Toppersnotes
Unleash the topper in you

THE IIT - JEE SECRET

JEE MAINS AND JEE ADVANCED

PHYSICS

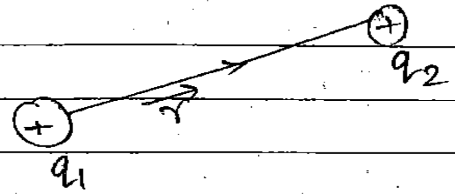
VOL - II

SIERRA
INNOVATIONS
Private Limited

Contents

ELECTROSTATICS

COULOMB'S LAW



$$\vec{F_{21}} = \frac{K q_1 q_2}{r^2}(\hat{r})$$

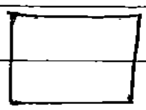
$$\vec{F_{12}} = \frac{K q_2 q_1}{r^2}(-\hat{r})$$

$\boxed{\vec{F_{21}} = -\vec{F_{12}}}$ → magnitude with direction

$\boxed{F_{12} = F_{21}}$ → magnitude only

Vacc.
$$K = \frac{1}{4\pi\epsilon_0} = 9\times10^9$$

m + q



$m \neq 0$
$q = 0$ ⟹ some mass have +ve & some mass have −ve charge.
↓
doesnot implies chargeless body

→ [Neutral body के पास में किसी भी nature का charge से लगेगा force always attractive. bcoz of induction]

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

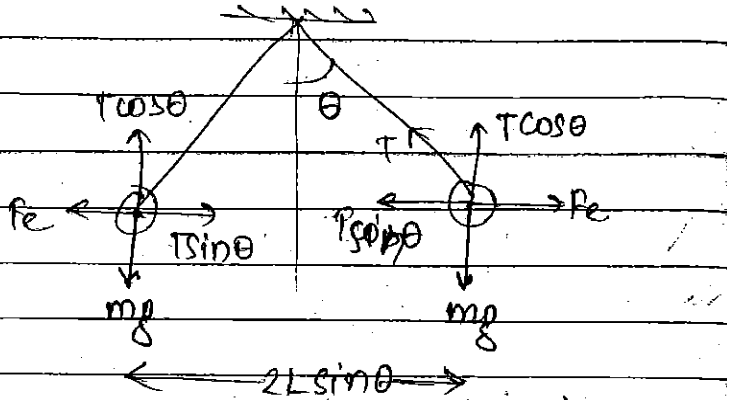
Take any nature of charge near ~~neutra~~ neutral body force will be always attractive, because of induction.

Vaccum
$$K = \frac{1}{4\pi\epsilon_0}$$

med. $K \rightarrow K' = \frac{1}{4\pi(\epsilon\,\epsilon_0)}$ → Absolute permittivity of free space in vaccum.

$$\boxed{K' = \frac{K}{\epsilon}}$$

Ques. m, q, ρ_B

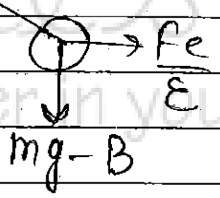


$T\cos\theta = mg$

$T\sin\theta = F_e$

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

we immerse this system in one liquid system
Now [हमने इस system को एक liquid में डुबो दिया] (Dielectric const. of liquid = 2) & $\tan\theta$ will not change bcoz change in Fe will be equal to change in mg [bcoz mg में buoyancy force भी आने लगेगा] Now find the density of liquid?
because buoyancy force will also come into picture along with mg



$$\frac{F_e}{mg} = \frac{F_e}{\varepsilon_r(mg - B)}$$

$$2(mg - B) = mg$$

$$B = mg/2$$

$$V_B \rho_l g = \frac{V_B \rho_B \cdot g}{2}$$

$$\boxed{\rho_l = \frac{\rho_B}{2}}$$

LIMITATIONS OF COULOMB'S LAW

(i) Coulomb's law is valid only for point charges.

(ii) Coulomb's law is valid only for static charges.
If charge tends to move, then moving charge will be considered as cur
[अगर charge move करेगा तो moving charges को तो हम current consider करेंगे]

[अगर current होगा तो वो अपने आस पास magnetic
If there is current

If there is a current, it will produce magnetic field around it. hence magnetic field will influence second charge. Hence net force will be due to both E-field and magnetic field. but if single charge is static, then also coulumb law holds true.

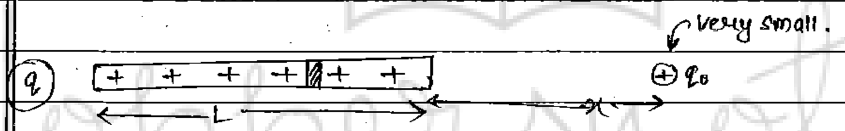
field create करेगा & दूसरे charge पर तो अब magnetic force लगेगा लगेगा force तो अब दोनों की electric & magnetic fields both की वजह से लगेगा। but अगर 1 charge static है तो सिर्फ Coloumb law valid होगा।

$V_1 \neq 0 \quad V_2 \neq 0 \quad (\times) \rightarrow$ Coulomb's law not valid

$V_1 \neq 0 \quad V_2 = 0 \quad F_e \neq 0 \quad F_m = 0$ (✓) valid

$V_1 = 0 \quad V_2 \neq 0 \quad F_e \neq 0 \quad F_m = 0$ (✓) valid.

