

task_5u1zbroaz75w39jk_with_calculation

Student Group

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electrostatic, field lines, exam ee2 SS2024

Exercise E2 Electrostatics I

(written test, approx. 8 % of a 120-minute written test, SS2024)

2. What has been given to you? The charges are $q_1 = 1 \text{ nC}$, $q_2 = 1 \text{ nC}$, $q_0 = 1 \text{ nC}$, $q_4 = 1 \text{ nC}$. Which value needs E_4 to have to get a resulting force of 0 N on q_0 ?

Path: $q_0 = 1 \text{ nC}$

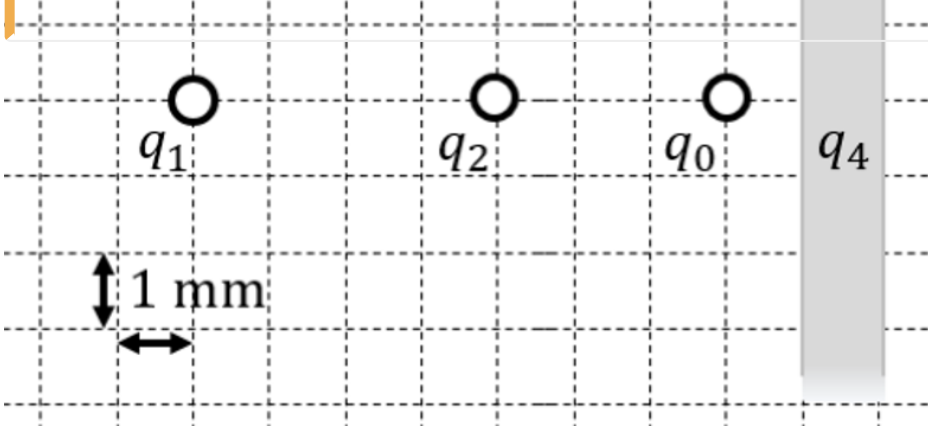
- $q_1 = 5 \text{ nC}$

Path: $E_4 = 907 \text{ (from N/C)}$

- $\vec{F}_{01} = \left(\begin{array}{c} 0 \\ 0 \\ 0 \end{array} \right) + 917 \cdot 10^{-6} \text{ N}$

In the x -direction, the force components are $F_{01} = 917 \cdot 10^{-6} \text{ N}$. The force F_{02} is $F_{02} = \frac{1}{4\pi\epsilon_0} \frac{q_0 q_2}{r_{02}^2} = 917 \cdot 10^{-6} \text{ N}$. In the y -direction, the force components are $F_{02} = 917 \cdot 10^{-6} \text{ N}$. Here, the field has to compensate the force \vec{F}_{01} from q_1 on q_0 :

$$|\vec{F}_{01}| = |E_4| \cdot |q_0| \Rightarrow \frac{|\vec{F}_{01}|}{|q_0|} = |E_4| \Rightarrow \frac{917 \cdot 10^{-6} \text{ N}}{1 \cdot 10^{-9} \text{ C}} = 917 \cdot 10^3 \frac{\text{V}}{\text{m}} = 917 \cdot 10^3 \frac{\text{V}}{\text{m}}$$



1. Calculate the single forces \vec{F}_{01} , \vec{F}_{02} , \vec{F}_{03} , on the charge q_0 !

Path

First, set up a coordinate system. Here, I choose x pointing to the right (positive values to the right) and y pointing upwards (positive values upwards).
Then, calculate the magnitude of the forces, like \vec{F}_{01} (force on q_0 from q_1).
The force \vec{F}_{01} is purely on the x -axis and therefore equal to

$$F_{01,x} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 \cdot q_0}{r_{01}^2} = \frac{1}{4\pi \cdot 8.854 \cdot 10^{-12} \cdot (7 \cdot 10^{-3})^2} = 917.4 \cdot 10^{-6} \frac{(As)^2 \cdot Vm}{As \cdot m^2} = 917.4 \cdot 10^{-6} \frac{VAs}{m} = 917.4 \cdot 10^{-6} \frac{Ws}{m} = +917.4 \mu N$$
 Since both q_0 and q_1 have the same sign for their charges, they are repelling each other. Therefore, The force \vec{F}_{01} points to the right (positive value).

Similarly, we get for \vec{F}_{02} and \vec{F}_{03}

$$\vec{F}_{02} = F_{02,x} = -1997.4 \mu N \quad \vec{F}_{03} = F_{03,y} = -1123.4 \mu N$$
 Since q_0 and q_2 have the different sign for their charges, they are attract each other. Therefore, The force \vec{F}_{02} points to the left (negative value).
 Since q_0 and q_3 have the different sign for their charges, they are attract each other. Therefore, The force \vec{F}_{03} points downwards (negative value).

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