V = 0$.

For Two parallel plate's electric field:

$$E = \frac{\sigma}{\epsilon_0},$$

Electric field for conducting plate:

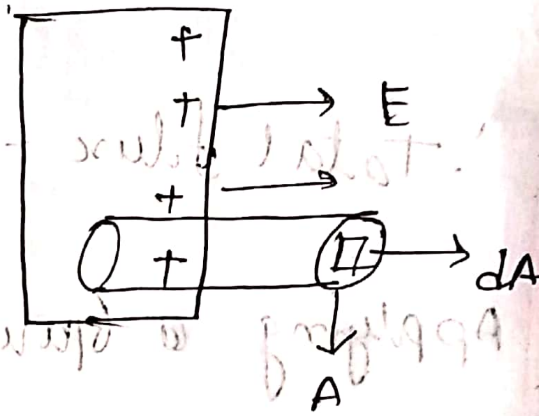
left cap $\Rightarrow \phi = 0$.

curved $\Rightarrow \phi = 0$

right cap $\Rightarrow \phi = \oint \bar{E} \cdot d\bar{A}$

$= E \oint dA$.

$= E.A$.



σ = charge per unit area

$\therefore$ Total flux $= EA + 0 + 0$

$= EA$.

charged enclosed, $q_{enc} = \sigma A$

Applying Gauss law. $\epsilon_0 \oint \bar{E}\, dA = q_{enc}$.

$\Rightarrow \epsilon_0 EA = \sigma A$.

$\Rightarrow E = \frac{\sigma}{\epsilon_0}$

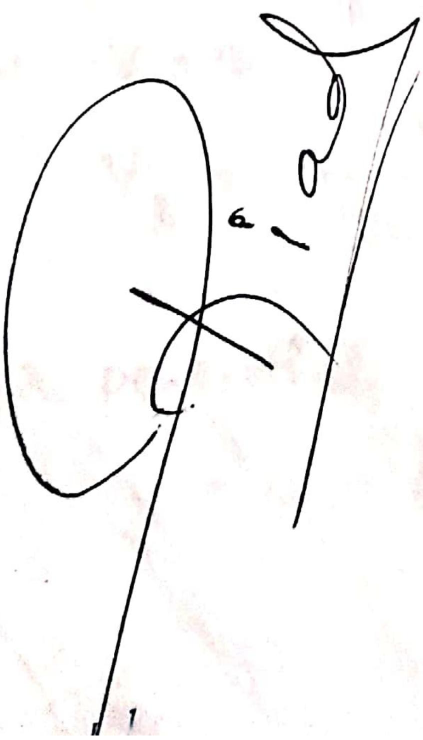
$$E_r = -\frac{\partial V}{\partial r} = \frac{1}{4\pi\epsilon_0} \frac{2p\cos\theta}{r^3}$$

$$E_\theta = -\frac{1}{r}\frac{\partial V}{\partial \theta} = \frac{p\sin\theta}{4\pi\epsilon_0 r^3}$$

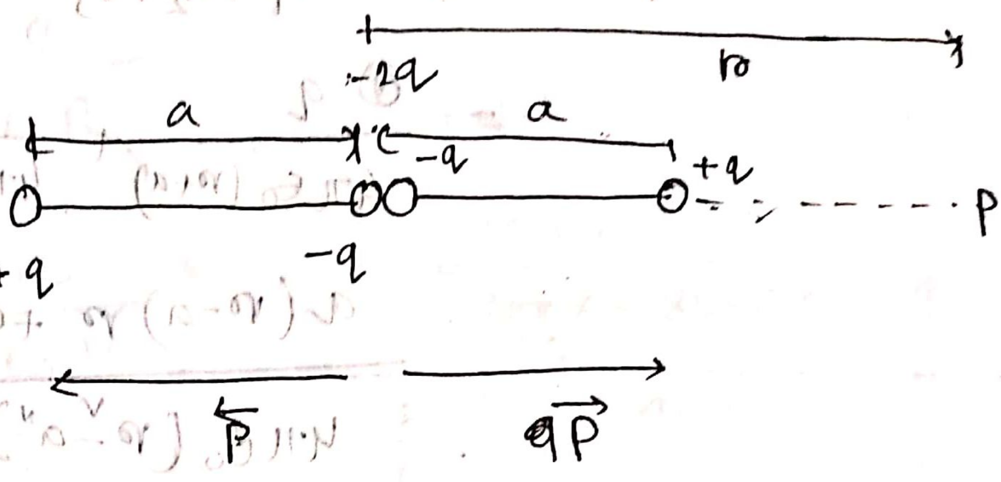
$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{p}{r^3}\sqrt{(4\cos^2\theta + \sin^2\theta)}$$

$$\frac{p}{4\pi\epsilon_0}\cos\theta$$

$$\theta = \pi/2 \rightarrow E = \frac{p}{4\pi\epsilon_0 r^3}$$



Electric potential due to electric quadrupole:



Electric quadrupole.

$Q = 2qa^2$

For +q (left).

Potential, $V_1 = \frac{q}{4\pi\epsilon_0(r+a)}$.