Ex.



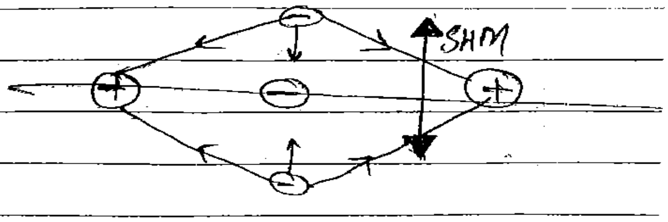
$$dq = \frac{q}{L} dr$$

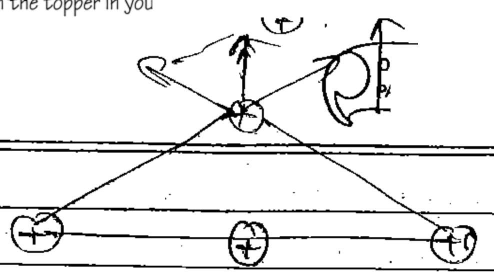
$$F = \int_x^{x+L} \frac{K q_0 q}{r^2 L} \cdot dr$$

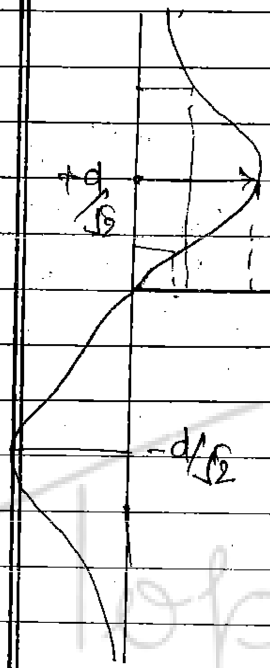
$$F = \frac{Kqq_0}{L} \int_x^{x+L} \frac{1}{r^2} dr$$

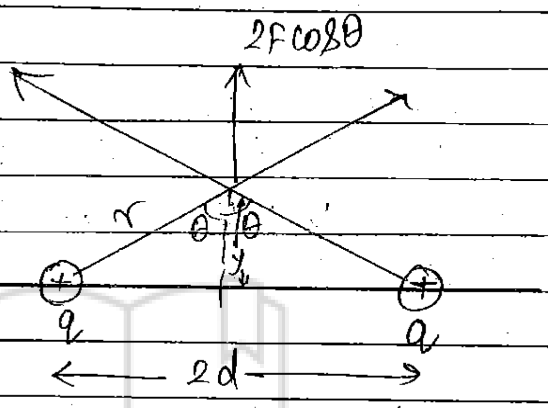
$$\boxed{F = \frac{Kqq_0}{L}\left[\frac{1}{x} - \frac{1}{x+L}\right]}$$

Case I







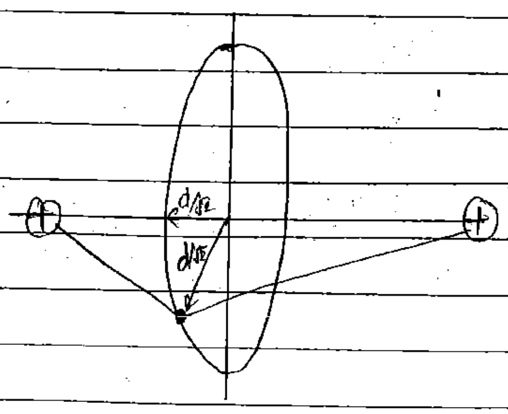


$f_{net} = 2F\cos\theta$

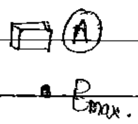
$F = 2\cdot\left(\frac{Kqq_0}{d^2+y^2}\right)\left(\frac{y}{\sqrt{d^2+y^2}}\right)$

$f_{net} = 2\cdot(\downarrow)(\uparrow)$

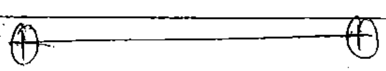
$\frac{df}{dy} = 0 \longrightarrow y = \pm\frac{d}{\sqrt{2}}$



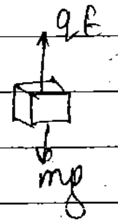
This is the circle where 'f' is max. at radius $d/\sqrt{2}$.

