Section 11.9: Circuit Analysis

Tutorial 1 Practice, Case 1, page 532

1.

Step 1. Find the total resistance of the circuit. Start by finding the equivalent resistance for the parallel part of the circuit.

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{30.0\ \Omega} + \frac{1}{30.0\ \Omega}$$

$$R_{\text{parallel}} = 15.0\ \Omega$$

Now find the total resistance.

R_{parallel} is in series with R_1, so

$$R_{\text{total}} = R_1 + R_{\text{parallel}}$$
$$= 25.0\ \Omega + 15.0\ \Omega$$
$$R_{\text{total}} = 40.0\ \Omega$$

Step 2. Find I_{source} using Ohm's law written as $I = \frac{V}{R}$.

$$I_{\text{source}} = \frac{V_{\text{source}}}{R_{\text{source}}}$$
$$= \frac{40.0\ \text{V}}{40.0\ \Omega}$$
$$I_{\text{source}} = 1.00\ \text{A}$$

Step 3. Apply KCL to find I_1. Note that the source is in series with I_1 and the parallel part I_{parallel}.

$$I_{\text{series}} = I_1 = I_2 = I_3 = \cdots$$
$$I_{\text{series}} = I_{\text{source}} = I_1 = I_{\text{parallel}} = 1.00\ \text{A}$$

Step 4. Find V_1 using Ohm's law written as $V = IR$.

$$V_1 = I_1R_1$$
$$= (1.00\ \text{A})(25.0\ \Omega)$$
$$V_1 = 25.0\ \text{V}$$

Step 5. Apply KVL to find V_{parallel}.

$$V_{\text{series}} = V_1 + V_2 + V_3 + \cdots$$
$$V_{\text{source}} = V_1 + V_{\text{parallel}}$$
$$V_{\text{parallel}} = V_{\text{source}} - V_1$$
$$V_{\text{parallel}} = 40.0\ \text{V} - 25.0\ \text{V}$$
$$V_{\text{parallel}} = 15.0\ \text{V}$$

Step 6. Apply KVL to find V_2 and V_3.

$$V_{\text{parallel}} = V_1 = V_2 = V_3 = \cdots$$
$$V_{\text{parallel}} = V_2 = V_3 = 15.0\ \text{V}$$

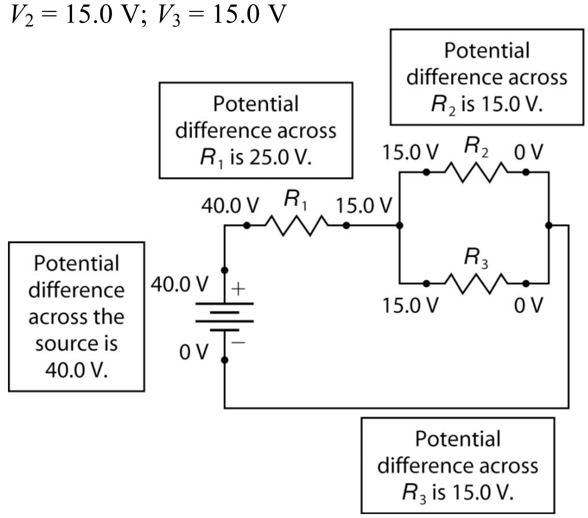
Step 7. Find I_2 and I_3 using Ohm's law written as $I = \frac{V}{R}$.

$$I_2 = \frac{V_2}{R_2}$$
$$= \frac{15.0\ \text{V}}{30.0\ \Omega}$$
$$I_2 = 0.500\ \text{A}$$

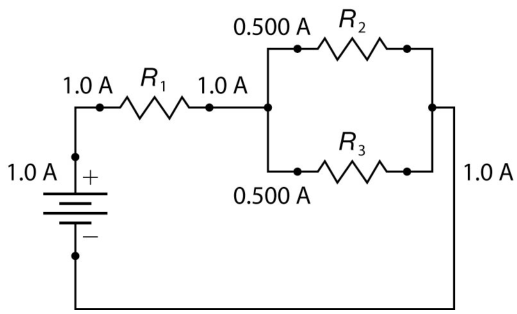
$$I_3 = \frac{V_3}{R_3}$$
$$= \frac{15.0\ \text{V}}{30.0\ \Omega}$$
$$I_3 = 0.500\ \text{A}$$

Step 8. Record your final answers using the correct number of significant digits. Look back at the circuit and see if the values you have calculated coincide with Kirchoff's laws.

