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Chapter 35 Electric Circuits

Exercises

35.1 A Battery and a Bulb (pages 703–704)

1. A circuit is a complete path along which charge can flow.
2. Circle the letter of each statement that is true about a completed electric circuit consisting of a battery, a lightbulb, and two wires.
   a. Electrons flow from the positive terminal of the battery to the negative terminal.
   b. The battery acts like a pump, causing current to flow through the circuit.
   c. The conduction electrons tend to pile up inside the bulb.
   d. The conduction electrons that drift through the circuit originate from the wires and the bulb filament.

35.2 Electric Circuits (page 704)

3. A gap in a circuit is usually provided by an electric switch.

Match each switch position with the correct effect on the circuit.

	Switch Position	Effect
a	4. open	a. cuts off electron flow
b	5. closed	b. allows electron flow

6. When connected in series, devices in a circuit form a single pathway for electron flow.
7. When connected in parallel, devices in a circuit form branches, each of which is a separate path for the flow of electrons.

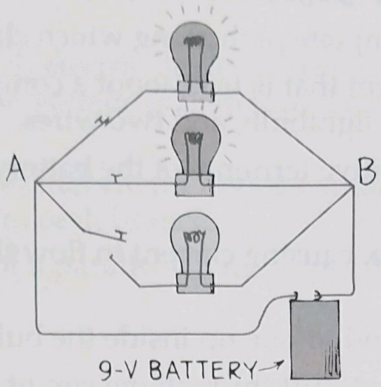
35.3 Series Circuits (pages 705–706)

8. Suppose you have a completed circuit with three lamps connected in series. Circle the letter of the statement that correctly describes what happens if the filament of the middle lamp burns out.
   a. Current ceases, and the remaining two lamps will also go out.
   b. Both of the remaining lamps will stay lit.
   c. Only one of the remaining lamps will stay lit.
   d. The amount of current flowing through the circuit drops by one third.
9. The total resistance to current in a series circuit is the sum of the individual resistances along the circuit path.
10. The voltage drop across each device in a series circuit depends directly on its resistance.
11. Describe the main disadvantage of a series circuit.

If one device fails in a series circuit, current in the whole circuit ceases and none of the devices will work.

35.4 Parallel Circuits (pages 707–708)

Use the figure below to answer Questions 12–17.



12. Circle the letter of the correct answer. How many *possible* pathways for current are there between points A and B?

a. 1

(b.) 3

c. 4

d. 5

13. Is the following sentence true or false? In a parallel circuit like the one shown, each device operates independent of the other devices.

true

14. Circle the letter of the correct answer. What is the voltage across each lit bulb in the circuit shown?

a. 3 volts

b. 4.5 volts

c. 6 volts

(d.) 9 volts

15. Suppose I is the total current in the circuit. Circle the letter of the amount of current through each lit bulb.

(a.) $\frac{I}{2}$

b. $\frac{I}{3}$

c. $2I$

d. $3I$

16. If the switch next to the unlit bulb were closed, the total current through the battery would increase.

17. Is the following sentence true or false? The overall resistance of the circuit is less than the resistance of any one of the branches.

true

35.5 Schematic Diagrams (page 709)

18. What is a schematic diagram?
a diagram that describes an electric circuit, using special symbols to represent certain circuit elements

19. Describe how the positive and negative terminals of a battery are indicated on a schematic diagram.
The positive terminal is represented with a long line and the negative terminal with a short line.

Match each circuit element with the description of its symbol in a schematic diagram.

Circuit Element	Symbol
a 20. resistance	a. zigzag line
d 21. connecting wire	b. broken line with one end tilted up at an angle
c 22. battery	c. set of short and long parallel lines
b 23. open switch	d. solid straight line

35.6 Combining Resistors in a Compound Circuit (pages 710–711)

24. Define equivalent resistance.
the value of the single resistor that would comprise the same load to the battery or power source as a combination of resistors

