

PhyzLab: Current Events III

a quantitative investigation of parallel circuits

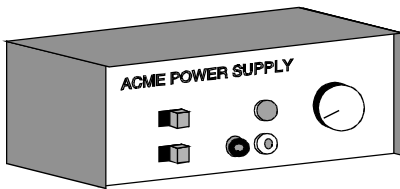
PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Purpose •

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

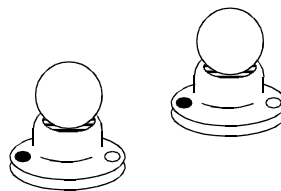
• Apparatus •

- ___ variable DC power supply (or 6 V lantern battery)
- ___ 3 miniature light bulbs in sockets (6.3V) [#46]
- ___ 12 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



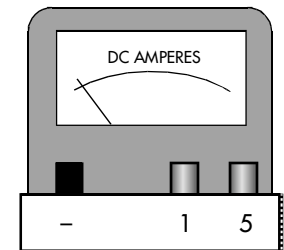
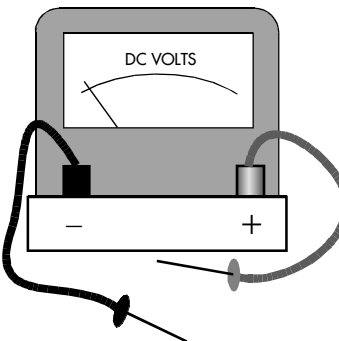
bulbs in sockets



connecting wires

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

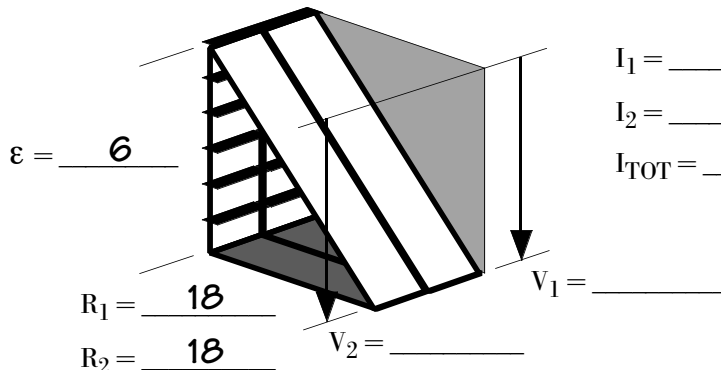
voltmeter
(with test leads)



ammeter

• Pre-lab •

Understanding The Parallel Slide. Identify the elevation (ϵ), 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 , and V_2). This parallel slide differs from the original simple slide (in *Current Events I*) in that it has two sections of run length placed side by side.



$$I_1 = \underline{\hspace{2cm}}$$

$$I_2 = \underline{\hspace{2cm}}$$

$$I_{TOT} = \underline{\hspace{2cm}}$$

$$V_1 = \underline{\hspace{2cm}}$$

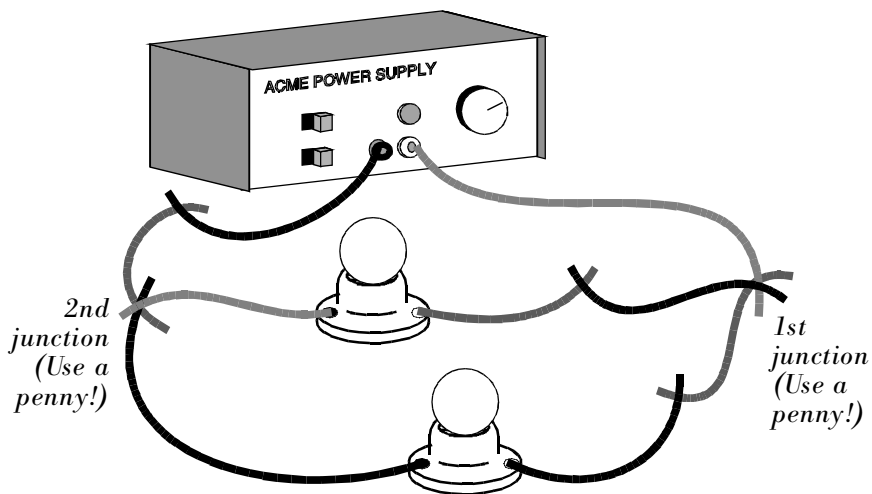
$$V_2 = \underline{\hspace{2cm}}$$

Keep in mind that I_{TOT} represents the total flow rate capacity (which is usually—but not always—proportional to slope of incline). If each slide has a capacity of 2 riders per second, the total capacity of two slides in parallel is 4 riders per second.

