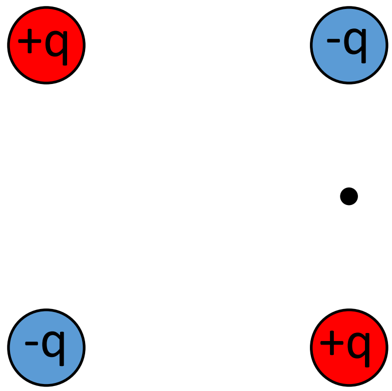
Exercise 1.



Four point charges of magnitude +/- *q* are arranged in a square as shown. The black dot is located in the middle between the two point charges on the right side of the square. Where does the total electric field point at this point?

A) Towards the left

B) Towards the right

C) Downward

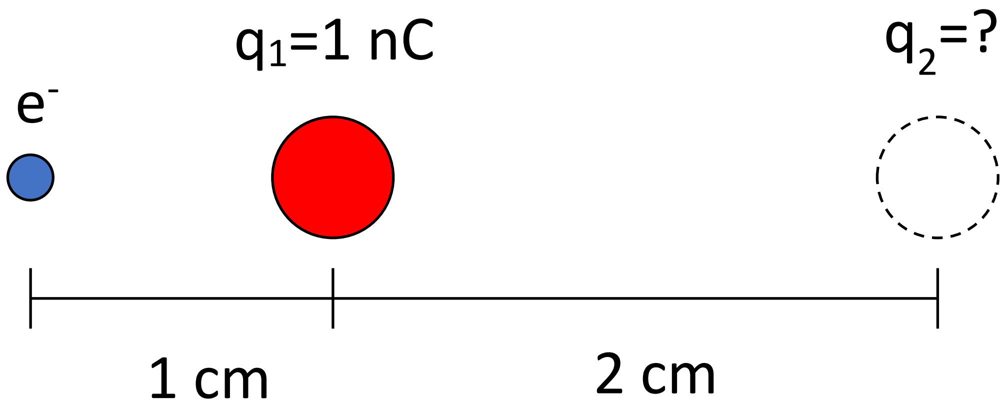
D) Upwards

E) The total field is zero

F) Cannot be determined with the given information

G) Don't know

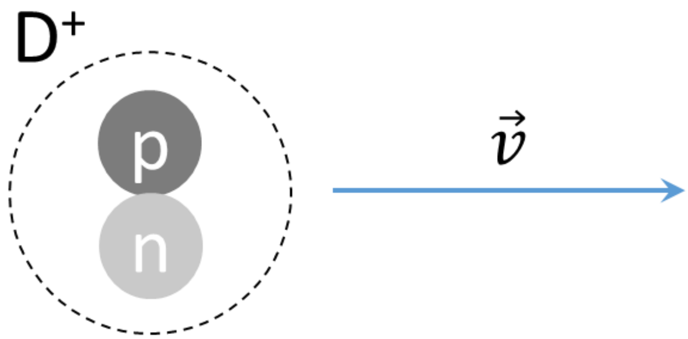
Exercise 2.



An electron and two spherically symmetric charge distributions are arranged on a line, as shown in the figure. The two spherically symmetric charge distributions are held fixed, while the electron is free to move. What must the value of q_2 be for the electron to be in static equilibrium?

A) $q_2 = 3$ nC
B) $q_2 = -3$ nC
C) $q_2 = 4$ nC
D) $q_2 = -4$ nC
E) $q_2 = 9$ nC
F) $q_2 = -9$ nC
G) Static equilibrium cannot be obtained for any value of q_2.
H) Don't know.

Exercise 3.



A deuterium ion moves with the speed $|\vec{v}_{ini}| = 10^5 \frac{m}{s}$ in vacuum. An external electric field $\vec{E}$ is applied to slow down the deuterium ion to the speed $|\vec{v}_{fin}| = 0 \frac{m}{s}$.

Calculate the electric field strength $|\vec{E}|$ needed to slow down the velocity of the ion to $|\vec{v}_{fin}| = 0 \frac{m}{s}$ across a distance of *d*=10 cm and indicate the direction of the E-field vector relative to the velocity vector $\vec{v}$. It is assumed that the nucleon mass $m \approx 1.67*10^{-27}$ kg and that the elementary charge *e*=1.602*10-19 C.

A: $|\vec{E}| \approx 1042 \frac{V}{m}$, $\vec{E}$ in the direction of $\vec{v}$.

