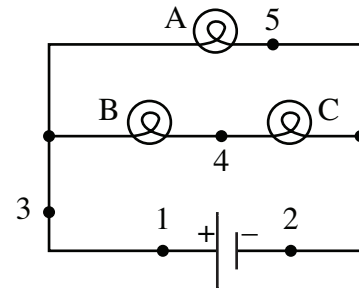


Unit 23 Homework Problems**Learning Goals:**

- F.23 Calculate the equivalent resistance of a network of resistors that may involve combinations of series and parallel combinations.
- A.23 Apply Ohm's law and Kirchoff's laws to a circuit that may involve multiple loops, wires, resistors, and batteries.

Questions 1 through 4 refer to the circuit shown to the right. In this "ideal" circuit, the battery has no internal resistance so that it maintains a constant potential difference between its terminals at points 1 and 2 regardless of how much current flows through it. Also, the three light bulbs, A, B, and C, are identical.*

* Adapted from Arons, A. A Guide to Teaching Introductory Physics (Wiley, 1990).

**23-1)**

- (a) How do the brightness's of the three bulbs compare to each other? Explain your reasoning.
- (b) What happens to the brightness of each of the three bulbs when bulb A is unscrewed and removed from its socket? Explain your reasoning.
- (c) What simultaneously happens to the current through points 3, 4 and 5? Explain your reasoning.

23-2)

- (a) What happens to the brightness of each of the three bulbs shown in the figure above if bulb C is unscrewed and removed from its socket? Explain your reasoning.
- (b) What simultaneously happens to the current through points 3, 4 and 5? Explain your reasoning.

23-3)

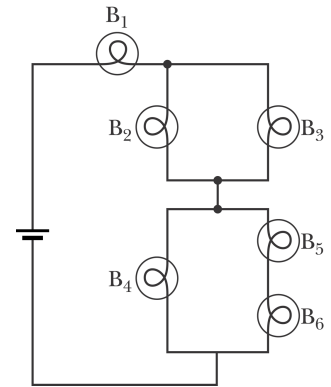
- (a) What happens to the brightness of each of the three bulbs if a wire is connected from the battery terminal at point 1 to point 4?
- (b) What simultaneously happens to the current through point 3?
- (c) What simultaneously happens to the potential difference across bulb B?
- (d) What simultaneously happens to the potential difference across bulb C?
- (e) What simultaneously happens to the potential difference between points 1 and 5? Explain your reasoning.

23-4)

- (a) What happens to the brightness of each of the three bulbs if a fourth bulb, D, is connected in parallel with bulb B (*not in parallel with B and C*). Include a sketch of the circuit with bulb D in place.
- (b) What simultaneously happens to the current through point 3?
- (c) What happens simultaneously to the potential difference between points 3 and 4?
- (d) What happens simultaneously to the potential difference between points 4 and 2?

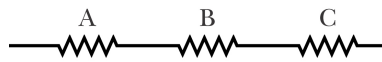
23-5)

- (a) Rank the light bulbs #1 through #6 in order of descending brightness. Explain the reasoning for your ranking.
- (b) Now assume that the filament of light bulb 6 breaks. Again rank the bulbs in order of descending brightness and explain the reasoning for your ranking.

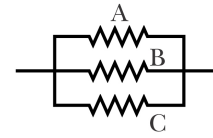


23-6)

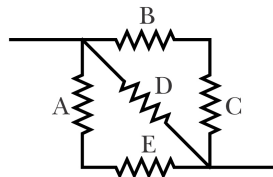
In the following circuits, tell which resistors are connected in series with which other resistors, which are connected in parallel with which other resistors, and which are neither in series or parallel.



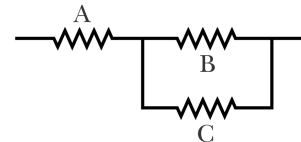
(a)



(b)



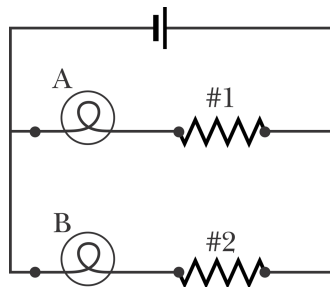
(c)



(d)

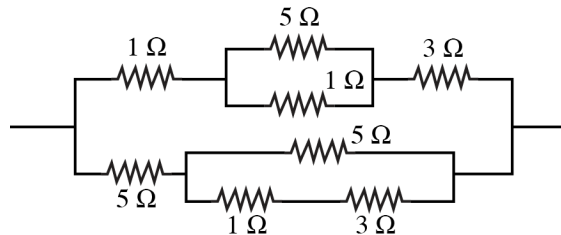
23-7)

The circuit diagram that follows shows two unlabeled resistors attached to identical bulbs. Explain how you would interpret the brightness's of bulbs A and B to decide which resistor is larger.

