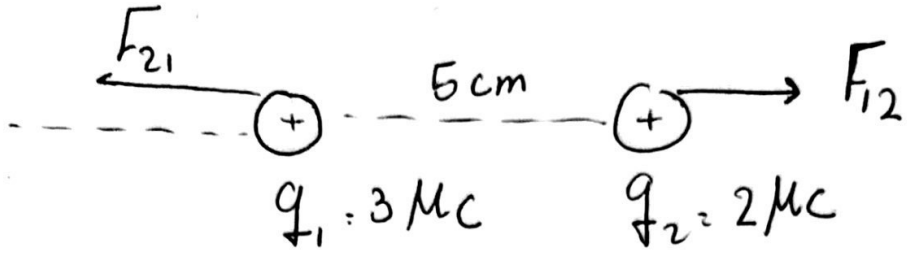
# Chapter 24

## Q1

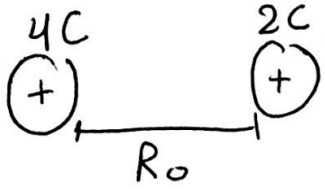



$$F_{12} = -F_{21} = \frac{k q_1 q_2}{r^2}$$

$$= \frac{9 \times 10^9 \times 3 \times 2 \times 10^{-12}}{(5 \times 10^{-2})^2}$$

$$= 21.6\,N$$

## Q2




if $R = 5R_o$

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

$$F' = \frac{k q_1 q_2}{(5R_o)^2} = \frac{1}{25}\left(\frac{k q_1 q_2}{R_o^2}\right)$$

$$\therefore F' = \frac{F}{25}$$

Q3


if $R = 2R_o$

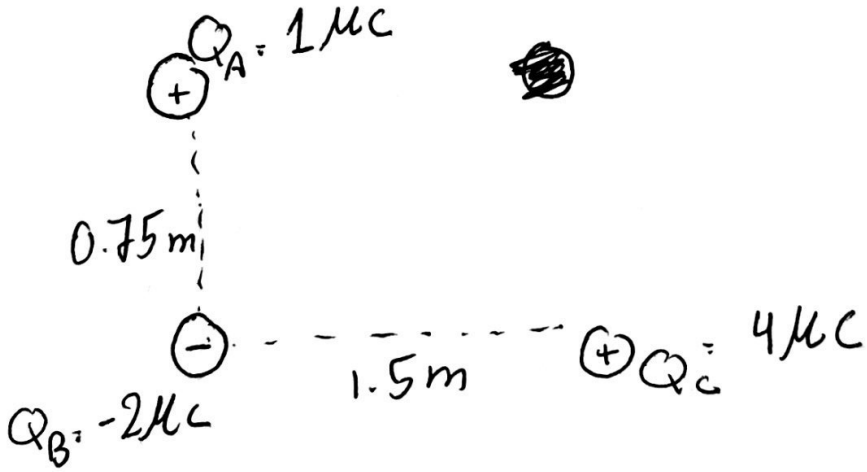
$Q'_A = 3Q_A$

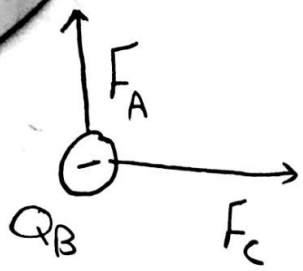
$$F_o = \frac{k Q_A Q_B}{R_o}$$

$$F' = k \frac{3Q_A Q_B}{(2R_o)^2} = \frac{3}{4}\left(\frac{k Q_A Q_B}{R_o}\right)$$

$$\therefore F' = \frac{3}{4} F_o$$

Q4






$$F_{Net} = \sqrt{F_A^2 + F_C^2}$$

$$F_A = \frac{k Q_B Q_A}{r^2} = \frac{9\times10^9 \times 2\times1\times10^{-12}}{(0.75)^2} = 32\times10^{-3}\ N$$

$$F_C = \frac{k Q_B Q_C}{r^2} = \frac{9\times10^9 \times 2\times4\times10^{-12}}{(1.5)^2}$$

$$= 32\times10^{-3}\ N$$

$$F_{Net} = \sqrt{(32\times10^{-3})^2 + (32\times10^{-3})^2}$$

$F_{Net} = 0.045\ N$ in North-East direction.

(b) The sign should be negative so the $F_{Net} = 0$

$$\therefore F_D = 0.045 = \frac{k Q_B Q_D}{r^2} = \frac{9\times10^9 \times 2\times10^{-6} \times Q_D}{1.058}$$

$r = \sqrt{(0.75)^2 + (0.75)^2} = 1.058\ m$

$\therefore Q_D = -2.8\ \mu C$

$ma = F_E$

$qE = ma$

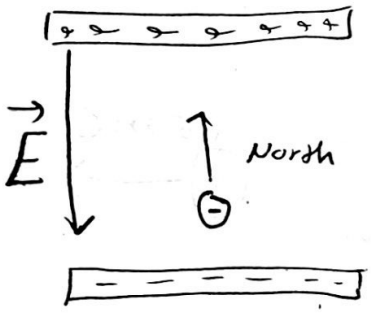
$E = \frac{ma}{q} = \frac{9 \times 10^{-6} \times 250}{3 \times 10^{-6}}$

$= 750\ N/C$ due South

$m = 9 \times 10^{-6}\ kg$

$q = -3 \times 10^{-6}\ C$

$a = 250\ m/s^2$




- Since it's negative charge where if moves due to North ∴ the $\vec{E}$ field due to opposite direction.

