Example 3

Three point charges lie along x axis, as shown in the figure, if the q_2 at the origin where & q_1 at 2m. The net force acting on q_3 is zero, what is x?

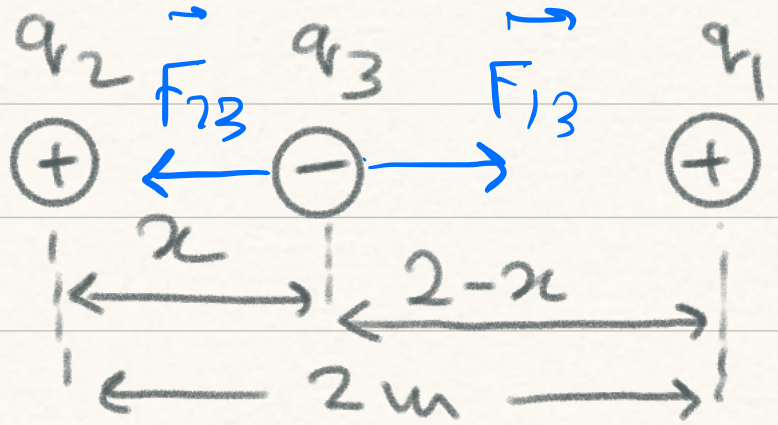
$q_1 = 15\,\mu C$

$q_2 = 6\,\mu C$

$q_3 = \text{unknown}$

$$\vec{F}_{23} = -k\frac{q_2 q_3}{x^2}\hat{i}$$

$$\vec{F}_{13} = k\frac{q_1 q_3}{(2-x)^2}\hat{i}$$



$$\sum F = 0 \Rightarrow \vec{F}_{13} - \vec{F}_{23} = 0 \Rightarrow \vec{F}_{13} = \vec{F}_{23}$$

$$K\frac{q_1 q_3}{(2-x)^2}\hat{i} = K\frac{q_2 q_3}{x^2}\hat{i}$$

$$\frac{q_1}{(2-x)^2} = \frac{q_2}{x^2} \Rightarrow \frac{15\times10^{-6}}{(2-x)^2} = \frac{6\times10^{-6}}{x^2}$$

$$\frac{15}{4+x^2-4x} = \frac{6}{x^2}$$

$$\Rightarrow 6(x^2-4x+4) = 15x^2$$

$$\Rightarrow 6x^2-24x+24 = 15x^2$$

$$\underset{a}{9}x^2 + \underset{b}{24}x - \underset{c}{24} = 0$$

$$x = \frac{-24 \pm \sqrt{(24)^2-4(9)(-24)}}{2\cdot 9}$$

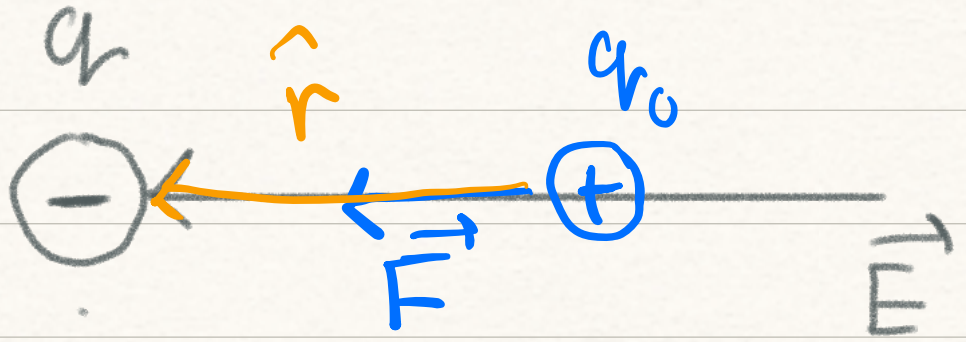
$$ax^2+bx+c=0$$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

$$x = 0.77\ m$$

Electric Field ($\vec{E}$) المجال الكهربائي

$$\vec{E} = \frac{\vec{F}}{q_0}$$



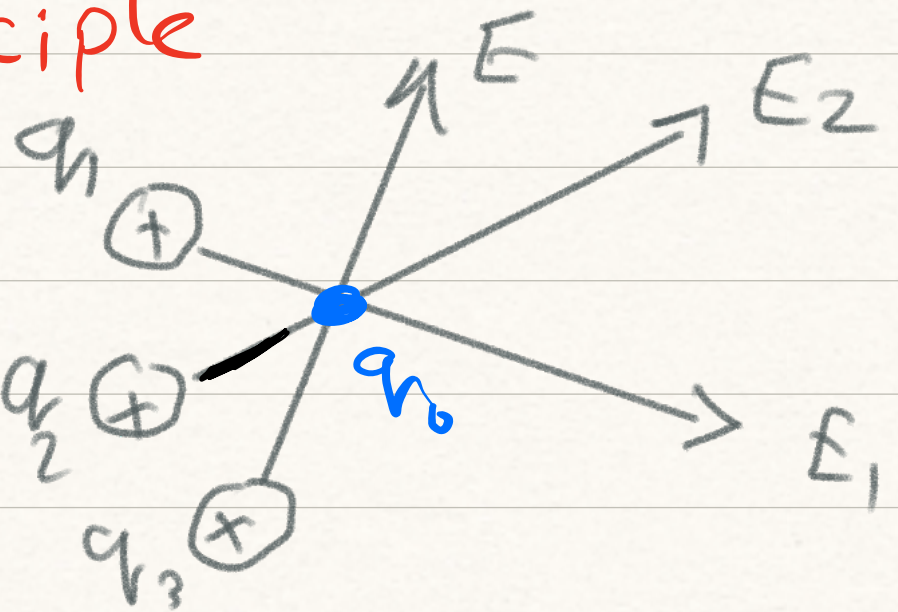
$$\vec{F} = K \frac{q q_0}{r^2} \cdot \hat{r}$$