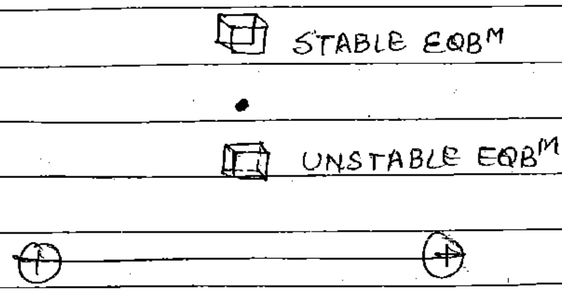


Ques will there be any point other than A where the block is again at eqb.



Yes, there will be a point just below the Emax at the same distance as (A). where the block can stay in eqb.





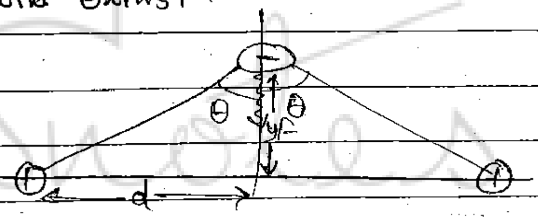
[अगर इसी system को table पर रख दिया तो Eqb^m exist ही नहीं करेगा] bcoz mg will be zero.

↳ If we keep this system on table then equilibrium wont exhist.

SHM OF CHARGE

-ve

CASE I



Condition of SHM

$a \propto -x$

$F \propto -x$

$$F = 2F\cos\theta$$

$$= \ominus\ 2 \cdot \frac{Kqq_0}{(d^2+y^2)^{3/2}} \cdot y$$

[bcoz हमने charge को ऊपर खिसकाया है E-force नीचे लगेगा]

because we have pushed the charge in upward directi -on so, E-force will act in downward directio

If $y <<<< d$

$$F = -\left(\frac{2Kqq_0}{d^3}\right) y$$

SHM ⇒ $F \propto -y$

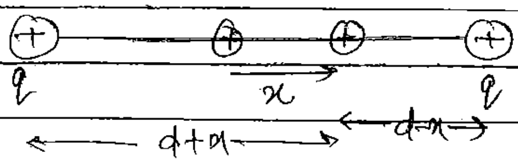
$$\frac{F}{m} = a$$

$$a = -\left(\frac{2Kqq_0}{md^3}\right) y$$

$$a = -\omega^2 y$$

$$\boxed{T = 2\pi/\omega = 2\pi\sqrt{\frac{md^3}{2Kqq_0}}}$$

CASE - II



$$F = \frac{kqq_0}{(d-x)^2} - \frac{kqq_0}{(d+x)^2}$$

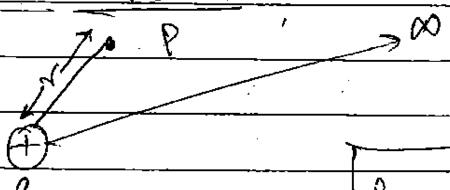
$$= -kqq_0 \left(\frac{4dx}{(d^2-x^2)^2}\right)$$

$$x <<< d$$

$$F = -\left(\frac{4kqq_0}{d^3}\right) x$$

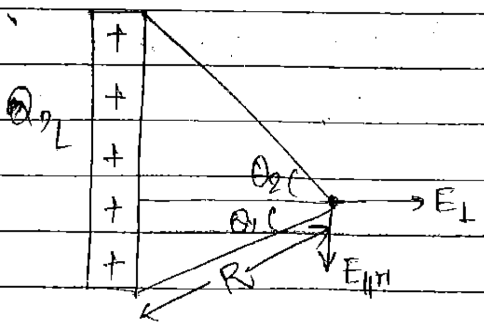
$$\boxed{T = 2\pi\sqrt{\frac{md^3}{4kqq_0}}}$$

