Subject : Phy112 - (STJA) Date :

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attendance → 5%
Quiz → Q/2 week
Assig → A/1 week
Lab → 10%
mid → 20%
final → 35%

Ref Book:

1. Fundamental of Physics (Holiday
2. Concept of Modern Physics (Aurthur Beis

Electric Charge :

Culombs Law :

if two charges particle are brought close to each other, they each exert an eletrostatic force on the other. The direction of the ~~charge~~ force vector depends on the sign of charge.

$$\vec{F} = k \cdot \frac{q_1 q_2}{r^2} \cdot \hat{r}$$

Force magnitude :

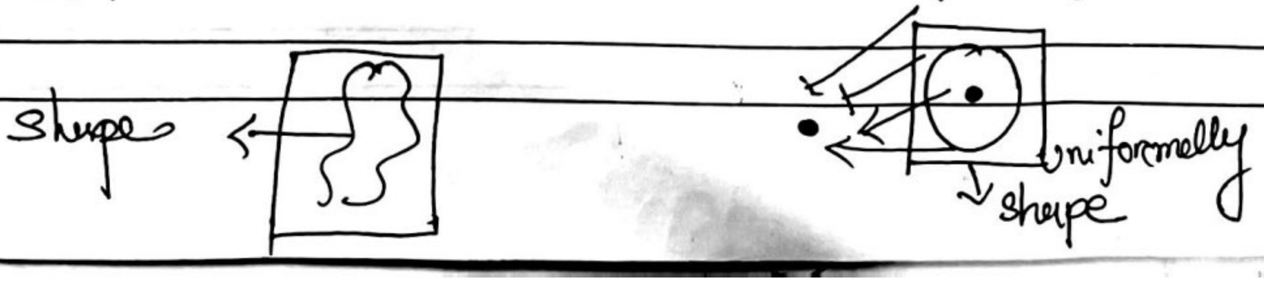
$$F = k \frac{|q_1||q_2|}{r^2}$$

$$k = \frac{1}{4\pi\epsilon_0} \; ; \; \epsilon_0 = 8.99 \times 10^{-12}$$

Shell Theories :

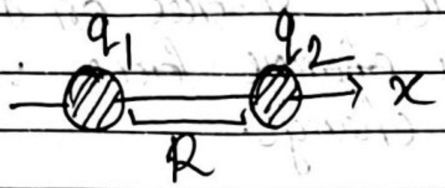
① A charged particle outside a shell with charge uniformly distributed on its surface is attracted or ve pulled as if the shell charge were concentrated as particle at its centre.

All charge come from center



(11) A charged particle inside a shell of uniform charge distributied on its surface has no net force acting on it due to the shell.

Problem 1 :



$q_1 = 1.60 \times 10^{-14}$ C

$q_2 = 3.20 \times 10^{-14}$ C

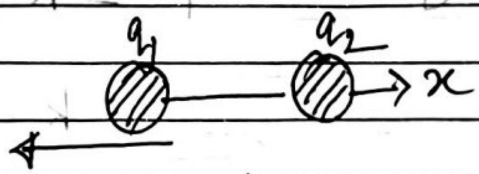
$R = 0.0200$ m

$$F_{12} = K \frac{q_1 q_2}{r^2} \times \hat{r}$$

$$\Rightarrow \frac{(1.60 \times 10^{-14}) \times (3.20 \times 10^{-14})}{(0.0200)^2} \cdot \frac{1}{4\pi \times (8.99 \times 10^{-12})}$$

$$\Rightarrow 1.15 \times 10^{-14} \text{ N}$$

Find direction :



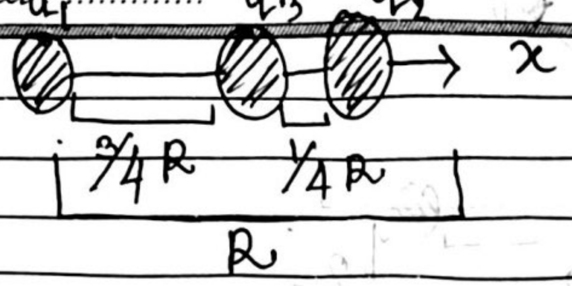
q_1 is in negative direction.

So, $F_{12} = 1.15 \times 10^{-14} \cdot (-\hat{i})$

$= -1.15 \times 10^{-14} \hat{i}$

Problem 2 :

Subject: q_1 .... q_3 q_2 Date : ....



$q_1 = 1.60 \times 10^{-14}$

$q_2 = 3.20 \times 10^{-14}$

$q_3 = -3.20 \times 10^{-14}$

$R = 0.0200$

q_1 distance is more
so q_1 will attract more
and ~~the~~ direction will be in
q_1 side.

$$\vec{F}_{net} = \vec{F}_{12} + \vec{F}_{13}$$

$$= (-1.15 \times 10^{-14})\hat{i} + (2.05 \times 10^{-24})\hat{j}$$

$$= 4.00 \times 10^{-24}$$

Ans is positive due to attraction.

$$F_{13} = k \cdot \frac{q_1 \times q_3}{r^2} \cdot \hat{r}$$

$$= k \frac{|1.60 \times 10^{-14}| \times |-3.20 \times 10^{-14}|}{(3/4 R)^2}$$

$$= 2.05 \times 10^{-24}$$

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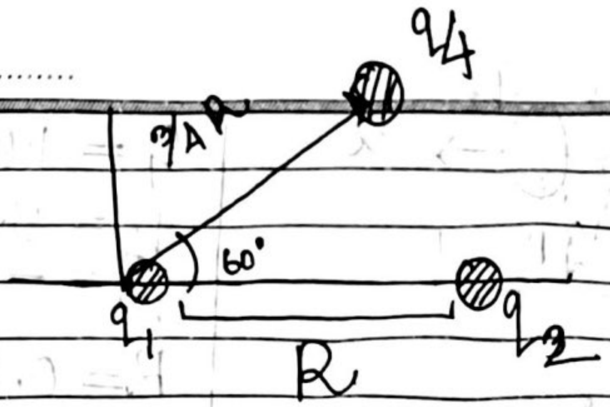


$$F_{14} = K \frac{q_1 q_4}{r^2} \cdot \hat{r}$$

$$\Rightarrow k \cdot 1.60\times10^{-19} \times \left(-3.20\times10^{-14}\right)$$

$$\Rightarrow 2.05\times10^{-24}$$

$$\vec{F}_{14} = \left(2.05\times10^{-24}\right)\left(\cos 60\,\hat{i}\right) + \left(2.05\times10^{-24}\right)\left(\sin 60\right)\hat{j}$$

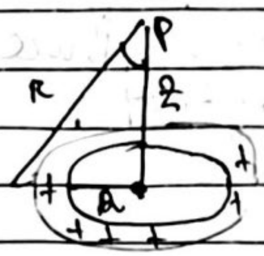
$$\Rightarrow \left(1.025\times10^{-24}\right)\hat{i} + \left(1.775\times10^{-24}\right)$$

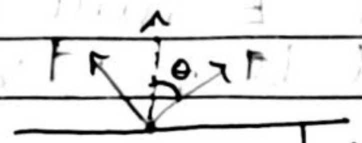
$$\therefore \vec{F}_{net} = \vec{F}_{12} + \vec{F}_{14}$$

$$= \left(-1.15\times10^{-24}\right)\hat{i} + \left(1.025\times10^{-24}\right)\hat{i} + \left(1.775\times10^{-24}\right)\hat{j}$$

"Lecture 4" Subject : .... Date : ....

$$dE = \frac{1}{4\pi\epsilon_0} \frac{\lambda\, ds}{(z^2+R^2)}$$





$$\cos\theta = \frac{z}{r} = \frac{z}{(z^2+R^2)^{1/2}}$$

r, θ ~~and~~ are not fixed if we moved the position.

$$dE.\cos\theta = \frac{1}{4\pi\epsilon_0} \frac{z\lambda}{(z^2+R^2)^{3/2}} \cdot \boxed{ds}$$

we need to integrate ds

charge = $dq = \lambda(ds)$

$$E = \int dE.\cos\theta = \frac{z\lambda}{4\pi\epsilon_0 (z^2+R^2)^{3/2}} \int_0^{2\pi R} ds$$

$$= \frac{z\lambda(2\pi R)}{4\pi\epsilon_0 (z^2+R^2)^{3/2}}$$

$$E = \frac{zq}{4\pi\epsilon_0 (z^2+R^2)^{3/2}}$$

if z in large distance, $z \gg R$, then we can skip R as R become too small.

so, when z is large,

$$E = \frac{zq}{4\pi\epsilon_0 (z^2)^{3/2}}$$

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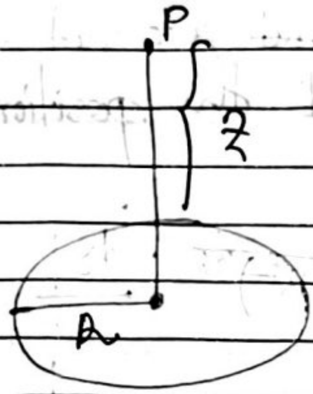
if z is small or $\boxed{z \text{ is } 0}$
then E will be 0 and there will be no longer effect.

