

The Potential Field of a Dipole Spring 2009

Introduction

The purpose of this lab is to directly measure a system that simulates the potential field of two charges. This is an opportunity to see a potential field first hand. There is no need for a conclusion or discussion; you will be graded on the *care* with which you made the measurements, sketches and calculations. Since this is the first experiment in which you will use a multimeter, be sure to print and read the document "Using a Digital Multimeter". Bring this document with you to lab for the next two weeks.

Theory

You have a conducting paper with wires that connect a voltage source to two bolts on the paper. The voltage source maintains one bolt on the paper about +15 volts above, and the other about -15 volts below the 'reference' potential, which is 0 volts. *Make sure the electrode nuts (under the paper) are finger tight!*

The assumption is that the electric current in the paper (due to these voltage sources) will cause a potential at each point on the paper, which is the same potential you would calculate if the bolts were charges in a vacuum.

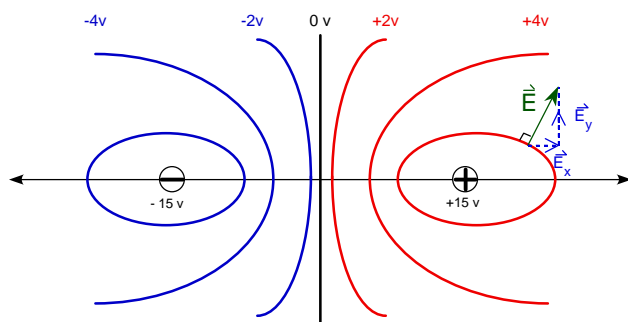


Figure 1: The potential field around two charges

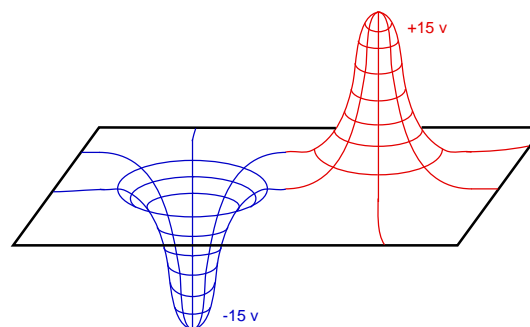


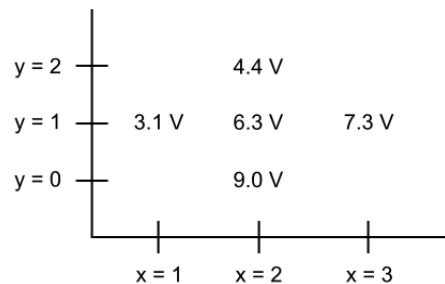
Figure 2: Topographic representation of the potential field around two charges

Experiment

1. Your instructor will show you how to label a piece of graph paper to correspond to the crosses on the conducting paper, with each major division on the graph equal to two crosses on the conducting paper (x ranges between 6 units, y between 4 units).
2. Plug in the power supply and turn the voltmeter on. Adjust the voltmeter to the 200 DCV setting (display's Direct Current voltages up to 200 volts). The voltmeter's (-) terminal is connected to the 'reference' terminal on the voltage supply; the (+) terminal is connected to the red meter probe that you will use for your measurements.
3. Touch the probe to the carbon paper. The voltmeter reading, *which is the potential at that point*, will depend on where you touch the carbon paper. The voltage along the y -axis (between the charged circles) should be close to zero. Move the probe around to get a sense of how the potential behaves. Keep your hand off of the carbon paper while measuring voltage – it will affect the reading!
4. Now record the potential for each integer x - y pair. You might want to collect a few more measurements to find where the electric potential equals zero volts.

Calculations

5. *Equipotentials*. Sketch equipotential lines for the following voltages: 0, ± 2 , ± 4 , ± 6 , and ± 8 volts (don't be concerned if the line for 0 volts isn't along the central vertical axis, or if you can't create a curve for 8 volts). Your instructor will show you how to do this by interpolation.
6. *The electric field \vec{E} from the potential V* . Copy the potentials around the point (2, 1) on another sheet of paper and use them to find the components of \vec{E} for your map as illustrated below:



$$E_x = -\frac{\Delta V}{\Delta x} = -\left(\frac{7.3 - 3.1}{3.0 - 1.0}\right) = -2.1 \frac{V}{cm}$$

$$E_y = -\frac{\Delta V}{\Delta y} = -\left(\frac{4.4 - 9.0}{2.0 - 0.0}\right) = +2.3 \frac{V}{cm}$$

7. After finding the components of \vec{E} , sketch them *on your graph* at the point (2, 1), using a scale of $1 \frac{V}{cm} = 2 \text{ cm}$ (drawn on graph). The vector sum of \vec{E}_x and \vec{E}_y (the \vec{E} field at that point) should be *perpendicular* to the nearest equipotential line (as shown in Figure 1). Be sure to place the components of \vec{E} tail to head, as shown in Figure 3 below.
8. Repeat steps 6 and 7 for a few more points near an equipotential line.

Discussion

- Briefly summarize what you did in this experiment, and what you observed.

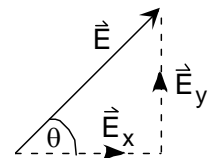


Figure 3: Vector addition (Remember???)

Please turn off the multimeter when finished!