PROBLEMS

Section 2.2 Ohm's Law

2.1 The voltage across a 5-kΩ resistor is 16 V. Find the current through the resistor.

2.2 Find the hot resistance of a lightbulb rated 60 W, 120 V.

2.3 When the voltage across a resistor is 120 V, the current through it is 2.5 mA. Calculate its conductance.

2.4 (a) Calculate current i in Fig. 2.68 when the switch is in position 1.
(b) Find the current when the switch is in position 2.

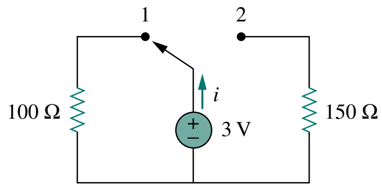


Figure 2.68 For Prob. 2.4.

Section 2.3 Nodes, Branches, and Loops

2.5 For the network graph in Fig. 2.69, find the number of nodes, branches, and loops.

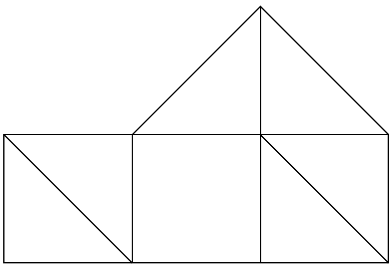


Figure 2.69 For Prob. 2.5.

2.6 In the network graph shown in Fig. 2.70, determine the number of branches and nodes.

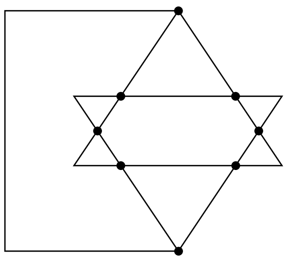


Figure 2.70 For Prob. 2.6.

2.7 Determine the number of branches and nodes in the circuit in Fig. 2.71.

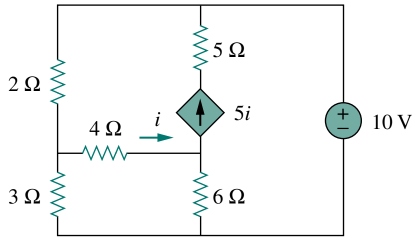


Figure 2.71 For Prob. 2.7.

Section 2.4 Kirchhoff's Laws

2.8 Use KCL to obtain currents i_1, i_2, and i_3 in the circuit shown in Fig. 2.72.

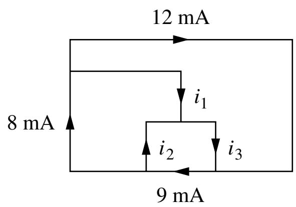


Figure 2.72 For Prob. 2.8.

2.9 Find i_1, i_2, and i_3 in the circuit in Fig. 2.73.

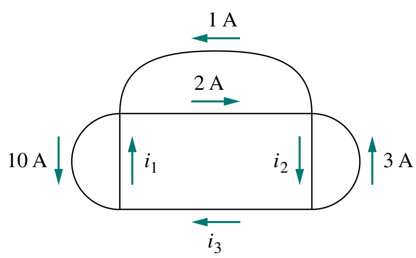


Figure 2.73 For Prob. 2.9.

2.10 Determine i_1 and i_2 in the circuit in Fig. 2.74.

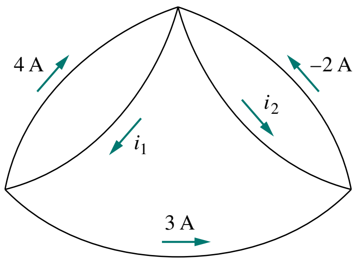


Figure 2.74 For Prob. 2.10.

2.11 Determine v_1 through v_4 in the circuit in Fig. 2.75.

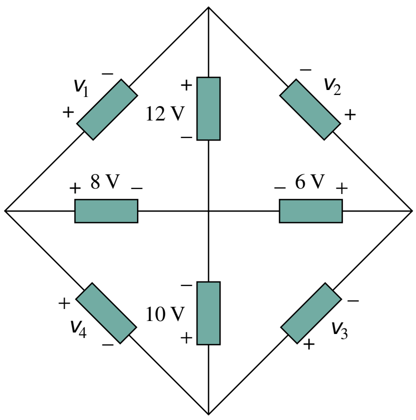


Figure 2.75 For Prob. 2.11.

2.12 In the circuit in Fig. 2.76, obtain v_1, v_2, and v_3.

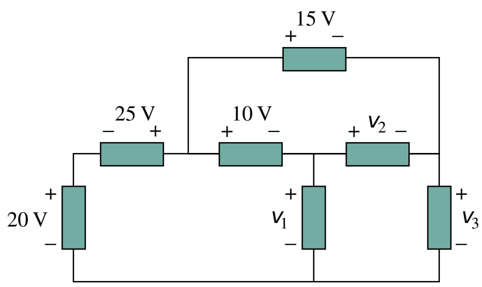


Figure 2.76 For Prob. 2.12.

