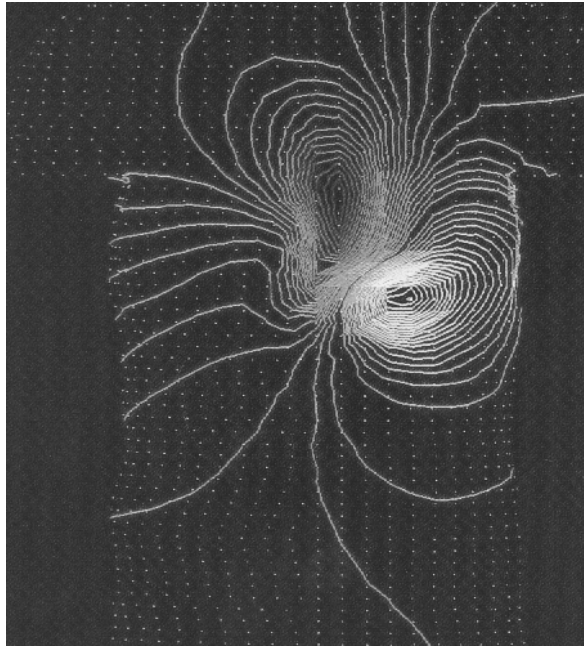


Name: _____

Partners: _____

PHYSICS 221 LAB 3: ELECTROSTATIC



The picture above shows several lines that each have a constant electric potential (equipotential lines) due to a person's beating heart. At the instant that the image was made, one side of the heart was positively charged and the other side was negatively charged.

OBJECTIVES

1. To learn about electric potential and how to find equipotential lines.
2. To learn how to draw electric field lines after equipotential lines are known.
3. To approximate the strength of an electric field using measurements of electric potential.

OVERVIEW

There are two tools used to describe electrical interactions. The Electric Field is the electric force on a test particle divided by its charge. It is useful because once you know the electric field at a point in space, the force on any charge placed there can easily be found. The Electric Potential Difference (or Voltage) between two points is defined as the difference in potential energy of a test charge moved between the points divided by the charge. Lines with the same electric potential are called equipotential lines. A voltmeter can be used to measure the potential difference between points (the units are $1 \text{ J/C} = 1 \text{ V}$).

There are several properties of electric potential to keep in mind:

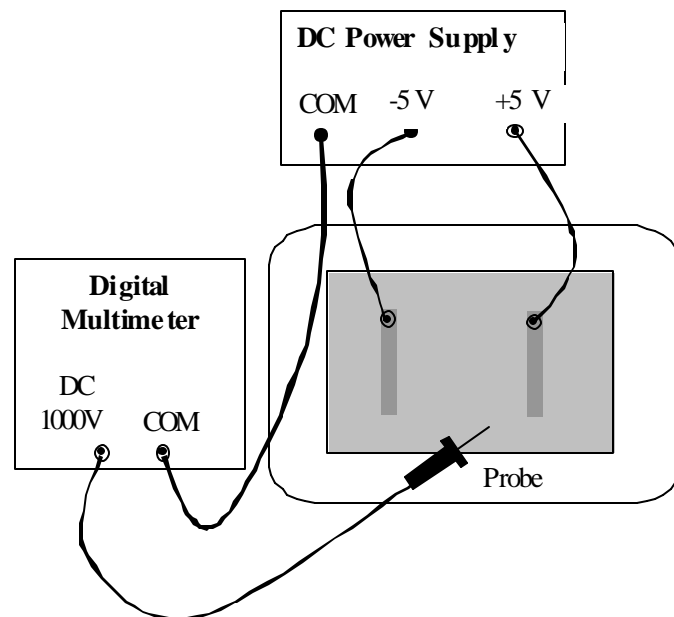
1. If no charge is moving, the voltage is the same everywhere on a conductor
2. Electric field lines are always perpendicular to equipotential lines and they point from higher to lower voltage
3. The voltage changes more quickly with distance where the electric field is larger. For short changes in distance, the size of the electric field can be approximated by $|E| = \frac{|V_B - V_A|}{d}$, where d is the distance between the points A and B where the voltage is measured. The units for electric field are $1 \text{ N/C} = 1 \text{ V/m}$.

Some important properties of electric field lines are:

1. They only start at positive charges and end at negative charges.
2. They are closer together (more dense) where the electric field is larger.
3. They are perpendicular to conducting surfaces.

PROCEDURES: Electric Potential and Electric Field

1. Get a sheet of resistance paper (carbon impregnated) with electrodes in the shape of a small dot and a circle or two parallel lines drawn on it in silver conductive ink. Tack the corners of the paper down on a corkboard. Carefully sketch the shape of the electrodes on one of the attached pages with the same grid pattern as the resistance paper.
2. Attach leads to a power supply and a multimeter as shown in the diagram below. Two of the leads should be connected to the electrodes with pins. Set the dial on the multimeter to “DC V” so that it will measure differences in electric potential (also called voltage). Turn on the multimeter and the power supply.



3. In order to test that good contacts are made with the electrodes, touch various points on each of the electrodes with the tip of the probe. The voltage readings for all points on an electrode should be very nearly the same (within about 0.1 volts).
4. Find several equipotential lines by touching various points on the paper with the tip of the probe to figure out where the voltage is the same. Start by finding the lines where the voltage is -4 V, -3 V, -2 V, ..., and +4 V. For each of these voltages, carefully draw and label the equipotential lines on the white "grid paper", not on the black resistance paper.
5. In a different color, carefully add electric field lines to the page with equipotential lines drawn on it. Be sure to include arrows to indicate the directions of the electric field lines.

Question: Briefly explain how you determined the directions of the electric field lines.

Question: Is the electric field necessarily zero where the electric potential is zero? Explain.

Question: What are the signs of the charges on the electrodes? Explain how you know.

6. Chose another sheet of resistance paper with a different electrode pattern on it. Carefully sketch the shape of the electrodes on the second piece of white “grid paper”.
7. Repeat steps 1 through 5 to find equipotential lines and electric field lines.

Question: How can you tell by just looking at the equipotential lines (without a calculation) where the electric field is large or small?

8. For two points selected by the instructor, use the electric potential measurements to estimate the magnitude of the electric field. Show your calculation for each. Don't forget to include units!

$$E_1 = \underline{\hspace{10em}}$$

$$E_2 = \underline{\hspace{10em}}$$

9. Check one of your estimates of the electric field using the wire with two prongs and the Digital Multimeter. Measure and record the distance between the two prongs.

$$d = \underline{\hspace{4cm}}$$

10. Touch the prongs to the conducting paper around the point and rotate them until the reading is maximum. Record the difference in the electric potential between the prongs.

$$\Delta V = \underline{\hspace{4cm}}$$

11. Calculate the electric field for the point.

$$E = \underline{\hspace{4cm}}$$

Question: How does this measurement compare with your estimate?

