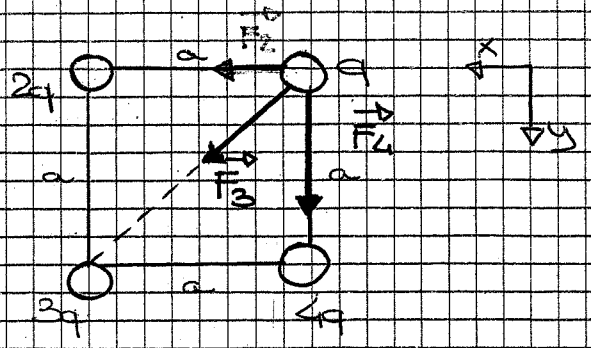
ESONIT ANGELOT CLASSE SECONDA



$|\vec{E}| = ?$

F_{TOT} su $q = ?$

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$E_{2x} = \frac{k_e \cdot 2q}{a^2}$ $\quad E_{2y} = 0$

$E_{4y} = \frac{k_e \cdot 4q}{a^2}$ $\quad E_{4x} = 0$

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$E_{3TOT} = \frac{k_e \cdot 3q}{(\sqrt{2}a)^2} = \frac{k_e \cdot 3q}{2a^2}$

$E_{3x} = \frac{k_e \cdot 3q}{2a^2} \cos 45° \quad E_{3y} = \frac{k_e \cdot 3q}{2a^2} \operatorname{sen} 45°$

$E_{3x} = \frac{k_e 3q}{2a^2} \cdot \frac{\sqrt{2}}{2} = \frac{3\sqrt{2} k_e q}{4a^2} \quad E_{3y} = \frac{k_e \cdot 3q}{2a^2} \cdot \frac{\sqrt{2}}{2} = \frac{3\sqrt{2} k_e \cdot q}{4a^2}$

$E_{XTOT} = E_{2x} + E_{3x} + E_{4x} = \frac{2 k_e q}{a^2} + \frac{3\sqrt{2} k_e q}{4a^2} + 0 = \frac{8 k_e q + 3\sqrt{2} k_e q}{4a^2}$

$E_{XTOT} = \frac{k_e q (8 + 3\sqrt{2})}{4a^2}$

$E_{YTOT} = E_{2y} + E_{3y} + E_{4y} = 0 + \frac{3\sqrt{2} k_e q}{4a^2} + \frac{4 k_e \cdot q}{a^2} = \frac{3\sqrt{2} k_e q + 16 k_e q}{4a^2}$

$E_{YTOT} = \frac{k_e q (16 + 3\sqrt{2})}{4a^2}$

$E_{TOT} = \sqrt{E_{XTOT}^2 + E_{YTOT}^2}$

$E_{TOT} = \sqrt{\frac{k_e^2 q^2 (8 + 3\sqrt{2})^2}{16a^4} + \frac{k_e^2 q^2 (16 + 3\sqrt{2})^2}{16a^4}} = \sqrt{\frac{k_e^2 q^2}{16a^4} \left[(8 + 3\sqrt{2})^2 + (16 + 3\sqrt{2})^2 \right]}$

$E_{TOT} = \frac{k_e q}{4a^2} \sqrt{(8 + 3\sqrt{2})^2 + (16 + 3\sqrt{2})^2} = \frac{k_e q}{4a^2} \sqrt{64 + 48\sqrt{2} + 18 + 256 + 96\sqrt{2} + 18}$

$E_{TOT} = \frac{k_e q}{4a^2} \sqrt{356 + 144\sqrt{2}}$ oppure $E_{TOT} = E_X \vec{i} + E_Y \vec{j}$

$E_{TOT} = \frac{k_e q (8 + 3\sqrt{2})}{4a^2} \vec{i} + \frac{k_e q (16 + 3\sqrt{2})}{4a^2} \vec{j}$

$F_{2x} = \frac{k_e e \cdot 2q^2}{a^2}$ $F_{2y} = 0$

$F_{4x} = 0$ $F_{4y} = \frac{k_e e \cdot 4q^2}{a^2}$

$F_{3x} = \frac{k_e e \cdot 3q^2}{2a^2} \cos(45°)$ $F_{3y} = \frac{k_e e \cdot 3q^2}{2a^2} \operatorname{sen}(45°)$

$F_{3x} = \frac{k_e e \cdot 3q^2}{2a^2} \frac{\sqrt{2}}{2}$ $F_{3y} = \frac{k_e e \cdot 3q^2}{2a^2} \frac{\sqrt{2}}{2}$

$F_{3x} = \frac{3\sqrt{2}}{4} \frac{k_e e q^2}{a^2}$ $F_{3y} = \frac{3\sqrt{2}}{4} \frac{k_e e q^2}{a^2}$

$F_{xTOT} = F_{2x} + F_{3x} + F_{4x} = \frac{k_e e \cdot 2q^2}{a^2} + \frac{3\sqrt{2}}{4} \frac{k_e e q^2}{a^2} + 0 = \frac{k_e e q^2 (8+3\sqrt{2})}{4a^2}$

