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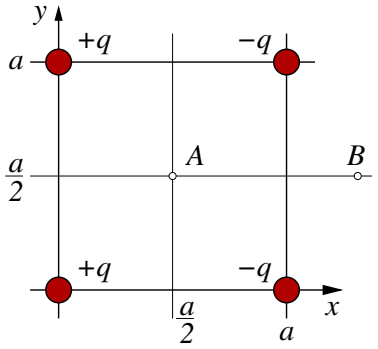
Exercises and Complements for the Introduction to Physics II

for Students

of Biology, Pharmacy and Geoscience

Sheet 1 / 23.02.2022 Discussion: **01.03.2022 / 02.03.2022**

Exercise 1.
The image shows two positive and two negative charges, each with absolute value q, arranged in a square with side length a.



(a) Qualitatively draw the electric field lines created by these four charges inside and outside of the square.
(b) Qualitatively draw the vector of the electric field $\vec{E}$ in points A and B.

Exercise 2.
Two spheres made out of lead with radius $r = 1$ cm are given. The distance between the spheres is $R = 1$ m.

(a) Calculate the gravitational force between the two spheres.
(b) With what force are these spheres attracted to each other if all conduction electrons are taken from the first and added to the second sphere? Assume that each lead atom has one conduction electron. ($\rho_{Pb} = 11.34$ g/cm^3 and atomic mass $A_{Pb} = 207.2$ u)
(c) At which value of the specific charge Q/m will the gravitational force and the Coulomb force in setting a) be the same? Q = total charge of each sphere. Comment on the results.

Exercise 3.
A H–Cl dipole with charge $q^+ = 0.176 \cdot e$ is given. The distance between the two atoms is 127 pm.

(a) Calculate the dipole moment of the H–Cl molecule.
(b) The dipole is at a 25° angle to the field lines of a homogeneous electric field with strength 3×10^3 NC^{-1}. Calculate the initial torque that acts on the molecule.
(c) What happens qualitatively in an inhomogeneous electric field?

Exercise 4.
The acceleration of a particle in an electric field is dependent on ratio of its charge to its mass $\frac{q}{m}$.

(a) Calculate this ratio for an electron.

(b) What is the magnitude and direction of the acceleration of an electron in a homogeneous electric field of strength 100 NC^{-1}?

Answers:

Exercise 2. (a) $1.5 \cdot 10^{-13}$ N und $4.4 \cdot 10^{18}$ N (b) $8.6 \cdot 10^{-11}$ C/kg

Exercise 3. (a) $3.58 \cdot 10^{-30}$ Cm (b) $4.53 \cdot 10^{-27}$ Nm

Exercise 4. (a) $1.76 \cdot 10^{11}$ $C \cdot kg^{-1}$ (b) $1.76 \cdot 10^{13}$ $m \cdot s^{-2}$