25. The equivalent resistance of resistors in series is the sum of their values.

26. The equivalent resistance of two resistors in parallel is half the value of either resistor.

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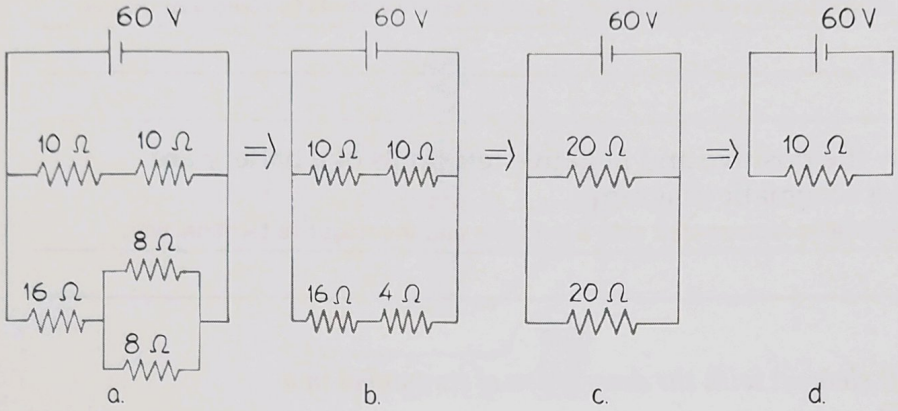
The diagrams below show how a complex schematic diagram can be simplified by using equivalent resistances. Use these diagrams to answer Questions 27–29.



27. Describe how diagram (a) was simplified to make diagram (b).

An equivalent 4-Ω resistor replaces two 8-Ω resistors in parallel.

28. Describe how diagram (b) was simplified to make diagram (c).

An equivalent 20-Ω resistor replaces two 10-Ω resistors in series, and an equivalent 20-Ω resistor replaces a 16-Ω and a 4-Ω resistor in series.

29. Describe how diagram (c) was simplified to make diagram (d).

An equivalent 10-Ω resistor replaces two 20-Ω resistors in parallel.

35.7 Parallel Circuits and Overloading (pages 711–712)

30. Is the following sentence true or false? The more devices you connect in parallel to your household supply line, the more you increase the total line current. true

31. What is the purpose of connecting a fuse or circuit breaker in series along the supply line?

to prevent overloading in circuits

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Ohm's Law and Parallel Circuits

The equivalent resistance for resistors in parallel can be found using the following equation.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_n}$$

Calculate the current in a 48-V battery that powers three 15-Ω resistors connected in parallel.

1. Read and Understand

What information are you given?

voltage = V = 48 V

individual resistances: $R_1 = R_2 = R_3 = 15\ \Omega$

2. Plan and Solve

What unknown are you trying to calculate?

current = I = ?

What equation can you use to find the unknown?

Ohm's law: $V = IR$

For a parallel circuit, $V = IR_{eq}$, where R_{eq} is the equivalent resistance.

Rearranging the equation gives you $I = \frac{V}{R_{eq}}$.

First, find the equivalent resistance R_{eq}.

$$\frac{1}{R_{eq}} = \frac{1}{15\ \Omega} + \frac{1}{15\ \Omega} + \frac{1}{15\ \Omega} = \frac{1}{5\ \Omega}$$

$R_{eq} = 5\ \Omega$

Then substitute for V and R_{eq} to solve for I.

$$I = \frac{48\ \text{V}}{5\ \Omega} = 9.6\ \text{A}$$

3. Look Back and Check

Is your answer reasonable?

Yes, a current of 9.6 A is reasonable, and the units are $\frac{\text{V}}{\Omega}$, or A, which is reasonable.

Math Practice

On a separate sheet of paper, solve the following problems.

1. Calculate the current in a 9-V battery that powers three 6-Ω resistors in parallel.

$R_{eq} = \frac{1}{\frac{1}{6}\Omega + \frac{1}{6}\Omega + \frac{1}{6}\Omega} = 2\ \Omega$; $I = \frac{V}{R_{eq}} = \frac{9\ \text{V}}{2\ \Omega} = 4.5\ \text{A}$

2. Calculate the voltage impressed across a circuit in which three 1.5-Ω resistors in parallel draw a current of 12 A.

$$R_{eq} = \frac{1}{\frac{1}{1.5}\Omega + \frac{1}{1.5}\Omega + \frac{1}{1.5}\Omega} = 0.5\ \Omega;\ V = IR_{eq} = (12\ \text{A})(0.5\ \Omega) = 6\ \text{V}$$

3. Calculate the current in 12-V battery that powers four 10-Ω resistors in parallel.

$$R_{eq} = \frac{1}{\frac{1}{10}\Omega + \frac{1}{10}\Omega + \frac{1}{10}\Omega + \frac{1}{10}\Omega} = \frac{5}{2\ \Omega};\ I = \frac{V}{R_{eq}} = \frac{12\ \text{V}}{2.5\ \Omega} = 4.8\ \text{A}$$