EXERCISES

Conceptual Questions

1. In many portable battery powered devices such as CD players, the batteries are inserted end to end.
   a) Are these batteries installed in series or in parallel?
   b) If a standard AA battery has a voltage of 1.5 V, what is the voltage requirement of a device that needs two batteries?
   c) What is the electrical benefit of a device that requires batteries side by side in parallel?

2. A student wants to think of current flow as negatively charged electrons moving through a wire, but her teacher states that current direction is defined as the direction of positive charge flow because of historical convention. Briefly describe what is meant by "convention" and include at least two other examples of where a historical convention is used in society today.

3. Many electronic devices will not guarantee that their products will work at extreme temperatures. Which components would be most affected by extreme temperatures?

4. Boosting a car using someone else's battery for cold weather starting requires the combination of two batteries. Are these batteries connected in series or parallel? Explain.

5. What type of circuit is used exclusively in our homes for all lighting and outlets, series or parallel? Describe at least two observations that could be used to back up your answer.

6. The new Christmas mini-lights come with a warning that a burnt-out light must be replaced immediately or a fire hazard may result. What does this warning imply about the way in which these lights are wired? What observation about series or parallel circuits must be overlooked in order for your previous answer about circuit type to make sense? (Some of these mini-lights have an internal shunt that keeps the series circuit active even if the filament burns out.)

7. You and your friend are having a friendly disagreement. You do not know which of your two unmarked resistors has the greatest resistance. The only way to settle this disagreement is to go into the lab and get experimental data. Draw a graph of the potential difference versus the current for each resistor on the same axis. In doing so, explain how you could tell from this graph which of you was right.

8. Why is energy consumption in your home measured in kilowatt hours and not in joules? Show by proper unit analysis that a kilowatt hour is a unit of energy.

Problems

16.2 Current

9. How long does it take for a current of 9.3 mA to transfer a charge of 12 C?

10. How much charge is transferred by a current of 0.80 A in 19 minutes?

16.3 Electrical Potential

11. What is the potential difference between two points if 2.0×10^3 J of work is required to move 1 C of charge between the two points?

12. What is the potential difference between two points when a charge of 65 C has 2.50×10^2 J of energy supplied to it as it moves between the points?

13. What is the energy of a proton accelerated through a potential difference of 500 kV? The charge on one proton is 1.6×10^{-19} C.

14. How much energy is transferred to a radio if a current of 0.40 A runs through it for 1.5 minutes, with a potential difference of 115 V?

15. What is the potential difference across a curling iron if there is a current of 2.5 A through it that transfers 9360 J of energy to the curling iron in 32 s?

16. How much energy is dissipated over a 2.5 minute period when a current of 5.0 A runs through a potential difference of 80 V?

17. A microwave at a potential difference of 120 V uses 50 000 J of energy during the 60 s it is on. What is the current through the microwave?

18. An electric saw operates at a potential difference of 120 V and draws a current of 9.5 A. If it takes 40 s to make a cut, calculate the amount of electrical energy used by the saw in that time.

19. An electric motor is used to do the 2.30×10^4 J of work needed to lift an engine out of a car. If the motor draws a current of 3.2 A for 30 s, calculate the potential difference across the motor.

20. In a lightning discharge, 45 C of charge move through a potential difference of 10^8 V in 3.0×10^{-2} s. Calculate
a) the current represented by the lightning bolt.
b) the total energy released by the lightning bolt.

21. How much energy is gained by an electron accelerated through a potential difference of 2.5×10^4 V?

22. How much energy is required to run a leaf blower if it draws 13 A from a 117 V outlet for 10.0 min?

16.5 Resistance—Ohm's Law

23. A voltmeter connected across the ends of a stove heating element indicates a potential difference of 120 V when an ammeter shows a current through the coil of 6.0 A. What is the resistance of the coil?

24. A TV remote control has a resistance of 9.2 Ω and is connected to two AA batteries with a potential difference of 3.0 V. What is the current through the remote control?

25. What is the potential difference across a computer power supply with a resistance of 50 Ω if the motor draws a current of 2.2 A?

