Problem 1 solution

$V_0 = 8\times10^{-3}\times10\times10^{3}\ V = 80V$

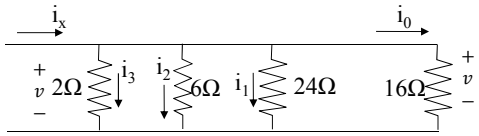
$I_{20} = \frac{5}{5+20}\times(0.01\times80)A = 0.16A$

$V_{20} = 0.16\times20\times10^{3}\,\mathrm{V} = 3200\mathrm{V}$

$\mathrm{P}_{20} = V_{20}\cdot I_{20} = 3200\times0.16\,W = 512W$

Problem 2 solution

All resistors in parallel, same voltage v across each resistor



By ohm's law,

$v = 16i_0 = 16\times3V = 48V$

$i_1 = v/24 = 48/24\ A = 2A$

$i_2 = v/6 = 48/6\ A = 8A$

$i_3 = v/2 = 48/2\ A = 24A$

By KCL,

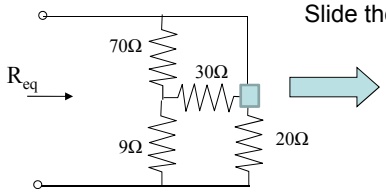
$i_x = i_0 + i_1 + i_2 + i_3 = 3+2+8+24\ A = 37A$

$p = vi_x = 48\times37\,W = 1776W$

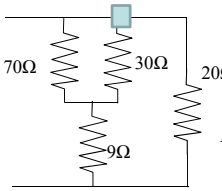
Answer:
$i_x = 37A$,
$p = 1776W$

Problem 3 solution

a)



Slide the square connection upward



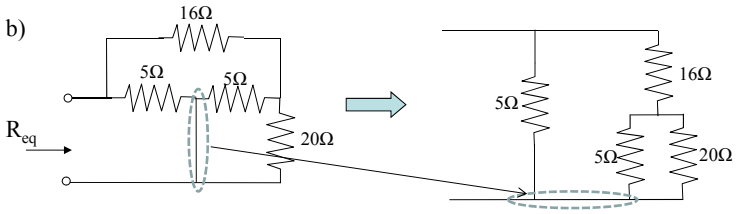
$R_{eq} = (30\,//\,70+9)\,//\,20\Omega$

$= 30//20\Omega$

$= 12\Omega$

Answer: $R_{eq} = 12\Omega$

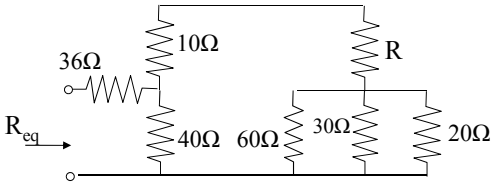
b)



Answer: $R_{eq} = 4\Omega$

$$R_{eq} = (5 // 20 + 16) // 5\Omega$$
$$= 20 // 5\Omega$$
$$= 4\Omega$$

Problem 4 solution



Answer: $R = 40\Omega$

$$R_{eq} = (60 // 30 // 20 + R + 10) // 40 + 36$$
$$= (20 + R) // 40 + 36$$
$$R_{eq} = 60$$
$$(20 + R) // 40 + 36 = 60$$
$$\frac{40(20 + R)}{20 + R + 40} = 24$$
$$800 + 40R = 1440 + 24R$$
$$R = 40\Omega$$

