

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)

5. Which two charges are placed on the horizontal axis at the positions shown in the picture below. The values of the point charges are $q_1 = -1 \text{ nC}$ and $q_2 = -5 \text{ nC}$. 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: $E_4 = 917 \text{ V/m}$

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

In the beginning, the same problem is given, we can calculate the resulting magnitude of the force F_{01} by using the formula $F = k \cdot \frac{q_1 \cdot q_2}{r^2}$ with $k = 8.99 \cdot 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$.

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

In the same way, we can calculate the force F_{02} by using the formula $F = k \cdot \frac{q_1 \cdot q_2}{r^2}$ with $k = 8.99 \cdot 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$.

Here, the field lines are shown, and the force $\vec{F}_{01}$ is from q_1 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{02}$ is from q_2 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{03}$ is from q_0 to q_4 .

Then, the field lines are shown, and the force $\vec{F}_{04}$ is from q_4 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{05}$ is from q_5 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{06}$ is from q_6 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{07}$ is from q_7 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{08}$ is from q_8 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{09}$ is from q_9 to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{10}$ is from q_{10} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{11}$ is from q_{11} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{12}$ is from q_{12} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{13}$ is from q_{13} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{14}$ is from q_{14} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{15}$ is from q_{15} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{16}$ is from q_{16} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{17}$ is from q_{17} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{18}$ is from q_{18} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{19}$ is from q_{19} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{20}$ is from q_{20} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{21}$ is from q_{21} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{22}$ is from q_{22} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{23}$ is from q_{23} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{24}$ is from q_{24} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{25}$ is from q_{25} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{26}$ is from q_{26} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{27}$ is from q_{27} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{28}$ is from q_{28} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{29}$ is from q_{29} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{30}$ is from q_{30} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{31}$ is from q_{31} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{32}$ is from q_{32} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{33}$ is from q_{33} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{34}$ is from q_{34} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{35}$ is from q_{35} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{36}$ is from q_{36} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{37}$ is from q_{37} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{38}$ is from q_{38} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{39}$ is from q_{39} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{40}$ is from q_{40} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{41}$ is from q_{41} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{42}$ is from q_{42} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{43}$ is from q_{43} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{44}$ is from q_{44} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{45}$ is from q_{45} to q_0 .

Then, the field lines are shown, and the force $\vec{F}_{46}$ is from q_{46} to q_0 .

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

$$F_{01,x} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 \cdot q_0}{r_{01}^2} = \frac{1}{4\pi \cdot 8.854 \cdot 10^{-12} \cdot \sim \text{As/Vm}} \cdot \frac{1 \cdot 10^{-9} \cdot \sim \text{C} \cdot 5 \cdot 10^{-9} \cdot \sim \text{C}}{(7 \cdot 10^{-3} \cdot \sim \text{m})^2} = 917. \cdot 10^{-6} \cdot \frac{(As)^2 \cdot Vm}{As \cdot m^2} = 917. \cdot 10^{-6} \cdot \frac{VAs}{m} = 917. \cdot 10^{-6} \cdot \frac{Ws}{m} = +917. \cdot 10^{-6} \cdot \mu N$$
 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 $\vec{F}_{03}$

$$\vec{F}_{02} = F_{02,x} = -1997. \cdot 10^{-6} \cdot \mu N$$

$$\vec{F}_{03} = F_{03,y} = -1123. \cdot 10^{-6} \cdot \mu N$$
 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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