Net electric force and Point crg

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

$K = 9 \times 10^9 \ N/m^2c^2$

$\epsilon_0 = 8.85 \times 10^{-12} \ c^2/Nm^2$

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

$q \uparrow \ F \uparrow$

$r \uparrow \ F \downarrow$

1. $+10\mu c$ (+) —— 25c.m —— (−) $-20\mu c$
q_1 q_2

$$F = \frac{9 \times 10^9 \times (10 \times 10^{-6}) \times (20 \times 10^{-6})}{(25 \times 10^{-2})^2}$$

$= 28.8 \ N$

Force act on q_1 due to q_2, F_{12}

" " q_2 " " q_1, F_{21}

2. $\leftarrow F$ (+) —— $r = ?$ —— (+) $F \rightarrow$
q_1 q_2
↓ ↓
800nc 900nc

magnitude = 15 N

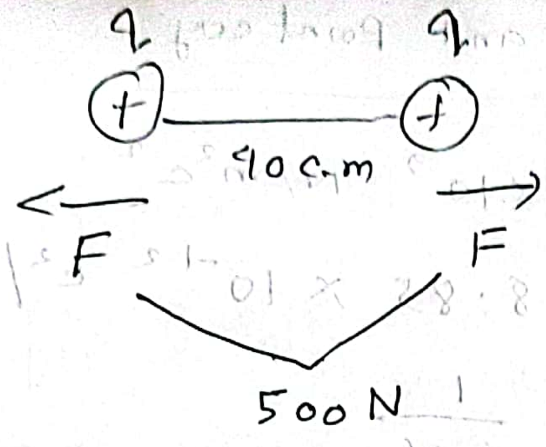
$$F = \frac{K q_1 q_2}{r^2}$$

$\Rightarrow F r^2 = K q_1 q_2$

$$\Rightarrow r = \sqrt{\frac{K q_1 q_2}{F}}$$

$$= \sqrt{\frac{9 \times 10^9 \times (800 \times 10^{-9})(900 \times 10^{-9})}{15 \ N}}$$

$r = 0.02078m.$

3. 

(*) Two identical point charges

$$F = \frac{K \cdot q^2}{r^2}$$

$$q^2 = \frac{Fr^2}{K}$$

$$q = \sqrt{\frac{Fr^2}{K}}$$

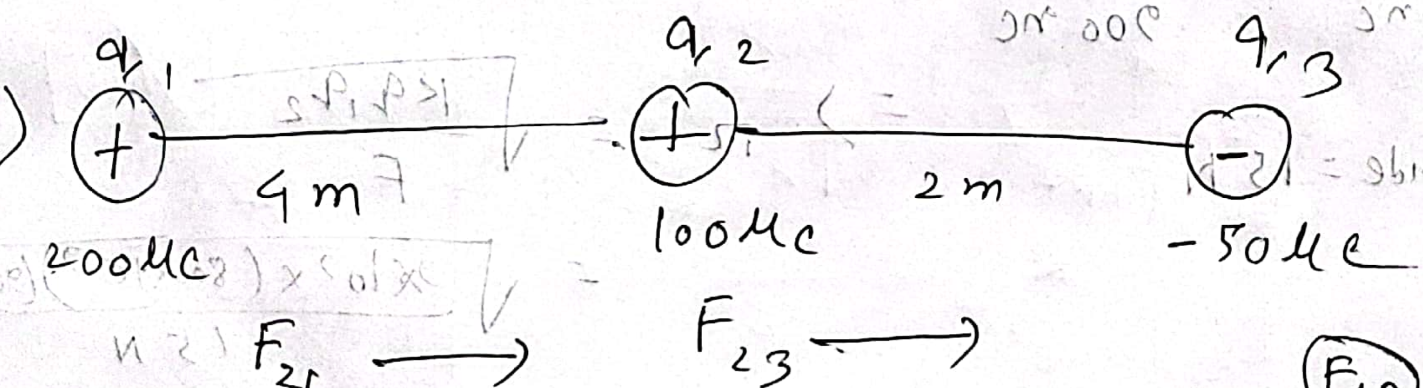
$$= \sqrt{\frac{500 \times (0.40)^2}{9 \times 10^9}}$$

$$q = 9.428 \times 10^{5}$$

+100 μC charge is placed at the origin. A −50 μC charge is placed at x = 2 m and a +200 μC is placed at x = −4 m.

