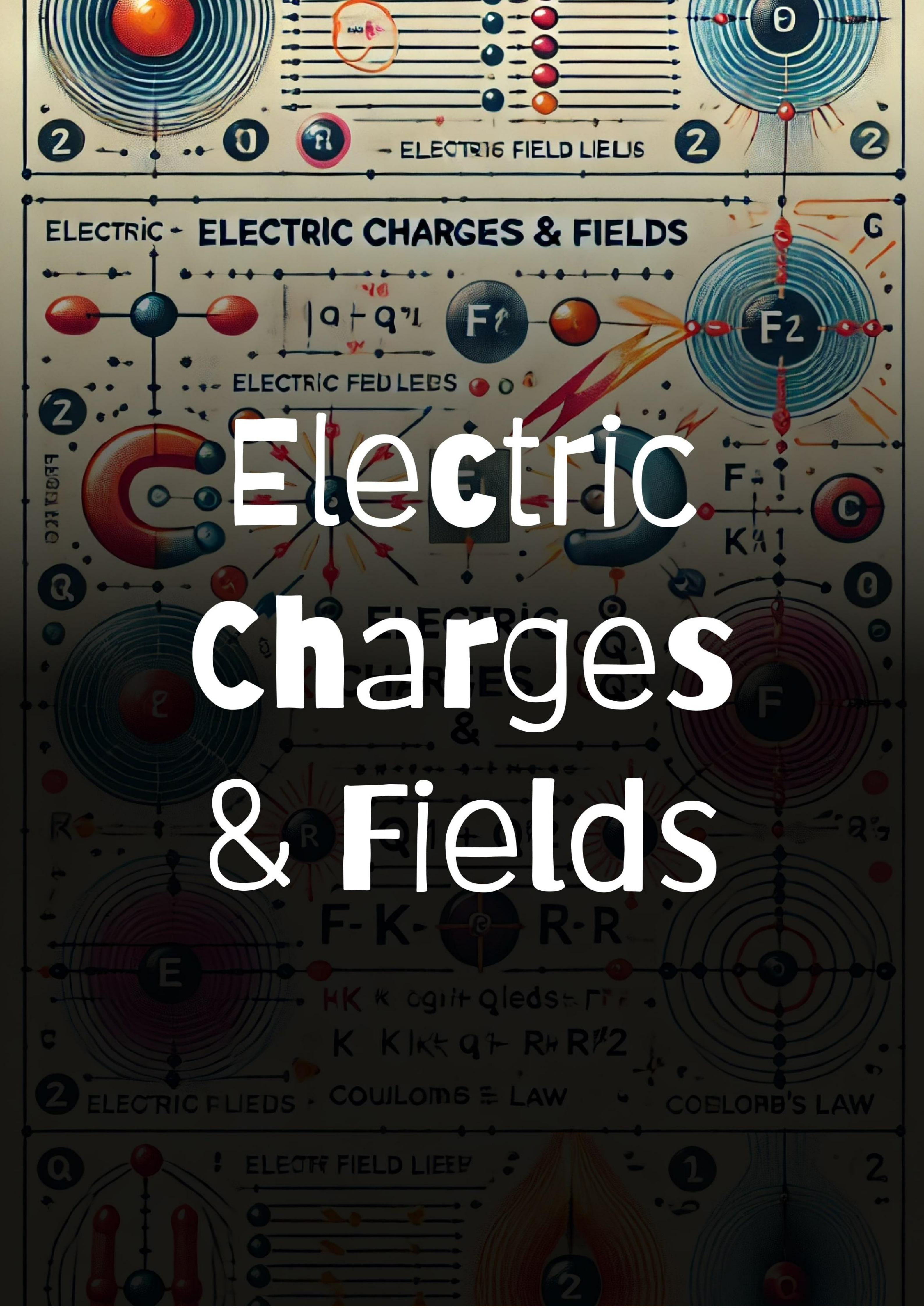


Electric Charges & Fields

Electric Charge and field

Charge → Charge is a property of object due to which it Experience or produce electromagnetic force..

Mass → quantity of matter contained in a body

ρ (density) = $\frac{\text{total mass}}{\text{Volume}}$.

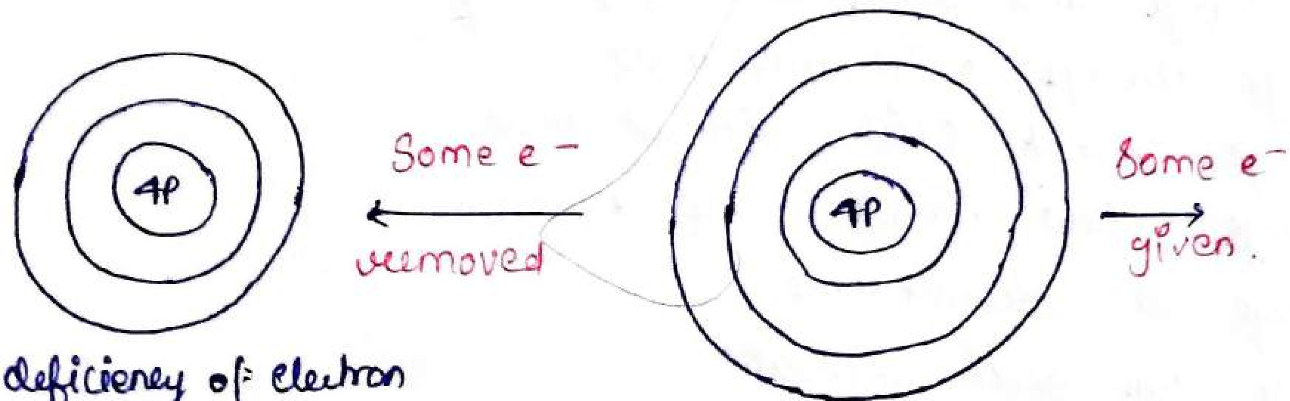
Mass → Property of object due to ~~other~~ which it attract every other matter in the Universe by gravitational force.

Mass ⇒ Mass is nothing but form of energy
$E = mc^2$

Electric field and Charges =

Charge	Electric field	Magnetic field	EM wave
Rest	✓	✗	✗
Const. Velocity	✓	✓	✗
accelerated	✓	✓	✓

How does a body attain any charge

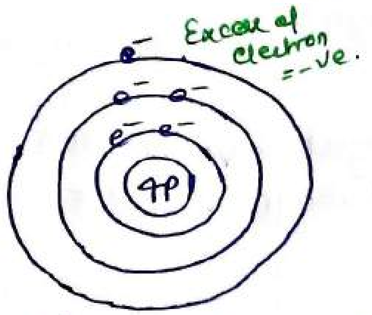


= deficiency of electron
= no of P > no. of e^-
θ = +ve

$m_\theta < m_0 < m_1$

Neutral
No. of P = No. of e^-

$Q_{net} = 0$



No. of Proton < no. of e^-

$Q = -ve$ mass — Increased.

$m_1 > m_0$

Charge

Property of object by virtue of which it apply or experience electromagnetic force

= Scalar
= S.I unit — Coloumb
C.G.S unit — e.s.u (electrostatic unit)
= 1 frankline.

$1C = 3\times10^9$ esu $= 3\times10^9$

Practical Unit - emu
Smallest Unit - e.su
Largest Unit - faraday.

Types of charge

1. Positive charge - deficiency of e^-
2. Negative charge — Excessness of e^-

Neutral body is not a type of charge. It mince uncharged body.

no. of electrons = no. of Proton.

Ex: Neutron.

⇒ Same nature of charge
⇒ same charge repel each other
⇒ One charge and other Uncharged may attract
⇒ Charge always exist with mass
⇒ Charge cannot exist without mass
⇒ Charge follow simple scalar addition
⇒ Charge is transferable
= Mass can exist without.

Charge is Invarient

Value of charge on the body does not depend on the speed of body and also Independent upon frame of reference

Q1 A Positively charge body can be make neutral by

An giving same e^-

Q During charging of body mass of the body Increase then body becomes

An Negatively charge

Qy Smallest unit of charge

frankline

Q If a body has positive charge on it. then It means it has loss some electrons

Q Sure check for Presence of electric Charge ie.

(1) Production of Induction
(2) Repulsion b/w bodies
(3) Attraction b/w bodies
(4) frictional force b/w bodies

Charge is conserved →

1. Conservation of momentum
2. " " Angular momentum
3. " " Energy
4. " " Charge

Que Charge developed

Que find no. of e^- transferred to create 1C charge.

$$Q = ne$$

$$1C = n \times 1.6 \times 10^{-19} C$$

$$n = \frac{1}{1.6 \times 10^{-19}} = \frac{10 \times 10^{18}}{1.6} = \boxed{n = 6.25 \times 10^{18}}$$

> # Air is Insulator upto Certain limit after that it became Conductor

Que A glass rod is rubbed

$$Q = 19.2 \times 10^{-19} C = ne$$

$$19.2 \times 10^{-19} C = n \, 1.6 \times 10^{-19}$$

$$n = \frac{19.2}{1.6} = \frac{192}{16} = 12$$ **Ans**

Quantization of charge

Possible charges are :-

(i) $Q = 1.6 \times 10^{-20} C$ = Not Possible

(ii) $Q = 0.1 e$ = Not Possible

(iii) $Q = 1.6 \times 10^{+20} C$ - Possible

(iv) $Q = 0.1C$ - Possible.

(v) $Q = 6.4 \times 10^{-17} C$ = Possible

Specific charge

$$\sigma = \frac{Q}{mass}$$

Proton = $\sigma = \frac{e}{m_p}$

Deutron = $(1P + 1N)$ $({}_1H^1)$

$$\sigma_D = \frac{e}{2m_p}$$

α- particle = $[{}_2He^4]$ $[2P + 2N]$

$$\sigma_4 = \frac{2e}{4m_p} = \frac{e}{2m_p}$$

If Speed Increase then mass Increase but charge same

$$\sigma = \frac{Q \leftarrow \text{Same}}{m\uparrow}$$

σ (decrease with Increase in speed)

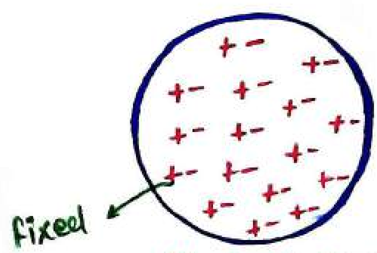
If Speed is decreasing then specific charge will Increase

$$(\uparrow \sigma) = \frac{Q}{m\downarrow}$$

CONDUCTOR ⇒ Have large no. of free e^-s

(a) at Surface

(b) Inside volume of conductor



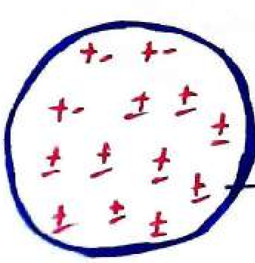
Neutral Conductor.

Excess charge given to conductor always reside on the Surface of Conductor.

Conductor allow flow of charge

Insulator ⇒

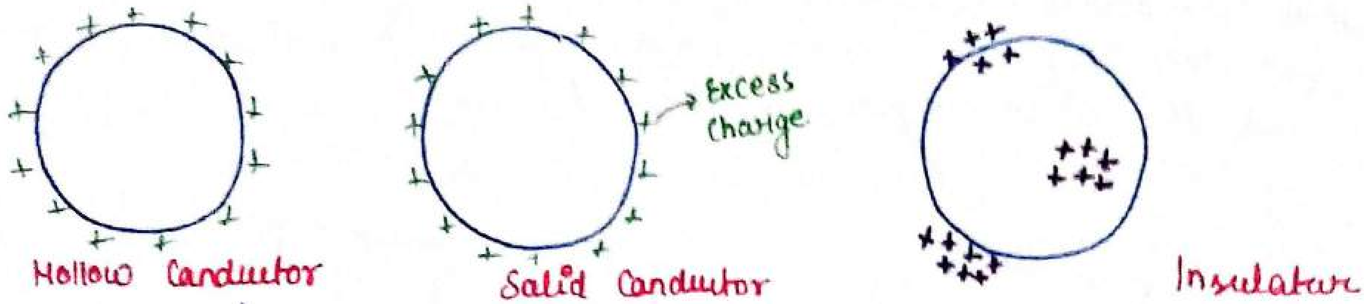
Excess charge remains there where it is placed.



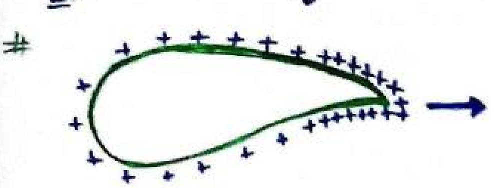
These e^- are highly & Strongly Bonded.

INDUCTION = Separation of charge

Excess charge



Ex:



In Conducture

In Insulator

Que If a solid and a hollow conducting sphere have same radius then.

① Hollow

② Solid

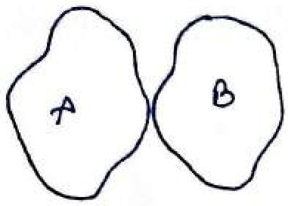
③

④

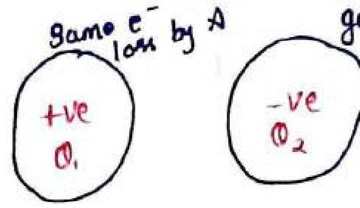
Charging of A Body

Charging by friction ⇒ Only for Insulator.

When two bodies are rubbed together, electrons, are transfered from one body to other making one body Positively charged and the other negatively charged.



Both are neutral Insulator

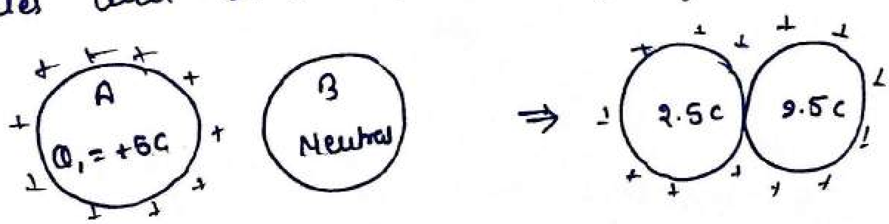


$$|Q_1| = |Q_2|$$

equal and opposite nature of charge created.

Charging by Conduction ⇒ For Conductor.

Conduction from a charged body Involve transfer of like charges. A positively charged body. can cause more bodies to get positively charged. but the sum of the total charge on all positively charges bodies will be the same as charge an initial Considered Charged Body



a & b are touched

Que When 10^{14} electrons

① 16 μC ✓
② -16 μC
③ -32 μC
④ 32 μC

$Q = ne$

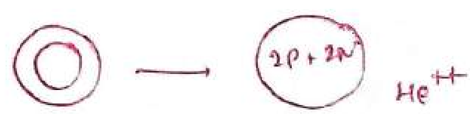
$10^{14} \times 1.6 \times 10^{-19}$

$1.6 \times 10^{-5} C$

$= \boxed{16\ \mu C}$ B

Que Charge on α- particle is

① 4.8×10^{-19}
② $3.2 \times 10^{-19} C$ ✓
③ $1.6 \times 10^{-19} C$
④ $6.4 \times 10^{-19} C$



Qu A body has -80 micro columb of charge

(1) 8×10^{-5}
(2) 80×10^{-17}
(3) 5×10^{14}
(4). 1.28×10^{-14}

$Q = ne$

$-80 \times 10^{-6} = -n \times 1.6 \times 10^{-19}$

$50 \times 10^{-6} \times 10^{19} = n$

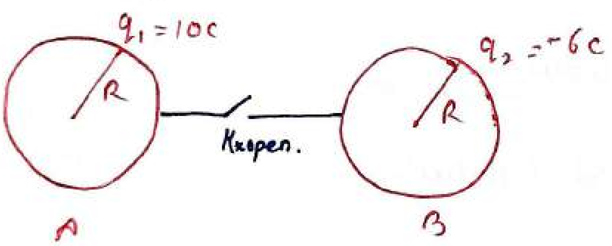
$\boxed{50 \times 10^{13} = n}$

+ve = deficiency e^-

Qu A Conductor has

(1) 9 electron in excess
(2) 27 electron in short
(3)
(4)

Qu Find charge



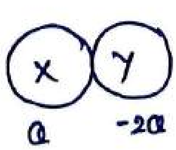
$q'_{1\,final} = \left(\frac{R}{R_1+R_2}\right)(10-6) = \frac{1}{2} \cdot 4 = 2c$

$q'_{2\,final} = +2c$

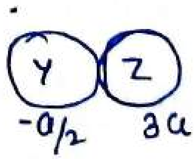
Qu When three identical sphere X, Y and Z having charge Q, -2Q and 3Q respectively. At first X and Y are in contact then Y and Z are in contact then final charge on X, Y and Z will be.

(1) $\frac{Q}{2}, \frac{3Q}{2}, \frac{Q}{2}$
(2) $\frac{-Q}{2}, \frac{5Q}{4}, \frac{+5Q}{4}$ ✓
(3) Q, Q, Q
(4) $\frac{Q}{2}, \frac{3Q}{2}, \frac{-Q}{2}$

X & Y in contact

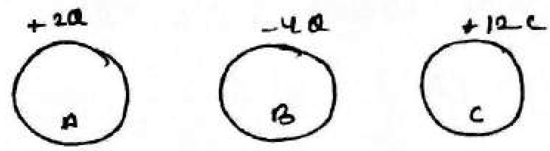


$Q_x = -\frac{Q}{2}$ $Q_y = -\frac{Q}{2}$



$= Q_y = \frac{5Q}{4} = Q_z$

Qu



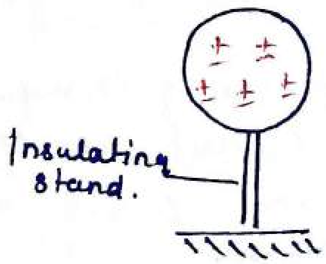
1st A & C are touched then B & C are touched then final Charge on each sphere

$Q_B = Q_C = \frac{11C}{2}$

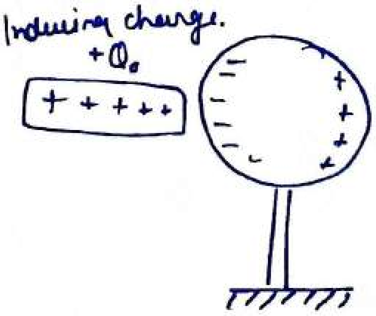
Charging by Induction ⇒

A body Can be charged by Induction ⇒

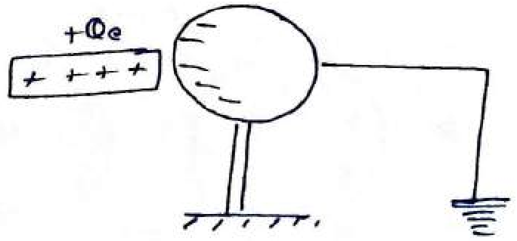
Step-1 Take an Isolated neutral Conductor.



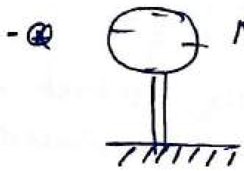
Step-2 Take A Positively or negatively charge Rod near to sphere



Step 3 Now earthing the sphere.

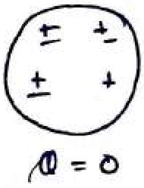


Step- 4 Removing earthing & Rod.



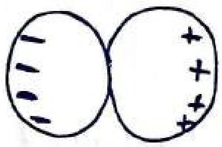
* 2nd method of Inducting

Step- 1 = take a Neutral sphere



Step = 2 = Placed A +Qo charge near to sphere

Step = 3 Now take Identical Neutral sphere & placed in contact with this sphere

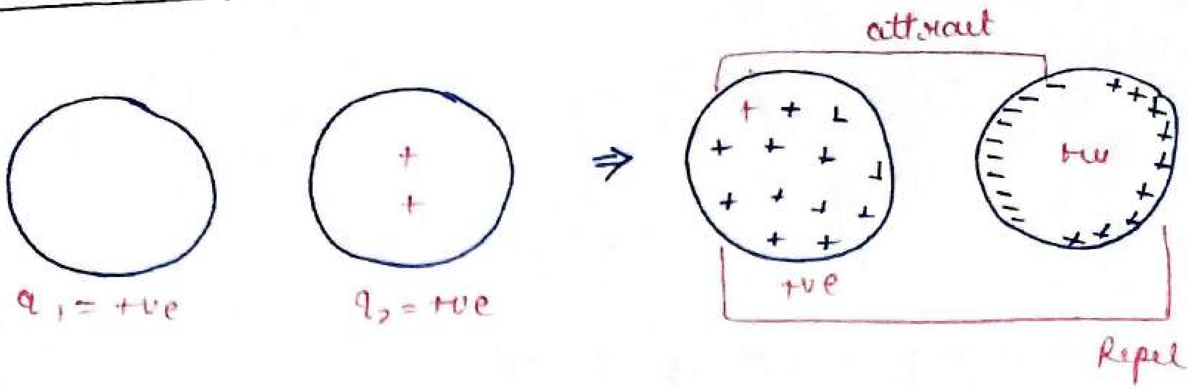


Step = 4 Remove 2nd sphere & +Qo charge

$Q_{Induced} = -Q_{Inducing}$ (for Conductor)

$Q_{Induce} \leq Q_{Inducing\ Charge}$

Attractive force b/w same nature of charge body



(attraction

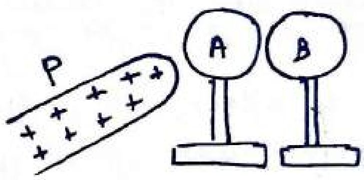
Que Two uncharged metal sphere placed in contact as shown in figure and A positive charged rod placed in contact with A, then charge on A and B will be

(1) Both became +ve ✓

(2) Both became -ve

(3) A -ve and B became +ve

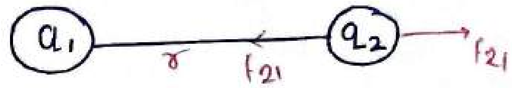
(4) A became +ve and -ve



Que Two uncharged

Que In induction the charge induced

Coulombs low ⇒



$|\vec{F}_{12}| = |\vec{F}_{21}|$

action reaction pair

$|\vec{F}_{21}| \propto \frac{q_1 q_2}{r^2}$

$|\vec{F}_{21}| = \frac{K q_1 q_2}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

ε_0 = Permittivity of free space
↓
Property of medium which define electric field line

Electrostatic → Central force / always along line joining.
- → Conservative
- → long range / infinite
- → follow - Inverse square law
- → depends on medium
- → conservative In nature
- → may be attractive or repulsive
- → mediated by photon.

** gravitational force always attractive

$|F_{21}| = |\vec{F}_{12}| = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$

$K = \left(\frac{1}{4\pi\varepsilon_0}\right) = 9 \times 10^9\ Nm^2/c^2$

air free space

$|\vec{F}_{21}| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$

↳ force on 2nd charge due to 1st charge

→ Net electrostatic on 2nd charge

other medium (ε_0)

$|\vec{F}_{21}| = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

↳ force on 2nd charge due to 1st charge

other medium (ε_m)

$\vec{F}_{(2^{nd})} = \frac{q_1 q_2}{4\pi\, \varepsilon_m r^2}$

↓ Net electrostatic force on 2nd charge

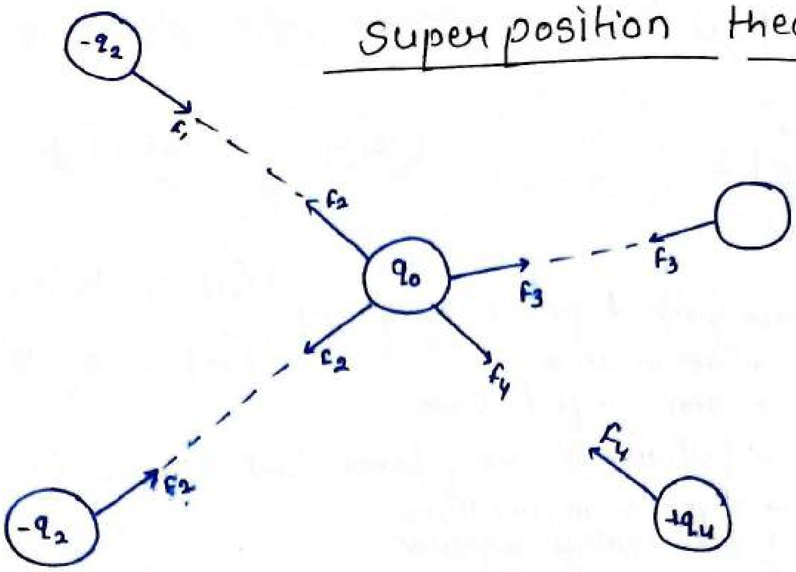
$\varepsilon_0 = 8.85 \times 10^{-12}\ c^2/Nm^2$

(A) Electrostatic force depend on medium

(B) Electrostatic force on one charge due to other does not depend on medium.