ELECTRIC FIELD



$$\boxed{E = \frac{kq}{r^2}\hat{r}}$$

Rod



$$\lambda = \frac{Q}{L}$$

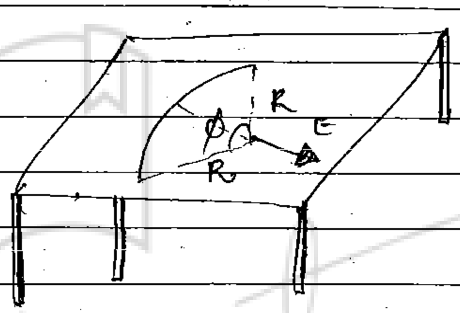
linear charge density

$$\boxed{E_{\perp} = \frac{KQ}{RL}(\sin\theta_1 + \sin\theta_2)}$$

$$\boxed{E_{\parallel m} = \frac{KQ}{RL}(\cos\theta_2 - \cos\theta_1)}$$

Circular Arc

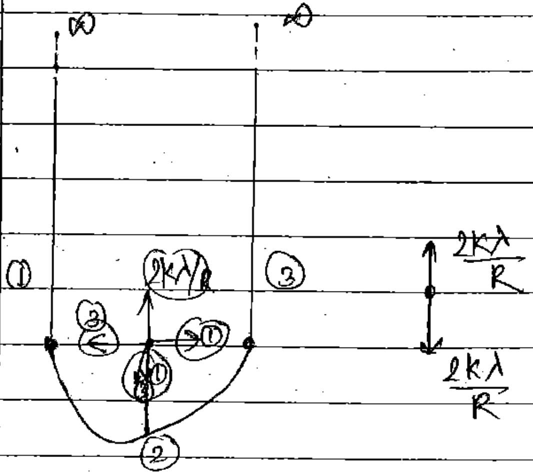
$$\lambda = \frac{Q}{\phi R}$$

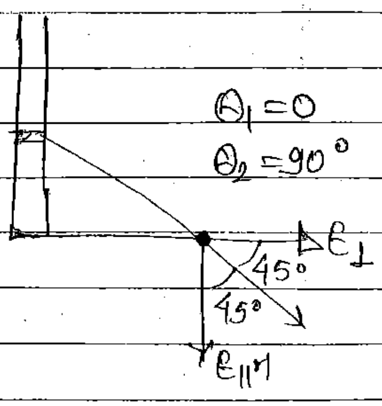


$$\boxed{E = \frac{2KQ}{\phi R^2}\sin\frac{\phi}{2}}$$

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

SEMI INFINITE WIRE





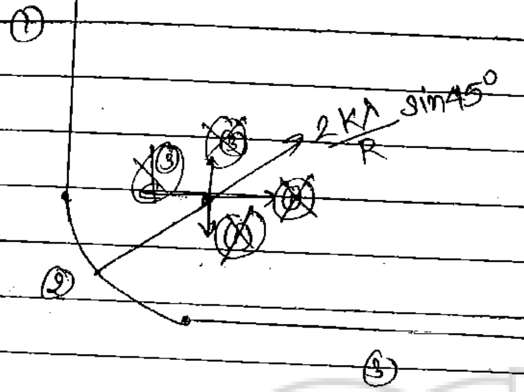
$\theta_1 = 0$
$\theta_2 = 90°$

$$\boxed{E_{\perp} = \frac{K\lambda}{R}}$$

$$\boxed{E_{\parallel m} = \frac{-K\lambda}{R}}$$

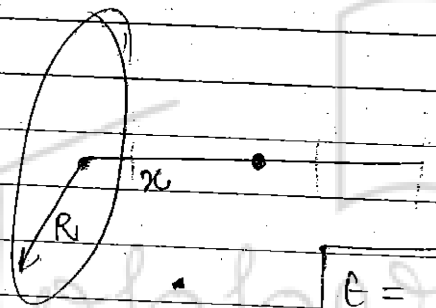
$$\boxed{E_{net} = 0}$$

Eg.



$$F = \frac{2K\lambda}{R}\cdot\frac{1}{\sqrt{2}}$$
$$= \frac{\sqrt{2}K\lambda}{R}$$

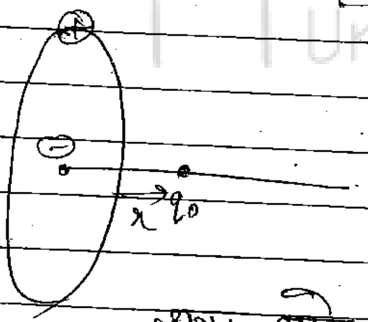
Ques



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

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

Eg.



$$F = \frac{-KQq_0x}{(R^2+x^2)^{3/2}}$$

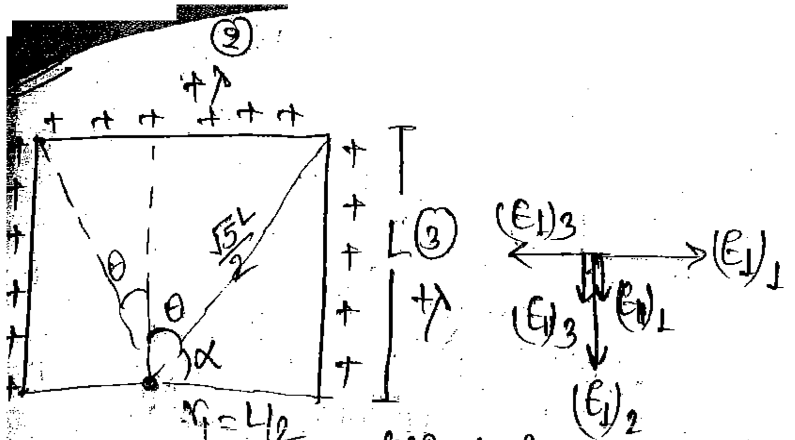
अगर हमने q_0 को displace किया तो वो SHM करेगा।

$x <<< R$

$$a = \frac{F}{m} = -\left(\frac{KQq_0}{mR^3}\right)x$$

$$F = q_0E$$

$$\boxed{T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{mR^3}{KQq_0}}}$$



$\cos\theta_2 - \cos\theta_1$

$$(E_{\parallel})_1 = (E_{\parallel})_3 = \frac{k\lambda}{L/2}\left|1-\frac{1}{\sqrt5}\right|$$

