# PHYS 230
# LAB-3 REPORT

**Name:** Misbah Ahmed Nauman
**CCID:** misbahah
**Student ID:** 1830574

**Section:** EM62
**TA:** Joshua Peltonen
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# Introduction

## Objectives

The objective of this experiment is to systematically map the electric potential between two parallel plate conductors and analyze the resulting electric field distribution. This investigation aims to visualize equipotential lines and electric field vectors while quantifying the electric field strength. The results will be used to compare experimental findings with theoretical expectations.

## Background Theory

When two conductors are held at different electric potentials, an electric field forms between them, pointing from the positively charged conductor to the negatively charged one. The relationship between electric field and potential difference is given by:

$E = -\frac{\Delta V}{\Delta s}$, where:

- $E$ is the electric field strength (N/C)
- $\Delta V$ is the potential difference (V)
- $\Delta s$ is the distance between the measured points (m)

Equipotential lines represent regions of constant electric potential and are always perpendicular to electric field lines. By mapping these equipotentials, the pattern and strength of the electric field can be inferred. The electric potential at a point is defined as:

$V = \frac{U}{q}$,

where $U$ is the electric potential energy and $q$ is the charge. The force experienced by a charge in an electric field is given by:

$F = qE$,

where $F$ is the electrostatic force on a charge $q$. These equations provide a basis for understanding the relationship between electric potential and electric field.

# Methods

## Equipment Used

- Conductive paper (acts as a resistor for potential mapping)
- DC power supply (set to 4.5V)
- Voltmeter (for measuring electric potential at multiple points)
- Grid paper (for recording voltage values and drawing equipotential lines)
- Pencil and pen (to distinguish equipotential and electric field lines)
- Ruler (for measuring distances for field strength calculations)

## Experimental Setup

The experiment involved using conductive paper with two parallel plate conductors drawn on it. A 4.5V DC power supply was connected to the conductors, with one side at +4.5V and the other grounded at 0V. A voltmeter probe was used to measure the potential at multiple grid points. The collected data was used to draw equipotential lines and determine the corresponding electric field directions.

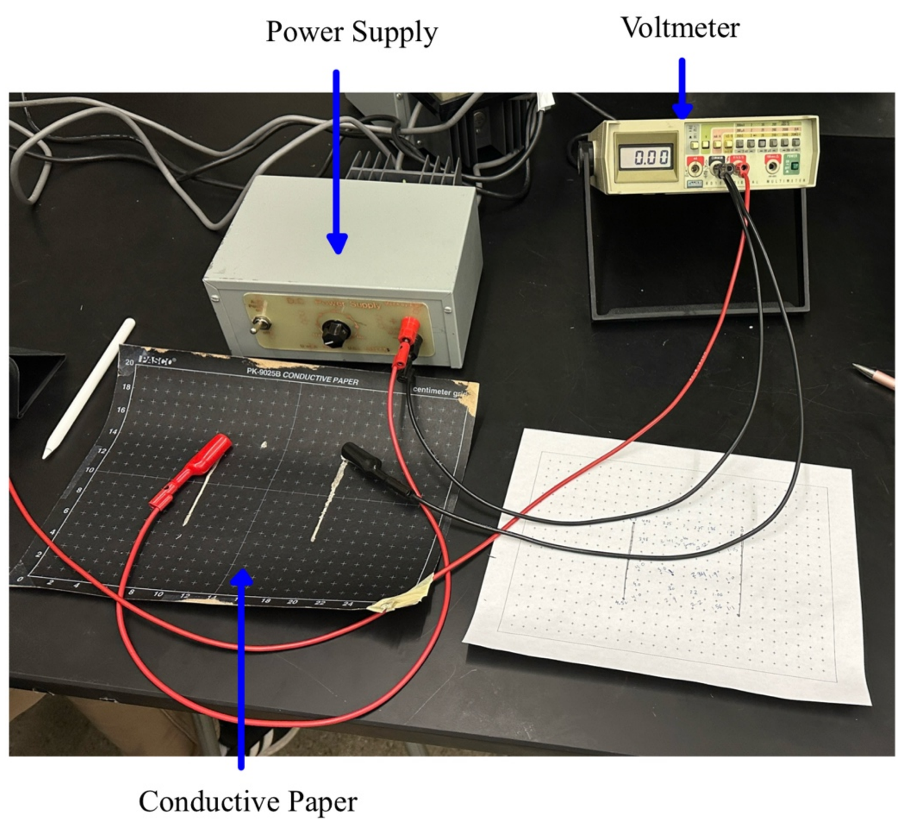


**Fig 3.1:** A labelled image of the experimental set-up.

## Procedure

1. The conductor layout was drawn on the grid paper.
2. The DC power supply was connected to the conductors (one at +4.5V and the other at 0V).
3. Using a voltmeter, the potential difference was measured at different points on the conductive paper.
4. Points with the same potential were connected to form equipotential lines.
5. Electric field lines were drawn perpendicular to the equipotential contours.
6. The distance between two points with a 1V potential difference was measured.
7. The electric field strength was calculated using $E = -\frac{\Delta V}{\Delta s}$

