problem 1 solution

\[ V_0 = 8 \times 10^{-3} \times 10 \times 10^3 \ V = 80 \ V \]

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

\[ V_{20} = 0.16 \times 20 \times 10^3 \ V = 3200 \ V \]

\[ P_{20} = V_{20} \cdot I_{20} = 3200 \times 0.16 \ W = 512 \ W \]

problem 2 solution

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

By ohm's law,

\[ v = 16 \ \Omega, 16 \ \times 3 \ V = 48 \ V \]

\[ i_1 = \frac{v}{24} = \frac{48}{24} \ A = 2 \ A \]

\[ i_2 = \frac{v}{6} = \frac{48}{6} \ A = 8 \ A \]

\[ i_3 = \frac{v}{2} = \frac{48}{2} \ A = 24 \ A \]

By KCL,

\[ i_x = i_0 + i_1 + i_2 + i_3 = 3 + 2 + 8 + 24 \ A = 37 \ A \]

\[ p = v i_x = 48 \times 37 \ W = 1776 \ W \]

problem 3 solution

a) Slide the square connection upward

\[ R_{eq} = 12 \ \Omega \]
problem 4 solution

\[ R_{eq} = 4\Omega \]

\[ R_{eq} = \frac{5}{20 + 16} \div 5\Omega = \frac{20}{5\Omega} = 4\Omega \]

b) \[ R_{eq} = 20\Omega \]

problem 5 solution

a) \[ R_{eq} = \frac{10}{15 + 20} \div 5 \Omega = 6 + 4 \Omega = 10\Omega \]

b) \[ R_{eq} = \frac{24}{4 + 24 + 7} \div 30 \Omega = \frac{3 + 7}{30} \Omega = 7.5\Omega \]

problem 6 solution

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

\[ R_{eq} = 20\Omega \]

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

Flip 7Ω and straighten the wire from top to bottom

\[ R_{eq} = 42\Omega \]

\[ R_{eq} = 9+90/10+40/60 = 9+9+24 = 42\Omega \]

problem 8 solution

\[ R_{eq} = 20/5/40/60 \Omega = \frac{24}{7} \Omega \]

\[ V = IR_{eq} = 14 \times \frac{24}{7} \Rightarrow V = 48V \]

\[ i_1 = \frac{V}{60} = \frac{48}{60} = 0.8A; \]
\[ i_2 = \frac{V}{40} = \frac{48}{40} = 1.2A \]
\[ i_3 = \frac{V}{5} = \frac{48}{5} = 9.6A; \]
\[ i_4 = \frac{V}{20} = \frac{48}{20} = 2.4A \]
problem 9 solution

Conductances are given. Note that $G=1/R$, or $R=1/G$.
6S $\rightarrow$ 1/6 $\Omega$; 8S $\rightarrow$ 1/8 $\Omega$; 4S $\rightarrow$ 1/4 $\Omega$; 12S $\rightarrow$ 1/12 $\Omega$

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

By current division, $i = 30 \times \frac{1}{6} + \frac{1}{4} A = 12 A$

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

problem 10 solution

$$R_{eq} = \left[ \frac{(19+10+7)/36+8+4}{30+35} \right] \Omega$$

$$= \frac{(36+36+12)/30+35}{50} \Omega$$

$$= 50 \Omega$$

$$P = \frac{V^2}{R_{eq}} = \frac{50^2}{50} W = 50 W$$

problem 11 solution

Assign currents $I$, $i_1$, $i_2$. To find $I$, need the total $R_{eq}$ with respect to 50V

$$R_{eq} = 10/10 + 30/60 = 5 + 20 = 25 \Omega$$

By Ohms Law, $I = 50/25 = 2A$

By current division,

$$i_1 = \frac{10}{10 + 10} \times 2 = 1A$$

$$i_2 = \frac{60}{30 + 60} \times 2 = 1.333 A$$

By KCL, $i_0 = i_1 - i_2 = 1 - 1.333 = -0.333 A$

Since 60$\Omega$ and 30$\Omega$ are in parallel, same voltage,

$$v_0 = 30 \times 1.333 = 40 V$$

$$i_0 = -0.333 A$$

$$v_0 = 40 V$$
problem 12 solution

\[ R_1 = \frac{20(12+18)}{12} \Omega = 12 \Omega \]
\[ R_2 = \frac{9+70}{30} \Omega = 3 \Omega \]
\[ R_{eq} = \frac{(R_1+18)}{R_2+5} \Omega = \frac{(12+18)}{30+5} \Omega = 20 \Omega \]
\[ i = \frac{V}{R_{eq}} = \frac{20}{20} A = 1 A \]
\[ i_1 = \frac{R_1}{R_1+R_2+18} \]
\[ i_2 = \frac{30}{12+30+18} \]
\[ v_0 = 18 i_2 = 18 \times 0.2 V = 3.6 V \]
\[ i = 1 A; v_0 = 3.6 V \]

Problem 13 solution: Find \( V_1 \), \( V_x \)

\[ R_{eq} = \frac{(6+12)}{(24+12)}/24 = \frac{18}{36}/24=12/24=8 \Omega \]

This \( R_{eq} \) is in series with 6\( \Omega \)

They share a total voltage of 21V

By voltage division:
\[ V_1 = \frac{R_{eq}+6}{R_{eq}} \times 21 = \frac{8+6}{8} \times 21 = 12 V \]

By voltage division again:
\[ V_a = \frac{6}{6+12} \times 12 = 4 V; \]
\[ V_b = \frac{24}{24+12} \times 12 = 8 V \]

Alternatively:
\[ I_1 = \frac{12}{18} = \frac{2}{3} A; I_2 = \frac{12}{36} = \frac{1}{3} A \]
\[ V_a = 6I_1 = 4 V; V_b = 24I_2 = 8 V \]

By KVL:
\[ V_b - V_x - V_a = 0, \]
\[ V_x = V_b - V_a = 8 - 4 = 4 V \]