Equipotential Mapping

Equipment Needed:

1 Equipotential Mapping Kit	Demo cart
1 Digital Multimeter	Demo cart
1 Power Supply	Demo cart

Introduction

As has been discussed in lecture, electric potential is a property of an electric field, and electric potential energy is an energy of a charged object in an external electric field. Therefore , adjacent points that have the same electric potential form an equipotential surface. Charge distribution allows for the formation of a family of equipotential surfaces (see Figure 1). A point charge creates a family of concentric spheres. A uniform field creates a family of planes perpendicular to the field lines, and so forth. Understanding this phenomena will allow the student to map the equipotential surfaces created by various combinations of electrically charged objects and the fields they generate.

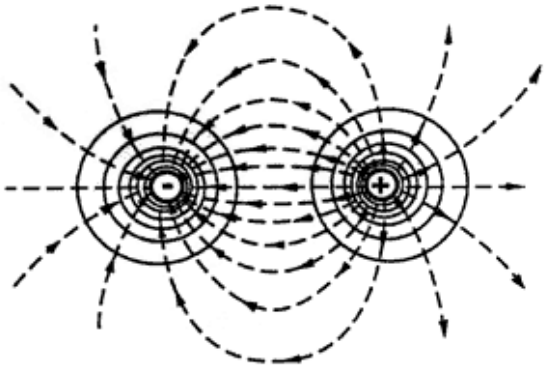

Figure 1: Equipotential Map

Procedure

You will be provided with a sheet of conductive paper with a design on it, created with a conductive ink. With this in hand follow the procedure below:

1 Equipotential Mapping

1. Mount the conductive paper on the corkboard using one of the metal push pins in each corner.

2. Connect the electrodes to a battery, DC power supply, or any other potential source in the 5 to 20 VDC range using the supplied connecting wires. (see Figure 2) The potential source should be capable of supplying 25 mA. (If possible, the potential should be equal to the full scale reading of the electronic voltmeter used in the experiment.)

3. Place the terminal of a connecting wire over the electrode, then stick a metal push pin through its terminal and the electrode into the corkboard. Make certain that the pin holds the terminal firmly to the electrode. (see Figure 2). NOTE: Check that the surface of the terminal which touches the electrode is clean. A dirty path may result in a bad contact.

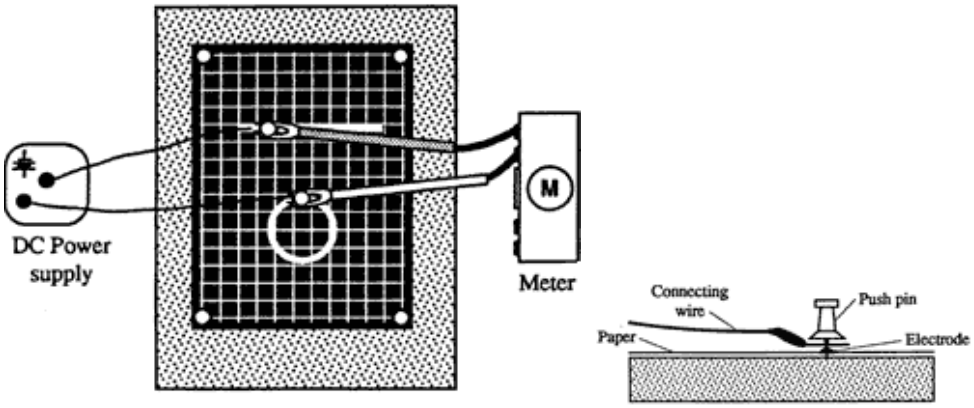

Figure 2: Equipment Setup and Electrode Connection

4. Connect the other end of the wire to the battery.

5. To check the electrodes for proper conductivity connect one voltmeter lead near the push pin on an electrode. Touch the voltmeter's second lead to other points on the same electrode. If the electrode has been properly drawn, the maximum potential between any two points on the same electrode will not exceed 1% of the potential applied between the two electrodes.

   NOTE: This test can only be made if the potential source is connected across the two electrodes. If the voltage across the same electrode is greater than 1% of the voltage applied between the two electrodes, then remove the paper from the corkboard and draw over the electrodes a second time with the conductive ink.

