

Emf, internal resistance and kirchhoff's laws

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

Name: _____ Date: _____ Class: _____

A fresh cell and a worn cell may both read 1.5 V on a voltmeter, yet one powers a torch much better than the other. In this lab you vary the current drawn from a cell and use the changing terminal voltage to find its emf and internal resistance.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB B.5

Aim

To find the emf and the internal resistance of a cell from the graph of terminal potential difference against current.

Equipment

- one 1.5 V cell in a holder (use a fresh one)
- rheostat (0–10 Ω , rated at 2 A or more)
- digital ammeter (0–1 A range)
- digital voltmeter (0–2 V range)
- switch and connecting leads

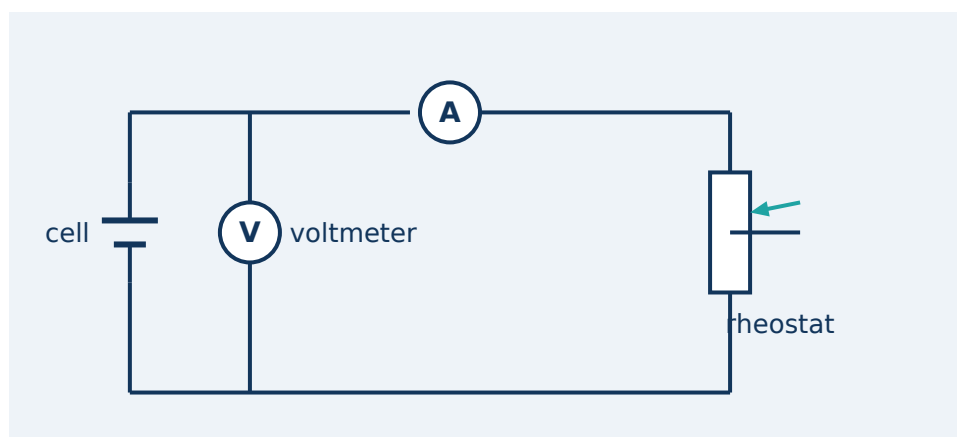
Safety

Safety

Keep the circuit switched off between readings and do not let the current exceed 0.6 A, because the cell and the rheostat warm up and a short circuit can burn the leads. Never connect the cell terminals directly to each other.

Method

1. Connect the circuit with the voltmeter directly across the terminals of the cell.
2. Set the rheostat to its largest resistance and close the switch.
3. Adjust the rheostat to give a current of 0.10 A and record the ammeter and voltmeter readings.
4. Reduce the resistance in steps to give currents of 0.20, 0.30, 0.40, 0.50 and 0.60 A, switching off for a few seconds between readings.
5. Plot V (vertical axis) against I (horizontal axis) and draw the line of best fit.
6. Determine the intercept and the gradient.



Set-up: the voltmeter measures the terminal p.d. of the cell while the rheostat changes the current.

Results

Sample measurements:

Current I (A)	Terminal p.d. V (V)
0.10	1.46
0.20	1.40
0.30	1.35
0.40	1.29
0.50	1.23
0.60	1.18

Analysis questions

Question 1 Graph

Plot V against I for the sample data and describe the relationship you see.

Question 2 Emf

Use the line of best fit to state the intercept on the V axis and say what it represents.

Question 3 Internal resistance

Calculate the gradient from the points (0.10 A, 1.46 V) and (0.60 A, 1.18 V) and state the internal resistance.

Question 4 Power in the cell

Calculate the power dissipated inside the cell when the current is 0.60 A.

Question 5 Short-circuit current

Use your values of ε and r to predict the short-circuit current, and explain why it cannot be tested directly.

Question 6 Switching off between readings

Explain why the cell should be disconnected between readings.

Question 7 Uncertainty

The voltmeter reads to ± 0.01 V. Calculate the percentage uncertainty in the p.d. at 0.60 A.

Question 8 Reliability of r

Give two procedural changes that would reduce the scatter in the measured internal resistance.