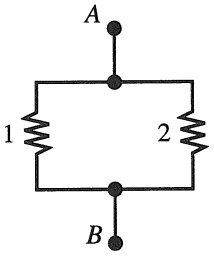
Analysis of electric circuits

In the next set of exercises, we examine how the concepts of current and voltage can be used to predict and explain the behavior of simple circuits. We will find that some circuits are more easily analyzed in terms of the currents through the circuit elements while others are more readily understood in terms of the voltages across the elements.

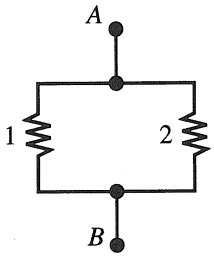
Exercise 7.12

In this exercise we will express mathematically the relationships of current and voltage in parallel networks.

A. For the parallel network shown, let V_1 be the voltage across resistor 1, let V_2 be the voltage across resistor 2, and let V_0 be the voltage across the whole network (from A to B). Write equations to express the relations among these three voltages.



B. For the parallel network shown let i_1 be the current through resistor 1, let i_2 be the current through resistor 2, and let i_0 be the current through the whole network (entering at A and leaving at B). Write equations to express the relations among these three currents.

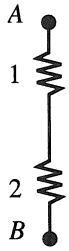


Exercise 7.13

In this exercise we will express mathematically the relationships of currents and voltages in series networks.

A. For the series network shown let V_1 be the voltage across resistor 1, let V_2 be the voltage across resistor 2, and let V_0 be the voltage across the whole network (from A to B). Write equations to express the relations among these three voltages.

B. For the series network shown let i_1 be the current through resistor 1, let i_2 be the current through resistor 2, and let i_0 be the current through the whole network (entering at A and leaving at B). Write equations to express the relations among these three currents.



✔ Discuss this exercise and Exercise 7.12 with a staff member.

Exercise 7.14

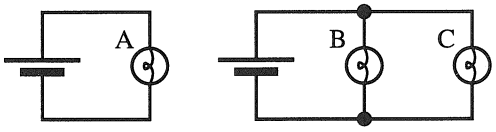
A. Refer to the definitions for series and parallel connections of elements given in Section 4. The definition for a series connection of elements was given in terms of the current passing through the elements. In Exercise 7.13, we found this leads to a simple mathematical relationship between the current through each element connected in series. What is this relationship?

B. In Exercise 7.12, we found there exists a simple mathematical relationship between the voltages across elements connected in parallel. What is this relationship? This relationship is characteristic of parallel branches in circuits. It is often a less cumbersome way of describing parallel connections than that given in Section 4.

As Exercises 7.12 and 7.13 show, the voltages across the elements in series and parallel networks are related to each other differently from the way the currents in these networks are related. We do not speak of voltage, as we do of current, as passing through elements in a circuit. A battery will always have approximately the same voltage across it but does not deliver the same current to all circuits. The following exercises provide practice in thinking about voltage and current in some familiar circuits.

Exercise 7.15

In this exercise, three students give predictions and explanations for the relative brightness of bulbs A, B, and C.



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

Student 1: *"B and C will be dimmer than A. Bulb A gets all of the current from the battery but B and C have to share it."*

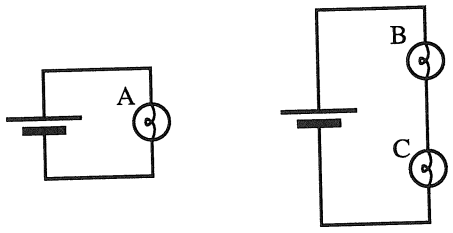
Student 2: *"A, B, and C will all be equally bright. They each have the same voltage across them."*

Student 3: *"A, B, and C will all be equally bright. Each has the same resistance, and each is connected directly across the battery, so each bulb has the same amount of current through it. So they are equally bright."*

✔ Check your reasoning with a staff member.

Exercise 7.16

In this exercise, three students give predictions and explanations for the relative brightness of bulbs A, B, and C. Identify which, if any, of the students are reasoning incorrectly, and determine what is wrong with their reasoning.



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."*

Student 2: *"B and C are equally bright but dimmer than A. B and C have to share the battery voltage whereas A gets all of it."*

Student 3: *"A is brighter than B and B is brighter than C. B uses up some of the current so less gets through to C. A gets all the current so it is the brightest."*

✔ Check your reasoning with a staff member.