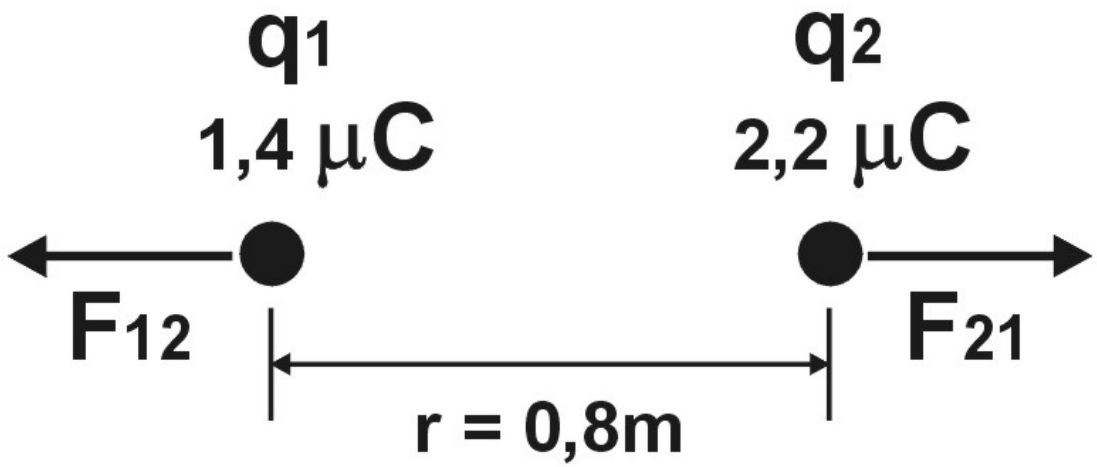
$\varepsilon_0 = 8,85418 \times 10^{-12}\ Coul^2/N\text{-}m^2$ = permitividad del vacío.

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \frac{N\text{-}m^2}{Coul^2}$



$\vec{F}_{12} = \vec{F}_{21} = \vec{F}$

$F = \frac{1}{4\pi\varepsilon_0}\ \frac{q_1 q_2}{r^2}$

$F = 9 \times 10^9\ \frac{N\text{-}m^2}{Coul^2} \times \frac{1,4 \times 10^{-6}\ Coul \times 2,2 \times 10^{-6}\ Coul}{(0,8)^2\ m^2} = 0,043\ N$

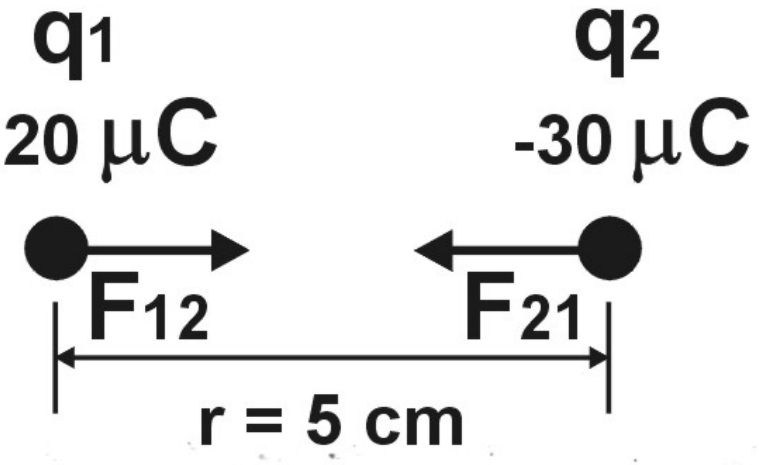
$F = 0,043\ N$

COULOMB SOLUCIÓN 2

$q_1 = 20\mu C$: $r = 5cm$

$q_2 = -30\mu C$

$\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \frac{N.m^2}{Coul^2}$



$F_{12} = F_{21} = F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2} \Rightarrow$

$$F = 9\times10^9 \frac{Nm^2}{C^2} \times \frac{20\times10^{-6} \times |30\times10^{-6}|\, C^2}{(0{,}05)^2 m^2}$$

