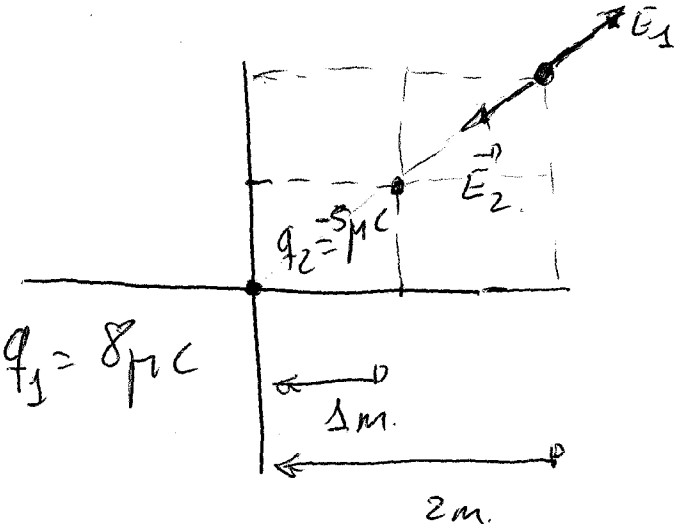
10.-

a)



$|\vec{E}_1| = 9.10^9 \frac{N.m^2}{C^2} \frac{8.10^{-6}C}{8m^2} = 9.10^3 N/C$

$|\vec{E}_2| = 9.10^9 \frac{N.m^2}{C^2} \frac{5.10^{-6}C}{2m^2} = 22'5.10^3 N/C$

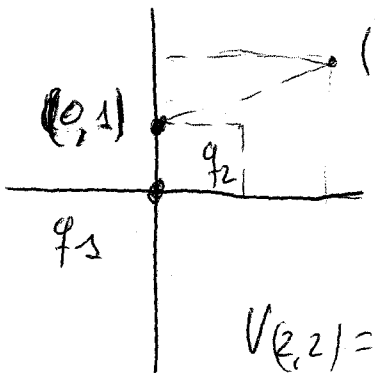
ángulo de 45°

$\vec{E}_1 = 6'36.10^3 \vec{i} + 6'36.10^3 \vec{j}$ N/C

$\vec{E}_2 = -1'59.10^4 \vec{i} - 1'59.10^4 \vec{j}$ N/C

$\vec{E} = -9'549.10^3 \vec{i} - 9'549.10^3 \vec{j}$ N/C

b)



(2,2) → (0,1)

$V_{(2,2)} = K \frac{q_1}{\sqrt{8m^2}} + K \frac{q_2}{\sqrt{2m^2}}$

$V_{(2,2)} = 9.10^9 \frac{Nm^2}{C^2} \left(\frac{8.10^{-6}C}{\sqrt{8m^2}} + \frac{(-5.10^{-6}C)}{\sqrt{2m^2}} \right)$

$V_{(1,1)} = 9.10^9 \frac{N.m^2}{C^2} \left(\frac{8.10^{-6}C}{1m} + \frac{(-5.10^{-6}C)}{1} \right)$

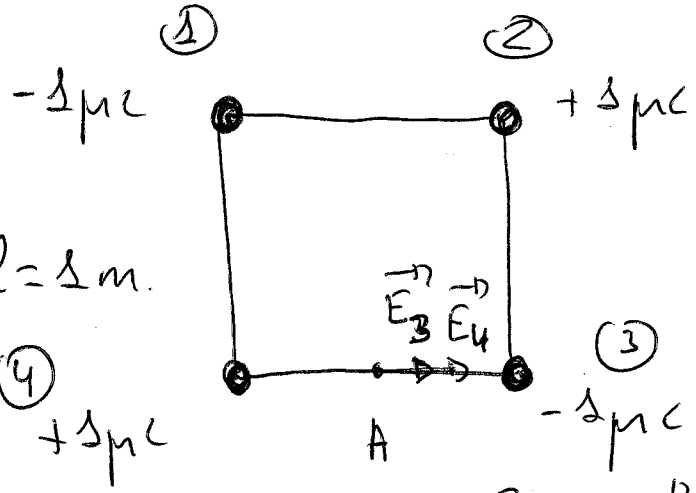
$V_{(2,2)} = -6.364\ V$; $V_{(1,1)} = 27.10^3 N/C$

$W_{(2,2)}^{(1,1)} = -1.10^{-6}C \left[V_{(1,1)} - V_{(2,2)} \right] =$

$W_{(2,2)}^{(1,1)} = -1.10^{-6}C \left[27.10^3\ V - (-6.364\ V) \right] = -3'34.10^{-2} J$

