Institutt for fysikk, NTNU
TFY4155/FY1003: Elektrisitet og magnetisme
Spring 2005

Øving 1

Guidance: January 13. and 14.
Deliver no later than: Monday January 17.

Exercise 1

a) The components of a vector $\boldsymbol{A}$ are $A_x = 8.5$ and $A_y = -1.3$. The length $A = |\boldsymbol{A}|$ of this vector is then
A) 5.6 B) 7.2 C) 8.6 D) 9.8

b) The angle between the x axis and the vector $\boldsymbol{A} = -3.7\,\hat{x} + 2.3\,\hat{y}$ is (in degrees, counterclockwise)
A) 32 B) 148 C) 212 D) 238

c) The components of two vectors $\boldsymbol{A}$ and $\boldsymbol{B}$ are, respectively, $A_x = 4.1$, $A_y = -7$ and $B_x = -6.6$, $B_y = -3.1$. The length of the vector $\boldsymbol{B} - \boldsymbol{A}$ is then
A) 11.4 B) 14.6 C) 19.5 D) 23.3

d) The components of two vectors $\boldsymbol{A}$ and $\boldsymbol{B}$ are, respectively, $A_x = -6.1$, $A_y = -5.8$ and $B_x = -9.8$, $B_y = 4.6$. The scalar product $\boldsymbol{A} \cdot \boldsymbol{B}$ is then
A) -9.7 B) 0 C) 33.1 D) 86.5

Exercise 2

Determine the gravitational force F_g between two oxygen molecules (O_2) separated by 300 Å. Is F_g attractive or repulsive?
The two oxygen molecules are given an extra electron each. How big is the electric force F_e between the two ions (O_2^-)? Is F_e attractive or repulsive?
Determine the ratio between F_e and F_g.

[Molecular oxygen has mass 32 g/mol, 1 mol = $6.02 \cdot 10^{23}$, the gravitation constant is $G = 6.67 \cdot 10^{-11}$ m^3/kg·s^2, e = the elementary charge = $1.6 \cdot 10^{-19}$ C and 1 Å = 1 angstrom = 10^{-10} m]

Exercise 3

Two equal point charges q are positioned on the x axis in $x = a$ and $x = -a$, respectively. Determine the resulting electric force $\boldsymbol{F}$ on a third point charge $-q$ which is located on the y axis ($y > 0$) in a distance $\sqrt{5}\,a$ from the two others. Draw a figure with the three charges where you clearly indicate the direction of $\boldsymbol{F}$. [Notation: **vectors** with **bold** letters.] Determine a numerical value of F when $q = 2\ \mu$C and $a = 4$ cm. What is the force on the charge on the y axis if the point charge in $x = -a$ changes sign? (Draw a figure.)

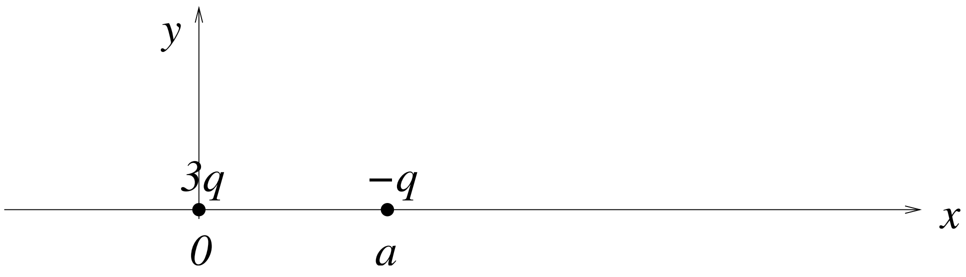
Exercise 4

a) Six identical charges q are located in the corners of a regular hexagon. What is the force on a test charge Q in the centre of this hexagon?

b) One of the six charges are removed. What is the resulting force on Q? Draw a figure and explain your reasoning.

c) Replace "six" with "seven" and repeat question *a*!

Exercise 5



a) Two point charges $3q$ and $-q$ are located on the x axis in $x = 0$ and $x = a$, respectively. Explain why possible equilibrium positions for a third charge q must be on the x axis.

b) There is *one* equilibrium position x_0 on the x axis for this third charge. (In addition to the "singular" point $x = a$.) Determine x_0. Argue, without further calculations, that this equilibrium position is unstable with respect to a small displacement in the x direction. (Alternatively, with further calculations: Consider the stability of the equilibrium by looking at the value of dF/dx in $x = x_0$.)

[In *equilibrium*, there is no net force on the charge. If the charge is displaced a distance Δx from the equilibrium position, it will be influenced by a force. If this force acts in the same direction as the displacement Δx, the equilibrium is unstable. In the opposite case, it is stable.]

Some answers:

Exercise 2: $F_e/F_g \simeq 10^{33}$
Exercise 3: $F = 8.0$ N.
Exercise 5b: $x_0 = (3 + \sqrt{3})a/2$.