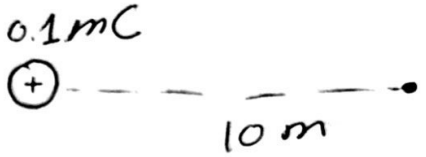
Q1

(a)

$$\vec{E} = \frac{k q}{r^2}$$

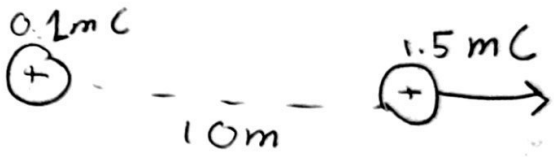
$$= \frac{9\times10^9 \times 0.1\times10^{-3}}{(10)^2}$$

$$= 9\ k\frac{N}{C}$$




pointing away from the charge.

(b)

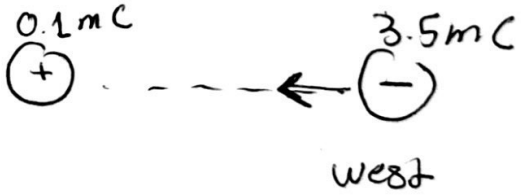



$$F = qE$$

$$= 9\times10^3 \times 1.5\times10^{-3}$$

$$= 13.5\ N \quad \text{east}$$

(c)




$$\vec{F} = qE$$

$$= 3.5\times10^{-3} \times 9\times10^3$$

$$= 31.5\ N$$

$$E_A = E_1 + E_2$$

$$= \frac{kq_1}{r^2} + \frac{kq_2}{r^2}$$

$$= \frac{9\times10^9 * 3\times10^{-3}}{(0.15)^2} + \frac{9\times10^9 * 12\times10^{-3}}{(0.45-0.15)^2}$$

$$= 2.4\times10^9 \ N/C \longrightarrow$$

$$E_B = \frac{k\ 3mC}{(22.5\times10^{-2})^2} + \frac{k\times12\times10^{-3}}{(22.5\times10^{-2})^2}$$

$$= 2.7\times10^9 \frac{N}{C}$$

$$E_C = \frac{k\ 3mC}{(30\times10^{-2})^2} + \frac{k\times12mC}{(15\times10^{-2})^2}$$

$$= 5.1 \frac{N}{C}$$

Q9

$$\rightarrow E_A = \frac{kq}{r_1^2} - \frac{kQ}{r_2^2} = 0$$

$$\frac{kq}{r_1^2} = \frac{kQ}{r_2^2}$$

$$\frac{q}{(0.05)^2} = \frac{Q}{(0.15)^2} \qquad \boxed{Q = 9q}$$

$$\rightarrow E_B = \frac{kQ}{(0.05)^2} - \frac{kq}{(0.15)^2}$$

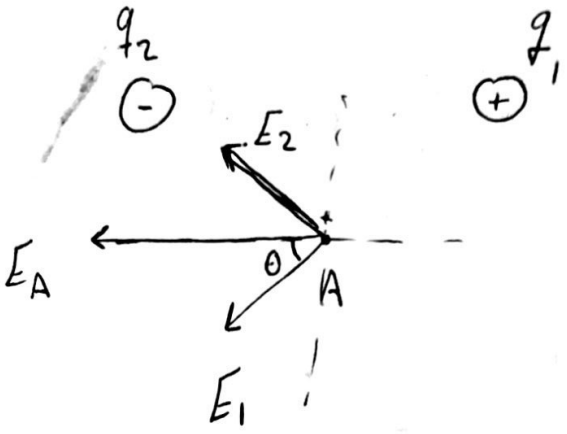
$$6.4 \times 10^4 = \frac{9k(q)}{(0.05)^2} - \frac{kq}{(0.15)^2}$$

$$7.1 \times 10^{-6} = 3600q - 45q$$

$$\therefore q = 2 \times 10^{9}\ C$$

$$Q = 18 \times 10^{9}\ C$$

at A




$E_A = 2E_1 \cos\theta$

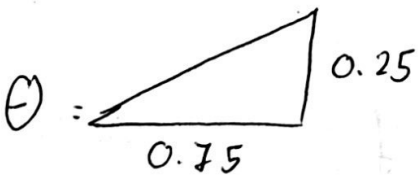
$= 2\left(\frac{k q_1}{r^2}\right)\cos\theta$

since $q_1 = -q_2$

$\therefore E_1 = E_2$

$r = \sqrt{(0.75)^2 + (0.25)^2}$

$\boxed{r = 0.79\ m}$




$\theta = \tan^{-1}\left(\frac{0.25}{0.75}\right)$

$E_A = 2\left(\frac{9\times10^9 \times 2\times10^{-6}}{(0.79)^2}\right)\cos(\theta)$

$= 5.47 \times 10^{4}\ N/C$ west

$E_B = 2 E_1 \cos\theta$

$\theta = 0$


$$E_B = \frac{2 \times 9 \times 10^9 \times 2 \times 10^{-6}}{(0.75)^2} \cos 0$$

$= 6.4 \times 10^4 \frac{N}{C}$ west

(C) $E_C = E_A = 5.4 \times 10^4$ N/C west

(D) $E_D$: in the same way as $E_A$ solved.

$= 3.69 \times 10^4$ N/C west

To find $\vec{F} = qE$ in each part.

$F_A = 10.9 \times 10^{-3}$ N west $= F_C$

$F_B = 12.8 \times 10^{-3}$ N west

$F_D = 7.38 \times 10^{-3}$ west