1. Both are ~~true~~ ✓
2. Both are false
3. A — T , B — false
4. A — F — B — T

Superposition thearum



\# $\vec{F}_{net} = \vec{F_1} + \vec{F_2} + \vec{F_3} + \vec{F_4} - - -$
on q_0

force b/w any two charges does not depend on presence of other charge and medium.

Relative permittivity / dielectric constant =

$K = \varepsilon_r = \frac{\varepsilon_m}{\varepsilon_0}$

└ unit less, dimension less

$\boxed{\varepsilon_m = \varepsilon_r \varepsilon_0}$

$\boxed{\varepsilon_m = \varepsilon_r \varepsilon_0 = K\varepsilon_0}$

$$F_0 = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2} \qquad F_m = \frac{q_1 q_2}{4\pi\varepsilon_m r^2} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2 K} = \frac{F_0}{K} = \frac{F_0}{\varepsilon_r}$$

Qu Two charge of 1 nC

$$F = \frac{K q_1 q_2}{r^2} = \frac{9\times10^9 \times 1\times10^{-9} \times 1\times10^{-9}}{(3\times10^{-2})^2}$$

$$\frac{9\times10^{-9}}{9\times10^{-4}} = \frac{10}{10}\times10^{-5}\ N = \boxed{10\,\mu N}$$

Que Charge 3 esu and 12 esu is placed at 3 cm then find electrostatic force.

$1C = 3\times10^9$ e.s.u

$q_1 = 3$ esu $= 3 \times \frac{1C}{3\times10^9} = 10^{-9}$ C

$q_2 = 12$ esu $= \frac{1}{3\times10^9} \times 12^4 = 4\times10^{-9}$ C

$F_{12} = \frac{9\times10^9 \times 10^{-9} \times 4\times10^{-9}}{(3\times10^{-2})^2}$

4×10^{-5} N

4 dyne

Que Two charge q_1 & q_2 apply force on each other F_0 when in air find force applied on each other when placed in a medium of dielectric Constant 81. also find net force on charge in medium.

Sol^n (1) $F_m = \frac{F_0}{81}$

(2) $F_m = F_0$ ✓

(3) $F_m = 81 F_0$

Que F_g and F_e represent

(1) 10^{42} ✓

(2) 10

(3) 1

(4) 10^{-4}

$$\frac{F_g = \frac{Gm^2}{r^2}}{F_e = \frac{ke^2}{r^2}} = \frac{6.6\times10^{-11}\times10^{-60}}{9\times10^9\times(1.6\times10^{-19})^2} = \frac{10^{-80}}{10^{-38}} = 10^{-42}$$

Que

$F = \left(\frac{Kq_1q_2}{r^2}\right) = 64$ N

$F' = \frac{K2q_1 2q_2}{(4r)^2} = \frac{4}{16}\frac{Kq_1q_2}{r^2}$

$= \frac{64}{4} =$ **16 N**

$F \propto \frac{q_1q_2}{r^2} =$

Que Charges Q, q

① q

② Q/2

③ -Q/2

④ -Q

Que A charge q is

① Q/4

② -Q/4 ✓

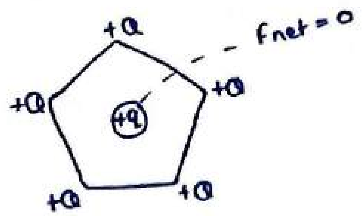
③ Q

④ -Q/8

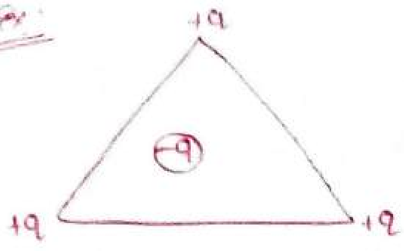
$$\frac{KQ^2}{2a^2} = \frac{KQq}{a^2}$$

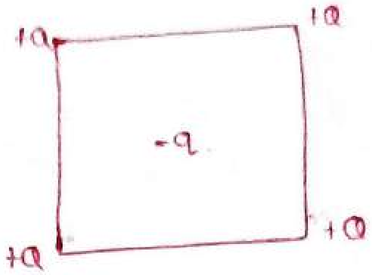
$$\frac{Q}{4} = q$$

Que Two small Conducting



Ex:

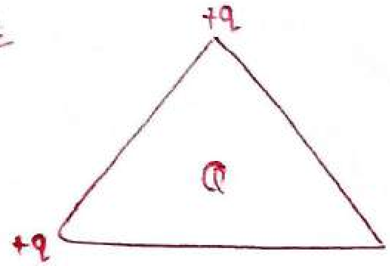




Fnet = 0

Fnet = 0

Ex:



⇒

Fnet on Q which is at Centre =

Que Five point charges, each of value +q, are placed on five vertices of a regular

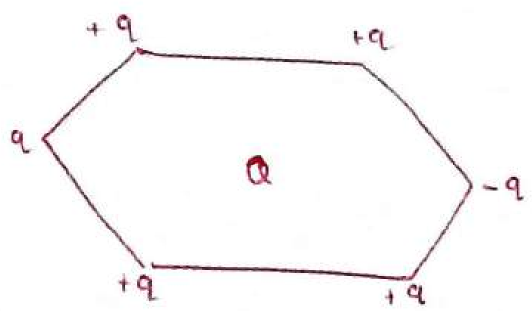
(1) $\frac{1}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

(2) $\frac{q}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

(3) $\frac{1}{2\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

(4) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$ ✓

Qu Find net force on charge Q which is at Centre



Qu Find position of 3rd charge so that force on 3rd charge will zero

① 

② 

③ 

Que Two charge Q_1 and Q_2 shows repulsion then which of the following option is correct for this.

1. $Q_1 \times Q_2 = 0$
2. $Q_1 \times Q_2 > 0$ ✓
3. $Q_1 Q < 0$
4. all of these

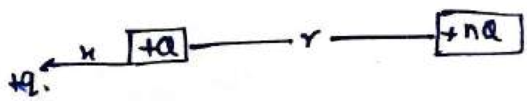
Que Find position of 3rd charge q in given system so that net force experienced by q is zero.

$F_{net} = 0$

$F_1 = F_2$

Opposite nature

From small charge. $\boxed{x = \frac{r}{\sqrt{x}+1}}$



$x = \frac{r}{\sqrt{x}-1}$

Que Find position and value of 3rd charge so that complete system will be in equilibrium.

$x = \frac{r}{\sqrt{x}+1}$

Step-1

1. Find position of 3rd charge so that 3rd charge in equilibrium.
2. Find nature of third charge.
3. Find value of 'q' so that force on any other two charge is zero

Fnet on +Q is zero

$$\frac{KQq}{\left(\frac{r}{\sqrt{x}+1}\right)^2} = \frac{K nQQ}{r^2}$$

$$q(\sqrt{x}+1)^2 = nQ$$

$$\boxed{q = \frac{nQ}{(\sqrt{x}+1)^2}}$$

$$\boxed{q = \frac{nQ}{(\sqrt{n}-1)^2}}$$

for opposite nature of initial two charge

Q. Find distance from 9Q where charge is placed to Experience zero force.

$$x = \frac{18}{\sqrt{9}-1} = \frac{18}{3-1} = \frac{18}{2} = 9m$$

from 9Q dist = 18 + 9 = 27 Ans

Que Find the Values and Position of q so that system will be in equilibrium.

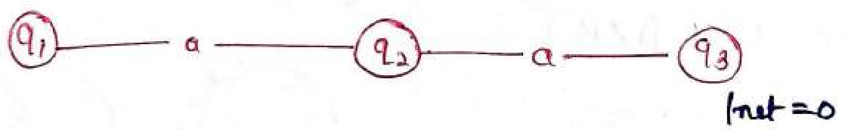
+Q ———— 10m ———— +16Q

$$x = \frac{10}{\sqrt{16}+1} = \frac{10}{5} = 2m \text{ from } +Q \quad \& \quad 10-2 = 8m \text{ from } 16Q.$$

- (q) Ka nature = −ve

$$q = \frac{16Q}{(\sqrt{16}+1)^2} = \frac{-16Q}{25}$$

Qu If net force q_3 is zero than find relation b/w q_1 and q_2



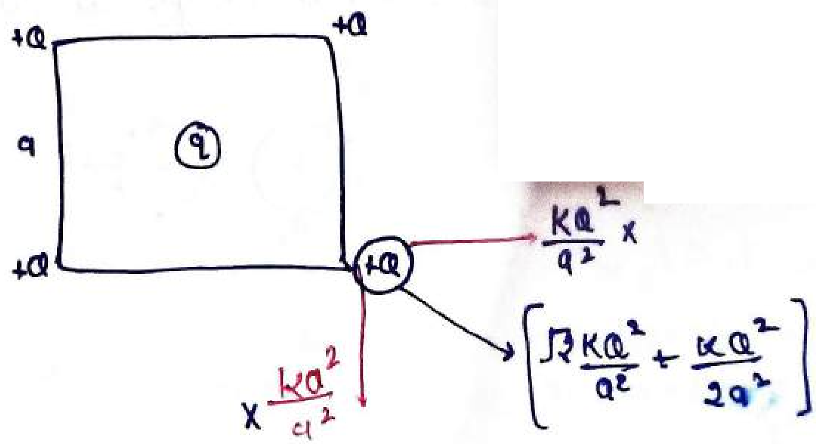
$$\frac{Kq_1 q_3}{(2a)^2} = \frac{Kq_2 q_3}{a^2} \Rightarrow \frac{q_1}{4} = q_2$$

$$\boxed{q_1 = -4q}$$

Qu Find Value of q so that system is in equilibrium.

Net force on q
Placed at centre = 0

q must be = −ve



$$\frac{KqQ}{\left(\frac{a}{\sqrt{3}}\right)^2} = \frac{KQ^2}{a^2}\left[\sqrt{2} + \frac{1}{2}\right]$$

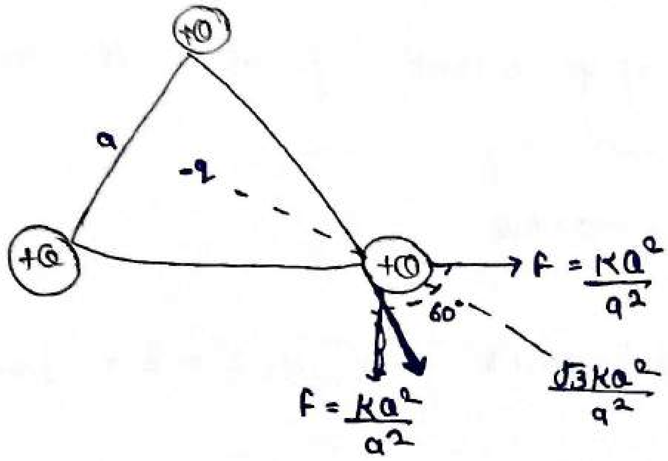
$$2q = Q\left[\frac{2\sqrt{2}+1}{2}\right]$$

$$q = \frac{Q}{4}(2\sqrt{2}+1)$$

$$\boxed{q = -\frac{Q}{4}(2\sqrt{2}+1)}$$

Ans

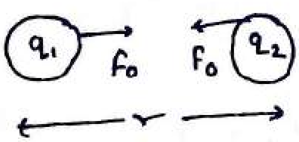
Que

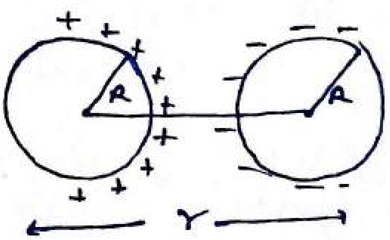


$$\frac{3KqQ}{a^2} = \sqrt{3}\,KQ^2$$

Que electrostatic attraction b/w two point charge is F_0. when they are placed at r. If they are given to the conducting sphere of radius R. Then electrostatic attraction will be. If distance b/w centre of sphere is r (r > R)

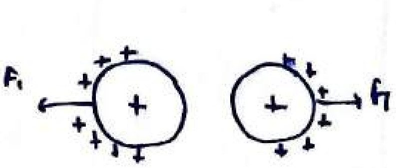
1. $F > F_0$ ✓
2. $F < F_0$
3. $F = F_0$
4. zero

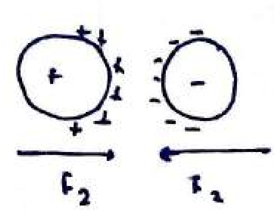




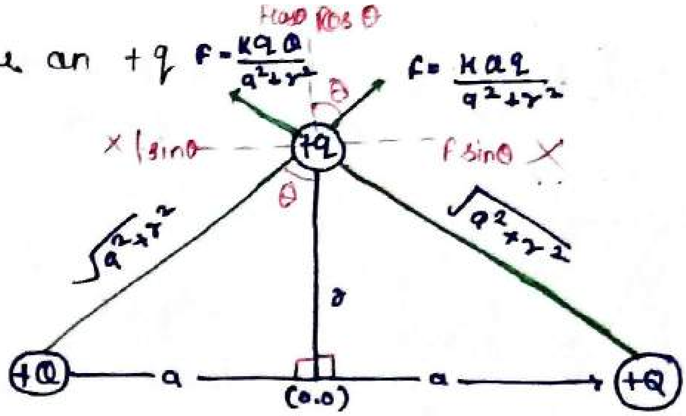
Que Two Identical sphere are given equal charge in one case & opposite charge in another case having force F_1 & F_2 respectively. distance b/w sphere is not large as compare to diameter then compare F_1 & F_2.

1. $F_1 > F_2$
2. $F_1 = F_2$
3. $F_1 < F_2$ ✓
4. Information is not sufficient to draw the conclusion.



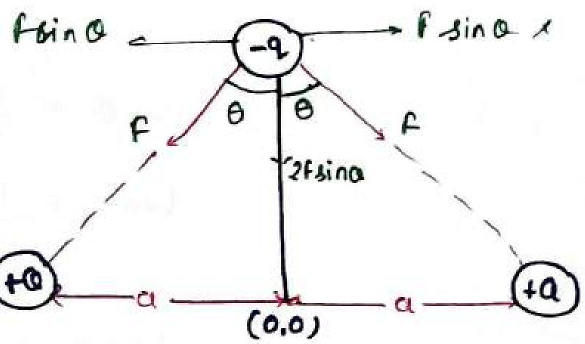


Qu. Find force on +q



$F_{net} = 2F\cos\theta$

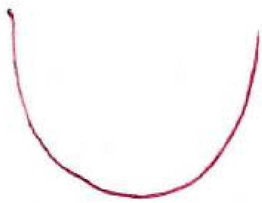
$$2\frac{KQq}{(a^2+r^2)} \times \frac{r}{\sqrt{a^2+r^2}} = \boxed{F_{net} = \frac{2KQqr}{(a^2+r^2)^{3/2}}}$$



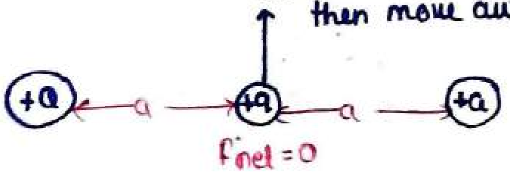
$$\boxed{F_{net} = \frac{2KQqr}{(a^2+r^2)^{3/2}}}$$

Unstable Equilibrium

Stable Equilibrium



Ex!



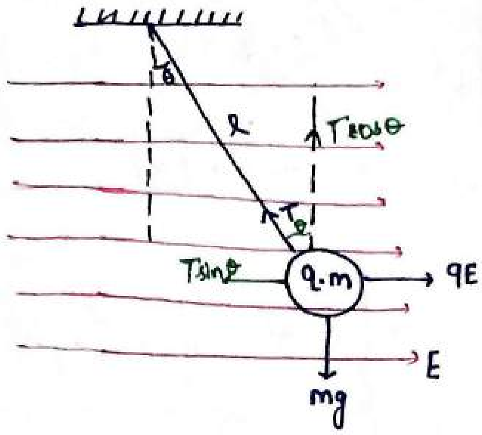
Unstable equilibrium in y-axis.

Released then move toward centre

Stable Equilibrium in x-axis.

Pendulum problem

→ Force on a charge in electric field is $F = qE$



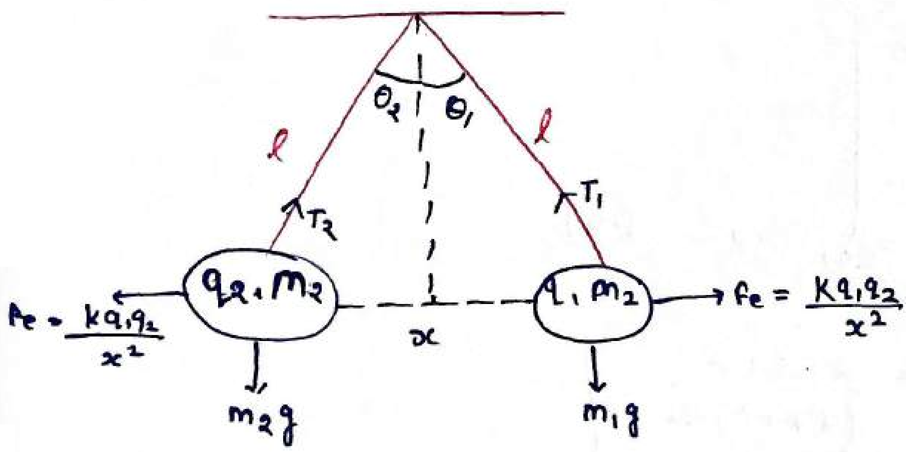
$\Sigma F_y = 0$ $\quad$ $\Sigma F_x = 0$

$T\cos\theta = mg$ — (I) $\quad$ $T\sin\theta = qE$ — (II)

(II)/(I)

$$\frac{T\sin\theta}{T\cos\theta} = \frac{qE}{mg}$$

$$\boxed{\tan\theta = \frac{qE}{mg}}$$



$$\tan\theta = \frac{qE}{mg}$$

$$\tan\theta_1 = \frac{Kq_1q_2}{x^2 m_1 g} \quad \text{— (I)}$$

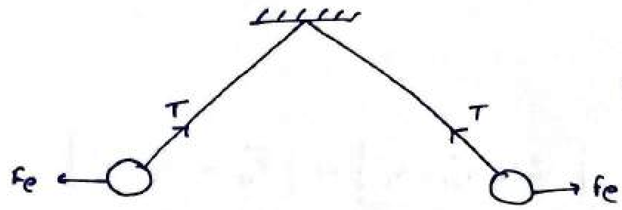
$$\tan\theta_2 = \frac{Kq_1q_2}{x^2 m_2 g} \quad \text{— (II)}$$

$$\frac{(I)}{(II)} \quad \boxed{\frac{\tan\theta_1}{\tan\theta_2} = \frac{m_2}{m_1}}$$

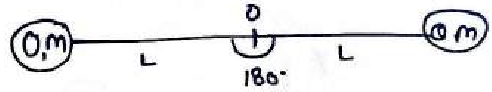
Ratio of θ_1 & θ_2 does not depend on charges q_1 & q_2.

Ques

(1) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$ $\quad$ (2) $90°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

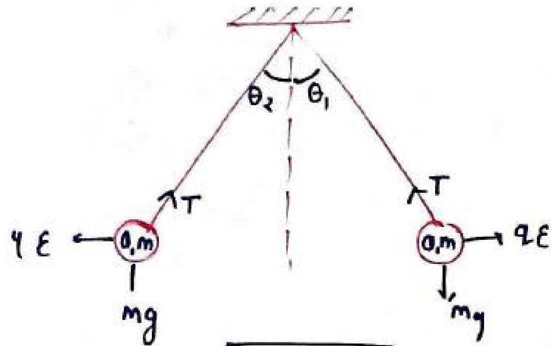


$\Rightarrow$



$$\boxed{T = \frac{KQ^2}{4L^2}}$$

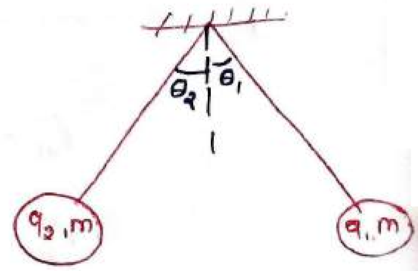
Qu



$$\boxed{\theta_1 = \theta_2}$$

Identical same

Qu



If $q_1 > q_2$

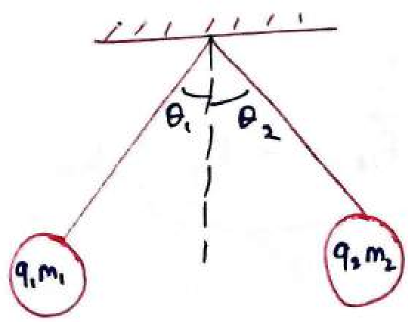
& $m_1 = m_2 = m$

(1) $\theta_1 > \theta_2$ (2) $\theta_1 < \theta_2$ (c) $\theta_1 = \theta_2$ ✓

$$\frac{\tan\theta_1 = \frac{Kq_1q_2}{x^2 m_1 g}}{\tan\theta_2 = \frac{Kq_1q_2}{x^2 m_2 g}}$$

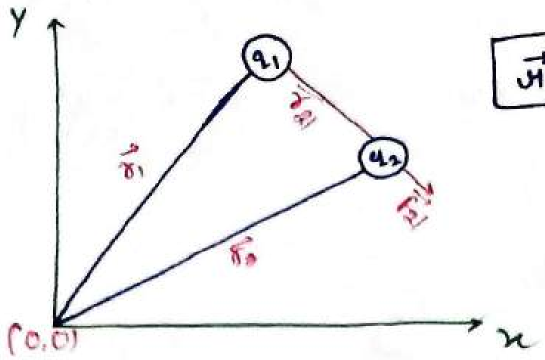
$$\boxed{\tan\theta_1 = \tan\theta_2}$$

Qu



If $q_1 > q_2$ but $m_1 < m_2$ then Correct

(1) $\theta_1 = \theta_2$ (2) $\theta_1 > \theta_2$ (3) $\theta_1 < \theta_2$



$\boxed{\vec{r}_1 + \vec{r}_{21} = \vec{r}_2}$ or $\boxed{\vec{r}_{21} = \vec{r}_2 - \vec{r}_1}$

Position of 2nd charge w.r.t 1st charge

⇓

$$\hat{r}_{21} = \frac{\vec{r}_{21}}{|\vec{r}_{21}|}$$

$$\hat{r}_{21} = \frac{\vec{r}_{21}}{|\vec{r}_2 - \vec{r}_1|}$$

$$\vec{F}_{21} = \frac{Kq_1q_2}{|\vec{r}_{21}|^2}\hat{F}_{21}$$

$$\vec{F}_{21} = \frac{Kq_1q_2}{|\vec{r}_{21}|^2} \times \hat{r}_{21}$$

$$\vec{F}_{21} = \frac{Kq_1q_2}{|\vec{r}_{21}|^2}\hat{r}_{21} = \frac{Kq_1q_2}{|\vec{r}_{21}|^3} \times \vec{r}_{21}$$

Put charge with sign.

$$\boxed{\vec{F}_{21} = \frac{Kq_1q_2}{|\vec{r}_{21}|^3}\vec{r}_{21} = \frac{Kq_1q_2}{|\vec{r}_{21}|^2}\hat{r}_{21}}$$

$$\boxed{\vec{F}_{12} = \frac{Kq_1q_2}{|\vec{r}_{12}|^2}\hat{r}_{12}}$$

$\vec{F}_{12} = -\vec{F}_{21}$ Action reaction Pair.