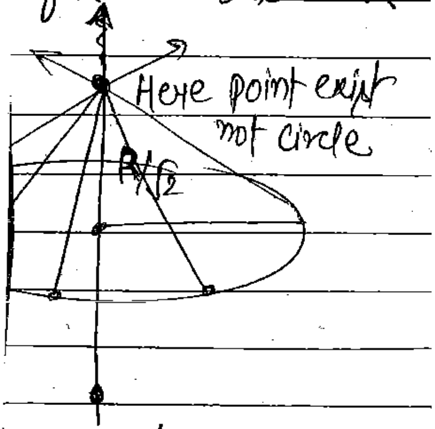
$$(E_\perp)_2 = \frac{2k\lambda}{L}\left(\frac{1}{\sqrt5}\right)$$

$$= \frac{4k\lambda}{L}\left(1 \ldots\right) \ldots \frac{2k\lambda}{L}\left(\frac{1}{\sqrt5}\right)$$

Ans

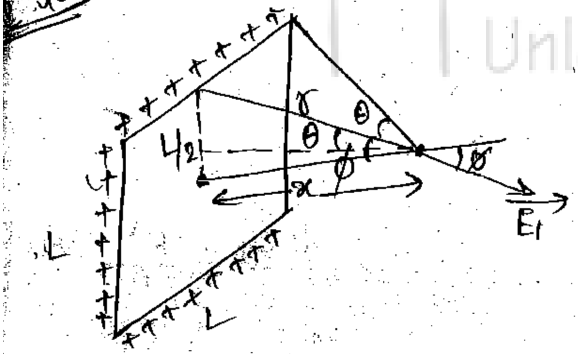
की 2d distance पर

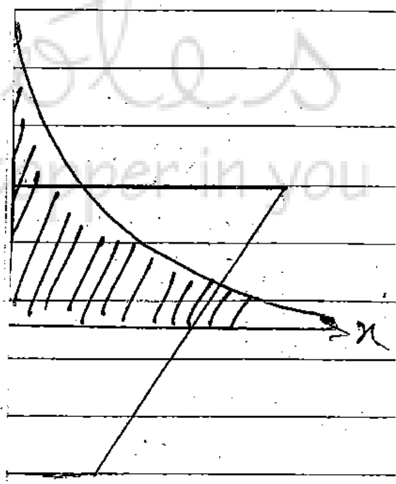
of radius 'r' show करेगी



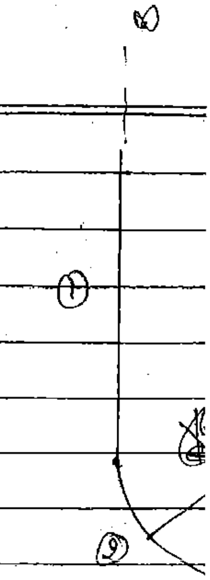
...arge system.

Ques





Eq.



$$\sqrt{\frac{L^2}{4}+x^2}$$

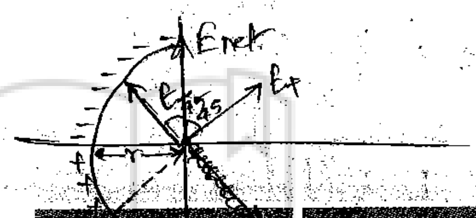
$$\cos\phi = \frac{x}{r}$$

$$E_\perp = \frac{2K\lambda}{r}\sin\theta$$

$$\sin\theta = \frac{L/2}{\sqrt{L^2/4+r^2}}$$

$$E = \frac{8K\lambda}{r}\,\frac{L/2}{\sqrt{L^2/4+r^2}}\cdot\cos\phi$$ Ans

Ques



98 DD MM YY Day – 9

$$E_- = E_+ = \frac{2K\lambda}{R}\sin\left(\frac{90}{2}\right)$$

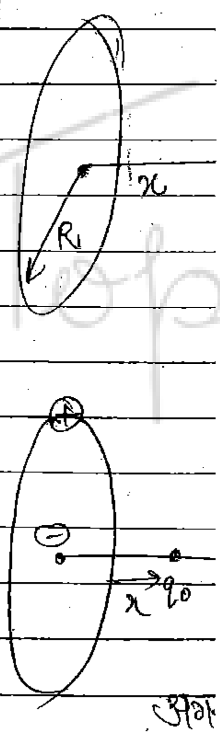
$$E_- = E_+ = \frac{\sqrt{2}K\lambda}{R}$$

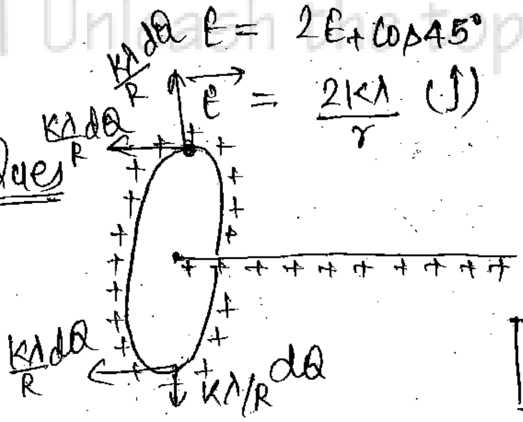
$$E = 2E_+\cos 45^\circ$$

$$E = \frac{2K\lambda}{r}\ (\uparrow)$$ Ans

Eq.