26. A 100 Ω wire resistor has its length doubled. What is its new resistance?

27. A 500 Ω wire resistor is compared to the resistance of the same material but of half its radius. What is the resistance of this wire?

28. Resistivity is given by the equation $\rho = \frac{RA}{L}$. What is the resistance of a 100 m piece of copper with a diameter of 1.0 mm? (The resistivity of copper is $1.7 \times 10^{-8}\ \Omega \cdot \text{m}$.)

16.6 Series and Parallel Circuits

29. A string of Christmas tree lights with 25 bulbs connected in series draws a current of 3.8 A from a 120 V source. Find
a) the total resistance of the string of lights.
b) the resistance of each light.
c) the potential difference across each light.

30. a) What is the resistance of a coffee maker that draws a current of 5.0 A from a 117 V source?
b) What resistance would have to be added in parallel with the same coffee maker to increase the current to 15.0 A?

31. Calculate the total resistance in each of these cases:
a) 20 Ω, 30 Ω, and 60 Ω in series

b) 8 Ω, 6 Ω, and 48 Ω in parallel

c) A combination of 4 Ω and 9 Ω connected in parallel, in series with another combination consisting of 4 Ω and 12 Ω connected in parallel with each other.

32. How many 60 Ω resistors must be connected in parallel to draw a current of 10.0 A from a 120 V source?

33. The potential difference across a resistor is 50.0 V when the current through it is 5.0 A. What resistance must be added in series with the resistor to reduce the current by half?

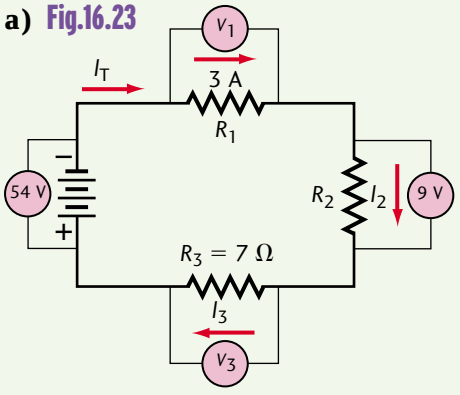
34. A portable mobile phone is designed to operate at a potential difference of 5.0 V and a current of 0.200 A, but the only source available has a potential of 12.0 V. What resistance must be added in series with the phone to make it operate?

16.7 The Circuit Analysis Game

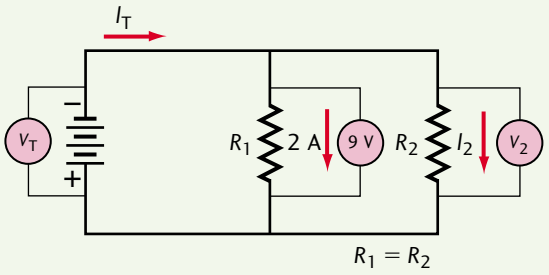
35. Examine these circuits and find all of the missing circuit parameters. For each one, remember to use the circuit analysis game score card. Let's play Circuit Analysis!

