

20.1

Series and Parallel Circuits



Question: How do series and parallel circuits work?

1 Voltage and current in series circuits

Table 1: Comparing series circuits

	1-bulb circuit	2-bulb circuit	3-bulb circuit
Battery voltage (V)			
Current (A)			
Bulb 1 voltage (V)			
Bulb 2 voltage (V)			
Bulb 3 voltage (V)			

2 Thinking about what you observed

- a. Use the data in Table 1 to explain the relationship between the battery voltage in a circuit and the voltage across the bulb or bulbs connected in series.
- _____
- _____
- _____
- _____
- b. What did you notice about the brightness of the bulbs as you increased number of bulbs in the circuit? Why do you think this is? How do the measurements you made support your hypothesis about why the bulbs changed in brightness?
- _____
- _____
- _____
- _____
- c. What happens to the other two bulbs when one bulb is removed from the three-bulb circuit? Explain why the circuit behaves as it does.
- _____
- _____
- _____
- _____

3**Determining the total resistance of resistors in series**

- a. You will use two 5-ohm and one 10-ohm resistor during this Investigation. Predict what the total resistance of the circuit will be when all three resistors are connected in series.

- b. Predict the circuit's total current when 3 volts are applied using two batteries.

4**Measuring the current and resistance in series circuits****Table 2: Three-resistor series circuit measurements**

Current (amps)	Voltage (V)	Resistance (ohms)

- a. Use Ohm's law (in the form $R = V/I$) to calculate the total resistance in each circuit from the combined battery voltage (Table 1) and the current for each circuit (Table 2). Record your results in the bottom row of Table 2.
- b. Compare your measurements with the predictions of Part 3. Explain the effect that adding resistors has on the current flowing in a series circuit.

5**Parallel circuits****Table 3: Comparing series circuits**

	Total circuit	Bulb 1	Bulb 2	Bulb 3
Voltage (V)				
Current (A)				
Resistance (Ω)				

6 Comparing series and parallel circuits

- a. Use Ohm's law and the total circuit voltage and total circuit current from Table 3 to calculate the total resistance of the circuit with three bulbs in parallel. Record the result in the last row of Table 3.
- b. Use Table 4 to summarize the total circuit current and voltage measurements from the single-bulb circuit and the two different three-bulb circuits (series and parallel).

Table 4: Comparing series and parallel circuits

	Single-bulb circuit	3-bulb series circuit	3-bulb parallel circuit
Current (A)			
Voltage (V)			
Resistance (Ω)			

- c. Compare the total resistance of the single-bulb circuit with the total resistance of the three-bulb series circuit. Which circuit resistance is greater? Why do you think this is?

- d. Compare the total resistance of the single-bulb circuit to the total resistance of the three-bulb parallel circuit. Which circuit resistance is greater? Why do you think this is?

- e. How are the branch currents in the parallel circuit related to the total current supplied by the batteries? Explain how you arrived at your answer.

- f. Compare the total current in the single-bulb circuit, the three-bulb series circuit, and the three-bulb parallel circuit. Is there an approximate relationship between the currents that also agrees with the observed brightness of the bulbs in each circuit?

g. If you wish to brightly light three bulbs with one battery, should you connect them in series or parallel?

h. Calculate the total current that should flow when three resistors (of 5, 5, and 10 ohms) are connected in parallel as shown. Build and test the circuit to evaluate your prediction. How close was your prediction to the actual measurements?
