Tutorial Nº 1 : ELECTROSTATICS

Exercise 1

Four charges are placed at the vertices of a rectangle (Figure 1).
Determine the expression for the electrostatic force exerted on charge q_1, then calculate its magnitude.
Given : : $q_1 = 4.0\ \mu C$, $q_2 = -4.0\ \mu C$, $q_3 = 2.0\ \mu C$, $q_4 = -5.0\ \mu C$ $a = 3.0\ cm$, $a = 4.0\ cm$

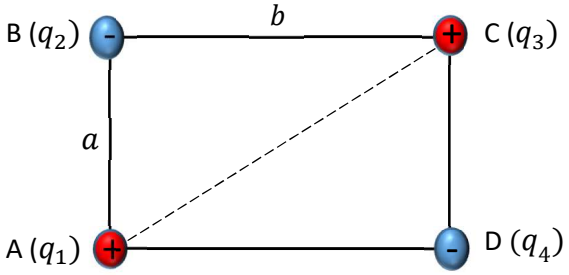

Figure 1

Exercise 2

Three point charges are distributed along half of a semicircle of radius R (figure 2).

1) Calculate the resultant electric field at the center O of the semicircle, produced by the three charges q_1, q_2 et q_3 .
2) Calculate the total electric potential at point O.
3) A charge $q_0 = -2.0\ \mu C$ is placed at point O.

Determine the electric force acting on charge q_0.
Given : $q_1 = 3.0\ \mu C$, $q_2 = -4.0\ \mu C$, $q_3 = 6.0\ \mu C$, $R = 3.0\ cm$

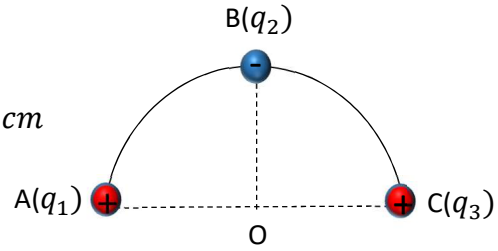

Figure 2

Exercise 3

Two point charges are given: $q_1 = 20\ \mu C$ en $(-d, 0)$ et $q_2 = -10\ \mu C$ en $(+d, 0)$.
Determine the resultant electric field at point P whose coordinates are (x, y) (Figure 3).
Given : $d = 1.0\ m$ et $x = y = 2\ m$

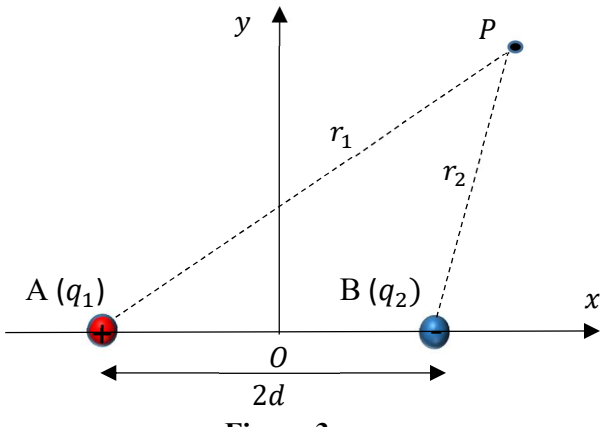

Figure 3

Exercise 04

A circular ring of radius *a,* centered at *O,* et de rayon, carries a total electric charge Q uniformly distributed along its circumference, with a constant linear charge density λ constante (Figure 4).

Determine the electric field vector $\vec{E}$ at a point *M* located on the axis of the ring (the *Ox* axis), at a distance *x* from its center *O*.

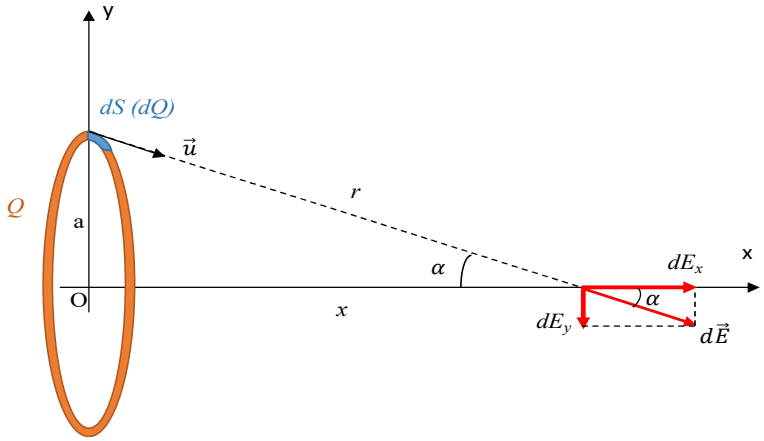

Figure 4

Exercise 05

A uniformly charged rod of length *l* carries a constant linear charge density λ (Figure 5).

1) Determine the electric field at a point *p* on the *Oy* axis.

Given that $OP = y$

2) Deduce the electric field for an infinitely long wire.

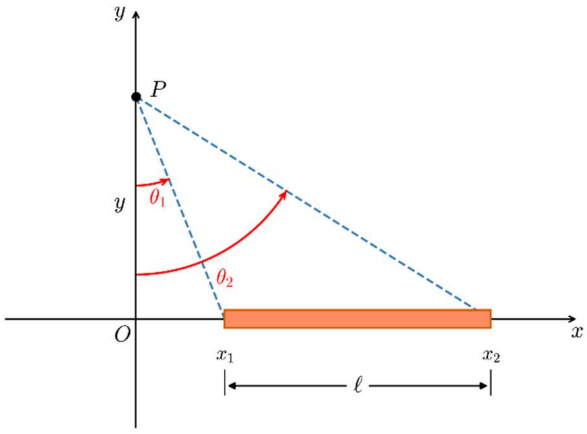

Figure 5

Exercise 06

Consider an infinitely long straight wire carrying a uniform linear charge density $\lambda > 0$.

1) Determine the direction and orientation of the electric field at a point *M* located at a distance *r* from the wire.
2) Which Gaussian surface is most suitable for this problem ?

3) Using Gauss's theorem, derive the expression for the electric field at any point *M*. Compare this result with that obtained in exercise 5.

Exercise 07

I- Uniformly charged spherical shell

Consider a spherical shell (hollow sphere) of radius *R* centered at *O*, carrying a uniformly distributed surface charge density $\sigma > 0$.

1) Using Gauss's theorem, determine the expression for the electric field inside the spherical shell ($r < R$).
2) Determine the expression for the electric field outside the spherical shell ($r > R$).

II- Uniformly charged solid sphere

Now consider a solid sphere of radius *R,* centered at *O*, with a uniform volume charge density $\rho > 0$.

1) Determine the expression for the electric field inside the sphere ($r < R$).
2) Determine the expression for the electric field outside the sphere($r > R$).

What can be concluded by comparing these results with the electric field produced by a point charge ?