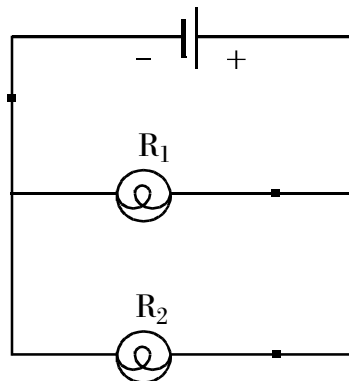
• **Procedure** •

1. TWO-RESISTOR PARALLEL CIRCUIT

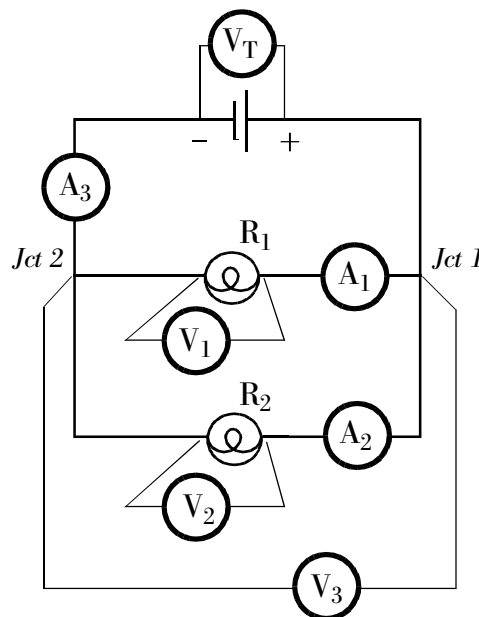
a. **Construct** a *parallel* circuit using the power supply, two bulbs, and **nine** wires as shown below. Consider using a coin at each junction (it's easier to connect the alligator clips to the coin than to each other). When the circuit is activated, the bulbs should be equally bright. If they are not, try other 6.3-V bulbs until you get a match.



BASIC SCHEMATIC DIAGRAM



SCHEMATIC WITH METERS



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.