The Electric Field due to Charged disk :

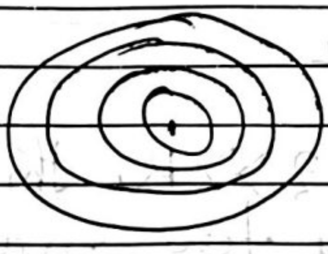


(i) how charge distribute

(ii) in P how electric pointed

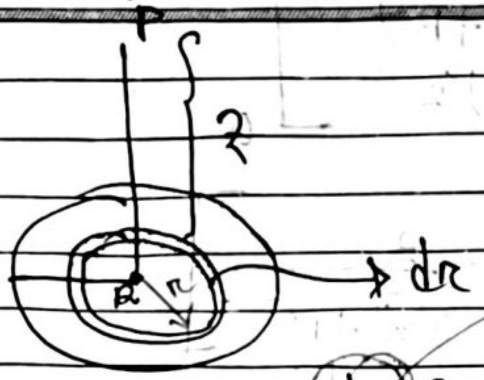
(iii)

Solid Angles: 3d angles like cone.



we can create more and more ring to solve this.

first we will create one ring and findout the charge
Subject : then we will find multiple ring.



$$dq = \lambda \cdot dS$$
$$dq = \sigma \cdot dA$$

$$dE = \frac{dq\, z}{4\pi \epsilon_0 (z^2 + r^2)^{3/2}}$$

Area = thickness × Circumference
$= 2\pi r \times dr$

$$= \frac{\sigma z}{4\pi \epsilon_0 (z^2 + r^2)^{3/2}} \cdot dA$$

$$= \frac{\sigma z}{4\pi \epsilon_0 (z^2 + r^2)^{3/2}} \cdot \boxed{(2\pi r \cdot dr)}$$ for one ring

now, integrate this,

$$E = \int dE = \int \frac{\sigma z}{4 \cdot \epsilon_0} \int_0^R \frac{2r}{(z^2 + r^2)^{3/2}}\, dr$$

here limit is "0 to R" means we will work on every ring. to get the total disk value.

$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{z}{\sqrt{z^2 + R^2}}\right)$$

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$$E = \frac{\sigma z}{4\varepsilon_0}\left[\frac{(z^2+R^2)^{-1/2}}{-1/2}\right]_0^{R}$$

$$\therefore E = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right]$$

if R is $\longrightarrow \infty$ or larage

Than, $E = \frac{\sigma}{2\varepsilon_0}$, and remain part is 0.

if $z \longrightarrow 0$ or close to disk.

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

Lecture-5

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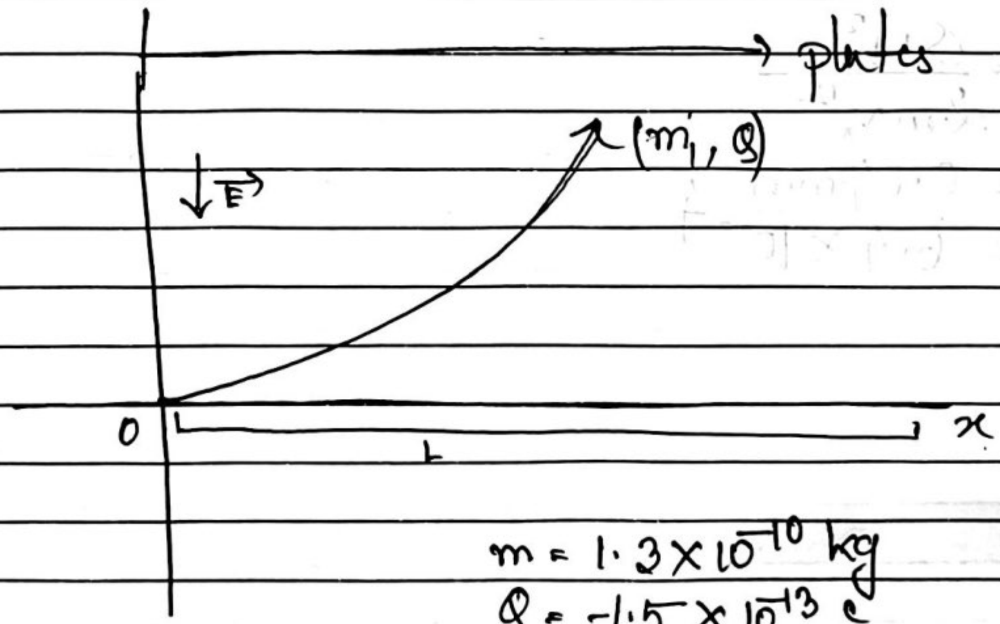
A point Charge in an Electric Field :

$F = qE$ → electric field and force same direction

$F = -qE$ → electric field and force opposite direction.

The electrostatic force $\vec{F}$ acting on a charged particle located in an external field $\vec{E}$ has the direction of $\vec{E}$ if the charge q of the particle is positive, and has the opposite direction if the particle is negative.

Ex :



$m = 1.3 \times 10^{-10}$ kg

$q = -1.5 \times 10^{-13}$ c

$v_x = 18$ m/s

$L = 1.6$ cm

$E = 1.4 \times 10^{6}$ N/c

What is the verticle direction of the particle at the far edge of the plates.

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Ans: $F = ma$

acceleration, $a_y = F/m$

$= \frac{QE}{m}$ | $F = QE$

(i) We need to find acceleration

(ii) find time.

Verticle displacement and the horizontal displacement

$y = \frac{1}{2} a_y \times t^2$ $L = v_x \cdot t$

$t = L/v_x$

$y = \frac{QEL^2}{2mv_x^2}$

$= 0.64mm$

$= 6.4 \times 10^{-4}$

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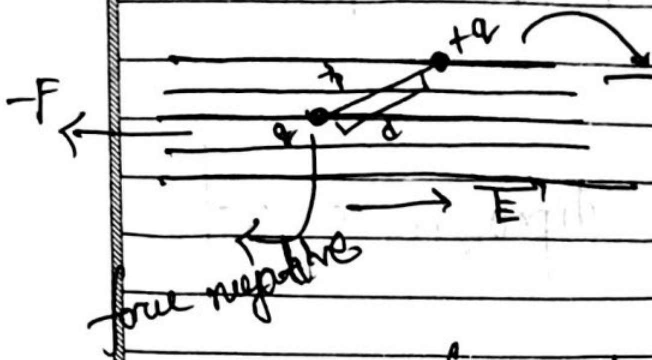
A dipole in an electric field:



force here ez is positive.

for a dipole we will get torque.

Electrostatic force act on the charged ends of the particle dipole in a uniform external electric field.

$$\boxed{F = qE}$$

The net electrostatic force is zero. so, the dipole doesnot move.

The charge and produce a net torque.

distance of center of mass from one end is x from other end $(d-x)$.