$R_{\text{total}} = 40.0\ \Omega$; $I_{\text{source}} = 1.00$ A; $I_1 = 1.00$ A; $I_2 = 0.500$ A; $I_3 = 0.500$ A; $V_1 = 25.0$ V; $V_2 = 15.0$ V; $V_3 = 15.0$ V



The electric potential energies associated with the electrons are marked on the diagram. We chose a reference point of 0 V. The boxes represent the voltage across each point in the circuit. In each complete path, the sum of the voltage gains (40.0 V) equals the sum of the voltage drops (25.0 V + 15.0 V). Therefore, the problem is solved correctly.



The values on the diagram represent the current at various points in the circuit. The only junction is where the current splits into R_2 and R_3. The current going into the junction is 1.00 A. The current coming out is also 1.00 A. The current in each path of the parallel part of the circuit must add up to 0.500 A. A check of the values (0.500 A + 0.500 A = 1.00 A) shows that the current in the parallel part of the circuit adds up to 1.00 A.

Tutorial 1 Practice, Case 2, page 534

1.

Step 1. Apply KVL to any complete pathway. In this case, one complete pathway involves the source, resistor 1, and resistor 4.

$$V_{\text{source}} = V_1 + V_4$$
$$V_1 = V_{\text{source}} - V_4$$
$$V_1 = 42.0 \text{ V} - 17.5 \text{ V}$$
$$V_1 = 24.5 \text{ V}$$

Step 2. Apply KVL to any complete pathway. In this case, another complete pathway involves the source, resistor 1, resistor 2, and resistor 3.

$$V_{\text{source}} = V_1 + V_2 + V_3$$
$$V_3 = V_{\text{source}} - V_1 - V_2$$
$$= 42.0 \text{ V} - 24.5 \text{ V} - 8.75 \text{ V}$$
$$V_3 = 8.75 \text{ V}$$

Step 3. Find I_2 using Ohm's law written as $I = \dfrac{V}{R}$.

$$I_2 = \frac{V_2}{R_2}$$
$$= \frac{8.75 \text{ V}}{35.0\ \Omega}$$
$$I_2 = 0.250 \text{ A}$$

Step 4. Apply KCL to find the missing current values. Note that $I_{2,3}$ represents the current going through the path that contains I_2 and I_3.

Find I_{source}:

$$I_{\text{source}} = I_1$$
$$I_{\text{source}} = 1.75 \text{ A}$$

Find I_3:

$$I_{\text{series}} = I_3$$
$$= I_2$$
$$= 0.250 \text{ A}$$
$$I_3 = 0.250 \text{ A}$$

Find I_4:

$$I_{\text{source}} = I_{2,3} + I_4$$
$$I_4 = I_{\text{source}} - I_{2,3}$$
$$I_4 = 1.75 \text{ A} - 0.250 \text{ A}$$
$$I_4 = 1.50 \text{ A}$$

Step 5. Find all other missing values using Ohm's law.

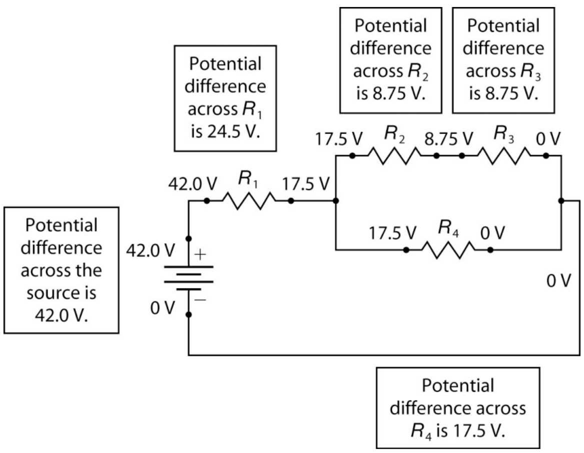
$$R_1 = \frac{V_1}{I_1}$$
$$= \frac{24.5 \text{ V}}{1.75 \text{ A}}$$
$$R_1 = 14.0\ \Omega$$

$$R_3 = \frac{V_3}{I_3}$$
$$= \frac{8.75 \text{ V}}{0.250 \text{ A}}$$
$$R_3 = 35.0\ \Omega$$