6. Equipotentials are plotted by connecting one lead of the voltmeter (the ground) to one of the electrode push pins. This electrode now becomes the reference. The other voltmeter lead (the probe) is used to measure the potential at any point on the paper simply by touching the probe to the paper at that point. To map an equipotential, move the probe until the desired potential is indicated on the voltmeter. Mark the paper at this point with a soft lead or light-colored lead pencil. Continue to move the probe, but only in a direction which maintains the voltmeter at the same reading. Continue to mark these points. Connecting the points produces an equipotential line.

2 Field Line Mapping

1. To plot field gradients (field lines), neither lead of the voltmeter is connected to an electrode. Instead, the two leads of the voltmeter will be placed on the conductive paper side-by-side at a set distance of separation (one centimeter is a useful separation to use). It is best to tape the two leads of the voltmeter together for this procedure (see Figure 3).

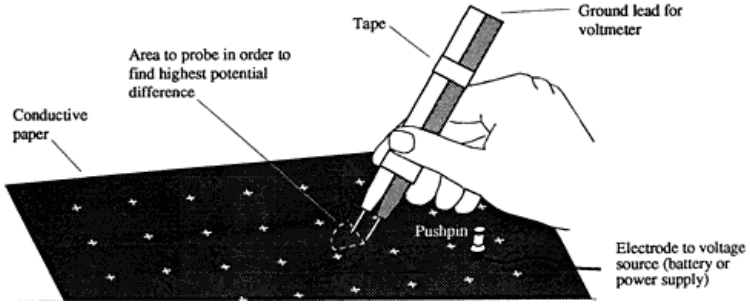

Figure 3: The Probes for plotting Field Gradient

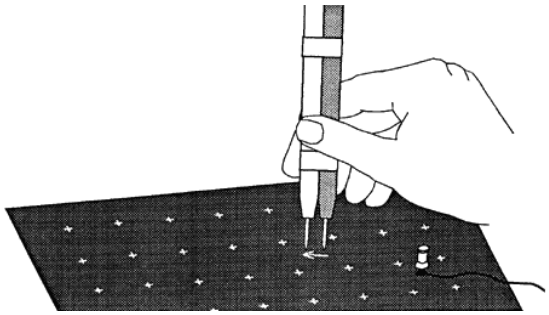

Figure 4: Directional Tracking

The technique is to use the voltmeter leads to find the direction from an electrode that follows the path of greatest potential difference from point-to-point.

NOTE: Do Not attempt to make measurements by placing the leads on the grid marks on the conductive paper. Touch the voltmeter leads only on the solid black areas of the paper. It may be necessary to use a higher voltmeter sensitivity for this measurement than was used in measuring equipotentials.

To plot the field lines on the conductive paper, place the voltmeter lead connected to ground near one of the dipoles. Place the other voltmeter lead on the paper and note the voltmeter reading. Now pivot the lead to several new positions while keeping the ground lead stationary

2. (see Figure 4). Note the voltmeter reading as you touch the lead at each new spot on the paper. When the potential is the highest, draw an arrow on the paper from the one lead to the other, but always make sure you are going from the high potential to the low potential (see Figure 5). Then move the ground lead to the tip (head) of the arrow. Repeat the action of pivoting and touching with the front lead until the potential reading in a given direction is highest. Draw a new arrow. Repeat the action of putting

the ground lead at the tip (head) of each new arrow and finding the direction in which the potential difference is highest. Eventually, the arrows drawn in this manner will form a field line. Return to the dipole and select a new point at which to place the voltmeter's ground lead. Again probe with the other lead until the direction of highest potential difference is found. Draw an arrow from the ground lead to the other lead, and repeat the process until a new field line is drawn. Continue selecting new points and drawing field lines around the original dipole.

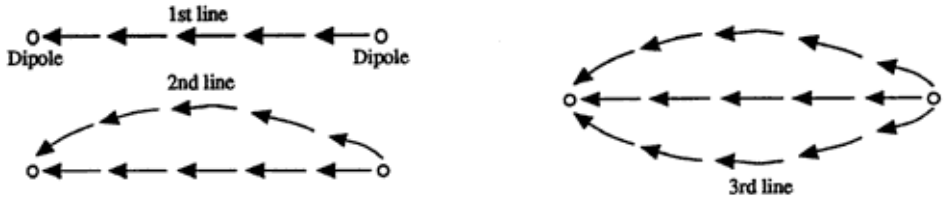

Figure 5: Electric Field Lines