PROBLEMA Nº 11

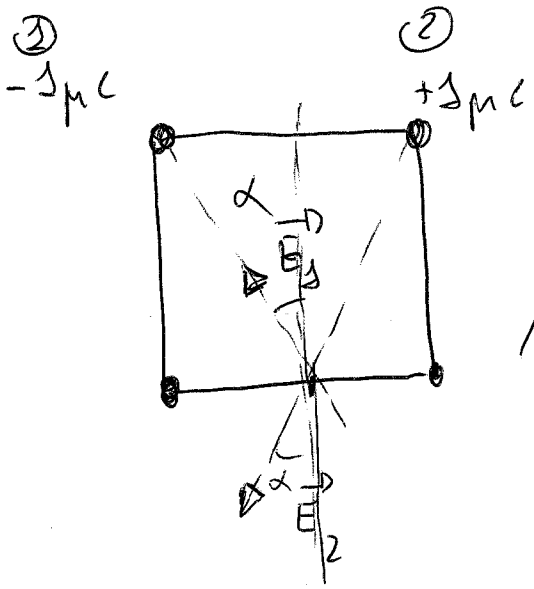
a) $\vec{E}_A$?



$$|\vec{E}_3| = |\vec{E}_4| = 9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{1\cdot10^{-6}C}{(0'5m)^2}$$

$$= 36\cdot10^3 N/C$$

$$\vec{E}_3 = 36\cdot10^3 N/C\ \vec{i} \quad ; \quad \vec{E} = 36\cdot10^3 N/C\ \vec{i}$$



$$\text{sen}\,\alpha = \frac{0'5m}{\sqrt{1'25m^2}} \quad ; \quad \cos\alpha = \frac{1m}{\sqrt{1'25m^2}}$$

$$|\vec{E}_3| = |\vec{E}_2| = 9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{1\cdot10^{-6}C}{\sqrt{1'25m^2}}$$

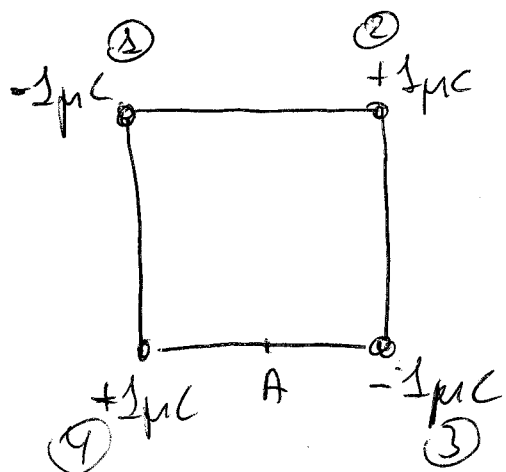
$$= 7200 N/C$$

As componentes y anularse.

$$\vec{E}_3 = \vec{E}_2 = -\text{sen}\,\alpha \cdot 7200 N/C\ \vec{i}$$

$$\vec{E}_A = \left(7\,2\,10^3 - 2\cdot\text{sen}\,\alpha\cdot 7200\right) N/C\ \vec{i} = 6'56\,10^9\ \vec{i}\ N/C$$

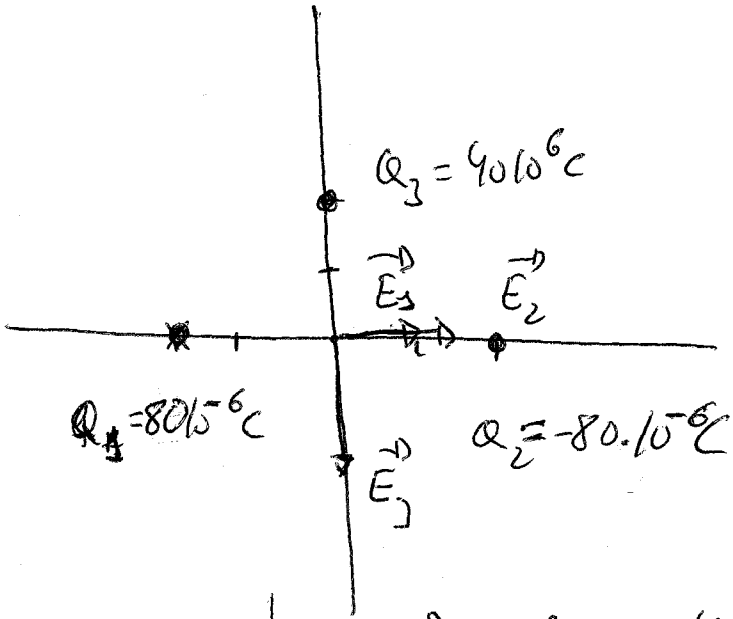
b)



V_1 e V_2 iguales pero de signo contrario, igual pasa con V_3 e V_4.