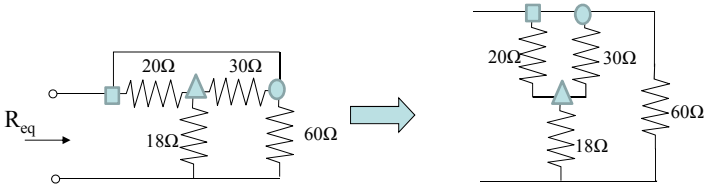
Problem 5 solution

a) $R_{eq} = 10 // 15 + 20 // 5 \quad \Omega = 6 + 4 \quad \Omega = 10\Omega$

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

Problem 6 solution

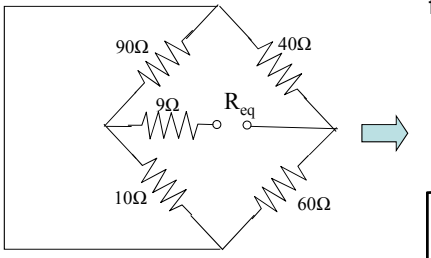
Straighten the top wire and slide the square and round connections toward center



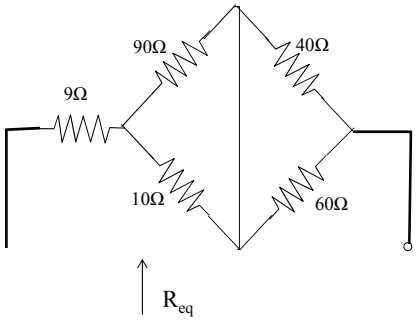
Answer: $R_{eq} = 20\Omega$

$$R_{eq} = (20 // 30 + 18) // 60 \quad \Omega = (12 + 18) // 60 \quad \Omega = 20\Omega$$

Problem 7 solution



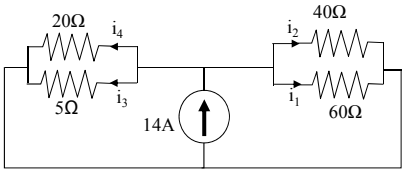
Flip 7Ω and straighten the wire from top to bottom

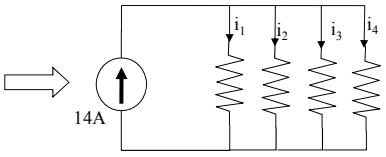


Answer:
$R_{eq} = 42\Omega$

R_{eq} = 9+90//10+40//60=9+9+24=42Ω

Problem 8 solution





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

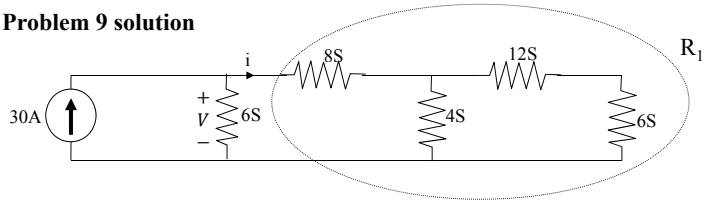
$$V = IR_{eq} = 14 \times \frac{24}{7}\ V = 48V$$

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

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

Answer:
$i_1 = 0.8A;$
$i_2 = 1.2A;$
$i_3 = 9.6A;$
$i_4 = 2.4A$

Problem 9 solution



Conductances are given. Note that G=1/R, or R=1/G.
6S → 1/6 Ω; 8S→ 1/8Ω; 4S→ 1/4Ω; 12S → 1/12Ω

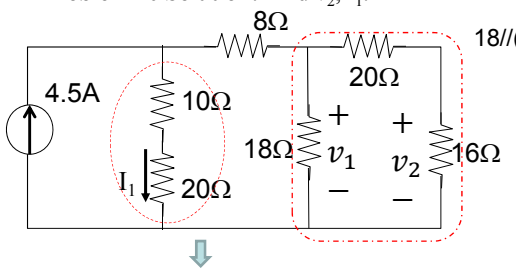
$$R_1 = [(\frac{1}{12}+\frac{1}{6})//\frac{1}{4}]+\frac{1}{8}\ \Omega = \frac{1}{4}\Omega$$

By current division, $i_1 = 30\times\frac{\frac{1}{6}}{\frac{1}{4}+\frac{1}{6}}A = 12A$

$$V = i_1 R_1 = 12\times\frac{1}{4}V = 3V$$

Answer:
$i = 12A;$
$v = 3V$

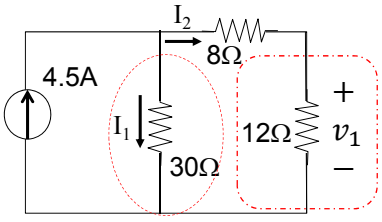
Problem 10 Solution: Find v_2, I_1.