Ques





$$dF = \frac{K\lambda}{R}dQ$$

$$\boxed{F = \frac{K\lambda Q}{R}}$$

$$a = \frac{F}{m} = -\left(\frac{KQq_0}{mR^3}\right)x$$

$$F = q_0E$$

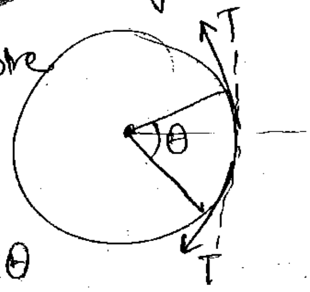
$$\boxed{T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{mR^3}{KQq_0}}}$$

D-Day – 96 DD/MM/YY

D-Day – 95 DD/MM/YY

Find tension developed in the string. in prev. ques.

Tension on the arc due to centre
$= T\,d\theta$

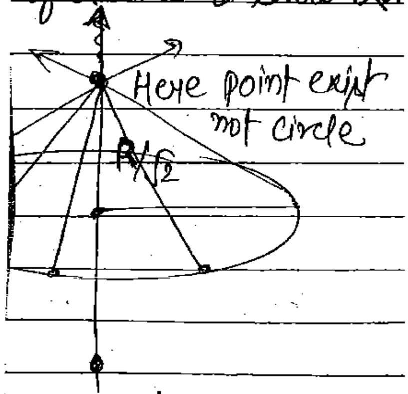


$$T\,d\theta = \frac{k\lambda}{R}\,d\theta$$

$$T\,d\theta = \frac{k\lambda}{R}\cdot\frac{Q}{2\pi R}\cdot R\,d\theta$$

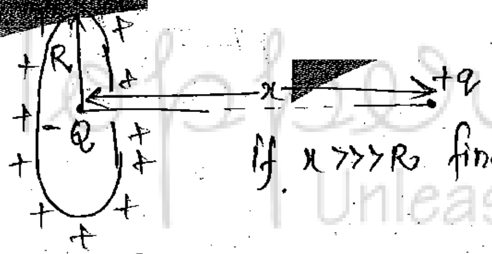
$$\boxed{T = \frac{k\lambda Q}{2\pi R}}$$ Ans

of 2d distance ...
of radius 'a' show ...

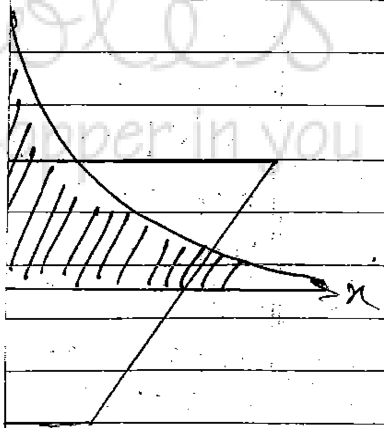


...charge system.

D-Day – 94



If $x >>> R$ find force on $+q$.



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

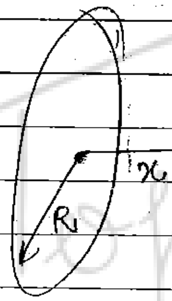
$$= \frac{kQq}{x^2\left[1+\frac{R^2}{x^2}\right]^{3/2}} - \frac{kQq}{x^2}$$

Ans. will not be zero we will not neglect R.
get answer by Binomial.

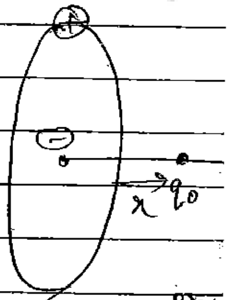
Toppersnotes
Unleash the topper in you

Eg.

Ques

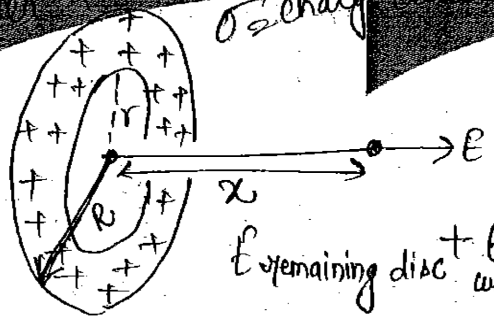


Eg.