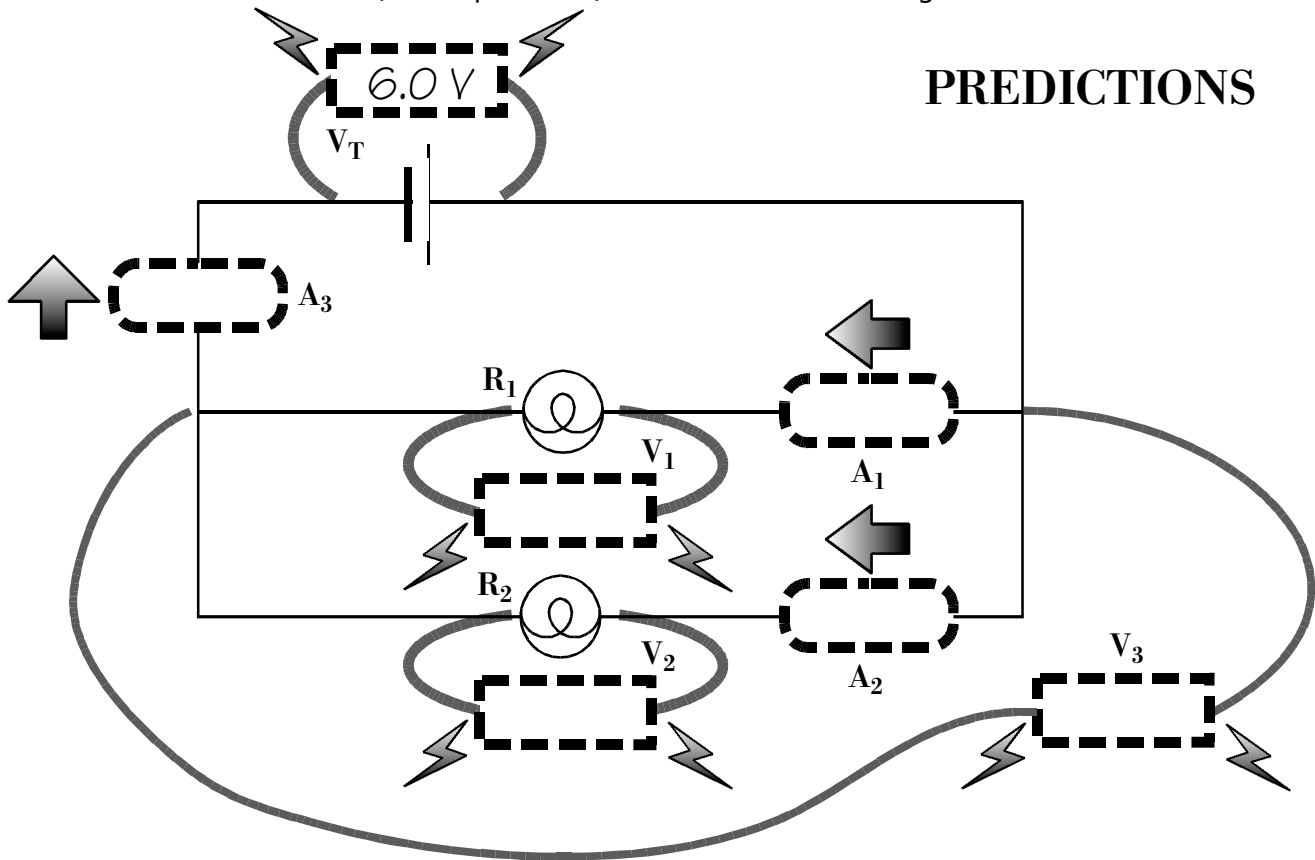
V_2 measures V_2 , the voltage drop across bulb 2.

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

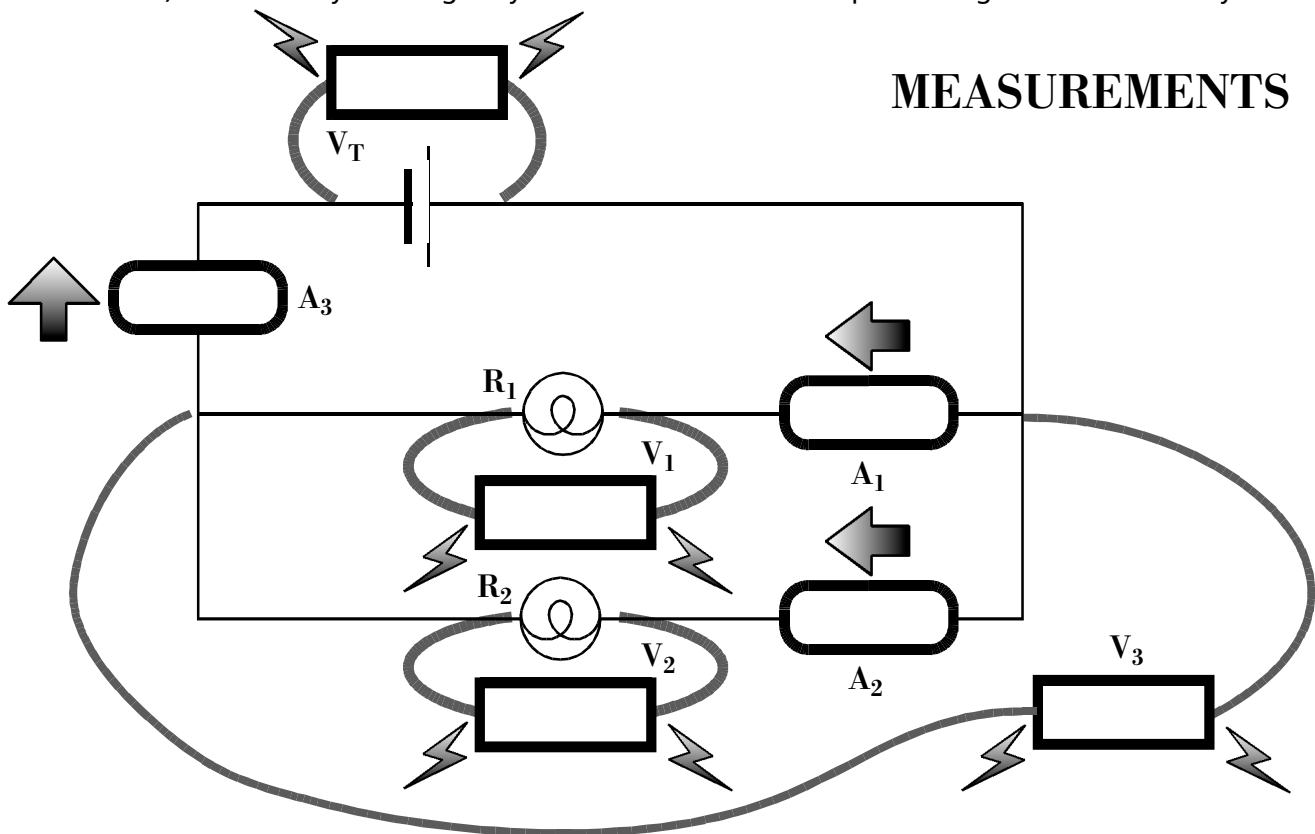
V_3 measures V_{TOT} , the voltage drop across *both* bulbs.