# Results

## Raw Data & Graph

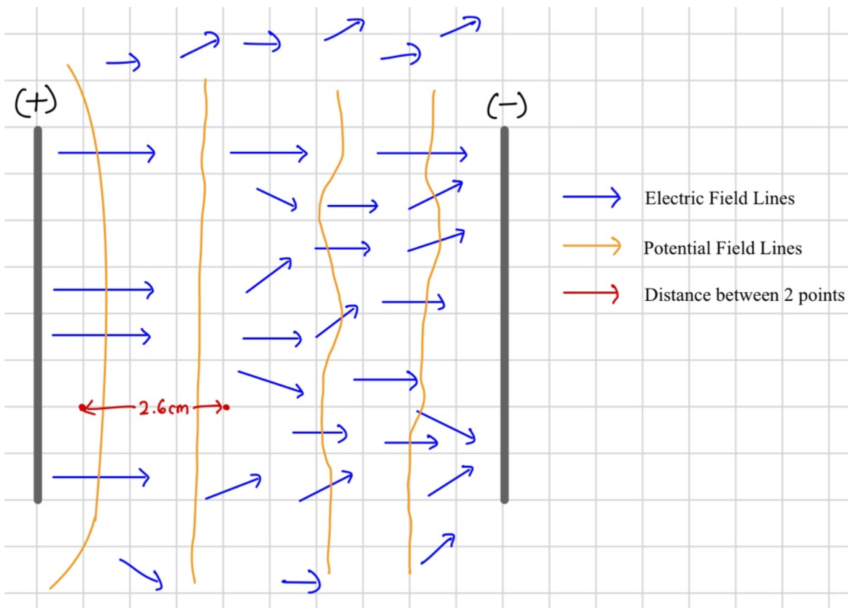


**Fig 3.2:** Potential Map with Equipotential and Electric Field Lines.

# Sample Calculations

Given:

- Maximum potential: $V_{max} = 4.5V$
- Distance between two points: $\Delta s = 2.6cm$
- Voltmeter precision $\pm 0.01V$
- Ruler accuracy $\pm 0.001m$

Using the equation for electric field:

$$E = -\frac{\Delta V}{\Delta s}$$

We compute the electric field for different potential differences.

**Sample Calculation:**

For two points $V_1 = 4V$ and $V_2 = 3V$, $\Delta V = 1V$.

Hence E = - $\frac{1\,V}{0.026\,m}$ = -38.46 N/C.

Using the Uncertainty propagation formula:

$$\delta E = |E| \times \sqrt{\left(\frac{\delta V}{V}\right)^2 + \left(\frac{\delta s}{s}\right)^2}$$

$$\delta E = 38.46 \times \sqrt{\left(\frac{0.01}{1}\right)^2 + \left(\frac{0.001}{0.026}\right)^2}$$

$$\delta E = 38.46 \times \sqrt{0.0001 + 0.00148}$$

$$\delta E = 38.46 \times \sqrt{0.00158}$$

$$\delta E \approx 1.53 \quad N/C$$

### Table of Calculated Electric Field Strength

| Equipotential Difference (V) | Distance ($\Delta s$, m) | Electric Field (E, N/C) | Uncertainty ($\delta E$, N/C) |
|---|---|---|---|
| 1V (0V – 1V) | 0.026 | -38.46 | $\pm 1.53$ |
| 1V (1V – 2V) | 0.026 | -38.46 | $\pm 1.53$ |
| 1V (2V – 3V) | 0.026 | -38.46 | $\pm 1.53$ |
| 1V (3V – 4V) | 0.026 | -38.46 | $\pm 1.53$ |
| 0.5V (4.5V – 4V) | 0.013 | -38.46 | $\pm 1.53$ |

## Discussion

### Results and Comparison

The highest electric field strength was found near the conductors, as expected. Since the field lines are more concentrated in these regions, the potential difference changes rapidly over short distances.

### Discussion of Results

The experimental results align with theoretical predictions. The parallel plate conductor design should produce a uniform electric field in the center of the plates, with field lines running parallel to each other. Slight variations in the measurements may have been caused by:

- Uneven spacing of data collection points
- Inaccuracies in manual placement of the voltmeter probe
- Small deviations in conductor alignment on the conductive paper

### Uncertainty Analysis and Improvements

The main sources of uncertainty in this experiment include:

1. Voltmeter precision $\pm 0.01$V
2. Ruler accuracy $\pm 0.001$m
3. Human error in probe placement

To improve accuracy, we could:

- Use a digital data acquisition system for voltage reading
- Increase the number of data points for a denser potential map
- Reduce interpolation errors by making finer grid measurements

## References


1. *PHYS 230 Lab Manual 3*, University of Alberta, 2025. [Online]. Available: eClass. [Accessed: Feb. 28, 2025].


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