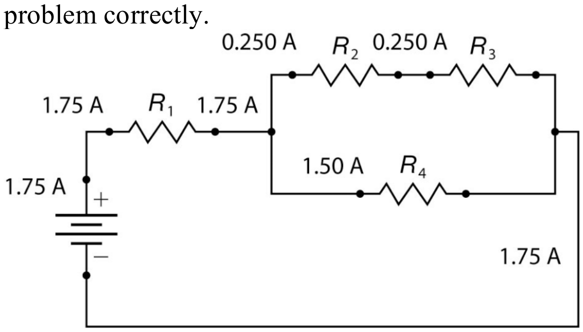
$$R_4 = \frac{V_4}{I_4}$$
$$= \frac{17.5 \text{ V}}{1.50 \text{ A}}$$
$$R_4 = 11.7\ \Omega$$

$$R_{\text{total}} = \frac{V_{\text{source}}}{I_{\text{source}}}$$
$$= \frac{42.0 \text{ V}}{1.7\ 5\text{A}}$$
$$R_{\text{total}} = 24.0\ \Omega$$

Step 6. Record your final answers with the correct number of significant digits. Now that you have finished the problem, you can look back at the circuit and see if the values you have calculated coincide with Kirchhoff's laws.
I_{source} = 1.75 A; I_2 = 0.250 A; I_3 = 0.250 A;
I_4 = 1.50 A; V_1 = 24.5 V; V_3 = 8.75 V; R_1 = 14.0 Ω;
R_3 = 35.0 Ω; R_4 = 11.7 Ω; R_{total} = 24.0 Ω



The electric potential energies associated with the electrons are marked on the diagram. We chose a reference point of 0 V. The red boxes represent the electric potential difference (or voltage) across the electric circuit parts. In one complete path, the sum of the voltage gains (42.0 V) equals the sum of the voltage drops (17.5 V + 15.75 V + 8.75 V). In the other complete path, the sum of the voltage gains (42.0 V) equals the sum of the voltage drops (24.5 V + 17.5 V). Therefore, you have solved the problem correctly.



The values on the diagram represent the current at various points in the circuit. The only junction is at the parallel part where the current splits into $R_{2,3}$ (R_2 and R_3 together) and R_4. The current going into the junction is 1.75 A. The current coming out is also 1.75 A. The currents in both paths of the parallel part of the circuit must add up to 1.75 A.

A check of the values (1.50 A + 0.250 = 1.75 A) shows that they do. Note that the current in the two resistors connected in series (R_2 and R_3) stays constant.

Section 11.9 Questions, page 535

1. (a)

Step 1. Find the total resistance of the circuit. Start by finding the equivalent resistance for the parallel part of the circuit.

$$\frac{1}{R_{parallel}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{parallel}} = \frac{1}{12.0\ \Omega} + \frac{1}{12.0\ \Omega}$$

$$R_{parallel} = 6.00\ \Omega$$

Now find the total resistance.
$R_{parallel}$ is in series with R_1, so

$$\begin{aligned} R_{total} &= R_1 + R_{parallel} \\ &= 12.0\ \Omega + 6.00\ \Omega \\ R_{total} &= 18.0\ \Omega \end{aligned}$$

Step 2. Find I_{source} using Ohm's law written as $I = \frac{V}{R}$.

$$\begin{aligned} I_{source} &= \frac{V_{source}}{R_{source}} \\ &= \frac{6.0\ \text{V}}{18.0\ \Omega} \\ I_{source} &= 0.33\ \text{A} \end{aligned}$$

Step 3. Apply KCL to find I_1. Note that the source is in series with I_1 and the parallel part $I_{parallel}$.

$$I_{series} = I_{source} = I_1 = I_{parallel} = 0.33\ \text{A}$$

Step 4. Find V_1 using Ohm's law written as $V = IR$.

$$\begin{aligned} V_1 &= I_1 R_1 \\ &= (0.33\ \text{A})(12.0\ \Omega) \\ V_1 &= 4.0\ \text{V} \end{aligned}$$

Step 5. Apply KVL to find $V_{parallel}$.

$$\begin{aligned} V_{source} &= V_1 + V_{parallel} \\ V_{parallel} &= V_{source} - V_1 \\ &= 6.0\ \text{V} - 4.0\ \text{V} \\ V_{parallel} &= 2.0\ \text{V} \end{aligned}$$

Step 6. Apply KVL to find V_2 and V_3.