2.13 Find v_1 and v_2 in the circuit in Fig. 2.77.

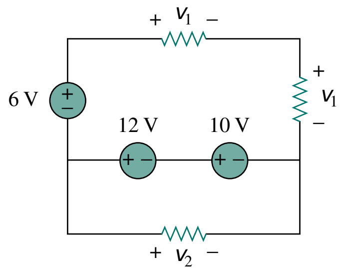


Figure 2.77 For Prob. 2.13.

2.14 Obtain v_1 through v_3 in the circuit of Fig. 2.78.

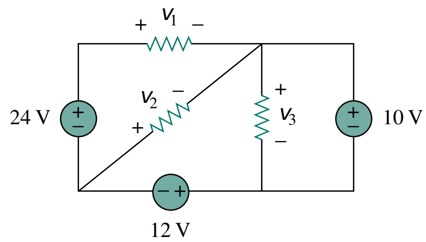


Figure 2.78 For Prob. 2.14.

2.15 Find I and V_{ab} in the circuit of Fig. 2.79.

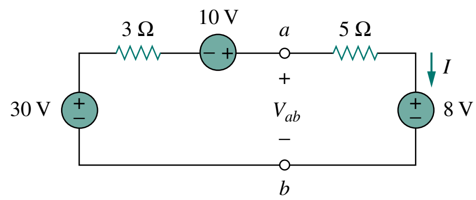


Figure 2.79 For Prob. 2.15.

2.16 From the circuit in Fig. 2.80, find I, the power dissipated by the resistor, and the power supplied by each source.

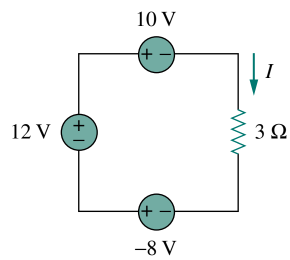


Figure 2.80 For Prob. 2.16.

2.17 Determine i_o in the circuit of Fig. 2.81.

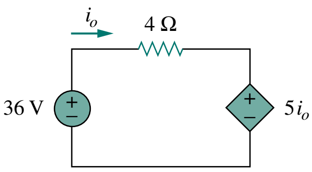


Figure 2.81 For Prob. 2.17.

2.18 Calculate the power dissipated in the 5-Ω resistor in the circuit of Fig. 2.82.

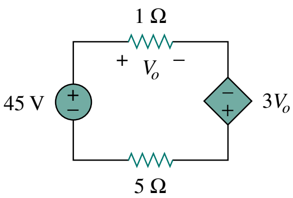


Figure 2.82 For Prob. 2.18.

2.19 Find V_o in the circuit in Fig. 2.83 and the power dissipated by the controlled source.

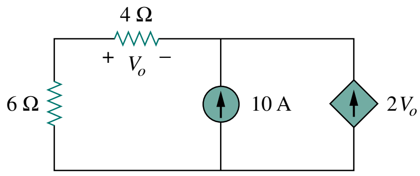


Figure 2.83 For Prob. 2.19.

2.20 For the circuit in Fig. 2.84, find V_o/V_s in terms of α, R_1, R_2, R_3, and R_4. If $R_1 = R_2 = R_3 = R_4$, what value of α will produce $|V_o/V_s| = 10$?

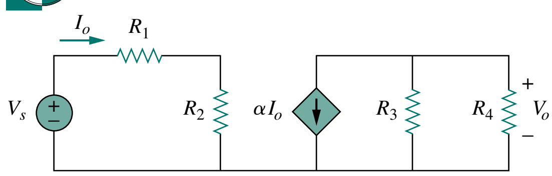


Figure 2.84 For Prob. 2.20.

2.21 For the network in Fig. 2.85, find the current, voltage, and power associated with the 20-kΩ resistor.

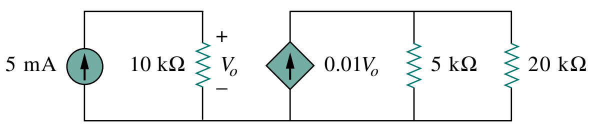


Figure 2.85 For Prob. 2.21.

Sections 2.5 and 2.6 Series and Parallel Resistors

2.22 For the circuit in Fig. 2.86, find i_1 and i_2.

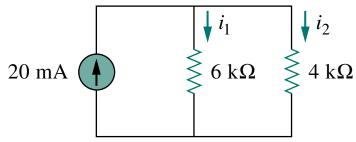


Figure 2.86 For Prob. 2.22.

2.23 Find v_1 and v_2 in the circuit in Fig. 2.87.

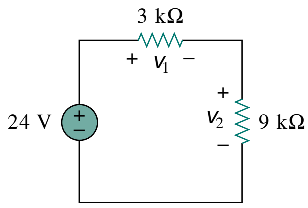


Figure 2.87 For Prob. 2.23.

2.24 Find v_1, v_2, and v_3 in the circuit in Fig. 2.88.

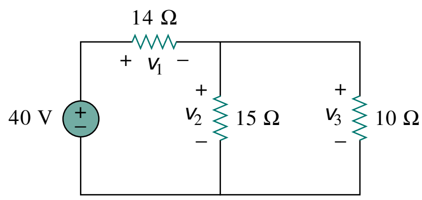


Figure 2.88 For Prob. 2.24.

