Experiment 5: Simple Resistor Circuits

Introduction

In this lab, we will investigate Ohm's Law, and study how resistors behave in various combinations. Along the way, you will establish that certain measurements are a ected by the way in which circuit elements are connected to each other. In a direct current (DC) circuit, the relationship between the current (I) passing through a resistor, the potential di erence (V) across the resistor, and the resistance (R) of the resistor is described by Ohm's Law:

$$V = IR \tag{1}$$

In Part 1 of the experiment, we will verify this law by measuring the potential di erence (i.e. voltage drop) across resistors in series and parallel. The typical resistor used here is a carbon resistor that is usually marked with colored bands to indicate its resistance in Ohms, as seen in Figure 1 (see Lab 2 for more detail). In Part 2, we will proceed to investigate how resistors behave in various combinations. To help us, we introduce two additional circuit laws:

Kirchho 's First Law - The current entering a junction is equal to the current leaving a junction.

Kirchho 's Second Law - The sum of all the voltage drops around a closed circuit is zero.

Figure 1: Resistor color codes: Black=0, Brown=1, Red=2, Orange=3, Yellow=4, Green=5, Blue=6, Violet=7, Gray=8, White=9.

We rst consider N resistors in *series* as shown in Figure 2. Since there are no branching junctions in the circuit, the current entering through all the resistors is identical, i.e. $I = I_1 = I_2 = I_3 = ::: = I_N$. We also know from Kirchho 's Second Law that V V_1 V_2 V_3

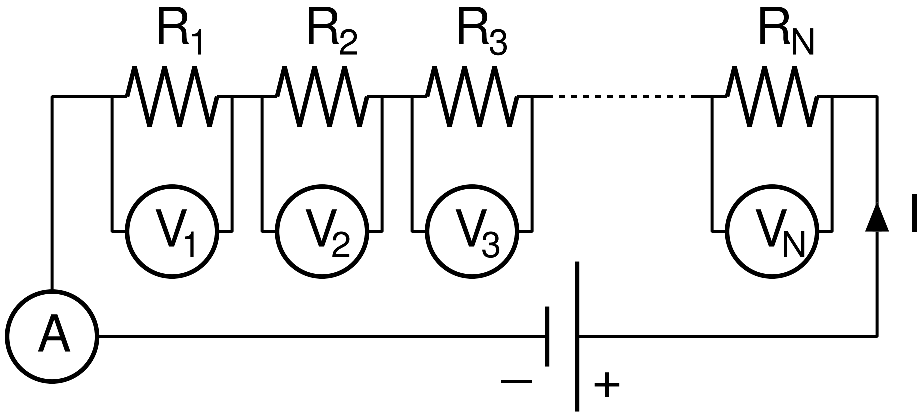

Figure 2: Resistors in series.

For a parallel arrangement, all the resistors have the same potential di erence (since they are essentially connected to the \same" two points). Thus $V_1 = V_2 = V_3 = ::: = V_N$. Since I=V/R (from Ohm's Law), we can write Equation 3 as

$$\frac{V}{R} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + ::: + \frac{V_n}{R_3}$$

(your rst resistor). Setting the power supply to 10 V, measure the current in the circuit, and the potential di erence across R_1. Record this as V_1. Move the Voltmeter to measure the potential di erence across R_2 and R_3. Now nd the total potential di erence across all three resistors. Record this as V and verify that $V = V_1 + V_2 + V_3$. Discuss the following questions in the analysis section of your lab report:

1. Find the experimental value of the resistance of each resistor using Equation 1 (i.e. $R_1 = V_1 = I$, etc.).
2. Find the experimental value of the total e ective resistance R in series using the value of I, total V, and Equation 3.
3. Compare resistance values for R_1, R_2, and R_3 obtained from the ohmmeter with those found using Ohm's Law.
4. (Why didn't we use resistor number 4?!?) Using the measured values of resistance, estimate the value of I with all 4 resistors in series (v=10V), and compare the result to the resolution of the Ammeter on it's most sensitive scale.

Procedure 1B - Resistors in Parallel:

Construct a parallel circuit as shown in Figure 3 using ALL

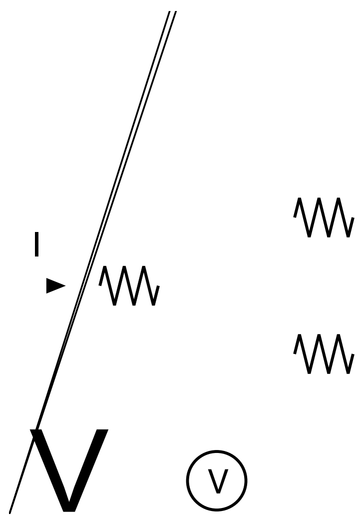

Figure 4: Resistors in series-parallel combination.