DC Circuits

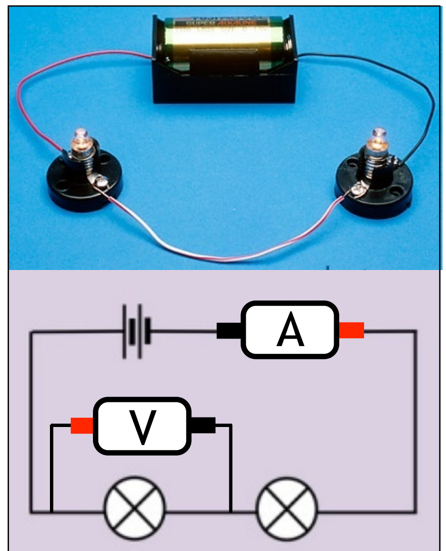
The bad bulb is always the 48th one you check (on a 50-light string).

Introduction

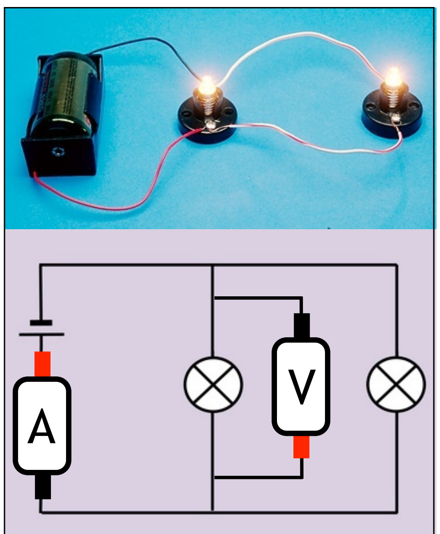
The difference between series and parallel circuits can be illustrated clearly using Christmas lights. Specifically, the old-fashioned kind compared to the type you can buy now. Back in the olden days, those old-timey lights were wired in series. This is an all-or-nothing proposition: If one bulb burns out, the whole string goes out. And there you sit under the Christmas tree, testing the string bulb by bulb until you find the bad one. Newer lights are wired in parallel, which means that when a bulb burns out, the rest of the string stays lit. The bad bulb can be found and replaced instantly. A parallel circuit allows multiple devices to be wired with the same voltage source, but independently of each other. Which is very convenient—breakfast would be a hassle every morning if your toaster, coffee maker, and microwave oven were wired in series.

Objectives

- Demonstrate the principles of DC circuits
- Observe qualitative differences between series and parallel circuits
- Become familiar with safely using the DC power supply
- Learn and use standard conventions for diagramming circuits
- Use Ohm's Law to qualitatively examine the difference between light bulbs



Series Circuit



Parallel Circuit

Equipment

- Vernier LabQuest
- Vernier Circuit Board
- Voltage Probe
- Current Probe
- DC power supply

Procedure

- Use the DC power supply, wires, and bulbs to construct simple circuits. The power supply should be switched to lowest setting. The dial which adjusts the voltage should be set at **3 volts**.
- Connect the **current** probe to **Channel 1** and **voltage** probe to **Channel 2** to the LabQuest, and switch the unit on. You will need to record values for current and voltage, but you will not need to collect data over timed intervals. The instantaneous values are displayed under the **Meter** tab.
- *The current and voltage probes are extremely sensitive, and can be permanently damaged by overloading them.* The current probe will be literally destroyed by currents greater than **0.600A**. The voltage probe is limited to **6V**. It is more forgiving than the current probe, but you will render it permanently inoperable if you exceed 7V. *Please do not exceed these limits, and keep the power supply at the 3V setting.*