2.25 Calculate v_1, i_1, v_2, and i_2 in the circuit of Fig. 2.89.

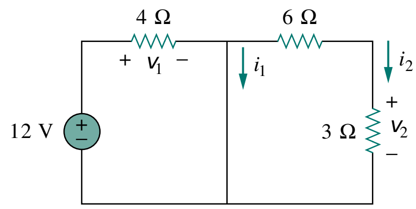


Figure 2.89 For Prob. 2.25.

2.26 Find i, v, and the power dissipated in the 6-Ω resistor in Fig. 2.90.

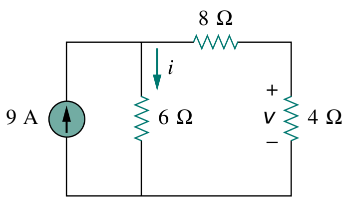


Figure 2.90 For Prob. 2.26.

2.27 In the circuit in Fig. 2.91, find v, i, and the power absorbed by the 4-Ω resistor.

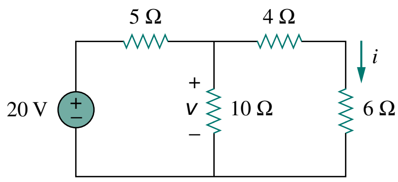


Figure 2.91 For Prob. 2.27.

2.28 Find i_1 through i_4 in the circuit in Fig. 2.92.

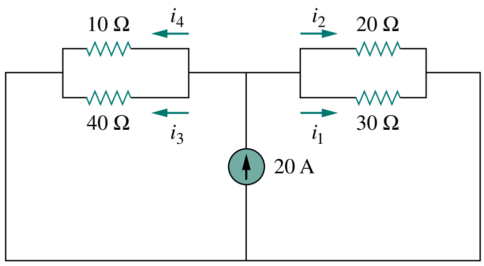


Figure 2.92 For Prob. 2.28.

2.29 Obtain v and i in the circuit in Fig. 2.93.

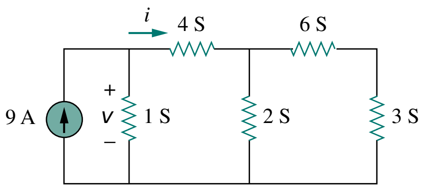


Figure 2.93 For Prob. 2.29.

2.30 Determine i_1, i_2, v_1, and v_2 in the ladder network in Fig. 2.94. Calculate the power dissipated in the 2-Ω resistor.

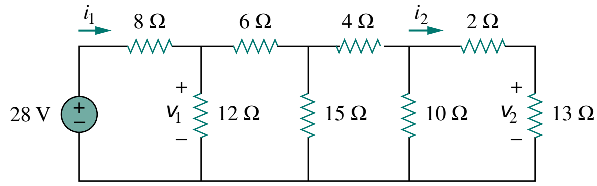


Figure 2.94 For Prob. 2.30.

2.31 Calculate V_o and I_o in the circuit of Fig. 2.95.

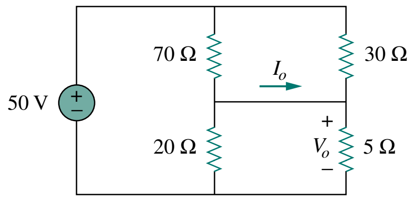


Figure 2.95 For Prob. 2.31.

2.32 Find V_o and I_o in the circuit of Fig. 2.96.

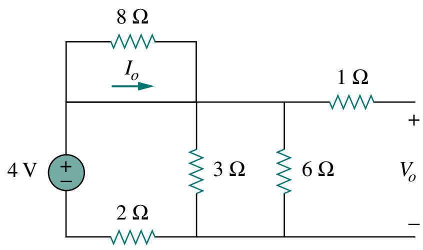


Figure 2.96 For Prob. 2.32.

2.33 In the circuit of Fig. 2.97, find R if $V_o = 4V$.

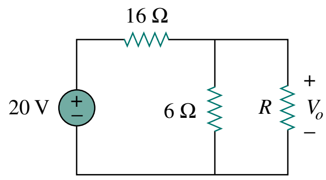


Figure 2.97 For Prob. 2.33.

2.34 Find I and V_s in the circuit of Fig. 2.98 if the current through the 3-Ω resistor is 2 A.

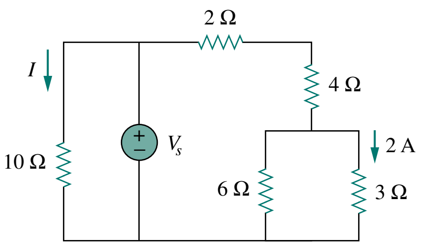


Figure 2.98 For Prob. 2.34.

