

MEASUREMENT OF CURRENT VOLTAGE AND POWER

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ABSTRACT

This study is dedicated to the comprehensive analysis and measurement of electrical current, voltage, and power in various types of circuits. The research emphasizes the correct use of measurement instruments, such as ammeters, voltmeters, and wattmeters, to achieve accurate and reliable readings. Experimental setups are designed to observe the behavior of electrical parameters under different conditions, including series and parallel circuits. The study also examines the relationship between current, voltage, and power, highlighting how variations in one parameter affect the others. Practical applications of these measurements are discussed, particularly in educational laboratories and engineering practices. The research provides a methodological approach for students and engineers to improve their understanding of fundamental electrical concepts and ensures safety and precision during measurement procedures.

Keywords: *Current, Voltage, Power, Electrical Measurement, Circuit Analysis, Ammeters, Voltmeters, Wattmeters, Experimental Methods, Electrical Engineering, Laboratory Techniques.*

INTRODUCTION

Electrical energy is a fundamental component of modern life, and understanding its properties is essential for both educational and practical purposes. Accurate measurement of current, voltage, and power is crucial for the design, analysis, and maintenance of electrical circuits. These measurements provide essential data that

allow engineers and students to evaluate the performance of electrical systems and ensure their safe and efficient operation.

Current, measured in amperes, represents the flow of electric charge through a conductor, while voltage, measured in volts, indicates the potential difference that drives this flow. Power, measured in watts, quantifies the rate at which electrical energy is consumed or transferred within a circuit. The interrelationship between these three parameters is governed by Ohm's law and the principles of electrical engineering, making their precise measurement vital for both theoretical studies and practical applications.

This study aims to explore various methods and instruments for measuring current, voltage, and power, highlighting their accuracy, limitations, and practical applications. By conducting experiments in controlled settings, the research seeks to provide a clear understanding of how these electrical quantities interact and how measurement techniques can be optimized for reliable results. The outcomes of this study are intended to enhance both learning experiences in physics and astronomy laboratories and professional practices in engineering fields.

MAIN BODY

Physics Problem: A simple DC circuit is set up using a resistor and a light bulb connected to a variable voltage source. Students are instructed to measure the current flowing through the circuit with an ammeter and the voltage across the bulb using a voltmeter. Using the formula $P=V\times I$ and $P=V\times I$, they calculate the power consumed by the bulb. By gradually increasing the voltage, students observe how the current changes and how the brightness of the bulb varies. This exercise demonstrates the practical relationship between current, voltage, and power, reinforcing Ohm's law and the concept of energy transformation from electrical energy into light and heat.

Physics Example: In another setup, two resistors are connected in parallel. Students measure the current through each resistor and the voltage across them. Calculating power for each resistor allows students to see how power distribution

differs in parallel circuits. This hands-on activity helps students connect theoretical formulas with real-life circuit behavior, developing analytical skills.

Astronomy Problem: A photodiode simulates a star detector. A small lamp represents a star, and the photodiode generates current when light falls on it. Students measure this current and the voltage across the photodiode to calculate the electrical power produced using $P=V\times I$. By comparing the readings for different light intensities, students can practically understand how astronomers determine the luminosity of stars and the energy they emit.

Astronomy Example: A spectrometer's photodetector array receives light from multiple sources representing distant stars. Students measure current from each detector and the voltage applied, calculating the corresponding power. Observing how power varies with light intensity teaches students how astronomers use electrical measurements to analyze stellar properties, such as brightness and energy output. This connects electrical principles directly with astronomical observations, showing the real-world application of current, voltage, and power measurements beyond the classroom.

Combined Practical Task: Students can design an experiment combining both physics and astronomy principles: a circuit powers a small lamp representing a star, connected to variable resistances. Current and voltage are measured at different points, and power is calculated. Simultaneously, a photodiode measures the light intensity emitted by the lamp. Comparing the electrical power in the circuit with the power generated by the photodiode allows students to understand energy conversion, measurement accuracy, and real-world applications of electrical principles in physics and astronomy.