For +q charge (right)

Potential, $V_2 = \frac{+q}{4\pi\epsilon_0(r-a)}$

For -2q charge

Potential, $V_3 = \frac{-2q}{4\pi\epsilon_0 r}$

(i) we know,

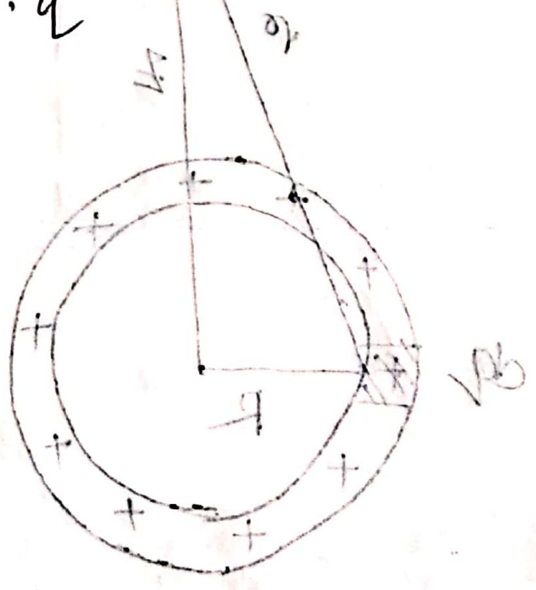
$$V = \frac{q}{4\pi\epsilon_0 R}$$

$$R = \frac{q}{4\pi\epsilon_0 V} = \frac{1.5\times10^{-8}}{4\pi\times8.854\times10^{-12}\times30}$$

$= 4.5$ m.

(ii) $dV = \frac{q}{4\pi\epsilon_0 R}$, $\Rightarrow dV = \frac{q}{4\pi\epsilon_0}\cdot\left(-\frac{1}{R^2}\cdot dR\right)$.

$$\Rightarrow dR = -\frac{4\pi\epsilon_0 R^2}{q}\,dV.$$



$\therefore$ net potential, $V = V_1 + V_2 + V_3$

$$= \frac{q}{4\pi\epsilon_0 (r+a)} + \frac{q}{4\pi\epsilon_0 (r-a)} + \frac{-2q}{4\pi\epsilon_0 r}$$

$$= \frac{q(r-a)r + q(r+a)r + 2q(r^2-a^2)}{4\pi\epsilon_0 (r^2-a^2) r}$$

$$= \frac{\cancel{qr^2} + \cancel{qar} + \cancel{qr^2} + \cancel{qar} - \cancel{2qr^2} + 2qa^2}{4\pi\epsilon_0 r (r^2-a^2)}$$

$$\therefore V = \frac{2qa^2}{4\pi\epsilon_0 r (r^2-a^2)}$$

Consider a point charge with $q = 1.5 \times 10^{-8}$ C.

1) what is the radius of the equipotential surface having a potential of 30 volts?

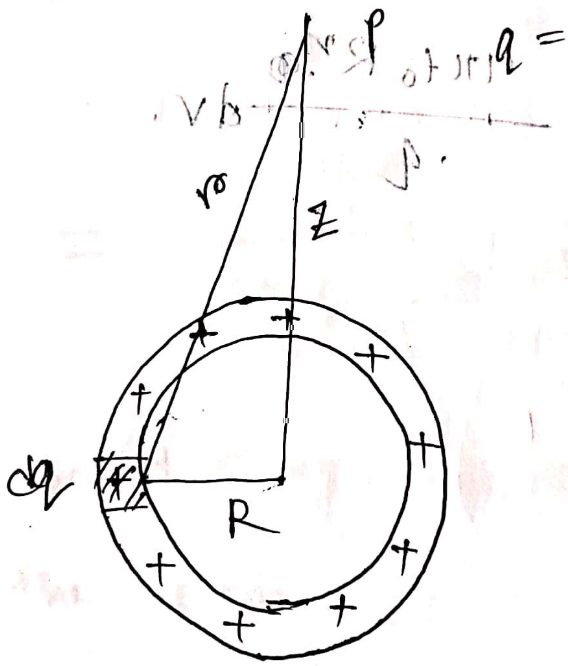
(ii) Are surfaces whose potentials differ by a constant amount equally spaced in the radius?

$V \propto \frac{1}{r}$ (monopole).

$V \propto \frac{1}{r^2}$ (dipole).

$V \propto \frac{1}{r^3}$ (quadrupole).

Electric potential due to charged ring:



q = total charge on the ring.

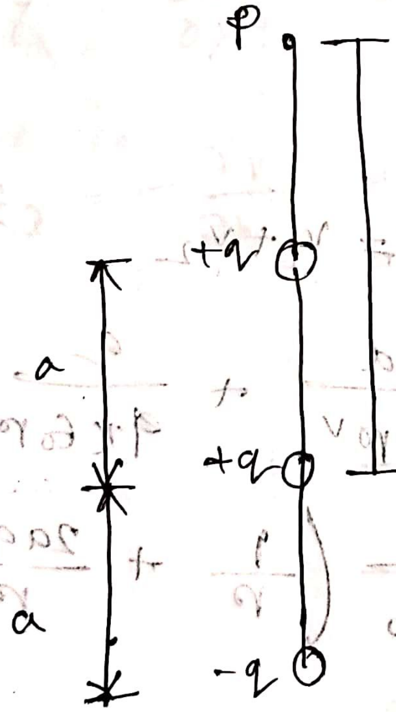
Potential due to charge element dq,

$$dV = \frac{dq}{4\pi\epsilon_0 r},$$

$\therefore$ Total potential, $V = \int \frac{dq}{4\pi\epsilon_0 r}$

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

$$\therefore \quad V = \frac{q}{4\pi\epsilon_0 \sqrt{(R^2+z^2)}}$$



Prove that $V = \frac{1}{4\pi\epsilon_0}\left(\frac{q}{r} + \frac{2qa}{r^2}\right)$ for $r \gg a$.