Que Find force applied by 2C charge

2C ⟶ 5C

(2, 3, 4) (5, 7, 9)

$$\vec{r}_{21} = \vec{r}_2 - \vec{r}_1$$

$$= 5\hat{i} + 7\hat{j} + 9\hat{k} - 2\hat{i} - 3\hat{j} - 4\hat{k}$$

$$\vec{r}_{21} = 3\hat{i} + 4\hat{j} + 5\hat{k}$$

$$\vec{F}_{21} = \frac{K\,2C \times 5C}{|\vec{r}_{21}|^3} \times \vec{r}_{21}$$

$$\frac{10K\,[3\hat{i} + 4\hat{j} + 5\hat{k}]}{(\sqrt{3^2 + 4^2 + 5^2})^3}$$

$$\frac{10K\,[3\hat{i} + 4\hat{j} + 5\hat{k}]}{(50)^{3/2}}$$

Electric field = electrostatic force experienced by 1C charge.

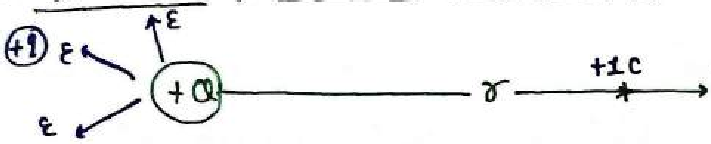
Electrostatic force (F) = $\frac{KQ_1 Q_2}{r^2}$ F = $\frac{KQ_1 1C}{r^2}$ = Electric field.

Force experienced by 1C = E
Force on qc is = qE

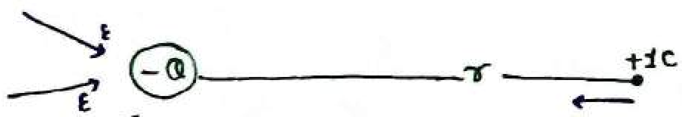
$$\vec{F} = q\vec{E}$$
$$\vec{F} = -q\vec{E}$$

→ force on +ve charge along electric field
→ force on -ve charge opposite to electric field.

* Electric field in Vector form

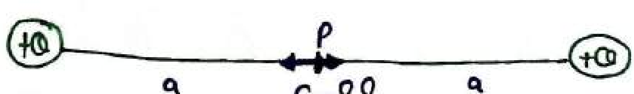


$\vec{E} = \frac{KQ}{r^2}\hat{r} = \frac{KQ}{r^2}\left(\frac{\vec{r}}{r}\right) = \frac{KQ}{r^3}\vec{r}$



$\vec{E} = \frac{-KQ}{r^2}\hat{r}$

$E = \frac{KQ}{r^2}$



E = ??
Enet = 0

(one charge) $E = \frac{KQ}{a^2}$

Qu 

In which region electric field will be zero.

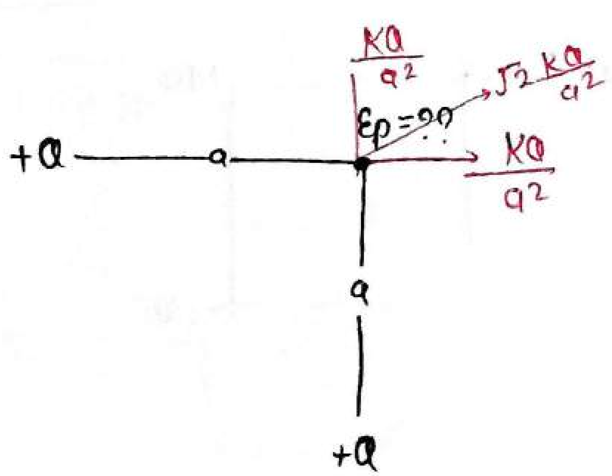
Qu find total net force

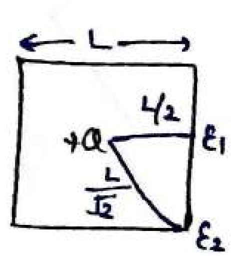
Qu find electric field at origin.

(0,0) +q

$$E_{net} = Kq\left(1 - \frac{1}{4} + \frac{1}{16} - \frac{1}{64} + \right)$$

$$Kq\left[\frac{1}{1-\left(-\frac{1}{4}\right)}\right] \Rightarrow Kq\left[\frac{1}{\frac{4+1}{4}}\right] = \frac{4Kq}{5} \text{ Ans}$$

Qu 

Qu 

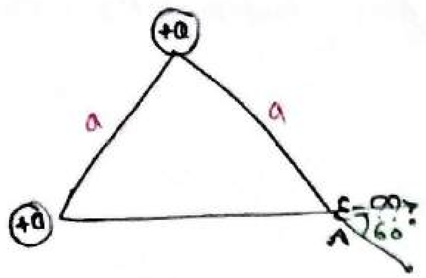
Find $\frac{E_1}{E_2} = ?$

$$E_1 = \frac{KQ}{\left(\frac{L}{2}\right)^2} = \frac{4KQ}{L^2}$$

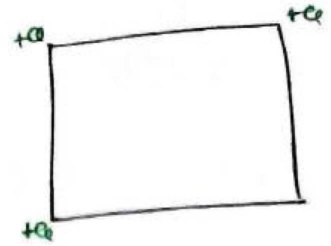
$$E_2 = \frac{KQ}{\left(\frac{L}{\sqrt{2}}\right)^2} = \frac{2KQ}{L^2}$$

$$\frac{E_1}{E_2} = 2:1$$

Qu



Qu



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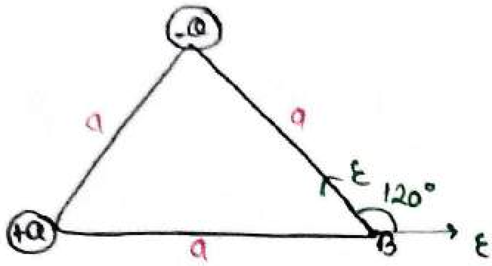

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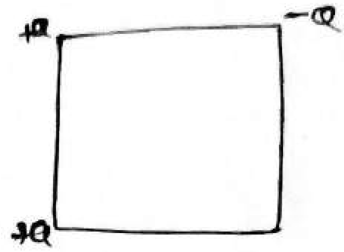

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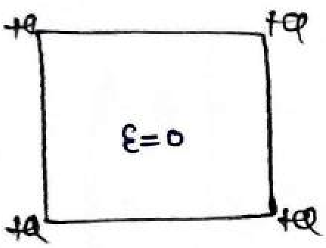
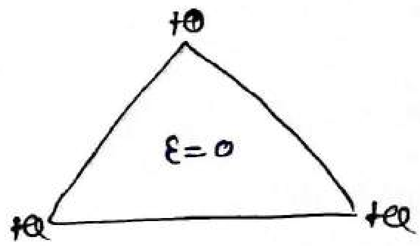
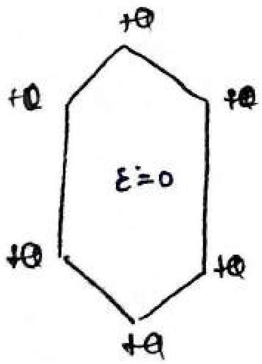


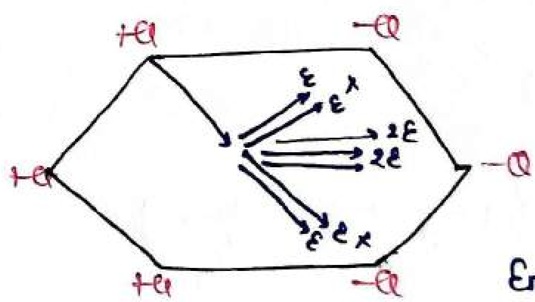
Qu



Qu



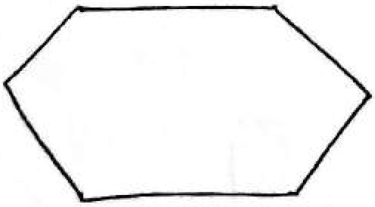
Qu



$E_{net} = 4E$

$E = \frac{KQ}{L^2}$

$$\frac{4KQ}{L^2} = \left(\frac{Q}{\pi\epsilon_0 L^2}\right)$$



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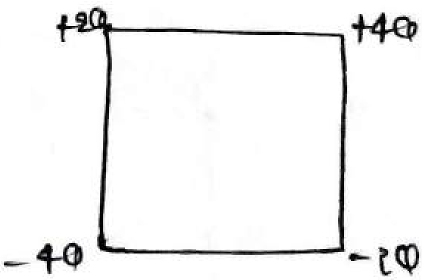
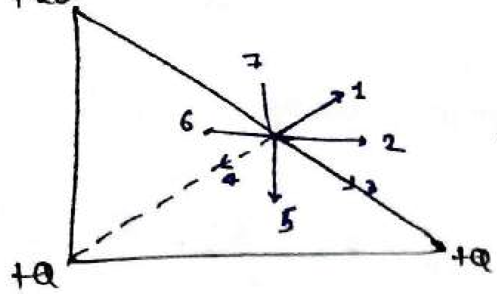
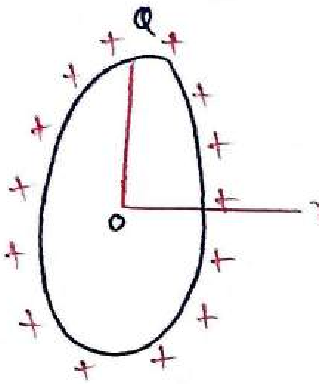


Que



Ans 2

Electric field due to ring



$\vec{E} = \dfrac{KQx}{(R^2+x^2)^{3/2}}$

$E_0 = 0$

at $x = 0$

centre

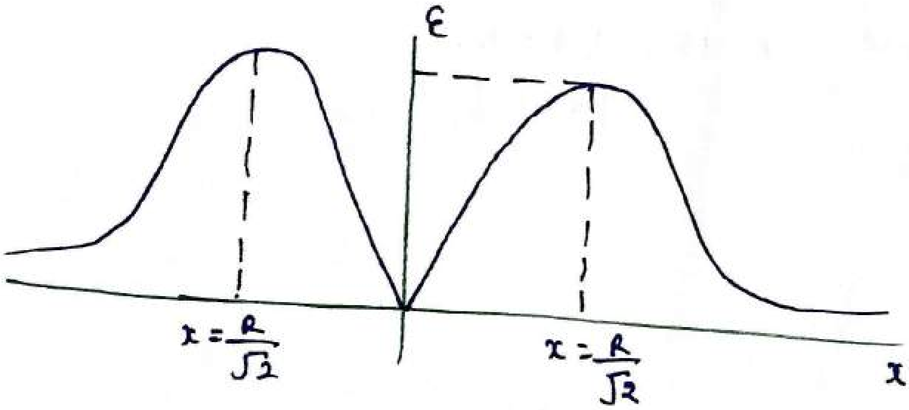
If $x <<< R$

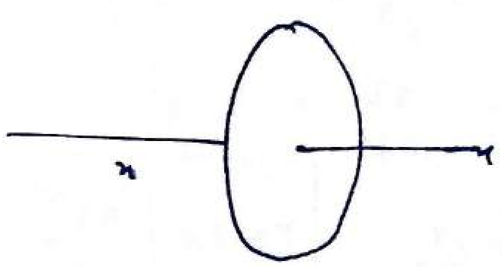
$E = \dfrac{KQx}{R^3}$

If $x >>> R$

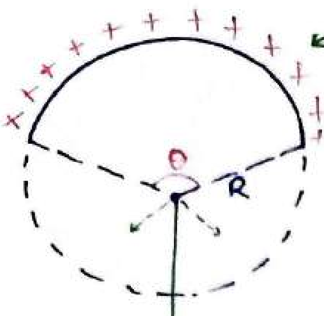
$E = \dfrac{KQx}{x^3} = \dfrac{KQ}{x^2}$

line point charge





Electric field due to Circular Arc



$$E = \frac{2K\lambda}{R} \sin\left(\frac{\theta}{2}\right)$$

$\because \lambda = \frac{q}{R\theta}$

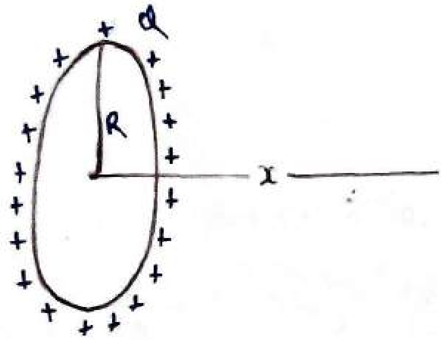
$q = \lambda R \theta$

MR*

$$E = \frac{Kq}{R^2} \cdot \frac{\sin\left(\frac{\theta}{2}\right)}{\left(\theta/2\right)}$$

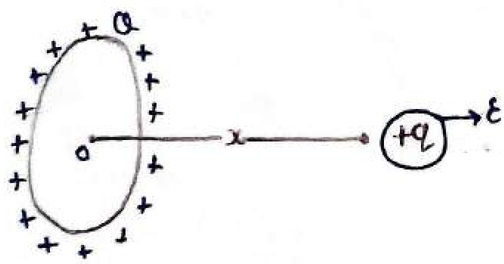
$$E = \frac{K\lambda R\theta}{R^2} \frac{\sin(\theta/2)}{\left(\frac{\theta}{2}\right)}$$

$$\boxed{E = \frac{2K\lambda}{R} \sin\left(\frac{\theta}{2}\right)}$$

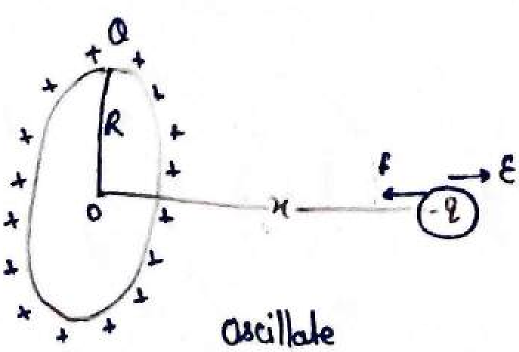


$$E = \frac{KQx}{(R^2+x^2)^{3/2}}$$

Force on ring due to +q Charge



$$F = qE = \frac{KQxq}{[R^2+x^2]^{3/2}}$$



Oscillate

$$F = \frac{KQqx}{(R^2+x^2)^{3/2}}$$

S.H.M $(x <<< R)$

$$ma = \frac{KQqx}{R^3}$$

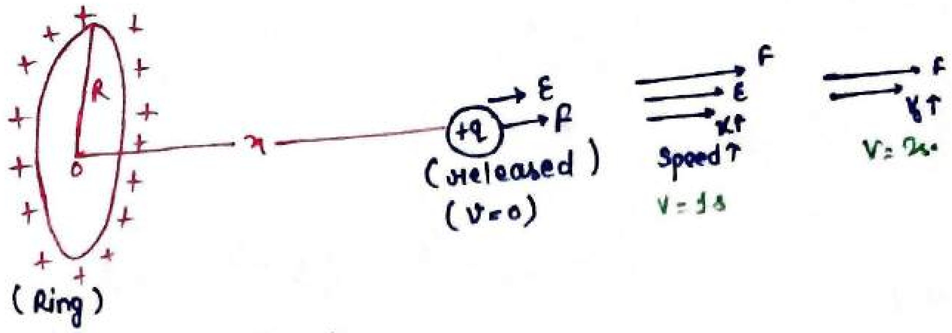
$$a = \frac{KQq}{mR^2} x$$

$\omega = \sqrt{\frac{KQq}{mR^3}}$

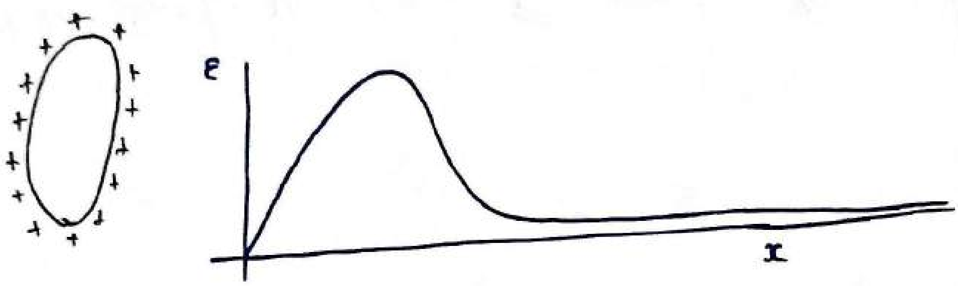
$$\boxed{T = 2\pi\sqrt{\frac{mR^3}{KQq}}}$$

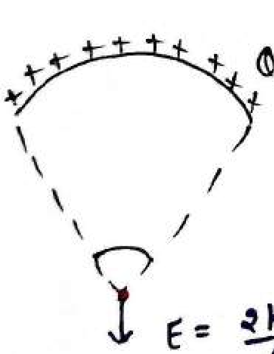
Time Period oscillation.

Qu

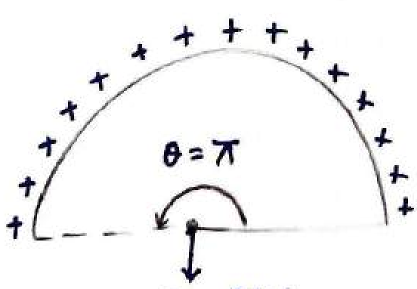


(a) Charge will Oscillate
(b) Moving away & speed Increasing ✓
(c) Moving away & speed decreasing
(d) Moving away & speed ↑ then decreasing

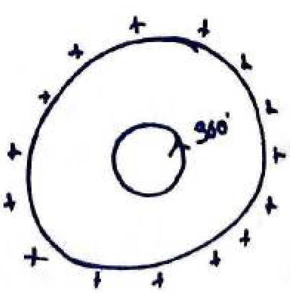




$$E = \frac{2K\lambda}{R}\sin\left(\frac{\theta}{2}\right) = \frac{KQ}{R^2}\,\frac{\sin(\theta/2)}{(\theta/2)}$$

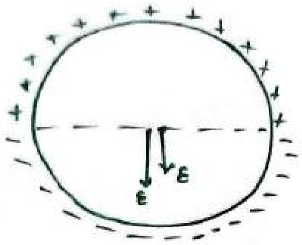


$E = \frac{2K\lambda}{R}$



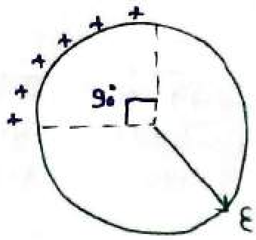
$$E = \frac{2K\lambda}{R}\sin\left(\frac{360}{2}\right) \quad (180)$$

$$E = \frac{2K\lambda}{R}$$



$E_{net} = 2(E)_{Half}$

$2\left(\frac{2K\lambda}{R}\right)$

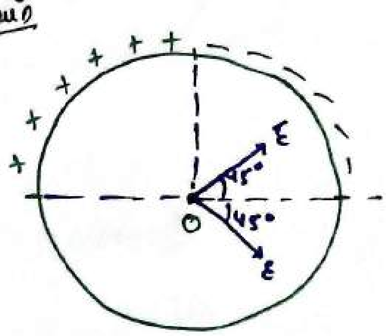


$E = \frac{2K\lambda}{2} \sin\left(\frac{90}{2}\right)$ (45)

$E = \frac{2K\lambda}{2} \sin 45^\circ$

$E = \frac{\sqrt{2}K\lambda}{R}$

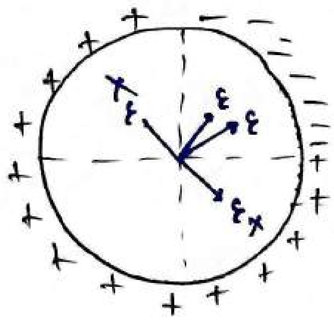
Qy IIT Main

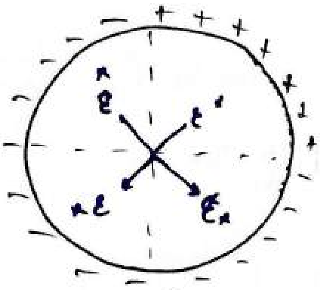


dirn of electric field along

(a) +y axis (b) +x axis (c) -y axis (d) y-x plane

Qy



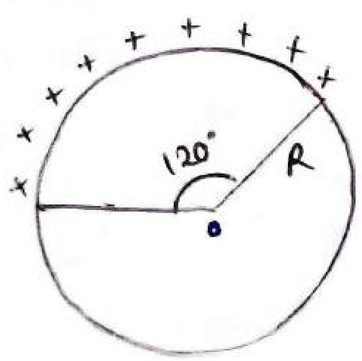


$E_0 = 2[E]_{\text{one fourth ring}}$

$2\left(\frac{\sqrt{2}K\lambda}{R}\right)$

$E_{net} = 0$

Q

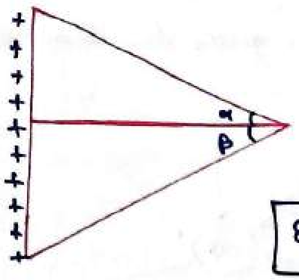


$E_0 = \frac{2K\lambda}{R} \sin\left(\frac{\theta}{2}\right)$

$\frac{2K\lambda}{R} \sin\left(\frac{120}{2}\right) = \frac{2K\lambda}{2} \times \frac{1}{2}$ (60)

$\frac{\sqrt{3}K\lambda}{R}$

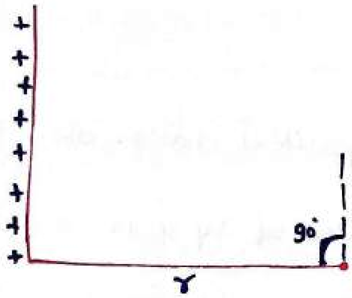
Electric field due to finite line charge of linear density λ.



$E = \frac{K\lambda}{R}$

$$\boxed{E = \frac{2K\lambda}{R}}$$

Semi-Infinite line charge



$E = \frac{K\lambda}{R}\left[\sin 90 + \sin 0\right]i + \frac{K\lambda}{R}\left[\cos 90 - \cos 0\right]j$

$\frac{K\lambda}{R}\left[i - j\right] = \boxed{\sqrt{2}\,\frac{K\lambda}{R}}$

Qu

(1) $\frac{2\lambda}{\varepsilon_0 a}$

(2) $\frac{\lambda\pi}{\varepsilon_0 a}$

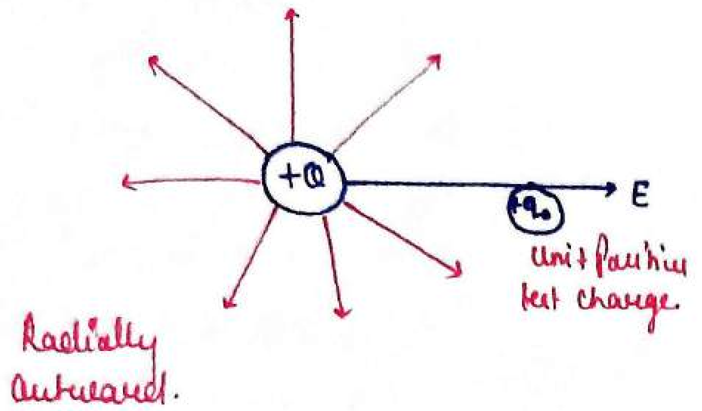
(3) $\frac{\lambda}{2\pi\varepsilon_0 a}$

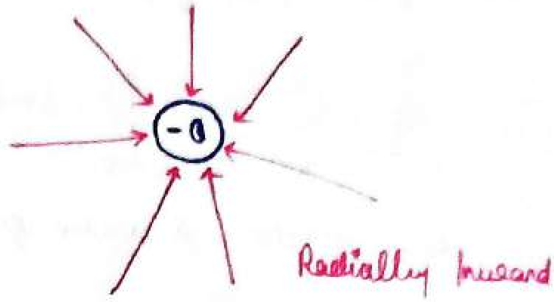
(4) $\frac{\lambda}{\pi\varepsilon_0 a}$

Electric field lines

✳ Electric field lines are the imaginary lines, tangent to which gives the direction of electric field.