$V_{\text{parallel}} = V_2 = V_3 = 2.0\ \text{V}$

Step 7. Find I_2 and I_3 using Ohm's law written as $I = \frac{V}{R}$.

$$I_2 = \frac{V_2}{R_2} = \frac{2.0\ \text{V}}{12.0\ \Omega}$$
$$I_2 = 0.17\ \text{A}$$

$$I_3 = \frac{V_3}{R_3} = \frac{2.0\ \text{V}}{12.\ \Omega}$$
$$I_3 = 0.17\ \text{A}$$

Step 8. Final answers:
$R_{\text{source}} = 18.0\ \Omega$; $I_{\text{source}} = 0.33$ A; $I_1 = 0.33$ A; $I_2 = 0.17$ A; $I_3 = 0.17$ A; $V_1 = 4.0$ V; $V_2 = 2.0$ V; $V_3 = 2.0$ V

(b)

Step 1. Find the total resistance of the circuit. Start by finding the equivalent resistance for the resistors in series in the parallel part of the circuit. Find R_{series1}, the equivalent of R_2 and R_3:

$$R_{series1} = R_2 + R_3 = 12.0\ \Omega + 12.0\ \Omega$$
$$R_{series1} = 24.0\ \Omega$$

Find R_{series2}, the equivalent of R_4 and R_5:

$$R_{series2} = R_4 + R_5 = 12.0\ \Omega + 12.0\ \Omega$$
$$R_{series2} = 24.0\ \Omega$$

Now find the equivalent resistance for the parallel part of the circuit.

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_{series1}} + \frac{1}{R_{series2}}$$
$$\frac{1}{R_{\text{parallel}}} = \frac{1}{24.0\ \Omega} + \frac{1}{24.0\ \Omega}$$
$$R_{\text{parallel}} = 12.0\ \Omega$$

Now find the total resistance.
R_{parallel} is in series with R_1 and R_6, so

$$R_{\text{total}} = R_1 + R_{\text{parallel}} + R_6 = 12.0\ \Omega + 12.0\ \Omega + 12.0\ \Omega$$
$$R_{\text{total}} = 36.0\ \Omega$$

Step 2. Find I_{source} using Ohm's law written as $I = \frac{V}{R}$.

$$I_{\text{source}} = \frac{V_{\text{source}}}{R_{\text{source}}} = \frac{6.0\ \text{V}}{36.0\ \Omega}$$
$$I_{\text{source}} = 0.17\ \text{A}$$

Step 3. Apply KCL to find I_1. Note that the source is in series with I_1, the parallel part I_{parallel}, and I_6.

$I_{\text{series}} = I_{\text{source}} = I_1 = I_{\text{parallel}} = I_6 = 0.17\ \text{A}$

Step 4. Find V_1 and V_6 using Ohm's law written as $V = IR$.

$$V_1 = I_1R_1 = (0.17\ \text{A})(12.0\ \Omega)$$
$$V_1 = 2.0\ \text{V}$$

$$V_6 = I_6R_6 = (0.17\ \text{A})(12.0\ \Omega)$$
$$V_6 = 2.0\ \text{V}$$

Step 5. Apply KVL to find V_{parallel}.

$$V_{\text{source}} = V_1 + V_{\text{parallel}} + V_6$$
$$V_{\text{parallel}} = V_{\text{source}} - V_1 - V_6 = 6.0\ \text{V} - 2.0\ \text{V} - 2.0\ \text{V}$$
$$V_{\text{parallel}} = 2.0\ \text{V}$$

Step 6. Apply KVL to find $V_{2,3}$ and $V_{4,5}$.

$V_{\text{parallel}} = V_{2,3} = V_{4,5} = 2.0\ \text{V}$

Step 7. Find $I_{2,3}$ and $I_{4,5}$ using Ohm's law written as $I = \frac{V}{R}$. Note that $I_{2,3}$ represents the current going through the path that contains I_2 and I_3, and $I_{4,5}$ represents the current going through the path that contains I_4 and I_5.

$$I_{2,3} = \frac{V_{2,3}}{R_{series1}} = \frac{2.0\ \text{V}}{24.0\ \Omega}$$
$$I_{2,3} = 0.083\ \text{A}$$

The same amount of current goes through both I_2 and I_3, so:
$I_{2,3} = I_2 = I_3 = 0.083$ A

$$I_{4,5} = \frac{V_{4,5}}{R_{series2}} = \frac{2.0 \text{ V}}{24.0\ \Omega}$$
$$I_{4,5} = 0.083 \text{ A}$$

The same amount of current goes through both I_4 and I_5, so:
$I_{4,5} = I_4 = I_5 = 0.083$ A

Step 8. Find all other missing values using Ohm's law.

