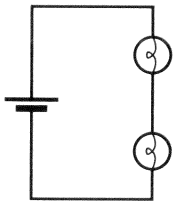
## II. Bulbs in series

Set up a two-bulb circuit with identical bulbs connected one after the other as shown. Bulbs connected in this way are said to be connected in *series*.



A. Compare the brightness of the two bulbs with each other. (Pay attention only to large differences in brightness. You may notice minor differences if two "identical" bulbs are, in fact, not quite identical.)

Use the assumptions we have made in developing our model for electric current to answer the following questions:

1. Is current "used up" in the first bulb, or is the current the same through both bulbs?

2. Do you think that switching the order of the bulbs might make a difference? Check your answer.

3. On the basis of your observations *alone,* can you tell the direction of the flow through the circuit?

B. Compare the brightness of each of the bulbs in the two-bulb series circuit with that of a bulb in a single-bulb circuit.

Use the assumptions we have made in developing our model for electric current to answer the following questions:

1. How does the current through a bulb in a single-bulb circuit compare with the current through the same bulb when it is connected in series with a second bulb? Explain.

2. What does your answer to question 1 imply about how the current through the *battery* in a single-bulb circuit compares to the current through the *battery* in a two-bulb series circuit? Explain.

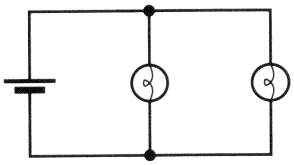
C. We may think of a bulb as presenting an obstacle, or *resistance,* to the current in the circuit.

1. Thinking of the bulb in this way, would adding more bulbs in series cause the total obstacle to the flow, or *total resistance,* to increase, decrease, or stay the same as before?

2. Formulate a rule for predicting how the current through the battery would change (*i.e.,* whether it would *increase, decrease,* or *remain the same*) if the number of bulbs connected in series were increased or decreased.

**III. Bulbs in parallel**

Set up a two-bulb circuit with identical bulbs so that their terminals are connected together as shown. Bulbs connected together in this way are said to be connected in *parallel*.



A. Compare the brightness of the bulbs in this circuit.

1. What can you conclude from your observation about the amount of current through each bulb?

2. Describe the current in the entire circuit. Base your answer on your observations. In particular, how does the current through the battery seem to divide and recombine at the junctions of the two parallel branches?

B. Is the brightness of each bulb in the two-bulb parallel circuit *greater than, less than,* or *equal to* that of a bulb in a single-bulb circuit?

How does the amount of current through a *battery* connected to a single bulb compare to the current through a *battery* connected to a two-bulb parallel circuit? Explain based on your observations.

C. Formulate a rule for predicting how the current through the battery would change *(i.e.,* whether it would *increase, decrease,* or *remain the same)* if the number of bulbs connected in parallel were increased or decreased. Base your answer on your observation of the behavior of the two-bulb parallel circuit and the model for current.

What can you infer about the total resistance of a circuit as the number of parallel branches is increased or decreased?

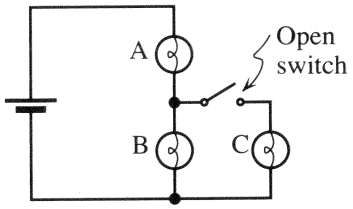
D. Does the amount of current through a battery seem to depend on the number of bulbs in the circuit and how they are connected?

E. Unscrew one of the bulbs in the two-bulb parallel circuit. Does this change significantly affect the current through the branch that contains the other bulb?

A characteristic of an *ideal* battery is that the branches connected directly across it are independent of one another.

## IV. Limitations: The need to extend the model

A. The circuit at right contains three identical bulbs and an ideal battery. Assume that the resistance of the switch, when closed, is negligible. Use the model we have developed to:




- predict the relative brightness of the bulbs in the circuit with the switch closed. Explain.

- predict how the brightness of bulb A changes when the switch is opened. Explain.

B. Show that a simple application of the model for current that we have developed thus far is inadequate for determining how the brightness of bulb B changes when the switch is opened.