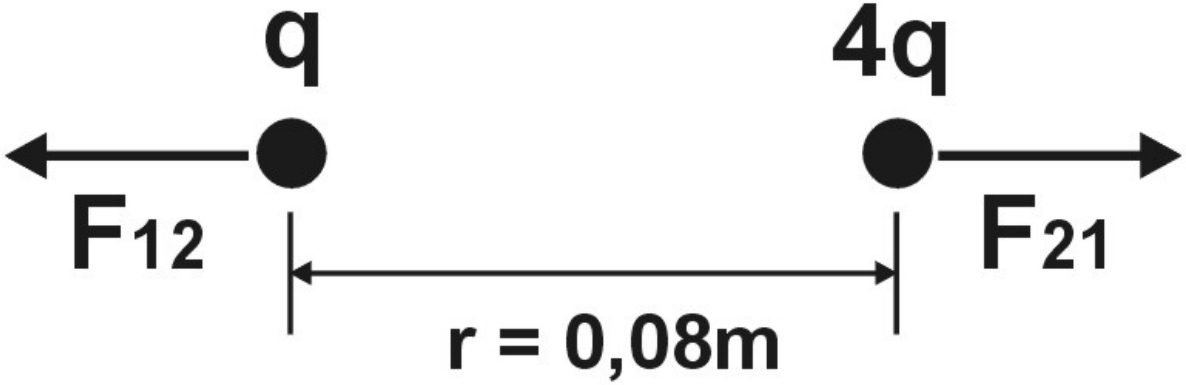
$$\therefore \boxed{F = 2160\ N}$$

$$\frac{1}{4\pi\varepsilon_0} = 9.10^9 \frac{C^2}{N.m^2}$$

$q_1 = q$

$q_2 = 4.q$

$r = 0{,}08m$



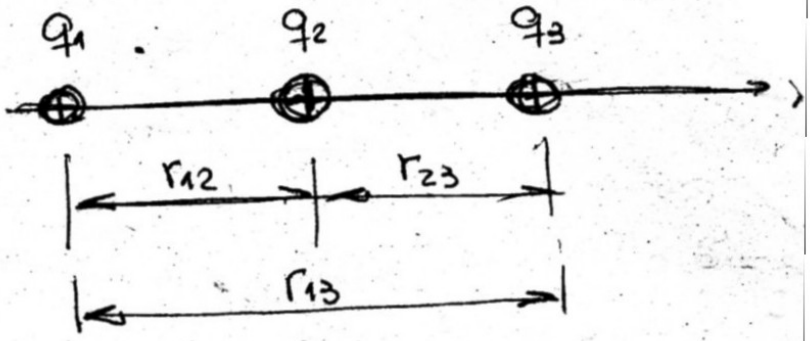
$$0{,}225\ N = 9.10^9 \frac{C^2}{N.m^2} \frac{4.q^2}{(0{,}08\ m)^2} \Longrightarrow \begin{cases} q_1 = 0{,}2\ \mu C \\ q_2 = 0{,}8\ \mu C \end{cases}$$

SUPERPOSICIÓN DE FUERZAS

6) $q_1 = 20\mu C$

$q_2 = 10\mu C$

$q_3 = 30\mu C$



$r_{12} = 0.1\,m$ $r_{23} = 0,1\,m$

$r_{13} = 0,2\,m$

$$F_{13} = 9\times10^9 \frac{Nm^2}{C^2} \times \frac{(20\times30)\times10^{-12}\,C^2}{(0,2\,m)^2} = 135\,N = F_{13} = F_{31}$$

$$F_{12} = 9\times10^9 \frac{Nm^2}{C^2} \times \frac{(20\times10)\times10^{-12}\,C^2}{(0,1\,m)^2} = 180\,N = F_{12} = F_{21}$$

$$F_{23} = 9\times10^9 \frac{Nm^2}{C^2} \times \frac{(10\times30)\,10^{-12}\,C^2}{(0,1\,m)^2} = 270\,N = F_{23} = F_{32}$$