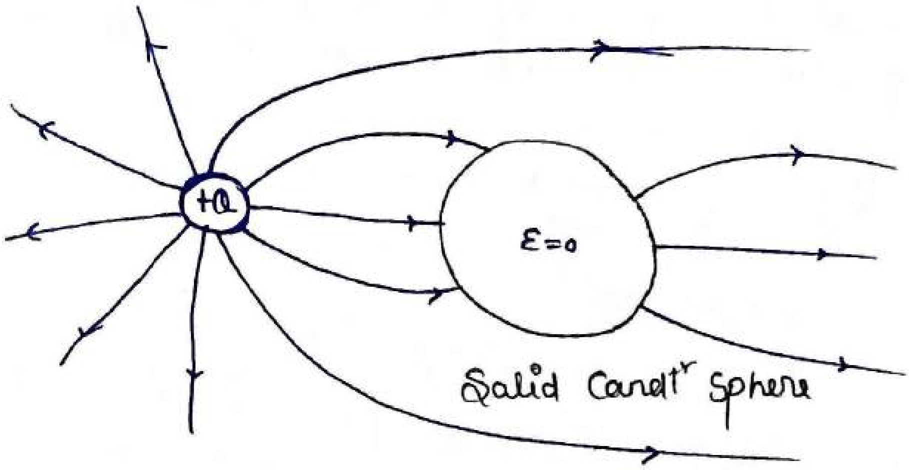
- and no. of field lines passing through per unit area gives the strength of field.



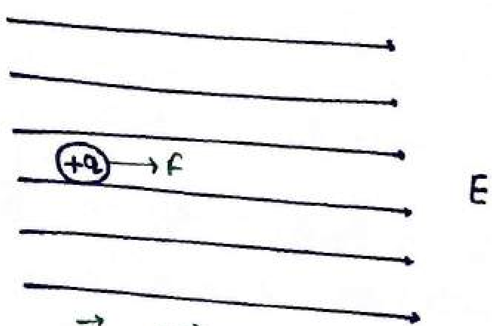


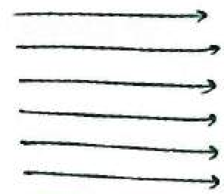
1. Imaginary line along the force on a unit positive charge also called
2. electric field lines not along the path followed by unit +ve charge.

3. Start from +ve charge, end at -ve charge
4. The tangent at any point on the electric field lines gives the direction of field
5. Radially outward from positive charge and radially inward negative charge
6. Do not intersect two lines
7. Magnitude of charge ∝ no. of field lines starting from that charge
8. magnitude of electric field is directly proportional to field line density
9. always perpendicular to the surface of conductor
10. Inside isolated conductor electric field line is zero
11. Sharp turn is not possible. always continuous at all point
12. Never forms close loop.
13. It is conservative field

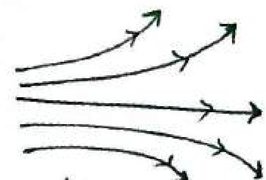


Motion of charge particle In Uniform Electric field





Uniform electric field :-



Non Uniform motion.

$\vec{F} = q\vec{E}$

$m\vec{a} = q\vec{E}$

Uniform acceleration (const) ← $\vec{a} = \frac{q\vec{E}}{m}$

$a = \frac{qE}{m}$ ⟶ Motion with const acel^n

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

$v = \cancel{u}^{0} + at$

$\boxed{v = \frac{qE}{m} t}$

$P = mu = \cancel{m} \frac{qE}{\cancel{m}} t$

$\boxed{P = qEt}$

Que The magnitude of force exerted by a uniform electric field on an electron having mass me and proton of mass mp are represented as fe and fp respectively are related are.

(1) $f_p = f_e$

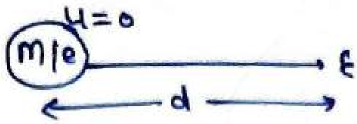
Que A proton of mass m charge 'e' is released from rest in a uniform electric field of strength 'E'. The time taken by it to travel a distance 'd' in the field is

(1) $\sqrt{\frac{2de}{mE}}$

(2) $\sqrt{\frac{2dE}{me}}$

(3) $\sqrt{\frac{2dm}{Ee}}$ ✓

(4) $\sqrt{\frac{2Ee}{m}}$

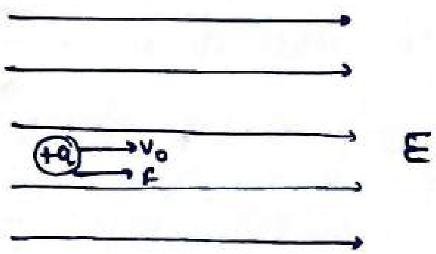


$s = \cancel{ut} + \frac{1}{2}at^2$

$d = \frac{1}{2}\frac{eE}{m}t^2$

$t = \sqrt{\frac{2dm}{eE}}$

Case-2 Charge is projected parallel to electric field $\vec{E}$.



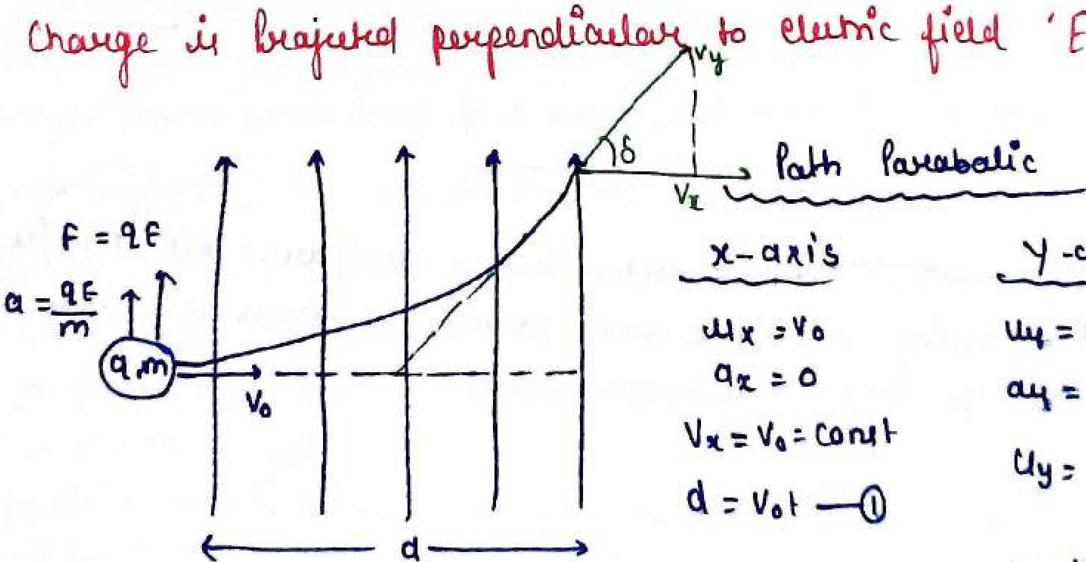
$F = qE$

$\boxed{a = \frac{qE}{m}}$ → Path straight line.

$V_t = V_0 + \frac{qE}{m}t$

$\boxed{S = V_0 t + \frac{1}{2}\frac{qE}{m}t^2}$

Case-3 Charge is projected perpendicular to electric field 'E'



x-axis

$u_x = v_0$

$a_x = 0$

$V_x = V_0 = \text{const}$

$d = v_0 t$ —(1)

y-axis

$u_y = 0$

$a_y = \frac{qE}{m}$

$v_y = \frac{qE}{m}t$

$y = \frac{1}{2}a_y t^2$ —(2)

$\tan\delta = \frac{v_y}{v_x} = \frac{qEt}{mv_0}$

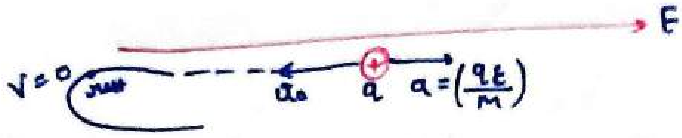
$\tan\delta = \frac{qEt}{mv_0}$

$\boxed{\tan\delta = \frac{qEd}{mv_0^2}}$

$\delta = \tan^{-1}\left(\frac{qEd}{mv_0^2}\right)$

1. Charge particle placed in uniform electric field at rest ?

charge is projected opposite to electric field find stopping distance



Path is straight line

$$v_p^2 - u_0^2 = 2Sa$$

$$-u_0^2 = 2\left(\frac{qE}{m}\right)S$$

$$S = \frac{-u_0^2}{2\left(\frac{qE}{m}\right)}$$

Que A mass m Carrying a charge q is suspended from a string and placed in a uniform horizontal electric field of intensity E. The angle made by the string with the vertical in the equilibrium position is.

(1) $\theta = \tan^{-1}\frac{mg}{Eg}$

(2) $\theta = \tan^{-1}\frac{m}{Eq}$

(3) $\theta = \tan^{-1}\frac{Eq}{m}$

(4) $\theta = \tan^{-1}\frac{Eq}{mg}$ ✓

$$\tan\theta = \frac{qE}{mg}$$

$$\boxed{\theta = \tan^{-1}\frac{qE}{mg}}$$ Ans

Que In a uniform electric field if a charge is fired in a direction different from the line of electric field then the trajectory of the charge will be a.

(1) Straight line
(2) Circle
(3) Parabola ✓
(4) Ellipse

Qu A positively charged pendulum is oscillating in a uniform electric field pointing upwards. its time period as compared to that when it oscillate without electric field

① Is less
② Is more ✓
③ Remain Unchanged
④ Starts fluctuating

Qu Two equal positive charges Q are fixed at points (a, 0) and (-a, 0) on the x-axis. An opposite charge -q at rest is released from point (0, a) on the y-axis the charge -q will

① move to infinity
② Move to origin and rest there
③ Undergo SHM about the origin
④ Execute Oscillatory periodic motion but not SHM ✓

Qu A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. the Kinetic Energy attained by the particle moving a distance y is.

① qEy ✓
② qE^2y
③ qEy^2
④ q^2Ey

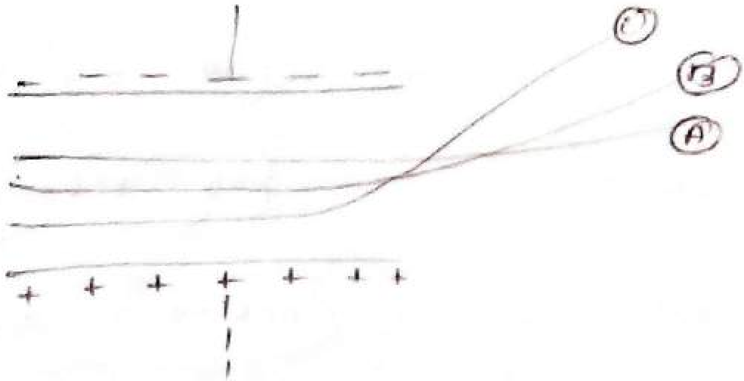
$K.E = W = F \times d$
$= qEy$

Qu A proton and an α particle having equal kinetic energy are projected in a uniform transverse electric field as shown in figure

① proton trajectory is more curved
② α-particle trajectory is more curved ✓
③ Both trajectories are equally curved but in opposite direction
④ Both trajectories are equally curved and in same direction

Qu Three particle are projected in a uniform electric field with same velocity perpendicular to the field as shown which particle has highest charge to mass ratio ?

① A ② B ③ C ④ all have charge to mass ratio



Que A particle of mass m and charge q is thrown at a speed u speed u against a uniform electric field E. How much distance will it travel before coming to rest ?

① $mu^2/2qE$ ✓
② $2mu^2/qE$
③ $mqE/2u^2$
④ mu/qE

$$s = \frac{u^2}{2\left[\frac{qE}{m}\right]}$$

Que If electron and proton released in electric field find ratio of momentum after time 't'.

(a) $m_p : m_e$
(b) $m_e : m_p$
(c) $\sqrt{m_e} : \sqrt{m_p}$
(d) $1 : 1$ ✓

Que Proton deutron and α-particle projected in electric field, perpendicular to it then find ratio of deviation if

① Velocity of projection is same
② K.E of projection same
③ projected with same momentum.

① $\delta p : \delta d : \delta \alpha = \frac{e}{m} : \frac{e}{2m} : \frac{2e}{4m}$

$= 2 : 1 : 1$

$$\tan\delta = \frac{qEd}{mv_0^2} \propto \frac{q}{m}$$

② $\tan\delta = \frac{qEd}{mV_0^2}$

$\tan\delta = q$

$\delta p : \delta D : \delta \alpha = e : e : 2e$

$1 : 1 : 2$

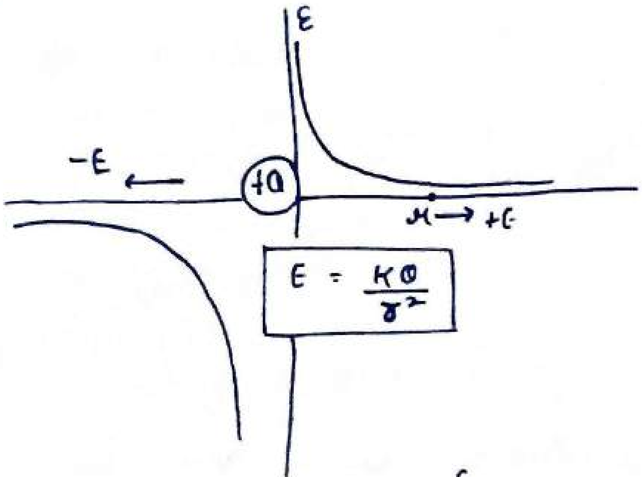
③ $\tan\delta = \frac{qEd}{[mV_0^2]}$

$\frac{mqEd}{p^2}$

$\tan\delta \propto mq$

$\delta p : \delta D : \delta \alpha = em : 2em : 8em$

$= 1 : 2 : 8$



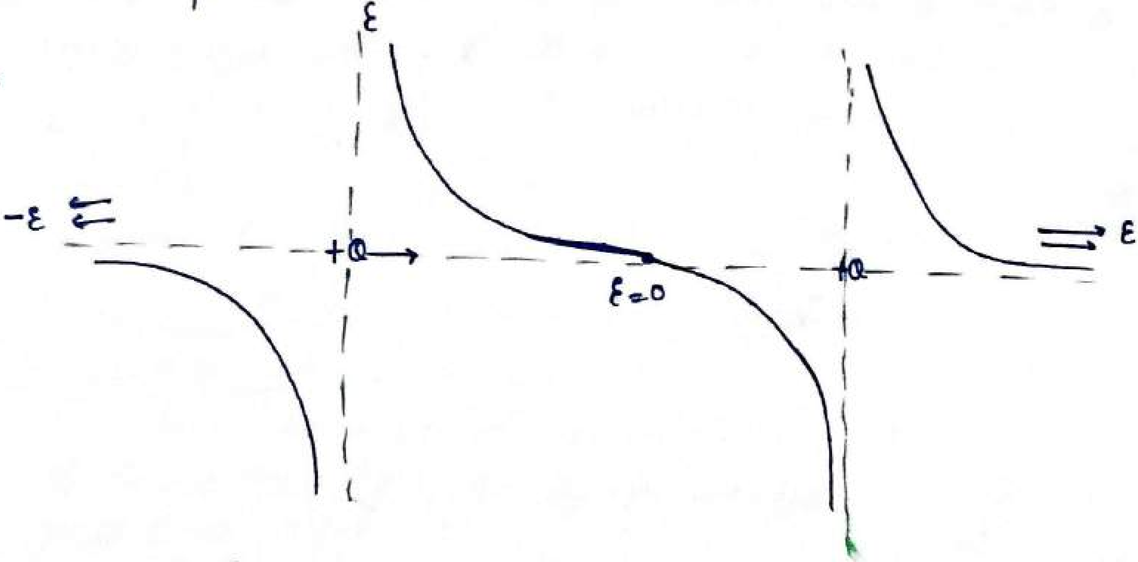
If

+Q   E = 0   +Q

+Q   E = 0 → + Q/8

E = 0 +Q   -8Q

#



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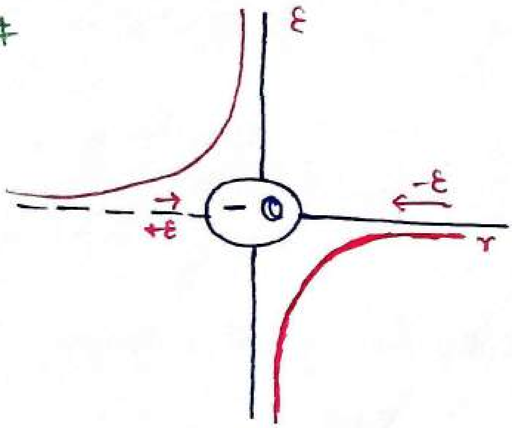

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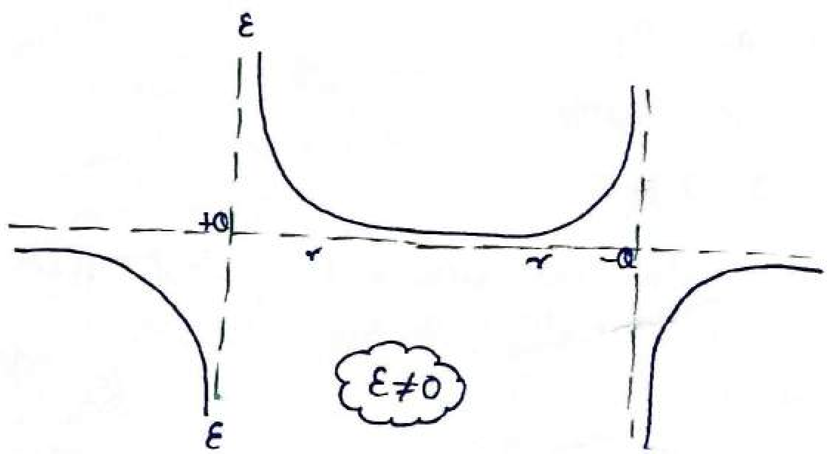

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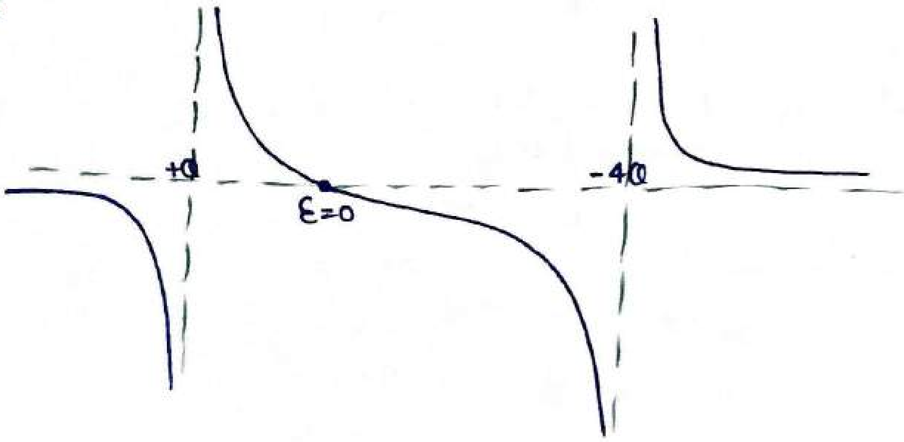


#

+Q   -Q

dipole – Combination of two equal & opposite charge placed at same dist

Electric-dipole

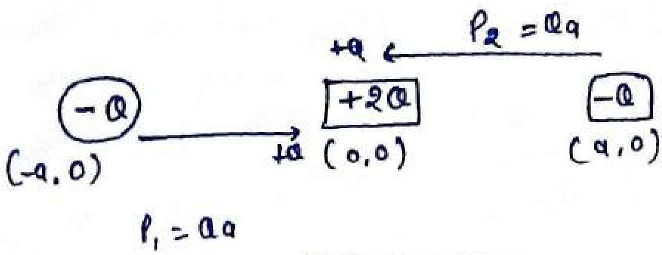
Pair of equal and opposite charge q and -q separated by a small distance 'r' then electric dipole moment is of directed along -q to +q.

$\vec{P} = q l$

$P = q\left[\text{dist B/w the charge}\right]$

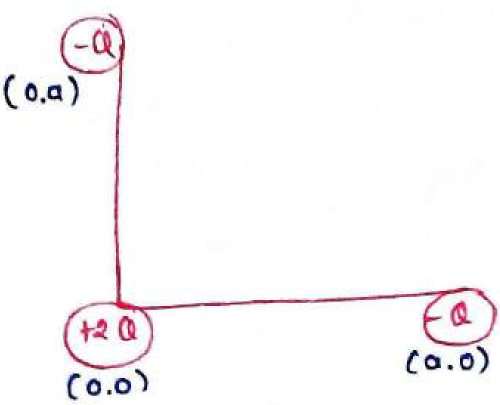
$P = q(2a)$

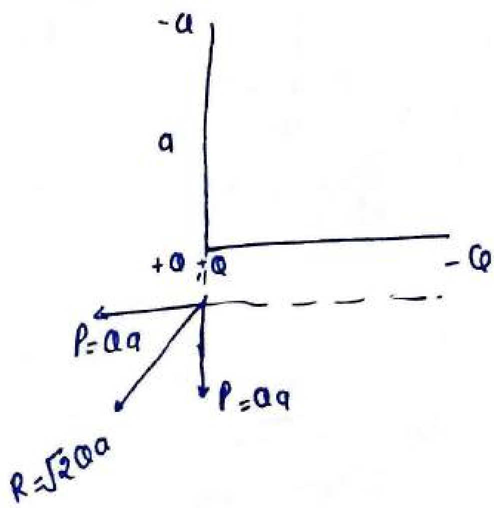
- Vector
- dirn form -q to +q Charge
- coloumn-metre (cm)
- $[A^1T^1L^1]$



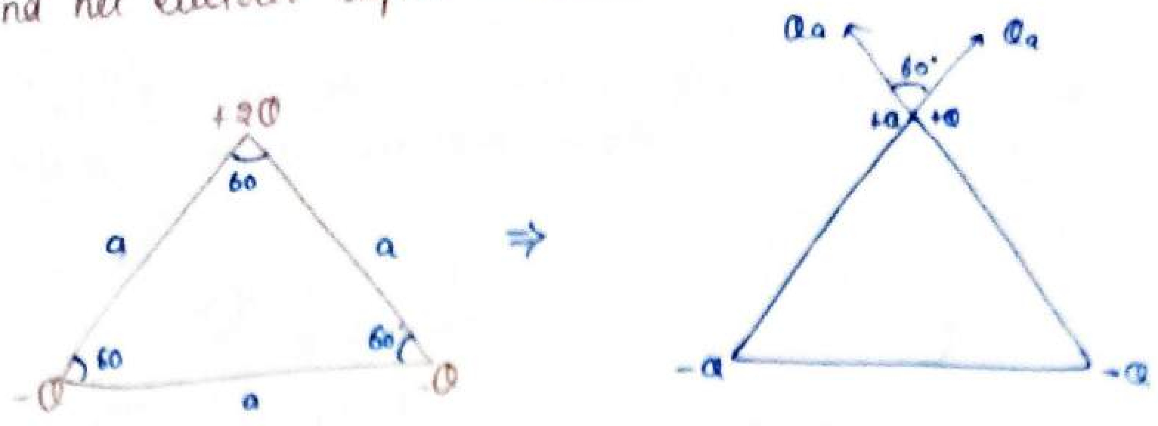
$P_{net} = 0$ Ans

Net electric dipole moment



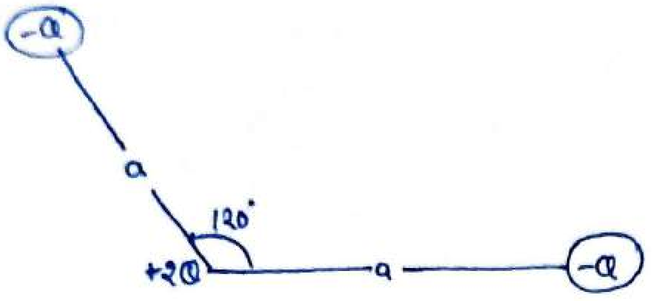


Q. Find net electric dipole moment ?



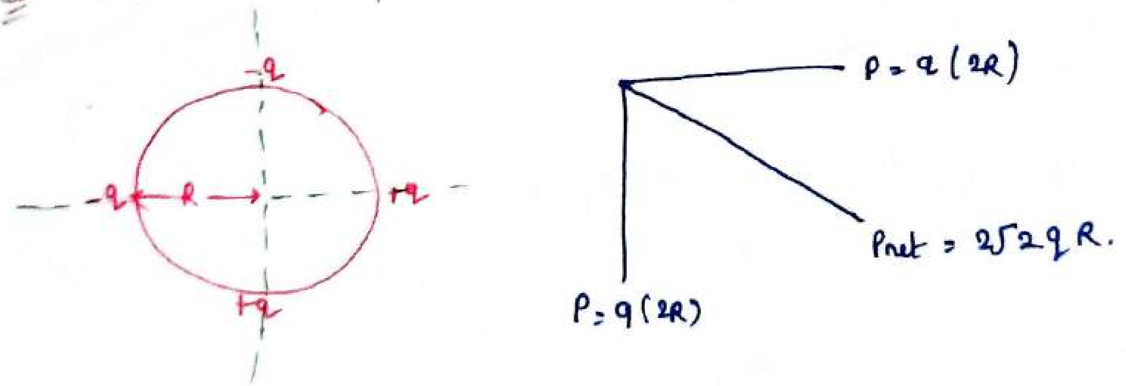
$P_{net} = \sqrt{3}\, Qa$ Ans

Que. Find net electric dipole moment ?