Sol^n: For dipole,

$$V_1 = \frac{2qa}{4\pi\epsilon_0 r^2} \quad [\theta = 0^\circ]$$

Pole.
For point charge,

$$V_2 = \frac{q}{4\pi\epsilon_0 r}$$

∴ Total potential at P_1, $V = V_1 + V_2$

$$= \frac{2qa}{4\pi\epsilon_0 r^2} + \frac{q}{4\pi\epsilon_0 r}$$

$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{1}{r} + \frac{2aq}{r^2}\right),$$

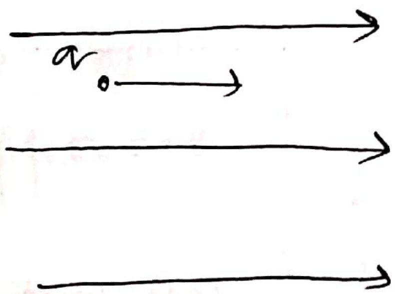
The potential at $(-2,4,6)$. is $V = 80x^2 + 60y^2$. then find E_x, E_y, E_z.

Soln:

$$E_x = -\frac{\partial V}{\partial x} = -160(-2) = 320 \ NC^{-1} \text{ or}$$

$$E_y = -\frac{\partial V}{\partial y} = 60.2.(4) = 480 \ NC^{-1} \text{ or } V/m$$

$$E_z = -\frac{\partial V}{\partial y} = 0.$$

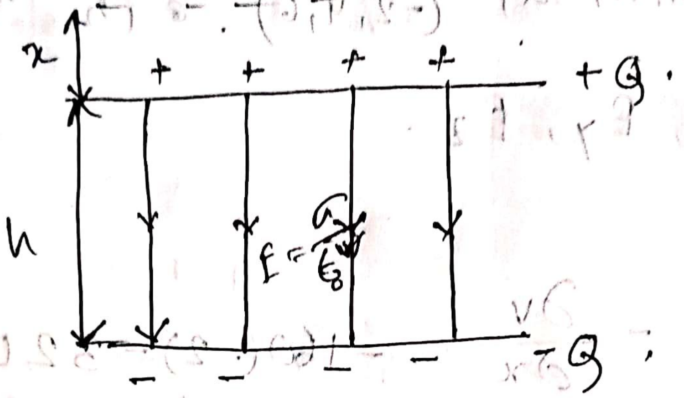


$$qE = ma$$

$$a = \frac{qE}{m}.$$

acceleration $a = v.\frac{dv}{dx}$

9.09.19.
6th D. Day



energy per unit volume → $\frac{1}{2}\epsilon_0 E^2$.

$\int \frac{1}{2}\epsilon_0 E^2 dV$.
Total energy

Capacitor and
Capacitance.

R

9×10^9 m

6400 Km

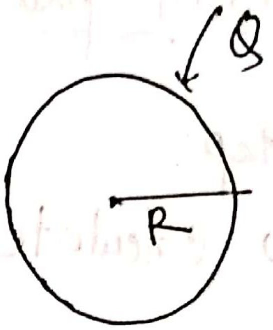
1 cm

Capacitance

1 F.

700 μF.

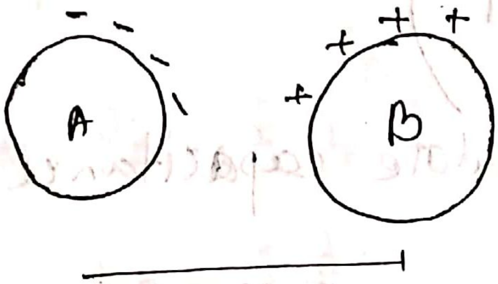
1 pF.



$$V = \frac{Q}{4\pi\epsilon_0 R}$$

$$C = \frac{Q}{V} = 4\pi\epsilon_0 R.$$

Constant.



$$C_B = \frac{Q}{V_B}$$

$$C = \frac{\text{charge on the Object}}{\text{Potential difference}}$$

V_B goes down C_B goes on.