D-Day – 92 DD/MM/YY D-Day – 91 DD/MM/YY

σ = charge



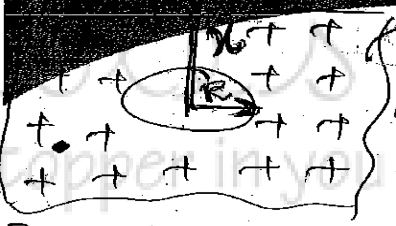
$E_{\text{remaining disc}} + E_{\text{disc with radius } r} = E_{\text{disc of radius } R}$

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

$$E = \frac{\sigma x}{2\epsilon_0}\left[\frac{1}{\sqrt{r^2+x^2}} - \frac{1}{\sqrt{R^2+x^2}}\right]$$ Ans

D-Day – 90 DD/MM/YY D-Day – 89 DD/MM/YY

... released on the axis of a hole from a point near its centre discuss its motion.



Sol $x \ll R$

$$E_{remain} + \frac{\sigma}{2\epsilon_0}\left[1 - \frac{x}{\sqrt{R^2+x^2}}\right] \rightarrow E_{\text{circular of radius } R} = \frac{\sigma}{2\epsilon_0}$$

$$E_{remain} = \frac{\sigma x}{2\epsilon_0\sqrt{R^2+x^2}}$$

$F = -qE$

$$\Rightarrow F = \frac{-q\sigma x}{2\epsilon_0\sqrt{R^2+x^2}}$$ Ans

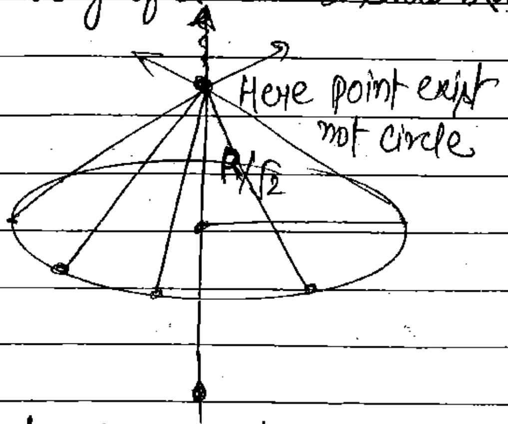
$$a = \frac{F}{m} = -\frac{KQq_0}{mR^3}x$$

$F = q_0E$

$$\boxed{T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{mR^3}{KQq_0}}}$$

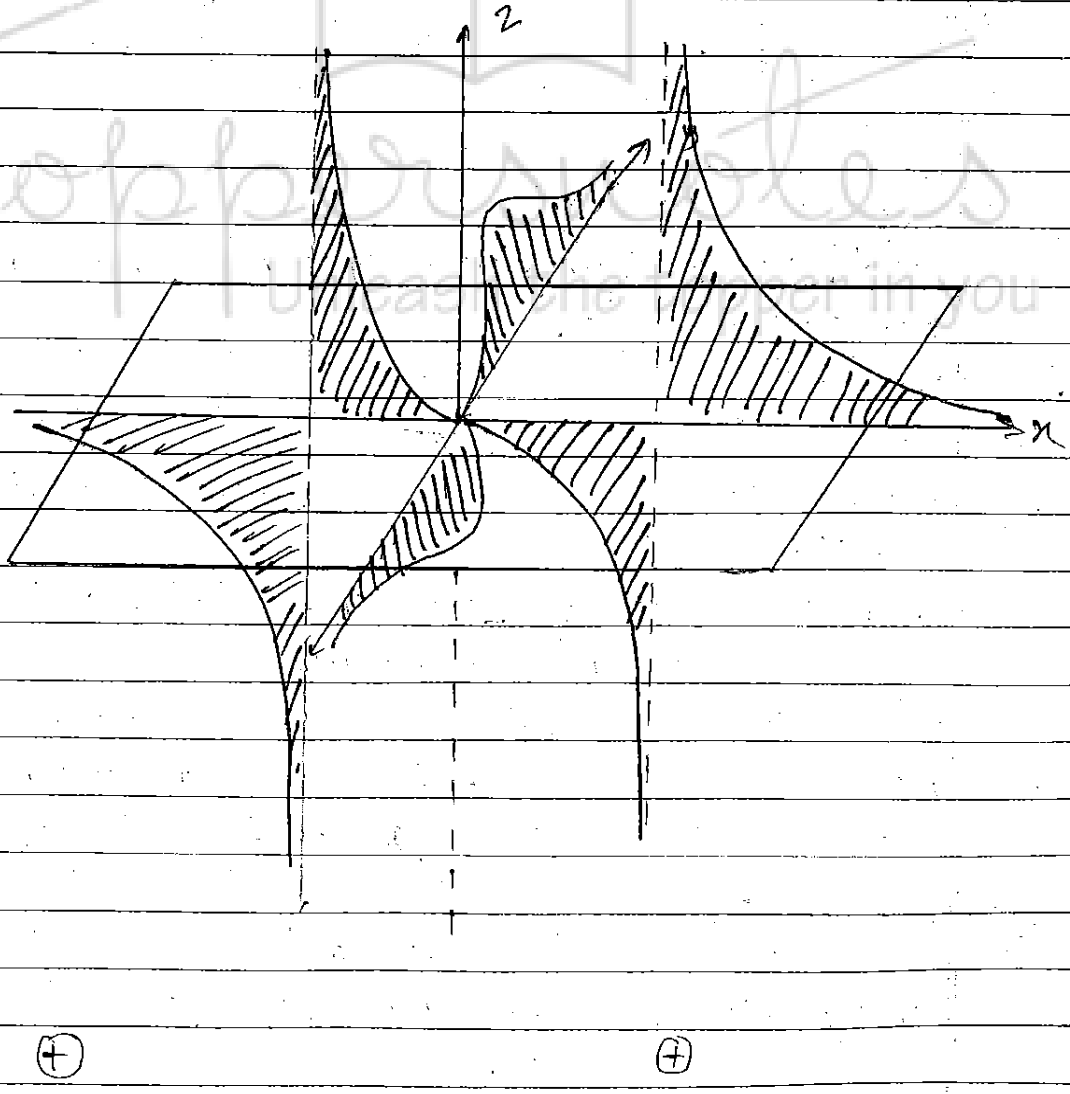
[जो behaviour 2 charges show करते हैं जो 2d distance पर रखे होते हैं same वही behaviour ring of radius 'd' show करती]

