Conductive Paper Module Student Guide

Today we will use a product called “PK-9025B Conductive Paper” from PASCO Scientific. The resistance of the paper is about 5000 Ohms per cm, which is a lot, but it is conductive enough to allow enough current through a voltmeter to measure an electric potential difference across its surface. The paper can be painted the PASCO PK-9031B conductive ink pen, which has a resistance of about 5 Ohms per cm. So it is 1000-times more conductive than the paper, and this allows you to draw two shapes and form a two-dimensional capacitor on the surface of the paper. In this experiment, charge distributions made of highly-conductive ink will be placed on conductive paper, and the static electric field set up by these charges will be mapped with a voltmeter.

Activity 1: Parallel Plate Capacitor (25 minutes)

Complete Questions A, B and C below for the Parallel Plate Capacitor 2D charge distribution, using the Blank PDF to sketch, and using the data provided for you.

Activity 2: Dipole (20 minutes)

Complete Questions A, B and C below for the Dipole 2D charge distribution, using the Blank PDF to sketch, and using the data provided for you.

Activity 3: Point Charge in Circular Faraday Cage (20 minutes)

Complete Questions A, B and C below for the Dipole 2D charge distribution, using the Blank PDF to sketch, and using the data provided for you.

Question A: Sketch Equipotential Lines

Voltage is sometimes referred to as "potential", so the lines or curves of equal voltage are called "equipotential paths", or "equipotential curves", or "equipotential lines". Choose at least four different values of voltage, spread over a range between 0 and 25 V. (For example, 5, 10, 15 and 20 V). Sketch the shape of each equipotential as it exists on the conductive paper, and label the lines. In “Notes for equipotentials”, include any interesting observations you have about the overall shape of the equipotential lines.

Question B: Sketch the Electric Field Lines

If one can map the equipotential curves of an electric field, one then has only to draw perpendicular curves or lines which intersect the equipotential curves at right angles in order to specify the electric field. Remember, the electric field lines point toward regions of *lower* potential. Use a different colour, and sketch at least 8 electric field lines, and include arrows to show the direction. In "Notes for electric field", include any interesting observations you have about the overall electric field for this pattern.

Question C: Electric Potential and Electric Field and Labeled Points.

Estimate the value of the Electric Potential, in Volts, and the magnitude of the Electric Field, in Volts/meter, for each of the labeled points on the Blank PDF for your pattern.

Keep in mind, as you plot the equipotential lines, that *the electric field is strongest in those regions where the equipotential lines are most closely spaced*. This is because the electric field $\vec{E}$ is the negative gradient of the potential field: $E = -\frac{\Delta V}{\Delta r}$, where ΔV is the change in the potential which occurs over a change in location Δr.