$V_A = 0$ igual en módulos lados $W = 0$

PROBLEMA N°12



a) $\vec{E}_{(0,0)}$

b) $W_{\infty}^{(0,0)}$; $q = 1\,\mu C$

$$|\vec{E_1}| = 9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{4\cdot10^{-6}C}{(2m)^2} = 9\cdot10^4 N/C$$

$$|\vec{E_3}| = 9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{8\cdot10^{-6}C}{(2m)^2} = 18\cdot10^4 N/C$$

$$|\vec{E_2}| = 18\cdot10^4 N/C$$

$$\vec{E}_{(0,0)} = 36\cdot10^4 \vec{i} - 9\cdot10^4 \vec{j}\ N/C$$

b) $V_{(0,0)} = V_1 + V_2 + V_3 = \frac{K}{r}(Q_1 + Q_2 + Q_3)$

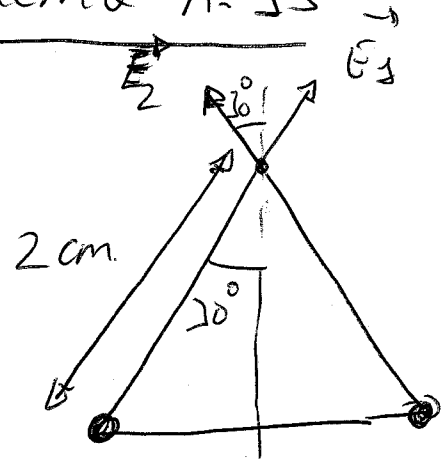
$$V_{(0,0)} = \frac{9\cdot10^9 N\cdot m^2/C^2}{2m}(8\cdot10^{-6}C - 8\cdot10^{-6}C + 4\cdot10^{-6}C)$$

$$V_{(0,0)} = 18\cdot10^4 V$$

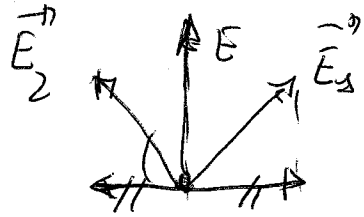
$$W_{\infty}^{(0,0)} = -1\cdot10^{-6}C\,(18\cdot10^4 V - 0) = 0{,}18\,J$$

Problema nº 13

a)



$$|\vec{E}_1| = |\vec{E}_2| = K \frac{q}{(2\cdot10^{-2}m)^2}$$

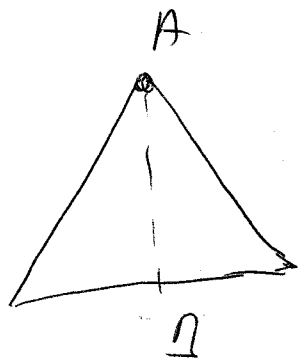


q_1 $+10\mu C$ $\quad$ q_2 $+10\mu C$

$$\vec{E} = 2\cdot\cos 30^\circ \cdot K \frac{q}{(2\cdot10^{-2}m)^2} = 2.087\ 9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{10\cdot10^{-6}C}{(2\cdot10^{-2}m)^2}$$

$$\vec{E} = 3'92\cdot10^8 N/C$$

b) W_A^1 ?



$q' = 5\cdot10^{-6}C$

$$V_A = 2K\frac{q}{r}$$

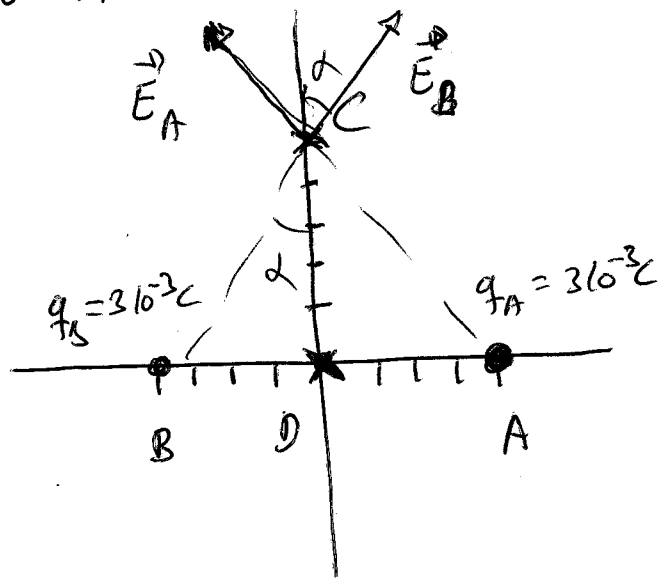
$$V_A = 2\cdot9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{10\cdot10^{-6}C}{2\cdot10^{-2}m} = 9\cdot10^6 V$$

$$V_1 = 2\cdot9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{10\cdot10^{-6}C}{1\cdot10^{-2}m} = 18\cdot10^6 V$$

$$W_A^1 = -q'(V_1 - V_A) \Rightarrow$$

$$W_A^1 = -5\cdot10^{-6}C\,(18\cdot10^6 V - 9\cdot10^6 V) = -45\ J$$

Problema nº 14.