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$$\tau_{net} = r \cdot F\sin\theta + r f \sin\theta$$
$$= x F \sin\theta + (d-x) F\sin\theta$$
$$= F d \sin\theta$$

$$\tau = F d \sin\theta$$
$$= qE \cdot \frac{p}{q} \sin\theta$$
$$= pE \cdot \sin\theta$$

p = dipole movement

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

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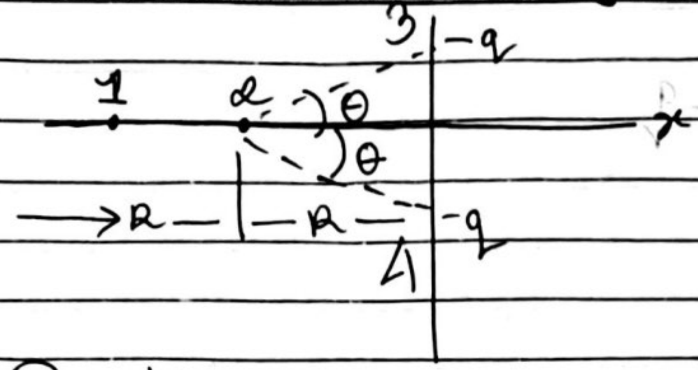
Q1)



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

$$\cos\theta = \frac{R}{r}$$

$$\therefore \quad F = \frac{2qe}{(R/\cos\theta)^2}$$

$$= \frac{2qe\cos^2\theta}{R^2} = \frac{ke^2}{R^2}$$

$$= \cancel{\frac{ke^2}{(R^2)}}$$

$$\Rightarrow \frac{2qe\cos^3\theta}{R^2} = \frac{ke^2}{R^2}$$

$$q e > \frac{e}{2\cos^2\theta}$$

$$q = \frac{e}{2\cos^3\theta}$$

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Q1 : $q_3 = -q$
$q_4 = -q$

$\tan\theta = d/R$

$\cos\theta = R/r$

$$F = \frac{kq_1q_2}{r^2}$$

$$F \Rightarrow k\frac{2qe}{r^2}\cdot\cos\theta$$

$$\Rightarrow \frac{2qe}{(R/\cos\theta)^2}\cdot\cos\theta$$

$$\Rightarrow \frac{2qe\cos^3\theta}{R} = \frac{ke^2}{R^2}$$

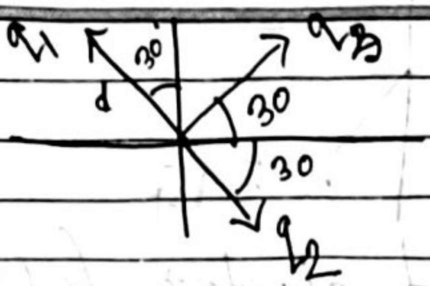
$q \leq 5e$

$$5e \geq \frac{e}{2\cos^3\theta}$$

$$q = e/2\cos^3\theta$$

$\theta \leq 62.34°$

(1)



$q_1 = +2Q$
$q_2 = -2Q$
$q_3 = -4Q$

(i) What is the net electric field $\vec{E}$ produced at the origin?

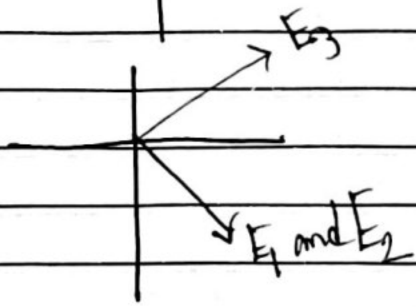
first their vector sum $\vec{E} = \vec{E_1} + \vec{E_2} + \vec{E_3}$

$\therefore E_1 = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1}{r^2}$
$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q}{d^2}$

$E_2 = \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q}{d^2}$

$E_3 = \frac{1}{4\pi\epsilon_0} \cdot \frac{4}{d^2}$

$\therefore$



direction.

$E_1 + E_2 \Longrightarrow \frac{1}{4\pi\epsilon_0} \frac{2Q}{d^2} + \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q}{d^2}$
$= \frac{1}{4\pi\epsilon_0} \frac{4Q}{d^2}$

$\therefore E_1 + E_2 = E_3$ $E_1 + E_2$ and E_3 has same magnitude and that are oriented symmetrically

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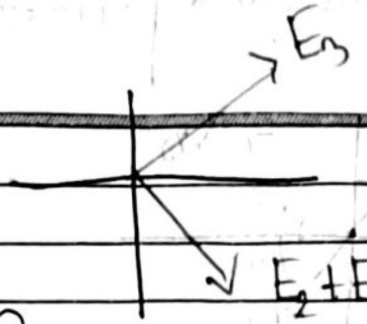

Thus the net electric field is positive and

$$\therefore\ E = 2E_{3x}\cos 30^\circ$$

$$= \cancel{8}\ 2\,\frac{1}{4\pi\epsilon_0}\,\frac{4Q}{d^2}\,(0.866)$$

$$= \frac{6.93Q}{4\pi\epsilon_0 d^2}$$

Ans.

Electric field due to circular road

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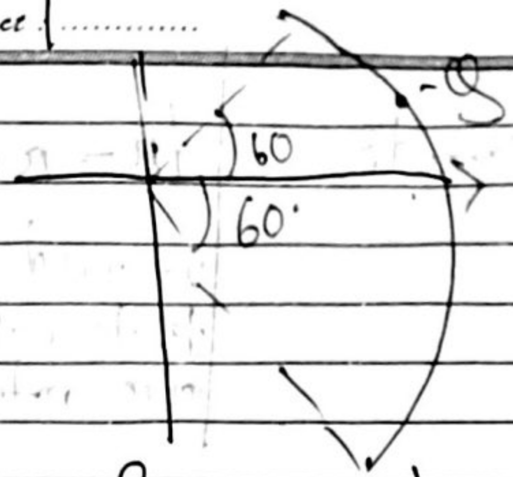
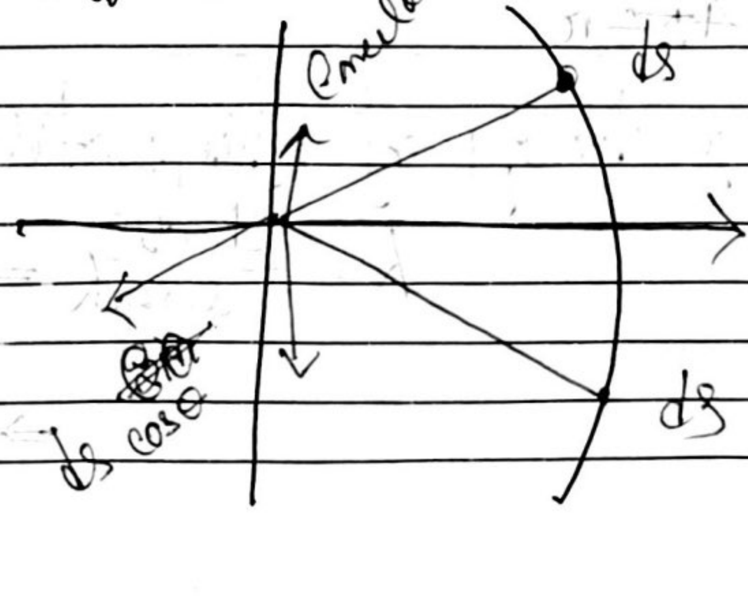


figure shows a plastic rod with a uniform charge $-Q$. it is bent in 120° circular arc of radius r and symmetrically paced across an x axis with the origin at the center of curvature $\vec{P}$. In term of Q and r, what is the electric field $\vec{E}$ due to the rod point P ?

$dq = \lambda\, ds$ | As the rod has continous charge distribution

$$dE = \frac{1}{4\pi\epsilon_0}\frac{dq}{r^2}$$

$$\therefore dE = \frac{1}{4\pi\epsilon_0}\frac{\lambda\, ds}{r^2}$$ → quantity of charge



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Now $dE_x = dE \cos\theta$

$$= \frac{1}{4\pi\epsilon_0} \frac{\lambda}{r^2} \cos\theta . ds$$

$ds = r\,d\theta$

we need to eliminate ds to calculate our integration.