Parallel plate capacitor:

Step:

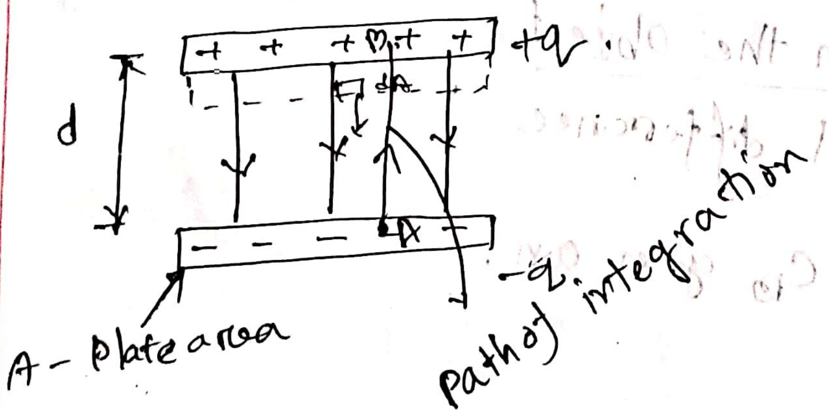
i) Calculate charge on each plate.

ii) Calculate electric field between two plates. (using Gauss law).

iii) Calculate potential difference between two plates.
$$\left(V_B - V_A = -\int_A^B E \cdot dl\right)$$

iv) $C = \frac{q}{V}$ → calculate capacitance.

$\bar{E} \cdot d\bar{A} = 0$



Applying Gauss law,
$$\epsilon_0 \oint \bar{E} \cdot d\bar{A} = q_{enc}$$
$$\Rightarrow \epsilon_0 E \oint dA = q.$$

$\Rightarrow \epsilon_0 E A = q.$

$\Rightarrow E = \frac{q}{\epsilon_0 A}$

potential difference, $V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{l}$

$= -\int_A^B -\vec{E} \cdot d\vec{l}.$

$V_B - V_A = \int_A^B E\,dl.$

$V_B - V_A = E \int_A^B dl$

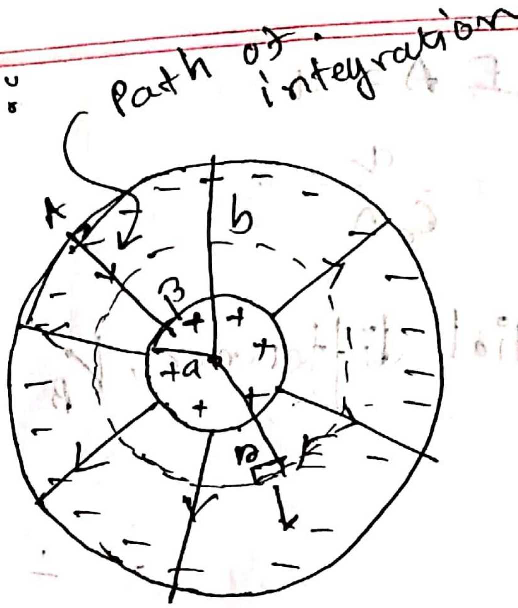
$V = Ed.$

capacitance, $C = \frac{q}{V}.$

$= \frac{\epsilon_0 E A.}{E d}$

$$\boxed{C = \frac{\epsilon_0 A}{d}}$$

cylindrical capacitor:



q = charge on each plate

l = length of the cylindrical plate

Applying Gauss' law.

$$\epsilon_0 \oint \bar{E}\, d\bar{A} = q_{enc}$$

$$\Rightarrow \epsilon_0 E \oint dA = q$$

$$\Rightarrow \epsilon_0 E\, 2\pi r l = q$$

$$\Rightarrow E = \frac{q}{2\pi\epsilon_0 r l}$$

Potential difference,

$$V_B - V_A = -\int_A^B \bar{E}\cdot d\bar{l}$$

$$= -\int_A^B (-\bar{E}\cdot dl)$$

$$= -\int_A^B E\, dr$$

$$= -\int_b^a E \cdot dr$$

$$= -\int_b^a \frac{q}{2\pi\epsilon_0 r l} \cdot dr$$

$$= -\frac{q}{2\pi\epsilon_0 l}\int_b^a \frac{dr}{r}$$

$$= -\frac{q}{2\pi\epsilon_0 l} \ln\frac{a}{b}$$

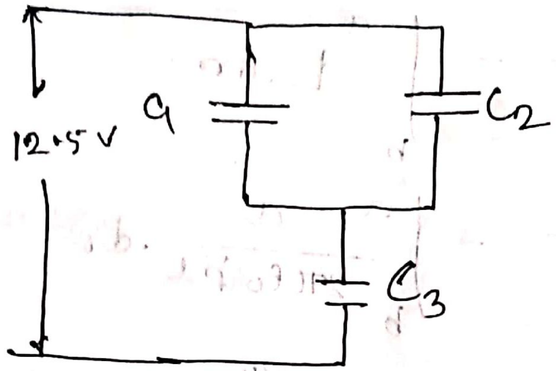
$$\therefore V = \frac{q}{2\pi\epsilon_0 l} \ln\frac{b}{a}$$

$$\therefore \text{capacitance, } C = \frac{q}{V}$$

$$= \frac{q}{\frac{q}{2\pi\epsilon_0 l \ln\frac{b}{a}}}$$

$$\therefore C = 2\pi\epsilon_0 l / \ln\frac{b}{a}$$

Problem:



$C_1 = 12\ \mu F$

$C_2 = 5.3\ \mu F$.