2.35 Find the equivalent resistance at terminals a-b for each of the networks in Fig. 2.99.

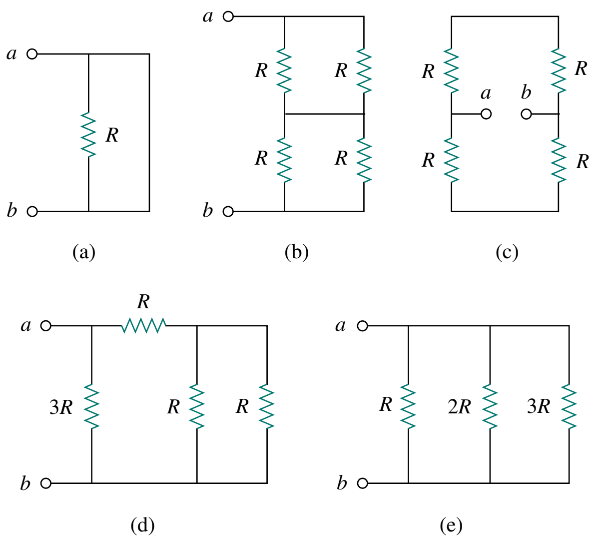


Figure 2.99 For Prob. 2.35.

2.36 For the ladder network in Fig. 2.100, find I and R_{eq}.

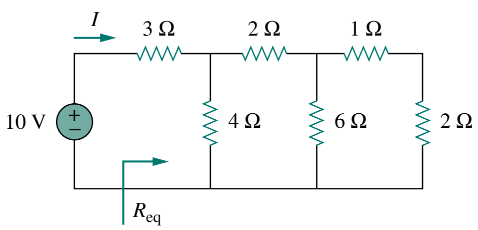


Figure 2.100 For Prob. 2.36.

2.37 If $R_{eq} = 50\ \Omega$ in the circuit in Fig. 2.101, find R.

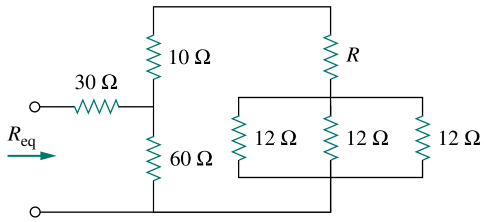


Figure 2.101 For Prob. 2.37.

2.38 Reduce each of the circuits in Fig. 2.102 to a single resistor at terminals a-b.

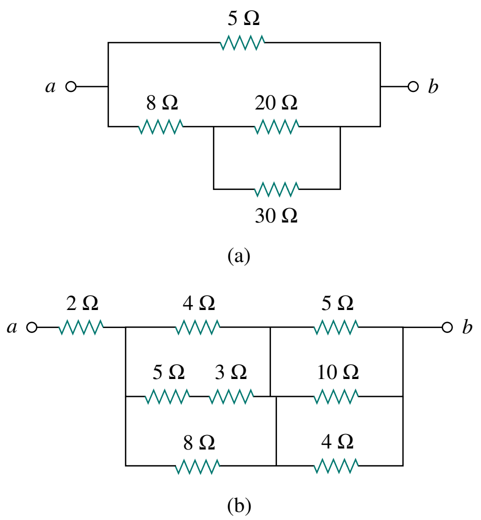


Figure 2.102 For Prob. 2.38.

2.39 Calculate the equivalent resistance R_{ab} at terminals a-b for each of the circuits in Fig. 2.103.

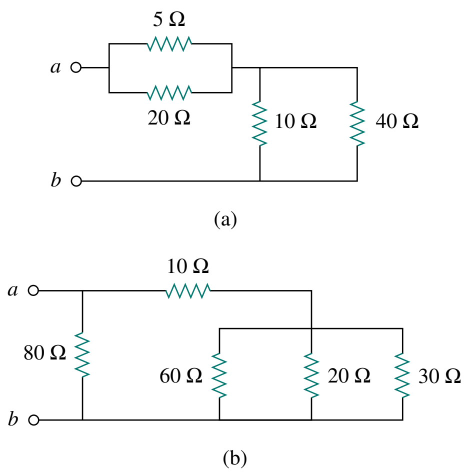


Figure 2.103 For Prob. 2.39.

2.40 Obtain the equivalent resistance at the terminals a-b for each of the circuits in Fig. 2.104.

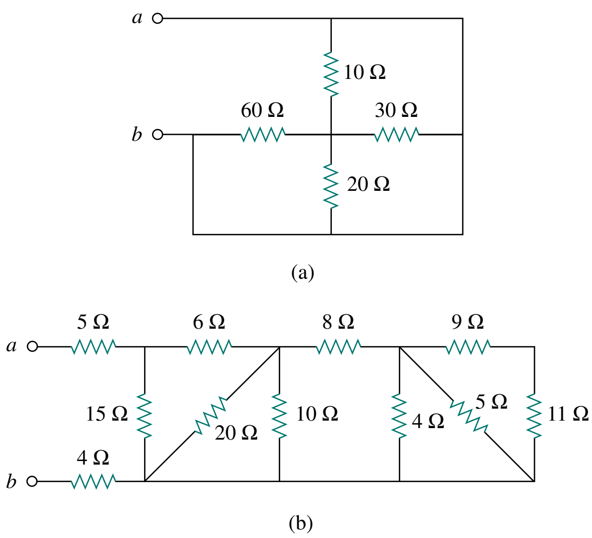


Figure 2.104 For Prob. 2.40.

