PhyzLab: Current Events II

a quantitative investigation of series circuits

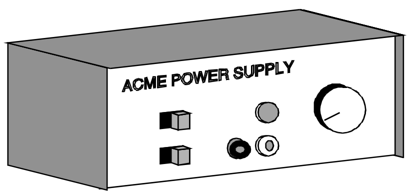
PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Purpose •

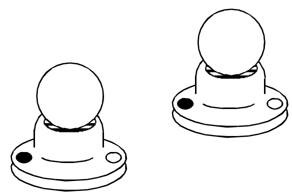
In this activity, you will measure current and voltage at various points in a series circuit to see how the flow of charge and the energy of that charge are distributed in the circuit.

• Apparatus •

___ variable DC power supply (or 6 V lantern battery)
___ 3 miniature light bulbs in sockets (6.3V) [#46]
___ 8 connecting wires
___ DC ammeter (0-1 A range)
___ DC voltmeter (0-10 V range) with test leads



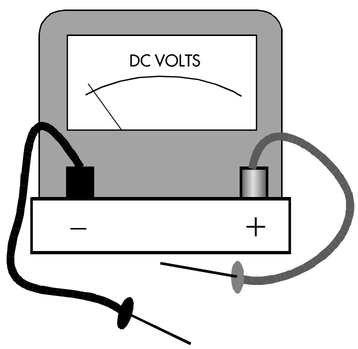
DC power supply
NOTE: black terminal is negative



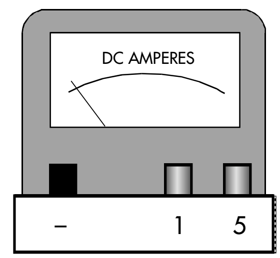
bulbs in sockets

connecting wires

THE TEST LEADS ARE ALWAYS CONNECTED TO THE VOLTMETER AND ARE NEVER CONNECTED TO THE AMMETER



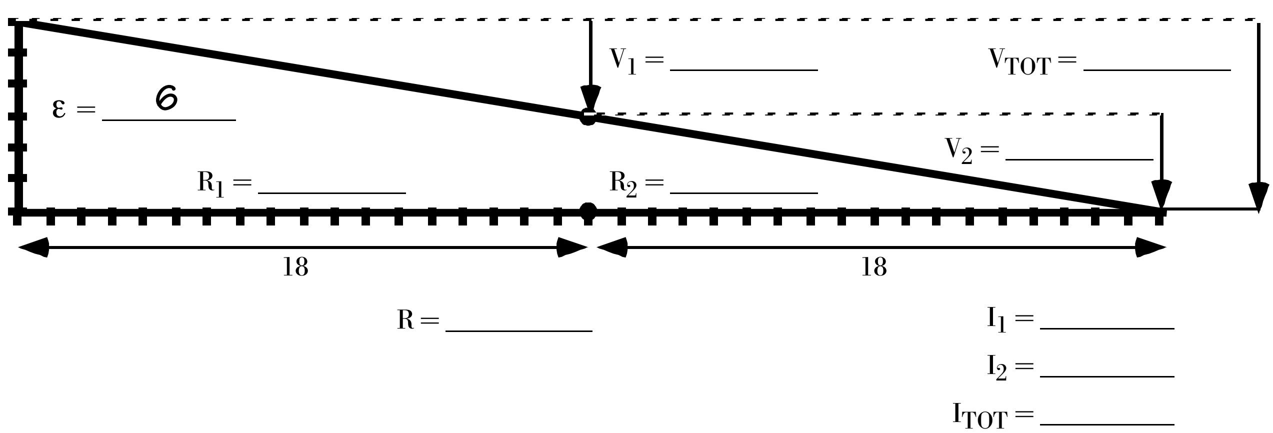
voltmeter (with test leads)



ammeter

• Pre-lab •

Understand The Series Slide. Identify the elevation ($\mathcal{E}$), run lengths (R_1 and R_2), and inclines (I_1, I_2, and I_{TOT}) on the slide shown below. Also identify the vertical drops (V_1, V_2, and V_{TOT}) and the overall run length (R). This series slide differs from the original simple slide (in *Current Events I*) in that it has two sections of run length placed end to end.



