Physics 196 Lab 3: Electric Potential

Equipment:
Battery Block, Digital Volt Meter, Cork Board, Alligator Leads, Voltage Probe Leads, Conductive Tacks, Patterned Conductive Paper: Line-Line, Patterned Conductive Paper: Dot-Line, Patterned Conductive Paper: Dot-Dot, Patterned Conductive Paper: Concentric Circles

Layouts:

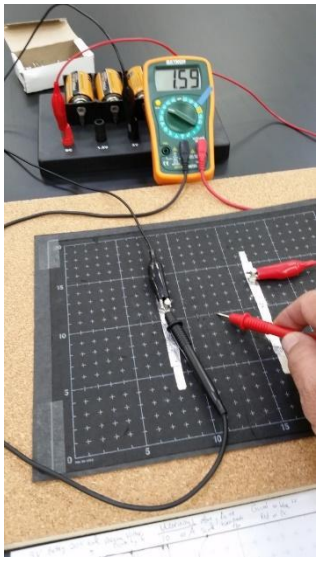


Fig. 1: Experimental Equipment

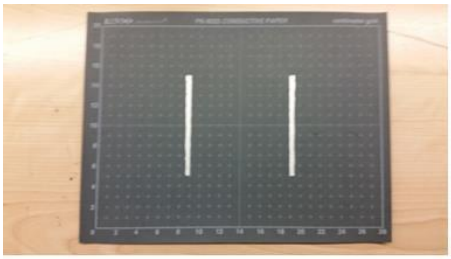


Figure 2a. Line-Line

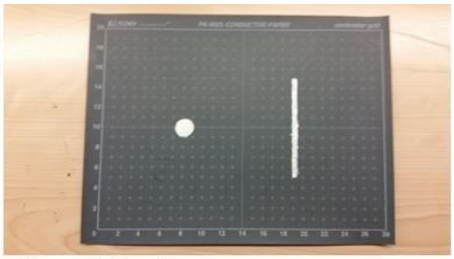


Figure 2b. Dot-Line

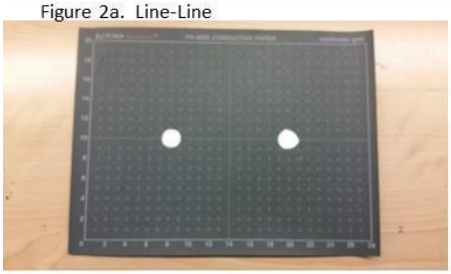


Figure 2c. Dot-Dot

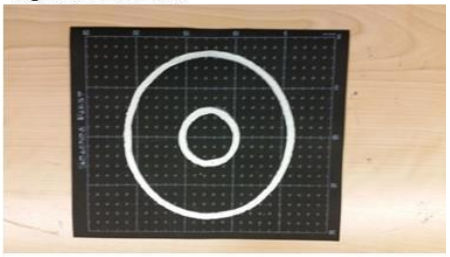


Figure 2d. Concentric Circles

Figure 2: Electric Potential Configuration Examples

Summary:

Students will work in teams of two, using a battery power source (3V output suggested) to apply a voltage difference to conductor patterns (high conductivity) which have been applied to black conductive paper (low conductivity). Students will use a Digital Volt Meter (**Warning- do not change meter knob setting while leads have any voltage applied)** to probe the electric potential (measured in volts) at various locations on the conductive paper. One team member will find locations which are at a particular electric potential (for instance 0.5V, 1.0V, 1.5V, 2.0V, 2.5V) while the other team member plots those locations on a separate diagram. In this way, equipotential curves will be mapped out. After drawing in equipotential curves, the direction of electric field lines can be inferred (because they are always perpendicular to equipotential curves), and compared to what was observed for similar conductor patterns in Laboratory 2. A diagram of the experimental set-up is shown in figure 1, along with four sample conductor patterns in figure 2.