$F_{yTOT} = F_{2y} + F_{3y} + F_{4y} = 0 + \frac{3\sqrt{2}}{4} \frac{k_e e q^2}{a^2} + 1 \frac{k_e e q^2}{a^2} = \frac{k_e e q^2 (16+3\sqrt{2})}{4a^2}$

$F_{TOT} = \sqrt{F_{xTOT}^2 + F_{yTOT}^2} = \sqrt{\frac{k_e^2 e^2 q^4 (8+3\sqrt{2})^2}{16a^4} + \frac{k_e^2 e^2 q^4 (16+3\sqrt{2})^2}{16a^4}}$

$F_{TOT} = \sqrt{\frac{k_e^2 e^2 q^4}{16a^4} \left[(8+3\sqrt{2})^2 + (16+3\sqrt{2})^2 \right]} = \frac{k_e e q^2}{4a^2} \sqrt{(8+3\sqrt{2})^2 + (16+3\sqrt{2})^2}$

$F_{TOT} = \frac{k_e e q^2}{4a^2} \sqrt{356 + 144\sqrt{2}}$ oppure $F_{TOT} = F_x \hat{i} + F_y \hat{j}$

$F_{TOT} = \frac{k_e e q^2 (8+3\sqrt{2})}{4a^2} \hat{i} + \frac{k_e e q^2 (16+3\sqrt{2})}{4a^2} \hat{j}$

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$|\vec{E}| = 640 \text{ N/C}$

$v(t) = 1{,}20 \text{ Mm/s} = 1{,}20 \cdot 10^6 \text{ m/s}$

$a = ?$

$\Delta t = ?$

$\Delta x = ?$

$E_c(t) = ?$



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L'unica forza che agisce sul protone è la forza elettrica che accelera le protone, quindi scrivendo l'equazione della forza si ha:

$F_{ee} = ma$

$a = \frac{F_{ee}}{m}$ $a = \frac{E_{ee} \cdot q_e}{m}$

$a = \frac{640 \cdot 1{,}602 \cdot 10^{-19}}{1{,}673 \cdot 10^{-27}} \text{ m/s}^2 = 613 \cdot 10^8 \text{ m/s}^2 = 61{,}3 \cdot 10^9 \text{ m/s}^2$

Il moto dell'protone è un moto uniformemente accelerato, in quanto il campo elettrico è uniforme quindi vanno bene le leggi del moto uniformemente accelerato sia:

$$a = \frac{V}{L}$$ (assumo come istante $t=0$ l'istante in cui il protone inizia a muoversi dall'interno della lamina)

$$t = \frac{V}{a} \qquad t = \frac{1,20 \cdot 10^{6}}{613 \cdot 10^{8}}\ s = 0,00196 \cdot 10^{-2}\ s = 1,96 \cdot 10^{-5}\ s$$

$$x(t) = x(0) + v_x(0)\,t + \frac{1}{2}a_x t^2$$ assumendo che l'origine nel punto di partenza del protone sia:

$$x(t) = \frac{1}{2}a_x t^2 \qquad x(t) = \frac{1}{2} \cdot 613 \cdot 10^{8} \cdot (1,96)^2 \cdot 10^{-10}\ m = 1177 \cdot 10^{-2}\ m = 11,77\ m$$

Per calcolare l'energia cinetica all'istante t, uheiTeo il teorema delle forze vive per cui:

$$L_{TOT} = \Delta K$$

$$F_{EL}\,\Delta x = \Delta K$$

$$\Delta K = F_{EL} \cdot q_P \cdot \Delta x$$

$$\Delta K = 640 \cdot 1,602 \cdot 10^{-19} \cdot 11,77\ J = 12068 \cdot 10^{-19}\ J$$

$$\Delta K = 1,2068 \cdot 10^{-15}\ J$$

oppure

$$\Delta K = \frac{1}{2} m v(t)^2$$

$$\Delta K = \frac{1}{2} \cdot 1,673 \cdot 10^{-27} \cdot (1,20)^2 \cdot 10^{12}\ J = 1,2068 \cdot 10^{-15}\ J$$

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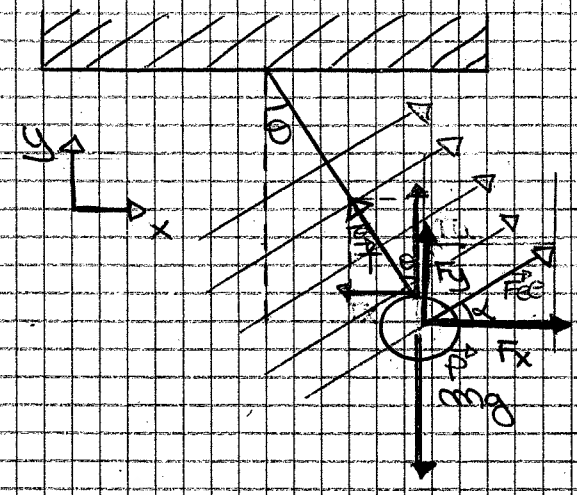
$m_{pallina} = 1{,}00 \cdot 10^{-3}\ kg$

