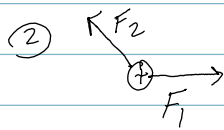
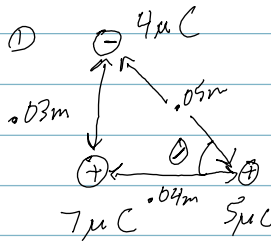


Chapter 15

1) Using an x,y coordinate system, a $7\mu\text{C}$ charge is at the point $0,0$. A $-4\mu\text{C}$ charge is at $(3,0)$ and a $5\mu\text{C}$ charge is at point $(0,4)$. Assume scale is in cm. A) What is the net force on the $5\mu\text{C}$ charged object? B) If the $5\mu\text{C}$ charge is removed, what would be the strength of the electric field at its old location?



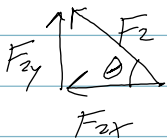
$$\textcircled{4} F_1 = \frac{9 \times 10^9 (7 \times 10^{-6})(5 \times 10^{-6})}{.04^2} = 196.875 \text{ N right}$$

$$\textcircled{3} F = \frac{kqq}{r^2}$$

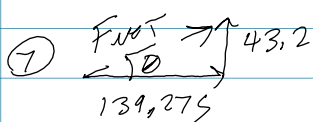
$$\textcircled{5} F_2 = \frac{9 \times 10^9 (5 \times 10^{-6})(4 \times 10^{-6})}{.05^2} = 72 \text{ N diagonally up \& left}$$

$$\textcircled{5} \tan^{-1}\left(\frac{.03}{.04}\right) = \theta = 36.87^\circ$$

$$\textcircled{6} \Sigma F_y = F_{2y} = 72 \sin 36.87^\circ = +43.2 \text{ N}$$



$$\Sigma F_x = +196.875 \text{ N} - 72 \cos 36.87^\circ = +139.275 \text{ N}$$



$$43.2^2 + 139.275^2 = C^2$$

$$\tan^{-1}\left(\frac{43.2}{139.275}\right) = \theta$$

$$C = \boxed{145.82 \text{ N at } 17.23^\circ \text{ above } +x \text{ axis}}$$

$$\text{B) } E = \frac{kq}{r^2} \textcircled{1} \frac{9 \times 10^9 (7 \times 10^{-6})}{.04^2} = 3.938 \times 10^7 \text{ N/C right}$$

$$\textcircled{2} \frac{9 \times 10^9 (4 \times 10^{-6})}{.05^2} = 1.44 \times 10^7 \text{ N/C at } 36.87^\circ \text{ above the } -x \text{ axis}$$

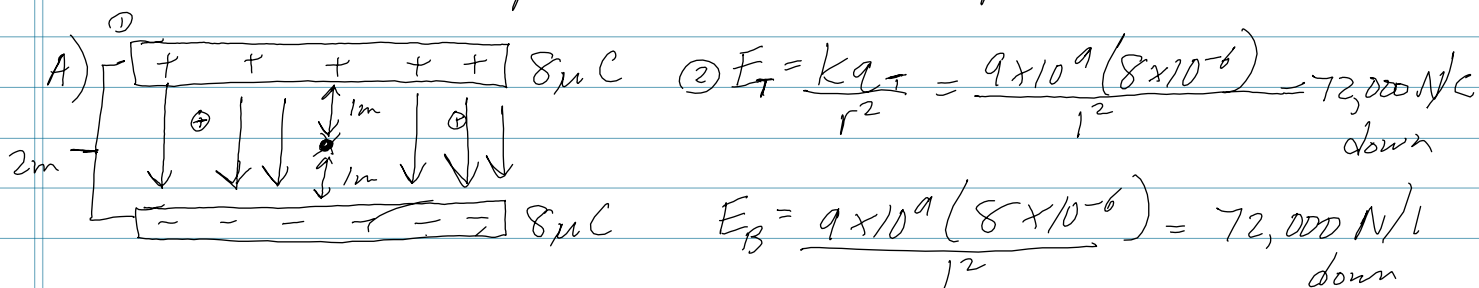
$$\textcircled{3} \Sigma E_y = 1.44 \times 10^7 \sin 36.87^\circ = 8.64 \times 10^6 \text{ N/C up}$$

$$\Sigma E_x = 3.938 \times 10^7 - 1.44 \times 10^7 \cos 36.87^\circ = +2.786 \times 10^7 \text{ N/C right}$$