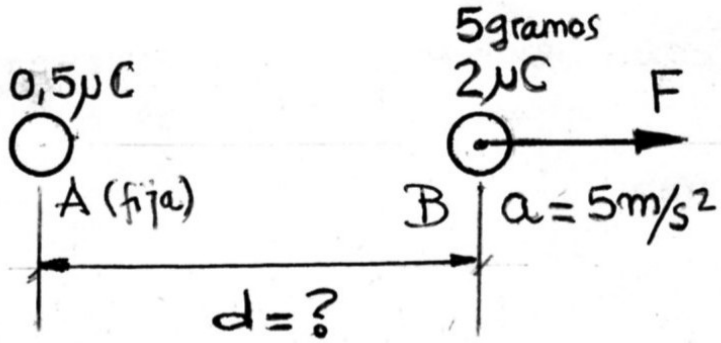
$$\vec{F_1} = \vec{F_{12}} + \vec{F_{13}} = (180\,N + 135\,N)(-\check{\imath}) = 315\,N(-\check{\imath}) \rightarrow \boxed{\vec{F_1} = -315\,N\,\check{\imath}}$$

$$\vec{F_2} = \vec{F_{21}} + \vec{F_{23}} =$$

$$\vec{F_2} = 180\,\check{\imath} - 270\,\check{\imath} = -90\,N\,\check{\imath} \rightarrow \boxed{\vec{F_2} = -90\,N\,\check{\imath}}$$

$$\vec{F_3} = \vec{F_{31}} + \vec{F_{32}} = 135\,N\,\check{\imath} + 270\,N\,\check{\imath} = 405\,N\,\check{\imath} \rightarrow \boxed{\vec{F_3} = 405\,N\,\check{\imath}}$$

El cuerpo B (sistema) experimenta una fuerza de origen Coulombiano



$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_A q_B}{d^2}$$

dado que posee Carga Eléctrica q_B

y además se encuentra en las cercanías del cuerpo A que posee carga q_A - que forma parte del medio ambiente -

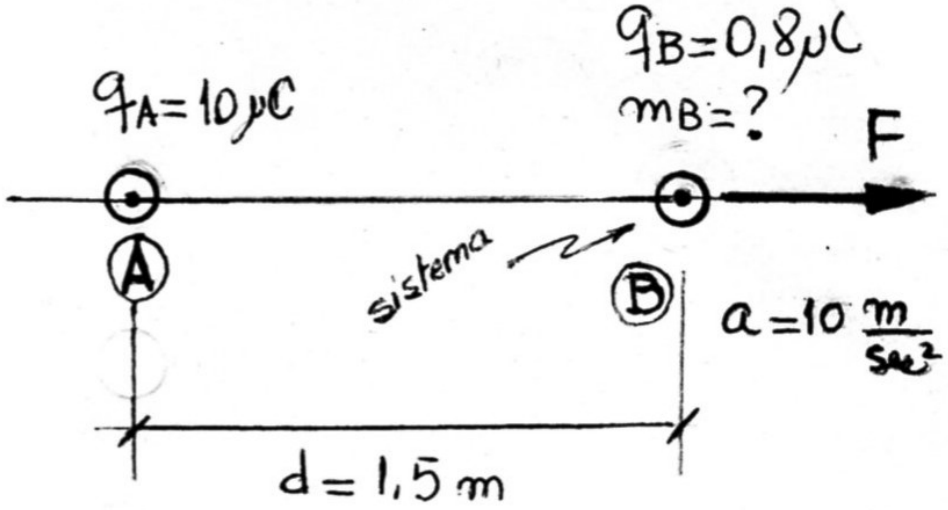
Pero el cuerpo B, además de carga tiene masa $m_B = 0{,}005\,kg$

y por lo tanto, según Newton, esa fuerza Coulombiana F, hará que B acelere con $a = \frac{F}{m_B}$. Es decir que

