EPITA-S3
2020/2021

Exercise sheet n°2
Electrostatics

Exercice 1

An electric dipole composed of two points charges (-Q,+Q), distant by the lenght a, create at any point M on the (xoy) plane, an electric potential which expresses :

$V(r,\theta) = \frac{k\,Q\,a\cos(\theta)}{r^2}$; where k, Q and a are positive constants.

The variables r and θ are the coordinates of the point M in the polar system $(\vec{u}_r, \vec{u}_\theta)$.

1- Express the radial E_r and tangential E_θ components of the electric field vector on the point M.

2- Express in function of k, Q, a and r_0, the electric field vector components, at the point $M_0(r_0, \theta_0)$, such that : $r = r_0$, and $\theta_0 = 0$. Sketch this vector at the point M_0 in the polar system $(\vec{u}_r, \vec{u}_\theta)$. Comment the result.

3- Same question for the point M_1 of coordinates $r = r_1$, and $\theta_1 = \pi/2$

Exercice 2

Some charge distribution with spherical symmetry centered at point O generates at point M, such that OM = r, a potential which can be described by:

$$V(r) = kq\frac{1}{r}\exp(-\frac{r}{a_0})$$

where a_0, k and q are positive constants.

1- Give the precise orientation of the electric field created by this spherical distribution at point M.
2- Deduce the expression of the electric field $\vec{E}(M)$.

Exercise 3: Millikan's experience

Between two horizontal metallic plaques, which are separated by d = 1.5 cm, of a capacitor one generates a potential difference ΔV = 3 kV. It can be noticed that some negatively charged oil droplets are in equilibrium between the plaques.
Given data: ΔV = E.d, where E is the electric field in the capacitor.

1- What are the respective plaque polarities?
2- What is the charge of one oil droplet? Compare this value with the electron charge.

Given data:
- volumic mass of oil: ρ = 900 kg/m^3
- droplet diameter: D = 4 µm
- intensity of Earth's gravitational field: g = 10 m/s²