Bulbs in Series and Parallel

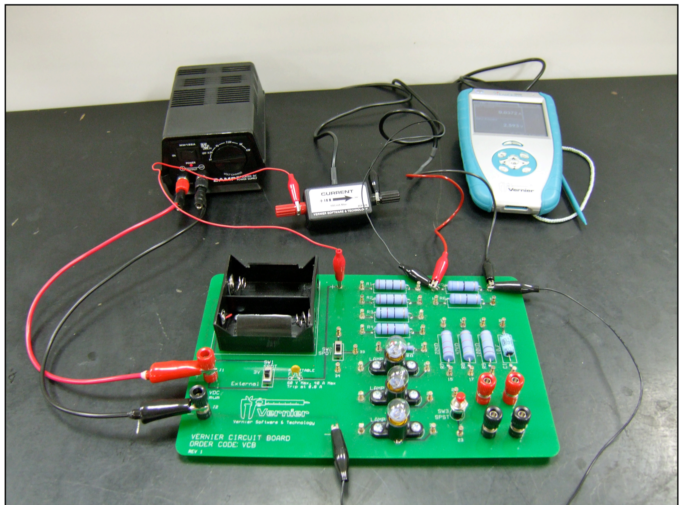
- With the power supply ***off***, construct and diagram circuit in which all three bulbs are wired in series. Wire the current probe in series as well. The current probe is *not* a switch, but in the circuit diagrams above, the probe would be wired in that position. Switch on the power supply, and record the amount of current being drawn by the circuit. (You do not need to measure or record any voltage yet.)
- With the power supply ***off***, construct and diagram circuit in which all three bulbs are wired in parallel. Do not change the setting on the power supply, and leave the current probe wired in series. Again, switch the power supply on and record the amount of current being drawn by the circuit.

Number of Bulbs	Current Drawn (amps)	
	Series Circuit	Parallel Circuit
Two		
Three		

Questions

1. Were the bulbs brighter in the series or parallel circuit?
2. Which circuit was drawing more total current? What happens to the total amount of current drawn through the circuit as bulbs are added in series? What happens to the total current when bulbs are added in parallel?
3. If you continued to add bulbs in the series circuit, what would happen to the brightness of the bulbs as each new one was added? What happens to the brightness when you add bulbs in parallel? Why isn't this the same in each case?

Resistors in Series and Parallel



Keep the current probe wired in series. The voltage probe should be connected in parallel (clip the leads on either side of the resistor you are measuring).

- With the power supply ***off***, wire a complete circuit using one 68Ω resistor. (The current probe should still be wired in series as previously.)
- Clip the leads of the voltage probe across the terminals of the resistor.
- Before switching the power supply on, zero the probes. Under the **Sensor** menu of the **Meter** tab, select **Zero**, and choose both probes.
- Switch on the power supply, and record the values for the current and the voltage across the resistor.
- Switch the power supply off, and add a second 68Ω resistor to the circuit in series. **Zero**, switch on, and measure the current.
- The voltage probe should still be connected across the first resistor. Record the voltage, then unclip the voltage probe and re-clip the leads across the second resistor. Record this voltage as well.
- Switch off, and rewire your circuit. You should wire the 68Ω resistor in parallel with a 51Ω resistor. Keep the voltage probe across the first resistor.
- **Zero**, switch on, and record the current and voltage values. Unclip the voltage probe and re-clip the leads across the second resistor. Record this voltage as well.

Circuit	Total Current Drawn (amps)	Voltage (volts)	
		$R_1 = 68\Omega$	$R_2 = 51\Omega$
One Resistor			———
Two Resistors Series			
Two Resistors Parallel			

Questions

4. Compare the current drawn by two resistors in the series circuit to the original single-resistor circuit. Is it *about* half as much? It will not be exactly half—why not?
5. What would expect the total current to be for the pair of resistors in parallel? Again, why isn't it exactly what you would predict?
6. With a single 68Ω resistor in the circuit, does the voltage across the resistor match the 3V power supply? Why might it not match exactly? (Hint: Is that 68Ω resistor really the only device in the circuit?)
7. For the series circuit, add the voltages across the resistors. Compare this to the voltage of the power supply.
8. Think about total resistance: Which circuit, series or parallel, has a greater total resistance? Does it matter whether the circuit you tested used light bulbs or resistors? Explain your reasoning.