Problem 1  Find $I_s$ so that $i_0 = 1A$. Also find $i_0$ for $I_s = 15A$. Use Linearity.

Pick the ground and assign node voltages, resistor voltages and currents

Start from $i_0 = 1A$, then by basic laws:

- $v_0 = 4i_0 = 4 \times 1 = 4V$
- $i_1 = \frac{v_0}{2} = 2A$
- $i_2 = i_0 + i_1 = 1 + 2 = 3A$
- $v_2 = 2i_2 = 2 \times 3 = 6V$
- $v_3 = v_0 + v_2 = 4 + 6 = 10V$
- $i_3 = \frac{v_3}{5} = \frac{10}{5} = 2A$
- $I_s = i_2 + i_3 = 3 + 2 = 5A$

Thus, $\frac{i_0}{I_s} = \frac{1}{5} \Rightarrow i_0 = \frac{1}{5} I_s$

So when $I_s = 15A$, $i_0 = \frac{1}{5} I_s = \frac{1}{5} \times 15 = 3A$

Problem 2: Find $V_s$ so that $v_0 = 5V$, $8V$, $3V$ respectively. What is $v_0$ when $V_s = 26V$? Use Linearity.

Start from $v_0 = 8V$, then other variables will be whole numbers.

Then,

- $i_1 = \frac{v_0}{8} = 1A$
- $v_1 = 2i_1 = 2V$
- $v_2 = v_0 + v_1 = 2 + 8 = 10V$
- $i_0 = \frac{v_2}{5} = \frac{10}{5} = 2A$
- $i_2 = i_0 + i_1 = 2 + 1 = 3A$
- $v_3 = 2i_2 = 2 \times 3 = 6V$
- $v_4 = v_2 + v_3 = 6 + 10 = 16V$
- $i_3 = \frac{v_4}{8} = \frac{16}{8} = 2A$
- $i_4 = i_2 + i_3 = 3 + 2 = 5A$
- $v_5 = 2i_4 = 2 \times 5 = 10V$

You may start $v_0$ with a different number, but other variables may not be whole numbers.
**Problem 3:** Apply Linearity to calculate $v_0$.

Assign ground and other variables. Assume $v_0$ to be a certain number; Use basic laws to find the corresponding $V_v$ (ignore the given value 51V)

Start with $v_0 = 2V$:

$v_0 = 2V$
\[i_0 = \frac{v_0}{2} = 1A\]
$v_1 = 8i_0 = 8V$
$v_2 = v_1 + v_0 = 8 + 2 = 10V$
\[i_1 = \frac{v_1}{10} = 0.8\ A\]
$i_2 = i_0 + i_1 = 1 + 2 = 3A$
$v_3 = 8i_2 = 8 \times 3 = 24V$
\[V_v = v_2 + v_3 = 10 + 24 = 34V\]

\[\text{In summary: } v_0 = 2V \Rightarrow V_v = 34\]

Thus \[k = \frac{v_0}{V_v} = \frac{2}{34} \approx \frac{1}{17}\]
\[\Rightarrow v_0 = \frac{1}{17}V_v\]
So when $V_v = 51V$, \[v_0 = \frac{1}{17} \times 51 = 3V\]

**Problem 4:** Determine $v_0$ by superposition.

Due to 5A: turn off 8V with short circuit.

Since $4//4+2\Omega$ is in parallel with 4\Omega, By current division:
\[i_1 = \frac{4}{4+2} \times 5 = 2.5V;\]
\[v_1 = 2i_1 = 5V\]

By voltage division,
\[v_2 = \frac{2}{2+2+4} \times 8 = 2V\]
Thus by superposition:
\[v_0 = v_1 + v_2 = 5 + 2 = 7V\]

Due to 8V, turn off 5A with open circuit:
Problem 5

\[ v_1 = \frac{29||70}{29||70+30} \times 40 \times \frac{25}{25+4} \quad V = 14V \]

\[ v_2 = -\frac{46||20}{46||20+5} \times 20 \times \frac{25}{25+21} \quad V = -8V \]

\[ v_3 = \frac{25}{25+25} \times 2 \times 25 \quad V = 25V \]

\[ v_0 = v_1 + v_2 + v_3 = 14 - 8 + 25 \quad V = 31V \]

Problem 6

\[ v_1 = 6 \times \frac{10}{10+20} \times 10 \quad V = 20V \]

\[ v_2 = 3 \times \frac{10}{10+20} \times 10 \quad V = 10V \]

\[ v_3 = -9 \times \frac{10}{30} V = -3V \]

\[ v_0 = v_1 + v_2 + v_3 = 20 + 10 - 3 \quad V = 27V \]
Problem 7

\[ v_1 = -6 \times \frac{10}{10+10} \times 10 = -30\text{V} \]

\[ v_2 = 3 \times \frac{10}{6.67+10+10} \times \frac{20}{10+20} \times 10 = 7.5\text{V} \]

\[ v_3 = 12 \times \frac{10}{10+10} \text{V} = 6\text{V} \]

\[ v_0 = v_1 + v_2 + v_3 = -30 + 7.5 + 6 = -16.5\text{V} \]
Problem 8
Better to keep the 5Ω resistor in every step

\[ I = \frac{(10+5)}{(5+5)} = 1.5A \]

Power supplied by 5Ω resistor:
\[ P_{5\Omega} = I^2R = (1.5)^2 \times 5 = 11.25W \]

Problem 9

Loop current:
\[ I = \frac{20+8+6-4}{2+2+2+9} = \frac{30}{15} = 2A \]
\[ V_0 = -9I = -9 \times 2 = -18V \]
Problem 10

\[ V_x = 4I; \]
\[ \text{KVL: } V_x + 2I + V_x = 20; \]
\[ 4I + 2I + 4I = 20; \]
\[ I = 2A; \]
\[ V_x = 4I = 8V \]