$C_3 = 4.5\ \mu F$.

① equivalent capacitance of for the combination.

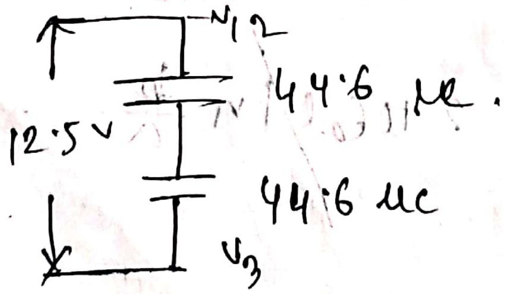
② what is the charge on C_1, C_2, C_3.

① $C'_{eq} = 3.57\ \mu F$.

② Total charge,

$C_{eq} = \frac{q}{V} \Rightarrow q = C_{eq} V$.

$= 44.6\ \mu c$.



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

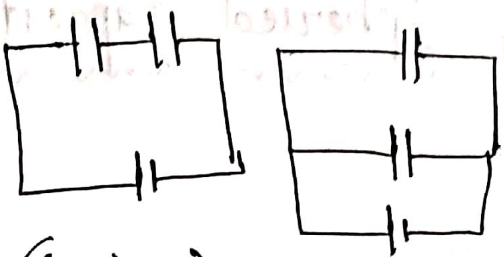
$V_3 = \frac{q_3}{C_3}$

$= \frac{44.6}{4.5}$

$V_3 = 9.91 V$

$$V_{12} = \frac{q_{12}}{C_{12}}$$

$$= 2.58\,V.$$



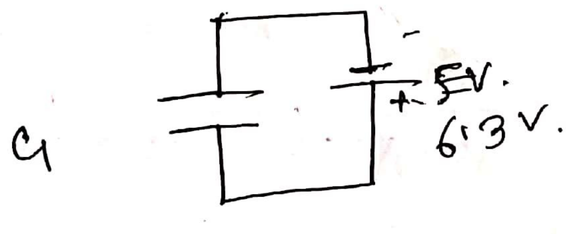
(Seri-q) (Par-v)

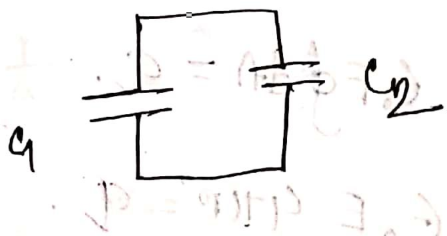
$$q_1 = C_1 V_{12} = 12 \times 2.58$$

$$= 31\,\mu C.$$

$$q_2 = C_2 V_{12} = 5.3 \times 2.58$$

$$= 13.7\,\mu C.$$

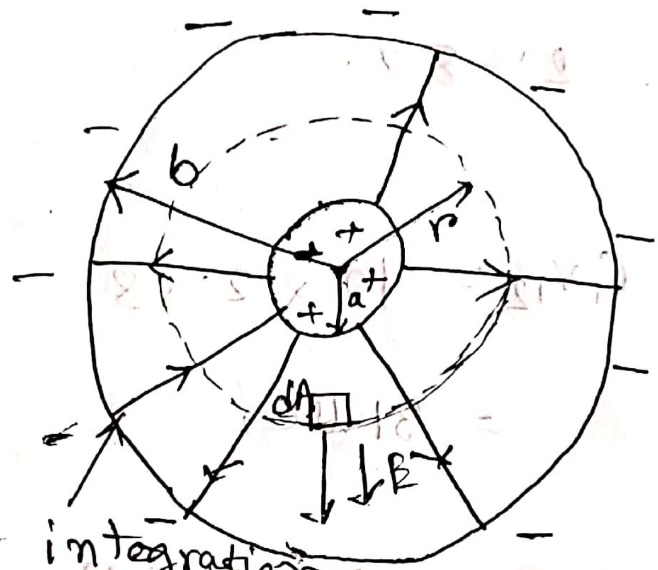




$$C_1 = 3.55\,\mu F.$$

$$C_2 = 8.95\,\mu F.$$

Spherical capacitor:



1 → charge on each plate.

$$\epsilon_0 \oint \bar{E} \cdot d\bar{A} = Q_{enc}.$$

$$\Rightarrow \epsilon_0 \oint E\, dA = q.$$

$$\Rightarrow \epsilon_0 E \oint dA = q.$$

$$\Rightarrow \epsilon_0 E \, 4\pi r^2 = q.$$

$$E = \frac{q}{4\pi\epsilon_0 r^2}.$$

Potential difference between two ~~pole's~~, plates,

$$V_B - V_A = -\int_A^B \bar{E} \cdot d\bar{l}.$$

$$= \int_A^B E dl$$

$$= -\int_A^B E . dr$$

$$= -\int_b^a \frac{a}{4\pi\epsilon_0 r^2} dr.$$

$$= -\frac{q}{4\pi\epsilon_0} \int_b^a \frac{dr}{r^2}.$$

$$V_B - V_A = -\frac{a}{4\pi\epsilon_0} \left(-\frac{1}{a} + \frac{1}{b} \right)$$

$$= \frac{q}{4\pi\epsilon_0} . \left(\frac{1}{a} - \frac{1}{b} \right).$$

$$\therefore V = \frac{q}{4\pi\epsilon_0} . \frac{b-a}{ab}$$

$$\text{Capacitance, } C = \frac{q}{V} = \frac{q}{\frac{a}{4\pi\epsilon_0} . \frac{b-a}{ab}}$$

$$= 4\pi\epsilon_0 . \frac{ab}{b-a}$$

~~Iso~~ Isolated sphere;

