Ministry of Higher Education and Scientific Research

University Mohamed Boudiaf of M'sila

Faculty of Mathematics and Computer Science

Department of Computer Science

General Electricity

Problems & Exercises (of Chap 1)

Electrostatics

Z. Elbahi (2025/2026)

Exercise 1

Find the total charge for each of the following distributions:

1. Linear charge λ_0, uniformly distributed along the perimeter of a square with side a.
2. Surface charge σ_0, uniformly distributed over a ring-shaped region bounded by two concentric circles with radii a and b (where $b>a$).
3. Volume charge ρ_0, uniformly distributed between two spheres with radii a and b (where $b>a$).
4. Volume charge ρ_0, uniformly distributed between two coaxial cylinders with radii a and b (where $b>a$) and height h.

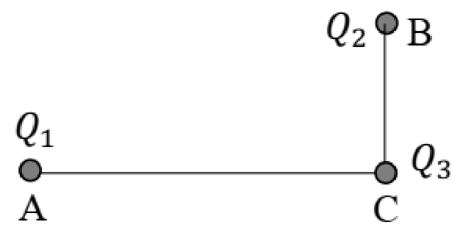
Exercise 2

Three charges Q_1, Q_2, and Q_3 are arranged as shown in the figure below.

Given: $Q_1 = 1.5 \times 10^{-3} C, AC = 1.2m,$

$Q_2 = -0.5 \times 10^{-3} C,\ Q_3 = 0.2 \times 10^{-3} C,\ BC = 0.6m.$

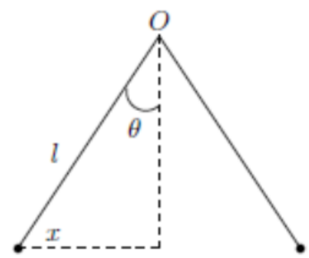
Calculate the resultant force exerted by charges Q_1 and Q_2 on charge Q_3.



Exercise 3

Two identical conducting spheres with mass m **= 10 g** carry charges q_1 and q_2. They are brought into contact and then separated.

1. Calculate the charges q_1' and q_2' they acquire in the following cases:
   a) $q_1 = +4 \times 10^{-8}\ C\ et\ q_2 = 0\ C.$
   b) $q_1 = +3 \times 10^{-8}\ C\ et\ q2 = +8 \times 10^{-8}\ C.$
   c) $q_1 = +3 \times 10^{-8} C\ et\ q2 = -8 \times 10^{-8} C.$



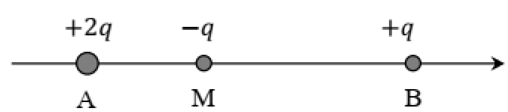
Specify the direction of electron transfer each time.

2. Both masses are suspended at the same point O by two identical Nylon threads of length l **= 80 cm** (figure).
   Neglecting the mass of the threads, calculate the distance $2x$ separating the two spheres for the three previous cases (assuming the angle θ is sufficiently small and g **= 10 m/s²**).

Given: $K = 9 \,.\, 10^9$ ***S.I***

Exercise 4

Below is the charge distribution:



The two charges placed at **A** (origin of the abscissa) and **B** are fixed;

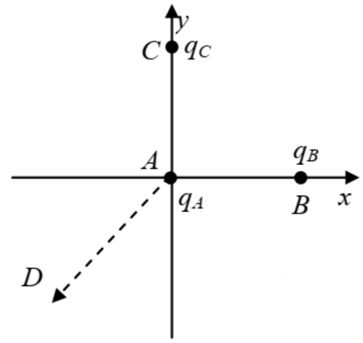
however, the charge placed at **M** is movable along the segment **AB**.

What is then the equilibrium position of the charge placed at **M**, if it exists?

Given **AB = d**.

Exercise 5

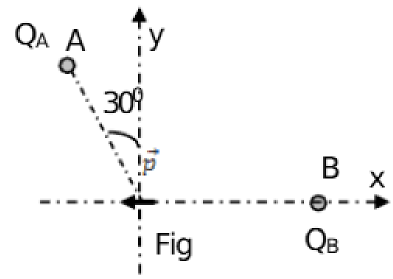
We place three charges $\mathbf{q_A = 10^{-7}\ C}$, $\mathbf{q_B = 2\ 10^{-7}\ C}$, and $\mathbf{q_C = -3\ 10^{-7}\ C}$ at points **A**, **B**, and **C** with respective Cartesian coordinates **A(0,0)**, **B(3,0)**, and **C(0,3)** in cm (figure).



1. Calculate and qualitatively represent the electric field created by charges $\mathbf{q_B}$ and $\mathbf{q_C}$, at point **A**
2. Determine the force exerted on the charge $\mathbf{q_A}$.
3. Calculate the potential created by charges $\mathbf{q_B}$ and $\mathbf{q_C}$ at point **A**. Deduce the potential energy of the charge $\mathbf{q_A}$.
4. Calculate the work done by the electrostatic force when moving charge $\mathbf{q_A}$ from point **A** to point **D(-3,-3)** cm.