$\vec{E} = (3{,}00\hat{i} + 5{,}00\hat{j}) \cdot 10^5\ N/C$

$\theta = 37°$

$q = ?$

$T = ?$



Per calcolare la carica q della pallina, essendo all'equilibrio scrivo le equazioni della forza lungo gli assi x e y:

$$\begin{cases} x: -T\sin\theta + F_{ec}\cos\alpha = 0 \\ y: T\cos\theta + F_{ec}\sin\alpha - mg = 0 \end{cases} \quad da\ cui\ \alpha = \arctan\frac{E_y}{E_x}$$

$$\begin{cases} x: F_{ec}\cos\alpha = T\sin\theta \\ y: T\cos\theta + F_{ec}\sin\alpha - mg = 0 \end{cases}$$

$$F_{ec} = \frac{T\sin\theta}{\cos\alpha}$$

$$T\cos\theta + \frac{T\sin\theta}{\cos\alpha}\sin\alpha - mg = 0$$

$$T\cos\theta + T\sin\theta\tan\alpha - mg = 0$$

$$T(\cos\theta + \sin\theta\tan\alpha) = mg$$

$$T = \frac{mg}{\cos\theta + \sin\theta\tan\alpha} \qquad \alpha = \arctan\frac{E_y}{E_x} \qquad T = \frac{1 \cdot 10^{-3} \cdot 9{,}81}{\cos(37°) + \sin(37°)\frac{5{,}00}{3{,}00}} N = 5{,}44 \cdot 10^{-3}\ N$$

Per calcolare la carica q della pallina, il campo elettrico:

$$E_{TOT} = \sqrt{E_x^2 + E_y^2} \qquad E_{TOT} = \sqrt{9{,}00 \cdot 10^{10} + 25{,}00 \cdot 10^{10}}\ \frac{N}{C} = \sqrt{34} \cdot 10^5\ \frac{N}{C}$$

$$E_{TOT} = 5{,}831 \cdot 10^5\ \frac{N}{C}$$

$$E_{TOT} = \frac{F_{ec}}{q} \qquad q = \frac{F_{ec}}{E_{TOT}}$$

$$F_{ec} = \frac{T\sin\theta}{\cos\alpha} \qquad q = \frac{\frac{T\sin\theta}{\cos\alpha}}{E_{TOT}} = \frac{T\sin\theta}{\cos\alpha E_{TOT}}$$

$$q = \frac{5{,}44 \cdot 10^{-3}\sin(37°)}{\cos(\arctan(\frac{5}{3}))5{,}831 \cdot 10^5}\ C = 1{,}091 \cdot 10^{-8}\ C = 10{,}91 \cdot 10^{-9}\ C$$

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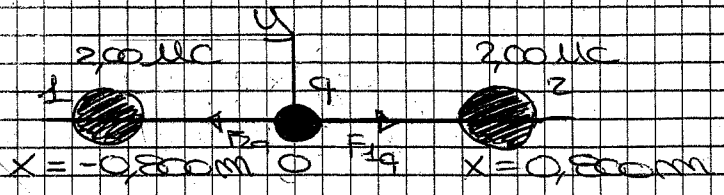
$q_1 = q_2 = 2{,}00\,\mu C = 2{,}00 \cdot 10^{-6} C$

$q = 1{,}28 \cdot 10^{-18} C$

$\vec{F}_{TOT\,su\,q} = ?$

$\vec{E} = ?$

$V(0) = ?$



$F_{1q} = \frac{k_e C q q_1}{r^2}$

$F_{2q} = -\frac{k_e C q q_2}{r^2}$ dato $q_1 = q_2$

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Quindi

$F_{TOT} = \frac{k_e C q Q}{r^2} - \frac{k_e C q Q}{r^2} = 0\,N$

Calcolo il campo elettrico totale prodotto dalle due cariche rispettivamente

$E_{1q} = \frac{k_e C Q}{r^2}$

$E_{2q} = \frac{k_e C Q}{r^2}$

$E_{TOT} = \frac{k_e C Q}{r^2} - \frac{k_e C Q}{r^2} = 0\,\frac{N}{C}$ oppure $E_{TOT} = \frac{F_{TOT}}{q C} \quad E_{TOT} = 0\,\frac{N}{C}$

$V_{TOT} = V_1 + V_2$

$V_1 = \frac{k_e C Q_1}{r}$ $\quad V_2 = \frac{k_e C Q_2}{r}$ dato $Q_1 = Q_2$

quindi:

$V_{TOT} = \frac{2 k_e C Q}{r}$ $\quad V_{TOT} = \frac{2 \cdot 8{,}98 \cdot 10^9 \cdot 2 \cdot 10^{-6}}{0{,}800}\,V = 44{,}938 \cdot 10^3\,V$

$V_{TOT} = 44{,}9 \cdot 10^3\,V$