$\because$ we know,

$$ds = r\,d\theta$$

Now, $E = \int dE_x$

$$= \int_{-60^\circ}^{60^\circ} \frac{1}{4\pi\epsilon_0} \frac{\lambda}{r^2} \cos\theta\, r\,d\theta$$

$$\Rightarrow \frac{\lambda}{4\pi\epsilon_0 r} \int_{-60^\circ}^{60} \cos\theta\, d\theta$$

$$\Rightarrow \frac{\lambda}{4\pi\epsilon_0 r} \left[\sin\theta \right]_{-60}^{60}$$

$$\Rightarrow \frac{\lambda}{4\pi\epsilon_0 r} \left[\sin 60^\circ - \sin(-60) \right]$$

$$\Rightarrow \frac{1.73\lambda}{4\pi\epsilon_0 r}$$

$\frac{\theta}{2\pi r/3}$

$\Rightarrow \frac{\theta}{2\pi r} 3$

$2\pi r/3$

$\Rightarrow \frac{2\pi r}{3}$

Charge density of this particle:

$$\lambda = \frac{\text{charge}}{\text{length}} \Rightarrow \frac{Q}{2r(\pi/3)}$$

$$\Rightarrow \frac{0.477Q}{r}$$

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Now adding this to equation,

$$E = \frac{(1.73)(0.4778)}{4\pi\epsilon_0 r \cdot r}$$

$\therefore$ And the vector notation will be,

$$\vec{E} = \frac{0.83Q}{4\pi\epsilon_0 r^2}\,\hat{i} \quad \underline{Ans;}$$

22.4 | Motion of charged in a field |

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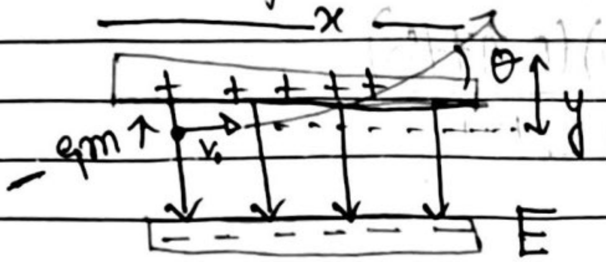
force $F = qE$



v_0 = velocity

This can't go strait as positive side attrack this particle.

force in F_y "y" direction = eE

and acceleration = $a_y = \frac{eE}{m}$ $eE \rightarrow$ force, $m \rightarrow$ mass

$a_x \rightarrow 0$ | as no force in x.

x	y
initial velocity $u_x = 0$	$u_y = 0$
$a_x = 0$	$a_y = \frac{eE}{m}$
$S_x = x$	$S_y = y$
't' =	$t = \frac{x}{v_0}$
$S = ut + \frac{1}{2} at^2$	$S = ut + \frac{1}{2} at^2$
$\therefore x = v_0 \times t + 0$	$y = 0 + \frac{1}{2} \frac{eE}{m} \frac{x^2}{v_0^2}$
$t = \frac{x}{v_0}$	

After missed 3 class | online class | Last topic : electric ~~flusk~~

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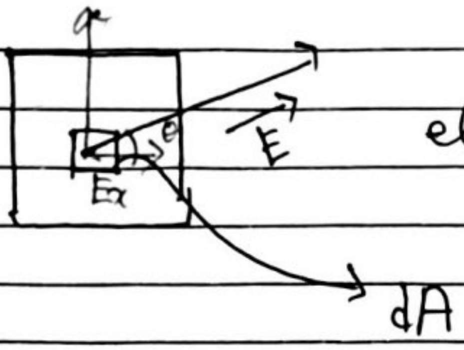
Electric ~~flusk~~ flux:

E_y flat surface, uniform field



electric field coming out

The only component for Gauss's Law that is of importance is the x component.

E_x $E\cos\theta$

$\cancel{\phi}$ $D\phi = (E\cos\theta)\, dA$

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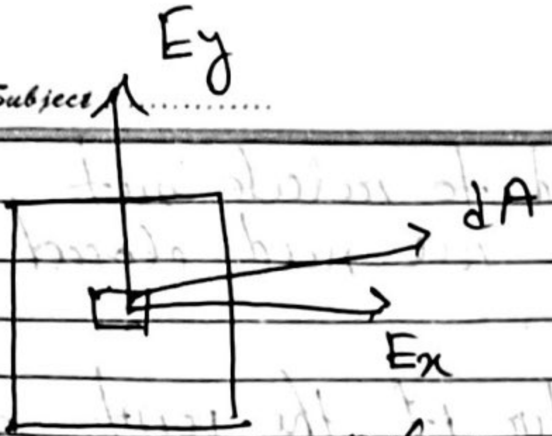

$$\Delta\phi = \vec{E} \cdot \vec{dA}$$

The dot product automatically gives us the component of $\vec{E}$ that parallel to dA.

To find total flux:

$$\phi = \sum \vec{E} \cdot \vec{dA}$$

$$\rightarrow \boxed{\phi = \int \vec{E} \cdot \vec{dA}}$$

For a uniform flat surface:

for a uniform flat surface the flux is the simplest and we take the component that is primary the surface.

$$\phi = (E\cos\theta) \cdot A$$

→ Gauss law is used to relate net force and charged.

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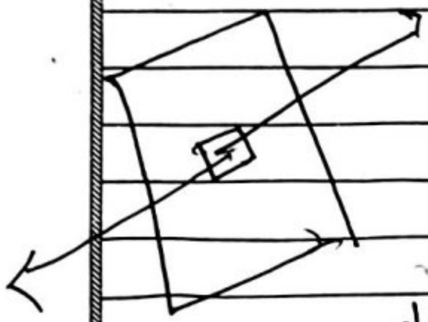
→ Gauss Law is used to relate net force and charge, we need closed surface.

→ We need to consider if the point is inward or outward, therefore, we need a concept of direction.



$$d\phi = (E\cos\theta) \cdot \vec{dA}$$
$$= (E\cos\theta) \cdot dA$$
$$= E \cdot dA$$

$$d\phi = (E\cos\theta) \cdot dA$$
$$= E \cdot \cos 180 \cdot dA$$
$$= -E \cdot dA$$

$\cos 180 = -1$

An inward piercing field will always gives a negative flux. An outward piercing is going to give a positive flux. A skimming field gives zero flux.

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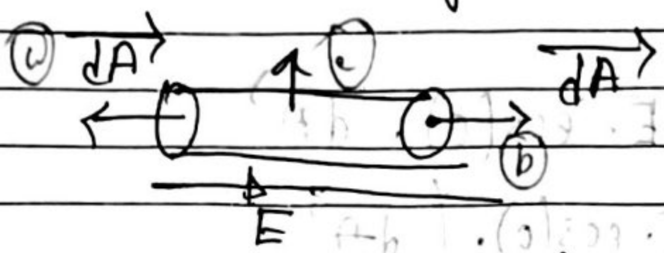
closed interval notation

Net flux : $\phi = \oint \vec{E} \cdot d\vec{A}$

Ex: Flux through a closed cylinder uniform field



Gaussian cylinder with radius r, its lies in a ~~bxxx~~ uniform electric field $\vec{E}$ with the axis (parallel to the length of the cylinder)

Q. what is the net flux ϕ of the electric field through the cylinder.

$$\phi = \oint \vec{E} \cdot d\vec{A}$$

$$\phi = \int_a \vec{E} \cdot d\vec{A} + \int_b \vec{E} \cdot d\vec{A} + \int_c \vec{E} \cdot dA$$

for a, $\int_a \vec{E} \cdot d\vec{A}$

$$\Rightarrow \int \underbrace{E \cos(180)}_{E \text{ constant}} \cdot dA$$

$$\Rightarrow -E \cdot \int_a dA$$

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$= -E \cdot A$

for part B,

$$\int_b \vec{E} \cdot \vec{dA}$$

$$= \int E \cdot \cos(0) \cdot \vec{dA}$$

$$= E \cdot \cos(0) \cdot \int \vec{dA}$$

$$= E \cdot A$$

for part C,

$$\int_c \vec{E} \cdot \vec{dA}$$

$$= \int_c E \cdot \cos(90) \cdot \vec{dA}$$

$$= E\cos(90) \int \vec{dA}$$

$$= 0$$

$\cos 90 = 0$

total flux: $-EA + 0 + E \cdot A$

$\Rightarrow 0$

Both sides electric are comming out so, the total is 0!

