EQUIPOTENTIALS

Objective

Equipotential contours for three geometries will be investigated to explore the relationship between potentials and electrical field lines.

Equipment

4 graph papers (included in your notebook), glass pan, 2 point sources, 1 metallic movable probe, wire leads, 6 V. battery, multimeter, 2 straight electrodes.

Procedure

1. Place a graph paper (graph paper 1 on the next pages) underneath the glass pan and fill it one centimeter deep with water. The graph paper will be used as a coordinate system to record the location of the probe. Center the origin of the coordinate system in the center of the pan.

Two Point Charges

2. Place the two metallic point sources opposite each other in the pan of water with about a centimeter gap between the edge of the pan and the point source. Using the jumper wires connect the battery to the electrodes. **Record the position and shape of the probe on a second graph paper** (graph paper 2) **similar to the one underneath the pan**.

3. Connect the meter with the negative lead to the negative battery terminal and the positive lead to the moveable probe. This is the probe you will use to measure the potential at different locations in the pan of water for the variously shaped electrodes. The meter should be set to read DC voltages.

4. Place the probe in the water and look for places with the same potential. Use your knowledge of how the electrical field lines should appear to aid you in finding the equipotential lines. **Find five equipotential contours: Find as many points on each contour as needed to create a smooth curve and record the corresponding potentials on graph 2. Sketch in the electrical field lines that correspond to the equipotential contours found. Indicate clearly the direction of the electric field.**

Error Analysis

5. You probably noticed that it is somewhat difficult to find points with exactly the same potential. This is due to the inherent **uncertainty in the measurement process**. Use the following method to estimate the **error in your position (Δx):**

- With the two point charges, measure the potential at the midpoint of the line connecting them.

- Keeping the moving probe vertical, slide it toward one or the other electrode until the meter displays the uncertainty on your measurement: This distance is the error in your position (Δx).

Uncertainty on your measurement (V)	Error in your position (mm)

Parallel Plates

6. Repeat steps 2-4 using the two straight electrodes aligned parallel to one another. **Include measurements of the potential along the line that connects the midpoints of the electrodes. Record your results on the graph paper 3.**

A Point and a Plate

7. Repeat with a point charge and a plate. Orient the plate as you choose, but be certain to sketch it correctly. **Record your results on the graph paper 4.**

Graphs and Diagrams:

For the two straight electrodes, plot the potential versus distance along the line that connects the midpoint of the electrodes.

Questions and Calculations:

1) How do the equipotential lines differ in the patterns they make for different geometries?

2) How does the potential vary with distance when the two straight electrodes are used? Explain what you expect this relationship to be and why.

3) What is the function of the water in the pan? Would it be possible to do this experiment with air in the pan? If so, how would it be different? If not why not?

4) Explain the relationship between contours of constant potential and the electric field direction.

5) Why is the electric field a vector quantity while the electric potential is a scalar?

Graph paper 1

Draw a coordinate system on this page: Center the origin approximately in the center of the page. Place this graph paper underneath the glass pan.

Last name: ……………………………… First name: ………………………………

Graph paper 2

- Record the position and shape of the probes. Label them.
- Find five equipotential contours.
- Using a different color, sketch in at least five electrical field lines.

Last name: ……………………………… First name: ………………………………

Graph paper 3

- Record the position and shape of the plates. Label them.
- Find five equipotential contours, including measurements of the potential along the line that connects the midpoints of the electrodes.
- Using a different color, sketch in at least five electrical field lines.

Last name: ……………………………… First name: ………………………………

Graph paper 4

- Record the position and shape of the plates. Label them.
- Find five equipotential contours.
- Using a different color, sketch in at least five electrical field lines.