a) what is the net electric force acting on the +100 μC charge?

b) what is the net electric force acting on the +200 μC charge?

a) 

F_{3P}

Source move
Point

$$\underline{F_{net} = F_{21} + F_{23}} \quad F_{21} = \frac{9\times10^9\,(200\times10^{-6})\times(100\times10^{-6})}{4^2}$$

$$= 11.25\text{ N}.$$

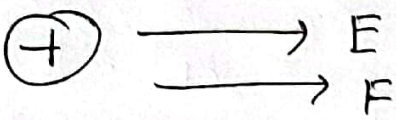
$$F_{23} = \frac{Kq_2q_3}{r^2} = \frac{9\times10^9\times(100\times10^{-6})\times(50\times10^{-6})}{2^2}$$

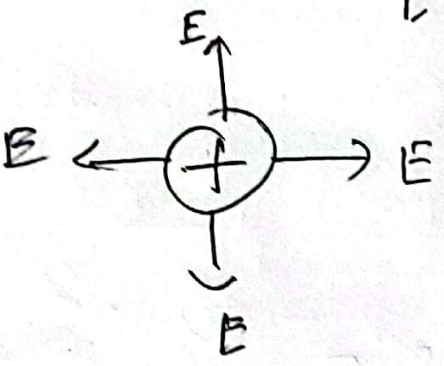
$$= 11.25\text{ N}.$$

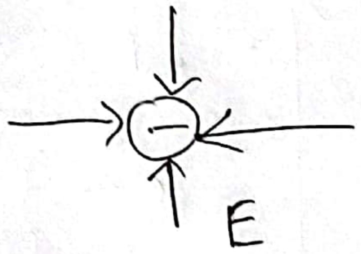
$$F_{,net} = 22.5\text{ N}$$

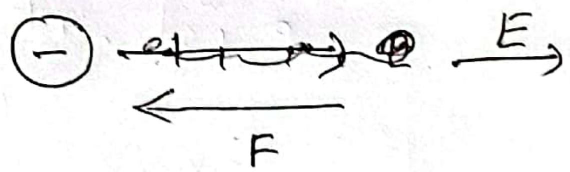
Electric field

$\boxed{1}$ $E = \dfrac{F}{q}$, $\boxed{2}$ $E = \dfrac{kQ}{R^2}$

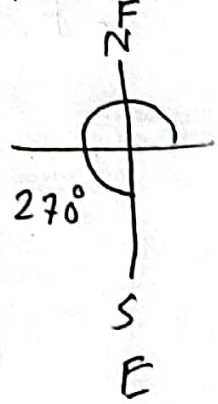








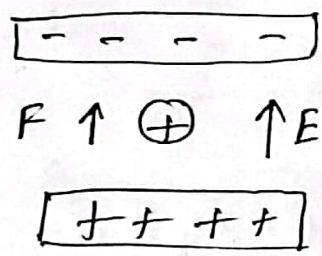
Given, Force directed north - 20μc, so, will be on south.

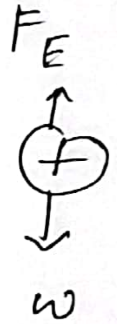


$$E = \frac{F}{q} = \frac{100}{20\times10^{-6}}$$

$$= 5\times10^6\text{ NC}^{-1}$$

A positive chg of $+50\ \mu c$, is place in an electric field of $50,000\ NC^{-1}$ directed upward. What mass should the chg have to remain suspended in the air?





$$\Sigma F_y = F_E - w = 0$$

$$F_E = w$$

$$\Rightarrow Eq = mg$$

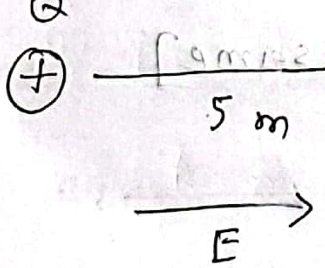
$$\boxed{E = \frac{F}{q} \qquad F = Eq}$$

$$m = \frac{Eq}{g} = \cancel{0.255 kg}$$

$$= \frac{50,000 \times (50\times10^{-6})}{9.8}$$

$$= 0.255\ Kg.$$

A +90 μC point chg is placed at the origin. Find magnitude and direction of the elec. field created by point chg. A) Point P(5m, 0) B) Point S (3m, 4m)

