46.

Monday, April 02, 2012
11:21 AM

19.46. Set Up: For resistors in parallel, $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$ For resistors in series, $R_{\text{eq}} = R_1 + R_2 + \cdots$ These rules may have to be applied in several ways.

Solve: (a) All four resistors are in parallel. $\frac{1}{R_{\text{eq}}} = \frac{1}{25\ \Omega} + \frac{1}{12\ \Omega} + \frac{1}{5.0\ \Omega} + \frac{1}{45\ \Omega}$ so $R_{\text{eq}} = 2.9\ \Omega$.

(b) The $75\ \Omega$ and $25\ \Omega$ resistors are in parallel. $\frac{1}{R_{\text{p}}} = \frac{1}{75\ \Omega} + \frac{1}{25\ \Omega}$ so their equivalent is $R_{\text{p}} = 18.8\ \Omega$. The $9.0\ \Omega$, $18.8\ \Omega$, and $18\ \Omega$ resistors are in series, so $R_{\text{eq}} = 9.0\ \Omega + 18.8\ \Omega + 18\ \Omega = 45.8\ \Omega$.

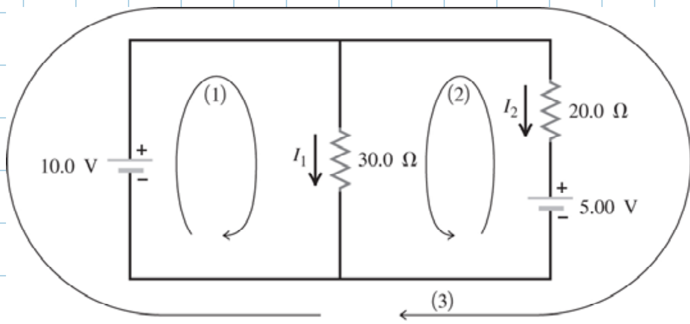
(c) The $13\ \Omega$ and $15\ \Omega$ resistors are in series, so their equivalent is $R_{\text{s}} = 13\ \Omega + 15\ \Omega = 28\ \Omega$. The $32\ \Omega$, $28\ \Omega$, and $14\ \Omega$ resistors are in parallel, so $\frac{1}{R_{\text{p1}}} = \frac{1}{32\ \Omega} + \frac{1}{28\ \Omega} + \frac{1}{14\ \Omega}$ and their equivalent is $R_{\text{p1}} = 7.2\ \Omega$. The $72\ \Omega$ and $45\ \Omega$ resistors are in parallel so $\frac{1}{R_{\text{p2}}} = \frac{1}{72\ \Omega} + \frac{1}{45\ \Omega}$ and their equivalent is $R_{\text{p2}} = 27.7\ \Omega$. This gives a network with $19\ \Omega$, $7.2\ \Omega$, $27.7\ \Omega$ and $24\ \Omega$ in series. The equivalent resistance is $R_{\text{eq}} = 19\ \Omega + 7.2\ \Omega + 27.7\ \Omega + 24\ \Omega = 77.9\ \Omega$.

(d) The $12\ \Omega$, $13\ \Omega$ and $14\ \Omega$ resistors are in series and their equivalent is $R_{\text{s}} = 12\ \Omega + 13\ \Omega + 14\ \Omega = 39\ \Omega$. R_{s} and the $22\ \Omega$ resistor are in parallel and their equivalent R_{p} is given by $\frac{1}{R_{\text{p}}} = \frac{1}{39\ \Omega} + \frac{1}{22\ \Omega}$, so $R_{\text{p}} = 14.1\ \Omega$. Then R_{p} and the $11\ \Omega$ resistor are in series and $R_{\text{eq}} = 14.1\ \Omega + 11\ \Omega = 25.1\ \Omega$.

57.

Monday, April 02, 2012
11:30 AM

19.57. Set Up: Assume the unknown currents have the directions shown in the figure below. We have used the junction rule to write the current through the 10.0 V battery as $I_1 + I_2$. There are two unknowns, I_1 and I_2, so we will need two equations. Three possible circuit loops are shown in the figure.