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_A q_B}{d^2} = m_B a \Rightarrow d = \sqrt{\frac{q_A q_B}{4\pi\varepsilon_0 \, a \, m_B}}$$

$$\therefore d = \sqrt{9\times10^9 \frac{Nm^2}{C^2} \times \frac{0{,}5\times10^{-6} \times 2\times10^{-6}\, C^2}{5\, m/seg^2 \times 5\times10^{-3}\, kg}} = 0{,}6\, m.$$

$$\therefore \boxed{d = 0{,}6\,m = 60\,cm}$$



Según Newton

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

Conocemos "a" pero

no conocemos "F" que q_A ejerce sobre q_B (sistema).-

La "F" es de origen Coulombiano

$$\therefore \quad F = 9\times10^{9}\ \frac{Nm^2}{C^2} \times \frac{10\times10^{-6}\,C \times 0,8\times10^{-6}\,C}{(1,5\,m)^2} = \boxed{0,032\,N = F}$$

$$\therefore m_B = \frac{0,032\,N}{10\ m/seg^2} = 0,0032\,Kg \Rightarrow \boxed{m_B = 3,2\,g}$$

$q_1 = -4\,\mu C$

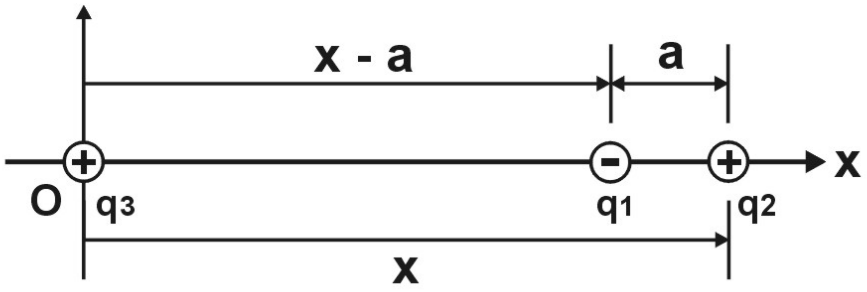
$q_2 = 6\,\mu C$

$q_3 = 2\,\mu C$

$r_{12} = a = 0{,}1m$

$r_{23} = x$

$r_{13} = x - a$



$$|F_{13}| = |F_{23}|$$

$$\frac{|4|\times|2|}{(x-a)^2} = \frac{|6||2|}{x^2} \Rightarrow \frac{(x-a)^2}{8} = \frac{x^2}{12} \Rightarrow \frac{3}{2}(x-a)^2 = x^2$$

$$3(x-a)^2 = 2x^2$$

$$3(x^2 - 2ax + a^2) = 2x^2 \therefore \quad 3x^2 - 2x^2 - 6ax + 3a^2 = 0 \therefore$$

