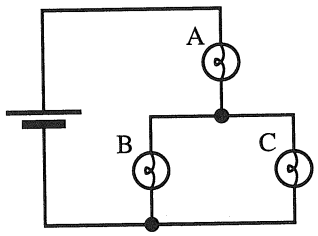
For example, the voltage across the battery in Experiment 8.1 is equal to the sum of the voltages across bulbs 1 and 2 in loop *ABEDA*, and also to the sum of the voltages across bulb 1 and the nichrome wire in loop *ABCFEDA*. The two forms of Kirchhoff's second rule that appear above are equivalent. (Kirchhoff's first rule was discussed in Section 5.)

Exercise 8.2

In this exercise, four students give explanations for the relative brightness of the bulbs in the circuit below.



Student 1: *"B and C are equally bright but dimmer than A. B and C have to share the current whereas A gets all of it. Therefore A is brighter than B or C."*

Student 2: *"Bulb A has more resistance than the B-and-C network so bulb A has more voltage across it. Therefore A is brighter than B or C."*

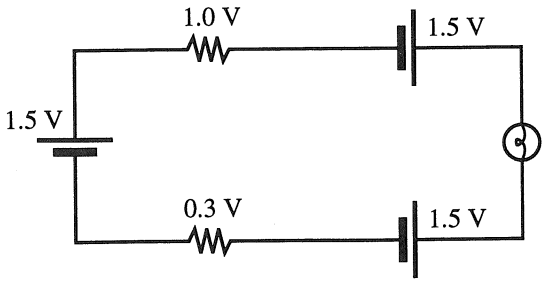
Student 3: *"Bulb A uses up most of the current so less is left for B and C. A is therefore brighter than B or C."*

Student 4: *"After bulb A, the voltage divides into two paths with the result that B and C each get less voltage than A. Therefore A is brighter than B or C."*

Identify which of the students, if any, are reasoning incorrectly, and determine what is wrong with their reasoning.

Exercise 8.9

Consider the following circuit.



Use your modified version of Kirchhoff's second rule to find the voltage across the bulb.

Experiment 8.10

A. Five different circuits can be formed with two batteries and one bulb. Since one of these circuits wears out batteries very quickly, do not set up the circuits yet. Instead, draw a diagram for each of the five circuits. Use your model for electric current and Kirchhoff's second rule to predict what will happen in each circuit. Check your predictions with a staff member.

B. Set up the circuits that will not damage the batteries and test your predictions for these circuits.

C. Measure the voltage across the bulb, each battery, and the battery combinations in each of the safe circuits. Compare the voltage across the bulb in these circuits. Also, for each circuit, compare the voltage across the bulb with the voltage across the battery combination.

D. Compare the brightness of the bulb in each circuit.

The voltmeter as a circuit tester

When a circuit does not behave as intended, the problem is often an open circuit or a short circuit. A voltmeter is an excellent instrument for detecting either of these defects because it can be used to test a circuit without disconnecting any of the elements.

The following two experiments show the patterns of voltages that are associated with these two common types of electrical malfunctions.