Course and Section_______ Names ___________________________

Date__________ _________________________________

EQUIPOTENTIAL LINES EXPERIMENT

Introduction

In this experiment you will measure the electric potential between two electrodes of different shape. This is achieved by placing the electrodes in a tray with water (the electrolyte) and by using a probe to find the points of the equal potential.

Equipment

Tray with water and graph paper, metal electrodes: 1 straight, 1 with a 90º angle, 1 circular electrode, 3 short cables and 1 long cable with probe at the end, Power supply (set to 12V AC) two graph paper, Multimeter.

Preliminary questions

a. Sketch and label **both** the equipotential and the electric field lines for the following two configurations. Assume $V_o > 0$.

Parallel conducting plates:

Electric dipole:

b. Electric field lines are everywhere _________ to electric potential lines.

PART 1 – Wedge Electrode

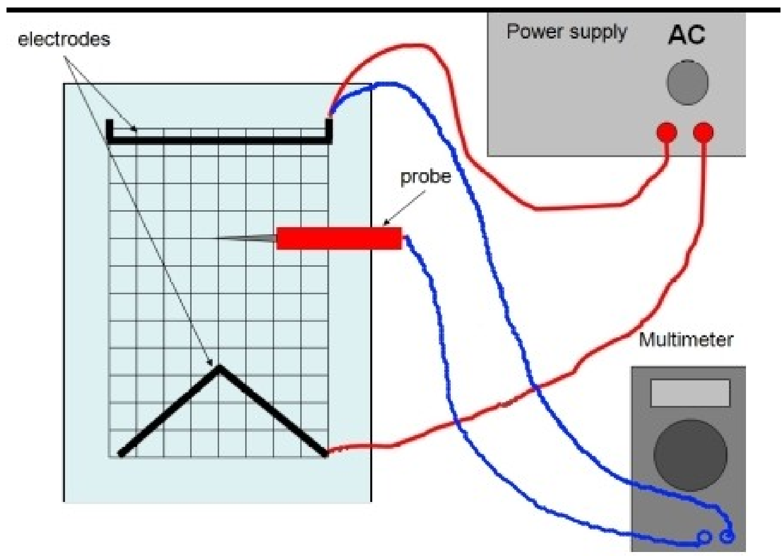

Figure 1

Procedure

The goal is to find the equipotential lines within the two electrodes.

Step 1. Ensure there is a grid plastic film in the bottom of the tray. Check there is at least 2mm of water covering the entire tray grid, if not ask for assistance.

Step 2. Place the straight electrode and the wedged electrode on the tray as shown in Figure 1.

Step 3. Connect the wedge electrode to the AC output terminal of the power supply using a banana cable.

Step 4. Connect the straight electrode to the AC output terminal of the power supply using a banana cable.

Step 5. Connect the straight electrode to *VΩHz* slot of the multimeter using a banana cable.

Step 6. Connect a probe to the COM slot of the multimeter.

1. Set the AC voltage to 12 V on the power supply. Use the probe to measure the potential on the straight electrode (top electrode in Figure 1).

$$V_{\text{Straight Electrode}} = \_\_\_\_\_\_\_\_$$

If it is not zero check that your connections match with Figure 1 or ask for assistance.

2. Use the probe to measure the potential on the wedge electrode

$$V_{\text{Wedge Electrode}} = \_\_\_\_\_\_\_\_$$

The label 12V on the AC power supply is clearly not precise. When taking the AC voltage measurements trust the readings on the multimeter, not the label on the power supply.

3. Place the probe vertically in the water, move it at random points in the tray, what is the range of the possible values of the AC voltage reading?

Step 7. Use the probe to find points having equal value of potential: by connecting these points you will obtain a equipotential line. Start measuring the first equipotential line about 2 cm away from the straight electrode. The grid of the graph paper is 0.5 cm.

Step 8. Read the coordinates of the probe location from the grid and have somebody else to draw the corresponding point on the graph paper. <u>Collect a minimum of six points of equal value of potential.</u>

Step 9. Connect the dots on the graph paper to trace out the equipotential line.

Step 10. Find the next set of points of equal potential and draw the equipotential lines. Take a intervals of about 2 V between the lines.

Step 11. As you move closer to the wedge electrode start using smaller interval of about 1 V.

Step 12. Try to be more accurate next to the wedge by taking a few extra measurements of points at equal potential.

Step 13. Using these equipotential lines, sketch the electric field lines on the same graph paper. The electric field lines are perpendicular to the equipotential lines.

Analysis

6. At which locations in the tray are the equipotential lines closest together?

7. At which locations in the tray are the equipotential lines farthest apart?

8. Mark and label your responses to question 6 and 7 on the graph paper.
9. What does the separation of the equipotential lines imply about the value of the electric field at these points?

10. Calculate approximate values of the electric field at the places where it is strongest.

11. Calculate approximate values of the electric field at the places where it is weakest.

12. Why do the equipotential lines near the electrodes tend to follow the shape of the electrodes?

13. For better experimental results, you have used AC Voltage instead of DC Voltage. Now consider instead a DC voltage: 0 V on straight electrode and 12 V on the wedge electrode.

No need to perform the experiment, simply imagine that a floating plastic object (positively charged) is placed in the middle of the tray. Will the object feel a force?

14. If it does feel a force, in which direction respect to the straight electrode?

15. If it does feel a force, would that force be constant throughout its motion?

PART 2 - Circular Electrode

Procedure

Step 1. Replace the wedge electrode in figure 1 with a circular electrode. Put the circular electrode in the center of the tray. Power supply set on 12 AC voltage.

17. Use the probe to measure of the voltages of the straight and the circular electrode.

$V_{\text{Straight Electrode}} =$ ________ $V_{\text{Cicular Electrode}} =$ ________

You want the reading of the voltages of the straight electrode to be zero and voltage of the circular electrode to be about 13.5V. If not check your connections or ask for assistance.

Step 2. Repeat the *Steps 7-11* of PART 1 to find the equipotential lines. Start on the straight electrode and move toward to the circular electrode.

Step 3. Draw the equipotential lines on the graph paper.

Step 4. Draw the electric field lines on the graph paper.

18. What is the value of the potential at the center of the circular electrode?

19. What is the value of the potential at any other point within the circular electrode?

20. What does your answer to question 19 indicate about the value of the electric field inside the circular electrode?

21. Imagine that a floating plastic object (positively charged) is placed inside the circular electrode. Will the object feel a force?

22. If it does feel a force, in which direction respect to the straight electrode?

Turn off the power supply and turn off the multimeter