Problem 1 solution

\( V_0 = 8 \times 10^{-3} \times 10 \times 10^3 \) \( V = 80 \) \( V \)

\( I_{20} = \frac{5}{5 + 20} \times (0.01 \times 80) A = 0.16 A \)

\( V_{20} = 0.16 \times 20 \times 10^3 \) \( V = 3200 V \)

\( P_{20} = V_{20} \cdot I_{20} = 3200 \times 0.16 \) \( W = 512 W \)

Problem 2 solution

All resistors in parallel, same voltage \( v \) across each resistor

By ohm's law,

\( v = 16i_0 = 16 \times 3 \) \( V = 48 V \)

\( i_1 = v/24 = 48/24 A = 2 A \)

\( i_2 = v/6 = 48/6 A = 8 A \)

\( i_3 = v/2 = 48/2 A = 24 A \)

By KCL,

\( i = i_0 + i_1 + i_2 + i_3 = 3 + 2 + 8 + 24 A = 37 A \)

\( p = vi = 48 \times 37 \) \( W = 1776 W \)

Problem 3 solution

a) Slide the square connection upward

Answer: \( R_{eq} = 12 \Omega \)
Problem 4 solution

\[ R_{eq} = \frac{60}{30 + 20 + R + 10} \div 40 + 36 = \frac{20 + R}{40 + 36} \]

Answer: \( R = 40 \Omega \)

Problem 5 solution

\( a) \quad R_{eq} = \frac{10}{15 + 20} = \frac{6 + 4}{10} \quad \Omega = 6 + 4 \quad \Omega = 10 \Omega \)

\( b) \quad R_{eq} = \frac{24}{4 + 24 + 7} = \frac{30}{3 + 7} \quad \Omega = 7.5 \Omega \)

Problem 6 solution

Straighten the top wire and slide the square and round connections toward center

\[ R_{eq} = \frac{20}{30 + 18} \div 60 \quad \Omega = 12 + 18 \div 60 \quad \Omega = 20 \Omega \]
Problem 7 solution

Flip 7Ω and straighten the wire from top to bottom

$R_{eq} = 9 + 90/10 + 40/60 = 9 + 9 + 24 = 42Ω$

Answer:
$R_{eq} = 42Ω$

Problem 8 solution

$R_{eq} = 20//5//40//60\ \Omega = \frac{24}{7}Ω$

$V = IR_{eq} = 14 \times \frac{24}{7} = 48V$

$i_1 = \frac{V}{60} = \frac{48}{60} = 0.8A; \quad i_2 = \frac{V}{40} = \frac{48}{40} = 1.2A$

$i_3 = \frac{V}{5} = \frac{48}{5} = 9.6A; \quad i_4 = \frac{V}{20} = \frac{48}{20} = 2.4A$

Answer:
$i_1 = 0.8A; \quad i_2 = 1.2A; \quad i_3 = 9.6A; \quad i_4 = 2.4A$
Problem 9 solution

Conductances are given. Note that \( G = 1/R \), or \( R = 1/G \).

\[ R_i = \left( \frac{1}{12} + \frac{1}{6} \right) + \frac{1}{8} \Omega = \frac{1}{4} \Omega \]

By current division, \( i = \frac{1}{2} \times 30 \times \frac{6}{4} \Omega = 12A \)

\[ V = iR_i = 12 \times \frac{1}{4} V = 3V \]

Problem 10 Solution: Find \( v_2, I_1 \).

Combine resistors, be careful which variables are still there in simplified circuit

\[ I_1 = \frac{(12 + 8)}{30 + 12 + 8} \times 4.5 = 1.8A \]
\[ I_2 = \frac{30 + 12 + 8}{30 + 12 + 8} \times 4.5 = 2.7A \]

Ohm’s Law: \( v_1 = 12I_2 = 32.4V \),

To find \( v_2 \), need to go back to original circuit. By voltage division:

\[ v_2 = \frac{16}{20+16} \times 32.4 = 14.4V \]
Problem 11 solution:

Assign currents \( I, \ ii, \ i_2 \). To find \( I \), need the total \( R_{eq} \) with respect to 50V

\[
R_{eq} = \frac{10}{10} + \frac{30}{60} = 5 + 20 = 25 \Omega
\]

By Ohms Law, \( I = \frac{50}{25} = 2A \)

By current division,
\[
\begin{align*}
I_1 &= \frac{10}{10 + 10} \times 2 = 1A \\
I_2 &= \frac{60}{30 + 60} \times 2 = 1.333A \\
\end{align*}
\]

By KCL, \( i_0 = i_1 - i_2 = 1 - 1.333 = -0.333A \)

Since 60\( \Omega \) and 30\( \Omega \) are in parallel, same voltage,
\( v_0 = 30 \times i_2 = 30 \times 1.333 = 40 \text{ V} \)

Answer:
\[
\begin{align*}
i_0 &= -0.333A \\
v_0 &= 40 \text{ V} \\
\end{align*}
\]

Problem 12 solution:

\[
\begin{align*}
R_1 &= \frac{20}{12 + 18} \Omega = 12 \Omega \\
R_2 &= 9 + \frac{30}{30} = 30 \Omega \\
R_{eq} &= \frac{R_1 + 18}{R_2 + 5} \Omega \\
&= \frac{12 + 18}{30 + 5} \Omega \\
&= 20 \Omega \\
i &= \frac{V}{R_{eq}} = \frac{20}{20} A = 1A \\
i_1 &= \frac{R_i}{R_i + R_1 + 18} = \frac{30}{12 + 30 + 18} \times 1A = 0.5A; \\
i_2 &= \frac{20}{20 + 30} i_1 = 0.4 \times 0.5A = 0.2A \\
v_o &= 18i_2 = 18 \times 0.2V = 3.6V \\
\end{align*}
\]
Problem 13 solution: Find \( V_1, V_x \)

\[ R_{eq} = \frac{(6 + 12)}{(24 + 12)} \] \[ = \frac{18}{36} = 0.5 \text{Ω} \]

This \( R_{eq} \) is in series with 6Ω. They share a total voltage of 21V.

By voltage division:

\[ V_1 = \frac{R_{eq}}{R_{eq} + 6} \times 21 = \frac{8}{8 + 6} \times 21 \]
\[ = 12 \text{V} \]

By voltage division again:

\[ V_a = \frac{6}{6 + 12} \times 12 = 4 \text{V} ; \]
\[ V_b = \frac{24}{24 + 12} \times 12 = 8 \text{V} \]

Alternatively:

\[ I_1 = \frac{12}{18} = \frac{2}{3} \text{A} ; I_2 = \frac{12}{36} = \frac{1}{3} \text{A} \]

\[ V_a = 6I_1 = 4 \text{V} ; V_b = 24I_2 = 8 \text{V} \]

By KVL:

\[ V_b - V_x - V_a = 0, \]
\[ V_x = V_b - V_a = 8 - 4 = 4 \text{V} \]

Answer:

\[ V_1 = 12 \text{V} ; \]
\[ V_x = 4 \text{V} \]