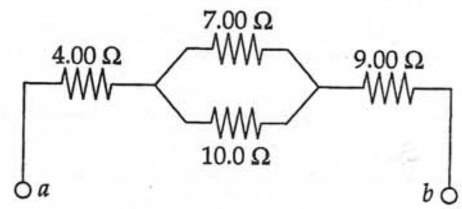
SOLUTIONS CHAPTER 18

4. The resistors should be connected in series. For example, connecting three resistors of $5\ \Omega$, $7\ \Omega$, and $2\ \Omega$ in series gives a resultant resistance of $14\ \Omega$.

18.5 (a) The equivalent resistance of the two parallel resistors is



$$R_p = \left(\frac{1}{7.00\ \Omega} + \frac{1}{10.0\ \Omega}\right)^{-1} = 4.12\ \Omega$$

Thus,

$$R_{ab} = R_4 + R_p + R_9 = (4.00 + 4.12 + 9.00)\ \Omega = \boxed{17.1\ \Omega}$$

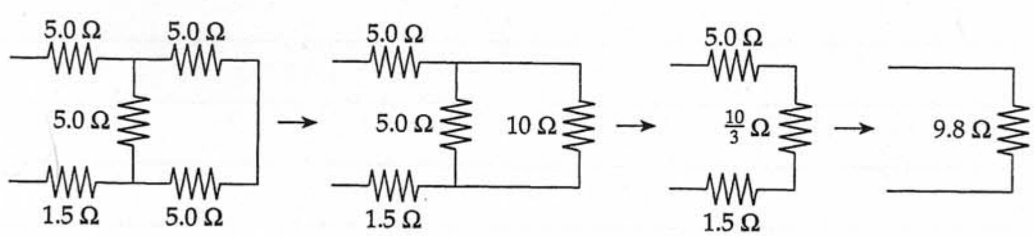
(b) $I_{ab} = \dfrac{(\Delta V)_{ab}}{R_{ab}} = \dfrac{34.0\ \text{V}}{17.1\ \Omega} = 1.99\ \text{A}$, so $\boxed{I_4 = I_9 = 1.99\ \text{A}}$

Also, $(\Delta V)_p = I_{ab}R_p = (1.99\ \text{A})(4.12\ \Omega) = 8.18\ \text{V}$

Then, $I_7 = \dfrac{(\Delta V)_p}{R_7} = \dfrac{8.18\ \text{V}}{7.00\ \Omega} = \boxed{1.17\ \text{A}}$

and $I_{10} = \dfrac{(\Delta V)_p}{R_{10}} = \dfrac{8.18\ \text{V}}{10.0\ \Omega} = \boxed{0.818\ \text{A}}$

18.7 The rules for combining resistors in series and parallel are used to reduce the circuit to an equivalent resistance in the stages shown below. The result is $R_{eq} = \boxed{9.8\ \Omega}$.



18.9 Turn the circuit given in Figure P18.9 90° counterclockwise to observe that it is equivalent to that shown in Figure 1 below. This reduces, in stages, as shown in the following figures.

