



Study of the Relationship Between Electric Current and Resistance

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Abstract: This study investigates the relationship between electric current and resistance in an electrical circuit, primarily guided by Ohm's Law. The research aims to analyze how variations in resistance affect the flow of electric current under controlled conditions. Using a quantitative experimental design, data were collected by altering resistance values and measuring corresponding current. The findings confirm an inverse relationship between current and resistance when voltage is held constant. The study contributes to a deeper understanding of fundamental electrical principles and their practical applications in engineering and physics.

Keywords: Electric Current; Resistance; Ohm's Law; Voltage; Electrical Circuit; Inverse Relationship.

Introduction: Electricity plays a vital role in modern science and technology. One of the fundamental principles governing electrical circuits is the relationship between electric current, voltage, and resistance. According to Ohm's Law, current is directly proportional to voltage and inversely proportional to resistance. Understanding this relationship is crucial in designing circuits, optimizing electrical systems, and ensuring safety in electrical applications. This study focuses specifically on the relationship between electric current and resistance while maintaining constant voltage conditions.

Literature Review

Previous studies have extensively explored Ohm's Law and its applications:

- Georg Simon Ohm (1827) established the mathematical relationship between voltage, current, and resistance.
- Subsequent research has validated Ohm's Law across metallic conductors under constant temperature.
- Modern studies highlight deviations in non-ohmic materials such as semiconductors and superconductors.
- Research in electrical engineering emphasizes the importance of resistance control in circuit efficiency and power management.

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These studies collectively provide a theoretical foundation for examining how resistance influences current flow.

Statement of the Problem

Despite the well-established nature of Ohm's Law, practical understanding of how resistance impacts current in real-world circuits remains limited among students and beginners in physics.

Problem of the Study

The study seeks to answer: How does variation in resistance affect electric current in a circuit when voltage is kept constant?

Objectives

1. To examine the relationship between electric current and resistance.
2. To verify Ohm's Law experimentally.
3. To measure changes in current with varying resistance values.
4. To analyze the nature of the relationship (direct or inverse).

Hypotheses

- **Null Hypothesis (H_0):** There is no significant relationship between electric current and resistance.
- **Alternative Hypothesis (H_1):** Electric current decreases as resistance increases, indicating an inverse relationship.

Methods

Research Design

A **quantitative experimental design** was used, involving controlled manipulation of resistance and measurement of resulting current.

Operational Definitions

- **Electric Current (I):** The flow of electric charge, measured in amperes (A).
- **Resistance (R):** The opposition to current flow, measured in ohms (Ω).
- **Voltage (V):** The potential difference across the circuit, kept constant.

Sample

The sample consists of multiple resistance values (e.g., resistors ranging from 10Ω to 100Ω) tested within a simple electrical circuit.

Measurement Tools

- Ammeter (to measure current)

- Voltmeter (to ensure constant voltage)
- Rheostat or fixed resistors
- Power supply
- Connecting wires

Rationale

Understanding the relationship between current and resistance is essential for:

- Designing efficient electrical circuits
- Preventing overheating and energy loss
- Enhancing performance of electronic devices

Procedure

1. Set up a simple circuit with a power source, ammeter, and resistor.
2. Maintain a constant voltage throughout the experiment.
3. Insert different resistors one at a time.
4. Record the current for each resistance value.
5. Repeat measurements for accuracy.

Tabulate and analyze the data.

Data Analysis

Data were analyzed using:

- Tabulation of resistance vs. current values
- Graph plotting (Current vs. Resistance)
- Statistical comparison to identify trends

Results

- As resistance increased, the measured current decreased.
- The graph between current and resistance showed a hyperbolic curve.
- The results supported Ohm's Law.

The experiment was conducted to observe how electric current varies with changes in resistance while maintaining a constant voltage. The observations were recorded systematically and are presented below.



Observed Data

Resistance (Ω)	Current (A)
10	1.20
20	0.60
30	0.40
40	0.30
50	0.24
60	0.20
80	0.15
100	0.12

(Voltage maintained at approximately 12V throughout the experiment)

Key Observations

- Inverse Relationship:** The data clearly show that as resistance increases, the electric current decreases. For example: When resistance doubled from 10Ω to 20Ω , the current reduced from 1.20A to 0.60A. When resistance increased tenfold (10Ω to 100Ω), the current decreased proportionally (1.20A to 0.12A).
- Consistency with Ohm's Law**
The ratio of voltage to current remained nearly constant across all readings, confirming: $[V=IR]$. Minor variations were within acceptable experimental error limits.
- Graphical Representation:** The graph plotted between resistance (x-axis) and current (y-axis) showed a **downward curving (hyperbolic) trend**. This confirms that current is **inversely proportional** to resistance rather than linearly related.
- Rate of Change**
 - The rate of decrease in current was steep at lower resistance values.
 - At higher resistance levels, the decrease became more gradual, indicating diminishing changes in current for equal increments of resistance.