$$x^2 - 6ax + 3a^2 = 0 \Rightarrow x^2 - 0{,}6x + 0{,}03 = 0 .$$

· Se resuelve la cuadrática y resulta $x_1 = 0{,}545\,m$ ← ✓

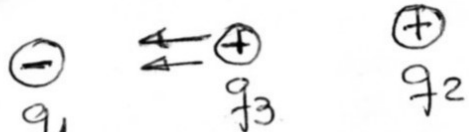
$x_2 = 0{,}045\,m$ ← NO

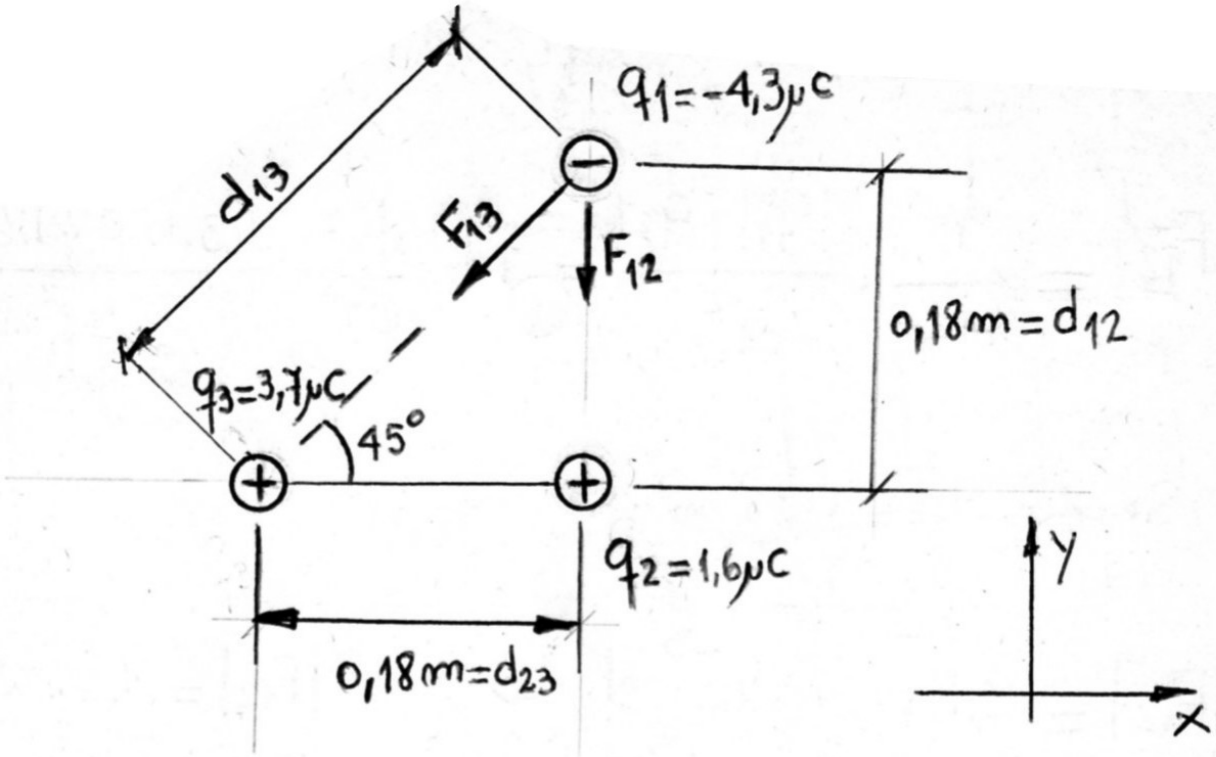
La solución correcta es

$\boxed{x = 0{,}545\,m = 54{,}5\,cm}$ ← CORRECTA.

(*) La otra solución debe descartarse ya que si la carga q_3 estuviese a 4,5cm de q_2, la q_3 estaría entre medio de q_1 y q_2.

Esto hace imposible la cancelación de fuerzas sobre q_3.





a) Acción de q_3 sobre q_1 : F_{13}.

$$|F_{13}| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{|q_1||q_3|}{d_{13}^2} = 9\times10^9 \frac{N\cdot m^2}{C^2} \times \frac{4,3\times10^{-6}\,C \times 3,7\times10^{-6}\,C}{d_{13}^2}$$

donde $d_{13}^2 = 0,18^2 + 0,18^2 = 0,065\ m^2$.

$$\therefore |F_{13}| = \frac{9\times 4,3\times 3,7}{0,065} \times 10^{-3} = 2202,92\times10^{-3}\ N \therefore$$

$$\boxed{|F_{13}| \simeq 2,2\ N} \Rightarrow \begin{cases} F_{13y} = 2,2\ N \times \cos 45° (-\check{j}) \\ F_{13x} = 2,2\ N \times \operatorname{Sen} 45° (-\check{i}) \end{cases}$$

$$\boxed{\begin{aligned} F_{13y} &= -1,56\,\check{j}\ N \\ F_{13x} &= -1,56\,\check{i}\ N \end{aligned}}$$

·) Acción de q_2 sobre q_1 : F_{12}

$$|F_{12}| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{|q_1||q_2|}{d_{12}^2} = 9\times10^9 \frac{N m^2}{C^2} \cdot \frac{4{,}3\times10^{-6} C \times 1{,}6\times10^{-6} C}{0{,}18^2 m^2}$$

Siendo $d_{12}^2 = 0{,}18^2 m^2$.

$$|F_{12}| = 1911{,}1\times10^{-3} N \Rightarrow \quad |F_{12}| = 1{,}91 N$$

$$\boxed{F_{12} = -1{,}91 \check{j} N}$$

·) Σ Fuerzas.