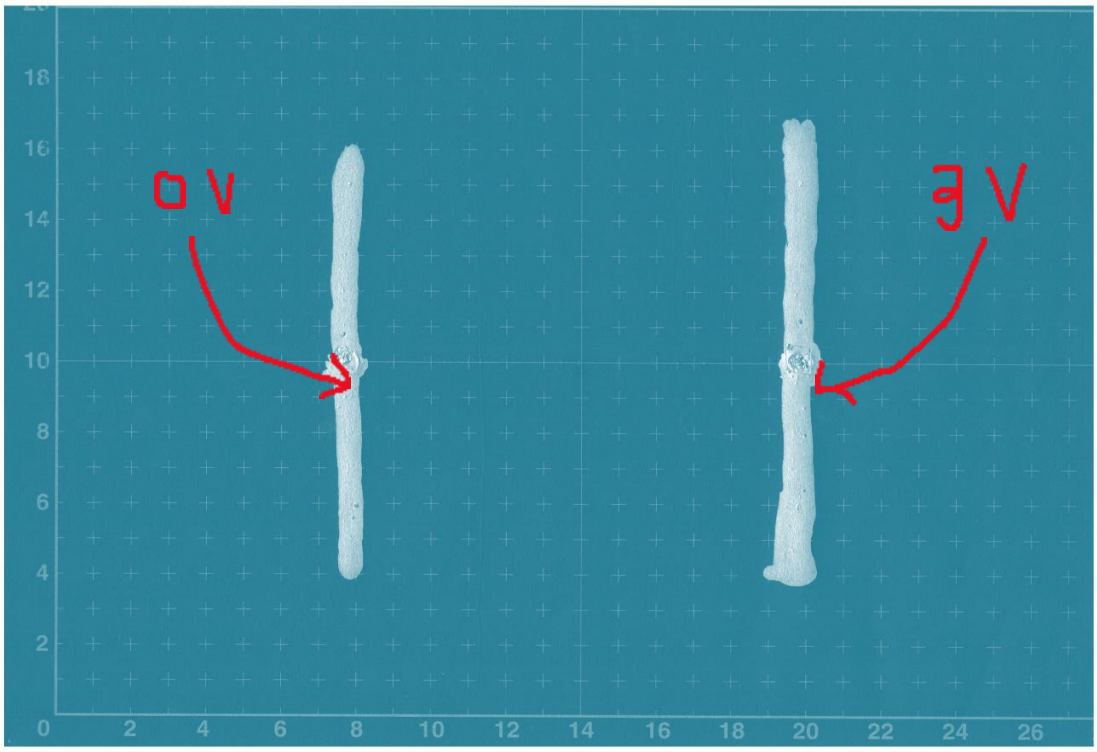
Prelab: On the first page of your lab write-up, please tape in the first page of this document, containing Equipment, Layouts and Summary. Then, prepare the next four pages so that the top of the page contains a prediction of what the equipotentials will look like for each of the four conductor configurations (a, b, c, d) and the bottom leaves room for the actual measurements of positions which are at the particular measured potentials. These pages could be prepared in a number of ways. You could print out the next four pages of the lab write-up and tape those into your notebook. Then make your prelab predictions in the top part. This should work both in color or in black and white. If you don't have a printer, or if you think it will be too hard to see things when writing on the scanned patterns, you can duplicate the patterns by scaling the drawings with one graph paper square equal to a 1 cm x 1 cm square on the conductive paper. The equipotential predictions should be for 0.5V, 1.0V, 1.5V, 2.0V and 2.5V assuming the conductors are at 0V and 3.0V.

