

Potential from fields and equipotentials

AP Physics C (Mechanics and E&M, calculus-based) · Lab

Name: _____ Date: _____ Class: _____

How does the potential change from one electrode to the other, and does the slope of that graph give the field? You will map V along a salt-water tray and test whether lines of equal potential run across the tray, using only a small battery and a voltmeter.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:E&M Unit 9

Aim

Map the potential between two electrodes in a conducting solution and find the electric field from the gradient of V .

Equipment

- Shallow plastic tray, about 20 cm $\times$ 10 cm
- Two metal strip electrodes (stainless steel)
- Salt water (a teaspoon of salt in 500 mL)
- Four 1.5 V cells in a holder (6.0 V) and leads
- Digital voltmeter with a pointed probe
- Ruler or paper scale under the tray

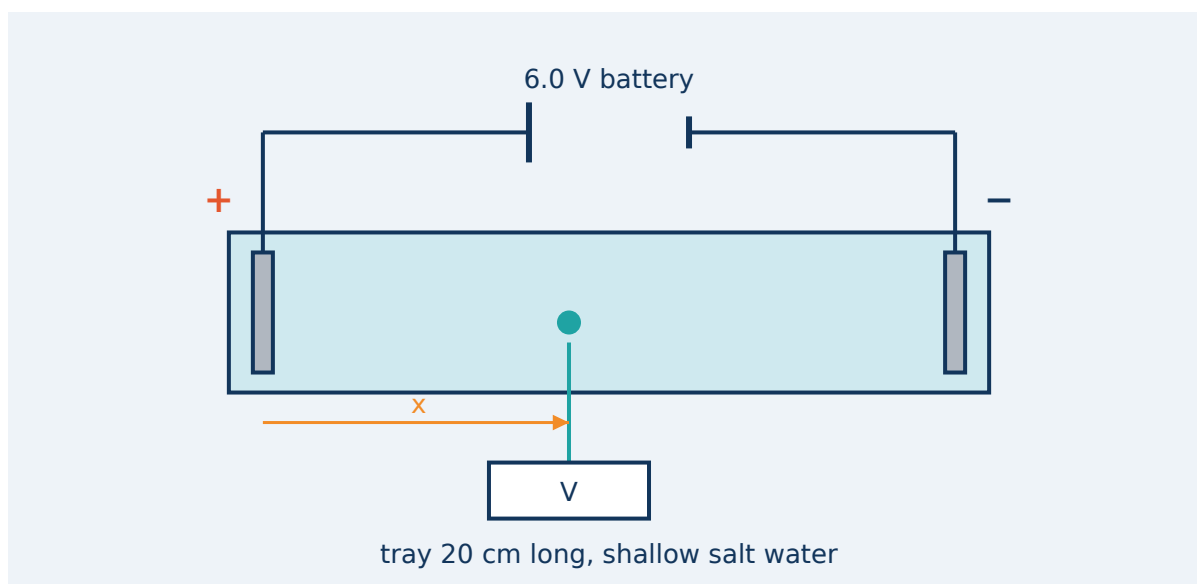
Safety

Safety

Use only the 6.0 V battery, never mains electricity, near water. Wipe up spills and wash your hands after handling the salt solution and electrodes.

Method

1. Fix the electrodes at the two short ends of the tray, 20 cm apart, and add water 1 cm deep.
2. Connect the battery across them, + to the left electrode.
3. Dip the voltmeter probe in the water on the centre line at $x = 4$ cm from the + electrode and read V relative to the – electrode.
4. Repeat every 2 cm up to $x = 16$ cm.
5. At $x = 10$ cm move the probe 2 cm sideways, both ways, and record V again.
6. Switch the battery off between readings to limit electrolysis.



Set-up: the probe measures the potential at distance x between the electrodes.

Results

Sample measurements, centre line, voltmeter negative lead on the – electrode:

x from + electrode (cm)	4	6	8	10	12	14	16
V (V)	4.9	4.3	3.8	3.1	2.5	1.9	1.3

Sideways check at $x = 10$ cm: 3.1 V on the centre line, 3.1 V at 2 cm left and 3.0 V at 2 cm right.

Analysis questions

Question 1 Plot the graph

Plot V against x and describe its shape.

Question 2 Gradient and field

Use the gradient to calculate the field in the middle of the tray, in V/m.

Question 3 Direction of E

State the direction of the field in the tray and justify it from your graph.

Question 4 Compare with theory

Calculate V_{battery}/d for the electrodes and compare it with your measured field.

Question 5 Equipotential check

Use the sideways readings to explain what they show about the lines of constant V.

Question 6 Uncertainty

The voltmeter reads to ± 0.1 V and the probe position to ± 2 mm. Estimate the uncertainty in the field.

Question 7 Reducing error

Propose two changes that would make the measured field more reliable, and say why each helps.