**Gauss’s Law (E2)**

**ABSTRACT:** This experiment measured the potential difference at any point between two charged conductors. It was investigated how electric potential varied with position, and concluded that the apparatus resembles a model of two concentric cylinders. Using Gauss’s Law, is derived and utilized to interpret the experimental data obtained.

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**INTRODUCTION**:

Electrostatic potential expresses the potential energy per unit charge as a function of position in an electric field. In other words, the potential describes the amount potential energy of a unit charge would have when located at that point. Therefore, it is equal to the potential energy divided by the charge of the particle. Unlike electric field, the electric potential is a scalar quantity and gives magnitude only. It is measured with a voltmeter. The potential expression in general is:

In this experiment, Gauss’s law is used to find a suitable potential expression for this particular experiment setup with two charged conductors. The goal is then to decide between models of concentric spheres or cylinders to best describe the experimentally obtained data.

**PROCEDURE**:

A piece of graphite paper is needed for this experiment. The paper should have pre-drawn circles of radii 1 and 10 cm. The graphite paper must be placed on the corkboard. To carry out this experiment, a wire is first connected from the positive terminal of the power to the center electrode. The negative terminal is then to be connected to the outer electrode to establish potential difference. Pins can be used to fix each wire end to the paper. Next, the DC CURRENT ADJUST knob must be turned clockwise and the power supply must be set to 10 volts adjusting the DC VOLTAGE knob.

The red probe is then connected to the voltage jack of the voltmeter and a yellow lead to the COM jack of the meter. One must also clamp an alligator clip to the push-pin that connects the lead from the negative jack of the power supply. The meter should be set to unidirectional flow of charge (DC ), the second position by rotating the dial to make it read dc volts.

Now, the setup is complete. In order to make sure that the potential difference is 10.0V between the inner and outer electrode, one can touch the red probe to the inner electrode. The procedure is to measure the potential difference between the outer electode and a point, a distance of 2.0 cm from the center of the inner electrode (center). In 1.0 cm steps the potential difference is measured as the red probe is touched toward the outer electode along the radial path.

The measured potential differences are recorded and entered into an Excel spreadsheet. (attached). The potential at any point between to concentric charged conducting spheres is given by:

Where r is the distance from the center of the inner sphere and R2 is the radius of the outer sphere. According to our preference V(R2)=0 (the outer electrode = negative terminal of the power). We also know that V(R1)=10.0

Substitution: 10 =

Making respective substitutions inside the equation, one will find the value of Q=1.24 \* 10^-11C.

Now using the equation 1 with different R2 values, the positions of the red probe, theoretical sphere voltages are obtained and put into a curve aside with the experimental results. With a smooth curve theoretical points are connected (attached).

Same procedure is followed using the equation for any point between two concentric cylinders:

Substitutions are repeated to obtain the value for the simulated linear charge density. One more curve is then added to the plot containing the theoretical results from the cylinder model. Lastly, the graph must be labeled.

**RESULTS AND ANALYSIS:**

Putting all three curves into the plot allows us to recognize that theoretical cylinder model is closer to the experimental data than the spherical model. The two other relevant equations for two models are yet to be derived. First, we find the Electric Field as a function of r and then substitute it to the general expression via

The derivations are as follows:

**CONCLUSION**:

Looking at the curves, although they do not match by 100%, which is due to experimental error, we can come to the conclusion that our circles-on-a-piece-of-paper apparatus is a model of two concentric cylinders, because the circles are, after all, a very thin form of cylinders and therefore the paper we are looking at resembles a cross sectional view of two cylinders. A sphere model would require that a conductor surround the apparatus in a spherical form.