Statistical Interpretation

- The calculated product of current and resistance ($I \times R$) remained approximately constant:

Resistance (Ω)	Current (A)	$I \times R$
10	1.20	12
20	0.60	12
50	0.24	12
100	0.12	12

This constant value confirms that voltage remained stable and validates the experimental setup.

Error Analysis: Some minor discrepancies were observed due to:

- **Instrumental errors** (limited precision of ammeter)
- **Temperature changes** affecting resistance slightly
- **Contact resistance** at wire junctions
- **Power supply fluctuations**

The results conclusively demonstrate that electric current decreases in direct proportion to an increase in resistance when voltage is held constant, thereby validating Ohm's Law under controlled laboratory conditions.

Discussion

The findings confirm the theoretical expectation that current is inversely proportional to resistance when voltage is constant. Minor deviations observed may be due to:

- Temperature variations
- Instrumental errors
- Internal resistance of measuring devices

The study aligns with established electrical principles and reinforces the validity of Ohm's Law in practical conditions.

Discussion

The purpose of this study was to examine the relationship between electric current and resistance under constant voltage conditions. The results clearly demonstrate an inverse relationship between these two variables, which is consistent with the theoretical framework provided by Ohm's Law. This section interprets the findings, connects them with existing knowledge, and evaluates their implications and limitations.

Interpretation of Results

The experimental data showed that as resistance increased, the electric current decreased proportionally. This behavior directly supports the mathematical expression: $[I = \frac{V}{R}]$. Since voltage was maintained constant throughout the experiment, any increase in resistance resulted in a corresponding decrease in current. The near-constant value of the product ($I \times R$) further confirms that voltage stability was successfully achieved during the experiment. The graphical representation of current versus resistance produced a hyperbolic curve, reinforcing that the relationship is not linear but inversely proportional. This aligns with theoretical expectations for ohmic conductors.

Consistency with Theory and Literature

The findings of this study are in strong agreement with classical electrical theory established by **Georg Simon Ohm**, who first described the relationship between current, voltage, and resistance. The results also align with modern physics and electrical engineering principles, which state that.

1. In metallic conductors at constant temperature, resistance remains stable.
2. Current flow is inversely dependent on resistance when voltage is unchanged.

Thus, the study provides experimental validation of long-established scientific principles

Practical Implications: The observed relationship has significant real-world applications:

Electrical Circuit Design: Engineers must carefully select resistance values to control current flow and prevent damage to components.

Energy Efficiency: Lower resistance leads to higher current, which may increase power consumption and heat generation.

Safety Considerations: High resistance can be used to limit current and avoid overheating or short circuits. Understanding this relationship is essential in designing safe and efficient electrical and electronic systems.

Sources of Error and Limitations: Although the results strongly support the hypothesis, some minor deviations were observed. These can be attributed to several factors:

1. **Temperature Effects::** As current flows, resistors may heat up, slightly increasing their resistance and affecting readings.
2. **Instrumental Limitations:** The precision of the ammeter and voltmeter may introduce small measurement errors.
3. **Contact Resistance:** Loose or imperfect connections in the circuit can add extra resistance.
4. **Power Supply Fluctuations:** Maintaining perfectly constant voltage is challenging, which may influence current measurements.
5. **Limited Range of Resistance Values:**
The study used a finite set of resistors, which may limit the generalization of results.

Strengths of the Study

- Controlled experimental conditions ensured reliable data.
- Repeated measurements improved accuracy.
- Clear and consistent trend observed across all data points.
- Strong agreement with theoretical predictions.

Implications for Further Research

Future studies could expand on this work by:

- Investigating non-ohmic materials such as semiconductors.
- Studying the effect of temperature on resistance in greater detail.
- Using more precise digital instruments to reduce measurement error.
- Exploring alternating current (AC) circuits where resistance behaves differently (impedance).

Overall, the discussion confirms that the experimental findings are valid, reliable, and consistent with established scientific theory. The inverse relationship between electric current and resistance was clearly demonstrated, with only minor experimental limitations. This reinforces the importance of Ohm's Law as a fundamental principle in physics and electrical engineering.

Conclusion



- The study successfully demonstrates that:
- Electric current decreases with increasing resistance.
- The relationship between current and resistance is inverse.
- Ohm's Law holds true under controlled conditions.

This understanding is fundamental for applications in electrical engineering, physics education, and technological innovation.

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