Capacitance :

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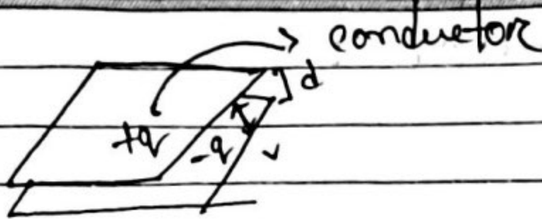

$$q = CV$$ → capacitance

Calculating the capacitance :

$$\epsilon_0 \oint \vec{E} \cdot \vec{dA} = q_{ent}$$

$$\epsilon_0 \cdot E \cdot A = q_{enc}$$

$$V_f - V_i = -\int_{-}^{+} \vec{E} \cdot \vec{ds} \Rightarrow E \cdot d$$

$$\therefore \quad C = \frac{q}{V}.$$

$$C = \frac{\epsilon_0 E \cdot A}{V}$$

$$C = \frac{\epsilon_0 A \cdot \cancel{E}}{\cancel{E} \cdot d}$$

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

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A cylindrical Capacitor :

$$q = \varepsilon_0 \cdot E \cdot A$$

$$= \varepsilon_0 \cdot E \cdot 2\pi r L$$

$$E = \frac{q}{\varepsilon_0 \, 2\pi r L}$$

$$V = \int_{-}^{+} \vec{E} \cdot d\vec{s}$$

$$= \int_{-}^{+} \frac{q}{\varepsilon_0 \, 2\pi r L} \cdot d\vec{s}$$

$$= \int_{-}^{+} \frac{q}{\varepsilon_0 \, 2\pi r L} \cdot dr$$

$$= - \frac{q}{2\pi \varepsilon_0 L} \int_{b}^{a} \frac{dr}{r}$$

$$= - \frac{q}{2\pi \varepsilon_0 L} \ln \left[\frac{b}{a} \right]$$

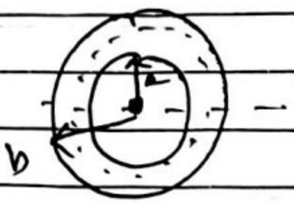
Subject : .... Date : ....

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

$$C = \boxed{2\pi\epsilon_0 \frac{L}{\ln\left(\frac{b}{a}\right)}}$$

capacitor for cylindrical capacitor.

A Spherical Capacitor :



$q = \epsilon_0 \cdot E \cdot A$

$= \epsilon_0 \cdot E \cdot (4\pi r^2)$

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

$V = \int_-^+ E \cdot ds$

$\Rightarrow \frac{q}{4\pi\epsilon_0} \int_b^a \frac{dr}{r^2}$

$\Rightarrow \frac{q}{4\pi\epsilon_0} \cdot \frac{b-a}{ab}$

capacitor for a spherical capacitance.

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Subject : .... Date : ....

Capacitance: An isolated sphere:

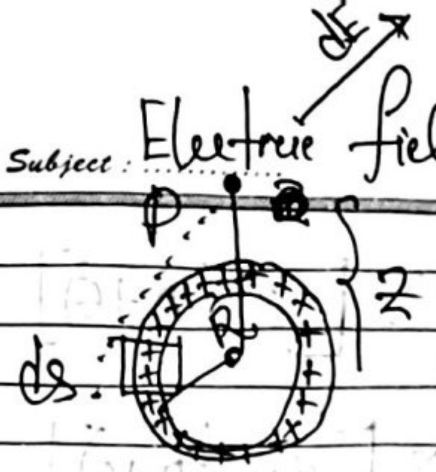
$$C = 4\pi\epsilon_0 \frac{ab}{b-a}$$

$$= 4\pi\epsilon_0 \frac{a}{1 - \frac{a}{b}} \qquad b \to \infty$$

$$\boxed{C = 4\pi\epsilon_0 R}$$

Isolated Sphere.

Subject: Electric field due to line of charge.



total Charge $+Q$

Coulombs law work for a single charge not for multiple charge. So, we will use differentiation.

Charge in length in element "ds" is:

$$dq = \boxed{\frac{Q}{2\pi R}} \cdot ds$$

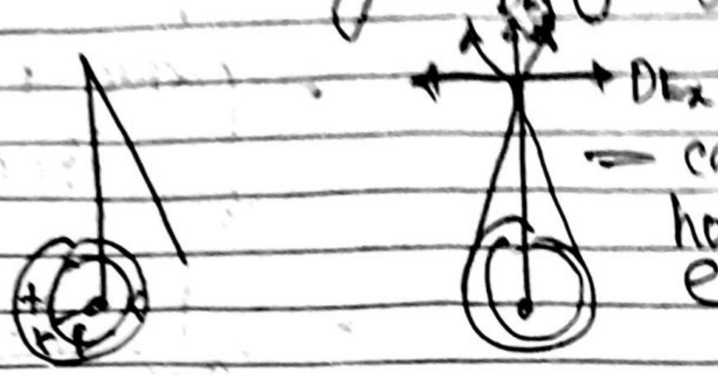
$\frac{Q}{2\pi R} \to$ line charge density "λ"

dq can be written as:

$$dq = \lambda \cdot ds$$

$$dE = \frac{1}{4\pi\epsilon_0} \frac{\lambda \cdot ds}{(z^2+R^2)}$$

The horizontal component will cancel other due to the symmetry of ring



= cancelling horizontal component

Only the vertical component will survive.

$$dE_y = dE \cdot \cos\theta \quad | \text{ for single}$$

$\therefore$ total field $E = \int_0^{2\pi r} dE \cdot \cos\theta$

$$E = \Big[dE \cdot \sin\theta \Big]_0^{2\pi r}$$

$$= dE \cdot \Big[\sin(0) - \sin(2\pi r) \Big]$$

$=$

Subject : .... Date : ....

total field $E = \int_0^{2\pi R} dE \cos\theta$

$$= \int_0^{2\pi r} \frac{1}{4\pi\epsilon_0} \frac{\lambda ds}{z^2+R^2} \cdot \cos\theta$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{\lambda \cdot 2\pi r}{z^2+R^2} \cdot \cos\theta$$

$\lambda \cdot 2\pi r = Q$

$$= \frac{1}{4\pi\epsilon} \cdot \frac{Q}{z^2+R^2} \cdot \cos\theta$$

$$= \frac{1}{4\pi\epsilon} \cdot \frac{Q}{z^2+R^2} \cdot \frac{z}{\sqrt{z^2+R^2}}$$

$$E = \frac{zQ}{4\pi\epsilon_0 \left(z^2+R^2\right)^{3/2}}$$

if we use vector

$$\vec{E} = \frac{zQ}{4\pi\epsilon_0 \left(z^2+R^2\right)^{3/2}} \hat{j}$$

Subject : .... Date : ....

* if $z >> R$, i.e. z is very very big / or in big distance

$$E = \frac{\cancel{z}Q}{4\pi\epsilon_0 z^{\cancel{3}}}$$

$$= \frac{Q}{4\pi\epsilon_0 z^2}$$ ∴ look like a point charge

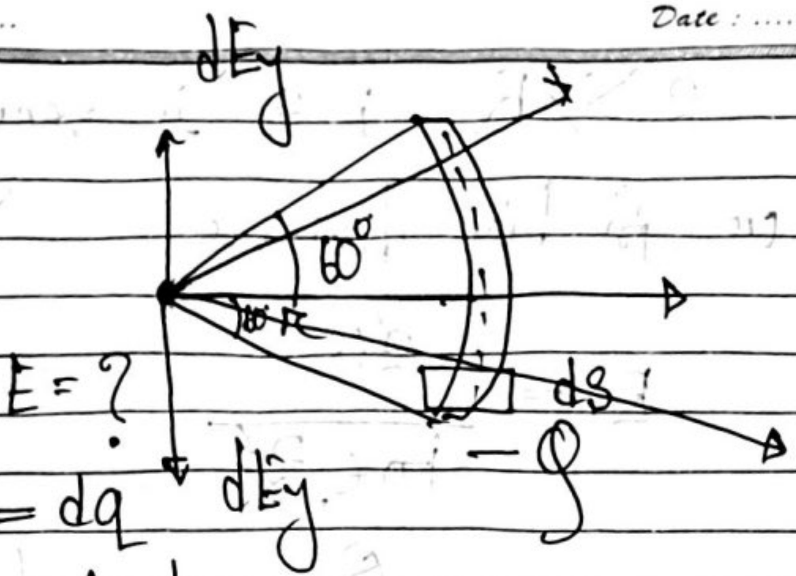
* if "z" is in the centre of the ring then the value will be "0"

$$E = \frac{\cancel{z}\,0 \cdot Q}{4\pi\epsilon_0 z^3}$$

$$= 0$$

$z = 0$

4#



$$ds = dq$$
$$= \lambda \cdot ds$$

$$dE = \frac{1}{4\pi\epsilon} \frac{dq}{\cancel{(r\theta)^2}\,(r^2)}$$

$$= \frac{1}{4\pi\epsilon} \cdot \frac{\lambda ds}{r^2}$$

Again all "y" component will cancel each other due to symmetric.

$$E = \int_{-60}^{+60} \frac{1}{4\pi\epsilon_0} \frac{\lambda\, ds}{r^2} \cdot \cos\theta$$

The angle are +60 and −60. So, the limit will be "−60" to "+60".

