General Physics II Lab (PHYS-2021)
Experiment ELEC-3:
Resistor Circuits

1 Equipment

	Included:	
1	Resistive/Capacitive/Inductive Network	UI-5210
1	Short Patch Cords (set of 8)	SE-7123
1	850 Universal Interface	UI-5000
1	PASCO Capstone	

2 Introduction

The purpose of this experiment is to determine the equivalent resistance of series/parallel circuits. This lab will require a formal Lab Report as described in the "Lab Report Format" document.

3 Theory

In Experiment ELEC-2 last week, we explored Ohm's Law given by Equation 1 below.

$$V = IR. \qquad (1)$$

In today's lab, we will be combining resistors I a variety of ways to determine the equivelent resistances of these circuits. Two (or more) resistors can be connected in series (as in Figure 1), or in parallel (as in Figure 2). Resistors could also be connected in a series/parallel circuit like Figure 3. An equivalent resistor is a single resistor that could replace a more complex circuit and produce the same total current when the same total voltage is applied. For a series circuit, the resistances are additive:

$$R_{eq} = R_1 + R_2 \qquad (2)$$

where R_{eq} is the equivalent resistance. For a parallel circuit, the resistances add as reciprocals

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \qquad (3)$$

A more complex circuit like Figure 3 can be handled by noting that R_1 and R_2 are in parallel and can be reduced to an equivalent resistance using Equation 3. That equivalent resistance is then in series with R_3 and can be treated using Equation 2 to find the equivalent resistance of the entire series/parallel circuit.

In the circuit figures below, the resistor labels (R_1, R_2, and R_3) do not correspond to the resistor labels on the circuit boards. On your circuit resistor boards, the 3.3 kΩ resistor is R2, and the 1.0 kΩ resistors are R3 and R4.

Equivalent Circuits Diagrams:

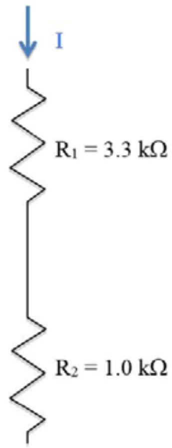

Figure 1: Series

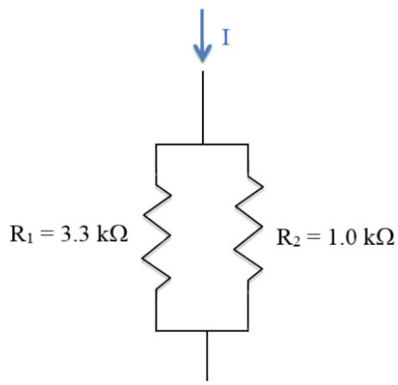

Figure 2: Parallel

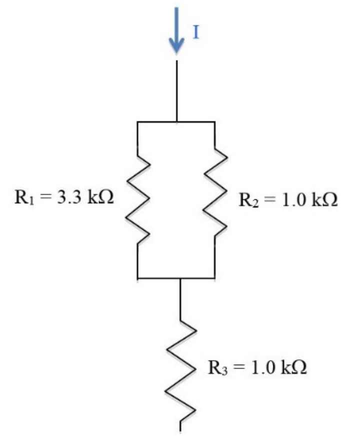

Figure 3: Series/Parallel

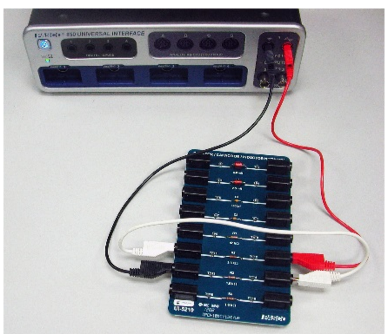

Figure 5: Series

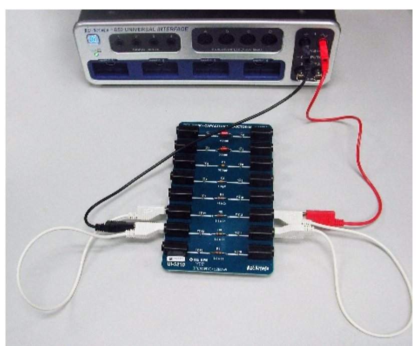

Figure 6: Parallel

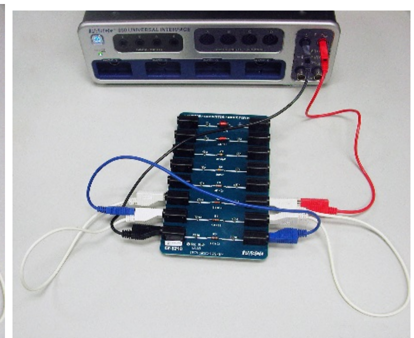

Figure 7: Series/Parallel

4 Resistance Measurements of Isolated and Combined Resistors

1. Create two tables (as shown below): “Resistor”, “Resistance”, “Circuit”, and “Theory Resistance” are user-entered data sets.

Table II: Resistor Check Values

	Resistor	Resistance (Ω)
1	R1	
2	R2	
3	R3	

Table III: Equivalent Resistance

	Circuit	Theory Resistance (kΩ)
1	Series	
2	Parallel	
3	Series/Parallel	

2. Resistor Check: The resistors on the UI-5210 circuit board are accurate to within ±5%. This can be improved substantially if a multimeter is available. These will generally measure resistance ±1%.

    a. Disconnect all the wires from the circuit board.

    b. Use a multimeter (if available) to measure the resistance of resistors R2, R3, & R4 on the circuit board. Enter the values in Table II.

3. Theory Resistance: Using Equivalent Circuits and the values for the resistors from Table II, calculate the equivalent resistance for each of the three circuits shown on the previous page. Enter the values in the Theory Resistance column of Table III.

5 Procedure: Equivalent Circuits

1. Create a new table: Select "Circuit" for the first column. Except for the calculations "True Cur" and "% Diff", the rest of the columns are all user-entered data sets. Open the calculator and make the calculations:

    True Cur = [Av. Current]-[Zero Cur.] Units of mA

    % Diff=100*([Exp. Resist]-[Theory Resistance])/[Theory Resistance]

Table IV: Equivalent Circuits

Circuit	Output 1 Voltage (V)	Zero Cur. (mA)	Av. Current (mA)	True Cur (mA)	Exp. Resist. (kΩ)	Theory Resistance (kΩ)	% Diff (%)
Series							
Parallel							
Series/Parallel							

2. Click open the Signal Generator. Set Output 1 for a DC waveform with a DC Voltage of 15 V. Click On. Close the Signal Generator panel.
3. Calibrate Check: With nothing attached to Output 1 of the 850 Universal Interface, click RECORD and record until the Average Current stops changing (a few seconds). Record the value of the Average Current in the Zero Cur. column of the Table IV. Enter the same value in each of the three rows. If the Output 1 Voltage reading is different from 15.00 V, enter the value in column 1, replacing the 15.00 values.
4. Set up the circuit shown in Figures 1 & 5.
5. Click RECORD and record until the Average Current stops changing. Record the value of the Average Current in the Av. Current column of Table IV. "True Cur" = "Av. Current" – "Zero Current".
6. Using the "True Cur" values and Equation 1 from Theory, calculate the total resistance (experimental) of the circuit. Enter the value in the Exp. Resist. column of the table.
7. Set up the circuit shown in Figures 2 & 6. Repeat steps 5 & 6.
8. Set up the circuit shown in Figures 3 & 7. Repeat steps 5 & 6.

6 Equivalent Circuits Conclusions

1. In your Lab Report conclusion section, make sure you answer the question: "How well does the method of equivalent circuits work?"