$$\vec{E} = K \frac{q q_0}{r^2} \cdot \frac{1}{q_0} \cdot \hat{r}$$

$$\Rightarrow \boxed{\vec{E} = \frac{Kq}{r^2} \cdot \hat{r}}$$

superposition principle

$$\vec{E} = K \sum \frac{q_i}{r_i^2} \hat{r}$$



Example 4

Tiny droplets of oil acquire a small negative charge while dropping at vacuum (pressure = 0) in an experiment. An electric field of magnitude $5.92 \times 10^{+4}$ N/C point stright down,

[1] one particular droplet is observed to remain suspended aginst gravity, the mass of droplet is 2.93×10^{-15} kg Find the charge carried by the droplet.

[2] Another droplet of the same mass fall 10.3 cm from the rest in 0.25 sec, again moving through the vacuum. Find the charge carried by the droplet?

[1] $\Sigma F = 0 \Rightarrow -mg + F_c = 0$

$F_c = m \cdot g$

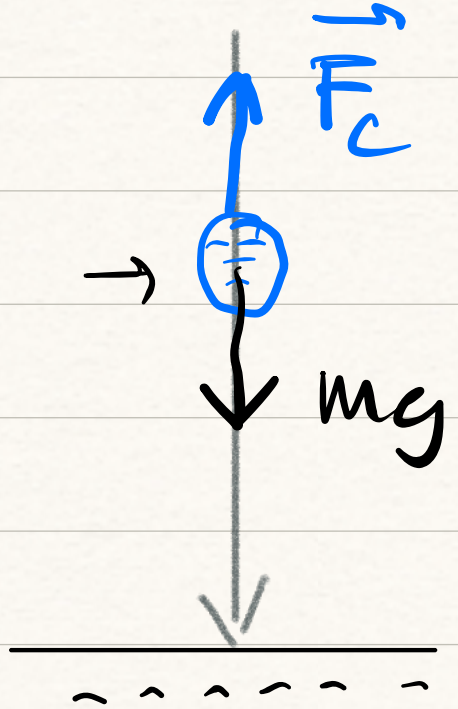
$E \cdot q = mg$

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

$F = Eq$

$q = -\frac{(2.93 \times 10^{-15})(9.8)}{5.92 \times 10^{+4}}$

$q = -4.85 \times 10^{-19} C$



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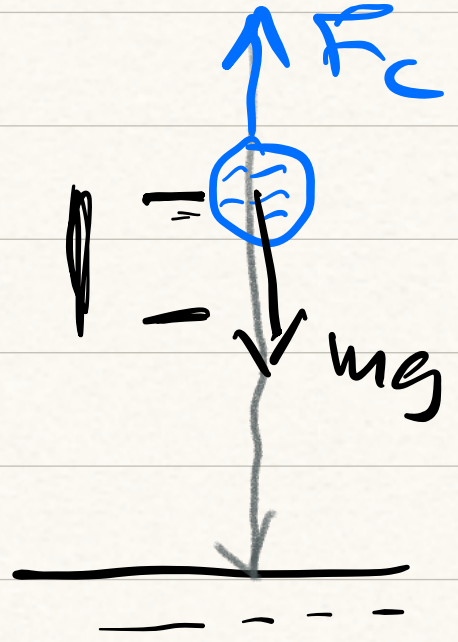
[2]

$v = v_0 + at$

$x - x_0 = \frac{1}{2}(v + v_0)t$

$x - x_0 = v_0 t + \frac{1}{2} a t^2$

$v^2 = v_0^2 + 2a(x - x)$



$$\Sigma F = ma$$

$$F_c - mg = ma$$

$$F_c = mg + m(-a)$$

$$F_c = m(g - a)$$

$$F_c = 2.93 \times 10^{-15}(4.8 - 3.3)$$

$$F_c = 19.045 \times 10^{-15}$$

$$E = \frac{F_c}{q} \Rightarrow qE = F_c$$

$$x - x_0 = v_0 t + \frac{1}{2} a t^2$$

$$0.103 = -\frac{1}{2} a (0.25)^2$$

$$a = -\frac{0.103}{0.03125}$$

$$a = -3.3\ m/s^2$$

$$q = \frac{F_c}{E} = \frac{+19.045 \times 10^{-15}}{-5.92 \times 10^{4}}$$

$$q = -3.22 \times 10^{-19}\ C$$