2.41 Find R_{eq} at terminals a-b for each of the circuits in Fig. 2.105.

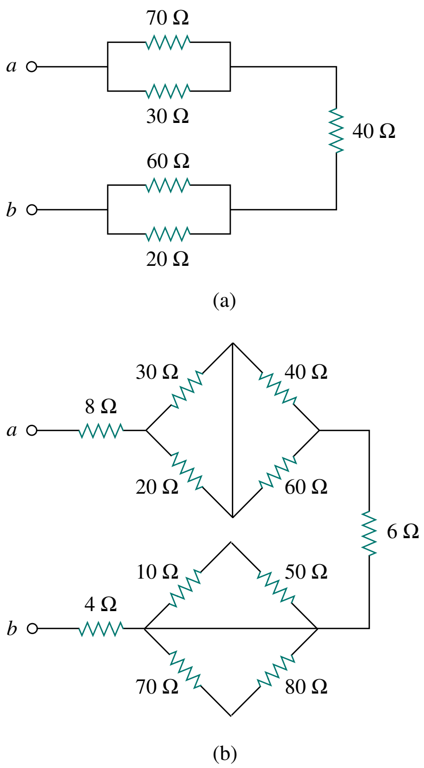


Figure 2.105 For Prob. 2.41.

2.42 Find the equivalent resistance R_{ab} in the circuit of Fig. 2.106.

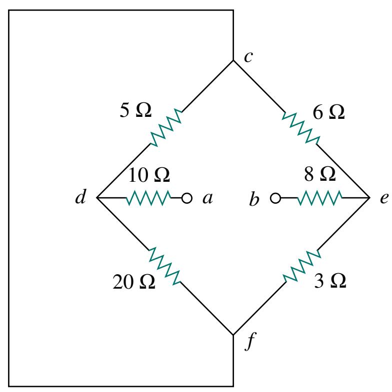


Figure 2.106 For Prob. 2.42.

Section 2.7 Wye-Delta Transformations

2.43 Convert the circuits in Fig. 2.107 from Y to Δ.

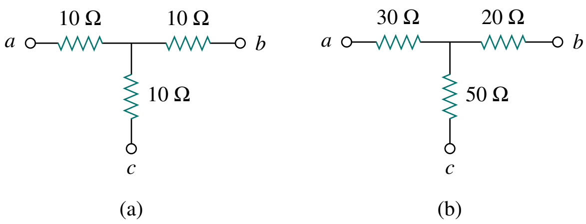


Figure 2.107 For Prob. 2.43.

2.44 Transform the circuits in Fig. 2.108 from Δ to Y.

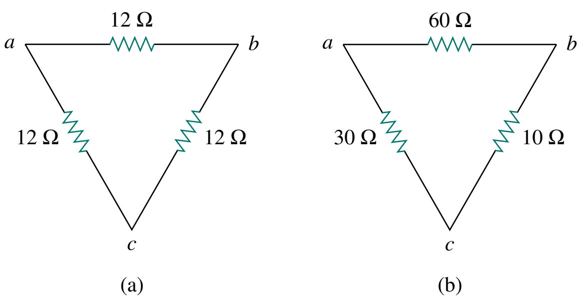


Figure 2.108 For Prob. 2.44.

2.45 What value of R in the circuit of Fig. 2.109 would cause the current source to deliver 800 mW to the resistors?

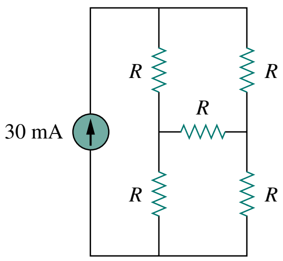


Figure 2.109 For Prob. 2.45.

2.46 Obtain the equivalent resistance at the terminals a-b for each of the circuits in Fig. 2.110.

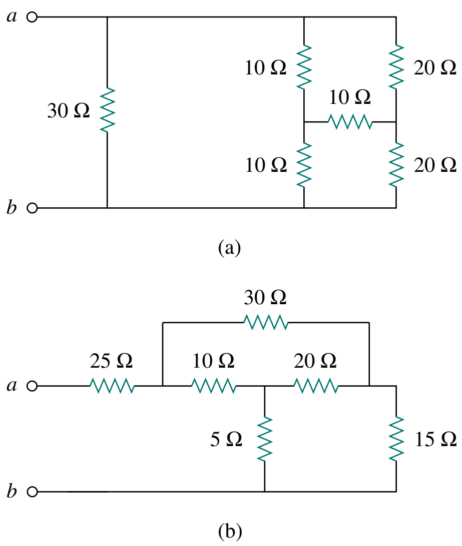
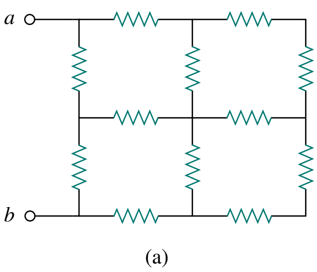


Figure 2.110 For Prob. 2.46.

*__2.47__ Find the equivalent resistance R_{ab} in each of the circuits of Fig. 2.111. Each resistor is 100 Ω.