B: $|\vec{E}| \approx 521 \frac{V}{m}$, $\vec{E}$ in the direction of $\vec{v}$.

C: $|\vec{E}| \approx 261 \frac{V}{m}$, $\vec{E}$ in the direction of $\vec{v}$.

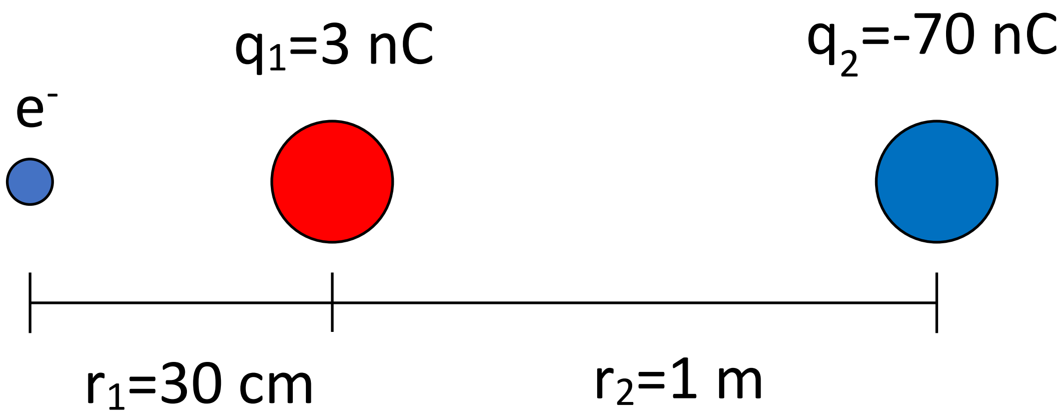
D: $|\vec{E}| \approx 1042 \frac{V}{m}$, $\vec{E}$ in the opposite direction of $\vec{v}$.

E: $|\vec{E}| \approx 521 \frac{V}{m}$, $\vec{E}$ in the opposite direction of $\vec{v}$.

F: $|\vec{E}| \approx 261 \frac{V}{m}$, $\vec{E}$ in the opposite direction of $\vec{v}$.

G: Don’t know.

Exercise 4.



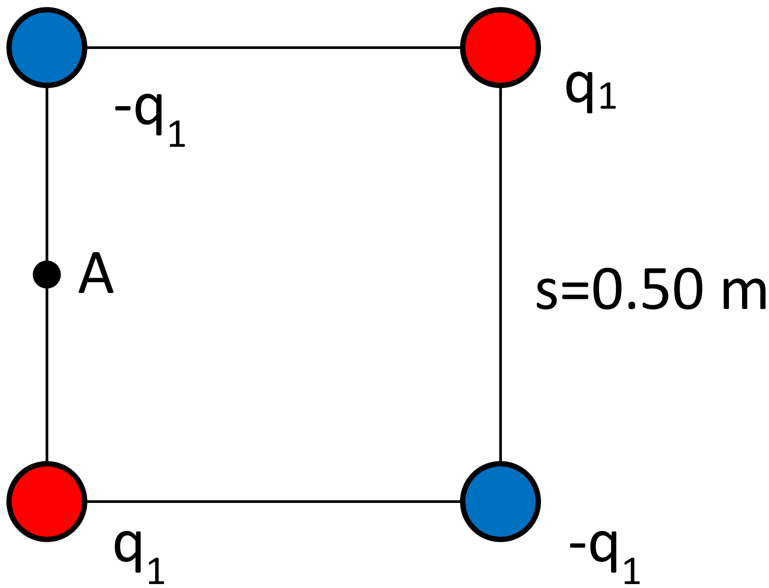
Two spherically symmetric charge distributions, q_1 og q_2 are held fixed on the x-axis next to an electron at rest, as shown in the figure. The elektronen is released to move under the influence of the electric forces from the two charge distributions, but no other forces.

The mass and charge of the electron are given by m_e=9.11·10^{-31} kg and -e=-1.602·10^{-19} C.

a) If we take the electrostatic potential energy to be zero at infinity, what is then the potential energy of the electron in the initial configuration?

b) What will be the final speed of the electron when it is (infinitely) far from the two other charges?

Exercise 5.