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).

c. **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.

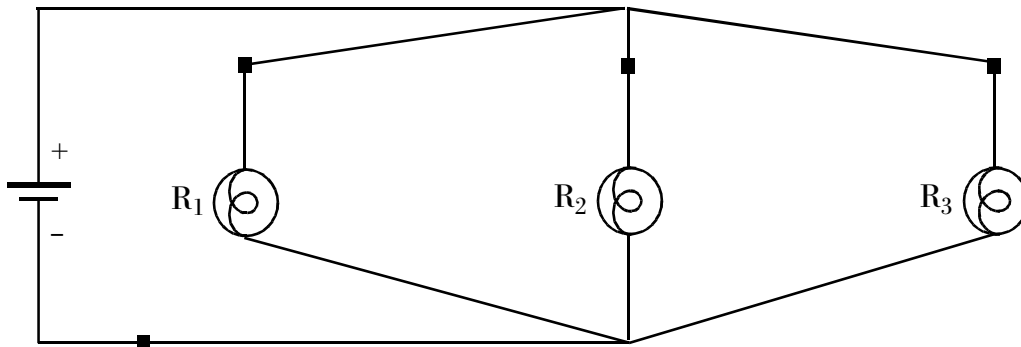


d. **Measure** the actual values of the current and voltage at the various points throughout the circuit. If you are using a variable DC power supply, set the terminal voltage to 6.0 V when the circuit is operating (the bulbs are lit). Secure a PhyzBlessing for your measurements before proceeding to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