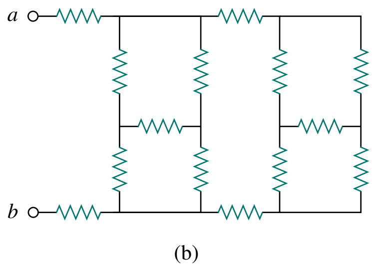


Figure 2.111 For Prob. 2.47.

*__2.48__ Obtain the equivalent resistance R_{ab} in each of the circuits of Fig. 2.112. In (b), all resistors have a value of 30 Ω.

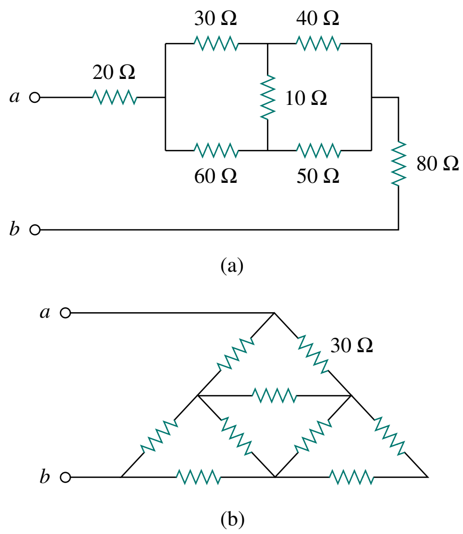


Figure 2.112 For Prob. 2.48.

2.49 Calculate I_o in the circuit of Fig. 2.113.

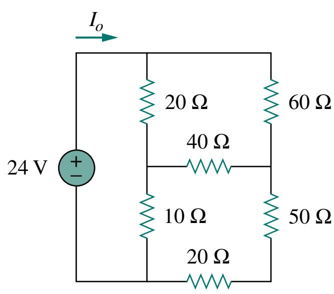


Figure 2.113 For Prob. 2.49.

*An asterisk indicates a challenging problem.

2.50 Determine V in the circuit of Fig. 2.114.

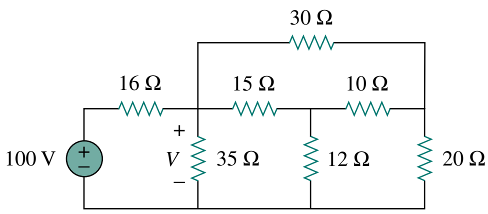


Figure 2.114 For Prob. 2.50.

*__2.51__ Find R_{eq} and I in the circuit of Fig. 2.115.

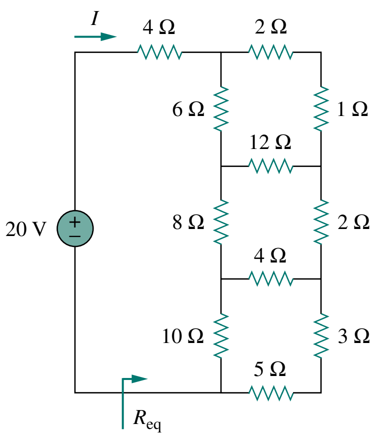


Figure 2.115 For Prob. 2.51.

Section 2.8 Applications

2.52 The lightbulb in Fig. 2.116 is rated 120 V, 0.75 A. Calculate V_s to make the lightbulb operate at the rated conditions.

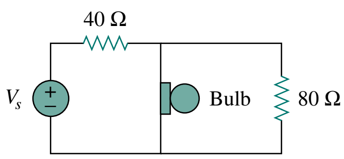


Figure 2.116 For Prob. 2.52.

2.53 Three lightbulbs are connected in series to a 100-V battery as shown in Fig. 2.117. Find the current I through the bulbs.

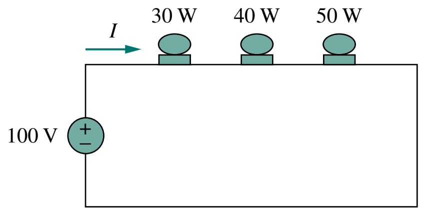


Figure 2.117 For Prob. 2.53.

2.54 If the three bulbs of Prob. 2.53 are connected in parallel to the 100-V battery, calculate the current through each bulb.

2.55 As a design engineer, you are asked to design a lighting system consisting of a 70-W power supply and two lightbulbs as shown in Fig. 2.118. You must select the two bulbs from the following three available bulbs.

$R_1 = 80\ \Omega$, cost = \$0.60 (standard size)
$R_2 = 90\ \Omega$, cost = \$0.90 (standard size)
$R_3 = 100\ \Omega$, cost = \$0.75 (nonstandard size)

The system should be designed for minimum cost such that $I = 1.2$ A $\pm$ 5 percent.

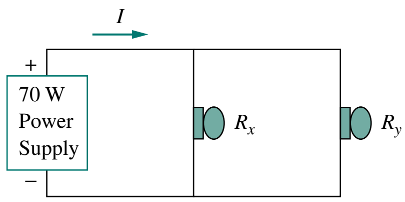


Figure 2.118 For Prob. 2.55.