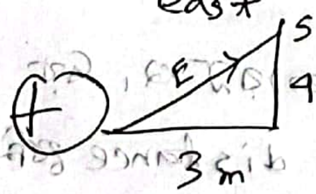


$$E = \frac{KQ}{r^2}$$

$$= \frac{9 \times 10^9 \times (90 \times 10^{-6})}{(5)^2}$$

$$E = 14,400 \ NC^{-1}$$

east



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

$$= \frac{9 \times 10^9 \times (90 \times 10^{-6})}{(5)^2}$$

$$= 14,400 \ NC^{-1}$$

$$c^2 = a^2 + b^2$$

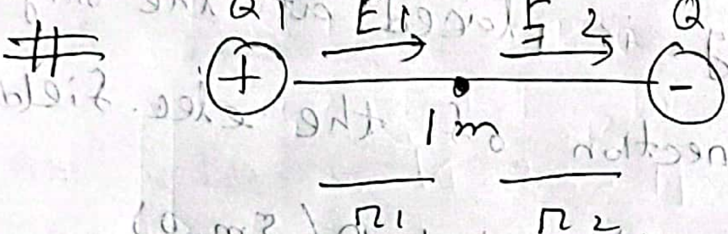
$$c^2 = 3^2 + 4^2$$

$$c = \sqrt{25} = 5$$

$$\tan\theta = \frac{4}{3}$$

$$\theta = \tan^{-1}\left(\frac{4}{3}\right)$$

$$\theta = 53.1^\circ$$



* Elec. field between midway of 2 charges and 30 c.m away.

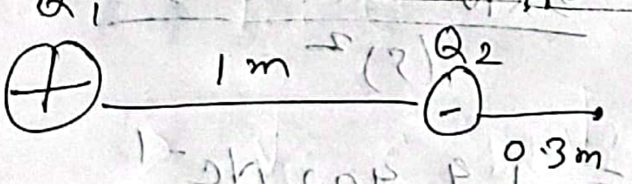
$E_{,net} = \frac{9\times10^9}{(0.5)^2}[200\times10^{-6} + 300\times10^{-6}]$

$= 1.8\times10^7\ NC^{-1}$

$E_{,net} = E_1 + E_2$

$= \frac{KQ_1}{r_1^2} + \frac{KQ_2}{r_2^2}$ [r same]

$= \frac{K}{r^2}[Q + Q_2]$



$\longrightarrow E_1$ [E_1 কম কারণ Q_1 এর সাথে distance বেশি

$\longleftarrow E_2$ [E_2 বেশি কারণ Q_2 এর সাথে distance

$E_{net} = E_1 - E_2$

$= \frac{KQ_1}{r_1^2} - \frac{KQ_2}{r_2^2}$

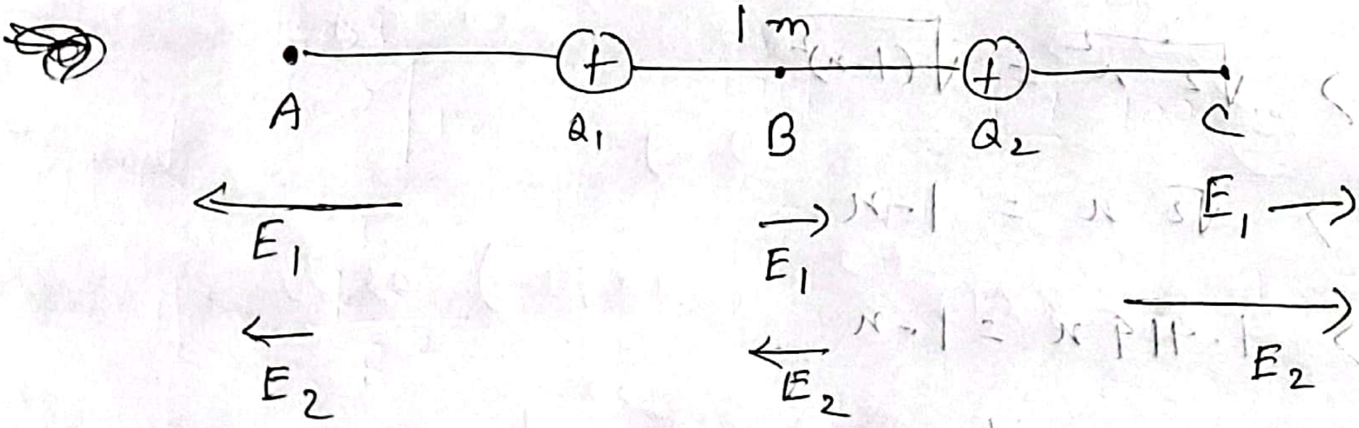
$= \frac{9\times10^9\times(200\times10^{-6})}{(1.3)^2} - \frac{9\times10^9\times(300\times10^{-6})}{(0.3)^2}$

