

Charges, coulomb's law and electric potential

Physics grades 11-12 (A Level · IB · Class 11-12) · Lab

Name: _____ Date: _____ Class: _____

The field between two parallel electrodes is uniform, which means the potential changes steadily with distance. In this lab you probe a sheet of conducting paper with a voltmeter, plot the potential against position and use the gradient to find the field strength.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB D.2

Aim

To measure how the electric potential changes along a line between two parallel electrodes and to calculate the strength of the uniform field from the gradient.

Equipment

- sheet of conducting paper, 10 cm × 10 cm, with two parallel strip electrodes painted 10.0 cm apart
- low-voltage dc supply set to 6.0 V
- digital voltmeter (0–10 V) with a flying lead and probe
- connecting leads, metre rule and masking tape

Safety

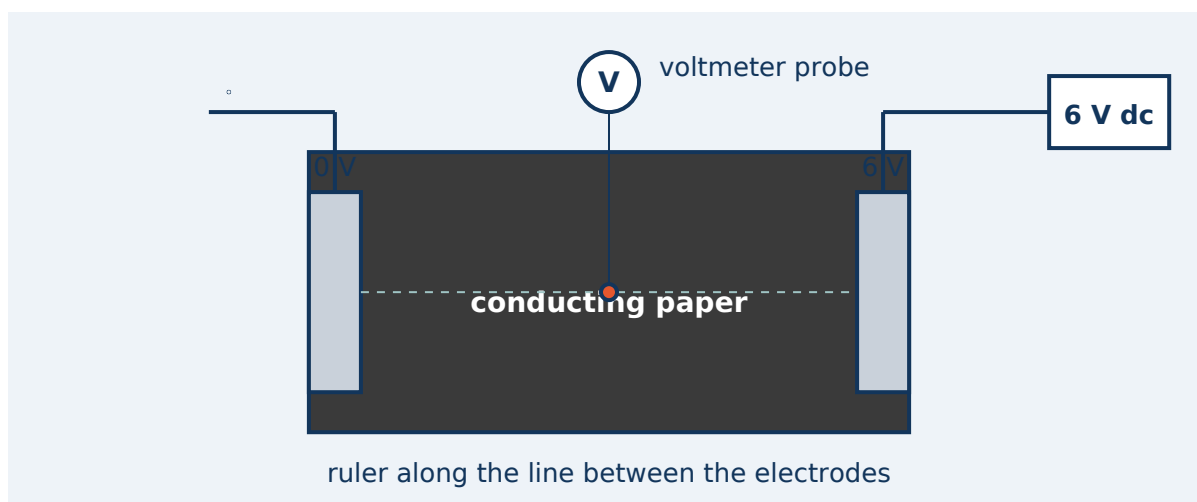
Safety

Use only the low-voltage supply, never the mains. Keep the leads dry and check that the supply is switched off while you connect the electrodes. Do not press the probe through the paper.

Method

1. Tape the paper flat and connect the left electrode to the 0 V terminal and the right electrode to the 6.0 V terminal.
2. Connect the voltmeter between the 0 V terminal and the probe.
3. Mark a line down the middle of the paper, from one electrode to the other, and label the position x in centimetres from the 0 V electrode.
4. Touch the probe on the line at $x = 0, 2, 4, 6, 8$ and 10 cm and record the potential at each.
5. Repeat the readings along a second line 3 cm above the first and compare them.

6. Plot V (vertical axis) against x (horizontal axis).



Set-up: one electrode is connected to the 0 V terminal and the voltmeter is used to read the potential at points along the paper.

Results

Sample measurements along the central line:

Distance x (cm)	Potential V (V)
0	0.00
2	1.22
4	2.38
6	3.61
8	4.79
10	6.00

Analysis questions

Question 1 Plotting the graph

Plot V against x for the sample data and describe the shape of the line.

Question 2 Gradient

Calculate the gradient of the line using the points $x = 0$ and $x = 10$ cm, in V/cm and in V/m.

Question 3 Field strength

State the electric field strength between the electrodes and the direction of the field.

Question 4 Force on a charge

Calculate the force on a 2.0 nC charge placed in this field.

Question 5 Predicted gradient

Use $E = V / d$ to predict the gradient from the supply voltage and electrode separation, and compare it with your measured value.

Question 6 Second line

The readings along a line 3 cm above the central line are the same at each x. Explain what this shows about equipotential lines.

Question 7 Near the edges

Explain why the potential readings near the top and bottom edges of a real sheet may deviate from a straight line.

Question 8 Better readings

Propose two changes that would make the potential measurements more accurate.