From spherical capacitor,

$$C = 4\pi\epsilon_0 \cdot \frac{ab}{b-a}$$

$$C = 4\pi\epsilon_0 \cdot \frac{a}{1-\frac{a}{b}}$$

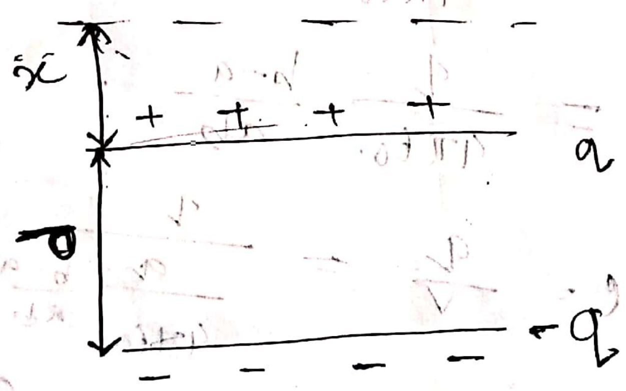
$b \to \alpha$.

$a = R$.

$\therefore\ C = 4\pi\epsilon_0 \cdot R$.

$\epsilon\ \epsilon_0\ .\epsilon_0$

Energy stored per unit volume:



$W = V'dq'$

$$\int_0^{w} dw = \int_0^{q} \frac{q'}{C}\, dq.$$

$$W = \frac{1}{C}\frac{q^2}{2}.$$

$$= \frac{1}{2}CV^2 = \frac{1}{2}qV.$$

work per unit volume, $= \dfrac{\frac{1}{2}CV^2}{Ad}$.

$$= \frac{\frac{1}{2}\frac{\epsilon_0 A}{d}V^2}{Ad}.$$

$$= \frac{1}{2}\epsilon_0 \cdot \frac{V^2}{d^2}.$$

$$= \frac{1}{2}\epsilon_0 E^2.$$

Again we know,

$$Fx = W.$$

$$F = q.\frac{E}{2}.$$

$$\therefore W = q.\frac{E}{2}.x.$$

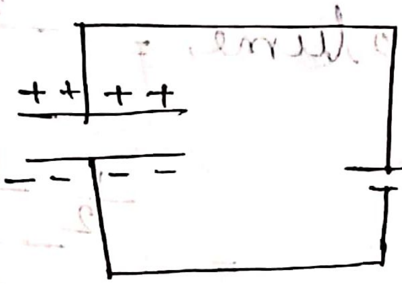
$$= \frac{1}{2}qV.$$

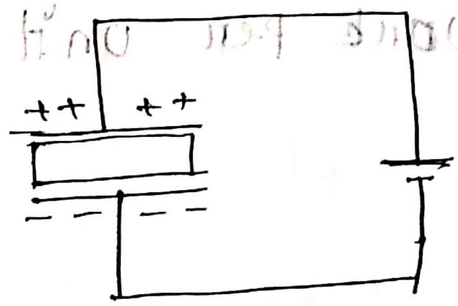
Capacitor with dielectric material :

1) When battery is connected;

$q = \frac{c}{v}$.

$V = Ed$.



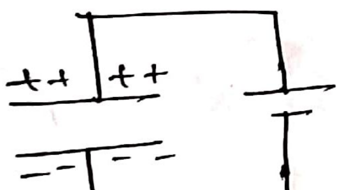


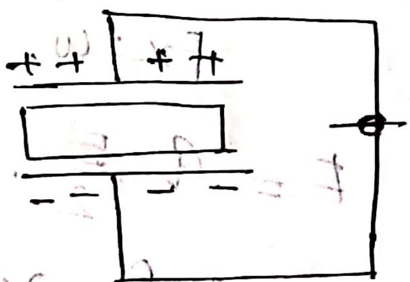
$q \rightarrow$ increase $C \rightarrow$ increases

$E \rightarrow$ unchanged

$V \rightarrow$ unchanged.