$$\vec{F} = \vec{F_{12}} + \vec{F_{13}} = -1{,}91 \check{j} + (-1{,}56)\check{j} - 1{,}56 \check{i}$$

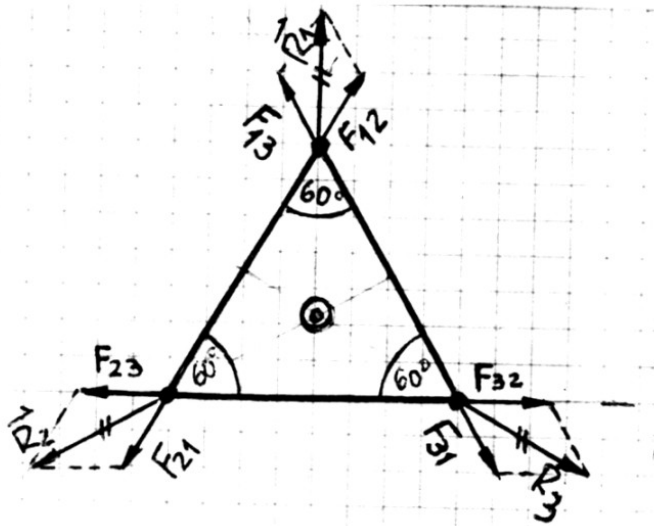
$$= \boxed{-1{,}56 \check{i} - 3{,}47 \check{j} = \vec{F}}$$

DATOS:

$q_1 = q_2 = q_3 = -1{,}6 \times 10^{-19}\ C$ (carga del electrón).

$r_{12} = r_{13} = r_{23} = a = 3\ cm\ (0{,}03\ m)$.

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \frac{N\,m^2}{C^2}$



1) Fuerza de Repulsión entre Cargas vértice

$|F_{12}| = |F_{13}| = |F_{23}| = |F_R|$ siendo

$$|F_R| = \frac{1}{4\pi\varepsilon_0} \times \frac{q_i\, q_j}{(r_{ij})^2} = 9 \times 10^9\ \frac{N \cdot m^2}{C^2} \times \frac{(1{,}6 \times 10^{-19})^2\ C^2}{(3 \times 10^{-2})^2\ m^2} = 2{,}56 \times 10^{-25}\ N.$$

$$\boxed{|F_R| = 2{,}56 \times 10^{-25}\ N}$$

2) SUPERPOSICIÓN VECTORIAL SOBRE UN EJE DE SIMETRÍA

Cada carga q_i "sentirá" una fuerza resultante R de Repulsión, que resulta de hacer:

$$|R| = 2\,|F_R| \cos 30° =$$

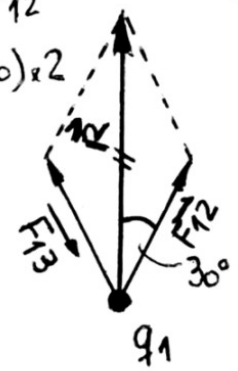
$$= 2 \times 2{,}56 \times 10^{-25} \times 0{,}866 = 4{,}43 \times 10^{-25}\ N$$