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$$E = \int \frac{1}{4\pi\epsilon_0} \frac{\lambda\, ds}{r^2} \cdot \cos\theta$$

$$= \frac{\lambda}{4\pi\epsilon_0} \int_{-60}^{+60} \frac{\cancel{r} \cdot r\, d\theta}{\cancel{r^2}} \cdot \cos\theta$$

We cant integrate two var.

So, we are replacing ds.

$s = r\theta$

$ds = r\,d\theta$

$$= \frac{\lambda}{4\pi\epsilon_0} \int_{-60}^{+60} \frac{d\theta}{r} \cdot \cos\theta$$

$$= \frac{\lambda}{4\pi\epsilon_0 r} \int_{-60}^{+60} d\theta \cdot \cos\theta$$

$$= \frac{\lambda}{4\pi\epsilon_0 r} \left[\sin(60) - \sin(-60) \right]$$

$$= \frac{\lambda}{4\pi\epsilon_0 r} \cdot 2 \times \sin 60^\circ$$

$$= \frac{\sqrt{3}\lambda}{4\pi\epsilon_0 r}$$

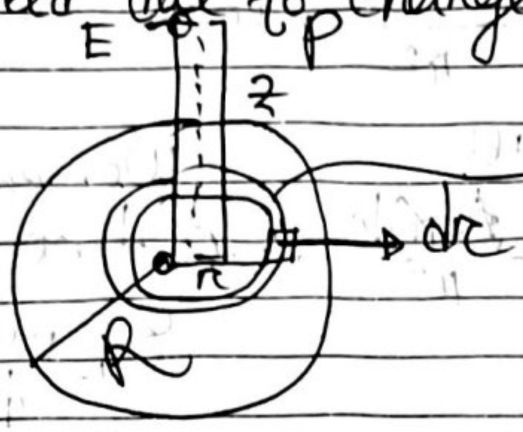
$$= \frac{\sqrt{3}\; 3Q}{8\pi^2\epsilon_0 r^2}$$

$$\lambda = \frac{Q}{2\pi r/3}$$

$$= \frac{3Q}{2\pi r}$$

Subject : .... Date : ....

Electric field due to charged disk :



use as rectangle then length × breadth
$2\pi r \times dr$

Area of the ring :

$$dA = \underbrace{2\pi r}_{\text{Circle}} \cdot dr \longrightarrow \text{[illegible]}$$

Surface charge density :

σ = total charge / density

$$= \frac{Q}{\pi R^2}$$

Subject : .... Date : ....

Electric field due to ring:

$$dE = \frac{z \cdot dq}{4\pi\epsilon_0 (z^2+r^2)^{3/2}}$$

Now, $dq = \alpha \, dA$ | from rectangle area

$= \alpha (2\pi r \cdot dr)$

Put the value to dq of equation.

$$dE = \frac{z \cdot \alpha \cdot 2\pi r \cdot dr}{4\pi\epsilon_0 (z^2+r^2)^{3/2}}$$

$$E = \int_0^R dE = \frac{z\alpha}{2\epsilon_0} \int_0^R \frac{r \cdot dr}{(z^2+r^2)^{3/2}}$$

$$\cancel{= \frac{z\alpha}{2\epsilon_0}}$$

$$\Rightarrow \frac{z\sigma}{2\epsilon_0} \int_0^R \frac{du}{2u^{3/2}}$$

$$\Rightarrow \frac{z\sigma}{\cancel{4}\epsilon_0} \left[\frac{u^{-1/2}}{-1/2} \right]_0^R$$

let,

$z^2 + r^2 = u$

$0 + 2r\,dr = du$

$r\,dr = \frac{du}{2}$

Subject : .... Date : ....

$$= \frac{z\sigma}{2\cancel{4}\epsilon_0}\left[\frac{u^{-1/2}}{-1/\cancel{2}}\right]_0^R$$

$$= -\frac{z\sigma}{2\epsilon_0}\left[(z^2+R^2)^{-1/2}\right]_0^R$$

$$= -\frac{z\sigma}{2\epsilon_0}\left[\frac{1}{(z^2+R^2)^{1/2}}-\frac{1}{z}\right]$$

$$= \frac{z\sigma}{2\epsilon_0}\cdot\left[\frac{1}{z^2\cancel{+R^2}}-\frac{1}{\left(\sqrt{z^2+R^2}\right)}\right]$$

$$= \frac{z\sigma}{2\epsilon_0}\left[1-\frac{1}{\sqrt{1+\frac{R^2}{z^2}}}\right]$$

z কমন নিয়ে $\sqrt{\frac{z^2+R^2}{z^2}}$ হবে। কারণ $\sqrt{x^2}$ কে y দিয়ে ভাগ করলে ও পাওয়ার y^2 হবে

Ex: $\sqrt{\frac{x^2}{y^2}}$

if $z \gg R$:

then $E = 0$

if $R \gg z$,

$$E = \frac{\sigma}{2\epsilon_0}$$

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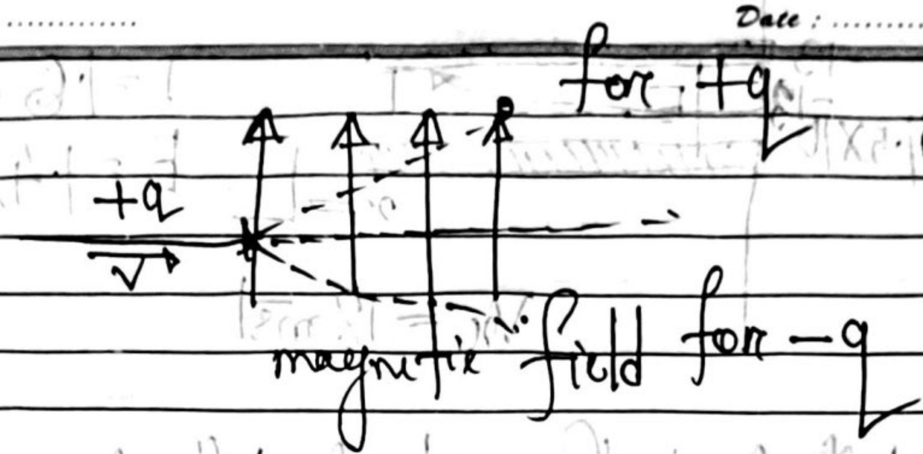

$$\vec{F_E} = q\vec{E}$$

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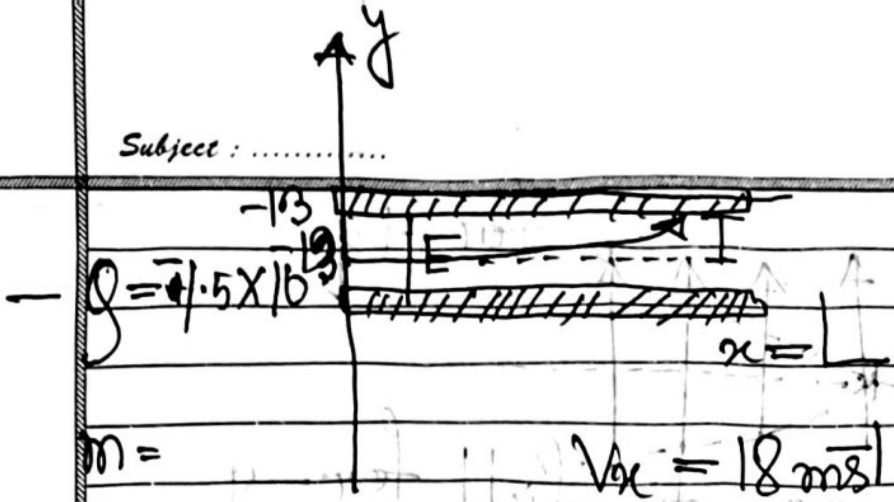

$L = 1.6$ cm

$E = 1.4 \times 10^6$ N/C

* What is the vertical deflection of the charge?