Solve: (a) Apply the loop rule to loop (1), going around the loop in the direction shown: $+10.0\text{ V} - (30.0\,\Omega)I_1 = 0$ and $I_1 = 0.333\text{ A}$.

(b) Apply the loop rule to loop (3): $+10.0\text{ V} - (20.0\,\Omega)I_2 - 5.00\text{ V} = 0$ and $I_2 = 0.250\text{ A}$.

(c) $I_1 + I_2 = 0.333\text{ A} + 0.250\text{ A} = 0.583\text{ A}$

Reflect: For loop (2) we get

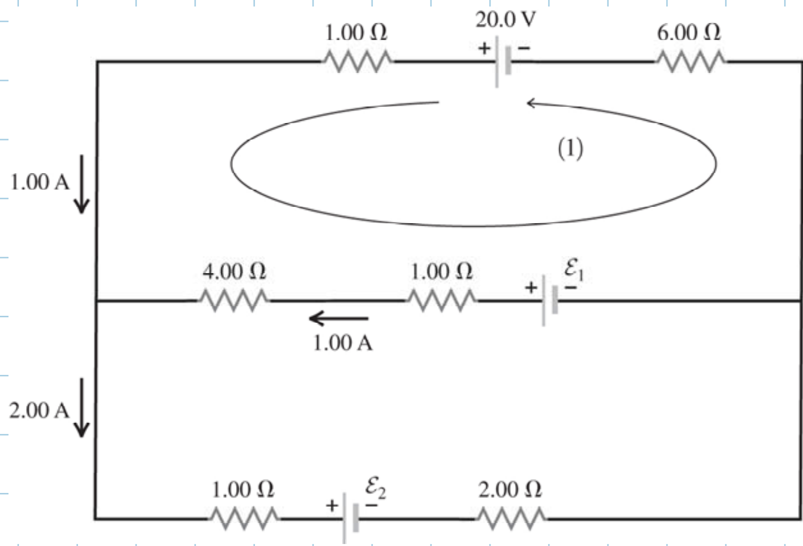
$$+5.00\text{ V} + I_2(20.0\,\Omega) - I_1(30.0\,\Omega) = 5.00\text{ V} + (0.250\text{ A})(20.0\,\Omega) - (0.333\text{ A})(30.0\,\Omega) =$$
$$5.00\text{ V} + 5.00\text{ V} - 10.0\text{ V} = 0,$$

so that with the currents we have calculated the loop rule is satisfied for this third loop.

58.

Monday, April 02, 2012
11:32 AM

58. Set Up: The circuit diagram is given in the figure below. The junction rule has been used to find the magnitude and direction of the current in the middle branch of the circuit. There are no remaining unknown currents.



Solve: The loop rule applied to loop (1) gives:

$$+20.0\text{ V} - (1.00\text{ A})(1.00\,\Omega) + (1.00\text{ A})(4.00\,\Omega) + (1.00\text{ A})(1.00\,\Omega) - \mathcal{E}_1 - (1.00\text{ A})(6.00\,\Omega) = 0$$

$$\mathcal{E}_1 = 20.0\text{ V} - 1.00\text{ V} + 4.00\text{ V} + 1.00\text{ V} - 6.00\text{ V} = 18.0\text{ V}.$$

The loop rule applied to loop (2) gives:

$$+20.0\text{ V} - (1.00\text{ A})(1.00\,\Omega) - (2.00\text{ A})(1.00\,\Omega) - \mathcal{E}_2 - (2.00\text{ A})(2.00\,\Omega) - (1.00\text{ A})(6.00\,\Omega) = 0$$

