task_dtoqvpvrbdtcozfk_with_calculation

Student Group

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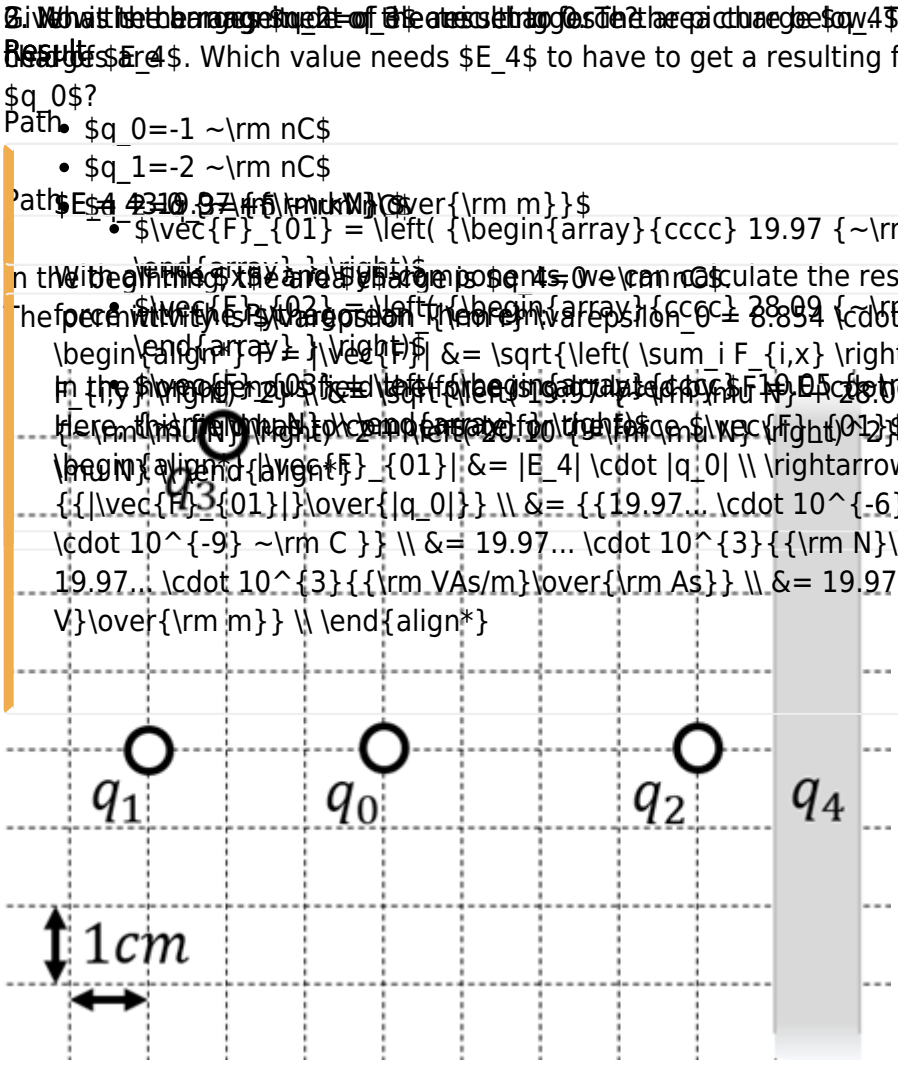
electrostatic, field lines, exam ee2 SS2022

Exercise E1 Electrostatics I
(written test, approx. 10 % of a 120-minute written test, SS2022)



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{align*} \vec{F}_{01} = F_{01,x} &= {{1}\over{4\pi\varepsilon}}\cdot {{q_1\cdot q_0}\over{r^2_{01}}} \\ &= {{1}\over{4\pi\cdot 8.854 \cdot 10^{-12} ~\rm As/Vm}}\cdot {{1 \cdot 10^{-9} ~\rm C \cdot 2 \cdot 10^{-9} ~\rm C}\over{(3 \cdot 10^{-2} ~\rm m)^2}} \\ &= 19.97... \cdot 10^{-6} {\rm {{(As)^2 \cdot Vm}\over{As \cdot m^2}}} = 19.97...

\cdot 10^{-6} {\rm {{VAs}\over{m}}} = 19.97... \cdot 10^{-6} {\rm {{Ws}\over{m}}} \\ &= 19.97... {\rm \mu N} \quad \text{(to the right)} \end{align*}

Similarly, we get for $\vec{F}_{02}$ and $\vec{F}_{03}$ \begin{align*} \vec{F}_{02} = F_{02,x} &= -28.09... {\rm \mu N} \quad \text{(to the right)} \\ \vec{F}_{03} &= -22.47... {\rm \mu N} \quad \text{(to the top left)} \\ \end{align*}

For $\vec{F}_{03}$, we have to calculate the x- and y-component.
This is possible, by using the angle α between the line through q_0 and q_3 and the positive x-axis (pointing to the right).
So, α has to be between $90°$ and $180°$. It can be calculated by: \begin{align*} \alpha = \arctan(\rm {{-4~cm}\over{+2~cm}}) = \pi - 1.1071... = 180° - 63.4...° = 116.6...° \end{align*}

Based on this, the x- and y-component is: \begin{align*} F_{03,x} &= |\vec{F}_{03}| \cdot \cos \alpha = 10.05... {~\rm \mu N} \text{(to the left)} \\ F_{03,y} &= |\vec{F}_{03}| \cdot \sin \alpha = 20.10... {~\rm \mu N} \text{(to the top)} \\ \end{align*}