$= 1.065\times10^6 - 3\times10^7$

$= -2.89\times10^7\ NC^{-1}$

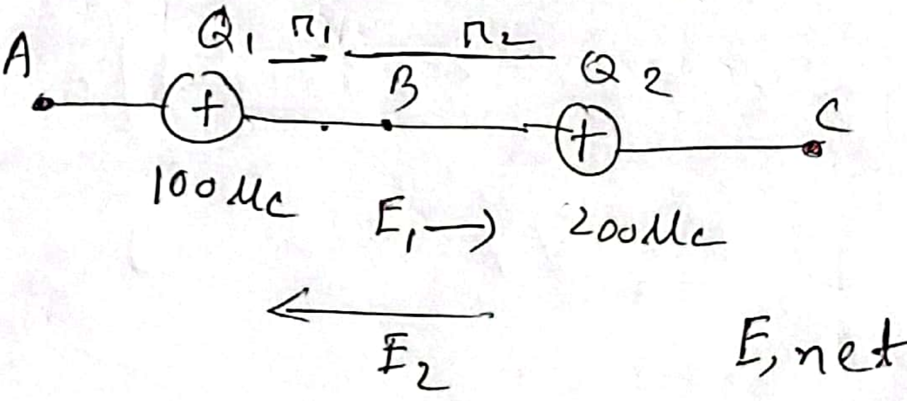
Two identical point crg with a magnitude of +100μc are separated by 1 m distance. a) At what point will the net electric field be equal to zero.

b) If the crg on Q_2 doubles to +200 μc, where along the x axis relative to the 1st crg will the net electric field be equal to zero?



a) $\boxed{E_{net} = 0 \quad x = 0.5\ m}$

b)



$E_{net} = E_1 - E_2 = 0$

$E_1 = E_2$

$r_1 = x$

$r_2 = (1-x)$

$$\frac{K Q_1}{r_1^2} = \frac{K Q_2}{R_2^2}$$

$$\Rightarrow \frac{Q_1}{x^2} = \frac{Q_2}{(1-x)^2}$$

$$\Rightarrow Q_2 x^2 = Q_1 (1-x)^2$$

$$\Rightarrow \frac{200}{100} x^2 = \frac{\cancel{100}}{\cancel{100}} (1-x)^2$$

$$\Rightarrow \sqrt{2 x^2} = \pm\sqrt{(1-x)^2}$$

$$\Rightarrow \sqrt{2}\, x = 1-x$$

$$\Rightarrow 1.414 x = 1-x$$

$$\Rightarrow x = \frac{1}{2.414} = 0.414 m$$

Electric field

Due to Ring of charge, Linear charge Density.

1. $E_x = \frac{KQX}{R^3}$ 2. $R = \sqrt{a^2 + x^2}$. 3. $\lambda = \frac{Q}{L} = \frac{Q}{2\pi a}$; $\lambda = \frac{dq}{ds}$

$\Rightarrow Q = 2\pi a \lambda$

4. $E_{net} = \frac{K(2\pi a)\lambda x}{R^3}$

A ring shaped conductor with radius 5c.m has a total charge of +50 nc a) what is the electric field at a point 12c.m east from its center? b) Linear charge density of the ring?

