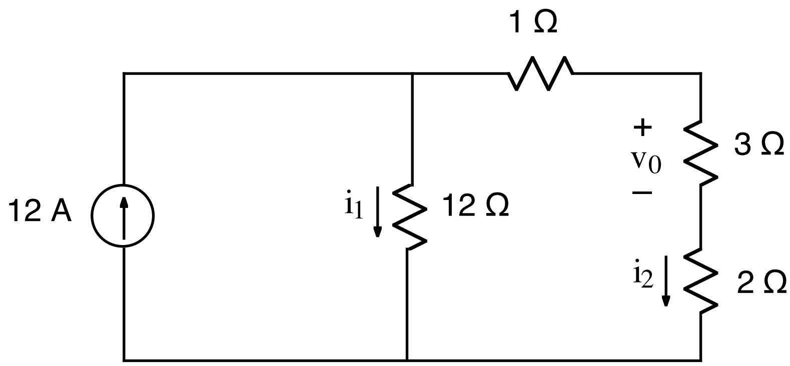
Ex:

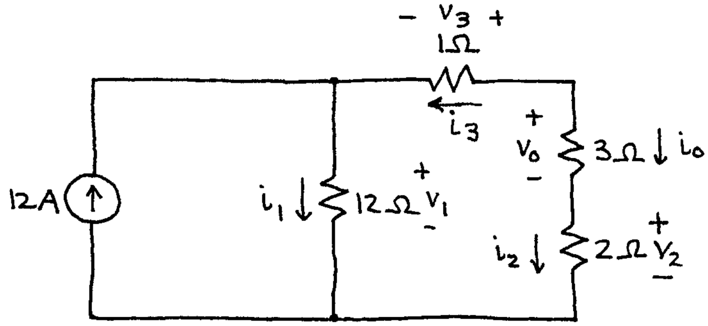


a) Calculate i_1, i_2, and v_0.

b) Find the power dissipated for every component, including the current source.

soln: a) We first label current and voltage for each resistor. We follow the passive sign convention: the arrow for the direction of current measurement points toward the – sign of the voltage measurement.

For the 1Ω resistor, we may define the current measurement in either direction. For the sake of illustration, we define the direction of current measurement in a way that is somewhat awkward.



Now we write eq'ns for voltage loops. We try to write v-loop eq'ns for inner loops, but we avoid loops that include a current source. (The reason we do so is to avoid defining a new variable that requires another eq'n.) In this problem, there is only one v-loop without a current source. Going around the inner loop on the right side in a clockwise direction and using the sign where we exit a component, we have

$$+v_1 + v_3 - v_0 - v_2 = 0\,\text{V}$$

Next, we write eq'ns for current summations at nodes. We sum the currents measured flowing away from the top center node.

$$-12\,\text{A} + i_1 - i_3 = 0\,\text{A}$$

There is always one redundant node. So we only need this one eq'n.

Now we look for components in series that carry the same current:

$i_3 = -i_0$ (minus sign because currents measured in opposite directions)

$i_0 = i_2$

Our last set eq'ns comes from Ohm's Law for each resistor.

$$v_1 = i_1 \cdot 12\Omega$$

$$v_0 = i_0 \cdot 3\Omega$$

$$v_2 = i_2 \cdot 2\Omega$$

To solve the simultaneous eq'ns, we substitute i_2 for i_0 and $-i_2$ for i_3. Then we substitute for v's using the Ohm's law eq'ns.

Our v-loop eq'n becomes

$$i_1 \cdot 12\Omega - i_2 \cdot 1\Omega - i_2 \cdot 3\Omega - i_2 2\Omega = 0V.$$

Our i-sum eq'n becomes

$$-12A + i_1 + i_2 = 0A.$$

Solving the second eq'n, we have, for i_2,

$$i_2 = 12A - i_1.$$

Substituting for i_2 in the v-loop eq'n:

$$i_1 \cdot 12\Omega - (12A - i_1)(\underbrace{1\Omega + 3\Omega + 2\Omega}_{6\Omega}) = 0V$$

or $i_1 (12\Omega + 6\Omega) = 12A \cdot 6\Omega$

or $i_1 = 12A \cdot 6\Omega / 18\Omega = 4A$

Using an earlier eq'n:

$$i_2 = 12A - i_1 = 12A - 4A = 8A$$

From earlier eq'n:

$$v_0 = i_0 \cdot 3\Omega = i_2 \cdot 3\Omega = 8A \cdot 3\Omega = 24V$$

b) Power dissipated: $p = i \cdot v = i^2 R$ for R's

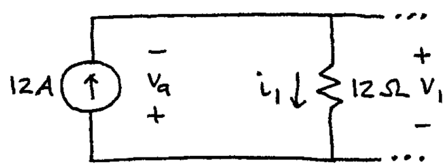
12Ω: $p = i_1^2 \cdot 12\Omega = 4A^2 \cdot 12\Omega = 192\,W$

1Ω: $p = i_3^2 \cdot 1\Omega = (-8A)^2 \cdot 1\Omega = 64\,W$

3Ω: $p = i_0^2 \cdot 3\Omega = (8A)^2 \cdot 3\Omega = 192\,W$

2Ω: $p = i_2^2 \cdot 2\Omega = (8A)^2 \cdot 2\Omega = 128\,W$

For the current source, we find the voltage drop from a v-loop on the left side.



We have $-v_a - v_1 = -v_a - i_1 \cdot 12\Omega = 0V$

$$v_a = -i_1 \cdot 12\Omega = -4A \cdot 12\Omega = -48V$$

Power for 12A src: $p = 12A \cdot v_a = 12A(-48V)$

$$p = -576\,W$$