18//(20+16)=12Ω

Answer:
$I_1 = 1.8A;$
$v_2 = 14.4V$

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



By current division:

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

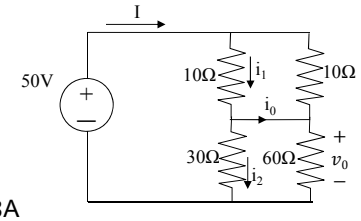
Ohm's Law: $v_1 = 12I_2 = 32.4V,$

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:

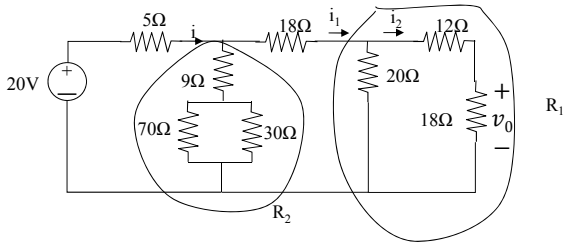
Answer:
$i_0 = -0.333A$
$v_0 = 40V$

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=25Ω
By Ohms Law, I =50/25=2A
By current division,
$i_1 = \frac{10}{10+10} \times 2 = 1A$
$i_2 = \frac{60}{30+60} \times 2$=1.333A
By KCL, $i_0 = i_1 - i_2 = 1 - 1.333 = -0.333$A
Since 60Ω and 30Ω are in parallel, same voltage,
$v_0 = 30\ i_2 = 30 \times 1.333 = 40$ V



Problem 12 solution:

Answer:
$i = 1A; v_0 = 3.6V$



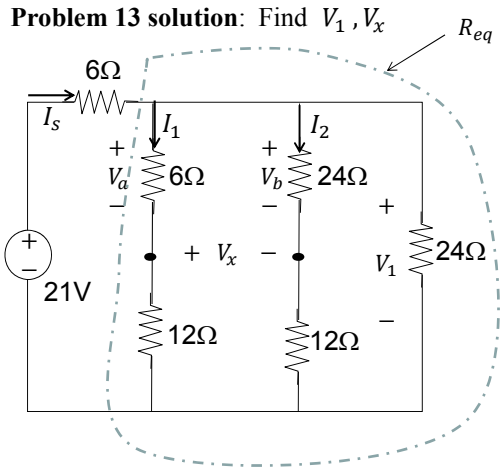
$R_1 = 20 /\!/ (12+18)\Omega = 12\Omega$
$R_2 = 9 + 70 /\!/ 30\Omega = 30\Omega$
$R_{eq} = (R_1 + 18) /\!/ R_2 + 5\ \Omega$
$= (12+18) /\!/ 30 + 5\ \Omega$
$= 20\ \Omega$

$i = V/R_{eq} = \frac{20}{20}\ A = 1A$

$i_1 = \frac{R_2}{R_1 + R_2 + 18} i = \frac{30}{12+30+18} \times 1A = 0.5A;$ $\quad i_2 = \frac{20}{20+30} i_1 = 0.4 \times 0.5A = 0.2A$

$v_0 = 18 i_2 = 18 \times 0.2V = 3.6V$

Problem 13 solution: Find V_1 , V_x



Answer:
$V_1 = 12V;$
$V_x = 4V$

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

This R_{eq} is in series with 6Ω
They share a total voltage of 21V
By voltage division:

$$V_1 = \frac{R_{eq}}{R_{eq} + 6} \times 21 = \frac{8}{8 + 6} \times 21$$
$$= 12V$$

By voltage division again:

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

Alternatively:

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

By KVL:

$$V_b - V_x - V_a = 0,$$
$$V_x = V_b - V_a = 8 - 4 = 4V$$