$$F = QE$$

$$t = \frac{L}{V_x}$$

$$a_y = F/m$$

$$= \frac{QE}{m}$$

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

$$= 0 + \frac{1}{2}at^2$$

$u = 0$ because

$$y = \frac{1}{2} \times \frac{QE}{m} \times (t)^2$$

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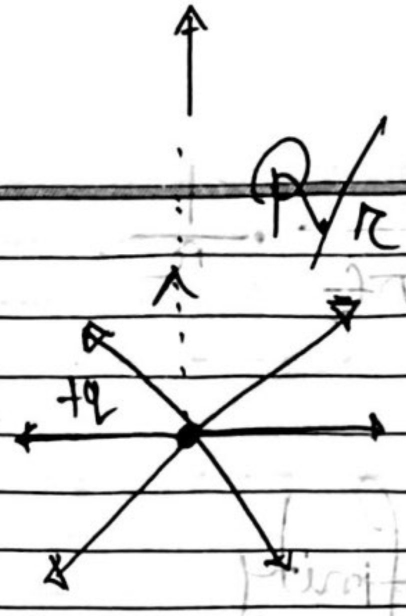

$$V_f - V_i = -\int_i^f \vec{E}\cdot d\vec{s}$$

$$= -\int_R^\infty E\cdot d\vec{s}$$

$$= -\int_R^\infty E\cdot dr \cos 0^\circ$$

$$= -\int_R^\infty E\cdot dr$$

$$= -\int_R^\infty \frac{1}{4\pi\epsilon_0}\cdot\frac{q}{r^2}\cdot dr$$

$$= \frac{1}{4\pi\epsilon_0}\int_R^\infty \frac{q}{r^2}\cdot dr$$

$$\Rightarrow \frac{q}{4\pi\epsilon_0}\left[\frac{1}{r}\right]_R^\infty$$

$$\Rightarrow \frac{q}{4\pi\epsilon_0}\left[\frac{1}{r}-\frac{1}{\infty}\right]$$

$$\Rightarrow \frac{q}{4\pi\epsilon_0}\cdot\frac{1}{r}$$

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$$V_f - V_i = -\frac{q}{4\pi\epsilon_0} \cdot \frac{1}{r}$$

$V_f = 0$ at infinity

$V_i = V$

$$\therefore -V = -\frac{1}{4\pi\epsilon_0} \frac{q}{R}$$

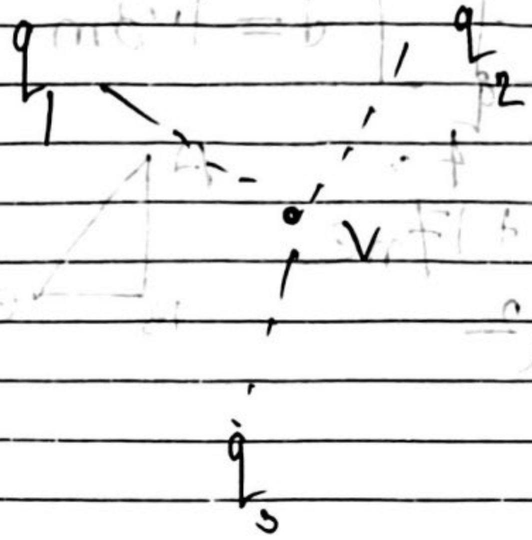
$$\boxed{V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}}$$

$\therefore$ potential at any distance r from a point charge q is

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

Subject : .... Date : ....

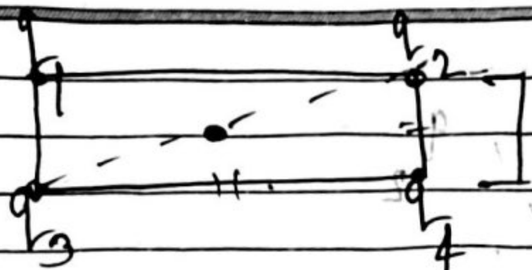
*



total Change $V = \frac{1}{4\pi\epsilon_0}\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3}\right)$

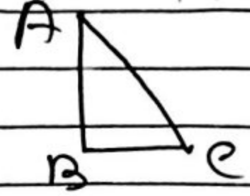
Subject: +12nC   -24nC   Date: ....

Q



d = 1.3m

+31nC   +17nC



$$(1.3)^2 + (1.3)^2 = x^2$$

$$\Rightarrow 2.6 = x$$

$$\Rightarrow x/2 = 1.3$$

$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{q_1}{r} + \frac{q_2}{r} + \frac{q_3}{r} + \frac{q_4}{r}\right)$$

$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{12\times10^{-9}}{1.3/\sqrt{2}} + \frac{-24\times10^{-9}}{1.3/\sqrt{2}} + \frac{31\times10^{-9}}{1.3/\sqrt{2}} + \frac{17\times10^{-9}}{1.3/\sqrt{2}}\right)$$

$$= 350\ V$$ Ans.

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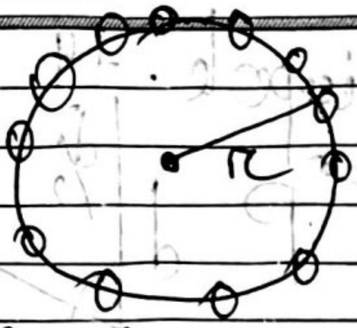
Q2



uniformly distributed 12 e^-.

* What is the potential "V" at centre?

$$V = \frac{1}{4\pi\epsilon_0}\left(-\frac{e}{r} \times 12\right)$$

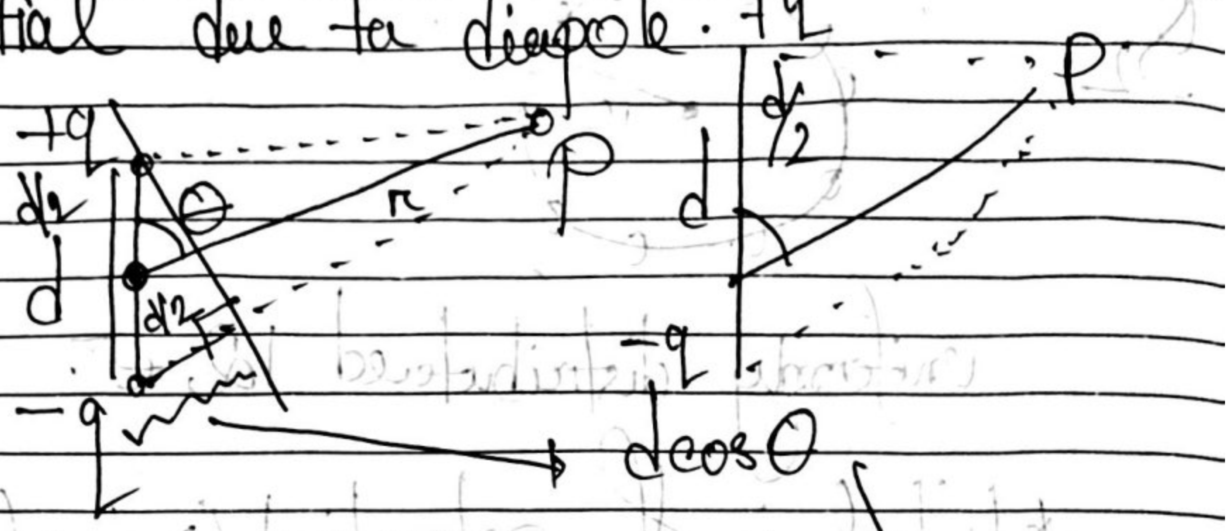
$$= \frac{1}{4\pi\epsilon_0} \cdot -\frac{12e}{r}$$

* What is E at the centre?

$\Rightarrow$ Zero

Subject : .... Date : ....

Q4 Potential due to diapole.



What is "V" at P ?

$$\Rightarrow \frac{1}{4\pi\epsilon_0}\left(\frac{q_1}{x_1}-\frac{q}{x_2}\right)$$

$$\frac{1}{4\pi\epsilon_0}\left(\frac{x_2-x_1}{x_1 x_2}\right)$$

$$\frac{q}{4\pi\epsilon_0}\cdot\frac{d\cos\theta}{r^2}$$

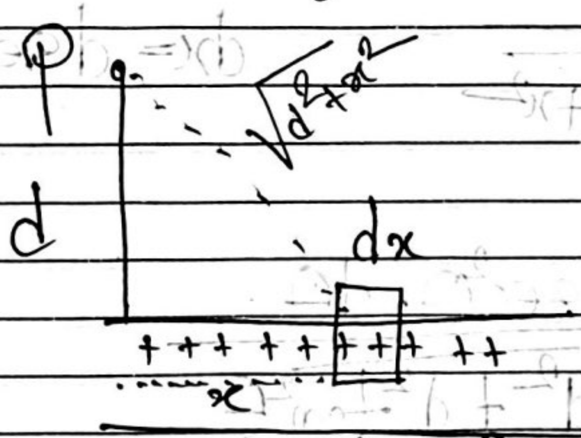
Subject : .... Date : ....

