

task_dtoqvpvrbdtdcozfk_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)

2. What will be the magnitude of the electric force on the charge q_4 ? The values of the point charges are $q_1 = 4 \text{ nC}$, $q_2 = 1 \text{ nC}$, $q_3 = 1 \text{ nC}$, and $q_4 = 4 \text{ nC}$. Which value needs E_4 to have to get a resulting force of 0 N on q_4 ?

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

- $q_1 = -2 \text{ nC}$

$$\text{path} \$Es_4 \frac{4310.97}{\sqrt{m}} \ln \left(\frac{\sqrt{m} M}{C_{\text{over}}} \right) \sqrt{m}$$

- $\vec{F}_{01} = \left(\begin{array}{ccc} 19.97 & \sim \text{rm } \mu \text{N} & \parallel 0 \parallel \end{array} \right)$

With `vecnorm` and `sqrt` components, we can calculate the resulting magnitude of the

the per-unit volume is $\Delta \rho_{\text{repsol}} = \rho_{\text{repsol}} - \rho_{\text{begin}} = 0.854 \text{ g/cm}^3$ and the resulting magnitude of the

$$\|\vec{F}\| = \sqrt{\left(\sum_i F_{i,x}\right)^2 + \left(\sum_i F_{i,y}\right)^2}$$

[illegible]

Here, this finding has to be done for the first time. The results of the study are as follows:

$$\{01\} \mid \&= |E| \cdot |q| \mid \rightarrow E \&=$$

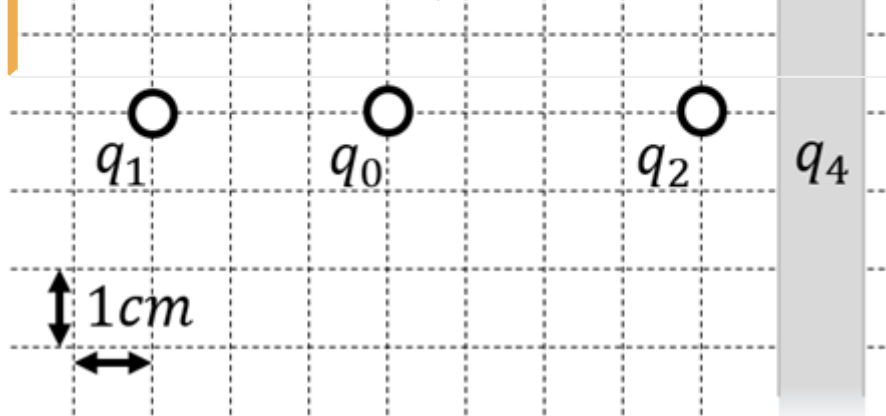
$$\frac{1}{\sqrt{10}} \left(\frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ 1 \end{pmatrix} \otimes \begin{pmatrix} 1 \\ 1 \end{pmatrix} + \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ -1 \end{pmatrix} \otimes \begin{pmatrix} 1 \\ -1 \end{pmatrix} \right)$$

$$\frac{\|\vec{v}_1\|_{\infty}}{\|\vec{v}_1\|_2} = \frac{1}{\sqrt{2}} \approx 0.7071$$

$$\langle \dot{\rho} \rangle \cdot 10^{-9} \sim \langle \dot{\rho} \rangle \cdot 10^{-9} \sim 19.9 / \dots \langle \dot{\rho} \rangle \cdot 10^{-9} \sim \langle \dot{\rho} \rangle \cdot 10^{-9} \sim 19.9 / \dots \langle \dot{\rho} \rangle \cdot 10^{-9} \sim \langle \dot{\rho} \rangle \cdot 10^{-9} \sim 19.9 / \dots$$

$$19.97... \cdot 10^3 \frac{\text{VAs/m}}{\text{As}} \quad \parallel \quad = 19.97... \cdot 10^3 \frac{\text{VAs/m}}{\text{As}}$$

$$V\}\over{\rm m}\}\ \backslash\ \backslash\end{align*}$$



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 $|\vec{F}_1|$.

The force $\vec{F}$ is purely on the x -axis and therefore equal to

$$\vec{F} \{01,x\} = F \{01,x\}$$

$$\frac{\{1\}}{4\pi\epsilon}\cdot\{q_1\cdot q_0\}^{r^2\{0\}} \quad \&=$$

$$\frac{\{1\}}{\{4\pi\}} \cdot 8.854 \cdot 10^{-12} \sim \text{As/Vm} \} \cdot \{1 \cdot 10^{-9}$$

$$\frac{\{1\} \over \{4\} \pi \cdot 8.854 \cdot 10^{-12} \sim \{m\} \text{As} \{m\}}{\{1\} \cdot 10^{-9} \sim \{m\} \text{C} \cdot 2 \cdot 10^{-9} \sim \{m\} \text{C} \over \{3 \cdot 10^{-2} \sim \{m\} \text{m}\}^2}} \quad \&=$$

$$\frac{\rho_{\text{C}} \cdot Z \cdot 10^{-9}}{\rho_{\text{C}} \cdot \frac{(3 \cdot 10^{-2})^2}{Z}} \approx 19.97 \dots \cdot 10^{-6} \text{ } \frac{\text{As}^2 \cdot \text{Vm}}{\text{As} \cdot \text{m}^2} = 19.97 \dots$$

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

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

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:

$\begin{align*} \alpha = \arctan\left(\frac{-4\text{ cm}}{+2\text{ cm}}\right) = \pi - 1.1071... = 180^\circ - 63.4...^\circ = 116.6...^\circ \end{align*}$

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

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