

Charges, coulomb's law and electric potential

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

The sample readings lie close to a straight line from 0 V to 6 V over 10 cm. The answers below use the gradient of 0.60 V/cm and show how it relates to $E = V / d$, which you should also check for your own set of readings.

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

Question 1 Plotting the graph

The points lie on a straight line through the origin, so **V increases linearly with distance** and the field between the electrodes is uniform.

Question 2 Gradient

Gradient = $\Delta V / \Delta x = (6.00 - 0.00) / (10 - 0) = \mathbf{0.60 \text{ V/cm} = 60 \text{ V/m}}$. (A least-squares fit of the six points gives 0.599 V/cm.)

Question 3 Field strength

$E = -dV/dx$ has magnitude **60 V/m**. The field points in the direction of falling potential, from the 6.0 V electrode towards the 0 V electrode.

Question 4 Force on a charge

$F = qE = 2.0 \times 10^{-9} \times 60 = \mathbf{1.2 \times 10^{-7} \text{ N}}$, in the direction of the field for a positive charge.

Question 5 Predicted gradient

$E = V / d = 6.0 / 0.100 = \mathbf{60 \text{ V/m}}$. The measured value 60 V/m agrees with the prediction within the reading error of the voltmeter.

Question 6 Second line

Points at the same x have the same potential, so lines of constant x are **equipotentials**. They are perpendicular to the field, which points along the length of the paper.

Question 7 Near the edges

The paper has a finite width, so current paths can bulge outwards and the field lines curve (edge effects). **The field is uniform only well inside the edges.**

Question 8 Better readings

Use a voltmeter with high resistance so it does not disturb the circuit; use a finer scale for x ; take readings at more points; ensure good contact between the paper and the electrodes; repeat and average each reading. **Any two sensible points.**