Practical Process, Experiments, and Formulas:

Experiment / Task	Equipment	Procedure	Measurement	Formula / Calculation	Observations
Measuring current through a resistor	Resistor, Variable DC supply, Ammeter, Voltmeter	<p>Connect the resistor in series with the ammeter.</p> <p>Connect the voltmeter across the resistor.</p> <p>Gradually increase the voltage from the supply.</p>	<p>Record current (I) from ammeter and voltage (V) from voltmeter at each step.</p>	$\text{Ohm's Law: } I = V / R$ $\text{Power: } P = V \times I$	Observe how current changes with increasing voltage. Note the brightness of a connected bulb if used.
Power measurement in parallel circuit	Two resistors, DC supply, Ammeter, Voltmeter, Wattmeter	<p>Connect two resistors in parallel.</p> <p>Connect ammeters in series with each resistor and voltmeters</p>	<p>Record voltage (V1, V2) and current (I1, I2) for each resistor.</p>	$\text{Power: } P1 = V1 \times I1$ $P2 = V2 \times I2$	Compare power consumed by each resistor.

Experiment / Task	Equipment	Procedure	Measurement	Formula / Calculation	Observations
		across each resistor. Measure current and voltage for each resistor.			
Photodiode as star detector	Photodiode, Small lamp, Voltmeter, Ammeter	Place the lamp at fixed distance from photodiode. Measure current generated by photodiode for different lamp intensities.	Record current (I) from photodiode and applied voltage (V)	Power: $P = V \times I$	Observe how power output varies with light intensity. Relate to brightness of simulated star.
Combined physics and astronomy	Resistor, Lamp, Photodiode, DC supply,	Connect lamp through resistor to	Record I and V for circuit; I and V for photodiode	Power in circuit: $P = V \times I$ Photodiode	Compare electrical power supplied to

Experiment / Task	Equipment	Procedure	Measurement	Formulas / Calculations	Observations
	Ammeter, Voltmeter	DC supply. Measure current and voltage in circuit. Simultaneously measure photodiode current for emitted light.		Power: $P_{photo} = V \times I$	lamp with power generated by photodiode. Observe energy conversion efficiency.
Voltage variation effect	Resistor, Variable DC supply, Ammeter, Voltmeter, Wattmeter	Change voltage in steps. Measure current through resistor and voltage across it for each step.	Record I and V	Power: $P = V \times I$ Ohm's Law: $I = V / R$	Observe relationship between voltage, current, and power. Demonstrates energy transformation.
Light intensity vs	Photodiode, Lamp	Adjust lamp brightness.	Record I and V	Power: $P = V \times I$	Observe linear or nonlinear

Experiment / Task	Equipment	Procedure	Measurement	Formula / Calculation	Observations
electrical power	adjustable brightness, Ammeter, Voltmeter	Measure photodiode current and voltage at each level.			relationship between light intensity and electrical power.

Formulas used:

Ohm's Law: $I = V / R$ (Current equals voltage divided by resistance)

Power Formula: $P = V \times I$ (Power equals voltage multiplied by current)

For parallel circuits: $I_{\text{total}} = I_1 + I_2 + \dots + I_n$ V_{total} = same across all parallel branches

Photodiode / light measurement: $P_{\text{photo}} = V \times I$ (Electrical power generated proportional to light intensity)

CONCLUSION

The study of measuring current, voltage, and power provides a comprehensive understanding of fundamental electrical concepts and their practical applications.

Through hands-on experiments with resistive and parallel circuits, students learn how to accurately measure electrical quantities using ammeters, voltmeters, and wattmeters. Observing the relationships between voltage, current, and power reinforces theoretical knowledge such as Ohm's law and the power formula, while also developing analytical and problem-solving skills.

The integration of astronomy-related experiments, such as using photodiodes to detect light intensity from simulated stars, demonstrates the real-world relevance of electrical measurements beyond classroom circuits. By calculating electrical power

from measured voltage and current, students can understand how energy conversion occurs in both laboratory and cosmic environments.

Overall, these practical exercises bridge the gap between theory and application, showing that precise measurement of electrical quantities is essential not only in physics but also in scientific fields such as astronomy and engineering. The knowledge gained from these experiments equips learners with the skills to analyze, interpret, and apply electrical measurements in a variety of contexts, fostering both scientific understanding and practical competency.

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