$$V_2 = I_2R_2 = (0.083 \text{ A})(12.0\ \Omega)$$
$$V_2 = 1.0 \text{ V}$$

$$V_3 = I_3R_3 = (0.083 \text{ A})(12.0\ \Omega)$$
$$V_3 = 1.0 \text{ V}$$

$$V_4 = I_4R_4 = (0.083 \text{ A})(12.0\ \Omega)$$
$$V_4 = 1.0 \text{ V}$$

$$V_5 = I_5R_5 = (0.083 \text{ A})(12.0\ \Omega)$$
$$V_5 = 1.0 \text{ V}$$

Step 9. Final answers:
$R_{source} = 36.0\ \Omega$; $I_{source} = 0.17$ A; $I_1 = 0.17$ A; $I_2 = 0.083$ A; $I_3 = 0.083$ A; $I_4 = 0.083$ A; $I_5 = 0.083$ A; $I_6 = 0.17$ A; $V_1 = 2.0$ V; $V_2 = 1.0$ V; $V_3 = 1.0$ V; $V_4 = 1.0$ V; $V_5 = 1.0$ V; $V_6 = 2.0$ V

(c)

Step 1. Find the total resistance of the circuit. Start by finding the equivalent resistance for the resistors in series in the parallel part of the circuit. Find $R_{series1}$, the equivalent of R_2 and R_3:

$$R_{series1} = R_2 + R_3 = 12.0\ \Omega + 12.0\ \Omega$$
$$R_{series1} = 24.0\ \Omega$$

Now find the equivalent resistance for the parallel part of the circuit.

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_{series1}} + \frac{1}{R_4}$$
$$\frac{1}{R_{\text{parallel}}} = \frac{1}{24.0\ \Omega} + \frac{1}{12.0\ \Omega}$$
$$R_{\text{parallel}} = 8.00\ \Omega$$

Now find the total resistance.
R_{parallel} is in series with R_1, so

$$R_{\text{total}} = R_1 + R_{\text{parallel}} = 12.0\ \Omega + 8.0\ \Omega$$
$$R_{\text{total}} = 20.0\ \Omega$$

Step 2. Find I_{source} using Ohm's law written as $I = \frac{V}{R}$.

$$I_{\text{source}} = \frac{V_{\text{source}}}{R_{\text{source}}} = \frac{6.0 \text{ V}}{20.0\ \Omega}$$
$$I_{\text{source}} = 0.30 \text{ A}$$

Step 3. Apply KCL to find I_1. Note that the source is in series with I_1 and the parallel part I_{parallel}.

$$I_{\text{series}} = I_{\text{source}} = I_1 = I_{\text{parallel}} = 0.30 \text{ A}$$

Step 4. Find V_1 using Ohm's law written as $V = IR$.

$$V_1 = I_1R_1 = (0.3 \text{ A})(12.0\ \Omega)$$
$$V_1 = 3.6 \text{ V}$$

Step 5. Apply KVL to find V_{parallel}.

$$V_{\text{source}} = V_1 + V_{\text{parallel}}$$
$$V_{\text{parallel}} = V_{\text{source}} - V_1 = 6.0 \text{ V} - 3.6 \text{ V}$$
$$V_{\text{parallel}} = 2.4 \text{ V}$$

Step 6. Apply KVL to find $V_{2,3}$ and V_4.

$$V_{\text{parallel}} = V_{2,3} = V_4 = 2.4 \text{ V}$$

Step 7. Find $I_{2,3}$ and I_4 using Ohm's law written as $I = \frac{V}{R}$. Note that $I_{2,3}$ represents the current going through the path that contains I_2 and I_3.

$$I_{2,3} = \frac{V_{2,3}}{R_{series1}} = \frac{2.4\ \text{V}}{24.0\ \Omega}$$
$$I_{2,3} = 0.10\ \text{A}$$

The same amount of current goes through both I_2 and I_3, so:
$I_{2,3} = I_2 = I_3 = 0.10$ A

$$I_4 = \frac{V_4}{R_4} = \frac{2.4\ \text{V}}{12.0\ \Omega}$$
$$I_{4,5} = 0.20\ \text{A}$$

Step 8. Find all other missing values using Ohm's law.

