EXPERIMENT I

OHM'S LAW

Objective

The objectives of this experiment are to examine the relationship between electric current and voltage, determine the resistance of a conductor, and verify the validity of Ohm's law.

Experimental Materials

Various resistors, ammeter, voltmeter, power supply, connecting wires, circuit board.

Theoretical Background

When a voltage V is applied across an element in an electrical circuit, the current I flowing through the element is determined by the resistance R. The relationship between these three quantities defines the resistance:

$$R = \frac{V}{I} \tag{1}$$

The unit of resistance is volt per ampere, which is called the *ohm*, and it is denoted by the symbol Ω. Some circuit elements obey **Ohm's Law**. For these elements, the value of R remains constant for different values of V. When the voltage V is varied, the current I also changes; however, the ratio $\frac{V}{I}$ remains constant. The resistance of an object to electrical current depends on the material from which it is made, its length, its cross-sectional area, and its temperature. At constant temperature, the resistance is given by:

$$R = \rho \frac{L}{A} \tag{2}$$

Here, R is the resistance (Ω), L is the length (m), A is the cross-sectional area (m^2), and ρ is a material-dependent constant called the **resistivity** ($\Omega\cdot$ m). In fact, the resistivity ρ depends on temperature. If the temperature of the wire increases due to the current flowing through it, this may become a source of experimental error. Ohm's Law is a fundamental principle in electricity that describes the relationship between electric current, voltage, and resistance. It was discovered by the German physicist Georg Simon Ohm in 1827.

Series and Parallel Resistors

The expressions for equivalent resistance in both series and parallel resistor connections are given below:

$$R_{\text{eq}} = R_1 + R_2 + R_3 + \cdots \qquad \frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \tag{3}$$

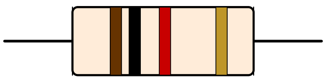
Resistor Color Codes

The following tables show resistor color code (digits and multipliers) common tolerance bands (4^{th} band in 4-band; 5^{th} band in 5/6-band), and typical temperature coefficient (TCR) bands for 6-band resistors, respectively.

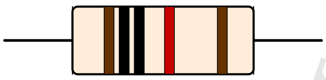
Color	Digit	Multiplier
Black	0	10^0
Brown	1	10^1
Red	2	10^2
Orange	3	10^3
Yellow	4	10^4
Green	5	10^5
Blue	6	10^6
Violet	7	10^7
Grey	8	10^8
White	9	10^9
Gold	–	10^{-1}
Silver	–	10^{-2}

Color	Tolerance
Brown	±1%
Red	±2%
Green	±0.5%
Blue	±0.25%
Violet	±0.1%
Grey	±0.05%
Gold	±5%
Silver	±10%
None	±20%

Color	TCR (ppm/°C)
Brown	100
Red	50
Orange	15
Yellow	25
Blue	10
Violet	5



4-band: Brown–Black–Red–Gold (1.0 kΩ ± 5%)



5-band: Brown–Black–Black–Red–Brown (10.0 kΩ ± 1%)

Figure: Example resistor band patterns: Read the tolerance band (often gold/silver) as the final band; for 5-band resistors the first three are significant digits.

Resistor values are indicated by color bands. Typically, four color bands represent the first digit, second digit, multiplier, and tolerance. Common tolerances are gold (±5%) and silver (±10%).

