

Electric Field Mapping / Equipotential Lines

Purpose: Find equipotential lines around a charged object(s) in order to draw in electric field lines.

Materials:

- Power Supply
- Digital Multimeter
- hollow copper circle
- High Tech – Excel Spreadsheet
- Clear Plastic/Glass Tub
- 2 metal plates (copper)
- graph paper (2)

Procedure:

Initial Setup

1. Label your two sheets of graph paper identically. On the long side of the paper assign a letter for each row. On the short side of the paper assign a letter with each row. You should have two sheets of graph paper that are identical with references to each other.
2. Place the clear dish on top of one of the sheets of graph paper.
3. Fill the dish with about a $\frac{1}{2}$ inch of water.
4. Continue with the experiment you are assigned.

Point Charges

1. Plug in the power supply and run the two leads to the clear dish and place them in the water. Place the positive lead around D10 over the graph paper. Place the negative lead at K10 over the graph paper.
2. Using the digital multimeter, connect the ground probe (black) to the negative lead from the power supply. The test probe (red) should be measuring voltage.
3. Starting with A1, place the test probe into the water directly over the A1 box on the graph paper.
4. Read the voltage off of the multimeter and write the value in the A1 box on your piece of graph paper.
5. Continue this process until your entire graph paper is filled out.

Parallel Plates

1. Plug in the power supply and connect the positive (red) to one of the metal plates and the negative (black) to the other metal plate.
2. Place the metal plates in the dish where the teacher instructs you to.

3. Using the digital multimeter, connect the ground probe (black) to the negative lead from the power supply. The test probe (red) should be measuring voltage.
4. Starting with A1, place the test probe into the water directly over the A1 box on the graph paper.
5. Read the voltage off of the multimeter and write the value in the A1 box on your piece of graph paper.
6. Continue this process until your entire graph paper is filled out.

Hollow Ring

1. Plug in the power supply and connect the positive end (red) to the hollow metal ring and then place the ring in the center of the dish. Allow the negative lead (black) to lie anywhere else in the dish outside of the ring. Note on your graph paper where the metal ring is at in the dish.
2. Using the digital multimeter, connect the ground probe (black) to the negative lead from the power supply. The test probe (red) should be measuring voltage.
3. Starting with A1, place the test probe into the water directly over the A1 box on the graph paper.
4. Read the voltage off of the multimeter and write the value in the A1 box on your piece of graph paper.
5. Continue this process until your entire graph paper is filled out.

Data Analysis

Low Tech Option

- 1) Students need to draw lines of different colors on the graph connecting areas of equal potential (voltage). Use intervals of .5 Volts.
- 2) Starting with the positive draw lines that are perpendicular to the equipotential lines. Every intersection should form a right angle.
- 3) Place arrows on your lines showing the direction of electric field.

High Tech Option

- 1) In excel, type your data from your graph into a spreadsheet. The letters and numbers from your graph paper should correspond to letters and numbers within the excel spreadsheet.
- 2) In the bar at the top select, insert then chart.
- 3) Select surface chart and choose either the color 2D chart or the Black/White 2D chart.
- 4) Put a title on the chart and do not worry about axis labels.
- 5) Right click on the legend and select format legend. Select the tab that says scale and make the major and minor units .5. Make sure the minimum and maximum correlate with the minimum and maximum voltages that you measured.
- 6) Print out your graph and your spreadsheet and make sure that your group members names are on the lab.

Teacher Directions For Discussion

This lab gets very tedious for students if they are required to map the point charges, the parallel plates and the hollow ring. What works best is to put students into groups six, where each pair of students does 1 of the 3 labs. Then copies of each graph can be made for the rest of the group. Handling the post lab for this is up to the teacher comfort level and/or time restrictions. Students could do a formal lab write up. A list of questions below can help to guide a post lab discussion

Questions

1. What does the legend of the graph tell us?
2. Place three test charges on each graph and show the direction each test charge will take.
3. Draw in three electric field lines for each field. (Remember: electric field lines are drawn perpendicular to equipotential lines.
4. Why are electric field lines drawn perpendicular to equipotential lines?
5. What do electric field lines show us?
6. Describe the spacing of the electric field lines around a point charge.
7. Describe the spacing of the electric field lines around/between parallel plates.
8. What does the spacing of electric field lines tell us?
9. What is the electric field strength inside of the copper ring? Explain why this is the case.