$$V_2 = I_2R_2 = (0.10\ \text{A})(12.0\ \Omega)$$
$$V_2 = 1.2\ \text{V}$$

$$V_3 = I_3R_3 = (0.10\ \text{A})(12.0\ \Omega)$$
$$V_3 = 1.2\ \text{V}$$

$$V_4 = I_4R_4 = (0.20\ \text{A})(12.0\ \Omega)$$
$$V_4 = 2.4\ \text{V}$$

Step 9. Final answers:
$R_{source} = 20.0\ \Omega$; $I_{source} = 0.30$ A; $I_1 = 0.30$ A; $I_2 = 0.10$ A; $I_3 = 0.10$ A; $I_4 = 0.20$ A; $V_1 = 3.6$ V; $V_2 = 1.2$ V; $V_3 = 1.2$ V; $V_4 = 2.4$ V

(d)

Step 1. Find the total resistance of the circuit. Start by finding the equivalent resistance for the resistors in series in the parallel part of the circuit.
Find $R_{series1}$, the equivalent of R_2 and R_3:

$$R_{series1} = R_2 + R_3 = 12.0\ \Omega + 12.0\ \Omega$$
$$R_{series1} = 24.0\ \Omega$$

Find $R_{series2}$, the equivalent of R_4 and R_5:

$$R_{series2} = R_4 + R_5 = 12.0\ \Omega + 12.0\ \Omega$$
$$R_{series2} = 24.0\ \Omega$$

Now find the equivalent resistance for the parallel part of the circuit.

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_{series1}} + \frac{1}{R_{series2}}$$
$$\frac{1}{R_{\text{parallel}}} = \frac{1}{24.0\ \Omega} + \frac{1}{24.0\ \Omega}$$
$$R_{\text{parallel}} = 12.0\ \Omega$$

Now find the total resistance.
R_{parallel} is in series with R_1, so

$$R_{\text{total}} = R_1 + R_{\text{parallel}} = 12.0\ \Omega + 12.0\ \Omega$$
$$R_{\text{total}} = 24.0\ \Omega$$

Step 2. Find I_{source} using Ohm's law written as $I = \frac{V}{R}$.

$$I_{\text{source}} = \frac{V_{\text{source}}}{R_{\text{source}}} = \frac{6.0\ \text{V}}{24.0\ \Omega}$$
$$I_{\text{source}} = 0.25\ \text{A}$$

Step 3. Apply KCL to find I_1. Note that the source is in series with I_1 and the parallel part I_{parallel}.

$$I_{\text{series}} = I_{\text{source}} = I_1 = I_{\text{parallel}} = 0.25\ \text{A}$$

Step 4. Find V_1 using Ohm's law written as $V = IR$.

$$V_1 = I_1R_1 = (0.25\ \text{A})(12.0\ \Omega)$$
$$V_1 = 3.0\ \text{V}$$

Step 5. Apply KVL to find V_{parallel}.

$$V_{\text{source}} = V_1 + V_{\text{parallel}}$$
$$V_{\text{parallel}} = V_{\text{source}} - V_1 = 6.0\ \text{V} - 3.0\ \text{V}$$
$$V_{\text{parallel}} = 3.0\ \text{V}$$

Step 6. Apply KVL to find $V_{2,3}$ and $V_{4,5}$.

$$V_{\text{parallel}} = V_{2,3} = V_{4,5} = 3.0\ \text{V}$$

Step 7. Find $I_{2,3}$ and $I_{4,5}$ using Ohm's law written as $I = \frac{V}{R}$. Note that $I_{2,3}$ represents the current going through the path that contains I_2 and I_3, and $I_{4,5}$ represents the current going through the path that contains I_4 and I_5.

$$I_{2,3} = \frac{V_{2,3}}{R_{series1}}$$
$$= \frac{3.0\ \text{V}}{24.0\ \Omega}$$
$$I_{2,3} = 0.125\ \text{A}\ \text{(one extra digit carried)}$$

The same amount of current goes through both I_2 and I_3, so:

$I_{2,3} = I_2 = I_3 = 0.125$ A (one extra digit carried)

$$I_{4,5} = \frac{V_{4,5}}{R_{series2}}$$
$$= \frac{3.0\ \text{V}}{24.0\ \Omega}$$
$$I_{4,5} = 0.125\ \text{A}\ \text{(one extra digit carried)}$$

The same amount of current goes through both I_4 and I_5, so:

$I_{4,5} = I_4 = I_5 = 0.125$ A (one extra digit carried)

Step 8. Find all other missing values using Ohm's law.