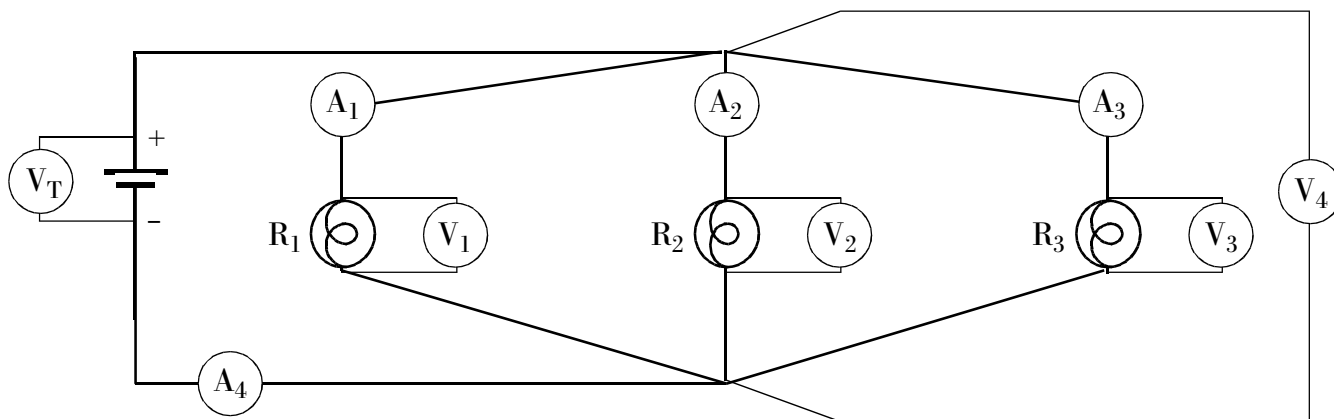


2. A THREE-RESISTOR PARALLEL CIRCUIT

a. **Construct** a parallel circuit with three bulbs and **twelve** wires as shown below. Consider using coins at the junctions. 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.



SCHEMATIC WITH METERS



b. **Predict** the values *before* taking measurements (use $V_T = 6.0\text{ V}$):

$V_T = \underline{6.0\text{ V}}$	$V_1 = \underline{\hspace{2cm}}$	$I_1 = \underline{\hspace{2cm}}$
	$V_2 = \underline{\hspace{2cm}}$	$I_2 = \underline{\hspace{2cm}}$
	$V_3 = \underline{\hspace{2cm}}$	$I_3 = \underline{\hspace{2cm}}$
	$V_{TOT} (V_4) = \underline{\hspace{2cm}}$	$I_{TOT} (A_4) = \underline{\hspace{2cm}}$

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

$V_T = \underline{\hspace{2cm}}$	$V_1 = \underline{\hspace{2cm}}$	$I_1 = \underline{\hspace{2cm}}$
	$V_2 = \underline{\hspace{2cm}}$	$I_2 = \underline{\hspace{2cm}}$
	$V_3 = \underline{\hspace{2cm}}$	$I_3 = \underline{\hspace{2cm}}$
	$V_{TOT} (V_4) = \underline{\hspace{2cm}}$	$I_{TOT} (A_4) = \underline{\hspace{2cm}}$

• **Data and Calculations** •

Transfer the measured voltage and current values to this table.

1. TWO-RESISTOR PARALLEL CIRCUIT. $V_T =$ _____

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

2. THREE-RESISTOR PARALLEL 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 $|A-B|/(A+B) \times 200$.**

2. **Patterns of Voltage**

a. Write a statement that most accurately characterizes your measurements of the voltages across the bulbs. (Review the statements listed in the Analysis section of Current Events II and make an appropriate statement in that style.)

b. Write a 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.

3. Patterns of Current

- a. Write a statement that most accurately characterizes your measurements of the currents through the bulbs.

- b. Write a statement and mathematical expression that most accurately compares your measurements of the current through the bulbs to the current through the entire circuit.

4. Patterns of Resistance

- a. Write a statement and mathematical expression that most accurately expresses the relation between the values of the resistance of the individual bulbs and the equivalent resistance of the circuit. (This one is difficult; think in terms of simple fractions.)

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

5. Patterns of Power

- a. Write a statement and mathematical expression that most accurately expresses the relation between the power of the individual bulbs and the total power of the circuit.

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

• Post-lab Questions •

1. What are the differences between the current in a series circuit and the current in a parallel circuit? Consider the relation between the current in each bulb as compared to the total current in the circuit.

2. What are the differences between the voltage in a series circuit and the voltage in a parallel circuit? Consider the relation between the voltage across each bulb as compared to the total voltage across the circuit.

3. a. How is the current in a series circuit similar to the voltage across a parallel circuit?
- b. How is the voltage across a series circuit similar to the current in a parallel circuit?
4. a. Does the **resistance** of a bulb depend on the type of circuit it's in? If so, in which type of circuit does a bulb have the greater resistance: series or parallel? Cite evidence from your data.
- b. If there is no difference, why is this so? If there is a difference, how come? (Hint for either case: consider the factors that determine the resistance of any resistor.)
5. Are the bulb filaments hotter when connected in series or in parallel; how do you know?
6. A 3-bulb series circuit and a 3-bulb parallel circuit are connected to identical batteries. Both circuits are turned on simultaneously.
- a. Which circuit emits more light?
- b. The battery in which circuit will run down first? Explain.