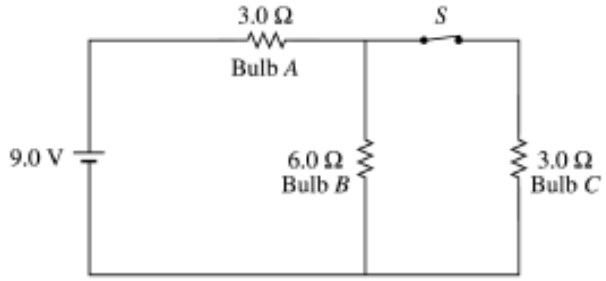
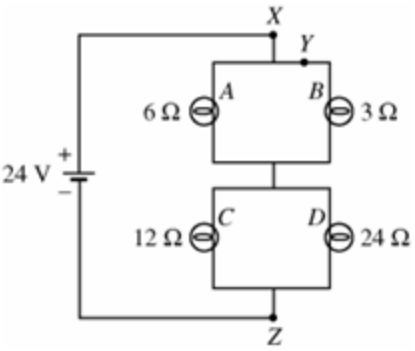


1. Lightbulbs of fixed resistance 3.0 Ω and 6.0 Ω, a 9.0 V battery, and a switch S are connected as shown in the schematic diagram above. The switch S is closed.

a. Calculate the current in bulb A.

b. Which lightbulb is brightest? Justify your answer.

c. Switch S is then opened. Indicate whether the brightness of each lightbulb increases, decreases, or remains the same. Explain your reasoning for each lightbulb.



2. Four lightbulbs are connected in a circuit with a 24V battery as shown above.

(a)

i. Determine the average potential energy change of an electron as it moves from point Z to point X.

ii. Indicate whether the electron gains or loses potential energy as it moves from point Z to point X.

(b) Calculate the equivalent resistance of the circuit.

(c)

i. Calculate the magnitude of the current through point Y.

ii. Indicate on the diagram the direction of the current through point Y.

(d) Calculate the energy dissipated in the 12Ω bulb in 5s.

(e) Rank the bulbs in order or brightness with 1 being the brightest. If any bulbs have the same brightness, give them the same ranking. Explain your reasoning.

3. Two lightbulbs, one rated 30 W at 120 V and another rated 40 W at 120 V, are arranged in two different circuits.

(a) The two bulbs are first connected in parallel to a 120 V source.

i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.

ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

(b) The bulbs are now connected in series with each other and a 120 V source.

i. Determine the resistance of the bulb rated 30 W and the current in it when it is connected in this circuit.

ii. Determine the resistance of the bulb rated 40 W and the current in it when it is connected in this circuit.

(c) In the spaces below, number the bulbs in each situation described, in order of their brightness. (1=brightest, 4=dimmest)
___ 30 W bulb in the parallel circuit
___ 40 W bulb in the parallel circuit
___ 30 W bulb in the series circuit
___ 40 W bulb in the series circuit

(d) Calculate the total power dissipated by the two bulbs in each of the following cases:

i. The parallel circuit
ii. The series circuit

4. Some students want to know what gets used up in an incandescent lightbulb when it is in series with a resistor: current, energy, or both. They come up with the following two questions.

1. In one second do fewer electrons leave the bulb than enter the bulb?

2. Does the electric potential energy of electrons change while inside the bulb?

The students have an adjustable power source, insulated wire, lightbulbs, resistors, switches, voltmeters, ammeters, and other standard lab equipment. Assume that the power supply and voltmeters are marked in 0.1 V increments and the ammeters are marked in 0.01 A increments.

a) Describe an experimental procedure that could be used to answer questions 1 and 2 above. In your description, state the measurements you would make and how you would use the equipment to make them. Include a neat, labeled diagram of your setup.

b)

i. Explain how data from the experiment you described can be used to answer question 1 above.

ii. Explain how data from the experiment you described can be used to answer question 2 above.

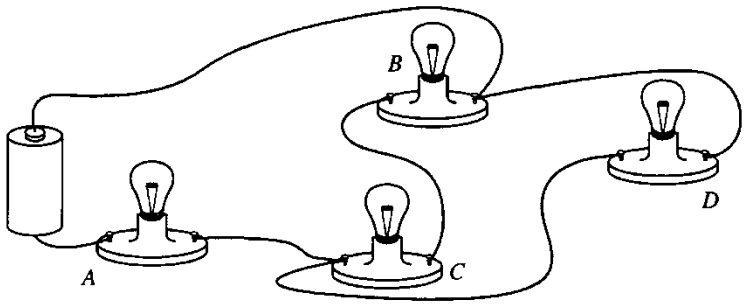
A lightbulb is nonohmic if its resistance changes as a function of current. Your setup from part (a) is to be used or modified to determine whether the lightbulb is nonohmic.

c)

i. How does the setup, if at all, need to be modified?

ii. What additional data, if any, would need to be collected

d) How would you analyze the data to determine whether the bulb is nonohmic? Include a discussion of how the uncertainties in the voltmeters and ammeters would affect your argument for concluding whether the resistor is nonohmic.



5. In the circuit shown above, A, B. C, and D are identical light bulbs. Assume that the battery maintains a constant potential difference between its terminals (i.e., the internal resistance of the battery is assumed to be negligible) and the resistance of each light bulb remains constant.

a. Draw a diagram of the circuit in the box below, using the standard symbols for batteries and resistors to represent the components in your diagram. Label the resistors A, B, C, and D to refer to the corresponding light bulbs.

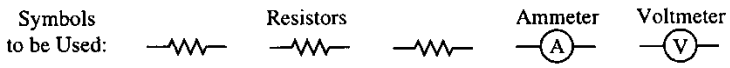
b. List the bulbs in order of their brightness, from brightest to least bright. If any two or more bulbs have the same brightness, state which ones. Justify your answer.

c. Bulb D is then removed from its socket.
   i. Describe the change in the brightness, if any, of bulb A when bulb D is removed from its socket. Justify your answer.
   ii. Describe the change in the brightness, if any, of bulb B when bulb D is removed from its socket. Justify your answer.

6. Three identical resistors, each of resistance 30 Ω are connected in a circuit to heat water in a glass beaker. A 24 V battery with negligible internal resistance provides the power.

a. The three resistors may be connected in series or in parallel.
   i. If they are connected in series, what power is developed in the circuit?
   ii. If they are connected in parallel, what power is developed in the circuit?

b. Using the battery and one or more of the resistors, design a circuit that will heat the water at the fastest rate when the resistor(s) are placed in the water. Include an ammeter to measure the current in the circuit and a voltmeter to measure the total potential difference of the circuit. Assume the wires are insulated and have no resistance. Draw a diagram of the circuit in the box below, using the following symbols to represent the components in your diagram.



Draw your diagram in this box only.