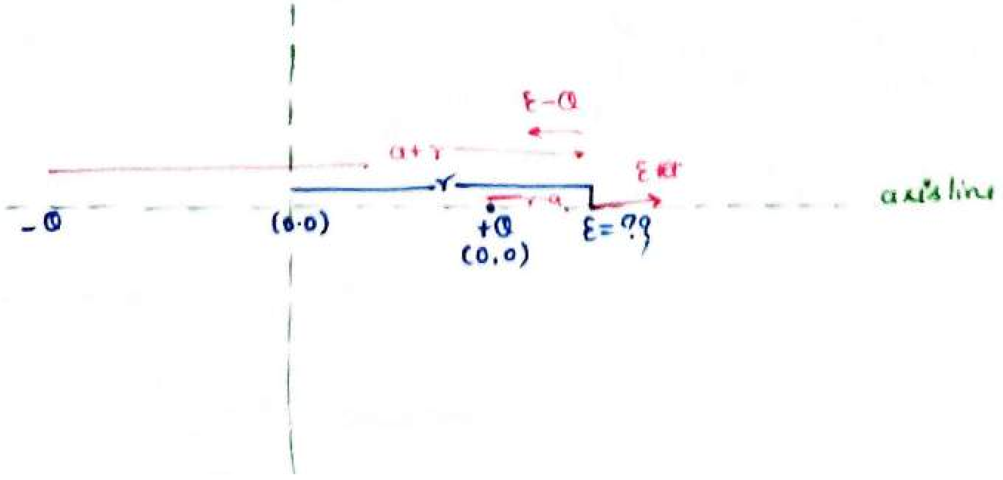
$P_{net} = Qa$

Q. Net electric dipole moment ?



$P_{net} = 2\sqrt{2}\, qR.$

Electric field due to dipole



$$\vec{E}_{net} = \vec{E}_{+q} - \vec{E}_{-q}$$

$$= \frac{kQ}{(r-a)^2} - \frac{kQ}{(r+a)^2}$$

$$= kQ\left[\frac{(r+a)^2 - (r-a)^2}{(r^2-a^2)^2}\right]$$

$$kQ\left[\frac{r^2 + a^2 + 2ra - r^2 - a^2 + 2ra}{(r^2-a^2)^2}\right]$$

$$E = \frac{4kQ\,ra}{(r^2-a^2)^2}$$

$$E_{axial} = \frac{4kQ\,ar}{(a^2-r^2)^2}$$

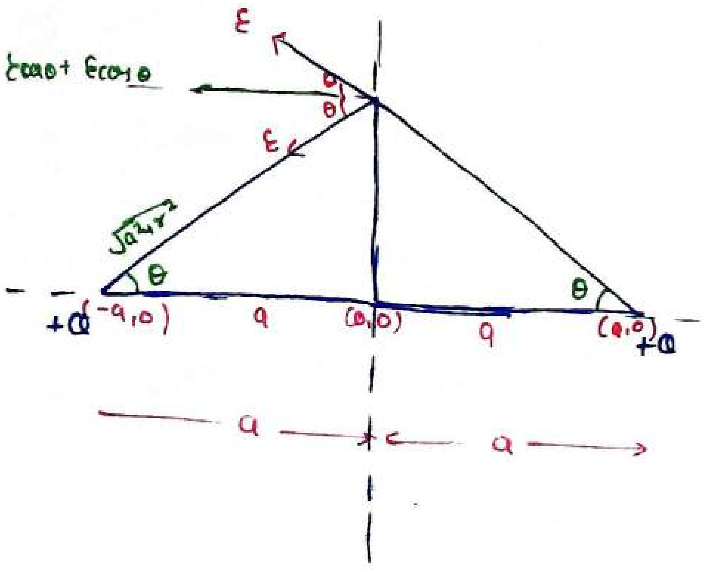
$$\boxed{\vec{E}_{axis} = \frac{2kPr}{(r^2-a^2)^2}}$$

dipal is small (a <<< r)

$$\boxed{\vec{E}_{axis} = \frac{2k\vec{P}}{r^3}}$$

~~Small dipole (r >>> a)~~

Electric field due to dipole =



$$E_{net} = 2E\cos\theta$$

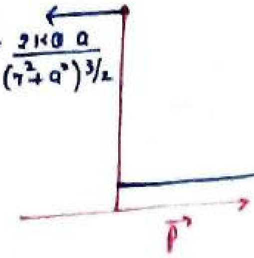
$$= 2\frac{kQ}{(a^2+r^2)} \times \frac{a}{(a^2+r^2)^{1/2}}$$

$$\boxed{\vec{E}_{net} = \frac{2kQa}{(a^2+r^2)^{3/2}}}$$

$$E = \frac{kP}{(a^2+r^2)^{3/2}}$$

Small dist (a <<<< r)

$$\boxed{\vec{E}_{equi} = \frac{-k\vec{P}}{r^3}}$$

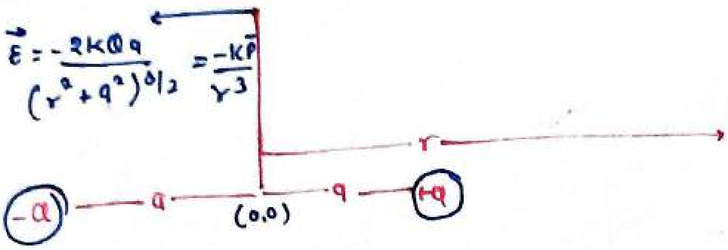


$$\vec{E} = \frac{-K\vec{P}}{r^3} = \frac{2KQa}{(r^2+a^2)^{3/2}}$$

$$\vec{E}_{axis} = \frac{2KP}{r^3} = \frac{4KQar}{(r^2-a^2)^2}$$

$$\frac{\vec{E}_{axial}}{\vec{E}_{equat}} = \frac{2KP}{r^3} \times \frac{1}{-\frac{KP}{r^3}} = \frac{2}{-1}$$

$P = Q2a$

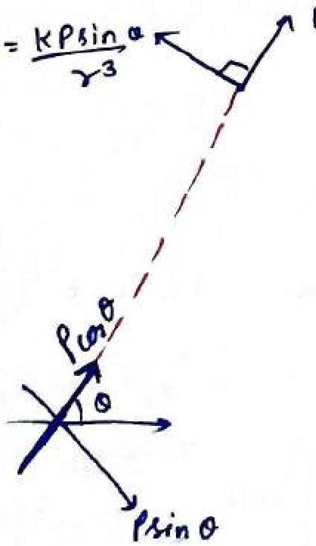


$$\vec{E} = -\frac{2KQa}{(r^2+a^2)^{3/2}} = \frac{-K\vec{P}}{r^3}$$

$$E = \frac{4KQar}{(r^2-a^2)^2} = \frac{2KPr}{(r^2-a^2)^2} = \frac{2KPr}{r^4} = \frac{2KP}{r^3}$$

Electric field due to dipole at general point ⇒

$$E_2 = \frac{KP\sin\theta}{r^3} \qquad E_1 = \frac{2KP\cos\theta}{r^3}$$



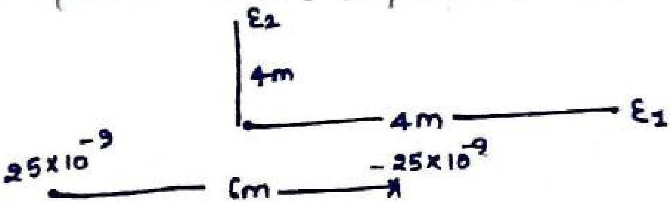
Que A electric field always along dipole moment on the axial line

B electric field always anti parallel to the dipole moment on equatorial line

=1 Both true
2. Both false
3. A (true) B (false)
4. A (false) B (true) ✓

Que Two charges of $+25 \times 10^{-9}$ Coulomb and -25×10^{-9} Coulomb are placed 6 m apart. find the electric field intensity ratio at points 4 m from the centre of the electric dipole (i) on

① $\frac{1000}{49}$ ✓
② $\frac{49}{1000}$
③ $\frac{500}{49}$
④ $\frac{49}{500}$



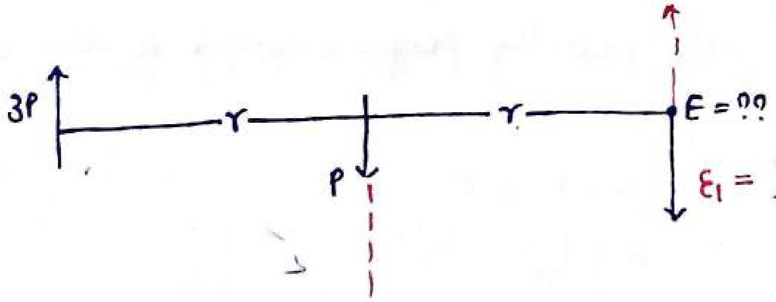
$$E_1 = \frac{4KQar}{(a^2-r^2)^2}$$

$$E_1 = \frac{4KQ\,3\times4}{(3^2-4^2)^2}$$

$$E_2 = \frac{2KQa}{(a^2+r^2)^{3/2}} = \frac{2KQ\times3}{(3^2+4^2)^{3/2}}$$

$$\frac{E_1}{E_2} = \frac{2\times4\times(25)^{3/2}}{49} = \frac{4\times2\times125}{49} = \frac{1000}{49}$$

Small dipole = Ideal dipole



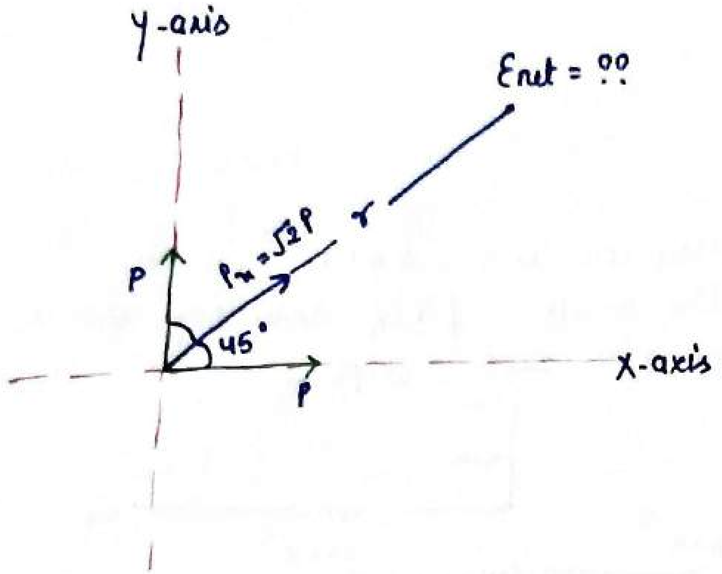
$$E_2 = \frac{KP}{r^3}$$

$$E_1 = \frac{K(8P)}{(2r)^3} = \frac{K\,8P}{8r^3} = \frac{KP}{r^3}$$

$E_{net} = 0$

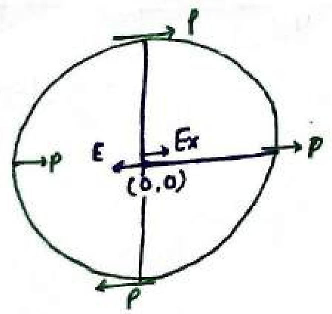
$E_2 = \frac{2KP}{r^3}$ $E_1 = \frac{2K(8P)}{(2r)^3} = \frac{2K8P}{8r^3}$

$= \frac{2KP}{r^3}$

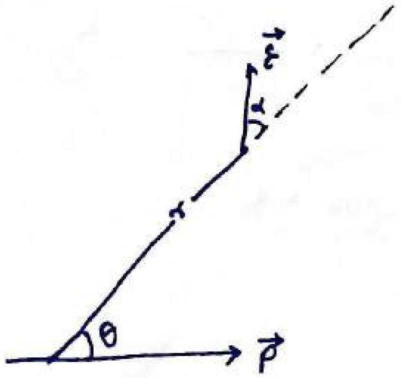


$E = \frac{2K(\sqrt{2}P)}{r^3} = \frac{2\sqrt{2}KP}{r^3}$

Net electric field at origin ??



Ans Find 'θ' so that electric field exactly perpendicular to the dipole mament vector ??



$\alpha + \theta = 90°$

$\alpha = (90 - \theta)$

taking tan Both side

$\tan\alpha = \tan(90 - \theta)$

$\frac{\tan\theta}{2} = \cot\theta = \frac{1}{\tan\theta}$

$\tan^2\theta = 2$ $\tan\theta = \sqrt{2}$

$\boxed{\theta = \tan^{-1}\sqrt{2}}$ Ans

Que electric force b/w dipole & charge is F, New dist^n b/w them becomes double the force will become.

(a) same
(b) one fourth
(c) 4 - times
(d) $\frac{1}{8}$ times

$F = q E_{dipole}$

$E = \frac{2KP}{r^3}$

$E \propto \frac{1}{r^3}$

Force b/w two point charge
$F \propto \frac{1}{r^2}$

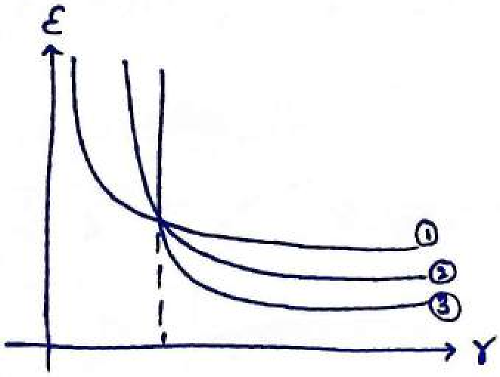
Force b/w dipole & point charge
$F \propto \frac{1}{r^3}$

force b/w two dipole
$F \propto \frac{1}{r^4}$

Electric force b/w two dipole is F, New dist^n b/w them becomes double the force will become.

① Same
② one fourth
③ $\frac{1}{16}$ time
④ $\frac{1}{8}$ times

$F \propto \frac{1}{r^4}$ $F' \propto \frac{1}{(2r)^4} = \frac{F}{16 r^2}$



Graph	Field
	(P) dipole electric field
	(Q) Electric field due to Point charge
	(R) electric field of line charge

$E_{point} \propto \frac{1}{r^2}$

$E_{line} \propto \frac{1}{r}$

$E_{dipole} \propto \frac{1}{r^3}$

Electric flux →

- It gives the idea of electrostatic energy passing through given area
- Counting of electric field lines passing through given cross section area

→ Scalar Unit – Nm^2/C

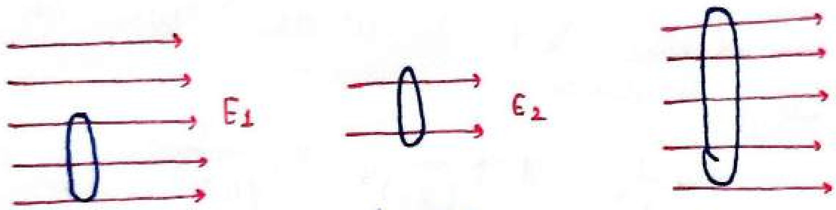
E = Uniform $\phi = \vec{E}\cdot\vec{A}$ Nm^2/C

$$\boxed{\phi = EA\cos\theta}$$

Electric field $\vec{E} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ then find flux through on Rod of length 5 m placed along 'y' axis.

(a) 10 (6%)
(b) 15 (50%)
(c) 40 (6%)
(d) Not possible

$$\boxed{\phi = \vec{E}\cdot\vec{A}}$$

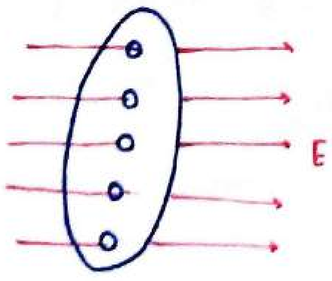


$\phi_1 = E_1 \times A$ $\phi_2 = E_2 A$ $\phi_3 = E_3 A$

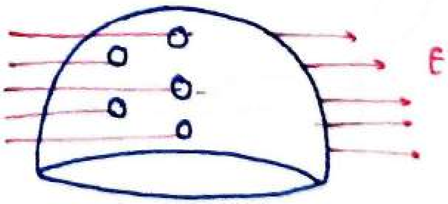
$$\boxed{\phi_3 > \phi_1 > \phi_2}$$

$\phi_1 > \phi_2$

Electric flux



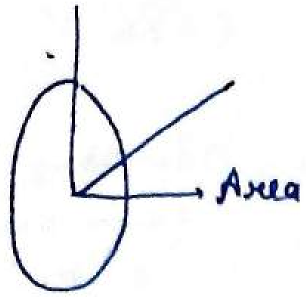
Disc / Ring / Square



Hemisphere

ϕ Passing through $= \vec{E}\cdot\vec{A}$

Que Electric field $E = 50\ N/C$ & Area is $20\ m^2$ & Angle b/w electric field & surface is $30°$ then find flux ??



$$\phi = EA\cos\theta$$
$$= 50 \times 20 \times \cos 60°$$
$$50 \times \frac{20}{10} \times \frac{1}{2}$$
$$= \boxed{500\ \frac{1}{2}}$$

Non-Uniform field

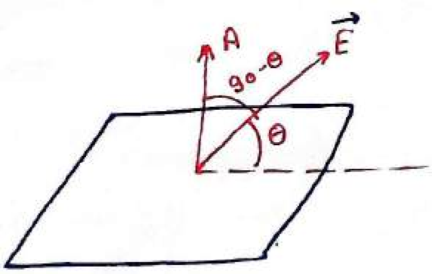
$$\int d\phi = \int E\,dA$$
$$\phi = \int E \cdot dA$$

$$\phi = (E_x\hat{i} + E_y\hat{j} + E_z\hat{k}) \cdot (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})$$
$$= E_xA_x + E_yA_y + E_zA_z$$

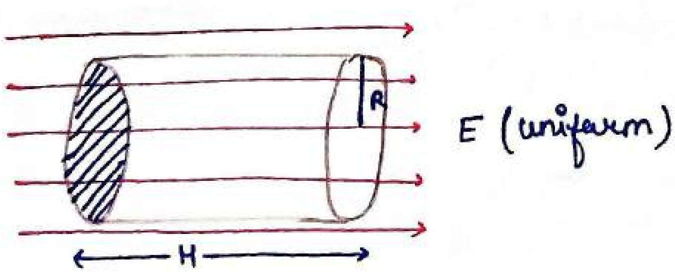
Angle b/w surface & electric field is θ

* $\phi = EA\cos(90 - \theta)$

* Angle b/w Area & surface is always 90



Que Find Incoming and outgoing flux through cylinder.



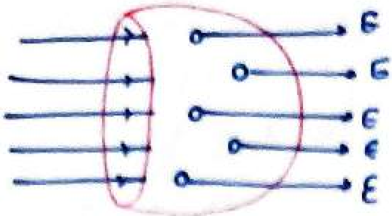
$$\phi_{in} = E\pi R^2 \cos 180°$$
$$= E\pi R^2$$

$$\phi_{out} = E\pi R^2 \cos 0°$$
$$= E\pi R^2$$

$$\phi_{total} = \phi_{in} + \phi_{out} = 0$$

Que The flux through the hemispherical surface in the figure shown below is

1. $\pi R^2 E$ ✓
2. $2\pi R^2 E$
3. $\pi R E$
4. zero



$\phi = E 2\pi R^2$ ✗

$\phi_{total} = \phi_{in} + \phi_{out} = 0$

$-\pi R^2 E + \phi_{out} = 0$

$\boxed{\phi = \pi R^2 E}$

Area $= \frac{4\pi R^2}{2} = 2\pi R^2$.

Que A cylinder of radius R and length l is placed in a uniform electric field E parallel to

Que A rectangular surface of sides

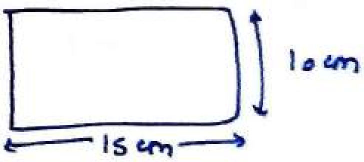
1. 0.1675 N/m²C
2. 0.1875 Nm²/C ✓
3. zero
4. 0.107

$\phi = EA\cos\theta$

$25 \times 10 \times 15 \times 10^{-4} \times \cos 15$

$25 \times 10 \times 15 \times 10^{-4} \times \frac{1}{2}$

$125 \times 15 \times 10^{-4}$



Que If an electric field is given by $10\hat{i} + 3\hat{j} + 4\hat{k}$

1. 100 unit
2. 10 unit
3. 30 unit
4. 40 unit

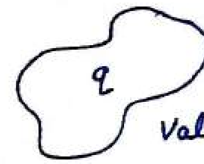
Ques There is uniform electric field of 8×10^3

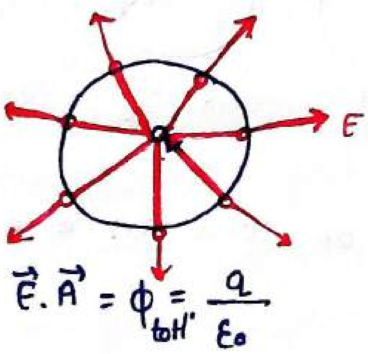
Gauss Law →

The total flux passing through any close surface is equal to $\frac{q}{\epsilon_0}$ where q is total enclosed charge.