	V (V)	I (A)	R (Ω)
R_1			
R_2			
R_3			
R_T			

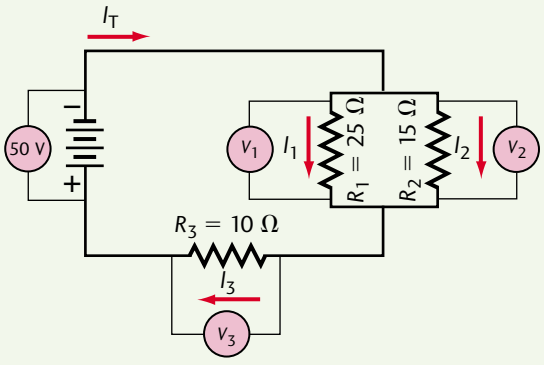
a) Fig.16.23



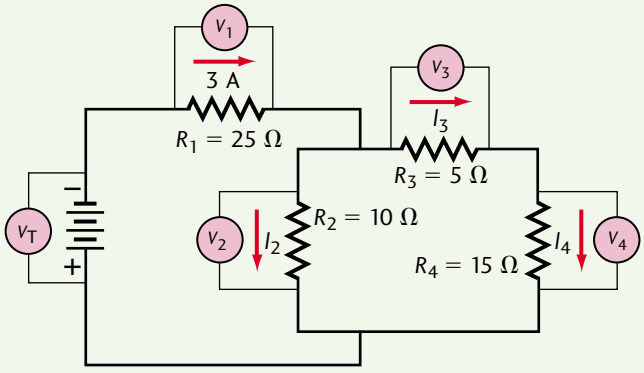
b) Fig.16.24



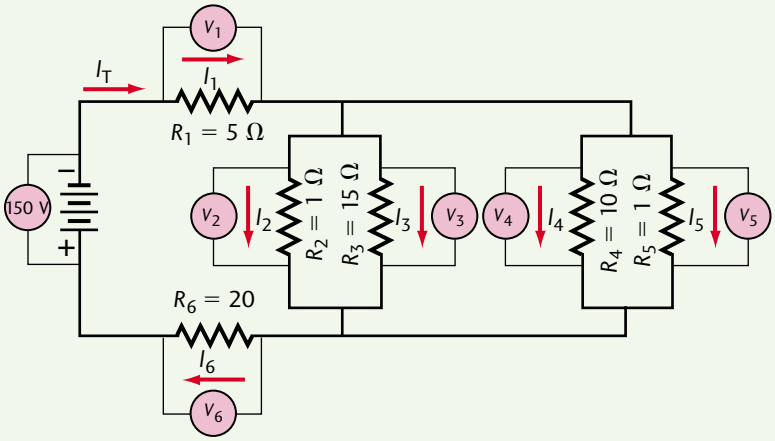
c) Fig.16.25



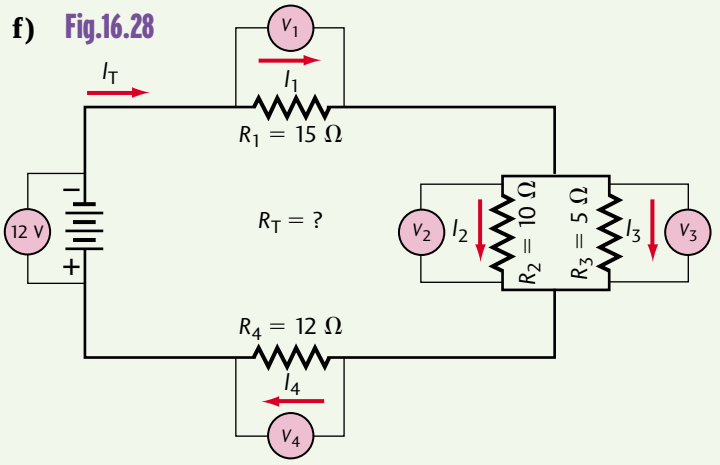
d) Fig.16.26



e) Fig.16.27



f) Fig.16.28



16.8 Power in Electric Circuits

36. Calculate the power dissipated by each of the following:

a) An electric stove drawing 13.0 A from a 240 V source

b) A frying pan that draws 11.0 A and has a resistance of 11.6 Ω

c) A 2057 Ω night light plugged into a 120 V source

37. **a)** What maximum power can be used on a 120 V circuit with a 15 A fuse?

b) How much more current can safely be drawn from a 120 V outlet fused at 15 A if a 600 W curling iron and a 1200 W hair dryer are already operating in the circuit?

38. A 1.2 kW iron that normally operates on a 120 V circuit is plugged into a 240 V outlet.

a) What current is the iron really supposed to draw?

b) What current will it draw when connected to 240 V?

c) What power will it use on 240 V?

d) What will happen to the iron when it is plugged into this 240 V circuit?

16.9 The Cost of Electricity

39. An automotive hoist motor draws 3.5 A from a 120 V source and operates for an average of nine minutes every hour in an eight-hour day. Calculate the annual cost of operating the hoist motor if the average cost of electrical energy is 8.2¢/kWh.

40. Four sets of Christmas lights, each holding 25 bulbs, are set up for a Christmas display. These 7 W bulbs were lit from 8:00 PM to 12:00 AM every night from December 1 to January 10. If the average cost of electrical energy is 8.2¢/kWh, how much will this Christmas display cost to light?