2) When Battery is removed;



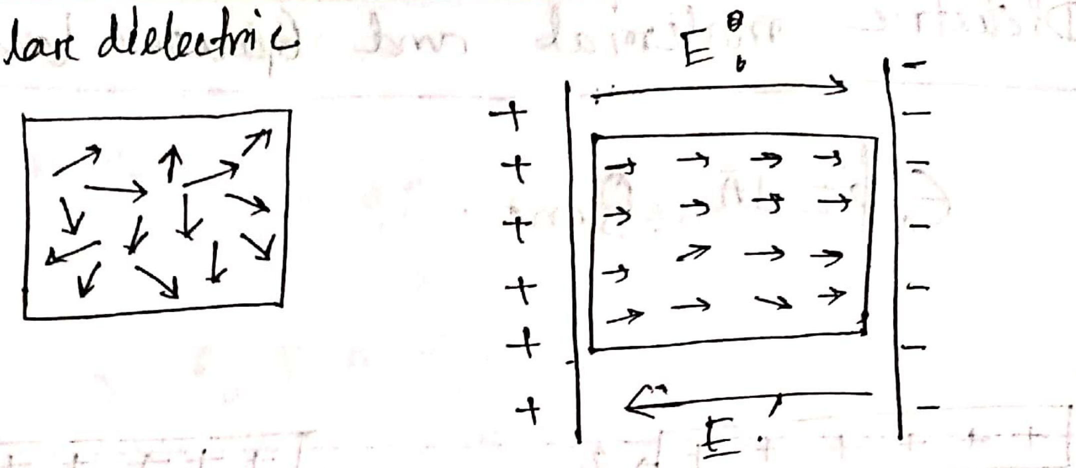


$q \rightarrow$ unchanged. $C \rightarrow$ increases.

$E \rightarrow$ decreases.

$V \rightarrow$ decreases

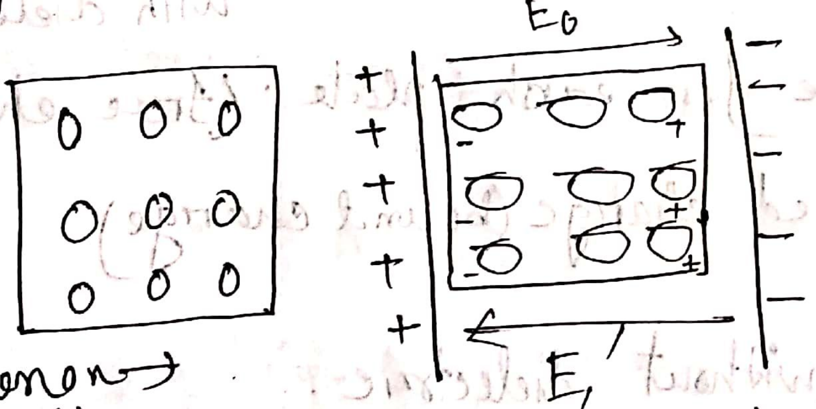
Polar dielectric



net Field, $E = E_0 - E'$.

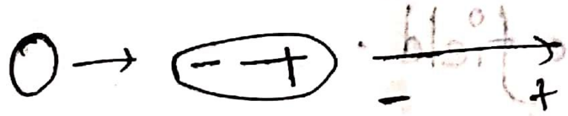
Non-polar-dielectric:

$c = \frac{q}{V}$.



$\therefore$ Net Field
$E = E_0 - E'$.

Phenomenon → polarization:-



induced dipole.

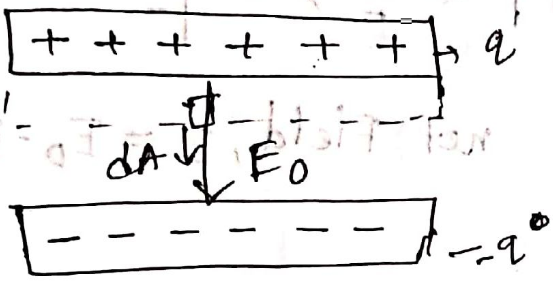
induced dipole moment.

dielectric constant, $K = \frac{E_0}{E}$ or $K = \frac{V_0}{V}$,

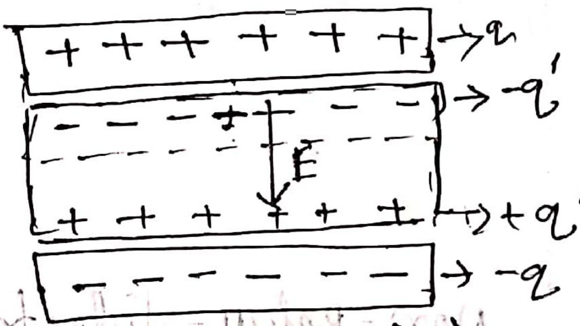
$K = \frac{C}{C_0}$

Dielectric material and Gauss's law:

$$\epsilon_0 \oint \vec{E}\, d\vec{A} = Q_{enc}$$



without dielectric



with dielectric.

$q \rightarrow$ charge for each plate (free charge).

$q' =$ induced charge (bound charge)

$E_0 \rightarrow$ field without dielectric.

$E' \rightarrow$ induced electric field.

$E \rightarrow$ net field when dielectric material is used.

$A \rightarrow$ plate area.

$$\Rightarrow \frac{q}{K} = q - q'$$

$$\Rightarrow q' = q - \frac{q}{K} = q\left(1 - \frac{1}{K}\right)$$

When, $K = 1$, $q' = 0$.

Gauss law,

$$\epsilon_0 \oint \bar{E} \cdot d\bar{A} = q - q'$$

$$\Rightarrow \epsilon_0 \oint \bar{E} \cdot d\bar{A} = \frac{q}{K}$$

$$\Rightarrow \boxed{\epsilon_0 \oint K\bar{E}\, d\bar{A} = q}$$

→ Gauss law when there is dielectric medium.

without dielectric,

Gauss law, $\epsilon_0 \oint \vec{E} \cdot d\vec{A} = Q_{enc}$.