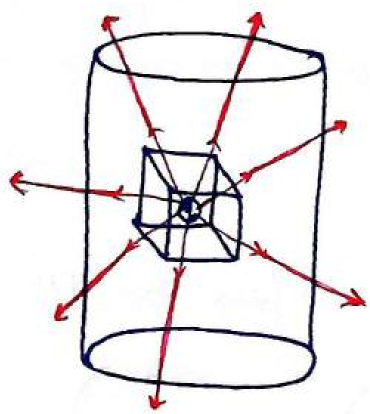
Disc.
Ring
Surface frame
(Not valid)

Ex: Close surface
Sphere, Cylinder, Cube





$\vec{E}.\vec{A} = \phi_{total} = \frac{q}{\epsilon_0}$

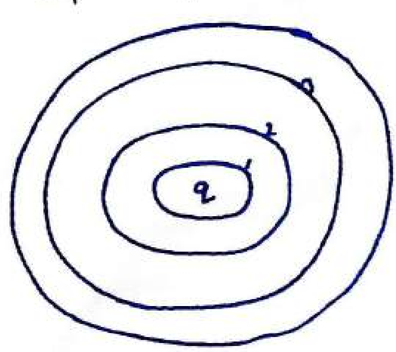


$\phi_{sphere} = \phi_{cube} = \phi_{cylinder}$

$\phi = \frac{q}{\epsilon_0}$

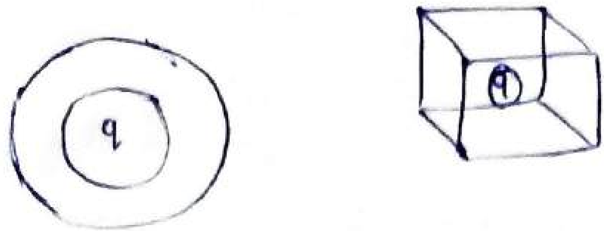
The electric flux passing through a closed surface 's' is equal to $\frac{q}{\epsilon_0}$ where q is total charge enclosed by surface

$\phi_1 = \phi_2 = \phi_3 = \phi_4$

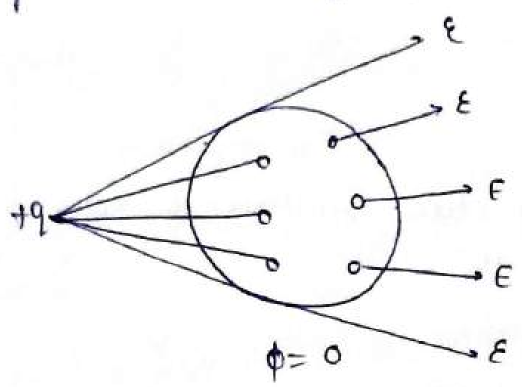


Important Points

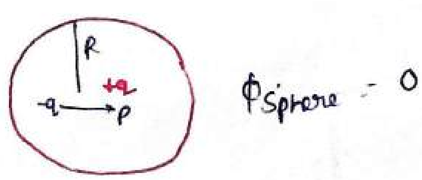
1. Gauss law is true for any closed surface, no matter what its shape or size only depend on charge enclosed.



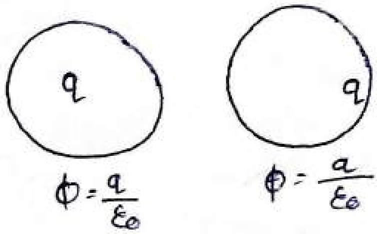
② If no charge is enclosed then total flux must be zero. It does not depends on charge present outside the surface.



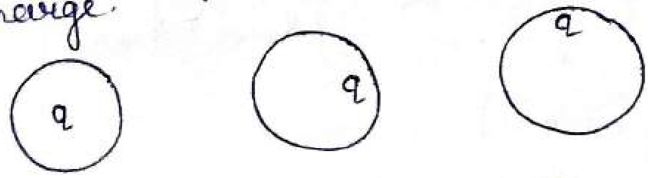
Ques



Ex:



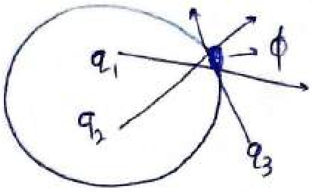
③ Flux through close surface does not depend on location of enclosed charge.



④ Gauss law is always valid, but it may not useful to calculate electric field.
↓
for closed surface.

$$\phi = \frac{q_{in}}{\varepsilon_0} = \oint \vec{E}\cdot d\vec{A}$$

Gauss is always valid and always useful to calculate flux. but not always useful to calculate electric field.



$$\phi_{\substack{total \\ case}} = \left(\frac{q_1+q_2}{\varepsilon_0}\right) = \oint \vec{E}\cdot d\vec{A}$$

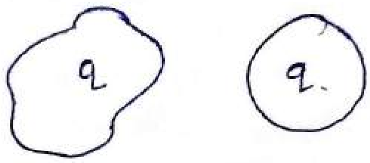
$\vec{E}$ due to all the charge q_1, q_2, q_3 Wether Inside or outside

$$\phi = \frac{q_{in}}{\varepsilon_0} = \int \vec{E}\cdot d\vec{A}$$

q_{in} - enclose charge
$\vec{E}$ = due to all charge

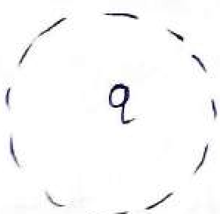
In Gauss law is valid for both Gaussian surface?

① yes ✓
② No
③ Can't say



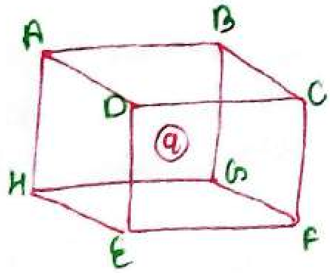
5. Gaussian Surface

Gauss law useful and easy to Calculate electric field when System have same symmetry. this is achieved by choice of a suitable Gaussian surface



Gaussian Surface – Imaginary, symmetric close surface

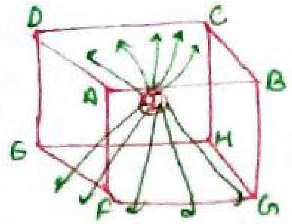
Que Find flux through cube in given situation



$$(\phi_{ABCD})_{surface} = \frac{q}{6\,\varepsilon_0}$$ **Ans**

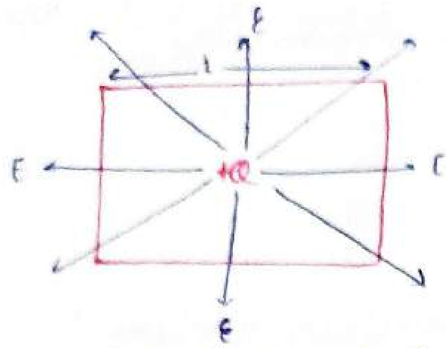
$$\phi_{cube} = \frac{q_{enclose}}{\varepsilon_0} = \frac{q}{\varepsilon_0} = 6\,\phi_{one\ flux}$$

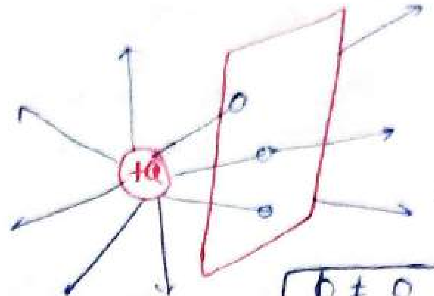
Ans



$$\phi_{ABCD} > \frac{q}{6\epsilon_0}$$

Ans



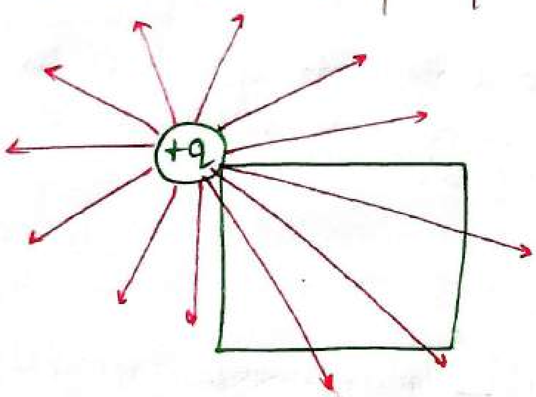


$$\phi \neq 0$$

Charge +q is placed at centre of square plate

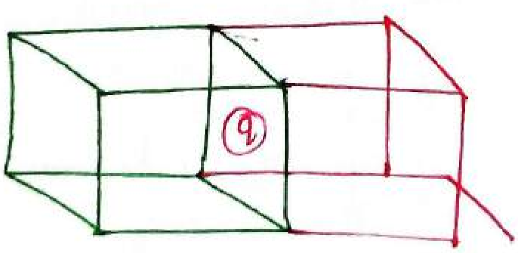
$$\phi = 0$$

Ans charge is at corner of square plate



$$\phi_{square plate} = 0$$

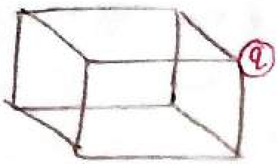
Ans charge is placed at centre of one phase then flux through cube ?



$$\phi_{2\,cube} = \frac{q}{\epsilon_0}$$

$$\phi_{1\,cube} = \frac{q}{2\epsilon_0}$$

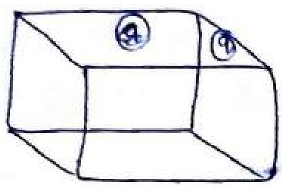
Que: Charge is at corner of cube?



$$8\phi_{cube} = \frac{q}{\varepsilon_0}$$

$$\boxed{\phi_{cube} = \frac{q}{8\varepsilon_0}}$$ Ans

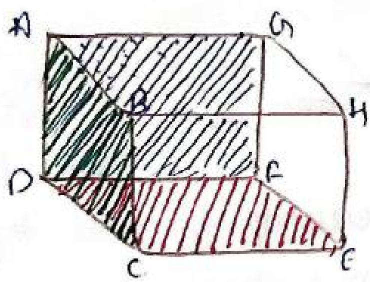
Que: Charge is at mid of side



$$4\phi_{cube} = \frac{q}{\varepsilon_0}$$

$$\boxed{\phi_{cube} = \frac{q}{4\varepsilon_0}}$$ Ans

Que: Find flux passing through phase ABCD of this cube??



$$\boxed{\phi_{1\,cube} = \frac{q}{8\varepsilon_0}}$$

$$\phi_{1\,cube} = \frac{q}{8\varepsilon_0} = 3(\phi_{ABCD})$$

$$\boxed{\phi_{ABCD} = \frac{q}{24\varepsilon_0}}$$ Ans

$$\phi_{HBAG} = \phi_{EFGH} = \phi_{HBCE} = 0$$

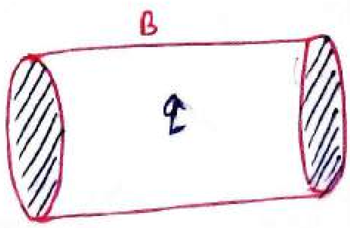
Que: A hollow cylinder has a charge q Coulomb within it. If ϕ is the electric flux in units of voltmetre associated with the curved surface B, the flux linked with the plane surface A in unit of voltmetre will be (charge is symmetrically placed within it)

(1) $\left(\frac{q}{\varepsilon_0} - \phi\right)$

(2) $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$ ✓

(3) $\frac{q}{2\varepsilon_0}$

(4) $\phi/3$



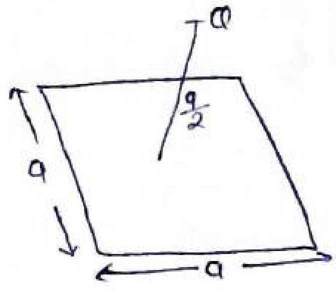
$$\phi_{cylinder} = \frac{q}{\varepsilon_0}$$

$$\phi_{curved} + 2\phi_{flat} = \frac{q}{\varepsilon_0}$$

$$\phi + 2\phi_{flat} = \frac{q}{\varepsilon_0}$$

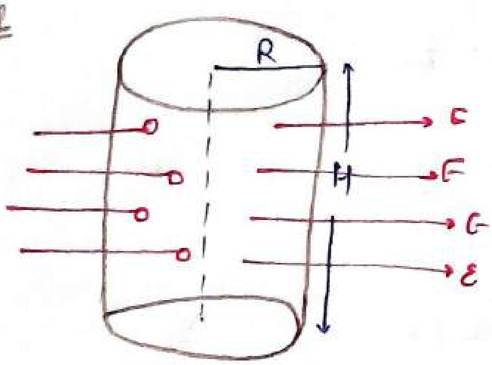
$$\phi_{flat} = \left(\frac{q}{\varepsilon_0} - \phi\right)\frac{1}{2}$$

Q. A charge Q is placed at a distance a/2 above the centre of a horizontal square of edge 'a' as shown in figure. Find the flux of the electric field through the square surface.



$$\phi = \frac{q}{6\varepsilon_0}$$ **Ans**

Que



$$\phi_{total} = 0$$

ϕ Ingoing flux in cylinder from curved surface ??

$\phi = -E\,2RH$ **Ans**

Que If the number of electric lines of force emerging out of a closed surface is 1000 then the charge enclosed by the surface is

1. 8.854×10^{-9} C ✓
2. 8.854×10^{-4} C
3. 8.854×10^{-1} C
4. 8.854 C

$\phi = \frac{q}{\varepsilon_0}$ = no. field line

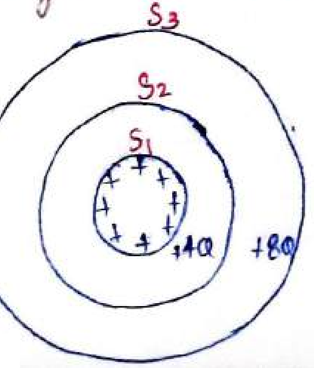
$q = 1000 \times \varepsilon_0$

$1000 \times 8.854 \times 10^{-12}$

8.85×10^{-9} C, **Ans**

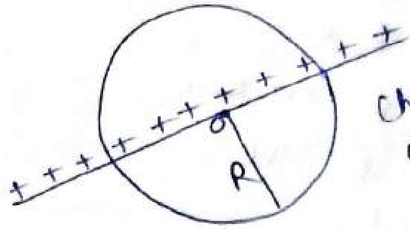
Que S_1, S_2, S_3 are three concentric spherical shells as shown in figure. S_1 and S_2 have charge 4 Q and 8 Q respectively whereas S_3 is uncharged. Find the ratio of the flux passing through S_1 to that through S_3

1. 1 : 3 ✓
2. 1 : 2
3. 2 : 1
4. 1 : 6



$$\frac{\phi_{S_1}}{\phi_{S_2}} = \frac{4Q}{\varepsilon_0} \times \frac{\varepsilon_0}{12Q}$$

$$= \frac{1}{3}$$



Charge on rod = λ

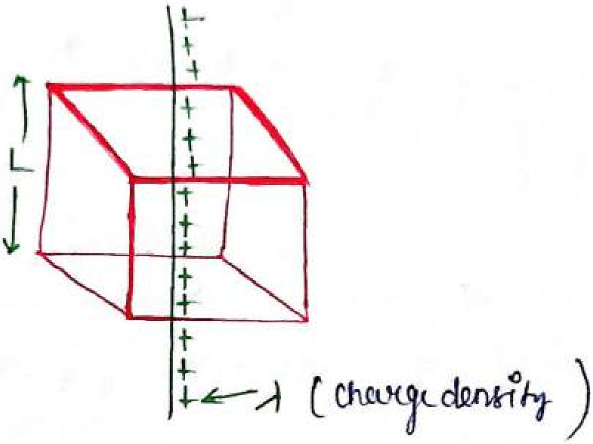
$dl = \lambda dl$

$2R = \lambda 2R$

$$\phi = \frac{q_{in}}{\varepsilon_0} = \frac{\lambda 2R}{\varepsilon_0}$$

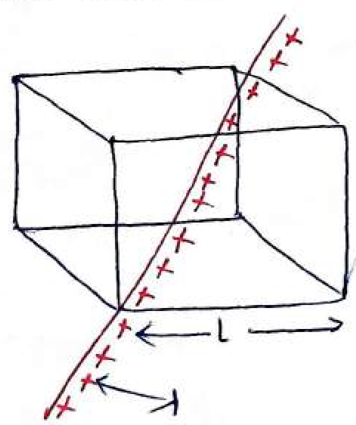
Charged Rod is passing through centre of sphere having linear charge density λ. then find flux through sphere.

Sol



$$\phi_{cube} = \frac{[L\lambda]}{\varepsilon_0}$$

Charged Rod is placed Inside Cube then find maximum flux that can passes through the Cube??

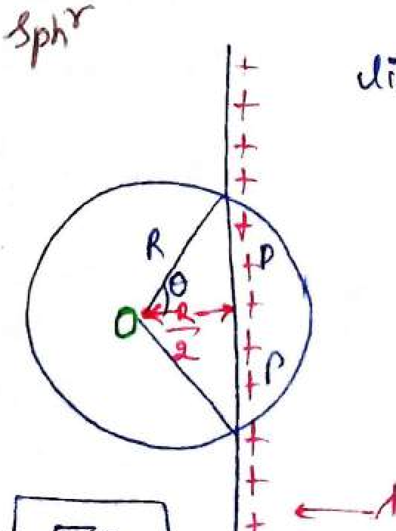


$l_{inside} = \sqrt{3} L$

$q_{in} = \lambda \sqrt{3} L$

$$\boxed{\phi = \frac{\sqrt{3} L\lambda}{\varepsilon_0}}$$

Que Find flux through Sph^r



$l_{inside} = 2P_0 = \sqrt{3} R$

$$P = \frac{\lambda\sqrt{3}R}{\varepsilon_0}$$

$P = \phi$

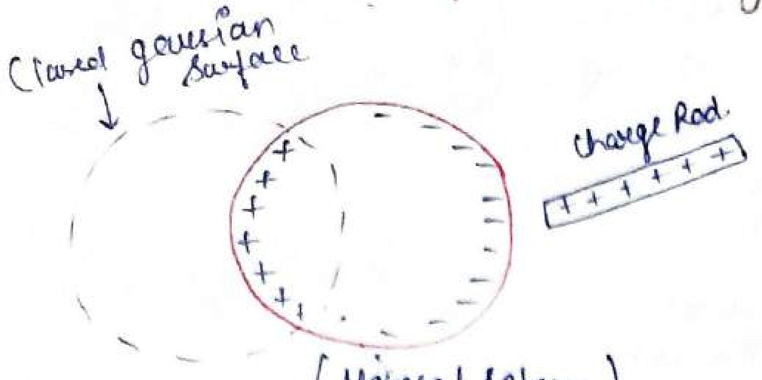
$\sin\theta = \frac{R}{2R} = \frac{1}{2}$

$\boxed{\theta = 30^\circ}$

$P^2 + \frac{R^2}{4} = R^2$

$P^2 = R^2 - \frac{R^2}{4} = \frac{3R^2}{4} \Rightarrow$ $\boxed{P = \frac{\sqrt{3}R}{2}}$

find flux passing through gaussian surface



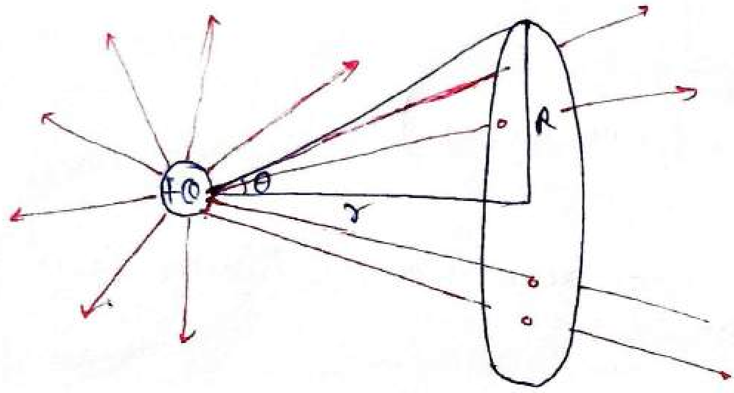
(a) $\phi = 0$

(b) $\phi = +ve$

(c) $\phi = -ve$

(d) None

find flux Passing through Disc of Radius R.



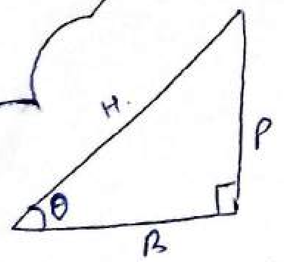
$$\phi = \frac{Q}{2\varepsilon_0}(1 - \cos\theta)$$

If $\theta = 90°$ [very-very large disc]

$$\phi_{disc} = \frac{Q}{2\varepsilon_0}$$

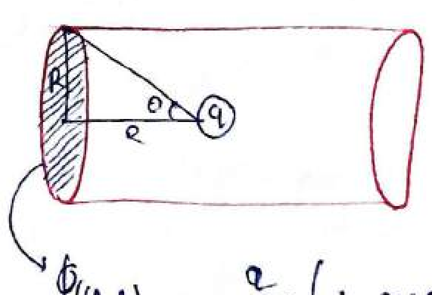
If $\theta =$ [Very - Small disc.

$\phi = 0$



$\sin\theta = \frac{P}{H}$; $\tan\theta = \frac{P}{B}$

$\cos\theta = \frac{B}{H}$



$$\phi_{(\text{Flat}) \text{ Circular}} = \frac{q}{2\varepsilon_0}(1 - \cos\theta)$$

$$\frac{q}{2\varepsilon_0}\left(1 - \frac{1}{\sqrt{2}}\right)$$

$\tan\theta = \frac{R}{R} = 1$

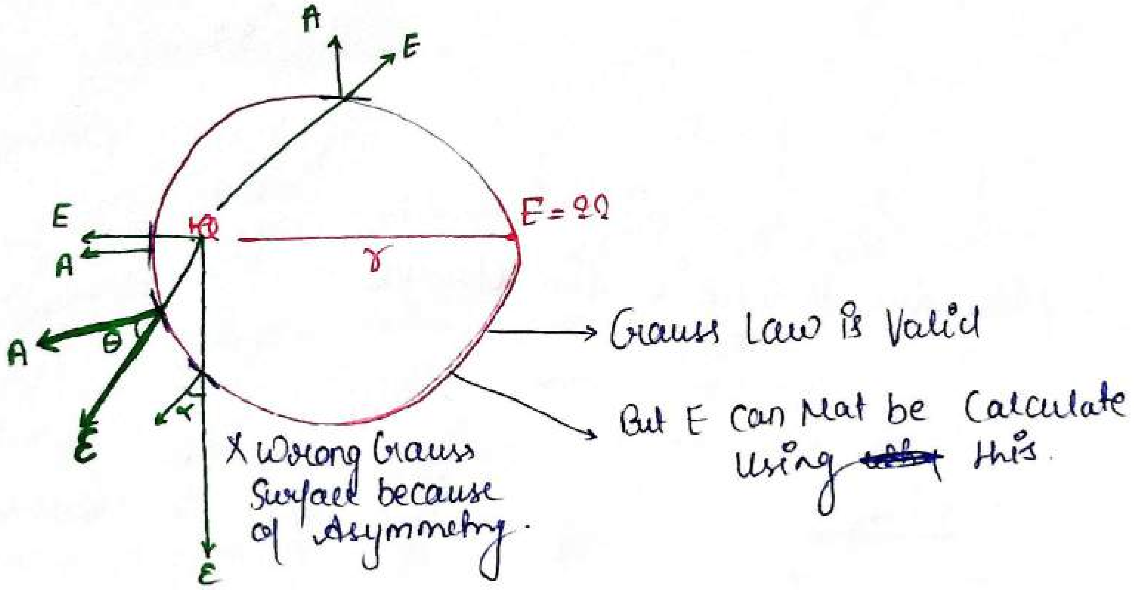
$\theta = 45$

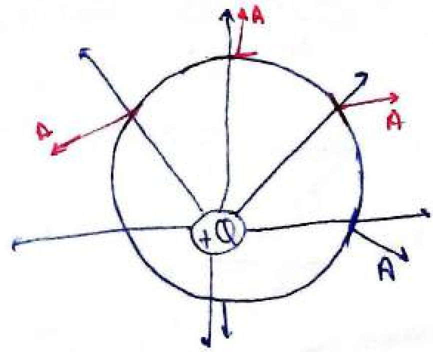
Application of Gauss law

Step to Calculate electric field Using Gauss Law

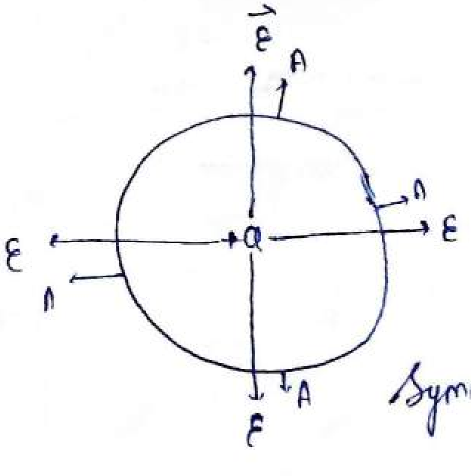
1. Draw Close symmetric gaussian Surface.
2. Gaussian Surface must be passing through the point where electric field have to be Calculate.
3. Gaussi Surface must be Symmetric to the charge distribution
4. Angle b/w Gaussian Surface and electric field must be 0°, 90°, 180°.
5. Apply $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$.
6. Gauss law always Valid for every type of charge distribution but only useful to Calculate electric field when charge distribution is Symmetric..