Ring of radius 'd' will show same behaviour as that shown by 2 charges kept at a distance of 2d

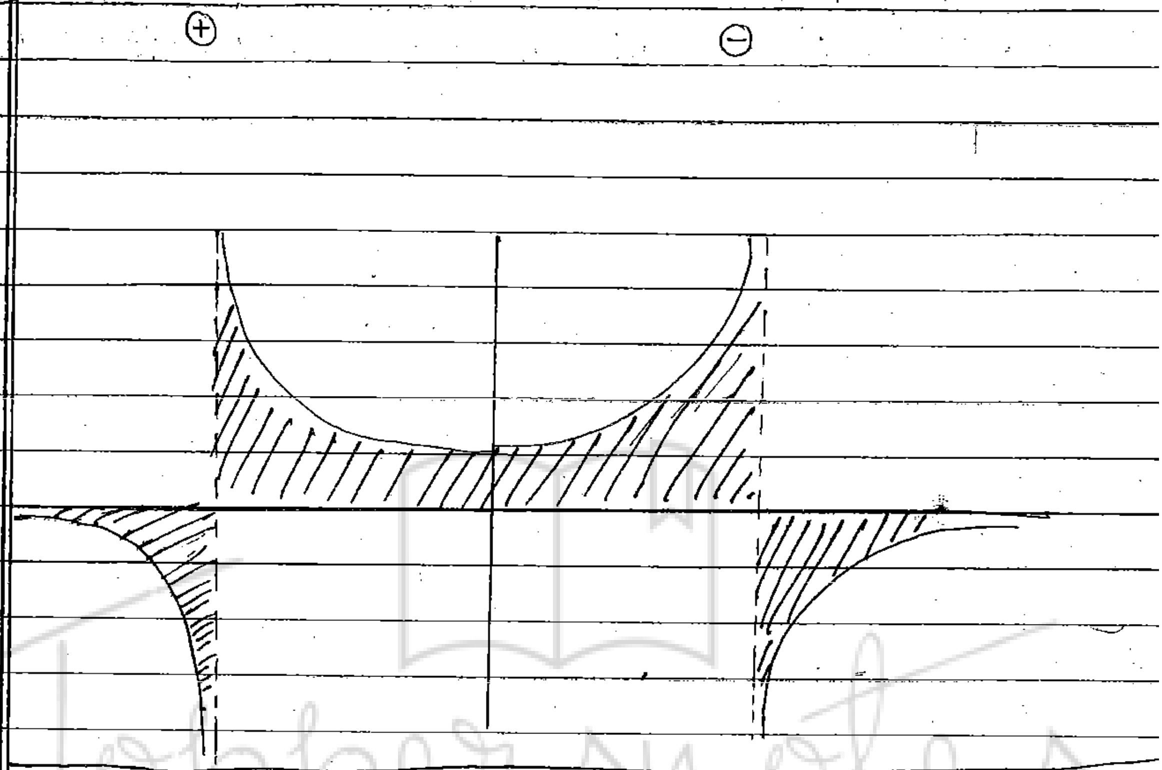


GRAPHS

Electric field ~~force~~ v/s Distance of a charge from two charge system.



CASE - II



FIELD LINES

Field lines are hypothetical lines gives information about net electric field.

Properties

1. Tangent at any point gives direction of electric field.

2. Relative density of field lines gives magnitude of electric field in that region.

3. Field lines originates either from a (+)ve charge or ∞ and terminates on a ∞ ~~and~~ or (-)ve charge.

4. Field lines have tendency to bent towards (-)ve charge and to bent away from (+)ve charge.

5. Donot forms closed loops.