(a) Calculate \(i_1\), \(i_2\), and \(v_o\).
(b) Find the power dissipated for every component including the current source.

**Solution:**

1. **Step 1:** First, label all resistors to have current and voltage

2. **Step 2:** Next, write eq. for wanted unknowns:
   - **Ohm’s law:**
     1. \(V_o = i_0 \cdot (10)\)
     2. \(V_1 = i_1 \cdot (30)\)
     3. \(V_2 = i_2 \cdot (40)\)
     4. \(V_3 = i_2 \cdot (50)\)
   - **Voltage equation:** (remember to avoid taking a Vloop with the current source in it)
     \[ +V_3 +V_2 -V_1 = 0 \]
   - **I sum equation:**
     \[ -i_o +i_1 +i_2 = 0 \]
     Since only one current can flow in a branch, \(i_o = -2A\)

   \[ V_o = -2 \cdot (10) = \boxed{-20 \text{V}} \]
Need to solve for \( i_1 \) and \( i_2 \). Knowing \( i_c \), eq. (6) is

\[ i_1 + i_2 = -2 \text{A} \]

\[ \rightarrow \text{Need another eq. with just } i_1 \text{ and } i_2 \text{ in it} \]

\[ \text{Use eq. (5) with eqs. (2), (3), and (4) in it:} \]

\[ i_2 (50) + i_2 (40) - i_1 (30) = 0 \]

We now have 2 eqs. and 2 unknowns:

\[ i_1 = (-2 - i_2) \]

\[ i_2 (90) - 30 (-2 - i_2) = 0 \]

\[ i_2 (90) + 30 i_2 + 60 = 0 \]

\[ i_2 (120) = -60 \]

\[ i_2 = \frac{-60}{120} = -\frac{1}{2} \text{A} \]

\[ i_1 = (-2 - i_2) = -2 - \frac{1}{2} = -1 \frac{1}{2} \text{A} \]

From eqs. (2), (3), and (4) we know all \( V \)s across \( R \)s. The voltage across the 2A is needed for power:

\[
\begin{array}{c|c|c}
\text{Power} & \text{absorbed} & \text{delivered} \\
\hline
2 \text{A src.} & -65 \times 2 & -130 \text{W} \\
10 \Omega & +20 \times 2 & 40 \text{W} \\
30 \Omega & +45 \times 1 & 45 \text{W} \\
40 \Omega & +20 \times 1 & 20 \text{W} \\
50 \Omega & +25 \times 1 & 25 \text{W} \\
\hline
\text{Total} & +130 \text{W} & -130 \text{W} \\
\end{array}
\]

\[ \text{delivered} = \text{absorbed} \]
Calculate $i_1$, $i_2$, and $v_o$.

1. Label all R's with an I and V

2. Ohm's law:
   - $V_3 = i_1 \times 20$
   - $V_1 = i_1 \times 35$
   - $V_o = i_o \times 10$
   - $V_2 = i_2 \times 10$

3. V loops:
   - $V_o - V_2 = 0 \Rightarrow V_o = V_2$
   - $+V_o + V_1 + V_3 + 120 = 0$

4. Current sum:
   - $-i_1 + i_o + i_2 = 0$

Now we need to get eq. with the same variables.

→ Replacing $V_2$ with $V_o$:

From Ohm's laws:

- $V_o = i_o \times 10$ and $V_o = i_2 \times 10$

→ $i_o \times 10 = i_2 \times 10$ so $i_o = i_2$

→ Replacing $V_o$, $V_1$, $V_3$ to be in terms of $i_o$ and $i_1$ gives another eq.

$$i_o (10) + i_1 (35) + i_1 (20) + 120 = 0$$

5. Using eq. 4, 5, and 6, put 5 into 4 and solve for $i_1$

- $-i_1 + 2i_o = 0 \Rightarrow i_1 = 2i_o$

→ Now put this eq. into 4

- $-2i_o + 2i_o = 0$ (see what happens when you put into the wrong eq.) → No sol. → put into 6
#2 (Cont.)

\[ i_1 = 2i_o \quad i_o = i_2 \]

\[ i_o (10) + 2i_o (55) + 120 = 0 \]

\[ 120 (i_o) = -120 \]

\[ i_o = \boxed{-1 A} \]

\[ i_o = i_2 = \boxed{-1 A} \]

\[ i_1 = 2i_o = \boxed{-2 A} \]

\[ V_o = i_o (10) = \boxed{-10 V} \]

\[ 2i_3 + 10m = i_x \]
3. Label all R's with a current and a voltage.

Find $v_x$, $i_1$, and the power dissipated by the dependent source.

2. a. Write Ohm's Law:
   (1) $V_x = i_x (10k)$
   (2) $V_3 = i_3 (15k)$
   (3) $V_2 = (5k) i_2$

b. Voltage equation:
   (4) $v_3 - v_2 - 2v_x + v_x = 0$

c. Current summation:
   (5) $i_3 + i_2 + 20mA = 0$
   (6) $-i_3 + 20mA + i_x = 0$

Equations (6) and (5) contain 3 unknowns. Using these 2 and rewriting (4) in terms of $i_2$, $i_3$, and $i_x$ gives 3rd eq:

(7) $i_3 (15k) - i_2 (5k) - 2i_x (10k) + i_x (10k) = 0$

(8) $i_3 (15k) - i_x (10k) = i_2 (5k)$

(9) $i_3 (3) - i_x (2) = i_2 \Rightarrow$ plug this into (5):

$4i_3 + 20mA = 2i_x$

$2i_3 + 10mA = i_x$
#3 (cont.)
\(2i_3 + 10m = l_x \Rightarrow \text{plug into (6)}\)

\[-i_3 + 20m + 2i_3 + 10m = 0\]
\[i_3 + 30m = 0\]
\[i_3 = -30 \text{mA} \Rightarrow \text{plug back into (6)}\]

\[2(-30m) + 10m = l_x\]
\[i_x = -50 \text{mA} \Rightarrow \text{use to find } V_x\]

\[V_x = l_x (10k) = -50 \text{mA}(10k) = -500 \text{V}\]

To find \(i_1\) \(\Rightarrow\) use current summation

\[-i_1 - 20m - l_x = 0\]
\[i_1 = -20m - (-50m) = +30 \text{mA}\]

\[\text{power for dependent source } \Rightarrow\]
\[P = i_1 (2V_x)\]
\[\text{power } = -(30 \text{mA})(-1000) = +30 \text{W}\]

\[\text{power } = -30 \text{W}\]