

Name _____ Date _____

Partner _____

Electric Field Plotting (Equipotentials): E&M Lab #2
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Objective: to become familiar with the concept of electric potential by mapping it manually.

Equipment:

Background:

An electric field exists in the space surrounding an electric charge. This field can be detected by a small positive (+ q) test particle, by noticing what force it experiences at different positions in the field. The intensity of the electric field vector $E(x)$ is defined as this force per unit charge.

$$\vec{E} = \frac{\vec{F}}{q} \quad \text{Newtons/Coulomb}$$

The direction of E is the same direction as the force on +q. This means that the direction of E points away from a positive charge Q , since a positive charge would repel a positive test particle.

Use a colored pencil to sketch the electric field lines around a positive charge (+Q): +Q

The electric field lines, or lines of force, are the lines a test particle would move along if allowed. In the region around a negative charge the lines of electric field point toward the charge since a negative charge would attract a positive test particle.

Use a colored pencil to sketch the electric field lines around a negative charge (-Q): -Q

In a careful drawing, the density of field lines represents the strength of the electric field.

Equipotentials:

Because it is difficult to trace the movements of actual small particles, an alternative method is used to map an electric field in space. This is the method of equipotential surfaces, or equipotentials. Such a surface (or a line in two dimensions) is perpendicular to the electric field lines. The electric field is the same value all along an equipotential surface, so an electrically charged particle could move anywhere on the surface with no input of energy.

Use a regular black pencil to sketch the equipotential lines on the drawings you made above of the field lines around the two different charges (positive and negative).

The equipotential method of finding the electric field involves first locating the equipotential lines by a voltmeter, then later constructing the field lines as perpendiculars to them.

Procedure:

1. On the corkboard surface place a piece of white paper. Cover it with a piece of carbon paper with the ink side toward the blank paper. Then cover the carbon paper with the heavy black conducting (how do they do that?) paper with electrodes drawn on it with silver ink. For your first trial use the black paper with two point (circular) electrodes on it. Later you will try other configurations of electrodes.

2. Use a metal pushpin to connect one long wire to one of the silver painted electrodes. Use the other metal pushpin to connect another long wire to the other silver painted electrode.

3. Make sure that your power supply is turned off. Set the knob to zero volts. Choose one of the long wires and connect it to the Negative output terminal on the power supply. Also connect the COMMON lead from your volt meter to this same terminal. Now you have a common ground for the power supply, the black paper, and your meter. This point electrode will be the zero volt electrode. Trace around the painted electrode and check to see that the carbon paper has marked this on your white paper underneath. Label it "zero."

4. Connect the other long wire to the Positive output terminal on the power supply. Turn on the power supply and gradually turn the knob to increase the voltage to 10 volts.

5. Set your meter so that it can read 10 DC volts. (Proper scale is _____.) Touch the positive probe from the meter to the positive metal pushpin. It should read 10 volts. Adjust the power supply's knob to make the reading as close to 10 volts as possible.

6. Gently run the meter's positive probe along the black paper between the electrodes until you locate a position where the voltage is 2 volts. Press down to make a mark through the carbon paper to the white paper underneath. However, try not to damage the black paper. Move the probe along until you find another position where the field is 2 volts. Again make a mark. Continue making marks so that later you can sketch the equipotential line of 2 volts from one side of the black paper all the way across to the other side of the black paper.

7. Move the probe to find points where the potential is 4 volts. Make different marks (x or circle) so that you can distinguish them from the 2 volt marks.

8. Locate and mark points for 6 volts, and then for 8 volts.
9. Turn off the power supply. Carefully remove the white paper. (This is your data.) Sketch in the complete equipotential lines and label their voltage values. Also draw the size of the electrodes and label their potential values.
10. Use a colored pencil to sketch the electric field lines as everywhere perpendicular to the equipotential lines you measured.
11. Set up the corkboard with a different black paper, one with electrodes which are two parallel lines. Repeat steps 6 to 10.
12. Set up the corkboard with a different black paper, one of your choosing, such as point and line, four points, two lines pointing at each other, triangle and line. Repeat steps 6 to 10.

Analysis:

Comment on how well your measurements correspond to theoretical pattern predictions. Consider your uncertainty in making the equipotential plots.

Future work with this method: