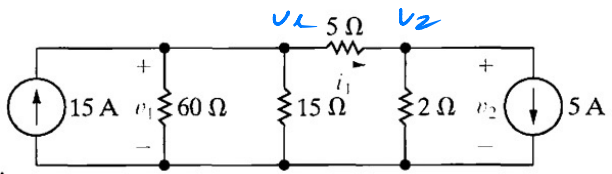
4.1 a) For the circuit shown, use the node-voltage method to find v_1, v_2, and i_1.

b) How much power is delivered to the circuit by the 15 A source?

c) Repeat (b) for the 5 A source



Answer: (a) 60 V, 10 V, 10 A;
(b) 900 W;
(c) −50 W.

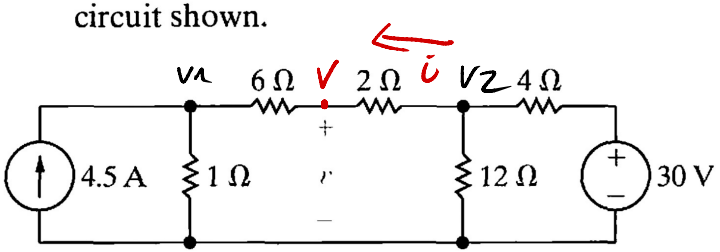
$$\begin{cases} \frac{v_1 - v_2}{5} + \frac{v_1}{15} + \frac{v_1}{60} - 15 = 0 \\ \frac{v_2 - v_1}{5} + \frac{v_2}{2} + 5 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} v_1 = 60\,V \\ v_2 = 10\,V \end{cases} \qquad i_1 = \frac{v_1 - v_2}{5} = 10A$$

b) $P_{15A} = I \times V_1 = 900$

c) $P_5 = (-i) \times V_2 = -5 \times 10$
$= -50\,W$

4.2 Use the node-voltage method to find v in the circuit shown.



Answer: 15 V.

$$\begin{cases} \dfrac{v_1 - v_2}{8} + \dfrac{v_1}{1} - 4.5 = 0 \\ \dfrac{v_2 - v_1}{8} + \dfrac{v_2}{12} + \dfrac{v_2 - 30}{4} = 0 \end{cases}$$

$$\Rightarrow \begin{cases} v_1 = 6\ V \\ v_2 = 18\ V \end{cases}$$

$$i = \frac{v_2 - v_1}{8} = \frac{3}{2}\ A$$

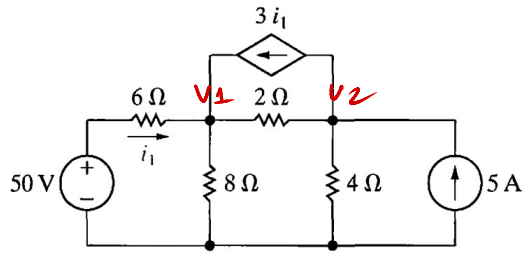
Ohm's Law:

$$\frac{(v_2 - v)}{2} = \frac{3}{2}$$

$$\Rightarrow v_2 - v = 3$$

$$\Rightarrow 18 - v = 3 \Rightarrow v = 15\ V$$

4.3 a) Use the node-voltage method to find the power associated with each source in the circuit shown.
b) State whether the source is delivering power to the circuit or extracting power from the circuit.



Answer: (a) $p_{50V} = -150$ W, $p_{3i_1} = -144$ W, $p_{5A} = -80$ W;
(b) all sources are delivering power to the circuit.

a) $\frac{v_1 - 50}{6} + \frac{v_1}{8} + \frac{v_1 - v_2}{2} - 3i_1 = 0$

b) $\frac{v_2}{4} + \frac{v_2 - v_1}{2} - 5 + 3i_1$

$i_1 = \frac{50 - v_1}{6} \Rightarrow 3i_1 = \frac{150 - 3v_1}{6}$

$$\begin{cases} \frac{v_1 - 50}{6} + \frac{v_1}{8} + \frac{v_1 - v_2}{2} - \frac{150 - 3v_1}{6} \\ \frac{v_2 - v_1}{2} + \frac{v_1}{4} - 5 + \frac{150 - 3v_1}{6} \end{cases}$$