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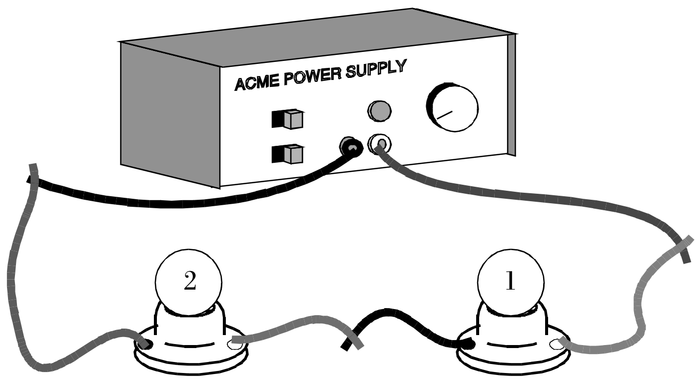
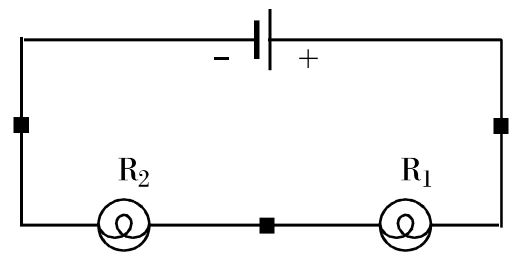
• Procedure •

1. TWO-RESISTOR SERIES CIRCUIT

a. **Construct** a series circuit using the power supply, two bulbs, and **six** wires as shown below. When the circuit is activated, the bulbs should be equally bright. If they are not, try other 6.3-V bulbs until you get a match.



BASIC SCHEMATIC DIAGRAM



DESCRIPTION OF MEASURED CIRCUIT QUANTITIES

V_T measures V_{TOT}, the voltage across the terminals of the power supply. Set this to 6.0 V when the circuit is operating.

A_1 measures I_1, the current through bulb 1.

V_1 measures V_1, the voltage drop across bulb 1.

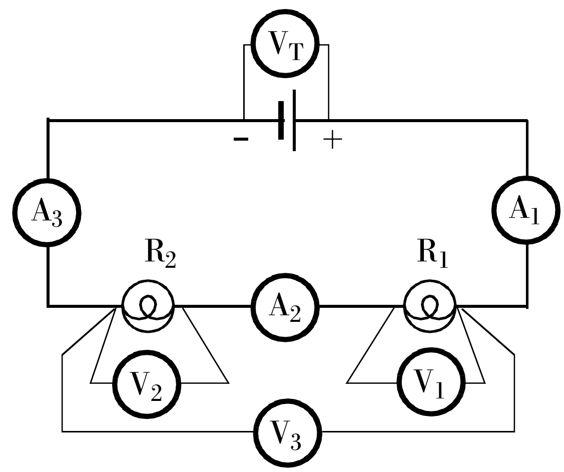
A_2 measures I_2, the current through bulb 2.

V_2 measures V_2, the voltage drop across bulb 2.

A_3 measures I_{TOT}, the total current in the circuit.

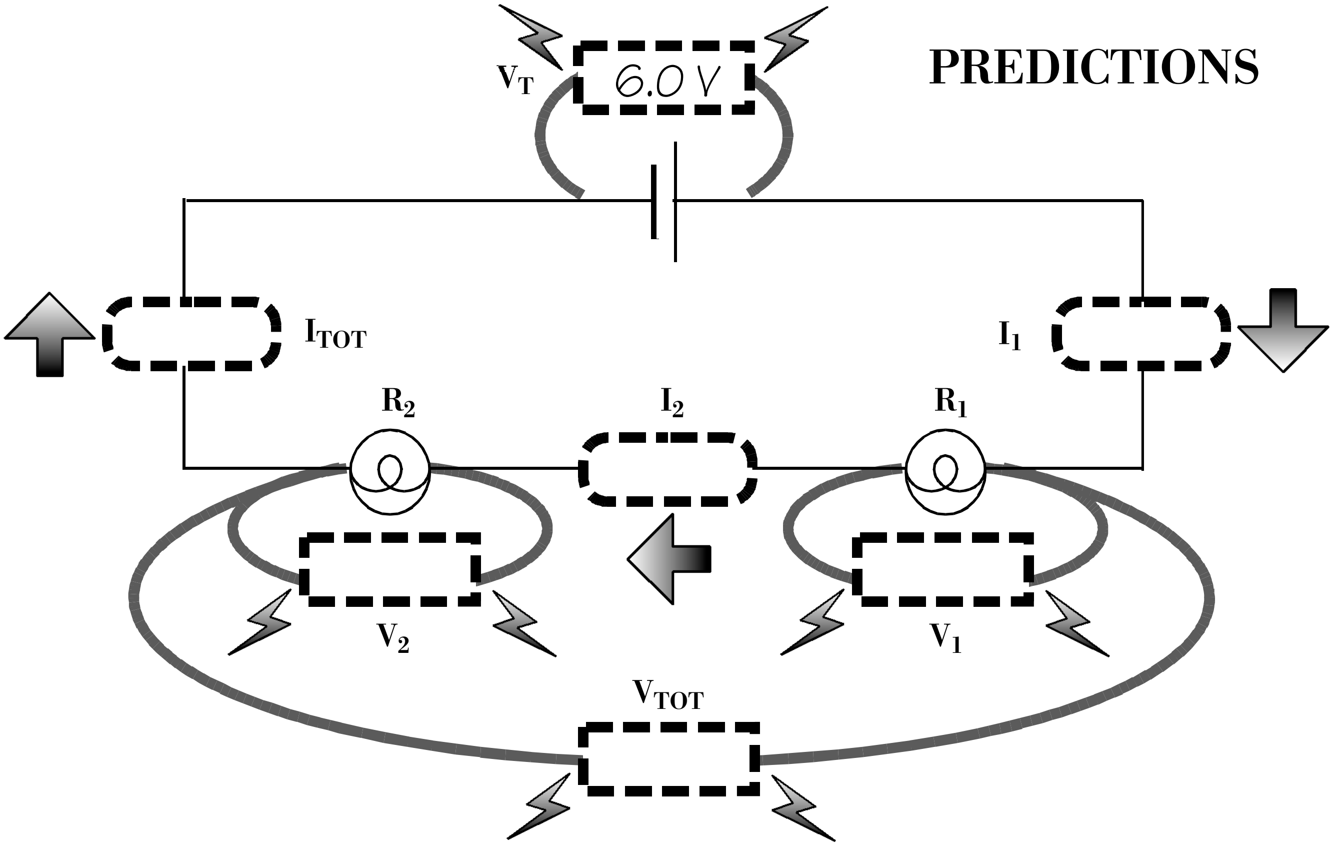
V_3 measures V_{TOT}, the voltage drop across *both* bulbs.