$$F = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}$$

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

$$F = -\frac{\partial V}{\partial r}$$

* For a uniform charge distribution



↳ total charge +Q

Potential at P due to length element dx is

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$$dV = \frac{1}{4\pi\epsilon_0} \frac{dq}{\sqrt{d^2+x^2}}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{\lambda \cdot dx}{\sqrt{d^2+x^2}}$$

$$\therefore V = \int_0^l dV$$

$$= \frac{\lambda}{4\pi\epsilon_0} \int_0^L \frac{dx}{\sqrt{d^2+x^2}}$$

$$x = d\tan\theta$$

$$dx = d\sec^2\theta \cdot d\theta$$

$$\Rightarrow \frac{\lambda}{4\pi\epsilon_0} \int_0^L \frac{d\sec^2\theta \cdot d\theta}{\sqrt{d^2 + d^2\tan^2\theta}}$$

$$= \frac{\lambda}{4\pi\epsilon_0} \int_0^L \frac{\cancel{d}\sec^{\cancel{2}}\theta \cdot d\theta}{\cancel{d} \cdot \cancel{\sec\theta}}$$

$$= \frac{\lambda}{4\pi\epsilon_0} \int_0^L \sec\theta \cdot d\theta$$

Subject: Date:

$$V = \frac{\lambda}{4\pi\epsilon_0} \ln\left(x + (x^2+d^2)^{1/2}\right)\Big|_0^L$$

$$\Rightarrow \frac{\lambda}{4\pi\epsilon_0} \left[\ln\left(L + (L^2+d^2)^{1/2}\right) - \ln d\right]$$

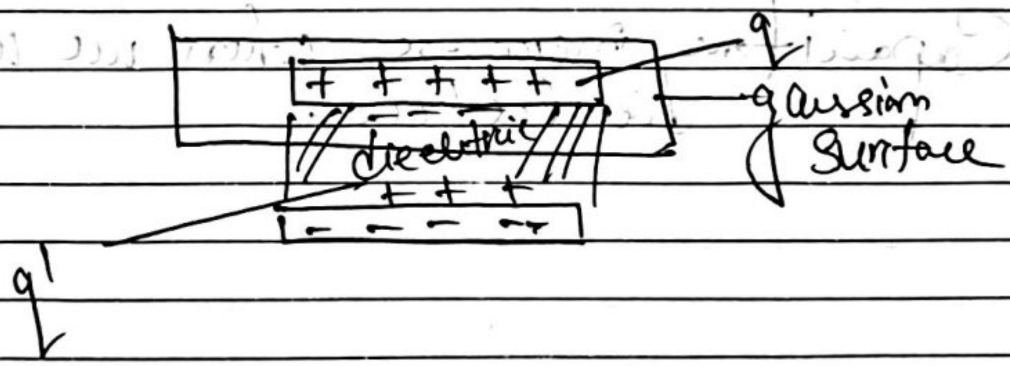
$$\frac{\lambda}{4\pi\epsilon_0} \ln\left(\frac{L+\sqrt{L^2+d^2}}{d}\right)$$

Subject: Capacitor with dieelectric: Date: ....

dieelectric → insulating matrial.
doesnot conduct current but has some electric field.

after adding battery (-) charge attract (+) charge

$$E = \frac{E_0}{K}$$ → dielectric constant



Subject : .... Date : ....

$$q = \varepsilon_0 \oint E\,d\vec{A}$$

$$q = \varepsilon_0 \cdot E \cdot A = q - q'$$

$$E = \frac{q - q'}{\varepsilon_0 \cdot A}$$

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

$$\frac{q - q'}{\varepsilon_0 A} = \frac{q}{\varepsilon_0 K \cdot A}$$

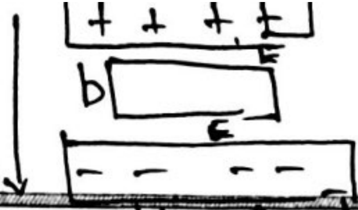
$$q' \Rightarrow q \times \left(1 - \frac{1}{k}\right)$$

$$C = \frac{\varepsilon A}{d}$$

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

Capacitance increase when we use dielectric.

d = 124



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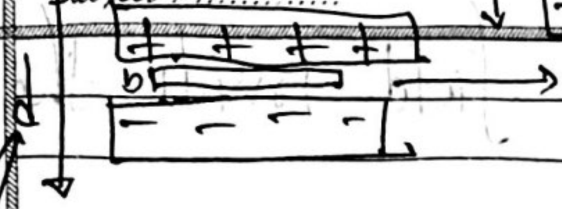
Q



dielectric

$V_0 = 85.5\ V$

Area = 115 cm^2

$k = 2.61$

124 cm

(a) What is the capacitance before the dielectric inserted

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

(b) What is the charge on the plate? [$C \cdot V_0$]

$$q = C . V_0$$

$$= 85.8 \times 8.21 \times 10^{-12}$$

$$= 7.01 \times 10^{-10}\ C$$

(c) What is the electric field inside the gap?

$$E_0 = \frac{q}{\epsilon_0 . A}$$

$$= \underline{\qquad\qquad}$$

= 6884 volt/m

Subject : .... Date : ....

(d) What is the electric field inside the dieelector?

$$E = E_0 / K$$

$$= 6884 / 2.61$$

$$= 2637$$

(e) What is the potential different between the plates?

$$V = \int E \cdot dr \quad \Big| \quad V = Eb + E_0(d-b)$$
$$= 2637$$

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

$$= 2637 \times 0.78 \times 10^{-2} + 6884 (1.24 - 0.78) \times 10^{-2}$$

$$= 52.3V$$

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Subject : .... Date : ....

(5) What is C?

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

$$= 13.4 \times 10^{-12}$$

Subject : .... Chapter-26 | Capacitance | Date : ....

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

$$\epsilon_0 \oint \vec{E} \cdot d\vec{A} = q$$

$$V = \int_{i}^{f} \vec{E} \cdot d\vec{r}$$

Current and Resistance

$$i = \frac{dq}{dt}$$

$$dq = i\,dt$$

num of charge: $q = \int i\,dt$

→ Cross sectional area

num of electrons per volume n

$\therefore$ total Charge $(ALn)e$

time $\Rightarrow t = \frac{L}{V_d}$

Subject : .... Date : ....

Current density $J = i/A$ ——— ①

$$\therefore i = \frac{(nAL)e}{L/v_d}$$

$$= (nAv_d)e$$

Again, $J = i/A$

$$= \frac{(n \cdot \cancel{A} \cdot v_d)e}{\cancel{A}}$$

$$\therefore J = (n \cdot v_d \cdot e)$$

And $i = (n \cdot A \cdot v_d)e$

Charge density in conductor is $10^{26} m^{-3}$

Subject : .... Date : ....

Q. (i)

$R = 2mm$

$J = 2 \times 10^5 \ A/m^2$

* What is the current through the outer porstion of the wire from $R/2$ to R:

$$A' = \pi R^2 - \pi (R/2)^2$$

$$=$$

$$i = J \times A'$$

$$= 1.88A$$

$$\cancel{q = \int i \cdot dt}$$

$$i = \int_{R/2}^{R} J \cdot dA$$

$$= \int_{R/2}^{R} 3 \times 10^{11} \cdot r^2 (2\pi r \cdot dr)$$

Subject : .... Date : ....

$$= \int_{R/2}^{R} 3\times10^{11} \cdot r^2 \left(2\pi r \cdot dr\right)$$

$$= \int_{R/2}^{R} 3\times10^{11} \cdot r^3 \cdot \left(2\pi\, dr\right)$$

$$= 3\times10^{11} \cdot 2\pi \int_{R/2}^{R} r^3 \cdot dr$$

$$= 3\times10^{11} \cdot 2\pi \left[\frac{r^4}{4}\right]_{R/2}^{R}$$

$$= 7.06$$

Subject : ....   Date : ....

Resistance :

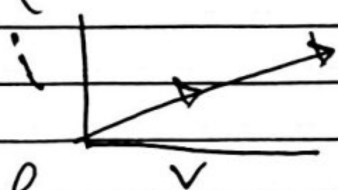
$$R = \rho \frac{L}{A}$$

If temperature high then resistance ~~also~~ → resistivity also high.

$$\rho - \rho_0 = \rho_0 \alpha (T - T_0)$$

Ohm law : $V = iR$ (When T is constant)

$i = V/R$



If material follow this graph then its a conductor