Lab: Set up the lab by placing a pattern on the cork board, and inserting a conductive tack all the way in so that the bottom of the tack is in FIRM CONTACT with the top of the conductor pattern. (One tack for each conductor). Apply black leads between the 3 V battery terminal and one of the conductors, and between that conductor and the ground input for the digital volt meter. This will be your ground (and don't ask why the battery supply is set up this way). Apply a red lead between the red terminal and the other conductor. Finally, after the digital volt meter is turned to a setting appropriate for a range from 0 to 3V DC, attach a meter probe to the red voltage meter input. The other, pointy end, will be used to measure the potential at various locations on the conductive paper. Measure the voltage on the conductor connected to ground (should be 0 V) and the other conductor (should be close to 3 V, but not exactly, write the value in your lab notebook on the appropriate conductor). You will move the probe to measure positions where the voltage is 0.5V, 1.0V, 1.5V, 2.0V and 2.5V, but notice that if the applied voltage is not exactly 3V, these positions will not be exactly where they would have been predicted in a perfect prelab. For each voltage, you will measure and plot 10 or more points spread fairly evenly across the width of the paper. For each pattern, MAKE A NEW GRAPH under the corresponding prediction graph from the prelab. (Use the template at the bottom of the page, or your own careful template).

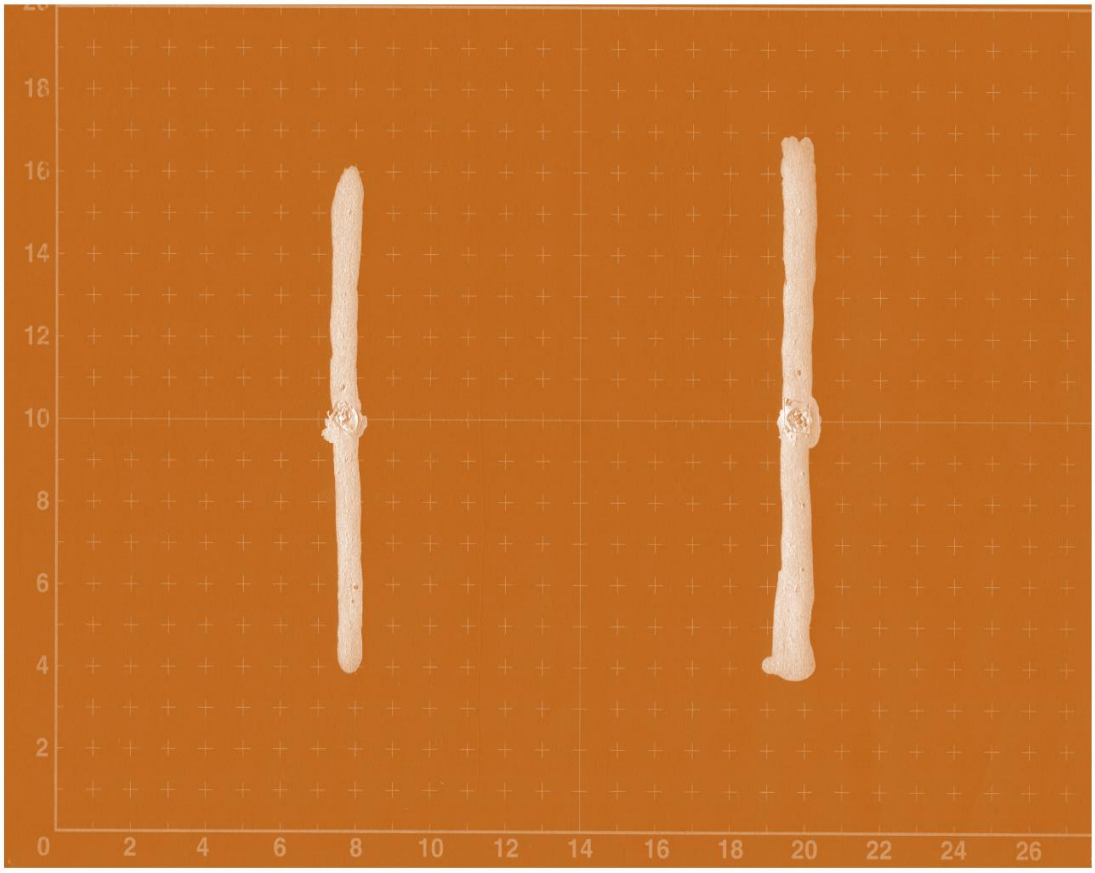
For the first pattern chosen, one team member should move the volt meter probe around on the paper to find a closely spaced set of points where the potential measures 1.5V. The other team member should plot these points on the corresponding graph (under the one from the prelab) in her/his notebook. Connect the points together in a curve (and label the measured voltage on this curve). This is an equipotential curve. Then in turn repeat these measurements for the other 4 voltages (0.5V, 1.0V, 2.0V, 2.5V), so that you have five equipotential curves at equally spaced voltages. Discuss the results with regard to the pre-lab predictions. Sketch in the electric field lines.

