Comparing Voltage Drops and Currents in Parallel Lab

Teacher's Guide

Topic:

Electric Circuits

The following information is provided to the student:

Question:
How do the voltage drops across the three resistors of a parallel circuit compare to each other? Are these voltage drops different for different resistors? How do the voltage drops compare to the voltage gain in the battery? How do the current values in the individual branches compare to each other? Are these currents affected by the resistance of the branches? How do the current values compare to the current at the battery location? For any individual resistor, how are the voltage drop, current and resistance related? How can all these comparisons be expressed using mathematical equations?

Purpose:
To compare voltage drops across the three resistors of a parallel circuit and to compare current values at the three resistor locations and outside of the branches of a parallel circuit.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include a schematic of a three-resistor parallel circuit. The resistance values should be indicated on the diagram. Ammeter locations should be indicated on the diagram as well. Measurements of ΔV_1, ΔV_2, and ΔV_3 should be indicated in a table or on the diagram. Measurements of I_1, I_2, and I_3 should be indicated in a table or on the diagram. The Conclusion/Discussion should identify equations relating the branch currents to the voltage drop and resistance values for those branches and to relate the branch currents to the total current in the circuit. Conceptual ideas should be extracted from the data and referenced to the data. Equations should be stated. An error analysis should be performed and percent difference values calculated.

Materials Required:

Four D-cells; battery holder; alligator leads; three resistors (with a different resistance); computer interfaced ammeter and voltage probes.

Description of Procedure:

A three-resistor parallel circuit is constructed with each resistor positioned within its own branch. An ammeter is placed outside of the branches between the node (where all three branches connect together) and the battery pack filled with four D-cells. The two leads of the voltage probes are simultaneously tapped on opposite sides of the *first* resistor; the voltage drop (ΔV_1) is recorded. The process is repeated for the other two resistors in order to determine their voltage drops (ΔV_2 and ΔV_3). Finally, the two leads of the voltage probes are simultaneously tapped to opposite sides of the battery pack to determine the voltage output of the battery (ΔV_{tot}). The ammeter reading is taken outside of the branches to determine the total current (I_{tot}) within the circuit. The ammeter is then moved inside of each individual branch in order to determine the current in each of the branches (I_1, I_2, and I_3). Resistance values of the resistors are also recorded. The data is inspected and calculations are performed in order to determine the answers to the questions raised in the Purpose of the lab.

Alternative Materials and Procedure:

The Laboratory

A couple of multimeters can be used in place of the computer interfaced ammeter and voltmeter.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

1. With a thorough explanation of terms and a description of how to use the equipment, both the procedure and the analysis are do-able by most students. At times they will struggle with what to do and how to do it. A re-iteration of how to use the equipment is often sufficient guidance to help lab groups hurdle the obstacles.
2. Demonstrate how to use the voltage probes to determine a voltage difference between two points. Make sure students are using the probes correctly and not *wiring* the voltage probes into the circuit. Make sure the ammeters are being wired into the circuit, in series with the resistors.
3. Combining the lab with a reading assignment on the mathematics of parallel circuits may make both the lab and the reading more enlightening.
4. This lab offers students a challenge at collecting quantitative data and making numerical sense of it. In their Conclusion/Discussion, students might simply state equations which they have read in some physics textbook. Emphasize that they are to provide evidence for such equations, making specific references to their data.
5. Many resistors utilize a color code to convey the theoretical resistance. Information about the interpretation of the colors is typically available online. Conducting a Google search for "Resistor Color Code Convention" will return a collection of web sites, such as

   http://www.diyaudioandvideo.com/Electronics/Color/

Auxiliary Materials:

None

Scoring Rubric:

C9.	**Comparing Voltage Drops and Currents in Parallel Lab**	**Score**
___	Included, labeled and organized all parts of the lab report.	____/____
___	Data section includes a schematic diagram; resistors are labeled and values are stated, along with a unit. Ammeter locations and voltmeter arrangements are shown and labeled as ΔV_1, I_1, etc. Measured values are listed on the diagram; all necessary measurements are made; units are given. Calculations are performed and work is shown in an effort to determine mathematical equations relating the quantities. Data is reasonably accurate.	
___	Conclusion/Discussion identifies the mathematical relationships between the voltage drops, currents and resistance values for each resistor. The voltage gain in the battery is compared to the voltage drops across each individual resistor; the current through the battery is compared to the branch currents. All questions are answered (see Questions section); data is used to support the answers. Discussion is complete and accurate; reveals understanding.	

Connections to The Physics Classroom Tutorial:

The Laboratory

The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/circuits/u9l4a.cfm

http://www.physicsclassroom.com/Class/circuits/u9l4d.cfm

Connections to Minds on Physics Internet Modules:

Sublevels 8 and 10 of the Electric Circuits module are suitable accompaniments to this lab:

http://www.physicsclassroom.com/mop/module.cfm