(i) Electric field due to point charge using Gauss law.



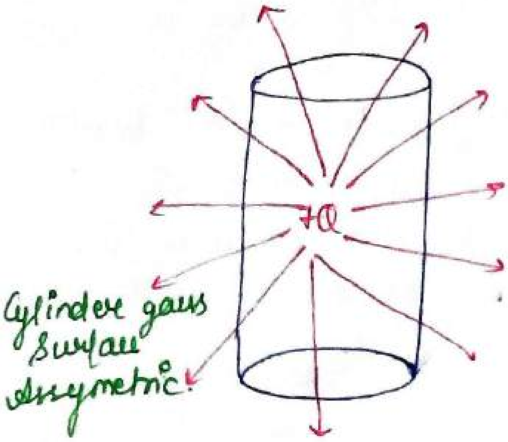


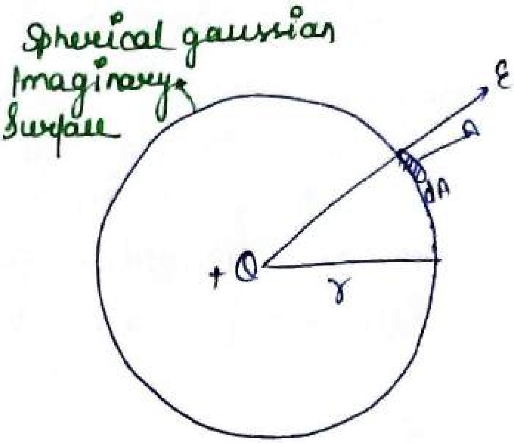
Ⓐ



(B)

(ii) Electric field due to Hallow non conducting sphere Hallow/ Salid Canducting sphere / Shell.





$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

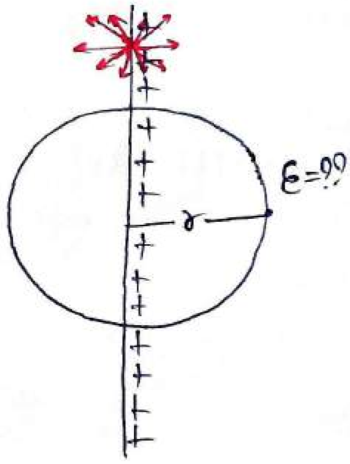
$$E\oint dA\cos 0 = \frac{Q}{\varepsilon_0}$$

$$E\,4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi\varepsilon_0}$$

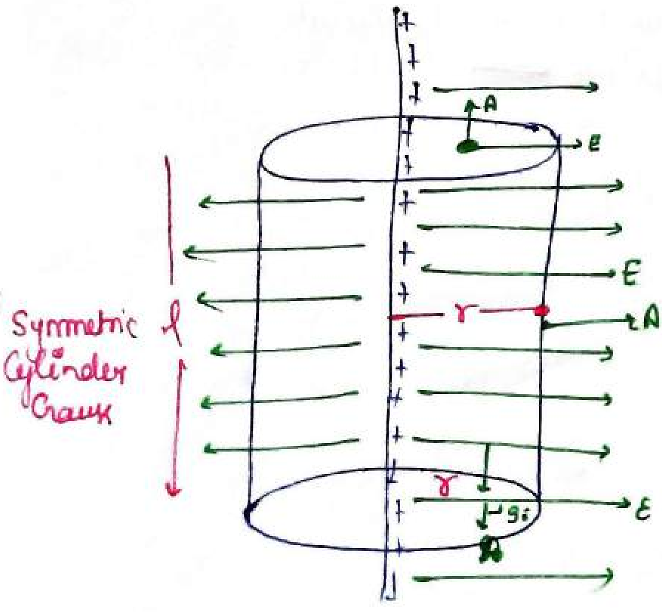
$$E = \frac{kQ}{r^2}$$

(iii) Electric field due to Infinite line charge



*** Conducting / metal / shell Salid / hallow — alway Hallow sphere

(iv) Electric field due to Infinite line charge



$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

$$\oint E\,dA\cos 90 + \oint E\,dA\cos 0 + \oint E\,dA\cos 0$$

$$\oint E\,dA\cos 0^\circ = \frac{q_{in}}{\varepsilon_0}$$

$$E\int dA = \frac{q_{in}}{\varepsilon_0}$$

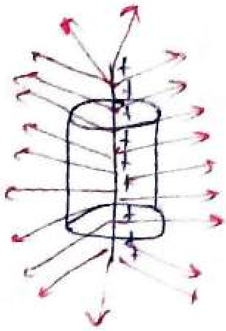
$$E\int dA = \frac{q_{in}}{\varepsilon_0}$$

$$E\times 2\pi r l = \frac{\lambda l}{\varepsilon_0}$$

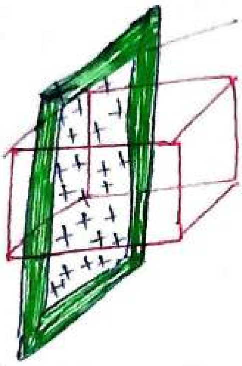
$$E = \frac{\lambda}{2\pi\varepsilon_0 r}\times\frac{2}{2} \Rightarrow \boxed{\frac{2k\lambda}{r} = E}$$

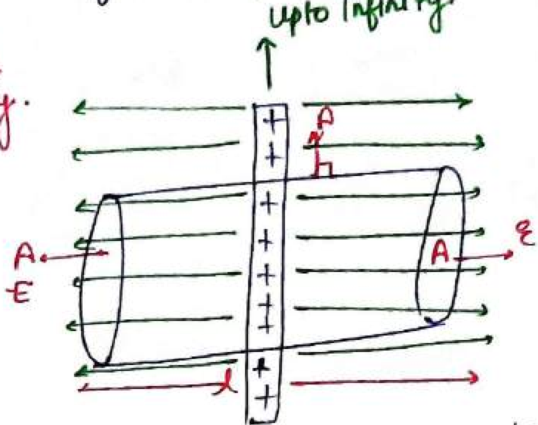
For finite line charge

Gauss law is valid or not — Yes valid
But not useful to calculate electric field.



Infinity large non conducting charge sheet





$\oint E\,dA\cos 0 + \int E\,dA\cos 90 + \int E\,dA\cos 0 = \frac{q_i}{\varepsilon_0}$

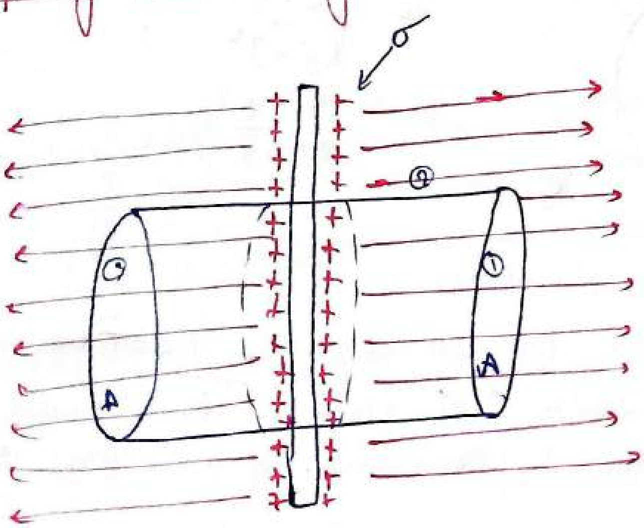
$2E\oint dA = \frac{q_{in}}{\varepsilon_0}$

$2EA = \frac{\sigma A}{\varepsilon_0}$

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

Uniform

Infinity Conducting sheet



$\phi_1 + \phi_2 + \phi_3 = \frac{q_{in}}{\varepsilon_0}$ ($\phi_2 = 0$)

$2\oint E\cdot dA = \frac{q_{in}}{\varepsilon_0}$

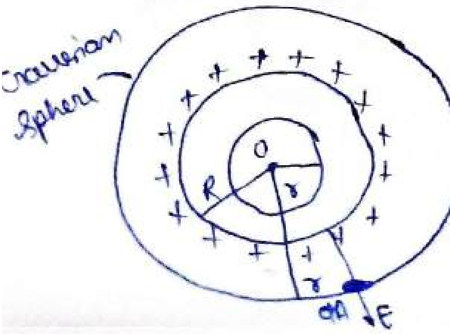
$2E\oint dA = \frac{\sigma 2A}{\varepsilon_0}$

$EA = \frac{\sigma A}{\varepsilon_0}$

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

Conducting Sheet

Electric field due to Hallow / Solid conducting sphere and nonconducting Hallow sphere.



Inside $(r < R)$

$E_{in} = 0$

$E_{centre} = 0$

$E_{surface} = \frac{KQ}{R^2}$

$E_{out} = \frac{KQ}{r^2}$

Outside $(r > R)$

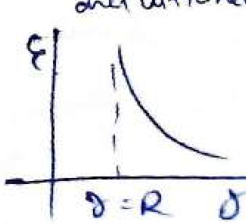
$\oint E\cdot dA = \frac{q_{in}}{\varepsilon_0}$

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

$$E = \frac{KQ}{r^2}$$

Same as point charge

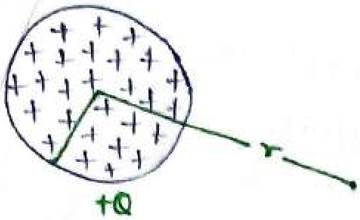
Electric field and distance



Electric field inside non conducting solid sphere / Charge uniformly distributed inside sphere

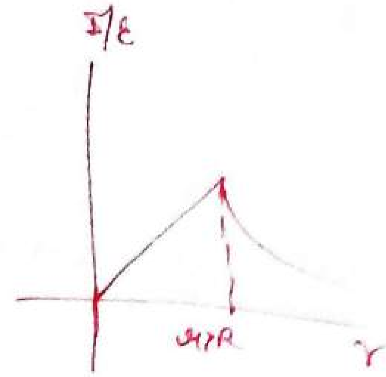
$I_{solid\,(outside)} = \frac{GM}{r^2}$, $I_{surf} = \frac{GM}{R^2}$, $I_{in\,(r<R)} = \frac{GMr}{R^3}$

$E_{out} = \frac{KQ}{r^2}$, $E_{surf} = \frac{KQ}{R^2}$. $E_{in} = \frac{KQr}{R^3}$



$E_{in} = \frac{\rho\, 4\pi R^3}{3\, 4\pi \varepsilon}$,

$E_{in} = \frac{\rho r}{3\varepsilon_0}$

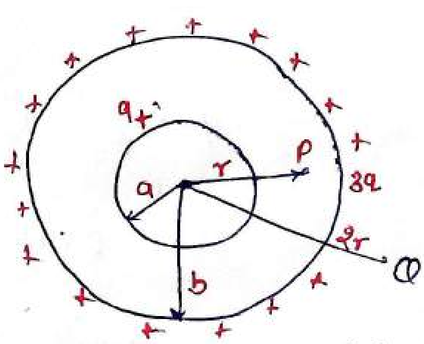


$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$, $\frac{Q}{R^3} = \frac{4}{3}\pi\rho$

Volume charge density

Que The electric field intensity at P and Q in the shown arrangement are in the ratio.

1. 1 : 2
2. 2 : 1
3. 1 : 1 ✓
4. 4 : 3



Hallow Concentric shell

$E_P = \frac{Kq}{r^2}$

$E_Q = \frac{4Kq}{(2r)^2}$

$\frac{4Kq}{4r^2}$

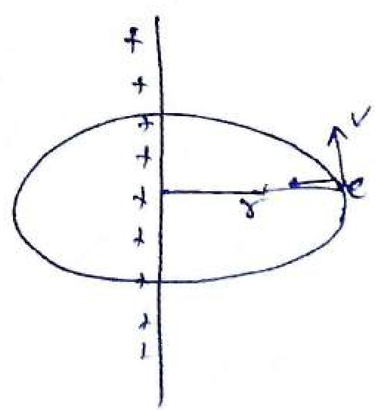
Que An electron is rotating around an infinite positive linear charge in a circle of radius 0.1 m if the linear charge density is 1 μc/cm. Then the velocity of electron in m/s will be.

1. 0.562×10^7
2. 5.62×10^7
3. 562×10^7
4. 0.0562×10^7

$\frac{mv^2}{r} = qE$

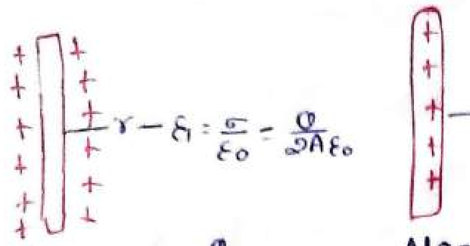
$\frac{mv^2}{r} = e\left[\frac{2K\lambda}{r}\right]$

$V = \sqrt{\frac{2K\lambda e}{m}}$



Q. Charge Q is given to Conducting and non Conducting large sheet respectively then find Ratio of electric field field very near surface of plate

(a) 1:1 —
(b) 1:2
(c) 2:1
(d) None

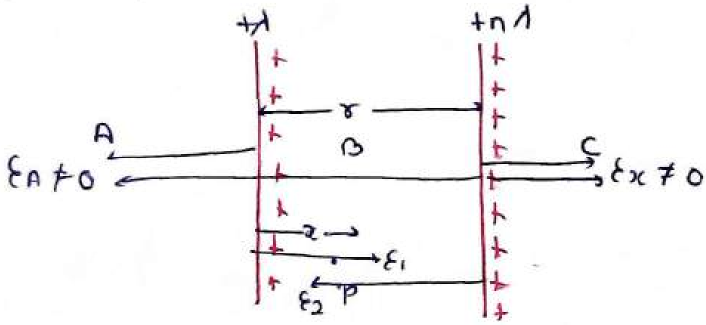


$E_1 = \frac{\sigma}{\varepsilon_0} = \frac{Q}{2A\varepsilon_0}$

$E_2 = \frac{\sigma}{2\varepsilon_0} = \frac{Q}{2A\varepsilon_0}$

Conducting $\sigma = \frac{Q}{2A}$

Q. Find position where electric field will be zero. due to Infinite line charge



$E_A \neq 0$
$E_C \neq 0$
$E_B \approx 0$

$E_P = 0$

$E_1 = E_2$

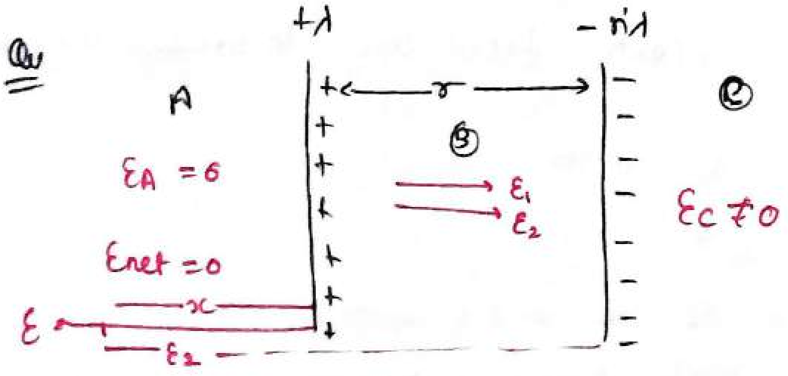
$\frac{2K\lambda}{x} = \frac{2Kn\lambda}{r-x}$

$nx = r - x$

$nx + x = r$

$x = \left(\frac{r}{n+1}\right)$

Q. then find Position where electric field is zero.



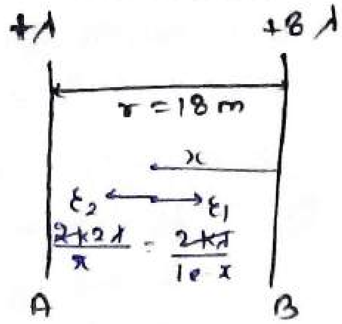
$E_1 = E_2$

$\frac{2K\lambda}{x} = \frac{2K\lambda n}{r+x}$

$nx - x = r$

$x = \left(\frac{r}{n-1}\right)$ from $+\lambda$ charge

Que



Find dist^n from B where electric field is zero.

$18 \times 8 - 8x = x$

$9x = 18 \times 8$

$\boxed{x = 16}$ B

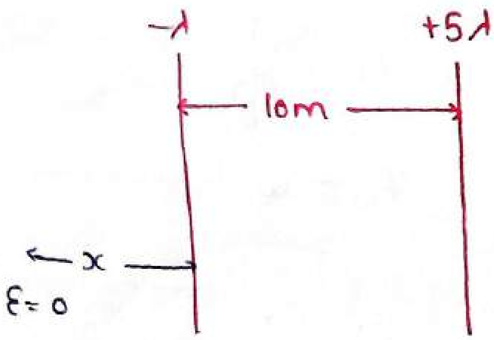
2nd method

$x = \frac{18}{8+1}$

$x = \frac{18}{9} = 2$

from $+8\lambda$ = $18 - 2 = 16m$

Que Find position where electric field is zero



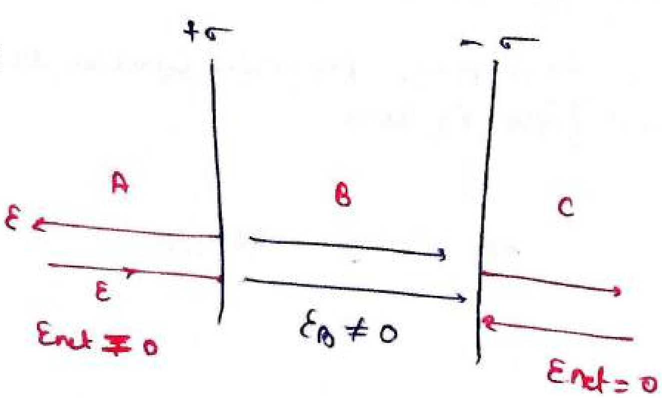
$x = \frac{10}{5-1} = \frac{10}{4} = 2.5m$

(From $-\lambda$)

from $(+5\lambda) = y = 12.5$

Electric field due to Combination of sheet :-

Que



Electric field zero In which region

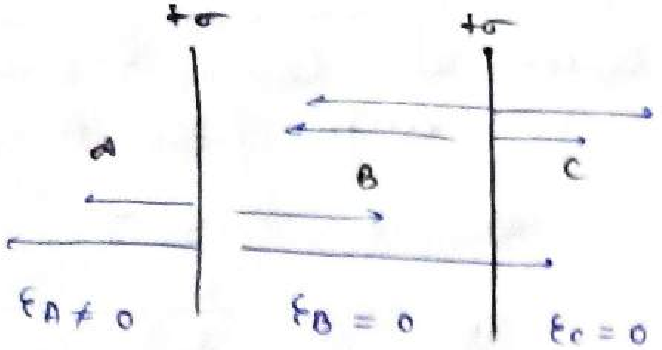
① In A

② In B

③ In A & C

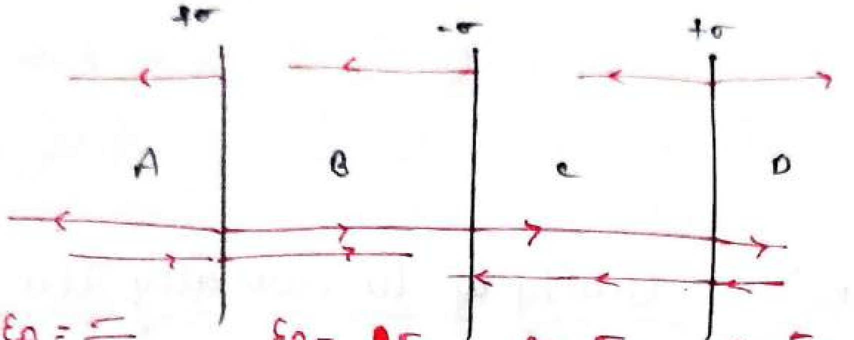
④ Not any region

Qu



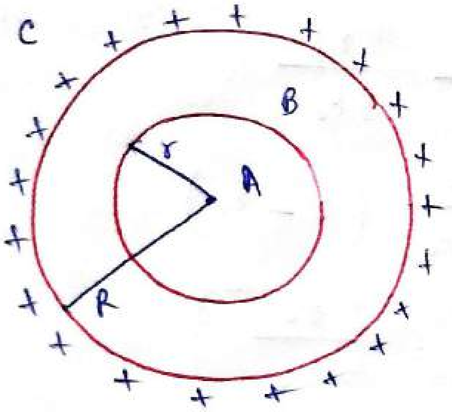
$E_A \neq 0$ $E_B = 0$ $E_C = 0$

Sheet



$E_A = \frac{\sigma}{2\varepsilon_0}$ $E_B = \frac{\sigma}{2\varepsilon_0}$ $E_C = \frac{\sigma}{2\varepsilon_0}$ $E_D = \frac{\sigma}{2\varepsilon_0}$

Electric field due to thick sphere (Conducting Sphere)

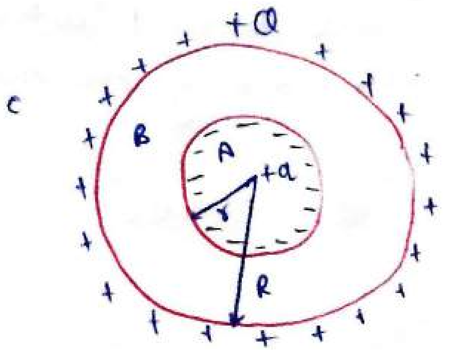


$E_A = 0$

$E_B = 0$

$E_C \neq 0$

Electric field due to thick Conducting Sphere having charge q at centre of Cavity & Q at surface of Sphere



$E_A \neq 0$

$E_B = 0$ (inside conductor always zero)

$E_C \neq 0$

$E_C = \frac{k(Q+q)}{r^2}$

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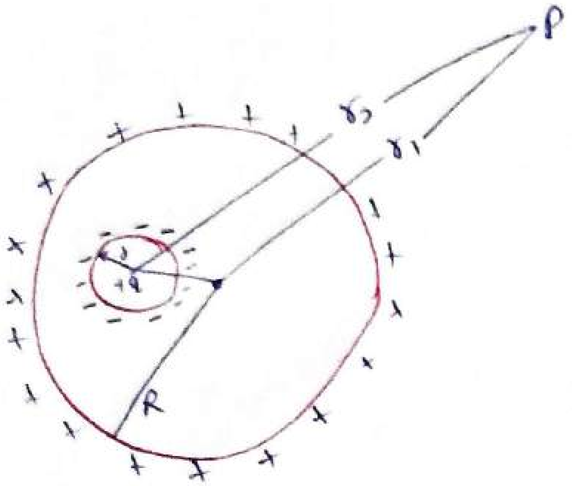
Que Conducting Neutral solid sphere having cavity and q is placed at centre at cavity find electric field at 'P'