SCHEMATIC WITH METERS

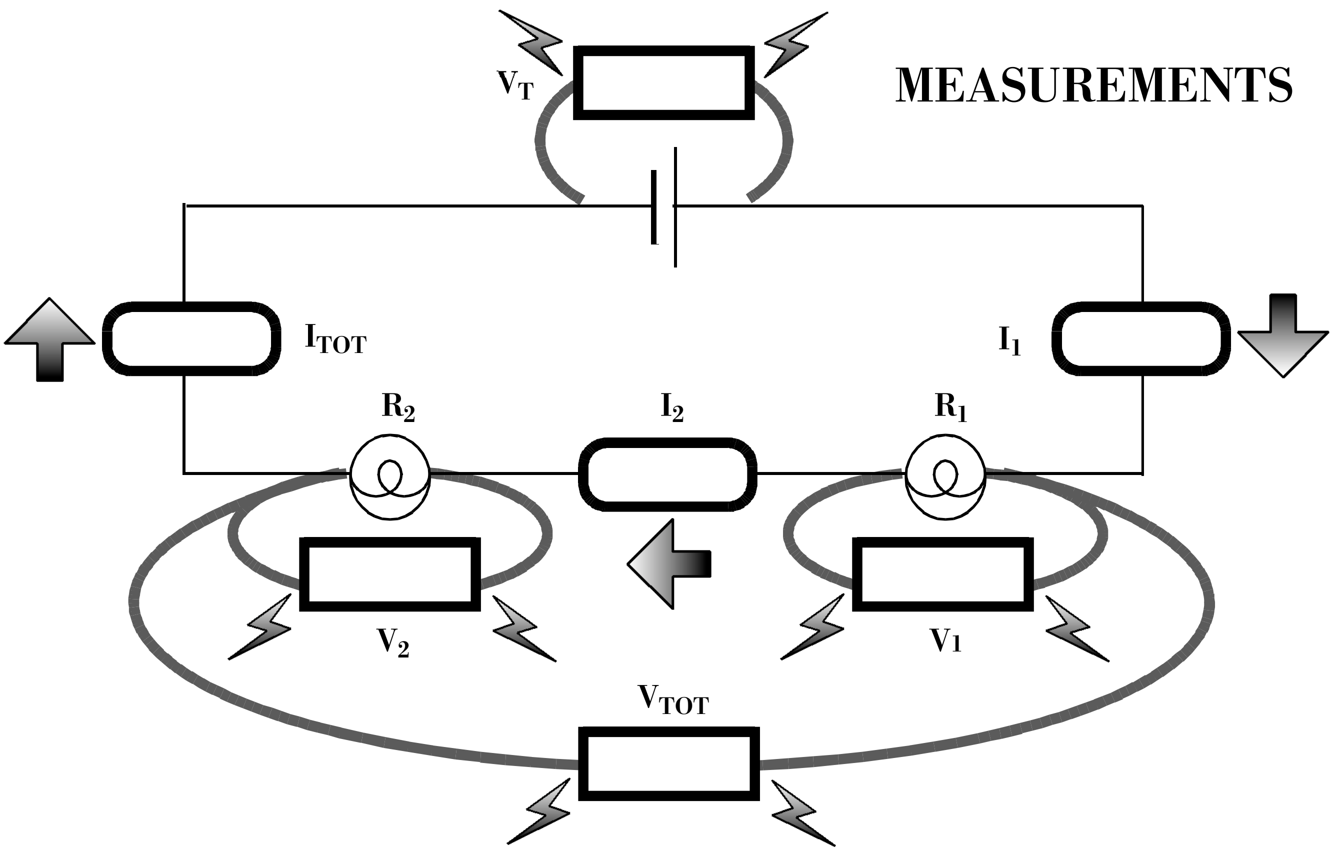


NOTE: Since you only have one voltmeter and one ammeter, you will reposition those meters throughout the circuit (while the circuit is operating) to make all required measurements. Review the technique described in *PhyzLab: Current Events I* (simple circuit).

b. **Predict** the current and voltage values at the various points throughout the circuit. Review the values obtained in *Current Events I* (the simple circuit). Assume a terminal voltage of 6.0 V.



c. **Measure** the actual values of the current and voltage at the various points throughout the circuit. If you are using a variable DC power supply, set the terminal voltage to 6.0 V when the circuit is operating (the bulbs are lit). Secure a PhyzBlessing for your measurements before proceeding to the next activity.



