

## College Physics II

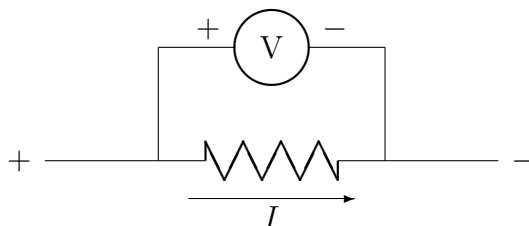
### Lab 7: Resistors

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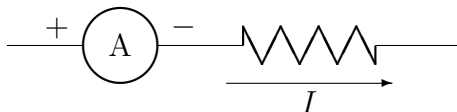
#### Introduction

You will use a voltmeter to measure potential difference (voltage) and an ammeter to measure current in some simple circuits.

Voltmeters and ammeters are sensitive instruments; please use them carefully and correctly. Before you connect or reconnect any circuit elements you should turn down the power supply.



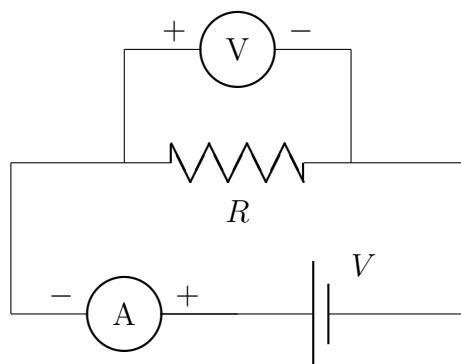
The voltmeter measures the voltage difference between two points in a circuit. The voltmeter must go *across* the element to be measured. Voltmeters have a very high resistance and little current goes through them. Voltmeters have a positive input (usually red) and a negative or “common” input (usually black). If the positive input is connected to the point in the circuit which is at a lower voltage, the display will show a minus sign.



The ammeter measures the current through a part of a circuit. In order to use it you must break the circuit and insert the ammeter into the circuit at that point so that all the current flows through the ammeter. Like the voltmeter it also has positive (red) and negative or “common” (black) terminals. The current should flow into the ammeter through the positive input and out through the negative one. Otherwise the display will include a negative sign.

## Part 1: Ohm's Law

You will graphically study the resistance of a resistor by measuring current through the resistor as a function of voltage. You will see that, for small voltages, a graph of current versus voltage is a straight line, and the slope of that line is  $1/R$ , where  $R$  is what we call the resistance of the resistor, in units of V/A (volts per ampere) or  $\Omega$  (ohms). At higher voltages, the resistor may smoke and burn. In addition, the graph of current versus voltage may start to deviate from a straight line, in which case the resistor does *not* obey Ohm's Law.



1. Connect the circuit shown. I will give you a resistor, and tell you the ranges of  $V$  and  $I$  you will need to measure. Have me check the wiring and the settings before you plug in your equipment.
2. Before turning on the power supply, turn the voltage control knob all the way down and the current control knob all the way up. Turn on the power supply, and gradually turn up the voltage until a reading appears on both the voltmeter and the ammeter, and record both  $V$  and  $I$ . Increase the current in steps (I will tell you the size of the steps),

recording  $V$  and  $I$  at each step. *Do not go to a higher voltage until you have recorded the data at the lower voltage!* Typically, at some point in this process, the resistor will start smoking. Take data for a few steps beyond that point.

3. Now make a graph of  $I$  (vertical or  $y$ -axis) versus  $V$  (horizontal or  $x$ -axis). Include a best-fit line to the data, but *only* for those points that look like they are on a straight line. (After your resistor burns up, it may deviate from a straight line.)
4. For the straight line region only, find the slope of  $I$  vs  $V$ . Take the inverse of the slope—this result is the experimentally determined resistance of the resistor over the region where it obeys Ohm's Law.
5. The power (energy per unit time) being dissipated in a resistor is equal to the current through the resistor times the voltage across the resistor. At what power did your resistor burn up?

### To hand in for part 1

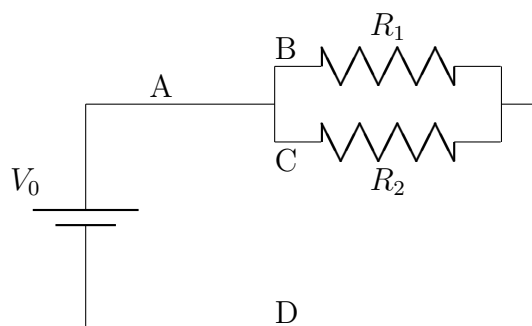
- Graph of  $I$  versus  $V$  for your resistor, showing where it burns up.
- The nominal resistance of your resistor, the experimentally determined resistance of your resistor, and power at which your resistor stops obeying Ohm's Law.

## Part 2: Parallel Resistors

You will practice constructing a circuit, measuring voltage across different elements in a circuit, using  $V = IR$ , and the junction and loop rules: the sum of the voltage drops along a loop in a circuit must be equal to the sum of the voltage rises, and the sum of the currents going into a junction must equal the sum of the currents going out.

## PART 2: PARALLEL RESISTORS

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1. The circuit shown contains two resistors in parallel and a battery. Set up such a circuit with two resistors: one  $20\ \Omega$  and one  $44\ \Omega$ . Set  $V_0$  to about  $5\ \text{V}$ .
2. Use the meters to measure the current at points A, B, C and D in the circuit—how are  $I_A$ ,  $I_B$ ,  $I_C$ , and  $I_D$  related?
3. Measure the voltage supplied by the source, across  $R_1$ , and across  $R_2$ . How are  $V_0$ ,  $V_1$ , and  $V_2$  related?
4. How are  $V_1$  and  $I_B$  related, and what does Ohm's Law predict? How are  $V_2$  and  $I_C$  related, and what does Ohm's Law predict?
5. What do you predict for the ratio  $I_B/I_C$ ? Explain. Do your data support those predictions?
6. This circuit splits the current put out by the battery between the two resistors. Devise a circuit that splits the *voltage* produced by the battery between two resistors, and draw a circuit diagram showing what it would look like.

### To hand in for part 2

- Data, relations used, and results.
- Answers to all the questions asked.