2.56 If an ammeter with an internal resistance of 100 Ω and a current capacity of 2 mA is to measure 5 A, determine the value of the resistance needed. Calculate the power dissipated in the shunt resistor.

2.57 The potentiometer (adjustable resistor) R_x in Fig. 2.119 is to be designed to adjust current i_x from 1 A to 10 A. Calculate the values of R and R_x to achieve this.

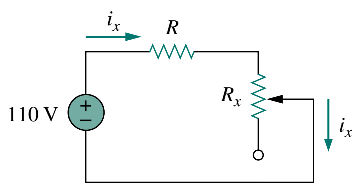


Figure 2.119 For Prob. 2.57.

2.58 A d'Arsonval meter with an internal resistance of 1 kΩ requires 10 mA to produce full-scale deflection. Calculate the value of a series resistance needed to measure 50 V of full scale.

2.59 A 20-kΩ/V voltmeter reads 10 V full scale.

(a) What series resistance is required to make the meter read 50 V full scale?

(b) What power will the series resistor dissipate when the meter reads full scale?

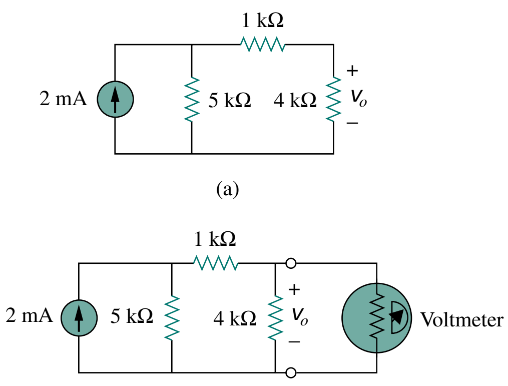
2.60 (a) Obtain the voltage v_o in the circuit of Fig. 2.120(a).

(b) Determine the voltage v_o' measured when a voltmeter with 6-kΩ internal resistance is connected as shown in Fig. 2.120(b).

(c) The finite resistance of the meter introduces an error into the measurement. Calculate the percent error as

$$\left|\frac{v_o - v_o'}{v_o}\right| \times 100\%$$

(d) Find the percent error if the internal resistance were 36 kΩ.



(b)

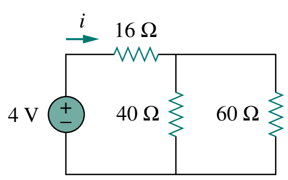
Figure 2.120 For Prob. 2.60.

2.61 (a) Find the current i in the circuit of Fig. 2.121(a).

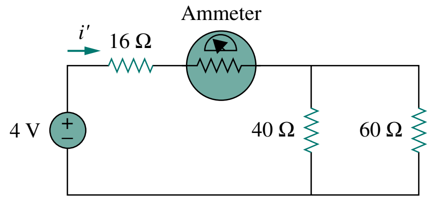
(b) An ammeter with an internal resistance of 1 Ω is inserted in the network to measure i' as shown in Fig. 2.121(b). What is i'?

(c) Calculate the percent error introduced by the meter as

$$\left|\frac{i - i'}{i}\right| \times 100\%$$



(a)



(b)

Figure 2.121 For Prob. 2.61.

2.62 A voltmeter is used to measure V_o in the circuit in Fig. 2.122. The voltmeter model consists of an ideal voltmeter in parallel with a 100-kΩ resistor. Let $V_s = 40$ V, $R_s = 10$ kΩ, and $R_1 = 20$ kΩ. Calculate V_o with and without the voltmeter when

(a) $R_2 = 1$ kΩ (b) $R_2 = 10$ kΩ

(c) $R_2 = 100$ kΩ

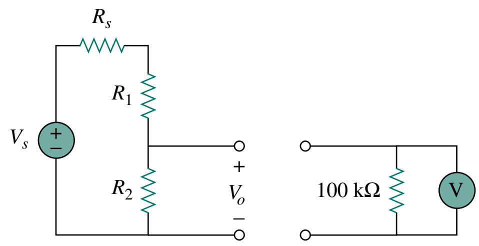


Figure 2.122 For Prob. 2.62.

2.63 An ammeter model consists of an ideal ammeter in series with a 20-Ω resistor. It is connected with a current source and an unknown resistor R_x as shown in Fig. 2.123. The ammeter reading is noted. When a potentiometer R is added and adjusted until the ammeter reading drops to one half its previous reading, then $R = 65$ Ω. What is the value of R_x?

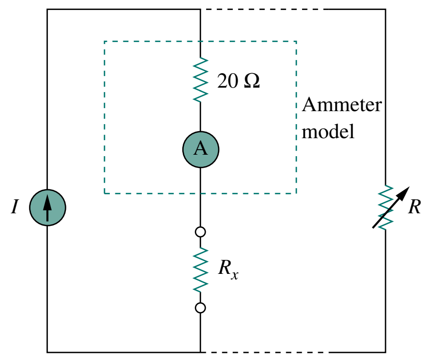


Figure 2.123 For Prob. 2.63.

