Lab Report: Internal Resistance

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1 Background

Batteries are essential components in various electronic devices, providing a portable and reliable source of electrical energy. Understanding the internal characteristics of a battery, such as its internal resistance and electromotive force (EMF), is crucial for optimizing their performance in practical applications.

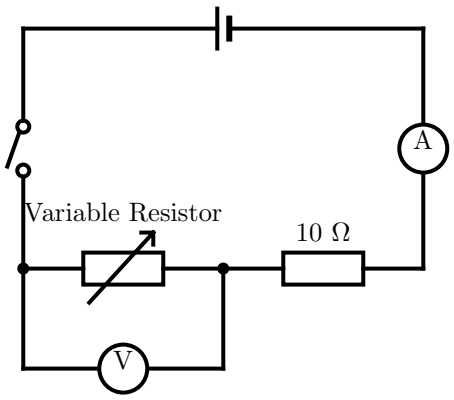
2 Objective

The primary objective of this experiment is to measure the internal resistance and EMF of a given battery. Internal resistance represents the opposition to the flow of current within the battery, while EMF is the maximum potential difference across its terminals when no current is drawn.

3 Experimental Setup

To measure the internal resistance and EMF of the battery, the following setup will be employed:

- **Components:** A variable resistor, an ammeter, a voltmeter, and the target battery.
- **Circuit Configuration:** The battery will be connected in series with the variable resistor and ammeter. The voltmeter will be connected across the terminals of the battery. This configuration allows for the determination of current, voltage, and their relationship under different load conditions.



4 Procedure

1. Set up the circuit according to the provided configuration.
2. Gradually vary the resistance in the circuit using the variable resistor and record corresponding values of current and voltage.
3. Plot a graph of current versus voltage to analyze the behavior of the battery under different loads.
4. Use the obtained data to calculate the internal resistance and EMF of the battery using relevant formulas.

5 Data Processing

5.1 Raw Data

V(V)	I(A)
2.45	0.11
2.42	0.15
2.41	0.17
2.40	0.19
2.37	0.21
2.32	0.22
2.30	0.24
2.25	0.27

Table 1: Raw data table including voltage between the variable resistor and current in the circuit.

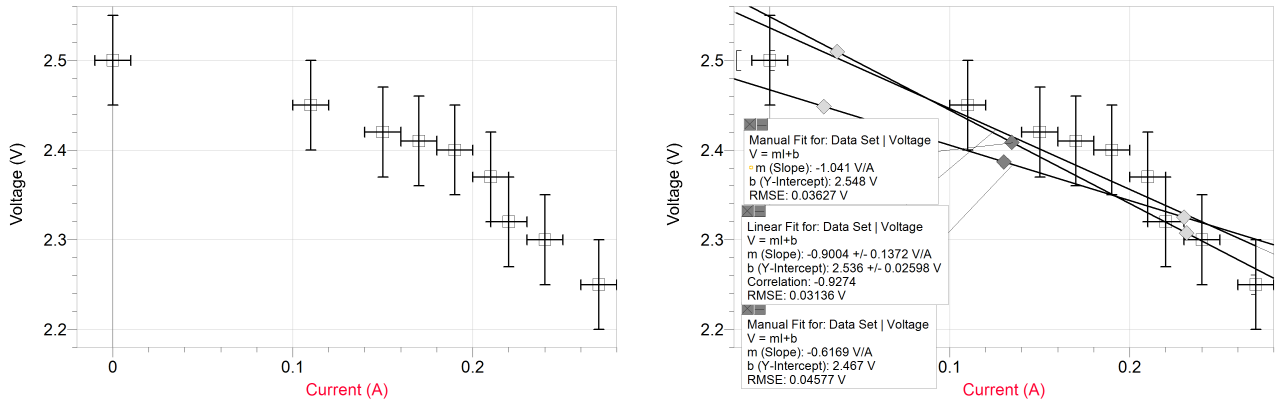
5.2 Processed Data

We can calculate the voltage between the resistor by The minimum scales for the ammeter and the voltmeter are 0.02A and 0.01V, respectively. Therefore, the horizontal and vertical error bar are 0.01A and 0.005V, respectively.

Because the relationship between the emf ε, internal resistance r is

$$V = -rI + \varepsilon,$$
$$y = mx + b,$$

we can deduce the internal resistance r and emf ε by the gradient and y-intercept.



(a) Plot of the Coordinates

(b) Plot with line fits

Figure 1: The plot representing the relationship between the potential difference V between the variable resistor and current I flowing in the circuit, with error bars.

The slope

$$m = \frac{-(1.041 + 0.6169)}{2} = -0.82895\text{V/A},$$

and the error is

$$\Delta m = \frac{1.041 - 0.6169}{2} = 0.21205\text{V/A}.$$

Therefore, the internal resistance r is $\boxed{(0.8 \pm 0.2)\Omega}$.

The y-intercept

$$b = \frac{2.548 + 2.467}{2} = 2.5075\text{V},$$

and the error is

$$\Delta b = \frac{2.548 - 2.467}{2} = 0.0405\text{V}.$$

Therefore, the emf ε is $\boxed{(2.51 \pm 0.04)\text{V}}$.

6 Conclusion and Evaluation

In conclusion, the internal resistance $r = (0.8 \pm 0.2)\Omega$, $\varepsilon = (2.51 \pm 0.04)\text{V}$.

By conducting this experiment, we aim to gain insights into the internal characteristics of the battery, allowing for a better understanding of its behavior in practical applications. The results obtained will contribute to the optimization of battery usage in electronic devices.