

# task\_dtoqvpvrbdtozfk\_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 has been given to you? The charges are \$q\_1 = 1 \text{ nC}\$, \$q\_2 = 2 \text{ nC}\$, \$q\_3 = 3 \text{ nC}\$, \$q\_4 = 4 \text{ nC}\$. The value of the point charge \$q\_0\$ is \$-1 \text{ nC}\$. Which value needs \$E\_4\$ to have to get a resulting force of \$0 \text{ N}\$ on \$q\_0\$?

Path: \$q\_0 = -1 \text{ nC}\$

- \$q\_1 = 2 \text{ nC}\$

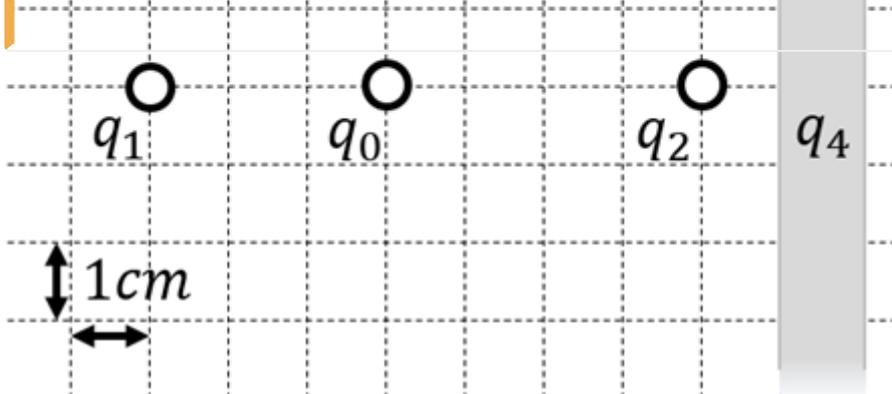
Path: \$E\_4 = 2310.97 \text{ (nN/m)}\$

- \$\vec{F}\_{01} = \left( \begin{array}{c} 19.97 \\ 0 \\ 0 \end{array} \right) \text{ (nN)}\$

In the end, the same force components, we can calculate the resulting magnitude of the force \$F\_0 = \sqrt{F\_{01}^2 + F\_{02}^2 + F\_{03}^2} = 38.94 \text{ (nN)}\$

$$|\vec{F}_0| = \sqrt{\left( \sum_i F_{i,x} \right)^2 + \left( \sum_i F_{i,y} \right)^2} = \sqrt{19.97^2 + 0^2 + 0^2} = 19.97 \text{ (nN)}$$

$$F_0 = 19.97 \text{ (nN)}$$



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

$$F_{01,x} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 \cdot q_0}{r_{01}^2} =$$

$$\frac{1}{4\pi \cdot 8.854 \cdot 10^{-12} \text{ (As/Vm)}} \cdot \frac{1 \cdot 1 \cdot 10^{-9} \text{ (nC)}^2}{(3 \cdot 10^{-2} \text{ (m)})^2} =$$

$$19.97 \dots \cdot 10^{-6} \text{ (N)} = 19.97 \dots \text{ (nN)}$$

$\cdot 10^{-6} \left\{ \frac{VAs}{m} \right\} = 19.97... \cdot 10^{-6} \left\{ \frac{Ws}{m} \right\} \quad \&= 19.97... \left\{ \mu N \right\} \quad \text{(to the right)}$

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

$$\vec{F}_{02} = F_{02,x} \quad \&= -28.09... \left\{ \mu N \right\} \quad \text{(to the right)}$$

$$\vec{F}_{03} \quad \&= -22.47... \left\{ \mu N \right\} \quad \text{(to the top left)}$$

For  $\vec{F}_{03}$ , we have to calculate the  $x$ - and  $y$ -component.

This is possible, by using the angle  $\alpha$  between the line through  $q_0$  and  $q_3$  and the positive  $x$ -axis (pointing to the right).

So,  $\alpha$  has to be between  $90^\circ$  and  $180^\circ$ . It can be calculated by:

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

Based on this, the  $x$ - and  $y$ -component is:

$$F_{03,x} \quad \&= |\vec{F}_{03}| \cdot \cos \alpha = 10.05... \left\{ \mu N \right\} \quad \text{(to the left)}$$

$$F_{03,y} \quad \&= |\vec{F}_{03}| \cdot \sin \alpha = 20.10... \left\{ \mu N \right\} \quad \text{(to the top)}$$

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