UOWD
University of Wollongong in Dubai

Lab Experiment 1: Electric Field Mapping

	1	2	3	4
Family Name:	....	....	....	....
First Name:	....	....	....	....
Student Number:	....	....	....	....

Introduction: The objective of this experiment is to study the potentials, equipotential curves and electric fields produced by various two dimensional electrostatic charge distributions. Note, however, that the conditions in this experiment are not truly electrostatic. Electrostatic charge configurations are difficult to setup and control. We will therefore simulate electrostatic charge distributions using a small current flowing through conducting paper and carefully shaped electrodes. The resulting potentials, equipotential curves and electric fields will be identical to the electrostatic case.

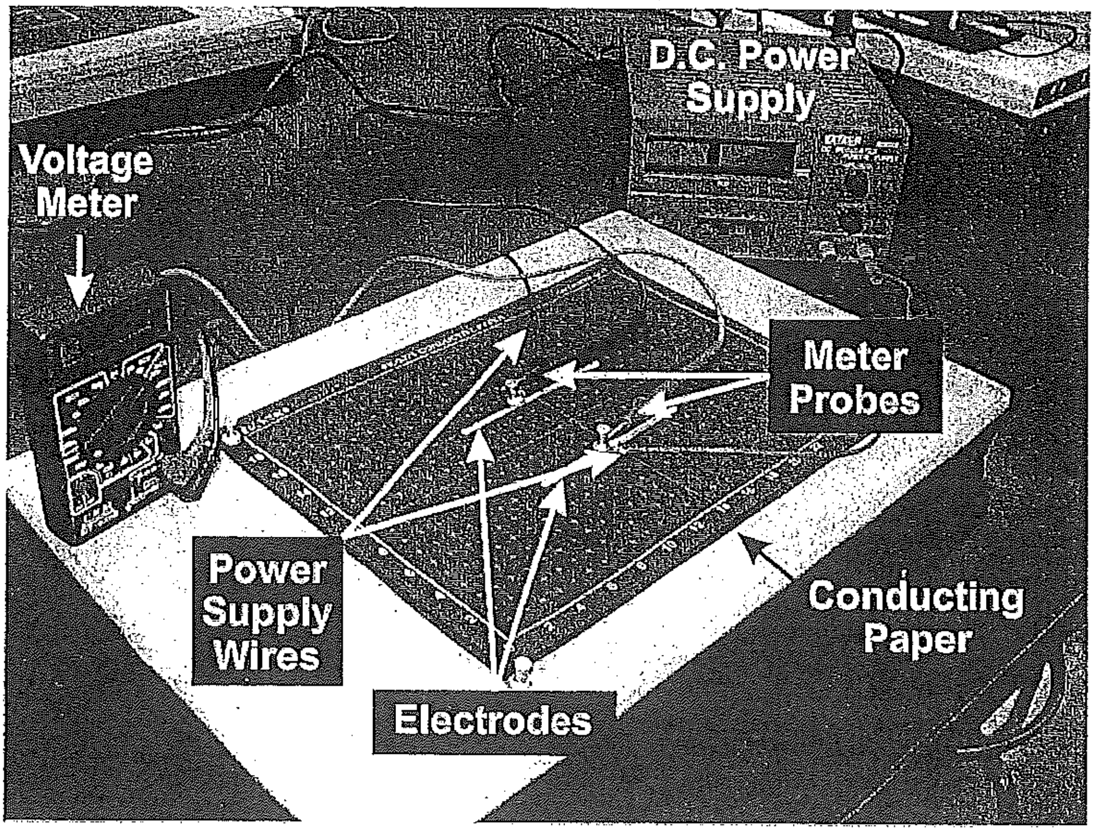

Figure 1: Setup for the *Mapping the Electric Potential and Electric Field* experiment showing the Pasco® field mapping board, voltage meter, D.C. power supply, conducting paper (here shown with the "Parallel Plate" electrode configuration).

Equipment: Pasco® field mapping board, digital voltage meter with point probes, D.C. power supply, several sheets of conducting paper with different electrode configurations, push pins.