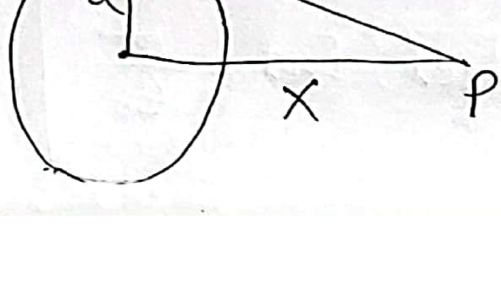
(a)

$\rightarrow$ $a = 0.05$ m, $Q = +50$ n.C $X = 0.12$ m

$\therefore R = \sqrt{(0.05)^2 + (0.12)^2} = 0.13$ m

$E_x = \frac{9 \times 10^9 \times (0.12) \times (50 \times 10^{-9})}{(0.13)^3}$

$E_x = 24,579$ NC^{-1}



b

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

$= \frac{50 \times 10^{-9}}{2\pi \times (0.05)}$

$= 1.59 \times 10^{-7}$ c.m

Due to charged disk, infinite sheet of chg, parallel plates

Charge per unit area $\sigma = \frac{Q}{A}$

2. $E_x = \frac{\sigma}{2\epsilon_0}\left[1 - \frac{x}{\sqrt{x^2-R^2}}\right]$

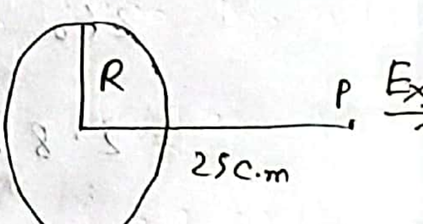
A disk of radius 3 m contains a total chg of +480nC

a) what is the charge per unit area? b) what is the electric field 25 c.m away from the center of the disk?

$R = 3$ m

$Q = +480$ nC

$x = 0.25$ m



a) $\sigma = \frac{Q}{A} = \frac{Q}{\pi R^2}$

$= \frac{480\times10^{-9}}{\pi(3m)^2}$

$\Rightarrow \sigma = 1.697\times10^{-8}$ c.m^{-2}

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

$= \frac{1.697\times10^{-8}}{2\times(8.85\times10^{-12})}\left[1 - \frac{0.25}{\sqrt{(0.25)^2+\dots}}\right]$

$= 959.1\,(0.91695)$

$= 879.5$ NC^{-1}

R infinite হলে,

$\lim_{R\to\infty} \frac{x}{\sqrt{x^2+R^2}} = \frac{x}{\sqrt{x^2+\infty^2}}$

$= \frac{x}{\infty}$

$\therefore E_x = \frac{\sigma}{2\epsilon_0}[1-0]$

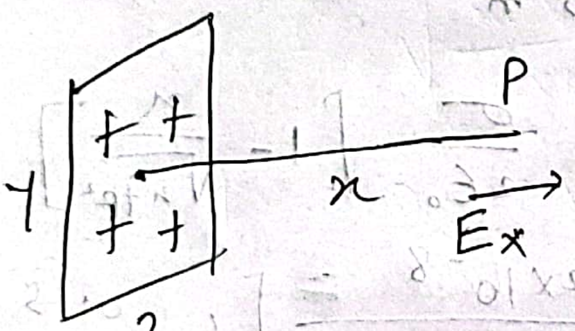
$= \frac{\sigma}{2\epsilon_0}$

What is the elec. field produced by an infinite sheet of chg. that has a chg. per unit area of +5μc at a distance of a) 50 c.m and b) 5 m away from the center of the plate?

a) $E_x = \frac{\sigma}{2\epsilon_0} = \frac{5\times10^{-6}}{2\times(8.85\times10^{-12})}$

$= 2.82\times10^{5}\ NC^{-1}$

[Plate থে x এর distance কম হবে অর্থাৎ infinite distance থে x]



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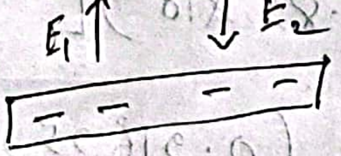
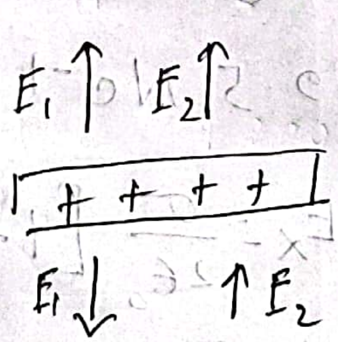


outside, $E_{net} = E_1 - E_2$
$= 0$



between $E_{net} = E_1 + E_2$

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

E_1 net $= E_1 + E_2 = 0$ $\boxed{= \frac{\sigma}{\epsilon_0}}$

$\therefore$ $\boxed{\text{Between 2 infinite sheet, } E_{net} = \frac{\sigma}{\epsilon_0}}$