Worksheet: Series Resistance

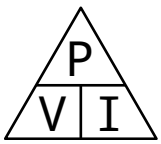
For this exercise, we will be discussing and experimenting with *voltage*, *resistance*, *current* and *power*. These are represented by the following symbols and measured with the following units.

Concept	Symbol	Unit name	Unit symbol
Voltage	V	Volt	V
Current	I	Amp	A

Concept	Symbol	Unit name	Unit symbol
Resistance	R	Ohm	Ω
Power	P	Watt	W

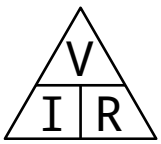
There are two formulas we will need for this exercise. The first relates power to voltage and current. The second, *Ohm's law*, defines the relationship between voltage and current. These formulas, as well as mnemonics often used to speed memory of them, are given in the boxes, below.

Power



$P = V \cdot I \qquad V = \frac{P}{I} \qquad I = \frac{P}{V}$

Ohm's Law



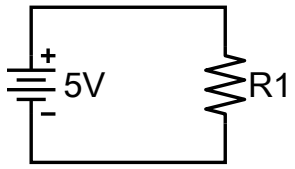
$V = I \cdot R \qquad I = \frac{V}{R} \qquad R = \frac{V}{I}$

In some instances, we may need to combine these formulas, for example, given either voltage and resistance or current and resistance, we can find the formula for power:

$$P = V \cdot I;\ P = (I \cdot R) \cdot I;\ \mathbf{P = I^2 R}$$

$$P = V \cdot I;\ P = V \cdot \left(\frac{V}{R}\right);\ \mathbf{P = \frac{V^2}{R}}$$

A schematic diagram of the first circuit we will examine is given to the right. It contains a single resistor in series with the power supply. Before we build the circuit, let's see what is the smallest value of resistor we can use in the circuit.



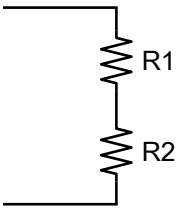
The resistors we have are rated to be able to dissipate a maximum of ¼ Watt. The power supply we are using outputs approximately 5 Volts. We know the power and the voltage, and wish to calculate the resistance. As shown to the right, rearranging the formula from above gives us the formula we require.

$$P = \frac{V^2}{R};\ \mathbf{R = \frac{V^2}{P}}$$

1. Given a voltage drop, $V = 5V$, across a resistor, and the maximum power that the resistor can dissipate, $P = 0.25W$, calculate the minimum value of resistor, in Ohms, that can be safely used in the circuit. Write the formula and show the steps in the calculation.

Worksheet: Series Resistance

When we connect electrical devices in ***series***, we connect them in such a way that the current must flow through each device one after the other. The diagram to the right shows two resistors connected in series.

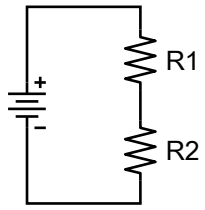


2. Choose two resistors that have approximately the same value (within the resistor tolerance). Measure the resistance of each resistor and record the values in table below. Then, connect the resistors together in series and measure and record the combined resistance of the two resistors, R_T.

R1	R2	R_T

Note: the combined resistance should be approximately the sum of the two individual values.

Using the same resistors used in question 2, connect these resistors in series to the power supply, as shown in the diagram to the right. **Do NOT measure resistance when the resistors are in a circuit**, especially if the power is turned on, as this may damage the ohmmeter.



3. Measure the voltage across each individual resistor and record the measurements in the table below. Then measure the voltage across both resistors (the voltage output by the power supply) and record that in the table.

V_{R1}	V_{R2}	V_T

Note: the voltage across each resistor should be approximately half of the supply voltage.

4. Choose two resistors that have **different** values (greater than the resistor tolerance). Perform the same measurements as you did above.

R1	R2	R_T

V_{R1}	V_{R2}	V_T

***Kirchhoff's Voltage Law* : the algebraic sum of all voltages around any closed loop is zero.**

Note: the voltage across the resistors should equal: $V_{R1} = \left(\frac{R1}{R1+R2}\right)V_T$ and $V_{R2} = \left(\frac{R2}{R1+R2}\right)V_T$.

5. Using Ohm's law and the measured values, calculate the current through each resistor. Record the final answer in milliamps (mA). Write the formula and show the steps in the calculation.

I_{R1}	
I_{R2}	

Note: The current through each resistor should be the same (there may possibly be a very small difference due to measurement error).