Theory:

An electric field is a vector field that is produced by an electric charge. The source of the field may be a single charge or many charges. To ~~visualize~~ an electric field, we use lines of force. The arrows on the lines point in the direction of a force felt by a unit positive charge placed into ~~such~~ a field, so that lines of force leave positive charges and enter negative ones for simple one charge configurations such as seen in (Figure 2.1)

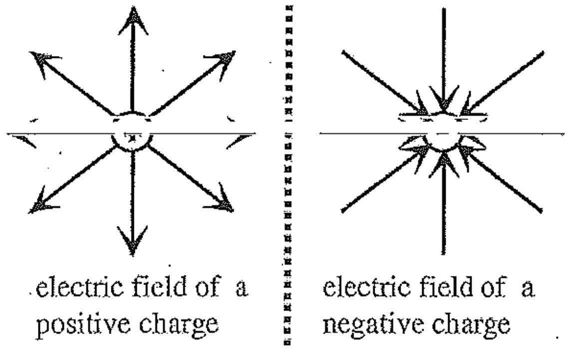

Figure 2.1: Electric fields of positive and negative charges.

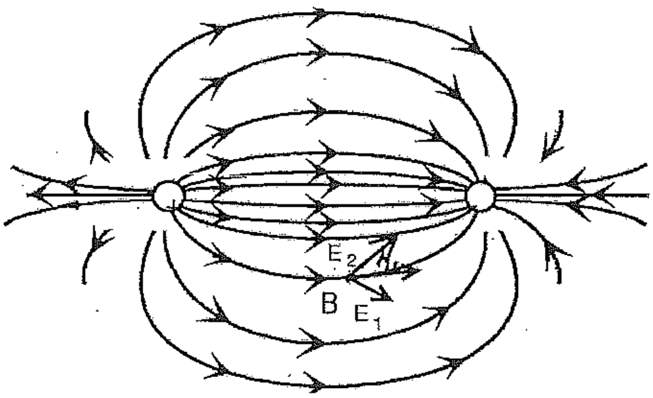

Figure 2.2: Electric Field near two equal charges of opposite sign

If the charge configuration has more than one member as in the configuration in figure 2.2, then the vector properties of the electric field must be considered. Here we see two charges and want to see what would happen to a positive test charge introduced into the system. Let's imagine the charge is introduced at point B. Generally, we must use vector analysis to predict the force on the charge. Let E_1 be the force felt by the test charge because of the presence of a like unit positive charge. Let E_2 be the attraction felt by the test charge to the unit negative charge. Here, using vector addition, the electric field line is calculated for this system of charges. The resultant, r, is tangent to the electric field lines, thus the lines can be drawn in by realizing the resultant at each point in the diagram, or several points and sketching the electric field lines from these observed resultant vectors.

[To maintain the charge at a specific position in the electric field or move it against the field requires an expenditure of energy. The work done to bring a charge from infinity to a particular point in the field is called potential energy. It would become kinetic energy if the charge were free to move. The electric potential energy, sometimes just called 'potential' is the energy per unit charge. Lines of equal potential define a force field, as lines of force are perpendicular to such potential lines (Figure 2.3). This is because when a charge is moving along an equipotential line no work is done, and thus the electric field cannot have a component in this direction. If potentials can be measured and equipotential lines drawn, electric fields can be mapped. (Remember both potential lines and lines of force do not actually exist but are simply mental devices for thinking about force fields.)

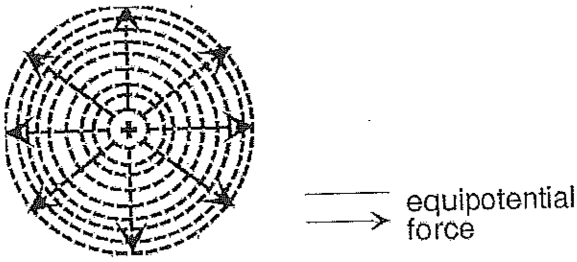

Figure 2.3: Equipotential lines, and lines of force for the field of a positive point charge

The procedure below gives details of the apparatus used in this experiment to map out equal potential lines, and thus the electric field. Try to anticipate the features of the equipotential lines within your group before the experiment is completed. Use the ideas presented above to predict the field geometry from the plate geometry.