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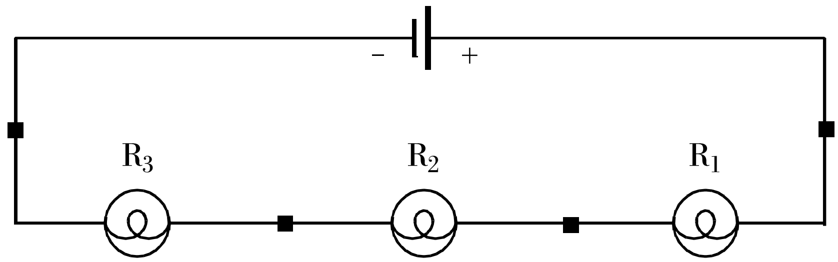
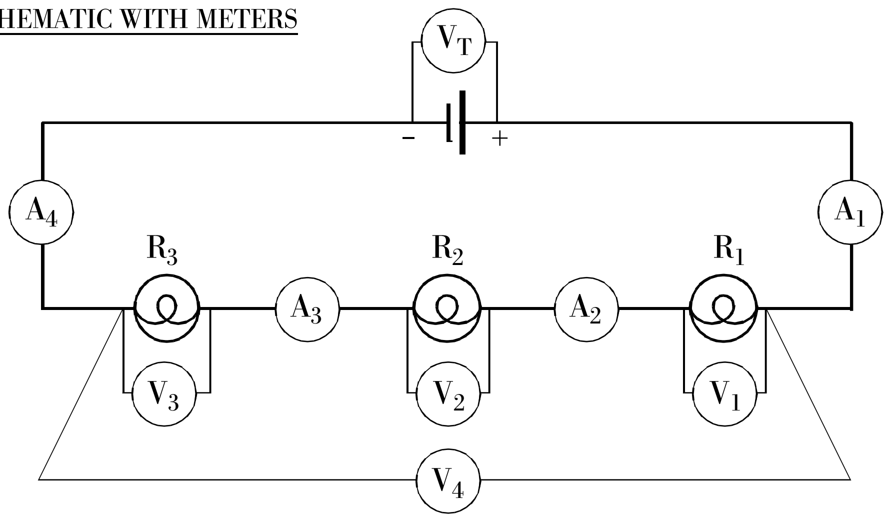
2. A THREE-RESISTOR SERIES CIRCUIT

a. **Construct** a series circuit with three bulbs and **eight** wires as shown below. When the circuit is activated, the bulbs should be equally bright. If they are not, try other 6.3-V bulbs until you get a match.





b. **Predict** the values *before* taking measurements (use V_T = 6.0 V):

V_T = 6.0 V

V_1 = ________ I_1 = ________

V_2 = ________ I_2 = ________

V_3 = ________ I_3 = ________

V_{TOT} (V_4) = ________ I_{TOT} (A_4) = ________

c. **Measure** all quantities listed above and record the values below.

