Theory

In class, we learned about electric potential energy. For simple point charges, this energy is proportional to $1/r$. However, for more complicated systems (such as two charged plates), the electric potential energy dependence is less obvious. Fortunately, it is still possible to "map out" the electric potential energy with equipotential lines.

Equipotential lines are lines where the potential energy is the same. Figure 1 shows equipotential lines in purple and electric field lines in black. Here, any point on a given circle has the same potential energy since it's the same distance from the positive charge.

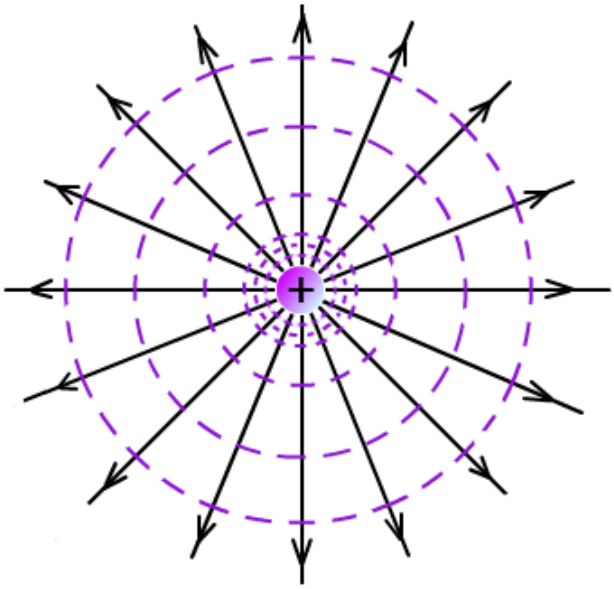

Figure 1: Schematic of a point charge. The solid black lines are the electric field lines. The purple dashed lines are the equipotential lines.

In this lab, we'll be measuring voltage. Voltage is related to electric potential energy as

$$V = \frac{E_{electric}}{q} = \frac{kq}{r}$$

The units of volts, then, are

$$1 \text{ V} = 1 \text{ N} \cdot \text{m/C}$$

Experiment

In this lab, we'll be mapping out the equipotential lines for several configurations.

1. Choose a configuration board (see Figure 2). This board may be in the front or back of the classroom.
2. Copy the schematic onto a separate sheet of paper. Your instructor should teach you how to do this accurately.

3. Turn the mapping board over (see Figure 3). Screw the configuration board into the bottom of the mapping board.
4. Turn the mapping board right-side-up.
5. Using either tape or the legs of the mapping board, fix the schematic onto the top of the mapping board.
6. In your notes, sketch a prediction of what both the electric field lines and equipotential lines will look like.
7. Turn your multimeter to measure voltage (DC).
8. Use the probe to measure the voltage on the mapping board. Your instructor should teach you how to operate the multimeter and the probe if you do not know how.
9. Select a voltage (around 3 V is a good start). Mark the spot where you measured the voltage with a pencil, like in Figure 4. Keep probing for this voltage and marking the spot until you have enough points to form a curve (at least five points).
10. Once you have at least five points on your equipotential curve, connect the points. Remember to write down what voltage you measured next to the curve.
11. Repeat steps 9–10 until you have at least five different equipotential curves.
12. Repeat the entire process for one additional configuration. Just like with all labs, **you should rotate responsibilities!**

Figure 2: An example of a configuration board.

Figure 3: The a mapping board.

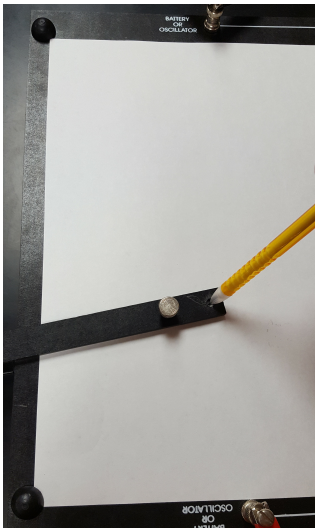

Figure 4: How to mark on the paper with a pencil. Note that the pencil is in the hole.

Questions

1. List at least three possible errors that you encountered during this lab.
2. Did your predictions match the experimental results? How were they different?