a) $\vec{E}_D = 0$

$$|\vec{E}_A| = |\vec{E}_B| = 9\cdot10^9 \frac{Nm^2}{C^2} \frac{3\cdot10^{-3}C}{(25+16)m^2} = 6'59\cdot10^5 N/C$$

$$\operatorname{sen}\alpha = \frac{4m}{\sqrt{41m^2}} =$$

$$\cos\alpha = \frac{5m}{\sqrt{41m^2}}$$

$$\vec{E}_C = 2\cdot6'59\cdot10^5 \cdot \frac{5m}{\sqrt{41m^2}} \cdot \vec{i}\ N/C = 1'03\,10^6\,\vec{i}\ (N/C$$

b)

$$V_D = 2K\,\frac{3\cdot10^{-3}C}{4m} = 1'35\,10^7 V$$

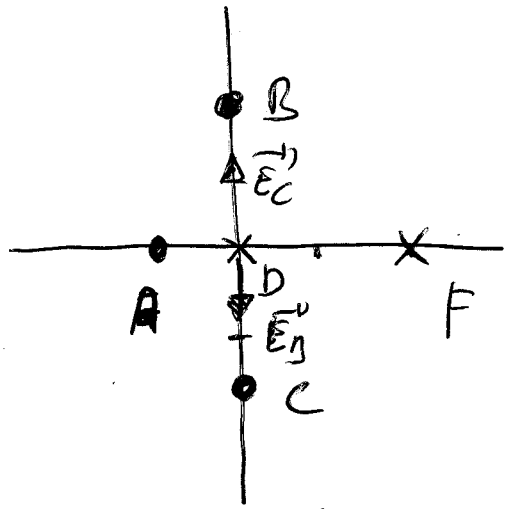
$$V_C = 2K\cdot\frac{3\cdot10^{-3}C}{\sqrt{41m^2}} = 8'43\,10^6 V$$

c) $W_C^0 = -\Delta E_p = -q'(V_D - V_C) = -(-10^{-3}C)\left[1'35\,10^7 V - 8'43\,10^6 V\right]$

$W_C^0 = 5270\,J$

Problema nº 15

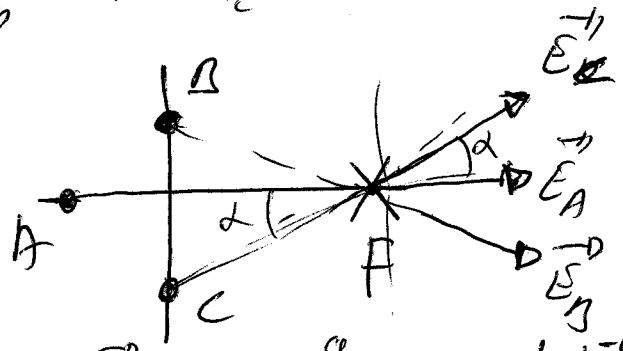
$q_A = q_B = q_C = 1\,10^{-6}\,C$



a)

$$|\vec{E}_D| = K\frac{q_A}{r_A^2} = 9.10^9\,\frac{N.m^2}{C^2}\,\frac{1\,10^{-6}\,C}{(1m)^2} = 9\,10^3\,N/C$$

$$\vec{E}_D = 9\,10^3\,N/C\ \vec{i}$$



$$|\vec{E}_B| = |\vec{E}_C| = 9.10^9\,\frac{N.m^2}{C^2}\,\frac{1.10^{-6}\,C}{8m^2} = 9/8.10^3\,N/C$$

$$|\vec{E}_A| = 9.10^9\,\frac{N.m^2}{C^2}.\,\frac{1\,10^{-6}\,C}{9m^2} = 1.10^3\,N/C$$

$$\operatorname{sen}\alpha = \frac{2m.}{\sqrt{8m^2}}\ ;\ \cos\alpha = \frac{2m.}{\sqrt{8m^2}} \qquad \alpha = 45°$$

$$\vec{E}_F = \left(1.10^3\,N/C + 2/\frac{9}{8}\,10^3\,N/C.\,\frac{\sqrt{2}}{2}\,N/C\right)\vec{i}$$

$$\vec{E}_F = 2'59\,10^3\,\vec{i}\ N/C$$

b) $V_D = 2\ 9\cdot10^9 \frac{N\cdot m^2}{C^2}\ \frac{1\cdot10^{-6}C}{2m} + 9\cdot10^9 \frac{N\cdot m^2}{C^2}\ \frac{1\cdot10^{-6}C}{1m}$

$V_D = \frac{9\cdot10^9 N\cdot m^2}{C^2} \cdot 10^{-6} C \left(\frac{2}{2m} + \frac{1}{1m}\right)$