V_T = ____________

V_1 = ________ I_1 = ________

V_2 = ________ I_2 = ________

V_3 = ________ I_3 = ________

V_{TOT} (V_4) = ________ I_{TOT} (A_4) = ________

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• Data and Calculations •

Transfer the measured voltage and current values to this table.

1. TWO-RESISTOR SERIES CIRCUIT. V_T = __________

	Voltage (V)	Current (A)	Resistance ( )	Power (W)
Bulb 1				
Bulb 2				
Circuit (Total)			= R_{EQ}	

2. THREE-RESISTOR SERIES CIRCUIT. V_T = __________

	Voltage (V)	Current (A)	Resistance ( )	Power (W)
Bulb 1				
Bulb 2				
Bulb 3				
Circuit (Total)			= R_{EQ}	

• Analysis •

1. Calculations of Resistance and Power

Calculate the resistance and power of each bulb and for each circuit in the lab. Record the values in the data table.

***NOTE: A "significant difference" is one that is 20% or greater: 115 is not significantly greater than 100, but 125 is. The percent difference between two numbers A and B is |A–B|/(A+B)x200.**

2. Patterns of Voltage

a. Select the statement that most accurately characterizes your measurements of the voltages values in the series circuit.

___ The first bulb in a series circuit (the bulb closest to the positive terminal of the battery) gets significantly more voltage than those that follow it.

___ The last bulb in a series circuit gets significantly more voltage than those before it.

___ All the bulbs in a series circuit get approximately the same voltage.

b. Select the statement and mathematical expression that most accurately compares your measurements of the voltages across the bulbs to the voltage across the terminals of the power supply.

___ The voltage across each bulb in the circuit is approximately equal to the voltage across the terminals: $V_1 = V_2\ (= V_3) = V_T$.

___ The sum of the voltages across each bulb in the circuit is approximately equal to the voltage across the terminals: $V_1 + V_2\ (+ V_3) = V_T$.

___ There is no apparent relation between the voltages across the bulbs in the circuit and the voltage across the terminals.

3. Patterns of Current

a. Select the statement and mathematical expression that most accurately characterizes your measurements of the currents through the bulbs.

___ The current through the first bulb in the circuit (the one closest to the positive terminal of the power supply) is significantly greater than the current through the bulbs that follow it.
___ The current through the last bulb in the circuit is significantly greater than the current through the bulbs before it.
___ The current through each bulb is approximately the same.

b. Select the statement and mathematical expression that most accurately compares your measurements of the current through the bulbs to the current through the entire circuit ($I_T = I_3$).

___ The current through each bulb is approximately equal to the current through the entire circuit: $I_1 = I_2 \ (= I_3) = I_T$.
___ The sum of the currents through the bulbs is approximately equal to the current through the entire circuit: $I_1 + I_2 \ (+ I_3) = I_T$.
___ There is no apparent relation between the current through the bulbs and the current through the entire circuit.

4. Patterns of Resistance

a. Select the statement that most accurately expresses the relation between the resistance of the bulbs in a series circuit and the equivalent resistance of the circuit as a whole.

___ The resistance of each bulb is approximately equal to the equivalent resistance of the circuit: $R_1 = R_2 \ (= R_3) = R_{EQ}$.
___ The sum of the resistances of the bulbs is approximately equal to the equivalent resistance of the circuit: $R_1 + R_2 \ (+ R_3) = R_{EQ}$.
___ There is no apparent relation between the resistances of the bulbs and the equivalent resistance of the circuit.

b. Compare the resistance of the series circuits to the resistance of the **simple circuit:** what happens to the resistance of a circuit when bulbs are added in **series?**

___ The resistance of the circuit increases when another bulb is added in series.
___ The resistance of the circuit decreases when another bulb is added in series.
___ The resistance of the circuit does not significantly change when bulbs are added in series.

5. Patterns of Power

a. Select the statement that most accurately expresses the relation between your calculations of the power dissipated in bulb 1, the power dissipated in bulb 2, and the total power dissipated in the circuit.

___ The power of each bulb is approximately equal to the total power of the circuit: $P_1 = P_2 = P_{TOT}$.
___ The sum of the powers of each bulb is approximately equal to the total power of the circuit: $P_1 + P_2 = P_{TOT}$.
___ There is no apparent relation between the powers of each bulb and the total power of the circuit.

b. Compare the total power of the series circuits to the power of the **simple circuit:** what happens to the power of a circuit when bulbs are added in **series?**

___ The power of the circuit increases when another bulb is added in series.
___ The power of the circuit decreases when another bulb is added in series.
___ The power of the circuit does not significantly change when bulbs are added in series.

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