Have fun, and try to get a feel for how equipotential curves behave close to conductive surfaces. On the page after the four sets of prediction and measurement graphs, be sure to write a complete description of the experimental procedure followed, with a labelled experimental diagram including electrical connections. Then provide a discussion of what you observed, including how your measurements compared to your predictions, and how the estimated electric field lines (perpendicular to the equipotential curves) compared to the electric field measurements made in Lab 2. Finally, include a conclusion paragraph about what you learned from this lab.

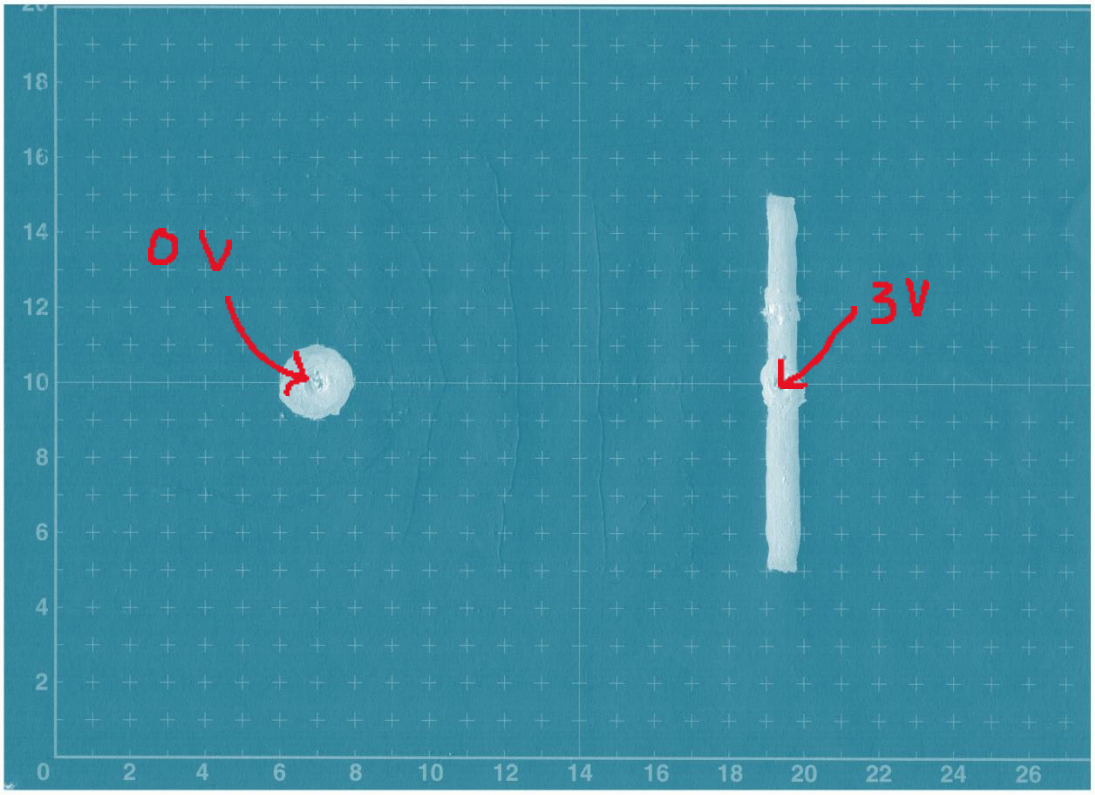
Prelab Predition for location of Equipotentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, Configuration a.