$V_D = 18\cdot10^3\ V\ \left(\frac{N\cdot m}{C}\right)$

$V_F = Kq\left(\frac{2}{\sqrt{8}m} + \frac{1}{3m}\right)$

$V_F = 9\cdot10^9 \frac{N\cdot m^2}{C^2} \cdot 1\cdot10^{-6} C \left(\frac{2}{\sqrt{8}m} + \frac{1}{3m}\right) = 9'04\cdot10^3 V$

c) Energia (D) = Energia (F) ; $q' = +1\ \mu C$; $m = 10g$

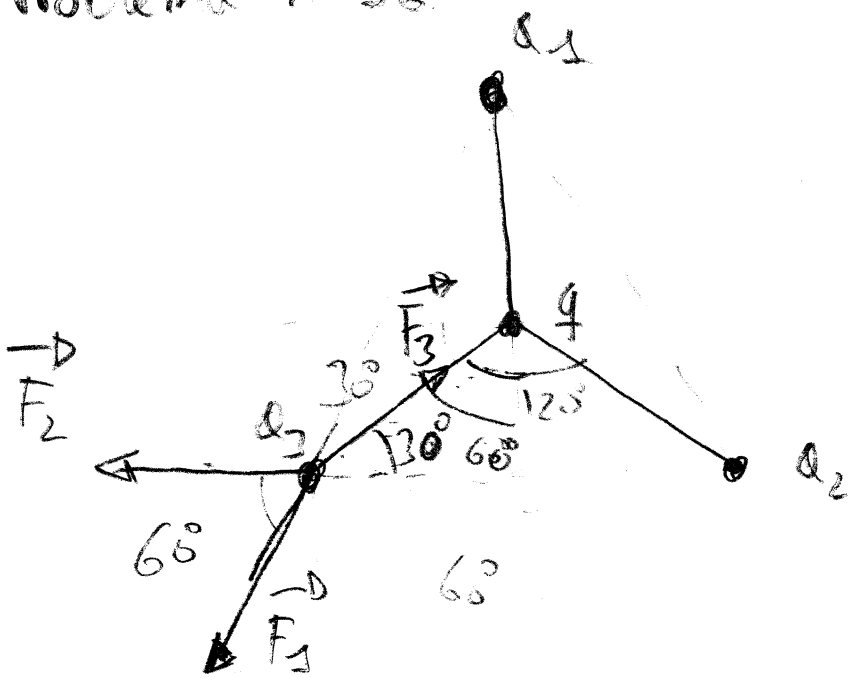
$(E_p)_D = (E_p)_F + (E_c)_F$

$V_D\ q' = V_F\ q' + \frac{1}{2} m v^2 \Rightarrow v^2 = \frac{[q'(V_D - V_F)]^2}{m}$

$v = 1'34\ m/s$

$\rightarrow Kg\ (S.I.)$

Problema nº 16



Si: q (+)

$$|\vec{F}_2| = |\vec{F}_1| = K\frac{Qq}{(3\sqrt{3})^2}$$

$$\vec{F}_2 = -K\frac{Qq}{(2\sqrt{3})^2}\,\vec{i}$$

$$(\vec{F}_1)_x = |F_1|\cdot\cos 60° \qquad (\vec{F}_1)_x = |\vec{F}_1|\cdot\frac{1}{2}$$

$$(\vec{F}_1)_y = |F_1|\cdot\operatorname{sen} 60° \qquad (\vec{F}_1)_y = |\vec{F}_1|\cdot\frac{\sqrt{3}}{2}$$

$$\vec{F}_1 = -K\frac{Qq}{(3\sqrt{3})^2}\cdot\frac{1}{2}\,\vec{i} - K\frac{Qq}{(2\sqrt{3})^2}\,\frac{\sqrt{3}}{2}\,\vec{j}$$

$$|\vec{F}_3| = K\frac{Q\cdot q}{(3)^2}$$

$$\vec{F}_3 = K\frac{Q\,q}{(3)^2}\,\frac{\sqrt{3}}{2}\,\vec{i} + K\frac{Q\,q}{(3)^2}\,\frac{1}{2}\,\vec{j}$$

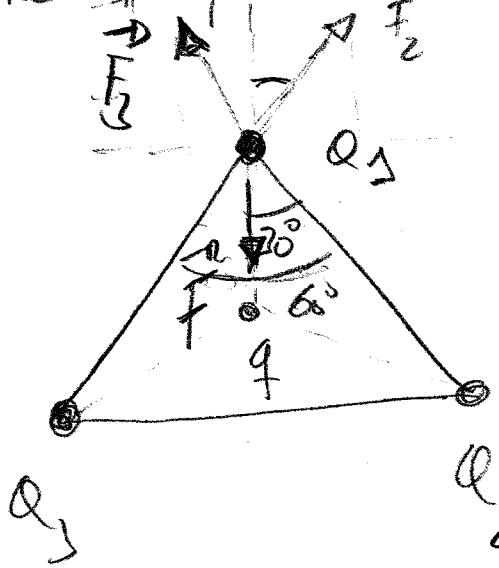
$(F_3)_y = (F_1)_y$

$K \frac{Q\,Q}{(3\sqrt{3})^2} \frac{\sqrt{3}}{2} = K \frac{Q \cdot q}{(3)^2} \frac{1}{2}$

