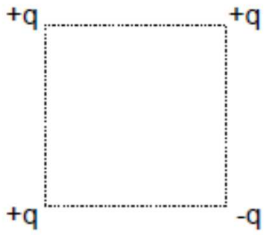
TD N°1

Electrostatic field

Exercise 1 : Electrostatic field created by the electrical charges.

Four-point charges are placed at the top of a square of side a:
Determine the characteristics of the electrostatic field prevailing in the center of the square.
Numerical application: q = 1 nC and a = 5 cm.



Exercise 2 : Electrostatic field created by the electrical charges.

Three-point charges +q, -q and -q are placed at the top of an equilateral triangle of side a.
Determine the characteristics of the electrostatic field prevailing at the center of the triangle.
Numerical application: q = 0.1 nC and a = 10 cm.

Exercise 3 : Electrostatic field created by two plans.

Consider two parallel planes with distance d. The first plane is positively charged with a surface charge density $+\sigma$ (in C/m^2). The second plane is negatively charged with a surface charge density $-\sigma$. Determine the electrostatic field created by the two planes at any point in space.

Exercise 4 : Millikan Experience (1911)

Between two horizontal metal plates of 1.5 cm distance, a potential difference of 3 kV is applied. We then see that small drops negatively charged of oil are in equilibrium between the two plates.
a) What are the polarities of the plates?
b) What is the charge of a drop of oil?
Compare to the charge of an electron.
We give : - oil density: $\rho = 900$ kg/m3
- diameter of a drop: D = 4.1 µm
- gravity field intensity: $g = 9.8$ m/s²

Exercise 5 : Electrostatic field created by metal ball.

Consider a metal ball of R ray having a global charge Q.
At equilibrium, how are the charges distributed in the conductor ?
Deduce the expression for the surface charge density σ (in C/m^2).
What is the electrostatic field in the conductor ?
By applying Coulomb's theorem, check that on the surface of the conductor :

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2}$$

Using Gauss' theorem, show that the intensity of the electrostatic field created at the distance r ($r \geq R$) from the center of the conductor is:

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

Exercise 6 : Conductor Association

Show that for conductors connected in parallel the capacitance add up.
Show that for conductors connected in series inverses of capacitance add up.

Exercice 7 : Conductors discharge

A conductor of capacitance C=100nF is charged under the potential V=20V.
We connect at a conductor of the same capacitance C, but initially discharged.

a) Calculate the potential which appears at the terminal of assembly.
b) Carry out an energy assessment before and after connection. Comment?