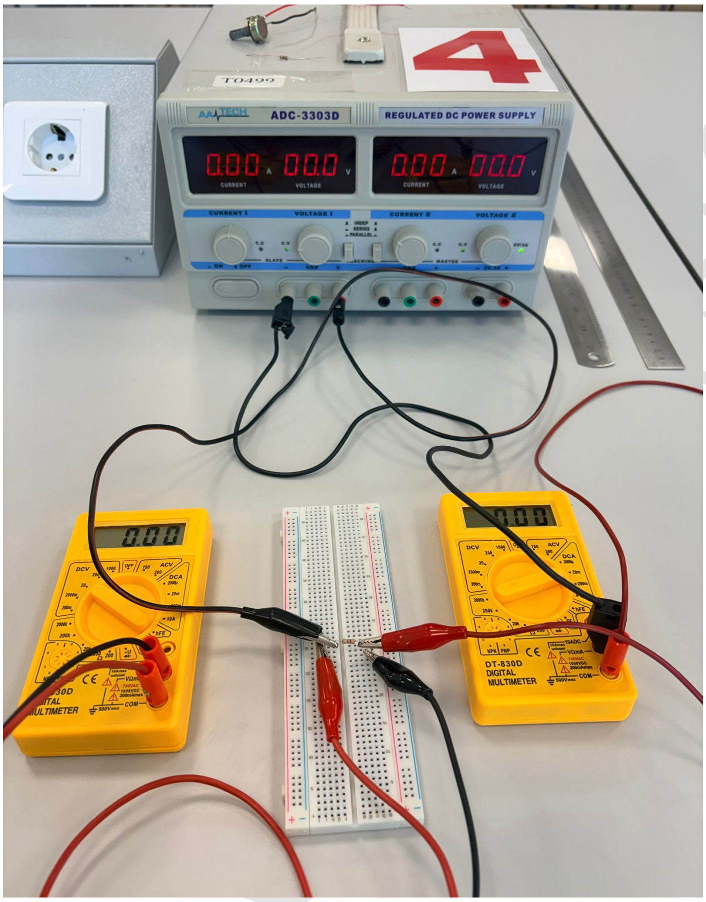
Measuring Instruments

Ammeter: Measures the current flowing through the circuit and must be connected in series.
Voltmeter: Measures the potential difference between two points and must be connected in parallel.

Procedure

1: Preparation Collect the required components (DC power supply, resistor(s), ammeter, voltmeter, connecting leads). Record the nominal resistance values (and tolerances, if available) of the resistor(s).
2: Circuit setup Construct the circuit so that the **ammeter is connected in series** with the resistor and the **voltmeter is connected in parallel** across the resistor. Check the polarity of the meters and ensure firm electrical connections.
3: Voltage and current measurements Set the power supply voltage from 0.5 V to 5.0 V in increments of 0.5 V. At each setting, measure and record the voltage V across the resistor (voltmeter) and the current I through the resistor (ammeter).
4: Verification of Ohm's law For each measurement pair (V, I), compute the resistance $R_i = V_i/I_i$. Estimate the uncertainty in each R_i using the measurement uncertainties in I_i.
5: Graphical determination of resistance Plot I (vertical axis) versus V (horizontal axis). Determine the resistance (R) from the slope.
6: Analysis Compare the resistance obtained from the slope with the nominal (or independently measured) resistance value.

Below is the experimental setup and circuit for verifying Ohm's Law using a regulated DC power supply and two digital multimeters.



The resistor constitutes the load of the circuit. The ammeter is connected in series within the main current loop to measure the circuit current, while the voltmeter is connected in parallel across the resistor (load) to measure the potential difference across it.

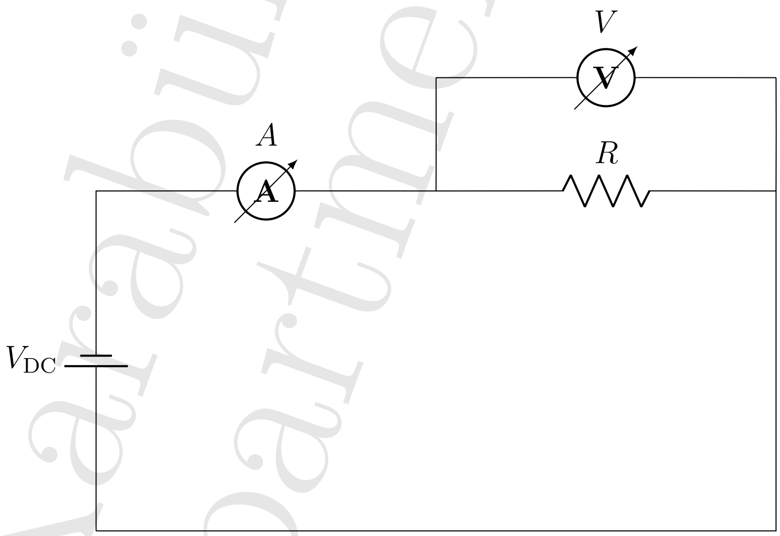


Figure: Experimental circuit for verifying Ohm's Law.

Prepared by
Prof. Dr. Necla ÇAKMAK
Dr. Ulvi KANBUR
Department of Physics
Karabük University
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OHM'S LAW EXPERIMENT REPORT

Name: **Surname:**

Student ID: **Group:** **Date:**

Experimental Data: Present the measured data in tables or figures where appropriate.

Table: Voltage–Current measurements for verification of Ohm's Law

No	V_{set} (V)	I (A)	ΔI_i (A)	$R_i = V_{\text{set}}/I_i (\Omega)$	ΔR_i (Ω)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Measurement Analysis: Show the calculations performed using the experimental data, including relevant formulas.

Conclusion / Discussion: Summarize the results, discuss their physical meaning, and compare them with theoretical expectations.