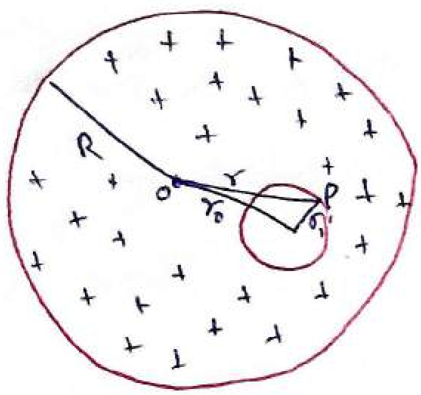
(a) $E = \frac{kq}{r_1^2}$

(b) $E = \frac{kq}{r_2^2}$

(c) $E = \frac{kq}{(r_1 - r_2)^2}$

(d) None of these

Electric field Inside Cavity of uniformally charge solid sphere



$\vec{r_0} + \vec{r_1} = \vec{r_1}$

$\vec{E}$ (due to remaining) $= (E_{comp\,spr})_P - (E_{cavity})_P$

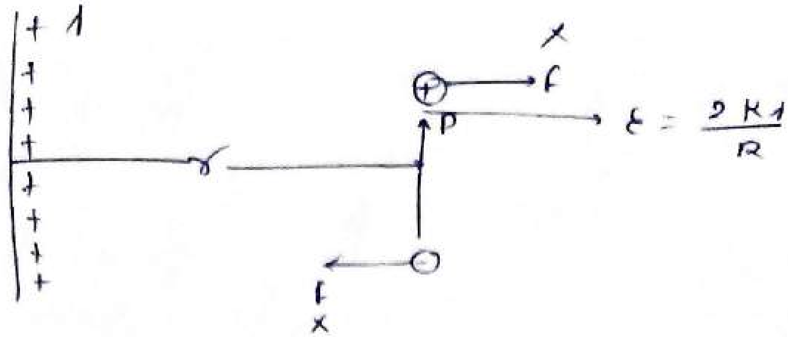
$\frac{\rho r'}{3\epsilon_0} - \frac{\rho r_1}{3\epsilon_0}$

$= \frac{\rho}{3\epsilon_0}(r' - r_1)$

Uniform field. $E_{cavity} = \frac{\rho r_0}{3\epsilon_0}$

Que A dipole with an electric moment $\vec{p}$ is located at a distance r from a long thread charged uniformly with a linear charge density λ. find the force F acting on the dipole if the vector $\vec{p}$ is oriented along the thread

① $\frac{P\lambda}{2\pi\epsilon_0 r^2}$ ② $\frac{P\lambda}{2\pi\epsilon_0 r}$ ③ $\frac{P}{2\pi\epsilon_0 r\lambda}$ ④ zero



Ans

Q. If a small sphere

① $\varepsilon_0 \left(\frac{mg}{q}\right) \tan\theta$

② $\varepsilon_0 \left(\frac{2mg}{q}\right) \tan\theta$

③ $\varepsilon_0 (mgq) \tan\theta$

④ $\varepsilon_0 \left(\frac{mg}{3q}\right) \tan\theta$

Que Two long thin

1. $\frac{K2\lambda}{d}$

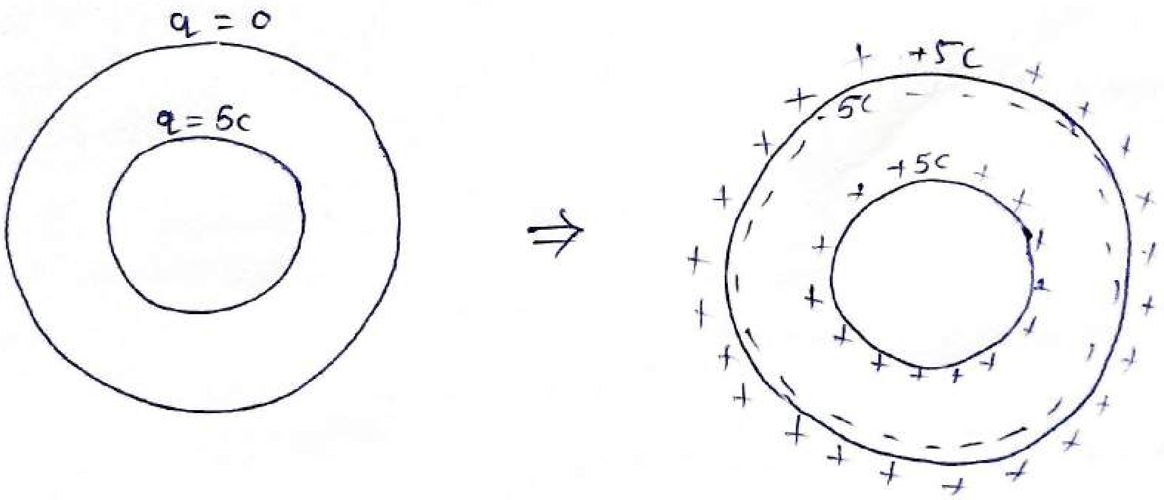
2. $\frac{K2\lambda^2}{d}$

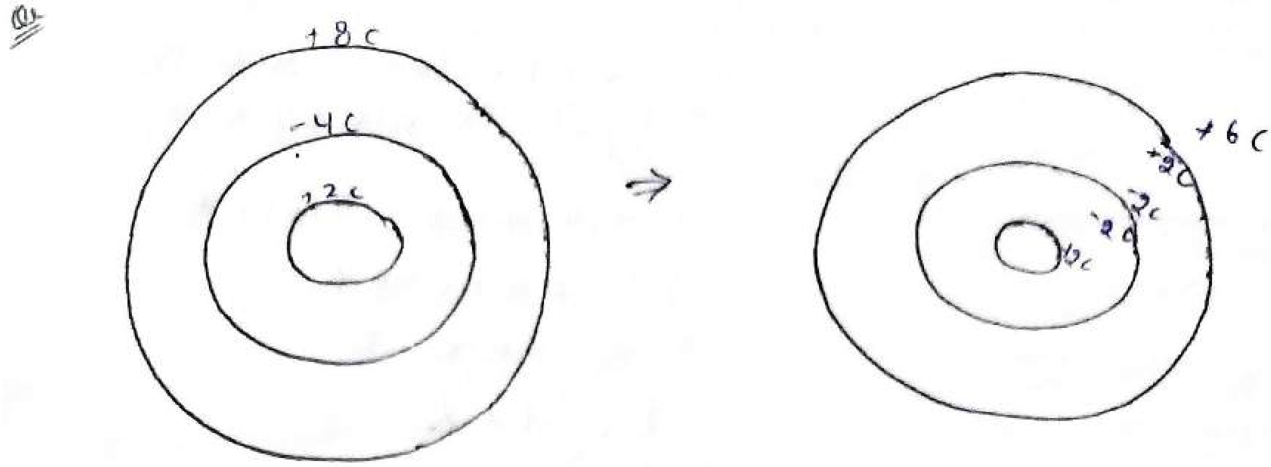
3. $\frac{K2\lambda}{d^2}$

4. $\frac{K2\lambda^2}{d^2}$

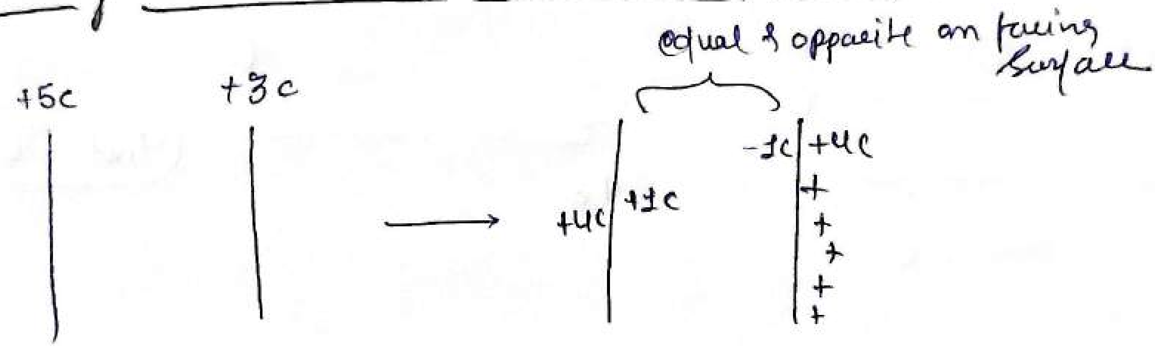
Charge distribution on Concentric sphere.

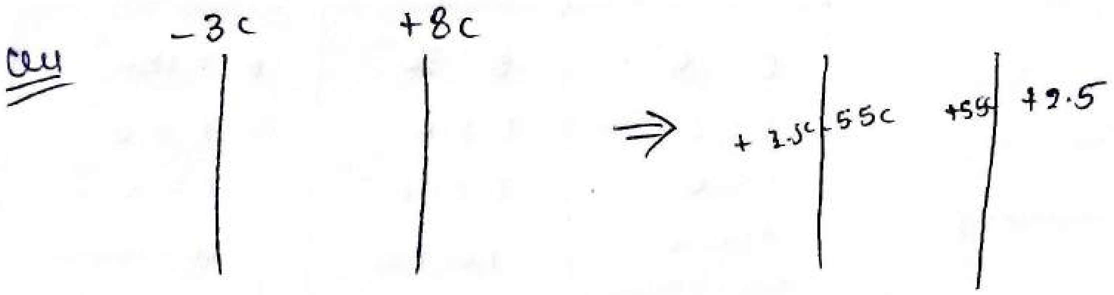
Find charge on inner & outer surface of both the sphere





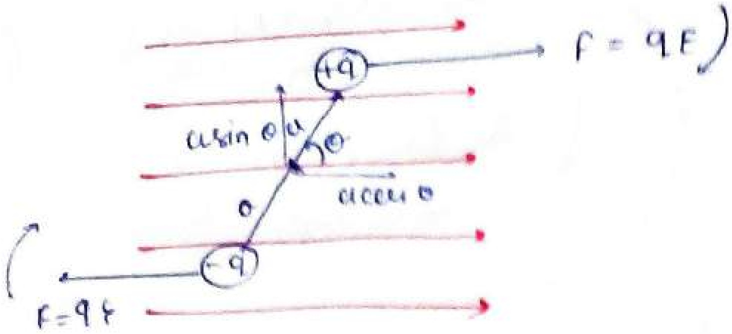
Charge distribution on Conductor parallel sheet





Charge on outer surface of plate $= \frac{Q_{total}}{2}$

Electric dipole in uniform electric field



electrostatic force on dipole is always zero.

$\tau = qE\,a\sin\theta + qE\,a\sin\theta$

$\tau = 2qE\,a\sin\theta$

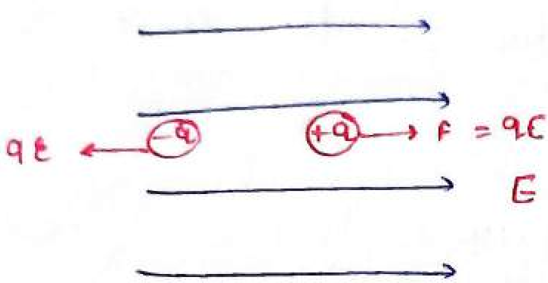
$\tau = pE\sin\theta$

$\vec{\tau} = \vec{p} \times \vec{E}$

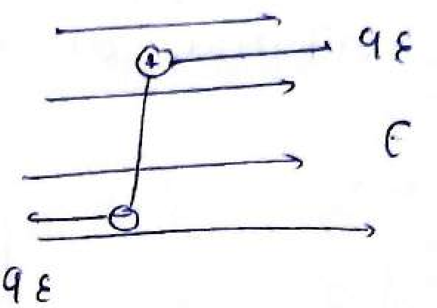
$\boxed{\tau = pE\sin\theta}$

$\boxed{F_{net} = 0}$

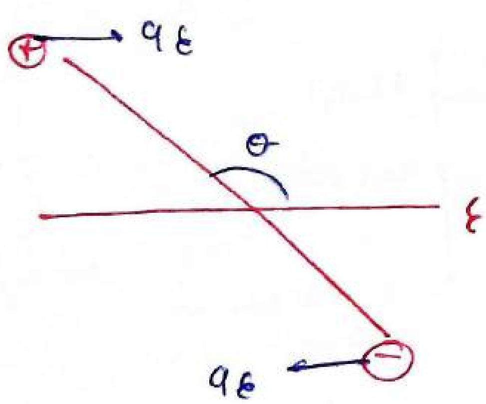
#



$f_{net} = 0$

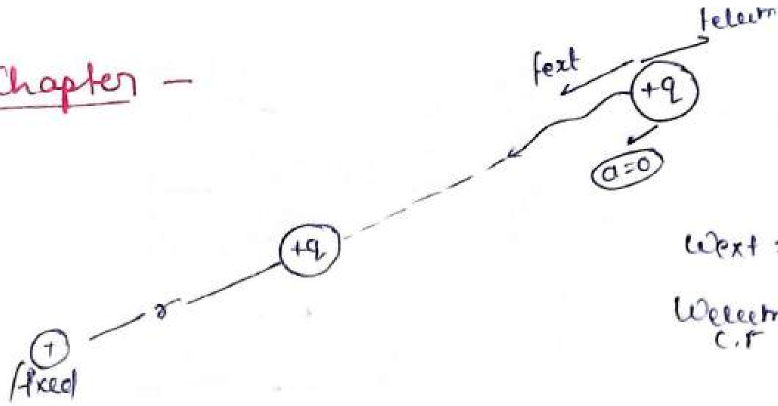


$\boxed{q_{net} = 0}$



$\theta = 0°$	$\theta = 90°$	$\theta = 180°$
$F = 0$	$F = 0$	$F = 0$
$\tau = 0$	$\tau = pE$	$\tau = 0$
stable equilibrium	not Ratn equilibrium	Unstabele equilibrium

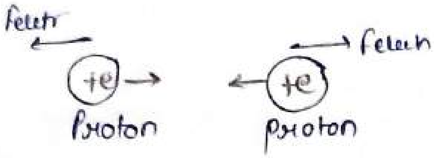
Last Chapter –



W_{ext} = +ve

$W_{electric}$ = -ve = ΔU
C.F

Que



U(potential) = U↑

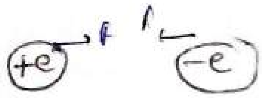
Ex!

PE = U↑

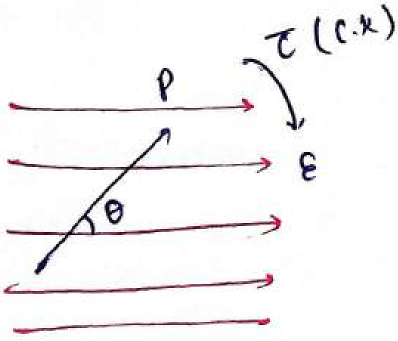
Q

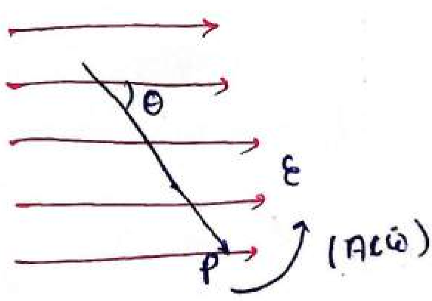
moving Away from each other

P.E = U↓



P.E = U↓



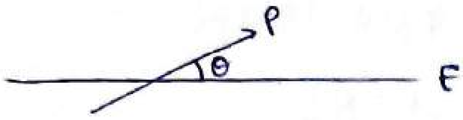


$\tau = PE \sin\theta$

θ = 0°	θ = 90°	θ = 180°
F = 0	F = 0	F = 0
τ = 0	τ_{max} = PE	
Stable equilibri		Unstable equilibrium.

dipole in uniform electric field always in translational equilibrium – True

Oscillation of dipole in uniform electric field



$\vec{\alpha} = \frac{PE}{I} \vec{\theta}$

$\omega^2 = \frac{PE}{I}$

$\omega = \sqrt{\frac{PE}{I}}$

$\tau = PE \sin\theta$

$I\alpha = PE \sin\theta$

S.H.M θ (small)

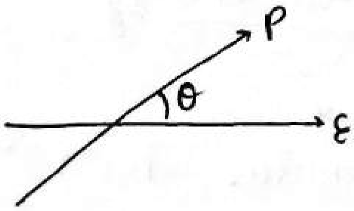
$\alpha = \left(\frac{PE}{I}\right)\theta$

$T = 2\pi \sqrt{\frac{I = ML^2}{PE = ML^2T^{-2}}}$

$$\boxed{T = 2\pi \sqrt{\frac{I}{P \cdot E}}}$$

I = moment of Inertia
P = dipole moment
E = Electric field.

Que



find taken by dipole to comes in the direction of electric.

① $T = 2\pi \sqrt{\frac{I}{P \cdot E}}$

② $T = \pi \sqrt{\frac{I}{P \cdot E}}$

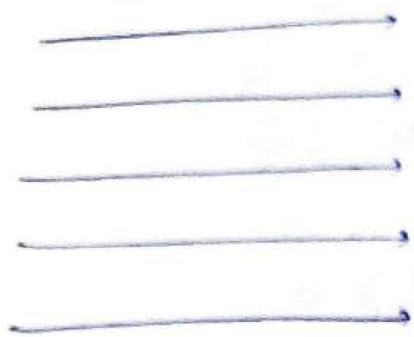
③ $T = \frac{\pi}{2} \sqrt{I / P \cdot E}$ ✓

Campair dimension / unit of energy & torque.

Energy = F x distⁿ = J = Nm = ML^2T^{-2}

torque = $\vec{\tau} = \vec{r} \times \vec{F}$ = Nm = ML^2T^{-2}

Electrostatic potential energy stored in dipole in electric field.



$$\Delta U = -W_{c.f}$$

$$dU = -(\vec{\tau} \cdot d\vec{\theta})$$

$$dU = \tau d\theta \cos 180^\circ$$

$$dU = +\tau d\theta$$

$$\int_{90}^{\theta} dU = PE \int_{90}^{\theta} \sin\theta d\theta$$

$$U_\theta - U_{90} = PE(-\cos\theta)_{90}^{\theta}$$

$$U_\theta = -PE\left[\cos\theta - \cos 90^\circ\right]$$

$$U = -PE\cos\theta$$

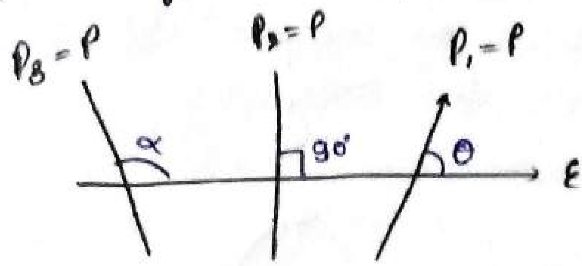
$$\boxed{U = -\vec{P} \cdot \vec{E}}$$

Torque	Potential energy
– Vector	Scalar
– dimension – ML^2T^{-2}	Dimension – ML^2T^{-2}
– unit – Nm	Unit – Nm
$\vec{\tau} = \vec{P} \times \vec{E}$ $PE\sin\theta$	$U = -\vec{P} \cdot \vec{E}$ $= -PE\cos\theta$
Torque on dipole in electric field	dipole store energy in (E)

$\theta = 0^\circ$	$\theta = 90$	$\theta = 180^\circ$
$F = 0$	$F = 0$	$F = 0$
$\tau = 0$	$\tau = PE$	$\tau = 0$
$U = -PE$	$U = 0$	$U = -PE\cos 180$

Increasing order of P.E

Qu



$U_3 > U_2 > U_1$ Ans

$U = -PE\cos\theta$

$W_{ext} = \Delta U$

$W_{C.F} = -\Delta U$

Qu Find work done to rotate the dipole from stable to unstable equilibrium ??

$W_{C.F} = -\Delta U$ $\qquad W_{ext} = \Delta U$

① PE
② 2PE ✓
③ -2PE
④ -PE

$W_{ext} = U_f - U_i$

$PE - (-PE)$

$2PE$

Qu Find work done to rotate from stable to unstable equilibrium by electric field.

$W_{ext} = -2PE$ Ans

$W_{C.F} = -\Delta U$

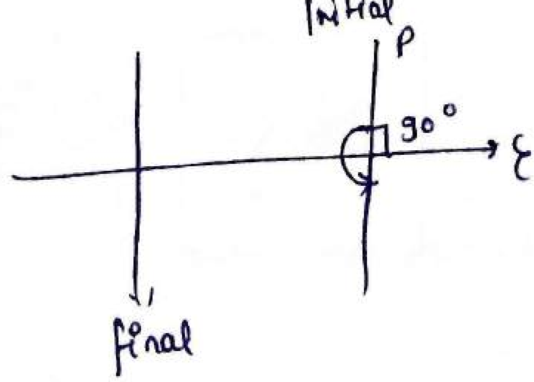
$-(U_f - U_i)$

$U_i - U_f$

$-PE - PE = -2PE$

Qu Find work done to dipole as shown in fig. from initial to fin

① PE
② $\frac{PE}{2}$
③ 2PE
④ zero ✓



$U_i = 0$

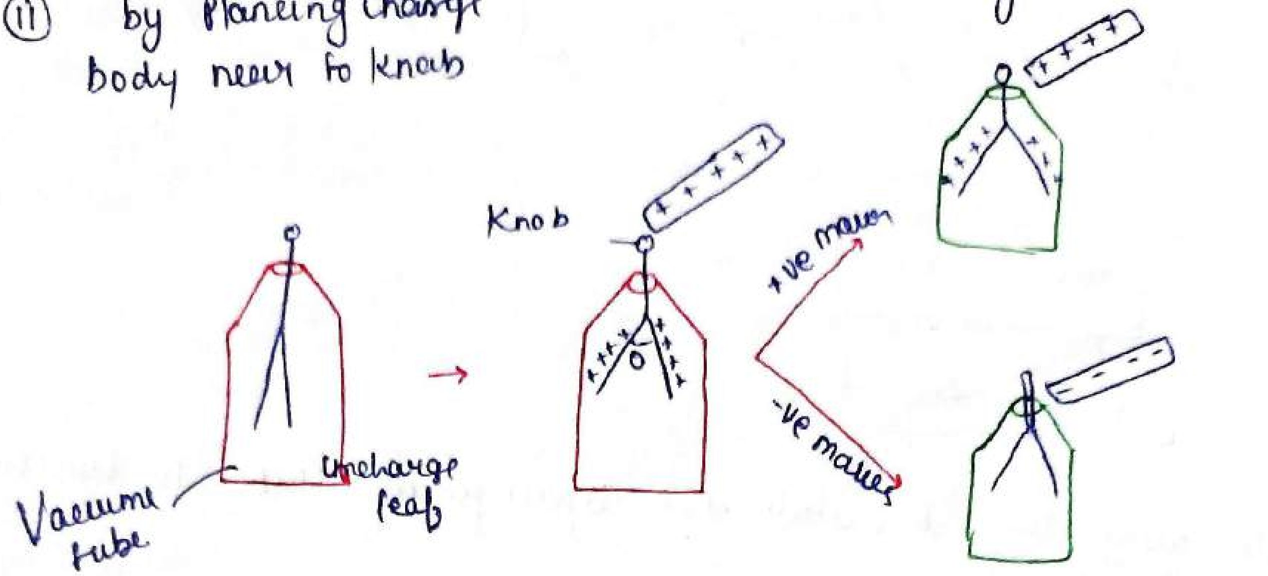
$U_f = 0$

$W = \Delta U = 0$

Gold leaf electroscope → Is an Instrument use to detect or campair Charge on the body

(i) by touching

(ii) by Planeing charge body near to knob



Que when a +20 C rod is touched to the knob the deflection of leaves was 5° and when an identical rod of -40 C is touched the deflection was found to be 9°. if an identical rod of +30 is touched then the deflection may be.

(1) 0

(2) 2°

(3) 7° ✓

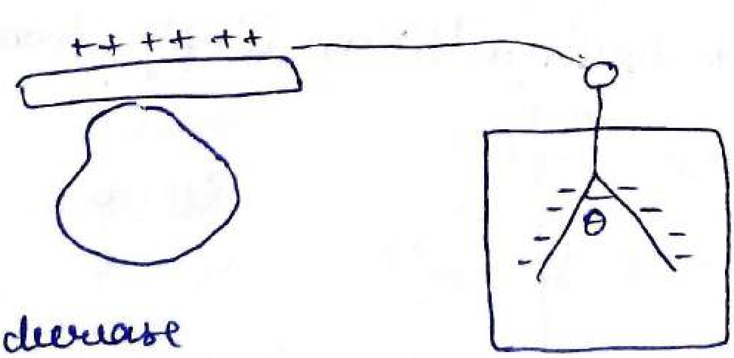
(4) 11°

$\theta \propto$ Charge

20 C ⟶ 5°

-40 C ⟶ 9°

Que A glass rod rubbed with silk is touched with the disc of Negatively charged Gold leaf electroscope the divergence



θ - decrease