Physics 121 Lab 4: Ohmic versus Non-Ohmic Devices

Introduction

Carbon resistors are the kind typically used in wiring circuits. They are made from a small cylinder of graphite, surrounded by a protective plastic coating. (See fig. 1a.) Short wires, or *leads*, are attached to the ends of the graphite cylinder and held in place by the coating. [You have two carbon resistors at your station.] Other materials and devices can also act like resistors; a light bulb filament, for example, usually consists of a thin tungsten wire with its two ends connected to separate parts of the metal base. (See fig. 1b.) Like most (but not all) solid materials, graphite and tungsten are *ohmic*, which means that resistors made from them obey Ohm's Law, $V = IR$.

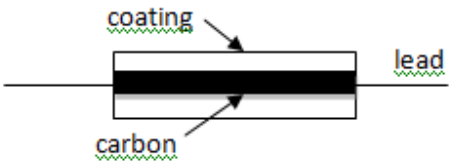

Fig. 1a: Carbon Resistor

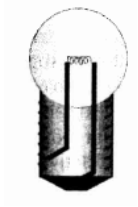

Fig. 1b: Light bulb

Ohm's law applies to each resistor in a circuit – even a complicated circuit with many resistors. V in the formula is the voltage difference between the two ends of any one of one of the resistors, I is the current through that same resistor; and R is the resistance of that resistor. The unit for resistance is the Ohm, abbreviated by a Greek omega, Ω; $1\Omega = 1V/1A$. Carbon resistors typically range from about $10\,\Omega$ to about $10\text{M}\Omega = 10^7\,\Omega$.

Since Ohm's Law says that V and I are proportional, one might expect that a graph of V (vertical axis) vs. I (horizontal axis) will be a straight line through the origin with slope equal to the resistance R. In some cases, however, such a graph will not be straight. One possible reason is that larger currents tend to heat up a resistor, and for most materials a change in temperature causes a change in resistance. This temperature-dependence of resistance appears as a changing slope in a V vs. I graph.

Resistors

- To investigate whether carbon resistors obey Ohm's law, wire the circuit shown in Figure 2 below.
- Set a potential of 1V for the battery. Measure the potential drop across the resistor (in V) and the current thought the resistor (in A) as measured by the two meters in the circuit.
- In increments of 1V repeat this set of measurements until you reach 10V on the battery.
- Measure the resistance of the resistor you used using one of the meters on your table.

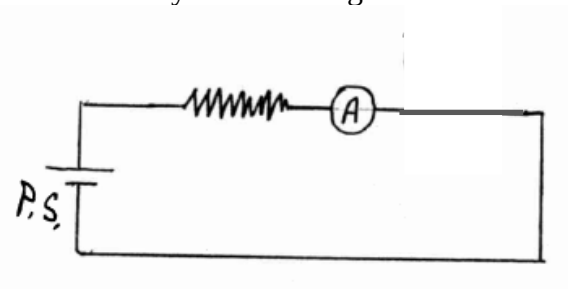

Figure 2: A single resistor circuit to test Ohm's law.

Light Bulb

- To see potential deviations from Ohm's law, wire the circuit shown in Figure 3 below and choose the 220W resistor.
- Set a potential of 1V for the battery. Measure the potential drop across the light bulb (in V) and the current thought the light bulb (in A) as measured by the two meters in the circuit.
- In increments of your choice repeat this set of measurements until you reach 30V. Do get at least 15 - 20 measurements with at least half at higher potential differences across the light bulb.

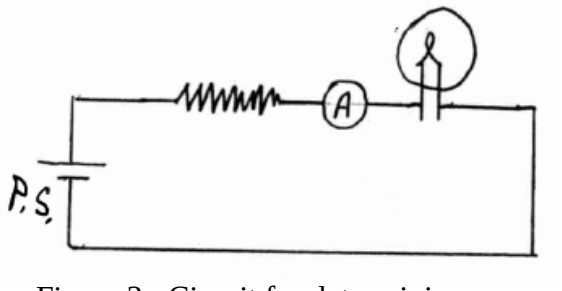

Figure 3: Circuit for determining whether a light bulb obeys Ohm's law.