

E&M Lab

Ohm's law

1. Objectives

- To verify Ohm's law.
- To determine the equivalent resistance of a series and parallel combination of resistors.

2. Material

- A power supply, switch, circuit boards, resistors, multimeters.

3. Theory

Ohm's law is an empirical relationship, observed as valid only for certain materials and under certain conditions such as constant temperature. In *ohmic materials*, for which Ohm's law is valid, the current " I " through a resistor of resistance " R " is directly proportional to the voltage difference " V " across the resistor. Mathematically this can be written as: $V = IR$, where R is constant. Materials for which Ohm's law is not valid are called *non-ohmic*. For such materials, the relationship between potential and current is not linear, i.e. resistance is not constant and depends on the direction and magnitude of current.

Although resistors can be grouped in an unlimited number of ways, most of them are combinations of series and parallel arrangements. As a reminder here are again the equations to find equivalent resistances.

If ' n ' resistors are connected in series, the equivalent resistance is given by:

$$R_{eq} = R_1 + R_2 + \dots + R_n = \sum_{i=1}^n R_i$$

If ' n ' resistors are connected in parallel, the equivalent resistance is given by:

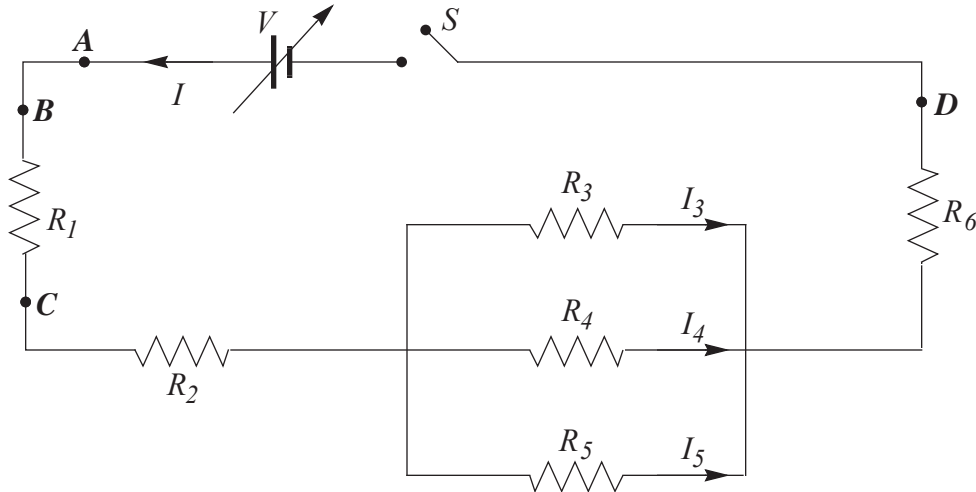
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n} = \sum_{i=1}^n \frac{1}{R_i}$$

An *ammeter* is an instrument used to measure currents. It is always *connected in series* with the component through which the current is to be measured.

A *voltmeter* is an instrument used to measure voltages or potential differences. It is always *connected in parallel* with the component across which the potential difference is to be measured.

4. Procedure and data collection

1. Use the multimeter to measure the resistance of each resistor.
2. Connect the circuit as shown in **fig.1**, keeping the switch **S** open. You can close it once your circuit has been verified.



(Fig.1)

3. Sketch an equivalent circuit with the resistors R_2 , R_3 , R_4 , R_5 , and R_6 replaced by their equivalent resistance.
4. Place the ammeter between **A** and **B** so that the total current I in the circuit can be measured.
5. Connect a voltmeter to the power supply and set it at 3 volts. Connect another voltmeter to measure the voltage V_{CD} . With the ammeter still in the circuit, measure the current I .
6. Change the voltage of the power supply six times from 3 to 8 volts. Each time measure the current I and the voltage V_{CD} .

5. Data analysis in the logbook

- Plot a graph of V_{CD} vs I .
- Calculate the slope, intercept and uncertainties on these parameters for the best fit line.
- What does the slope represent?
- Calculate % difference.
- You must show this analysis **BEFORE** leaving the lab.
- Identify the possible sources of errors present in this experiment. “Human error” is not a valid source of error, I’m looking for sources of errors that could not be avoided in this experiment.