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LAB: EQUIPOTENTIAL MAPPING

AP PHYSICS II

Driving Question | Objective

How does electricity flow from positive to negative? How do scientists map this flow? In this lab, we will be creating equipotential maps to discover electricity flow.

Materials and Equipment

Voltmeter

Wires – 1 red wire, 1 black wire, red metal stylus

Capstone

Conductive paper – 2 sheets – 1 simple, 1 random

2 different colored pencils

Regular pencil

Cardboard

PASCO 550 Universal Interface

Background

In the same way that objects travel from high potential to low potential energy (falling towards the Earth, for example), charges move from high voltage to low voltage. This traveling creates an electric field. Equipotential/isolines model where the electric potential energy on the electric field is equal.

The electric potential energy, or voltage, at any point can be found using V=kQ/r, where k is constant 9x10^9, Q is the charge, and r is the distance away from the charge.

In this lab, you will find equipotential lines around the charges by testing different spots on conductive paper and plotting where they are the same.

Safety

- Follow this important safety precaution in addition to your regular classroom procedures:
  - Follow instructions pertaining to the Voltmeter carefully.
  - Be cautious in the use of electrical outlets.
  - Make sure to remove all wires from the outlets before disconnecting them from the sensor.

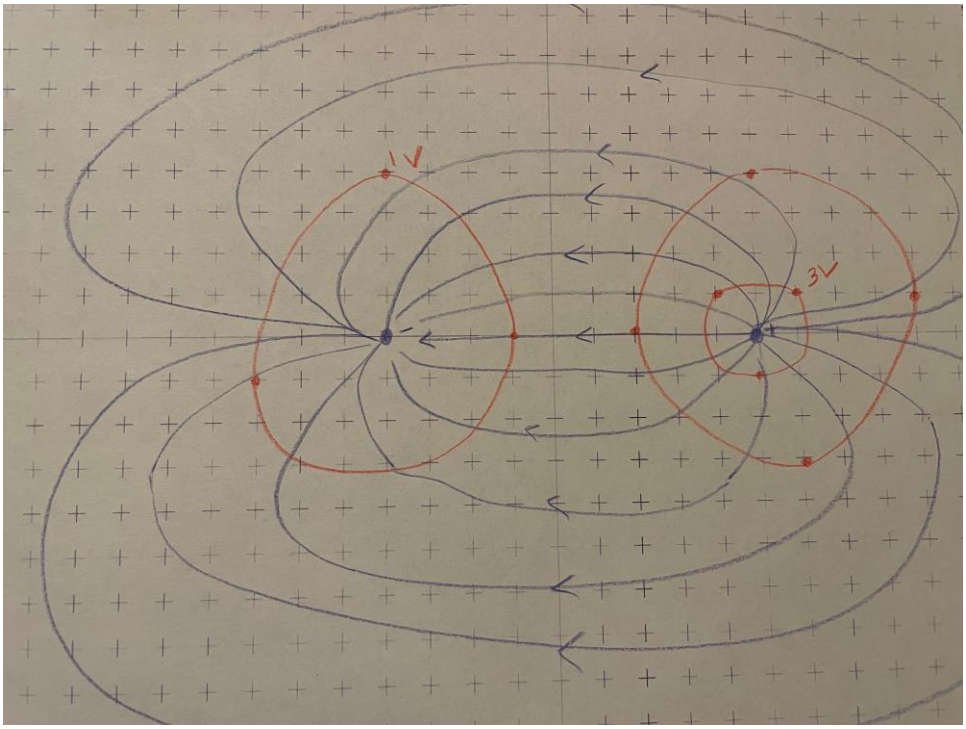
Procedure

1. Open the Capstone file on your computer. Make sure the settings are correct. Go to Tools > Signal Generator and make sure the 550 device is connected. Under “waveform”, make sure it is set to “DC”. Then, make sure “DC Voltage” is set to 5 V, and set the voltage limit to 8 V. Finally, click the on button located at the bottom of the window.
2. Put the first conductive paper (with the two dots) on the cardboard. On the graph paper, mark the location of the two dots with your pencil.
3. Have one group member hold the metal part of the red wire on one dot and the metal part of the black wire on the other dot. Don’t let the wires themselves or anything else touch the paper.
4. Have another group member use the stylus. Put the stylus on the conductive paper and drag it until the voltmeter says 4 volts. Have a third group member mark that spot on the graphing paper with the first colored pencil and label it with a 4. Continue until you get several points for 4 volts. Draw a connecting line/loop through these 4-volt points with that first colored pencil.
5. Repeat step 5 for 3V, 2V, and 1V.
6. Now, get the second colored pencil. Draw a line starting from the positive wire location to the negative wire location. Make sure this line is perpendicular to the original colored lines each time it crosses them. Repeat at different angles several times, and it is recommended that you draw the lines in pairs.
7. Attach a picture of this completed equipotential map in the “data” section.
8. We will now give you another conductive sheet, this time with a random design on it. Mark this design on another sheet of graph paper with your regular pencil.
9. Repeat each step as with the first sheet and attach a picture in the “data” section.

Data Analysis

On this page, attach a picture of each of your two equipotential maps.

Two-Dot Map:



Random Map:

Unfortunately, we did not have enough time to get a random map.

Analysis Questions

1. What did you notice about how charges moved across the paper?

   Charges moved from the positive to negative, as we would expect them to. They moved in circular-like motions that were perpendicular to the equipotential lines.

2. Based on what you have learned in the lab, what correlation did you find between positive/negative charge and the amount of voltage?

   There is a strong linear correlation between charge and the amount of voltage. There is higher voltage near a positive charge and lower voltage near a negative charge.

3. How did the different shapes of the conductive tape or insulators (if you had it) affect the outcome of your second mapping compared to the first?

   We did not have enough time, but the shape of the equipotential lines are probably different.

4. If you add an insulator in the middle of the sheet (or another one if you already have one), how would that change your new map? What would be the new shape?

   We did not have enough time to do so.

5. What are some ways to prevent error when conducting the lab?

   Not using our hands to hold the black and red wires (if it was attached to a stationary object it would be more stable) and making sure our hands do not touch the conductive paper.