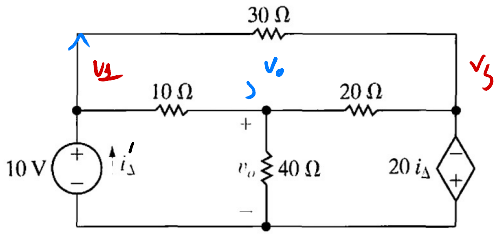
$$\Rightarrow \begin{cases} v_1 = 32V \\ v_2 = 16V \end{cases}$$

$P_{50V} = (-i_1) \times V_1 = (-5) \times 50 = -150\ W$

$P_{3i_1} = (-3i_1) \times (v_2 - v_1)$
$= -9 \times 16$
$= -144\ W$

$P_{5A} = (-5) \times 16 = -80\ W$

4.4 Use the node-voltage method to find v_o in the circuit shown.



$$v_\Delta = \frac{10 - v_o}{10} + \frac{10 + 20 v_\Delta}{30}$$

Answer: 24 V.

$$\Leftrightarrow \frac{30 - 3v_o + 10 + 20 v_\Delta}{30}$$

$$\Rightarrow v_\Delta = \frac{20 - 3v_o + 20 v_\Delta + 10}{30}$$

$$\Leftrightarrow 30 v_\Delta = 20 - 3v_o + 20 v_\Delta + 10$$

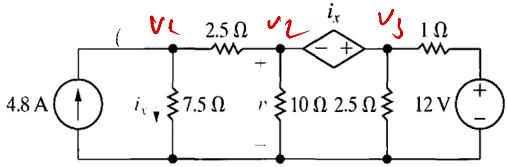
$$\Leftrightarrow 10 v_\Delta = 20 - 3v_o$$

$$\Rightarrow v_\Delta = \frac{40 - 3v_o}{10}$$

Node v_o : $\frac{v_o - 10}{10} + \frac{v_o}{40} + \frac{v_o + 20 v_\Delta}{20}$

$$\Rightarrow v_o = 24\ V$$

4.5 Use the node-voltage method to find v in the circuit shown.



Answer: 8 V.

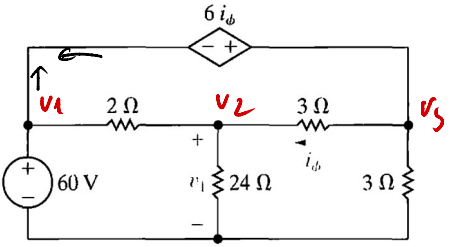
$$\frac{v_1 - v_2}{2.5} - 4.8 + \frac{v_1}{7.5}$$

$$\frac{v_2 - v_1}{2.5} + \frac{v_2}{10} + \frac{v_3 - 12}{1} + \frac{v_3}{2.5}$$

$$(=) \begin{cases} \frac{v_1 - v_2}{2.5} + \frac{v_1}{7.5} = 4.8 \\ \frac{v_2 - v_1}{2.5} + \frac{v_3 - 12}{1} + \frac{v_2}{10} + \frac{v_3}{2.5} = 0 \\ \frac{v_1}{7.5} + v_2 - v_3 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} v_1 = 15 \\ v_2 = 8 = V \\ v_3 = 10 \end{cases}$$

4.6 Use the node-voltage method to find v_1 in the circuit shown.



Answer: 48 V.

$V_1 = 60$, $V_3 = 6 i_\phi$ $\quad i_\phi = \dfrac{6 i_\phi + 60 - V_2}{3}$

$\Rightarrow i_\phi = \dfrac{V_2 - 60}{3}$

$\dfrac{V_2 - 60}{2} + \dfrac{V_2}{24} + \dfrac{V_2 - 6 i_\phi - 60}{3} = 0$

$\Rightarrow V_2 = 48$ V $\quad i_\phi = -4$ A