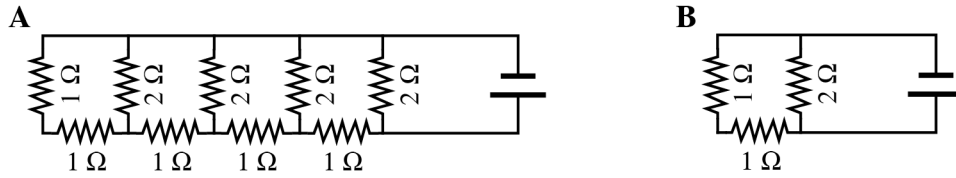


23-8)

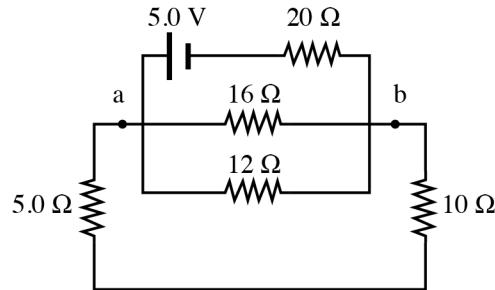
Find the equivalent resistance in Ohms of the following network. Show your work!



- 23-9) If the batteries are identical in the diagram below, which circuit draws more current from the battery? Circuit A? Circuit B? Or neither? Show your calculations and reasoning.

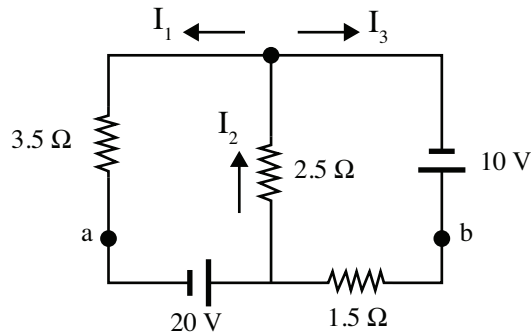


- 23-10) Consider the circuit shown below.

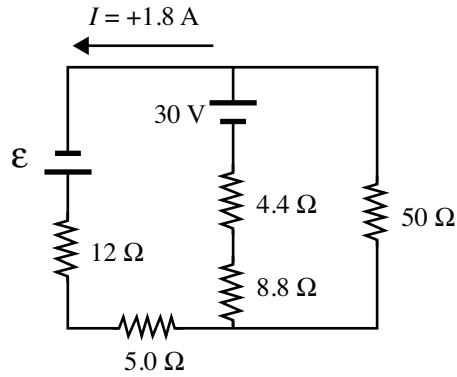


- (a) What is the potential difference between points a and b?
 (b) Calculate the current passing through the 12-Ω resistor.

- 23-11) Show that the currents in the circuit shown in the figure below are $I_1 = +3.1\text{A}$, $I_2 = +3.7\text{A}$, and $I_3 = +0.56\text{A}$. You must show your equations and calculations! Assume that the batteries are ideal and have no internal resistance.

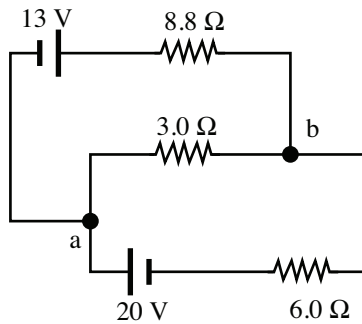


- 23-12)** What is the emf (potential difference) of the battery in the circuit shown below? Assume that the batteries are ideal and have no internal resistance.



- 23-13)** For the circuit shown in the figure below, assume that the batteries are ideal and have no internal resistance.

- (a) What is the current in the 8.8Ω resistor?
 (b) Find the potential difference between points a and b. Explain your reasoning and show your calculations.



Bonus Problem

Find the equivalent resistance of the cubical resistor arrangement shown on the right. All resistors are $1 \text{ k}\Omega$.