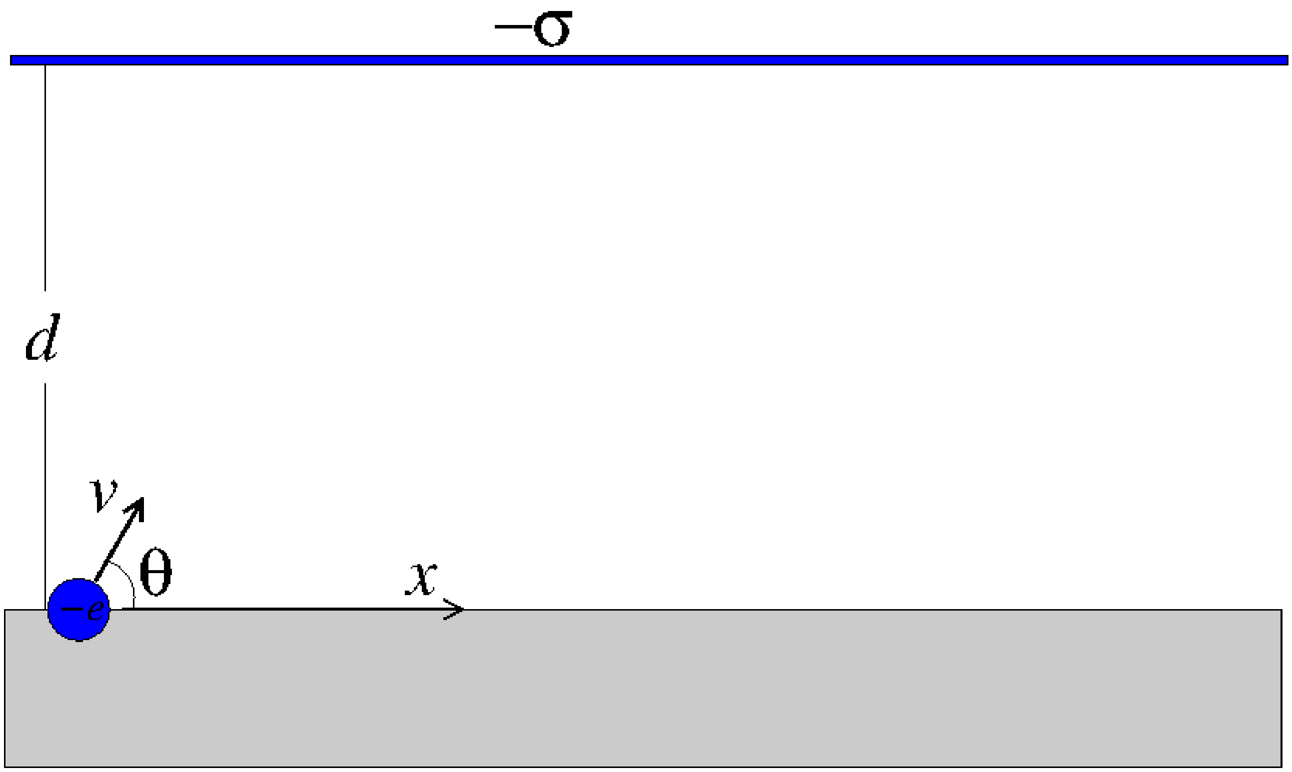


Four point charges are arranged in a square with side length s=0.50 m as shown in the figure. The red point charges have the positive charge q_1=100 nC, while the blue ones have charge $-q_1$. Point A is in the middle of the left side of the square.

Determine the field strength, i.e. the length of the electric field vector, at point A.

A) E=0 N/C
B) E=$4.6 \cdot 10^3$ N/C
C) E=$1.5 \cdot 10^4$ N/C
D) E=$2.4 \cdot 10^4$ N/C
E) E=$2.6 \cdot 10^4$ N/C
F) E=$3.1 \cdot 10^4$ N/C
G) E=$3.5 \cdot 10^4$ N/C
H) Don't know

Exercise 6.



