Mapping Electric Field Lines

Purpose:

You will use multimeter probes to find equipotential curves for at least two different electrode arrangements. Electric field lines will then be drawn from your equipotential curves.

Materials:

- ✓ Electric Field Lines Apparatus
  - Clear plastic platform
  - Clear plastic dish
  - Various metal electrodes
- ✓ Connecting wires
- ✓ Two D-cell batteries
- ✓ Graph paper, multiple sheets
- ✓ Water
- ✓ Multimeter

Preliminary Setup:

1. Trace the outline of the clear plastic dish onto a sheet of graph paper (call this the base paper). Repeat this two more times for each lab partner, making sure to put the dish in the same place on the paper each time (call these the recording papers). This is important because you will be mapping out potentials at very specific points. Each lab partner should now have two sheets of graph paper with the dish tracing.
2. Set the clear plastic dish between the four short posts on the platform. Set the platform on top of the base paper, lining up the tracing and dish carefully.
3. Fill the dish about halfway with water.
4. To start, you will be looking at the electric field created by two point sources. Attach the two point source electrodes (the ones that look like L's) to the electrode posts on the platform base. Make sure enough of the metal is exposed behind the post so that you can connect a wire to it.
5. On your multimeter, make sure the red lead is plugged into the jack labeled "VΩmA" and the black lead is plugged into the jack labeled "COM". Turn the dial to DCV 20V. To test, touch the ends of the probe to a battery. Is the reading accurate (should be close to the voltage labeled on the battery)?
6. Connect two batteries together, negative terminal to positive terminal. Connect two connecting wires to the ends of the batteries, but do not connect them to the platform just yet.
7. Look over your setup. Is everything ready to go?

Procedure:

1. Connect the batteries to the electrodes.
2. Choose a starting point in the dish – it can be anywhere you like. Place the black multimeter probe on that starting point. Mark this spot X_0 at the corresponding point on one of your recording papers (each partner is marking their own recording paper).
3. Move the red multimeter probe around the dish until the reading on the multimeter is "0", meaning the potential difference between the red and black probes is zero – these are equipotential points. Mark this point with an X_1.
4. Keeping your black probe in place, move the red probe around until you find at least 3 more equipotential points (but more is always better – you'll get a better shape of the equipotential curve this way). Label the points with X_2, X_3, etc.
5. Repeat steps 2-4 until you have found 5 equipotential curves. For clarity, use a different marking scheme for each curve (i.e., X's for the first, dots for the second, triangles for the third, etc.)

6. Choose another electrode arrangement. There are two plane and two circle electrodes. Choose a combination from the six available electrodes.
7. Repeat steps 2-5 for the new electrode arrangement.

Analysis:

For each electrode arrangement:

1. Connect your equipotential points to create a curve.
2. Using a different color pen, draw the electric field lines created by the two electrodes.

In Your Lab Notebook

Write out the purpose and materials. *Summarize in your own words* the preliminary setup and procedure. The wording on this sheet was in an 'instructive voice'. The wording will you use should be in a 'reporting voice'. pretend that you are presenting your procedure to another class – you wouldn't want to read instructions to them.

Tape your drawings into your lab notebook. Each lab partner should have their own set of drawings.

Write a conclusion to the lab answering the following:

1. What did you learn by performing this lab? Is the relationship between equipotentials and electric fields clearer in your mind?
2. What was easy about performing this lab? What was difficult?
3. If you were asked to perform this lab again, what would you do differently?
4. Did you observe anything strange, unusual, or unexpected (these are the fun things about labs)? If so, what was it?

In Case You Need A Reminder…

Properties of Electric Field Lines and Equipotential Curves and Surfaces

1. Electric field vectors are tangent to electric field lines.
2. The field lines begin on a positive charge and end on a negative charge. If there is an excess of one type of charge, some lines will begin or end infinitely far away.
3. The field line arrowheads point from positive charges and toward negative charges.
4. The number of field lines that leave a positive charge or that end on a negative charge is proportional to the magnitude of the charge.
5. No two field lines can cross.
6. Electric field lines are perpendicular to equipotential surfaces where they intersect.
7. The closer the electric field lines are to each other, the strong the electric field is in that region.