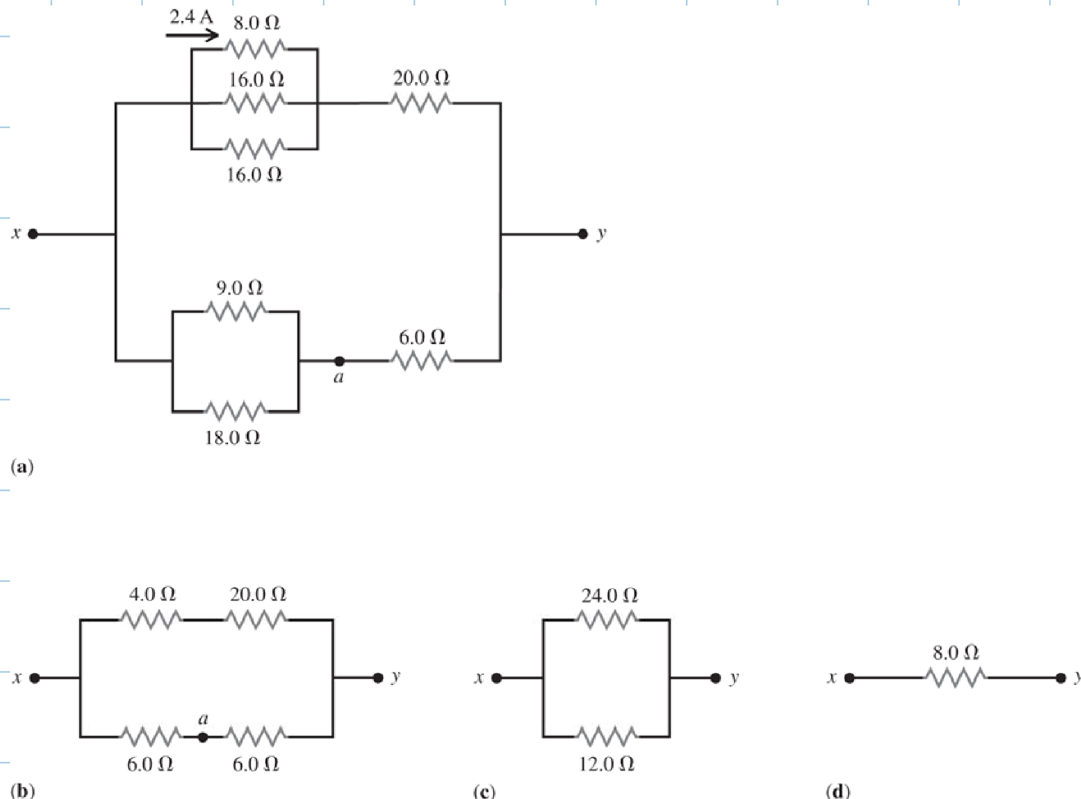
$\mathcal{E}_2 = 20.0\text{ V} - 1.00\text{ V} - 2.00\text{ V} - 4.00\text{ V} - 6.00\text{ V} = 7.0\text{ V}.$

86.

Monday, April 02, 2012
11:33 AM

86. Set Up: For resistors in series, the currents are the same and the voltages add. $R_{eq} = R_1 + R_2 + \ldots$ For resistors in parallel, the currents add and the voltages are the same. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

Solve: (a) Replacing series and parallel combinations of resistors by their equivalents gives the equivalent networks as shown in the figure below. The equivalent resistance of the network is $8.0\,\Omega$.



(b) The voltage across the $8.0\,\Omega$ resistor in Figure (a) above is $(2.4\text{ A})(8.0\,\Omega) = 19.2\text{ V}$. This is the voltage across the $4.0\,\Omega$ resistor in Figure (b) above. The current through the $4.0\,\Omega$ resistor is 4.8 A. This is also the current through the $20.0\,\Omega$ resistor and the voltage across that resistor is 96.0 V. Therefore, the voltage between points *x* and *y* is $19.2\text{ V} + 96.0\text{ V} = 115.2\text{ V}$. This voltage is divided equally between the $6.0\,\Omega$ resistors in Figure (b), so the voltage between points *x* and *y* is $(115.2\text{ V})/2 = 57.6\text{ V}$. The voltmeter will read 57.6 V.