$$V_2 = I_2R_2$$
$$= (0.125\ \text{A})(12.0\ \Omega)$$
$$V_2 = 1.5\ \text{V}$$

$$V_3 = I_3R_3$$
$$= (0.125\ \text{A})(12.0\Omega)$$
$$V_3 = 1.5\ \text{V}$$

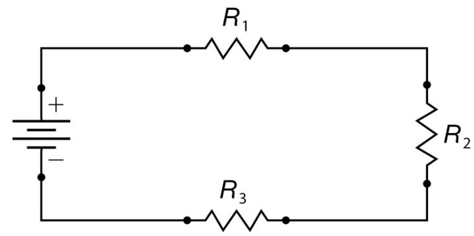
$$V_4 = I_4R_4$$
$$= (0.125\ \text{A})(12.0\ \Omega)$$
$$V_4 = 1.5\ \text{V}$$

$$V_5 = I_5R_5$$
$$= (0.125\ \text{A})(12.0\ \Omega)$$
$$V_5 = 1.5\ \text{V}$$

Step 9. Final answers:

$R_{source} = 24.0\ \Omega$; $I_{source} = 0.25$ A; $I_1 = 0.25$ A; $I_2 = 0.13$ A; $I_3 = 0.13$ A; $I_4 = 0.13$ A; $I_5 = 0.13$ A; $V_1 = 3.0$ V; $V_2 = 1.5$ V; $V_3 = 1.5$ V; $V_4 = 1.5$ V; $V_5 = 1.5$ V

2.



Step 1. Apply KCL to find the missing current values.

$$I_{series} = I_{source} = I_1 = I_3 = 0.20\ \text{A}$$

Step 2. Find V_1 using Ohm's law written as $V = IR$.

$$V_1 = I_1R_1$$
$$= (0.20\ \text{A})(30.0\ \Omega)$$
$$V_1 = 6.0\ \text{V}$$

Step 3. Apply KVL to any complete pathway. In this case, one complete pathway involves the source, resistor 1, resistor 2, and resistor 3.

$$V_{source} = V_1 + V_2 + V_3$$
$$V_3 = V_{source} - V_1 - V_2$$
$$V_3 = 15.0\ \text{V} - 6.0\ \text{V} - 4.0\ \text{V}$$
$$V_3 = 5.0\ \text{V}$$

Step 4. Find all other missing values using Ohm's law.

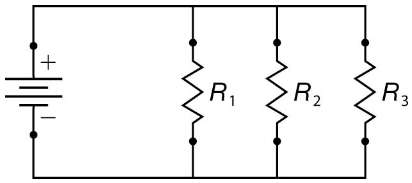
$$R_2 = \frac{V_2}{I_2}$$
$$= \frac{4.0\ \text{V}}{0.20\ \text{A}}$$
$$R_2 = 2.0 \times 10^1\ \Omega$$

$$R_3 = \frac{V_3}{I_3}$$
$$= \frac{5.0\ \text{V}}{0.20\ \text{A}}$$
$$R_3 = 25\ \Omega$$

$$R_{total} = \frac{V_{source}}{I_{source}}$$
$$= \frac{15.0\ \text{V}}{0.20\ \text{A}}$$
$$R_{total} = 75\ \Omega$$

Step 5. Final answers:
V_1 = 6.0 V; V_3 = 5.0 V; I_1 = 0.20 A; I_3 = 0.20 A; I_{source} = 0.20 A; $R_2 = 2.0 \times 10^1\ \Omega$; R_3 = 25 Ω; R_{total} = 75 Ω

3.



Step 1. Apply KVL to any complete pathway. In this case, one complete pathway involves the source and resistor 1.

$$V_{source} = V_1$$
$$V_1 = 1.5\text{ V}$$

Step 2. Apply KVL to any complete pathway. In this case, another complete pathway involves the source and resistor 2.

$$V_{source} = V_2$$
$$V_2 = 1.5\text{ V}$$

Step 3. Apply KVL to any complete pathway. In this case, another complete pathway involves the source and resistor 3.

$$V_{source} = V_3$$
$$V_3 = 1.5\text{ V}$$

Step 4. Find I_2 and I_3 using Ohm's law written as $I = \frac{V}{R}$.

$$I_2 = \frac{V_2}{R_2} = \frac{1.5\text{ V}}{7.5\ \Omega}$$
$$I_2 = 0.20\text{ A}$$

$$I_3 = \frac{V_3}{R_3} = \frac{1.5\text{ V}}{5.0\ \Omega}$$
$$I_3 = 0.30\text{ A}$$

Step 5. Apply KCL to find the missing current values.
Find I_{source}:

$$I_{source} = I_1 + I_2 + I_3 = 0.10\text{ A} + 0.20\text{ A} + 0.30\text{ A}$$
$$I_{source} = 0.60\text{ A}$$

