Equipotential surfaces and field lines

1. Purpose of the experiment

The aim of the experiment is to be able to determine the field lines and equipotentials

2. Principle and description

If a positive or negative electric charge q is at rest, it creates around it an electric field defined by Coulomb's law.

$\vec{E} = \frac{q}{4\pi\varepsilon_0 r^2}\vec{u}_r$, ε_0 is the vacuum permittivity.

r : is the distance between the charge and the place where the field is evaluated.

If there is a field at a point in space, we know that it derives from a potential, that is to say

$$\vec{E} = -\overrightarrow{grad}V \Rightarrow V = -\int \vec{E}d\vec{l}$$

V : is the potential created by the charge at the point considered.

dl : is the elementary displacement of the electric field vector along the curve C.

There are points in space around the charge where the value of the potential is constant. The geometric locus of these points constitutes an equipotential surface.

If we take a set of charges distributed over a surface with a distribution σ.

They create an electric field given by the following relation:

$$\vec{E} = \int \frac{dq}{4\pi\varepsilon_0 r^2}\vec{u}_r = \int \frac{\sigma dS}{4\pi\varepsilon_0 r^2}\vec{u}_r$$

1. If we take two large parallel plates compared to the distance between the charges, we can compare them to infinite planes.
2. Demonstrate that each plane, assumed to be a disk of infinite radius R, has a field $E = \frac{\sigma}{2\varepsilon_0}$.

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Note: The field is independent of the distance separating the two plates.

3. If we take these two plates and supply them with opposite charges (one carries positive charges and the other carries negative charges), we demonstrate that the uniform field which reigns between them has an intensity $E = \frac{\sigma}{\varepsilon_0}$ and fixed direction (from the plate which carries negative charges towards the plate which carries positive charges, as indicated in the figure opposite).

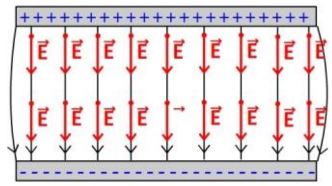

Figure 1

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Each of the two distinct points x_0 and x has a potential V_0 and V respectively and the potential difference (d.d.p) between these two points is given by:

$$\int_{V_0}^{V} VdV = -\int_{x_0}^{x} Edx \Rightarrow V - V_0 = -E\left(x - x_0\right)$$

If we take $x_0 = 0$ as the origin which corresponds to a potential V then the dependence of the potential on the distance x is a straight line given by:

$$V\left(x\right) = -Ex + V_0$$

3. Handling

1. Carry out the assembly shown in the figure opposite.
2. Place the tank filled with distilled water on graph paper.
3. Place the two bars parallel to the limits of the tank, and locate the negative terminal as the origin of the potential V0 mark.
4. Power the assembly as shown in the figure.
5. Connect the x and y coordinates of the 5 points which have the same potential (a central point and two points on either side). Repeat the same thing for different potentials.

Potential V												
$P_1(x_1,y_1)$												
$P_2(x_2,y_2)$												
$P_3(x_3,y_3)$												
$P_4(x_4,y_4)$												
$P_5(x_5,y_5)$												

1. Complete the table above.
2. Join the points of the same potential (figure 3).
3. What do these curves represent? What do they look like?

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1. Take the middle points for which the y component is zero. Draw the curve V=F(x) (figure 4).

2. From the graph, calculate the electric field prevailing inside. E= V/Cm

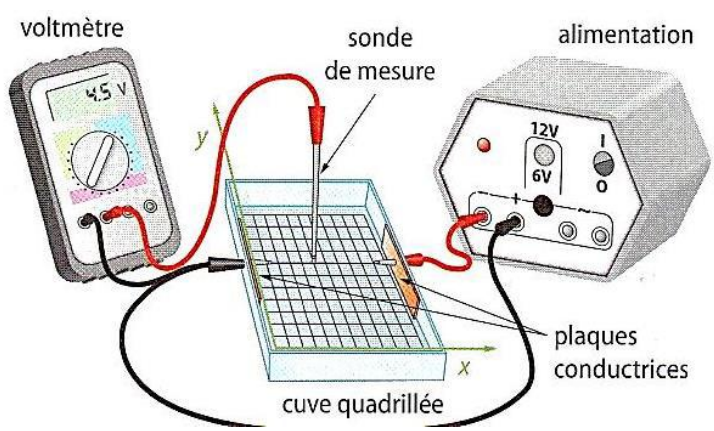

Figure 2