$$\boxed{|R| = 4{,}43 \times 10^{-25}\ N}$$

$\vec{R} = \vec{F_{13}} + \vec{F_{12}}$

$|\vec{F_{13}}| = |\vec{F_{12}}| = F$

$|\vec{R}| = (F \cos 30) \times 2$



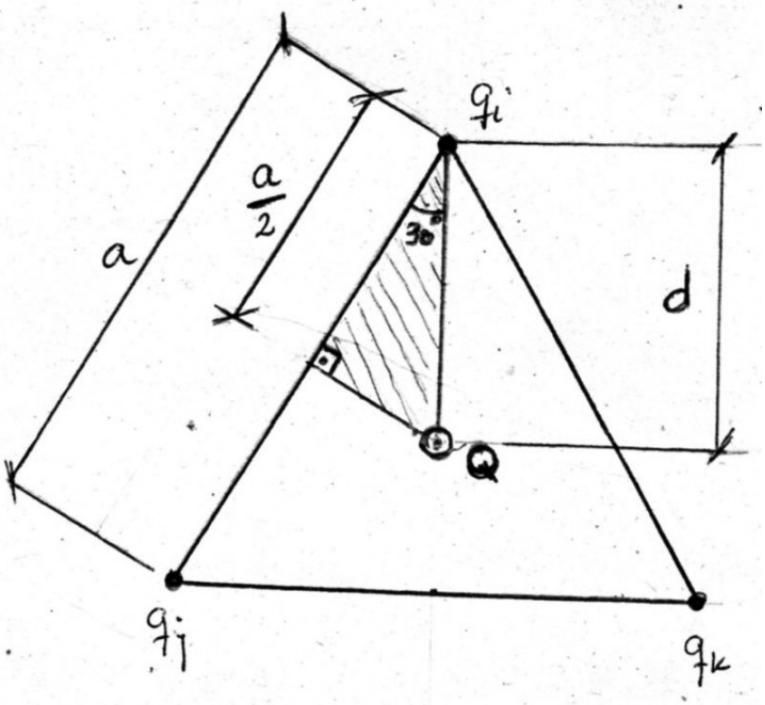
3) CARGA Q (POSITIVA)

•) La carga Q se ubica a una distancia "d" de c/una de las cargas q_i, siendo

$$d = \frac{a/2}{\cos 30°}$$

$$\therefore d = \frac{3\,cm/2}{0{,}866} = 1{,}73\,cm.$$

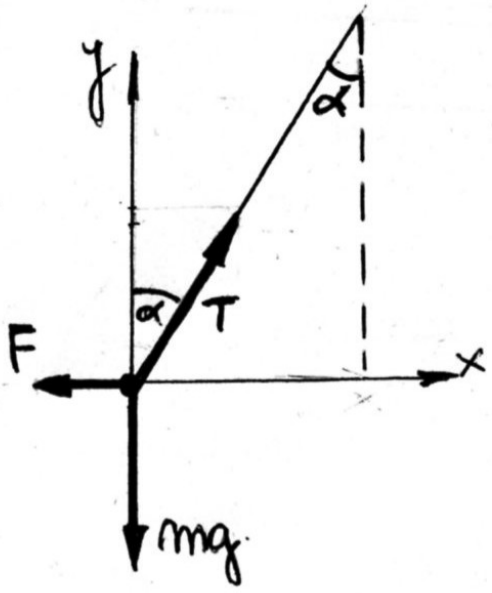
$$\therefore \boxed{d = 1{,}73 \times 10^{-2}\,m}$$

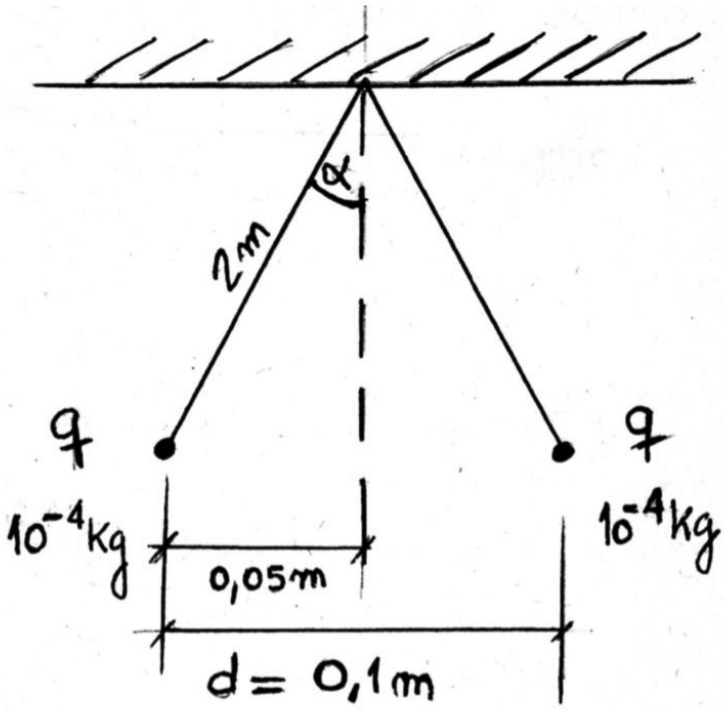


•) La fuerza que la carga Q produce sobre las q_i de los vertices es igual y de sentido opuesto a la resultante $|F_{RA}| = 4{,}43 \times 10^{-25}\,N$. $\therefore |F_Q| = |F_{RA}|$.