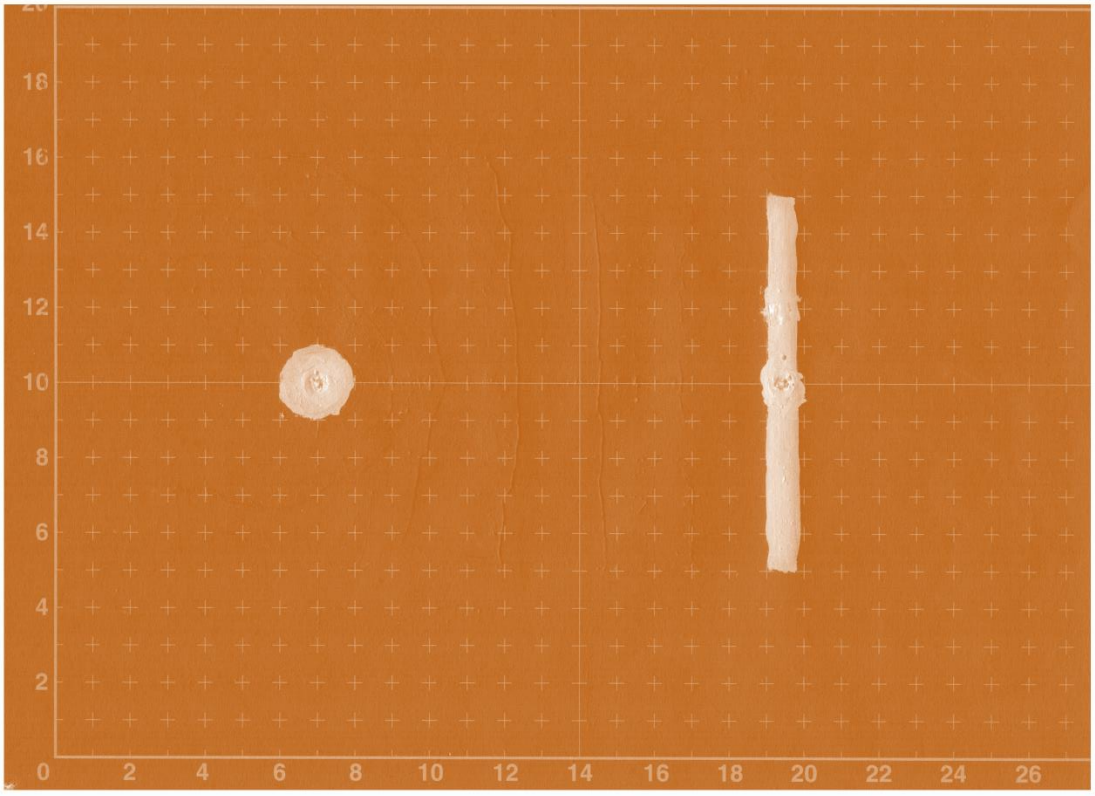
Measured points at potentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuration 1, Line-Line