$\frac{Q}{3^2 3} \sqrt{3} = \frac{q}{(3)^2} \Rightarrow Q = \frac{3}{\sqrt{3}} q$

$Q = \frac{3}{\sqrt{3}} 2 \cdot 10^{-3} C = 3{,}5 \cdot 10^{-3} C$

Na parte superior fazem podemos fazelo



	0°	30°	45°	60°	90°
Sen	$\frac{\sqrt{0}}{2}$	$\frac{\sqrt{1}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{4}}{2}$
Cos	$\frac{\sqrt{4}}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{1}}{2}$	$\frac{\sqrt{0}}{2}$

$K \frac{Q\,q}{(3)^2} = 2K \frac{Q \cdot Q}{(3\sqrt{3})^2} \frac{\sqrt{3}}{2}$; $\frac{q}{3^2} = \frac{Q\sqrt{3}}{3^2 3}$

$K \frac{Q \cdot q}{(3)^2} = 2K \frac{Q \cdot Q}{(3\sqrt{3})^2} \frac{\sqrt{3}}{2}$

$\frac{q}{(3)^2} = \frac{Q}{(3)^2 3} \sqrt{3} \Rightarrow Q = \frac{q\,3}{\sqrt{3}}$

$$V = 2k\frac{Q}{3\sqrt{3}} + k\frac{q}{3}$$

$$V = 9\cdot10^9 \frac{N\cdot m^2}{C^2}\left(\frac{2\cdot(-3'5\cdot10^{-3}C)}{3\sqrt{3}\ m} + \frac{2\cdot10^{-3}C}{3m}\right) = -6'12\cdot10^6 V$$

$$E_p = q\,V = (-3'5\cdot10^{-3}C)(-6'12\cdot10^6 V) = 2'14\cdot10^4 J$$

PROBLEMA Nº 17.-

Q? positiva?

$V = -100\,V$

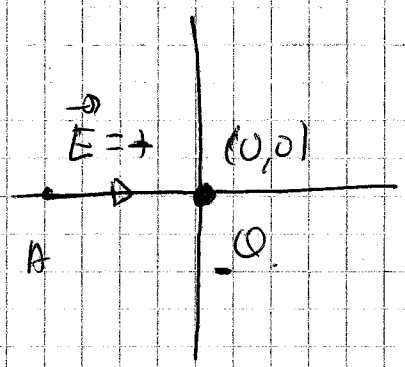
$\vec{E} = -10\,\hat{i}\ N/C$

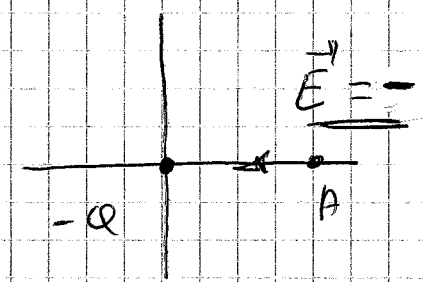
carga negativa

sobre o eixo X

$V = k\frac{Q}{r}$

$(-) = (-)\,Q(-)$





tomando só os valores

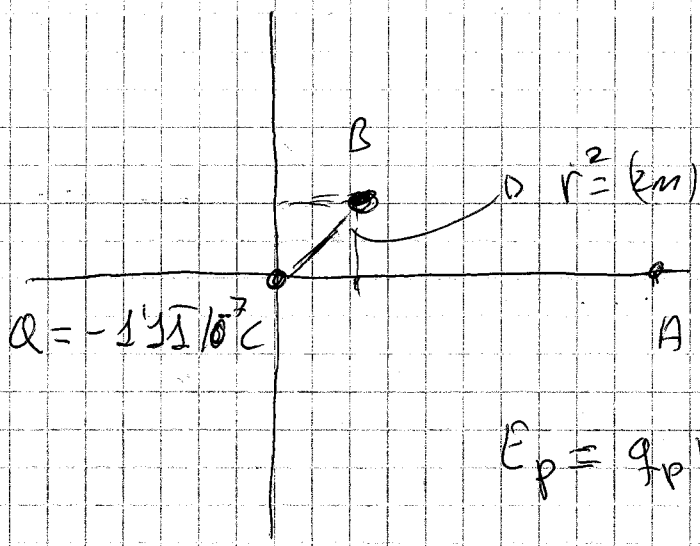
$$V = k\frac{Q}{r} \;;\; |\vec{E}| = k\frac{Q}{r^2} \Rightarrow k = \frac{V.r}{Q} \;;\; k = \frac{|\vec{E}|.r^2}{Q}$$

$$\frac{V.r}{Q} = \frac{|\vec{E}|.r^2}{Q} \Rightarrow r = \frac{V}{E} = \frac{100\,V}{10\,N/C} = 10\,m$$

$$V = k\frac{Q}{r} \Rightarrow Q = \frac{V.r}{k} = \frac{100\,V.10\,m}{9.10^9\,\frac{N.m^2}{C^2}} = 1'11\,10^{-7}\,C$$

$$\frac{\frac{J}{C}.m}{\frac{N.m^2}{C^2}} = \frac{\frac{N.m.m}{C}}{\frac{N.m^2}{C^2}} = m$$

