ELECTRICITY DAY 13: LAB L10.3 - FIELD & EQUIPOTENTIAL MAPPING

CED 10.5 · Skills 3.A/1.A · FRQ: ED · target: field lines cross equipotentials, not follow them

RETRIEVAL - NO DEMO

A map shows a 9 V contour beside a 6 V contour. Draw the local electric-field direction and state the angle at which it crosses each contour.

QUESTION AND MEASUREMENT PLAN

Question: How can measurements of V(x,y) be used to construct equipotential contours and electric-field lines?

Measured quantity: potential relative to the 0 V electrode. **Position convention:** record x and y from the marked origin.

SUPPLIES

Conductive paper, electrode paint, 0–12 V DC supply, digital multimeter, probes, ruler, and leads. Keep the supply at 12 V or below and switch it off before changing leads.

No-equipment route: PhET *Charges and Fields*, using the voltage tool/equipotential pen and the same coordinate grid. Record this as simulation data.

PREDICTION

Sketch the expected contours and field direction for your electrode shape before collecting data.

PROCEDURE

1. Trace the electrode positions and mark a coordinate origin on the map.
2. Connect the high-potential electrode to +12 V and the reference electrode to 0 V. Verify the electrode voltages.
3. Measure V at every marked grid point without moving the electrodes or changing the supply.
4. Repeat at least four grid points. Record both readings; investigate differences larger than 0.2 V.
5. Switch off the supply after measurements are complete.

VOLTAGE GRID

y \ x	0 cm	2 cm	4 cm	6 cm	8 cm	10 cm
8 cm						
6 cm						
4 cm						
2 cm						
0 cm						

REPEAT CHECK

Point (x,y)	V_1	V_2	difference

CONSTRUCT THE MAP

1. Mark each measured value at its coordinate.
2. Interpolate and draw at least five smooth equipotential contours. A contour cannot cross itself or another contour.
3. Draw at least five field lines. Each must cross every contour at 90° and point toward lower V.
4. Use arrow spacing only as a qualitative strength cue; do not claim a numerical field without a distance measurement.

MAP

FIELD ESTIMATE

$$E_n \approx -\Delta V/\Delta n$$

Use the distance Δn measured perpendicular to adjacent contours.

location	Vhigh	Vlow	Δn m	E magnitude V/m	direction
A					
B					

ANALYSIS AND CER

1. Where is the field strongest on your map? Cite contour spacing as evidence.

2. Compare your two E estimates. Is the field approximately uniform? Support the claim with numbers.

3. Explain why field lines must cross equipotentials at 90°.

4. Identify one measurement limitation and explain its likely effect on contours or E.

Claim: Describe how the field varies across the mapped region.

Evidence and reasoning: cite the map and both numerical estimates.

Required lab record: prediction, raw grid, repeat checks, constructed map, E estimates, and CER remain together.