Electronics Club English Name: ______________________

Worksheet: Internal Resistance

1. Write the formula to calculate the following:

a) The total resistance, R_T, of three resistors, R1, R2, and R3, in *series*.	R_T =
b) The total resistance, R_T, of three resistors, R1, R2, and R3, in *parallel*.	$\frac{1}{R_T}$ =
c) The current, I, in *Amperes*, through a circuit with resistance R supplied by voltage V.	
d) The power, P, in *Watts*, dissipated by a circuit with resistance R supplied by voltage V.	

2. Write *Kirchhoff's Current Law* on the lines below.

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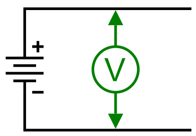
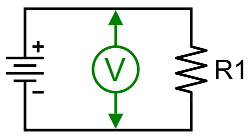
Ideal Voltage Source

An ideal voltage source will output the same voltage, regardless of the amount of current that the circuit it is connect to draws from it. Said in another way, an ideal voltage source will output the same voltage regardless of the resistive load. We will perform an activity that will show our voltage source is not actually ideal.

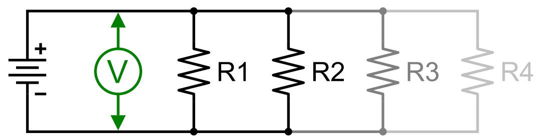
3. Measure the ***open circuit voltage*** output by the power supply – the voltage when the power supply has no load (no resistors connected to it). Then measure the voltage output when a single resistor is connected to the power supply. Continue to add a second, third, and fourth parallel resistor, measuring the voltage each time. The diagrams below show the circuit at various stages. Record your measurements in the table. For this activity, **use 100Ω resistors**. Be aware the **resistors may get hot**.



Measuring Open Circuit Voltage



Measuring Voltage with a Single Resistor Connected



Measuring Voltage with Four Parallel Resistors

		Number of Resistors				
		0	**1**	**2**	**3**	**4**
a)	Total Resistance, R_T [Ω]					
b)	Measured Voltage [V]					
c)	Total Current [mA]					
d)	Power [mW]					

4. Write *Kirchhoff's Voltage Law* on the lines below.

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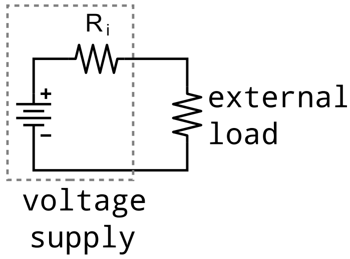


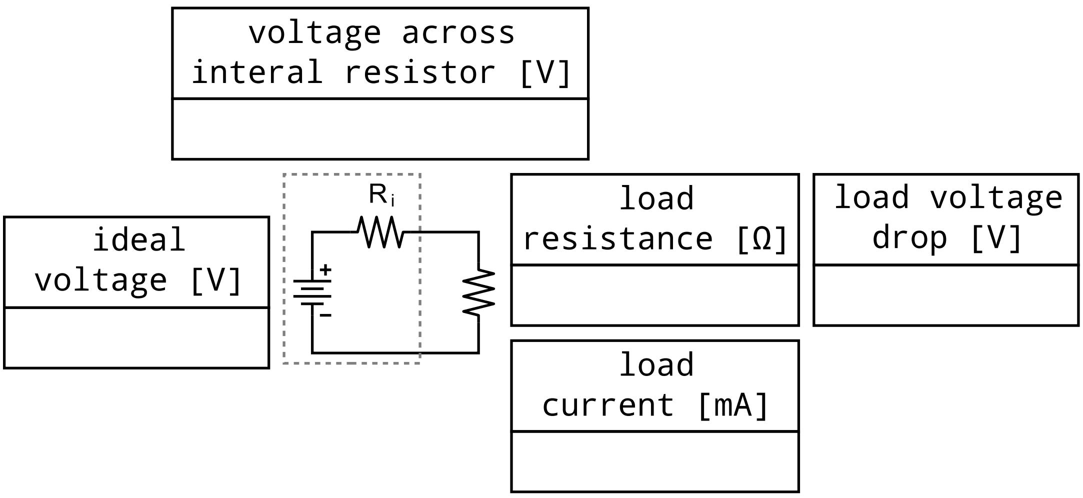
Notice that as we add more load to the power supply, the output voltage decreased. The output voltage did not stay constant, as we would expect if the power supply were ideal. It is common to model real-world power supplies (including batteries) as an ideal supply in series with an internal resistance. This is shown in the diagram to the right.

When there is no load on the voltage supply, no current flows through the internal resistor, so the voltage drop across the internal resistor is zero. You can verify this with *Ohm's law*:

$$V = I \cdot R = 0 \times R = 0$$

Thus, the open circuit voltage of the power supply measures the ***ideal voltage*** of the power supply.

5. Use the data you measured above for **four parallel resistors** to complete the diagram below.



6. Using the voltage across the internal resistor and the current flowing around the circuit, you can now use *Ohm's law* to calculate the internal resistance, R_i, of the power supply you are using. Perform this calculation, showing the initial formula and all steps for the calculation in the box below.