(17 CONTINUACIÓN)



$r^2 = (2m)^2 + (2m)^2 = 8m^2$

$r = \sqrt{8}\ m = 2'83m$

$E_p = q_p V$

$$V_A = K\frac{(-1'11\cdot 10^{-7}C)}{10m} = -99'9\ J$$

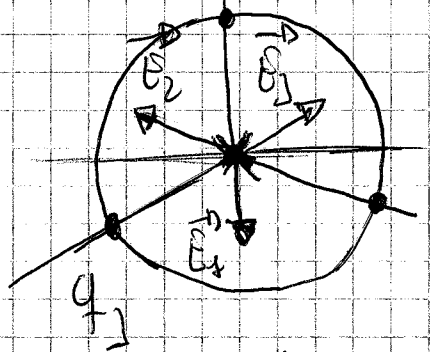
$$V_B = K\frac{(-1'11\cdot 10^{-7}C)}{2'83m} = -353'2\ J$$

$$W_{\infty}^{A} = -(E_{pA} - E_{p\infty}) = -q_p(V_A - V_\infty)$$

$$W_{\infty}^{A} = -1'6\cdot 10^{-19}C\left[(-99'9\ V - (-353'2\ V)\right] = -4'05\cdot 10^{-17}\ J$$

Problema N° 18.-

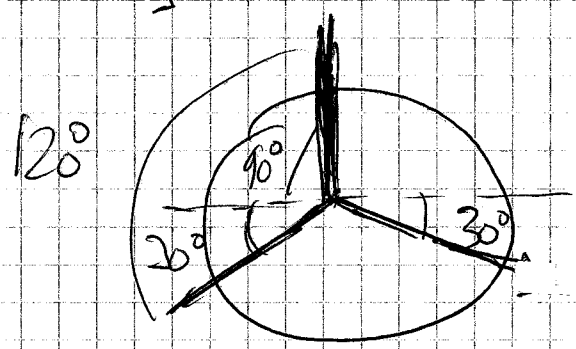
$q_1 = 3\cdot10^{-6}\,C$ $\quad r = 2\,m$

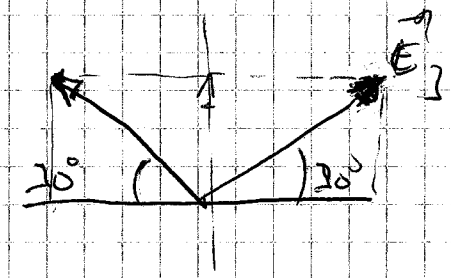


$$|\vec{E}_3| = |\vec{E}_2| = |\vec{E}_3| = 9\cdot10^9 \frac{N\cdot m^2}{C^2} \frac{3\cdot10^{-6}\,C}{(2m)^2}$$

$$= 6750\ N/C$$

b)





$$\text{Sen } 30° = \frac{(E_2)_y}{|\vec{E}_2|} \rightarrow (E_2)_y = |\vec{E}_2| \cdot \text{Sen } 30°$$

$$(E_2)_y = 6750\ N/C \cdot 0'5 = 3.375\ N/C$$

$$(E_2)_x = 6750\ N/C \cdot 0'87 = 5.873\ N/C$$

$$\vec{E}_2 = -5.873\,\vec{i} + 3.375\,\vec{j}\ (N/C)$$

$$\vec{E}_3 = 5.873\,\vec{i} + 3.375\,\vec{j}\ (N/C)$$

$$\vec{E}_A = -6.750\ N/C\ \vec{j}$$

$$\vec{E}_T = 0$$

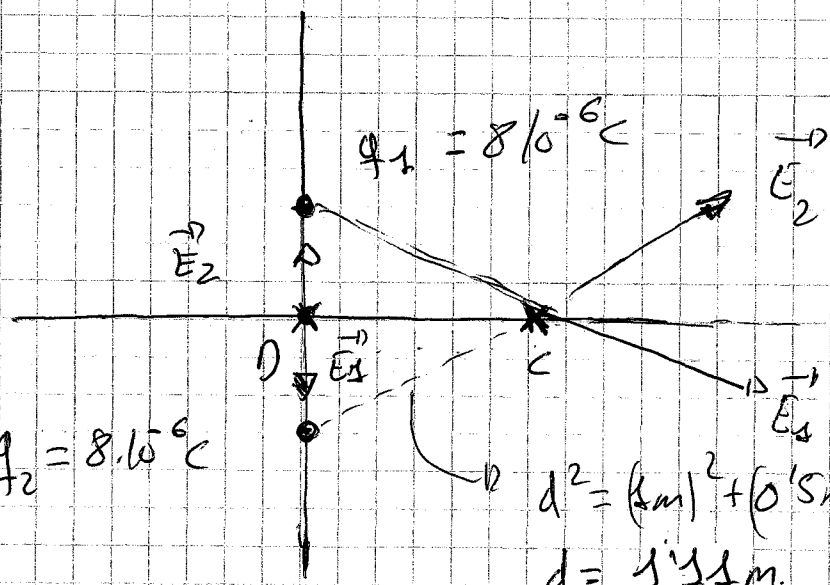
a) $$V = 3\,K\,\frac{q}{r} \Rightarrow V = 3.9\cdot10^9 \frac{N\cdot m^2}{C^2} \cdot \frac{3\cdot10^{-6}\,C}{2m} = 405\cdot10^4\,V$$

