

task_1.1.3_with_calc

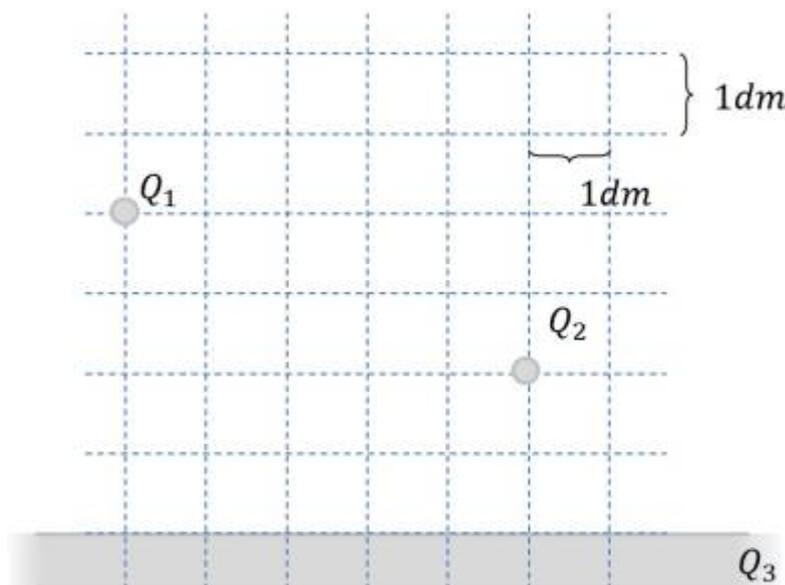
Student Group

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Task 1.1.3 Forces on Charges (exam task, ca 8% of a 60 minute exam, WS2020)



Given is an arrangement of electric charges located in a vacuum (see picture on the right).

The charges have the following values:

$Q_1 = 7 \mu\text{C}$ (point charge)

$Q_2 = 5 \mu\text{C}$ (point charge)

$Q_3 = 0 \text{ C}$ (infinitely extended surface charge)

$\epsilon_0 = 8.854 \cdot 10^{-12} \text{ F/m}$, $\epsilon_r = 1$

1. calculate the magnitude of the force of Q_2 on Q_1 , without the force effect of Q_3 .

Tips for the solution

- Which equation is to be used for the force effect of charges?
- How can the distance between the two charges be determined?

Solution

$$F_C = \frac{1}{4\pi \cdot \epsilon_0} \cdot \frac{Q_1 \cdot Q_2}{r^2} \quad \&\amp; \quad | \text{with } r = \sqrt{\Delta x^2 + \Delta y^2} \quad F_C = \frac{1}{4\pi \cdot \epsilon_0} \cdot \frac{Q_1 \cdot Q_2}{\sqrt{\Delta x^2 + \Delta y^2}} \quad \&\amp; \quad | \text{Insert numerical values, read off distances: } \Delta x = 3 \text{ dm}, \Delta y = 1 \text{ dm} \quad F_C = \frac{1}{4\pi \cdot 8.854 \cdot 10^{-12} \text{ F/m}} \cdot \frac{7 \cdot 10^{-6} \text{ C} \cdot 5 \cdot 10^{-6} \text{ C}}{\sqrt{(0.3 \text{ m})^2 + (0.1 \text{ m})^2}}$$

Result

$$|\vec{F}_C| = 1.084 \text{ N} \rightarrow 1.1 \text{ N}$$

2. is this force attractive or repulsive?

Tips for the solution

- What force effect do equally or oppositely charged bodies exhibit on each other?

Solution

The force is repulsive because both charges have the same sign.

Now let $Q_2=0$ and the surface charge Q_3 be designed in such a way that a homogeneous electric field with $E_3=100 \text{ ~kV/m}$ results. What force (magnitude) now results on Q_1 ?

Tips for the solution

- Which equation is to be applied for the force action in the homogeneous field?

Solution

$$\begin{aligned} F_C &= E \cdot Q_1 \quad \& | \text{Insert numerical values} \\ F_C &= 100 \\ &\cdot 10^3 \text{ ~V/m} \cdot 7 \cdot 10^{-6} \text{ ~C} \end{aligned}$$

Result

$$|\vec{F}_C| = 0.7 \text{ ~N}$$

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