2.64 The circuit in Fig. 2.124 is to control the speed of a motor such that the motor draws currents 5 A, 3 A, and 1 A when the switch is at high, medium, and low positions, respectively. The motor can be modeled as a load resistance of 20 mΩ. Determine the series dropping resistances R_1, R_2, and R_3.

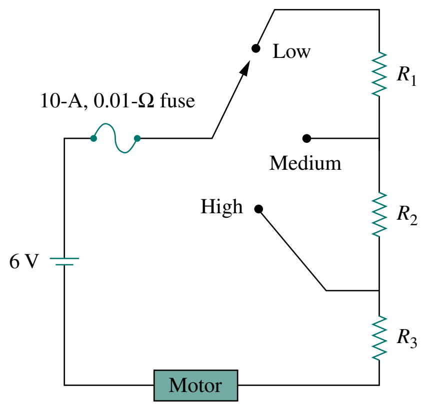


Figure 2.124 For Prob. 2.64.

2.65 An ohmmeter is constructed with a 2-V battery and 0.1-mA (full-scale) meter with 100-Ω internal resistance.

(a) Calculate the resistance of the (variable) resistor required to be in series with the meter and the battery.

(b) Determine the unknown resistance across the terminals of the ohmmeter that will cause the meter to deflect half scale.

COMPREHENSIVE PROBLEMS

2.66 An electric heater connected to a 120-V source consists of two identical 0.4-Ω elements made of Nichrome wire. The elements provide low heat when connected in series and high heat when connected in parallel. Find the power at low and high heat settings.

2.67 Suppose your circuit laboratory has the following standard commercially available resistors in large quantities:

1.8 Ω 20 Ω 300 Ω 24 kΩ 56 kΩ

Using series and parallel combinations and a minimum number of available resistors, how would you obtain the following resistances for an electronic circuit design?

(a) 5 Ω (b) 311.8 Ω
(c) 40 kΩ (d) 52.32 kΩ

2.68 In the circuit in Fig. 2.125, the wiper divides the potentiometer resistance between αR and $(1-\alpha)R$, $0 \le \alpha \le 1$. Find v_o/v_s.

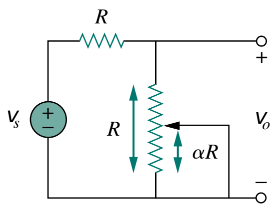


Figure 2.125 For Prob. 2.68.

2.69 An electric pencil sharpener rated 240 mW, 6 V is connected to a 9-V battery as shown in Fig. 2.126. Calculate the value of the series-dropping resistor R_x needed to power the sharpener.

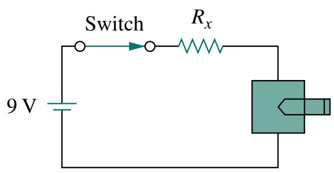


Figure 2.126 For Prob. 2.69.

2.70 A loudspeaker is connected to an amplifier as shown in Fig. 2.127. If a 10-Ω loudspeaker draws the maximum power of 12 W from the amplifier, determine the maximum power a 4-Ω loudspeaker will draw.

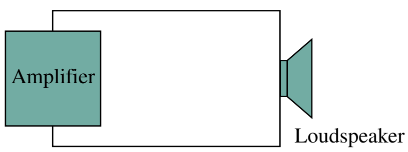


Figure 2.127 For Prob. 2.70.

2.71 In a certain application, the circuit in Fig. 2.128 must be designed to meet these two criteria:

(a) $V_o/V_s = 0.05$ (b) $R_{eq} = 40$ kΩ

If the load resistor 5 kΩ is fixed, find R_1 and R_2 to meet the criteria.

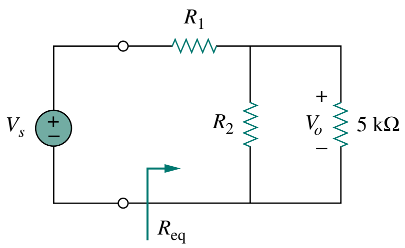


Figure 2.128 For Prob. 2.71.

2.72 The pin diagram of a resistance array is shown in Fig. 2.129. Find the equivalent resistance between the following:

(a) 1 and 2 (b) 1 and 3 (c) 1 and 4

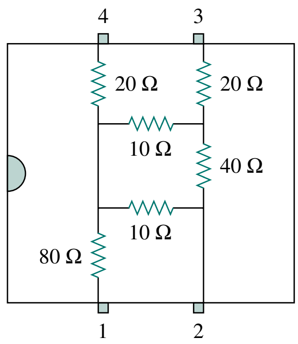


Figure 2.129 For Prob. 2.72.

2.73 Two delicate devices are rated as shown in Fig. 2.130. Find the values of the resistors R_1 and R_2 needed to power the devices using a 24-V battery.

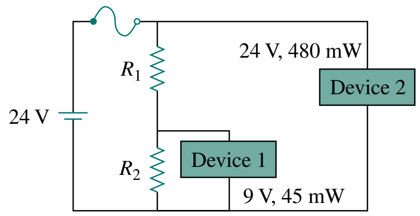


Figure 2.130 For Prob. 2.73.

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