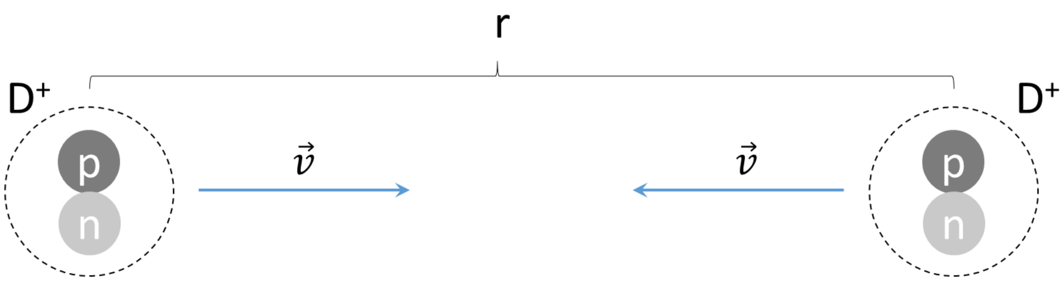
An electron is detached from the surface of a neutral material located at a distance d under an infinite planar charge distribution with negative charge density -σ, as illustrated in the figure. The electron is detached with speed v_0 and the speed vector forms the angle θ with the x-axis, as shown in the figure. Numerical values are d=1.0 cm, σ=1.0 μC/m^2, θ=60.0º, v_0=2.0·10^7 m/s. The starting point of the electron is taken to be (x,y)=(0,0).

a) Determine the magnitude and direction of the electric field from the charge distribution, and of the force on the electron.

b) What type of trajectory will the electron describe?

c) Will the electron fall back on the neutral material, and if so where? *Hint: Find expressions for maximum height and range on the basis of results from the previous semester.*

Exercise 7.



Two deuterium ions move paraxially toward each other with equal speeds *v*. Determine the speed $|\vec{v}|$ needed to bring the deuterium ions within a distance of $r = 10^{-15}$ m from each other, which is the distance where nuclear forces come into play.

It is assumed that the elementary nuclear mass is $m \approx 1.67*10^{-27}$ kg and the elementary charge is $e=1.602*10^{-19}$ C. It is further assumed that the deuterium ions start out infinitely far from each other, and that they are not influenced by other external forces than their own electric forces.

A: $|\vec{v}| \approx 1.66 * 10^6 \frac{m}{s}$

B: $|\vec{v}| \approx 1.76 * 10^7 \frac{m}{s}$

C: $|\vec{v}| \approx 2.08 * 10^{16} \frac{m}{s}$

D: $|\vec{v}| \approx 8.31 * 10^6 \frac{m}{s}$

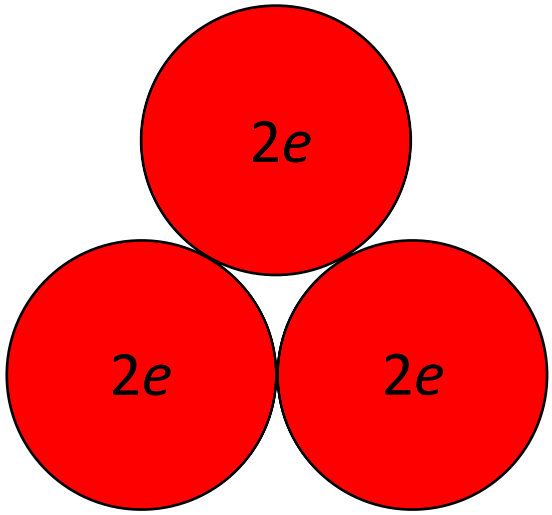
E: $|\vec{v}| \approx 6.91 * 10^{13} \frac{m}{s}$

F: $|\vec{v}| \approx 3.00 * 10^8 \frac{m}{s}$, the speed of light.

G: The ions will never get so close without an external electric field.

H: Don't know.

Exercise 8.



In the so-called 'triple-alpha' process Carbon-12 is formed by the collision of 3 alpha-particles (He-4 nuclei) which must be brought very close to each other within a time interval of $\sim 10^{-17}$ s. This process is thought to be decisive for the formation of Carbon and heavier elements in the universe.

In this exercise the alpha-particle is described as a spherically symmetric charge distribution with a radius of $1.68 \cdot 10^{-15}$ m, and an electric charge of $2e$ where e is the elementary charge, $1.602 \cdot 10^{-19}$ C.

We consider 3 alpha-particles which are very far from each other in the initial state, and having a total kinetic energy K_i . What is the minimal value of K_i needed to bring the three alpha-particles to just touch each other as shwon in the figure, assuming that only electrostatic forces need to be taken into account?

A) 0.206 pJ

B) 0.412 pJ

C) 0.549 pJ

D) 0.824 pJ

E) 1.65 pJ

F) 2.23 pJ

G) 3.30 pJ

H) Don’t know