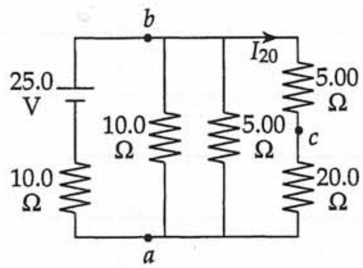


Figure 1

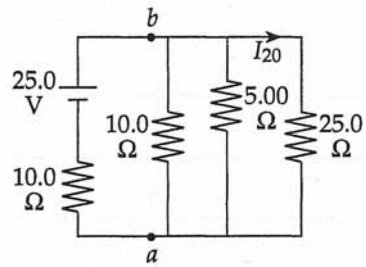


Figure 2

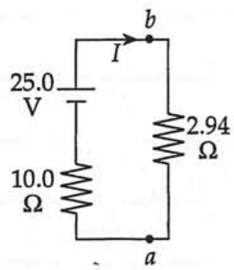


Figure 3

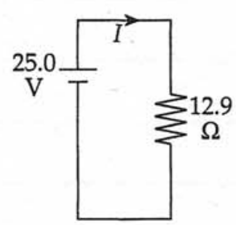


Figure 4

From Figure 4,

$$I = \frac{\Delta V}{R} = \frac{25.0\text{ V}}{12.9\ \Omega} = 1.93\text{ A}$$

(b) From Figure 3,

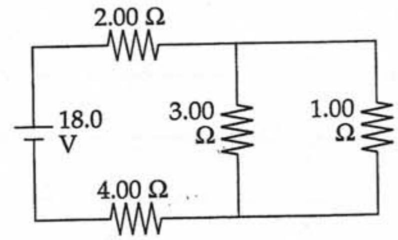
$$(\Delta V)_{ba} = I R_{ba}$$

$$= (1.93\text{ A})(2.94\ \Omega) = \boxed{5.68\text{ V}}$$

(a) From Figures 1 and 2, the current through the 20.0 Ω resistor is

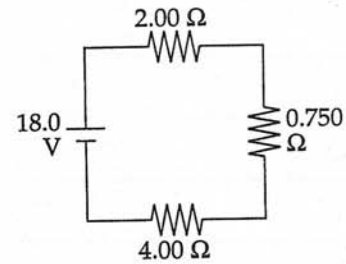
$$I_{20} = \frac{(\Delta V)_{ba}}{R_{bca}} = \frac{5.68\text{ V}}{25.0\ \Omega} = \boxed{0.227\text{ A}}$$

18.14 The resistance of the parallel combination of the $3.00\ \Omega$ and $1.00\ \Omega$ resistors is



$$R_p = \left(\frac{1}{3.00\ \Omega} + \frac{1}{1.00\ \Omega}\right)^{-1} = 0.750\ \Omega$$

The equivalent resistance of the circuit connected to the battery is



$$R_{eq} = 2.00\ \Omega + R_p + 4.00\ \Omega = 6.75\ \Omega,$$

and the current supplied by the battery is

$$I = \frac{\Delta V}{R_{eq}} = \frac{18.0\ \text{V}}{6.75\ \Omega} = 2.67\ \text{A}$$

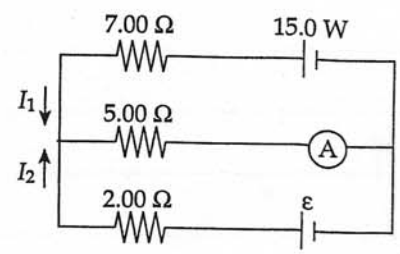
The power dissipated in the $2.00\text{-}\Omega$ resistor is

$$\wp_2 = I^2 R_2 = (2.67\ \text{A})^2 (2.00\ \Omega) = \boxed{14.2\ \text{W}},$$

and that dissipated in the $4.00\text{-}\Omega$ resistor is

$$\wp_4 = I^2 R_4 = (2.67\ \text{A})^2 (4.00\ \Omega) = \boxed{28.4\ \text{W}}$$

18.16 Going counterclockwise around the upper loop, applying Kirchhoff's loop rule, gives



$$+15.0\ \text{V} - (7.00)I_1 - (5.00)(2.00\ \text{A}) = 0,$$

or $$I_1 = \frac{15.0\ \text{V} - 10.0\ \text{V}}{7.00\ \Omega} = \boxed{0.714\ \text{A}}$$

From Kirchhoff's junction rule, $I_1 + I_2 - 2.00\ \text{A} = 0$,

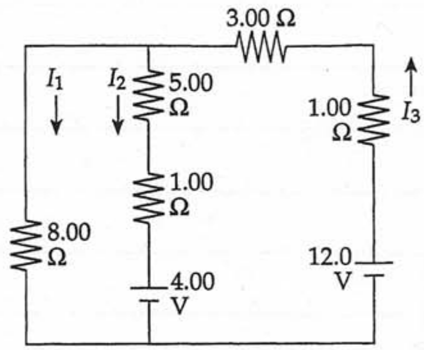
so $$I_2 = 2.00\ \text{A} - I_1 = 2.00\ \text{A} - 0.714\ \text{A} = \boxed{1.29\ \text{A}}$$

Going around the lower loop in a clockwise direction gives

$$+\varepsilon - (2.00)I_2 - (5.00)(2.00\ \text{A}) = 0$$

or $$\varepsilon = (2.00\ \Omega)(1.29\ \text{A}) + (5.00\ \Omega)(2.00\ \text{A}) = \boxed{12.6\ \text{V}}$$

18.17 We name the currents I_1, I_2, and I_3 as shown. Using Kirchhoff's loop rule on the rightmost loop gives



$$+12.0\text{ V}-(1.00+3.00)I_3 -(5.00+1.00)I_2-4.00\text{ V}=0$$

or $\quad (2.00)I_3+(3.00)I_2=4.00\text{ V} \qquad (1)$

Applying the loop rule to the leftmost loop yields

$$+4.00\text{ V}+(1.00+5.00)I_2-(8.00)I_1=0,$$

or $\quad (4.00)I_1-(3.00)I_2=2.00\text{ V} \qquad (2)$

From Kirchhoff's junction rule, $I_1+I_2=I_3 \qquad (3)$

Solving equations (1), (2) and (3) simultaneously gives

$$\boxed{I_1=0.846\text{ A}, I_2=0.462\text{ A}, \text{and } I_3=1.31\text{ A}}$$

All currents are in the directions indicated by the arrows in the circuit diagram.