c) $$W_{\varphi}^{A} = -(E_{pA} - E_{p\infty}) = -405\cdot10^4\,V \cdot 10^{-6}\,C = -405\cdot10^{-2}\,J$$

($E_{p\infty} = 0$)

$$E_{pA} = V_A \cdot q'$$

PROBLEMA Nº 19.-



$d^2 = (1m)^2 + (0'5m)^2 = 1'25m^2$

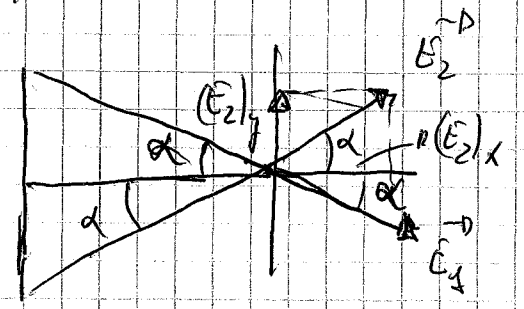
$d = 1'11m.$

a) ? b) ? $\vec{E}_C$? $\vec{E}_D$?

$\vec{E}_D = 0$

Calculo E_C ; $|\vec{E}_1| = |\vec{E}_2| = 9.10^9 \frac{Nm^2}{C^2} \frac{8\,10^{-6}C}{1'25m^2}$

$= 5'76.10^4\,N/C$



$\operatorname{sen}\alpha = \frac{0'5m}{1'11m} = 0'45$

$\cos\alpha = \frac{1m}{1'11m} = 0'89$

$\operatorname{sen}\alpha = \frac{(E_2)_y}{|\vec{E}_2|}$; $(E_2)_y = |\vec{E}_2| \cdot \operatorname{sen}\alpha$. $|(E_2)_x = |\vec{E}_2| \cos\alpha$

$(E_2)_y = 5'76.10^4\,N/C \cdot 0'45 = 2'59\,10^4\,N/C$

$(E_2)_x = 5'76.10^4\,N/C \cdot 0'89 = 5'19\,10^4\,N/C$

$\vec{E}_2 = 5'19\,10^4\,\vec{i} + 2'59\,10^4\,\vec{j}\ N/C$

$\vec{E}_1 = 5'19.10^4\,\vec{i} - 2'59\,10^4\,\vec{j}\ N/C$

$\Big\} \; \vec{E}_C = 10'38\,10^4\,\vec{i}\ N/C$

b) $V_C = (V_C)_1 + (V_C)_2 = 2\,k\,\frac{8\,10^{-6}C}{1'11m} = 1'30\,10^5\,V.$

$$V_D = (V_D)_1 + (V_D)_2 = 2K \frac{8\cdot10^{-6}C}{0'5m} = 2'88\cdot10^5 V$$

c) Energía C = Energía D

$$\frac{1}{2}mv_C^2 + E_{pC} = \frac{1}{2}mv_D^2 + E_{pD}$$

$$v_D^2 = \frac{2}{m}\left(\frac{1}{2}mv_C^2 + E_{pC} - E_{pD}\right)$$

$$E_{pC} = (E_{pC})_1 + (E_{pC})_2 = 2K\frac{q\cdot(-1\mu C)}{1'11m} = 2\cdot9\cdot10^9 \frac{Nm^2}{C^2}\frac{8\cdot10^{-6}C\cdot(-1\cdot10^{-6}C)}{1'11m}$$

$$E_{pC} = -0'120\,J$$

$$(E_p)_D = (E_{pD})_1 + (E_{pD})_2 = 2K\frac{q(-1\mu C)}{0'5m} = 2\cdot9\cdot10^9\frac{Nm^2}{C^2}\frac{8\cdot10^{-6}C(-1\cdot10^{-6}C)}{0'5m}$$

$$(E_p)_D = -0'288\,J$$

$$v_D^2 = \frac{2}{0'5\cdot10^{-3}Kg}\left[\frac{1}{2}0'5\cdot10^{-3}Kg\,(10^3 m/s)^2 + (-0'120J) - (-0'288\,J)\right]$$

$$v_D = 1000'31\ m/s$$