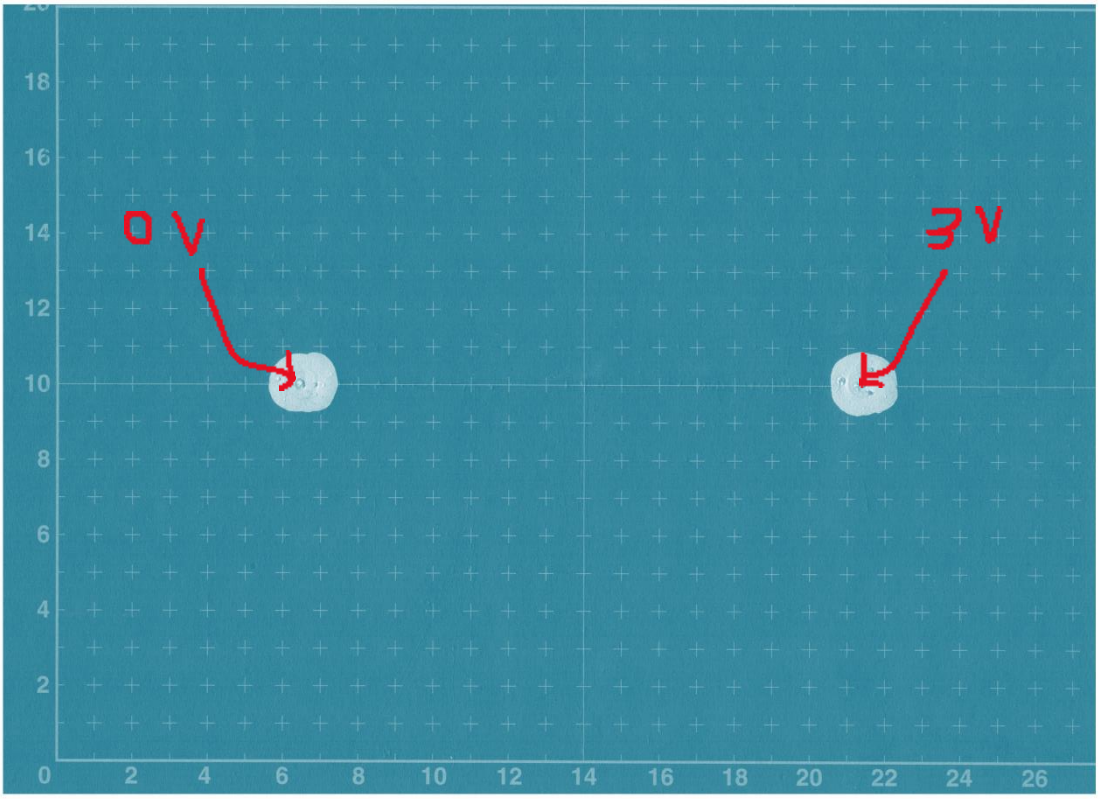
Prelab Predition for location of Equipotentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuration b.



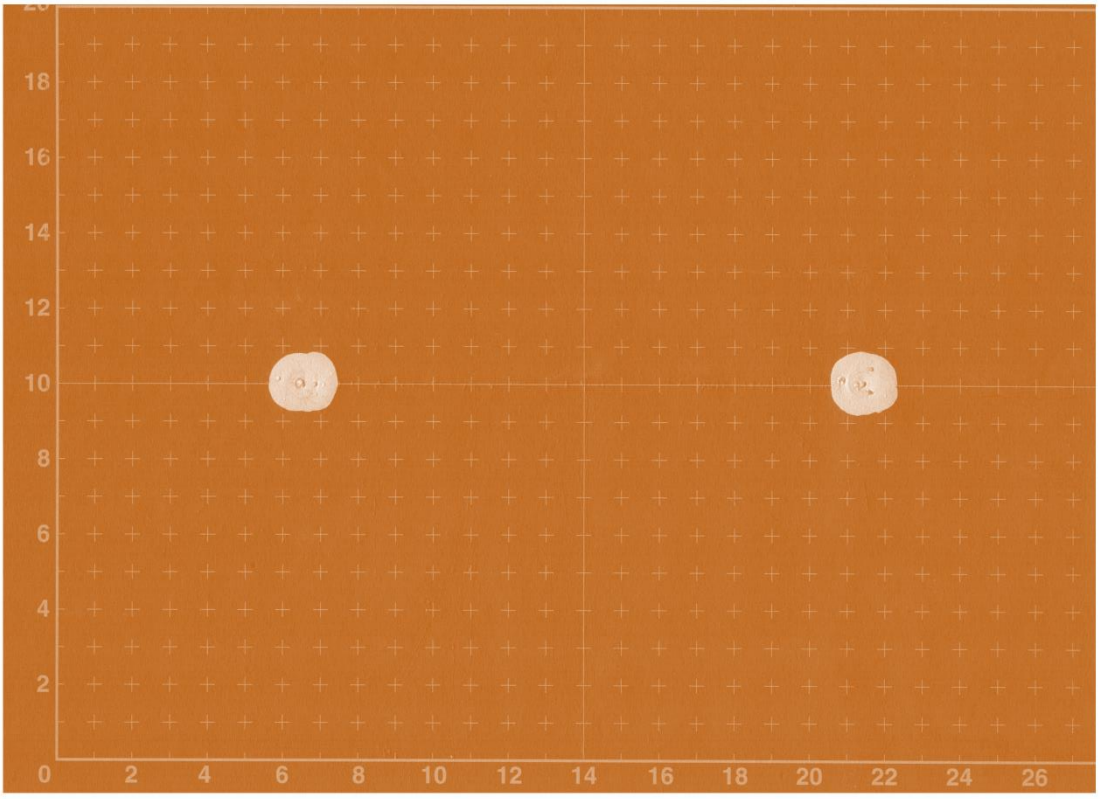
Measured points at potentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuration b, Dot-Line