Step 6. Find all other missing values using Ohm's law.

$$R_1 = \frac{V_1}{I_1} = \frac{1.5\text{ V}}{0.10\text{ A}}$$
$$R_1 = 15\ \Omega$$

$$R_{total} = \frac{V_{source}}{I_{source}} = \frac{1.5\text{ V}}{0.60\text{ A}}$$
$$R_{total} = 2.5\ \Omega$$

Step 7. Final answers:
V_1 = 1.5 V; V_2 = 1.5 V; V_3 = 1.5 V; I_2 = 0.20 A; I_3 = 0.30 A; I_{source} = 0.60 A; R_1 = 15 Ω; R_{total} = 2.5 Ω

4.

Step 1. Find V_4 using Ohm's law written as $V = IR$.

$$V_4 = I_4R_4 = (0.10\text{ A})(70.0\ \Omega)$$
$$V_4 = 7.0\text{ V}$$

Step 2. Apply KVL to any complete pathway. In this case, one complete pathway involves the source, resistor 1, resistor 3, and resistor 4.

$$V_{source} = V_1 + V_3 + V_4 = 2.5\text{ V} + 5.0\text{ V} + 7.0\text{ V}$$
$$V_{source} = 14.5\text{ V}$$

Step 3. Apply KVL to any complete pathway. In this case, another complete pathway involves the source, resistor 1, resistor 3, and resistor 5.

$$V_{source} = V_1 + V_3 + V_5$$
$$V_5 = V_{source} - V_1 - V_3 = 14.5\text{ V} - 2.5\text{ V} - 5.0\text{ V}$$
$$V_5 = 7.0\text{ V}$$

Step 4. Apply KVL to any complete pathway. In this case, another complete pathway involves the source, resistor 2, resistor 3, and resistor 4.

$$V_{\text{source}} = V_2 + V_3 + V_4$$
$$V_2 = V_{\text{source}} - V_3 - V_4$$
$$V_2 = 14.5 \text{ V} - 5.0 \text{ V} - 7.0 \text{ V}$$
$$V_2 = 2.5 \text{ V}$$

Step 5. Apply KCL to find the missing current values.

Find I_{source}:

$$I_{\text{source}} = I_3$$
$$I_{\text{source}} = 0.50 \text{ A}$$

Find I_1:

$$I_{\text{source}} = I_1 + I_2$$
$$I_1 = I_{\text{source}} - I_2$$
$$I_1 = 0.50 \text{ A} - 0.30 \text{ A}$$
$$I_1 = 0.20 \text{ A}$$

Find I_5:

$$I_{\text{source}} = I_4 + I_5$$
$$I_5 = I_{\text{source}} - I_4$$
$$I_5 = 0.50 \text{ A} - 0.10 \text{ A}$$
$$I_5 = 0.40 \text{ A}$$

Step 6. Find all other missing values using Ohm's law.

$$R_1 = \frac{V_1}{I_1} = \frac{2.5 \text{ V}}{0.20 \text{ A}}$$
$$R_1 = 13 \ \Omega$$

$$R_2 = \frac{V_2}{I_2} = \frac{2.5 \text{ V}}{0.30 \text{ A}}$$
$$R_2 = 8.3 \ \Omega$$

$$R_3 = \frac{V_3}{I_3} = \frac{5.0 \text{ V}}{0.50 \text{ A}}$$
$$R_3 = 1.0 \times 10^1 \ \Omega$$

$$R_5 = \frac{V_5}{I_5} = \frac{7.0 \text{ V}}{0.40 \text{ A}}$$
$$R_5 = 18 \ \Omega$$

$$R_{\text{total}} = \frac{V_{\text{source}}}{I_{\text{source}}} = \frac{14.5 \text{ V}}{0.50 \text{ A}}$$
$$R_{\text{total}} = 29 \ \Omega$$

Step 6. Final answers:
$V_{\text{source}} = 14.5$ V; $V_2 = 2.5$ V; $V_4 = 7.0$ V; $V_5 = 7.0$ V; $I_{\text{source}} = 0.50$ A; $I_1 = 0.20$ A; $I_5 = 0.40$ A; $R_1 = 13\ \Omega$; $R_2 = 8.3\ \Omega$; $R_3 = 1.0 \times 10^1\ \Omega$; $R_5 = 18\ \Omega$; $R_{\text{total}} = 29\ \Omega$