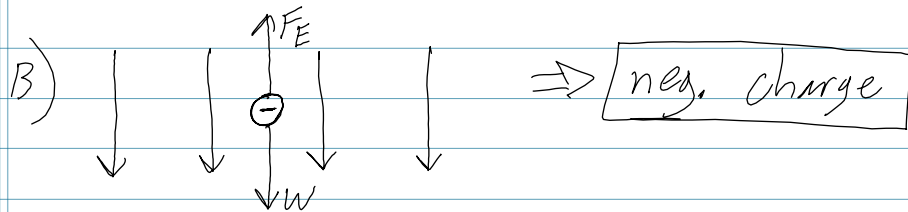
$$\textcircled{4} E_{\text{NET}} \rightarrow \begin{matrix} 8.64 \times 10^6 \\ \uparrow \\ \leftarrow 2.786 \times 10^7 \end{matrix} \quad (8.64 \times 10^6)^2 + (2.786 \times 10^7)^2 = C^2 \quad \tan^{-1}\left(\frac{8.64 \times 10^6}{2.786 \times 10^7}\right) = \theta$$

$$C = \boxed{2.91 \times 10^7 \text{ N/C at } 17.26^\circ \text{ above } x \text{ axis}}$$

- 2) 2 metal plates are separated by 2m and each have the same magnitude of charge, $8\mu\text{C}$. The top plate has a positive charge & the bottom plate has a negative charge.
- A) If the plates create a uniform field, what is the field right in the middle of the plates? B) What is the sign of the charge that could be suspended between the plates? C) What mass would a $\pm 3\text{nC}$ object need to have to be suspended between the plates?



③ $E_{\text{tot}} = E_T + E_B = 72,000(2) = \boxed{144,000 \text{ N/C down}}$



C) $\Sigma F = 0 = F_E + W \Rightarrow 0 = +4.32 \times 10^{-4} + W$

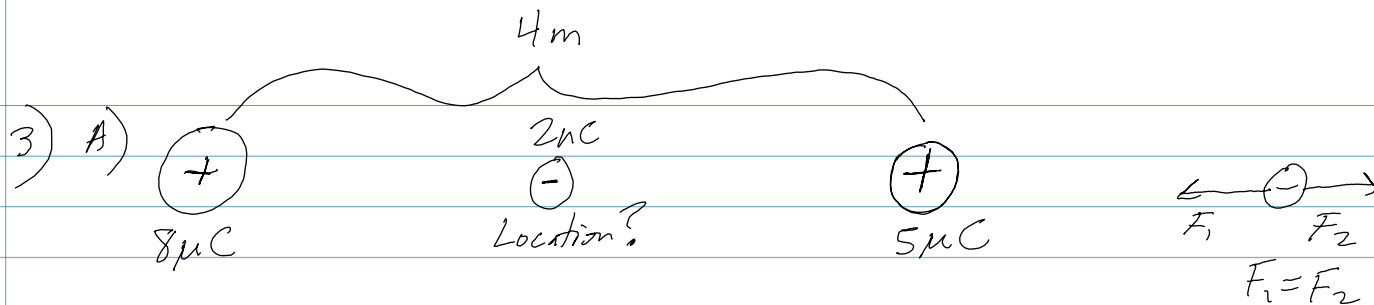
$E = \frac{F}{q}$

$W = \frac{-4.32 \times 10^{-4} \text{ N}}{10}$

$144,000 = \frac{F_E}{3 \times 10^{-9}}$

$m = 4.32 \times 10^{-5} \text{ kg}$

$F_E = 4.32 \times 10^{-4} \text{ N}$



Where can the -2nC charge be placed & remain in static equilibrium?

$$F_1 = \frac{kq_1q_2}{r_1^2}$$

$$F_2 = \frac{kq_3q_2}{r_2^2}$$

$$\frac{kq_1q_2}{r_1^2} = \frac{kq_3q_2}{r_2^2}$$

$$\frac{q_1}{r_1^2} = \frac{q_3}{r_2^2}$$

$$\frac{q_1}{r_1^2} = \frac{q_3}{(4-r_1)^2}$$

$$\frac{8 \times 10^{-6}}{r_1^2} = \frac{5 \times 10^{-6}}{(4-r_1)^2}$$

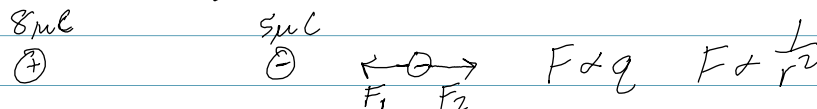
$$\sqrt{8 \times 10^{-6}(4-r_1)^2} = \sqrt{5 \times 10^{-6}(r_1)^2} \quad \sqrt{8 \times 10^{-6}}(4-r_1) = \sqrt{5 \times 10^{-6}}(r_1)$$

$$0.01131 - 0.00283r_1 = 0.00224r_1$$

$$0.01131 = 0.003066r_1$$

$$r_1 = \boxed{2.23\text{m from the } 8\mu\text{C charge}}$$

B) If the $5\mu\text{C}$ charge is changed to $-5\mu\text{C}$, where does the -2nC charge need to be placed to be in static equilibrium?



$$\frac{kq_1q_2}{r_1^2} = \frac{kq_3q_2}{(r_1+4)^2}$$

$$\frac{8 \times 10^{-6}}{r_1^2} = \frac{5 \times 10^{-6}}{(r_1+4)^2}$$

$$r_1 = \boxed{18.94\text{m from the } 8\mu\text{C charge \& to right of } 5\mu\text{C}}$$