$\Rightarrow \epsilon_0 \cdot E_0 A = q$.

$\Rightarrow E_0 = \dfrac{q}{\epsilon_0 A}$. —— (I)

with dielectric medium,

Gauss' law; $\epsilon_0 \oint \vec{E} d\vec{A} = Q_{enc}$.

$\Rightarrow \epsilon_0 . E A = q - q'$.

$\Rightarrow E = \dfrac{q - q'}{\epsilon_0 A}$.

$= \dfrac{q}{\epsilon_0 A} - \dfrac{q'}{\epsilon_0 A}$. —— (II)

we know,

$E = \dfrac{E_0}{K}$

$= \dfrac{q}{K \epsilon_0 A}$. —— (III)

$\therefore E = E_0 - E'$.

from (II) and (III), $\dfrac{q}{K \epsilon_0 A} = \dfrac{q}{\epsilon_0 A} - \dfrac{q'}{\epsilon_0 A}$.

Q-5: Figure 30-12 shows a dielectric [illegible]

b and dielectric constant K placed between the plates of a parallel plate capacitor of plate area A and seperation d. A potential difference V_0 is applied with no dielectric present, the battery is then disconnected and the dielectric slab inserted.

Assume that $A = 100\ cm^2$, $d = 1.0$ cm, $b = 0.50$ cm

$K = 7.0$, $V_0 = 100$ volts.

a) Calculate the capacitance C_0 before the slab is inserted.

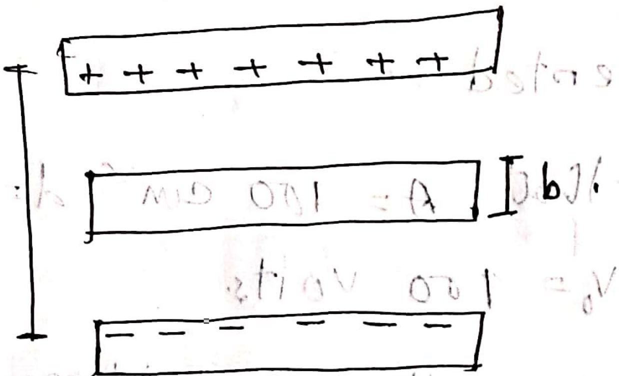
b) calculated the free charge q.

c) Calculate the electric field strength in the gap.

d) Calculate the electric field strength in the dielectric.

e) Calculate the potential difference between the plates.

f) Calculate the capacitance with the slab in place.



a) $C = \frac{\epsilon_0 A}{d} = \frac{8.854\times10^{-12}\times 100\times10^{-4}}{1\times10^{-2}}$

$= 8.9 \mu\mu F$

b) $q_0 = C_0 V_0 = 8.9\times10^{-12}\times 100$

$= 8.9\times10^{-10} C$

c) $$E_0 = \frac{q_0}{\epsilon_0 A} = \frac{8.9\times10^{-10}}{8.854\times10^{-12}\times100\times10^{-4}}$$

$$= 10^4\ \mathrm{V\,m^{-1}}.$$

d) $$E = \frac{E_0}{K} = \frac{10^4}{7.0} = .14\times10^4\ \mathrm{Vm}$$

e) $$V = -\int_{i}^{V} \vec{E}\cdot\vec{dl}$$

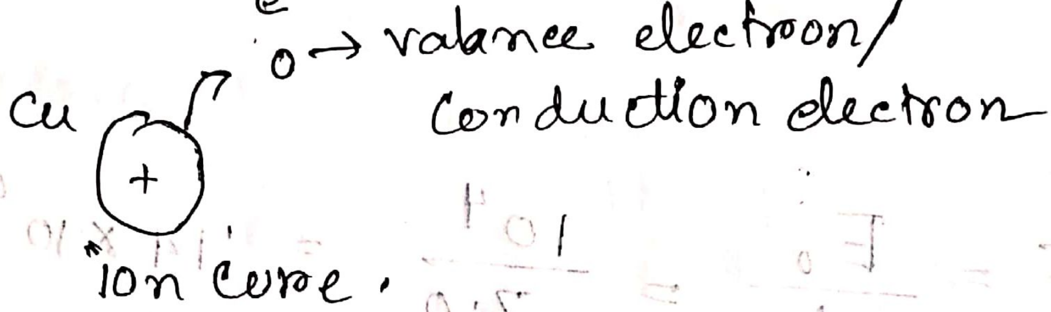
$$= E_0(d-b) + Eb.$$

$$= 57\ \mathrm{V}.$$

f) $$C = \frac{q_0}{V} = \frac{8.9\times10^{-10}}{57}$$

$$= 16\ \mathrm{PF}.$$

current, current density, resistivity, Conductivity ; drift velocity.



Drift velocity of Cu:

$n \rightarrow$ no. of electron per $m^3 \simeq 10^{29}$.

average velocity $\langle v \rangle \simeq 10^6 \; ms^{-1}$.

Time between two colision, $\tau = 3 \times 10^{-14}$ s.