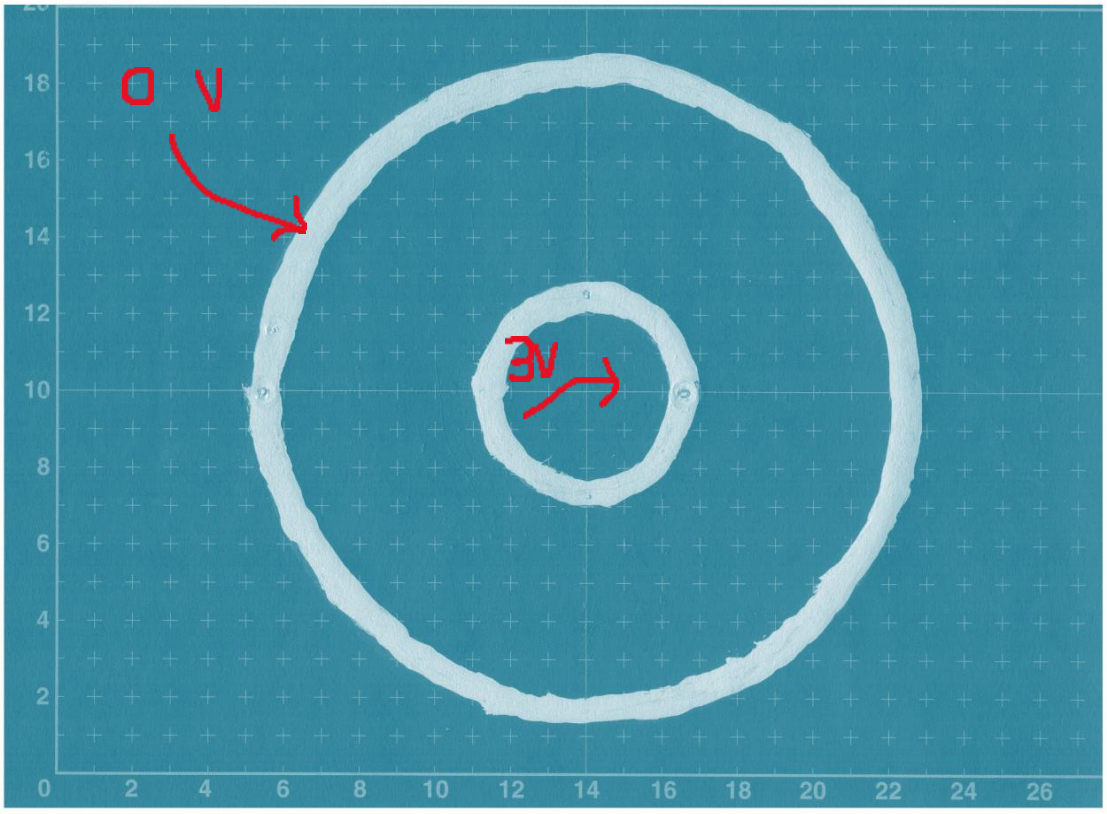
Prelab Predition for location of Equipotentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuraton c.



Measured points at potentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuration c, Dot-Dot



Prelab Predition for location of Equipotentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuration d



Measured points at potentials of 0.5V, 1.0V, 1.5V, 2.0V, 2.5V, configuration d, concentric circles.