Exercise 6

We consider two point charges $\mathbf{Q_A}$ and $\mathbf{Q_B}$ placed at points **A** and **B**, such that **OA** makes an angle of **30∘** with the **Oy**-axis, while **B** lies on the **Ox**-axis (see Figure). The given data are:



- $\mathbf{Q_A = Q_B = -5\times10^{-6}\ C}$
- **OA = OB = 5 cm**

1. Determine and represent the electric field created at point **O**.
2. Calculate the electric potential at this point.
3. A dipole **p** is placed at **O**, with charges ± **q** where $\mathbf{q = 10^{-12}\ C}$,

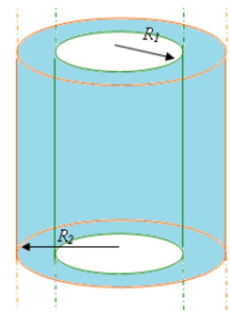
separated by a distance **a = 5mm**.
a) Calculate the potential energy of the dipole in the given configuration (Figure).
b) Calculate the work required to bring the dipole to its stable equilibrium position.

Exercise 7

Consider two coaxial cylinders with radii $R1$ and $R2$ such that $R1<R2$ and infinite height.

The cylinder of radius $R1$ carries a surface distribution with density $\sigma1= \sigma>0$.

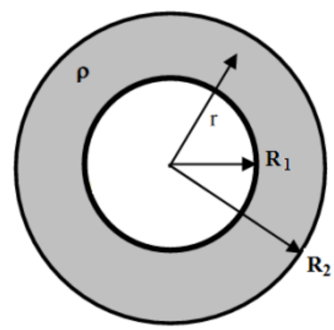
Similarly, the second cylinder of radius $R2$ carries a surface distribution with density $\sigma2= 2\sigma>0$.



1- Using Gauss's theorem, find the expression of the electrostatic field $E(r)$ at any point in space. 2- Deduce the expression of the electric potential $V(r)$ at any point in space.

Exercise 8

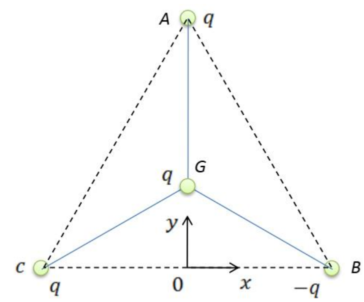
Consider a uniform distribution of charges, with volumetric density $\rho>0$, spread between two concentric spheres, $S1$ and $S2$, centered at O, with radii $R1$ and $R2$ respectively, such that $R1<R2$ (see figure).



Using Gauss's theorem, calculate the electrostatic field created by this distribution at any point M in space, where $OM=r$. Differentiate the regions: $r<R1$, $R1<r<R2$, $r>R2$.

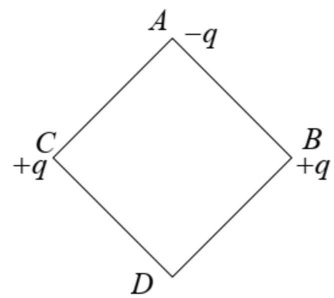
Additional Exercises

Exercise 9



Calculate the force exerted by three charges **1µC**, **-1µC**, and **1µC**, placed at the vertices of an equilateral triangle with a side length of **1cm**, on a charge of **1µC** located at the center of the triangle.

Exercise 10



Point charges occupy the vertices **A**, **B**, and **C** of a rhombus with side length ***a***, as shown in the figure below (there is no charge at **D**).

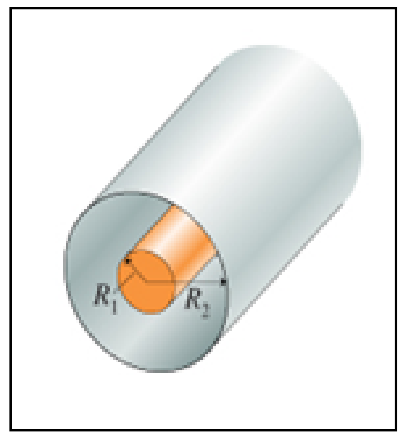
1/ Calculate the electric field produced by the three charges at vertex **D**; graphically represent this field.

2/ A charge **+2q** is placed at point **D**. Calculate the electric force exerted by the other charges on the center of the rhombus.

Exercise 11

Consider two coaxial cylinders with radii $R1$ and $R2$ such that $R1<R2$ and infinite height. The cylinder of radius $R1$ carries a volume distribution with density $\rho_1 = \rho$, $\rho > 0$.

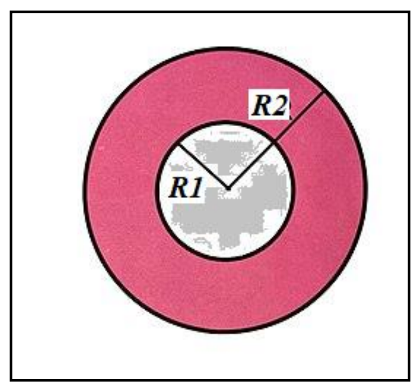
The second cylinder of radius $R2$ carries a volume distribution with density $\rho_2 = 2\rho$, $\rho > 0$. **Figure 3**



1- Using Gauss's theorem, find the expression of the electrostatic field $E(r)$ at any point in space.
2- Deduce the expression of the electric potential $V(r)$ at any point in space.

Exercise 12:

Two concentric spheres (with the same center) of radius R_1 and R_2 are defined such that $R_1 < R_2$. The sphere with radius R_1 is volumetrically charged with a constant distribution $\rho_1 = \rho$, and the sphere with radius R_2 is volumetrically charged with a constant distribution $\rho_2 = 2\rho$. **Figure 3**



1. Calculate the electric field ($\vec{E}$) created at any point in space using Gauss's theorem.

2. Calculate the potential (V) created at any point in space using Gauss's theorem.