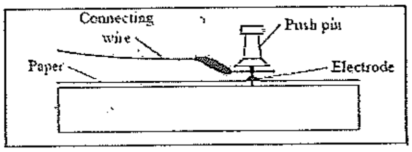

Figure 3: Connecting the power supply wire to the electrode using the push pin.

Experiment Setup:

The equipment used and the experimental setup is shown in Figure 1. Notice that in the figure the meter probes are shown lying on the conducting paper. During measurement taking you will of course be holding them so only the metal point part of the probes will touch the paper.

For each electrode configuration you will use:

- In order to keep the ~~conductive paper~~ stationary, mount the conductive paper by placing two push pins in opposite corners (one corner pin can be seen in Figure 1).
- Connect the electrodes to the DC power supply using the power supply wires by placing a push pin through the hole in the wire terminal, into the electrode and into the cork board beneath. See Figure 3.
- Connect the other end of the wires to the power supply.

- Check the electrodes for proper conductivity (a damaged electrode could skew your results). Connect one voltmeter lead near a push pin on an electrode. Touch the voltmeters second lead to other points on the *same* electrode. The **maximum** potential between any two points on the same electrode should not exceed 1% of the potential applied between the two electrodes. That is, if potential difference between the terminals of the power supply is 5.00V than the reading on the volt meter should be between -0.05V and +0.05V. Should the difference in voltage between any two points on the *same* electrode exceed 1% ask your lab instructor for a new piece of conducting paper.

Procedure:

Parallel Plate Configuration

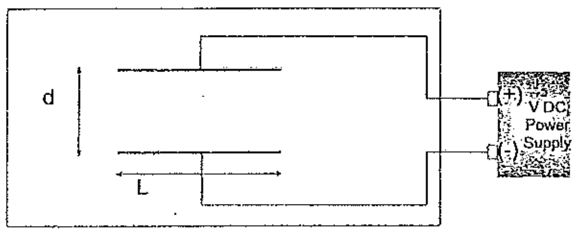

Figure 4: Parallel plate configuration showing the power supply connections. The voltage meter probes are not shown.

A. Parallel Plates. (Figure 4)
- Draw a thin line from one plate to the other, connecting the midpoints of the two plates.
- Place one of the volt meter leads on one of the parallel plate electrodes at one end of your line. This is your reference probe.
- Measure the potential difference between your reference probe and the other volt meter probe every 0.5cm along your line, starting at 0.5cm. Tabulate your measurements.

Dipole of opposite charges

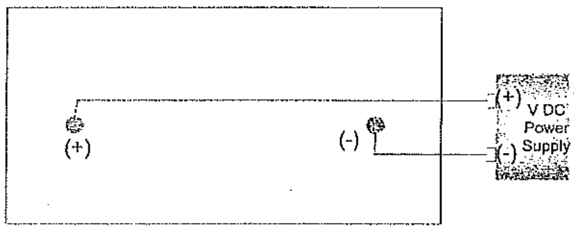

Figure 5: Dipole configuration. Power supply connections are shown. Voltage meter probes are not shown.

B. Electric Dipole – opposite charges. (Figure 5)
- Place your reference voltage probe between the two electrodes, along an imaginary line that connects the two electrodes.
- With the other voltage probe, find points that are at the same potential as your reference probe. That is, map out the equipotential line on which your reference probe is located. What is its shape? How would you describe its location? Include a sketch of your charge (electrode) configuration and this equipotential line in your lab report.
- Map out a few equpotential curves near each of your point charges. Include these on the sketch done for the previous step. Describe their shapes, and comment on whether the shapes of all your equpotentials seem consistent with your knowledge of the shape of the electric fields and equipotentials of point charges.
- Since we know that electric field lines must cross equipotential lines in a particular way (see above in the Theory section if you do not recall this point), on your sketch draw in a few electric field lines. Be sure to include an indication of the direction of your field lines.