

task_5u1zbroaz75w39jk_with_calculation

Student Group

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electrostatic, field lines, exam ee2 SS2024

Exercise E1 Electrostatics I

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

2. Which value needs E_4 to have to get a resulting force of 0 N on q_0 ?

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

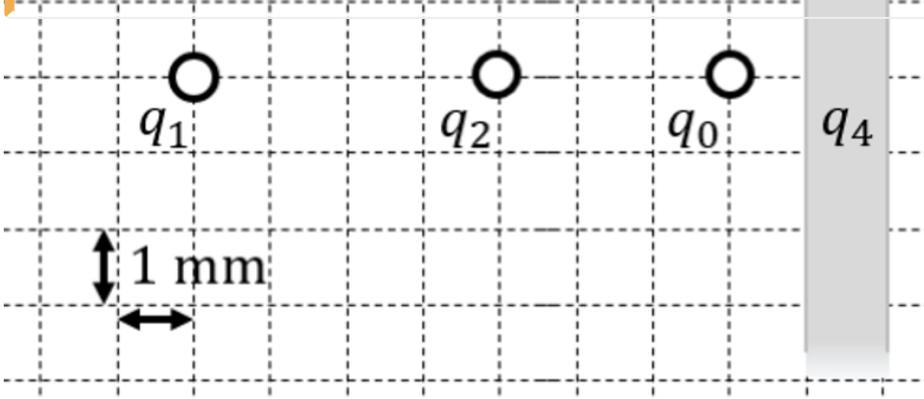
- $q_1 = -5 \text{ nC}$

Path: $E_4 = 907 \text{ (from 100 N/C)}$

- $\vec{F}_{01} = \left(\begin{array}{c} 917 \\ 0 \\ 0 \end{array} \right) \text{ (in } \mu\text{N)}$

In the x -direction, the force components are $F_{01,x}$. We can calculate the magnitude of the force F_{01} by using the formula $F = k \cdot \frac{q_1 \cdot q_0}{r^2}$. The permittivity ϵ_0 is $8.854 \cdot 10^{-12} \text{ As/Vm}$. In the x -direction, the force is $F_{01,x} = F_{01} \cdot \cos(\theta)$. Here, the force is purely in the x -direction, so $\cos(\theta) = 1$. The force F_{01} is $917 \text{ (in } \mu\text{N)}$.

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



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

Path

First, calculate the magnitude of the forces, like \vec{F}_{01} .

The force \vec{F}_{01} is purely on the x -axis and therefore equal to $F_{01,x}$.

$$\begin{aligned} \vec{F}_{01} &= F_{01,x} \cdot \hat{x} \\ &= \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 \cdot q_0}{r_{01}^2} \\ &= \frac{1}{4\pi \cdot 8.854 \cdot 10^{-12} \text{ As/Vm}} \cdot \frac{1 \cdot 10^{-9} \text{ C} \cdot 5 \cdot 10^{-9} \text{ C}}{(7 \cdot 10^{-3} \text{ m})^2} \end{aligned}$$

$$917. \cdot 10^{-6} \frac{\text{As}^2 \cdot \text{Vm}}{\text{As} \cdot \text{m}^2} = 917. \cdot 10^{-6} \frac{\text{VAs}}{\text{m}} = 917. \cdot 10^{-6} \frac{\text{Ws}}{\text{m}} \quad \&= 917. \cdot 10^{-6} \mu\text{N} \quad \text{(to the right)}$$

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

$$\vec{F}_{02} = F_{02,x} \quad \&= -1997. \cdot 10^{-6} \mu\text{N} \quad \text{(to the right)}$$

$$\vec{F}_{03} = F_{03,y} \quad \&= -1123. \cdot 10^{-6} \mu\text{N} \quad \text{(to the top)}$$

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