$$\therefore F_Q = \frac{1}{4\pi\varepsilon_0} \times \frac{q_i Q}{d^2} \Rightarrow Q = \frac{F_Q \times d^2}{q_i} \cdot \left(\frac{4\pi\varepsilon_0}{1}\right) =$$

$$\therefore Q = \frac{4{,}43 \times 10^{-25} \times (1{,}73 \times 10^{-2})^2}{1{,}6 \times 10^{-19} \times 9 \times 10^{9}}\,C \Rightarrow \boxed{Q = 9{,}207 \times 10^{-20}\,C}$$





El ángulo α :

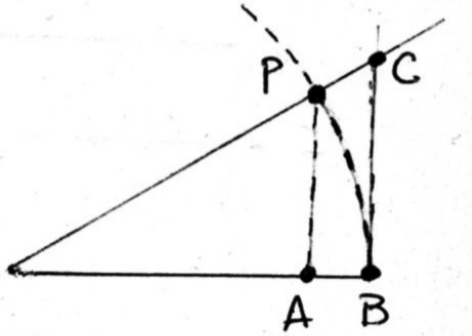
Con las dimensiones dadas podemos calcular el $\text{Sen}\,\alpha = \frac{0{,}05\,m}{2\,m}$

$\therefore \text{Sen}\,\alpha = 0{,}025 \Rightarrow \alpha = 1{,}4325^\circ$ sexagesimales

Expresado en radianes queda 360° — 2π radianes

$1{,}4325^\circ$ — x $\Rightarrow \boxed{x = 0{,}025}$

$\therefore \alpha = 1{,}4325^\circ = 0{,}025$ radianes.



Calculemos $\text{tg}\,\alpha = \text{tg}\,(1{,}4325^\circ) = 0{,}025$.

$\therefore$ $\boxed{\alpha = 1{,}4325^\circ = 0{,}025\ \text{rad} \cong \text{Sen}\,\alpha \cong \text{tg}\,\alpha}$ → Se cumple

Arco $\cong \overline{BP}$ — CATETO $\overline{PA}$ — CATETO $\overline{BC}$

Por Ley de Coulomb $\equiv F = \frac{1}{4\pi\varepsilon_0}\frac{qq}{d^2} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{d^2}$ dado que ambas cargas son iguales a "q".

$$\Rightarrow q = \sqrt{4\pi\varepsilon_0 d^2 \times F} = \sqrt{\frac{(0,1\,m)^2 \times F}{9\times10^9 \frac{N\,m^2}{C^2}}}$$

El problema es que aún no conocemos F:

Para conocerla apelamos al diagrama de cuerpo aislado:

Equilibrio:

$$\left.\begin{array}{l} T\cos\alpha - mg = 0 \\ T\,\mathrm{sen}\,\alpha - F = 0 \end{array}\right\} \Rightarrow \boxed{F = mg\,tg\alpha}$$

$$F = mg\,tg\alpha \cong mg\alpha = 10^{-4}\,kg \times 10\,\frac{m}{seg^2} \times 0,025:$$

$$F = 25\times10^{-6}\,N.$$

Introducimos el valor de F en la expresión de q y queda:

$$q = \sqrt{\frac{0,1^2 \times 25\times10^{-6}}{9\times10^9}} = \frac{5}{3}\cdot\sqrt{10^{-2}\cdot10^{-6}\times10^{-9}} = \frac{5}{3}\sqrt{10^{-17}} =$$

$$\frac{5}{3}\times3,16\times10^{-9}\,C = 5,27\,nC \qquad \boxed{q = 5,27\,nC}$$