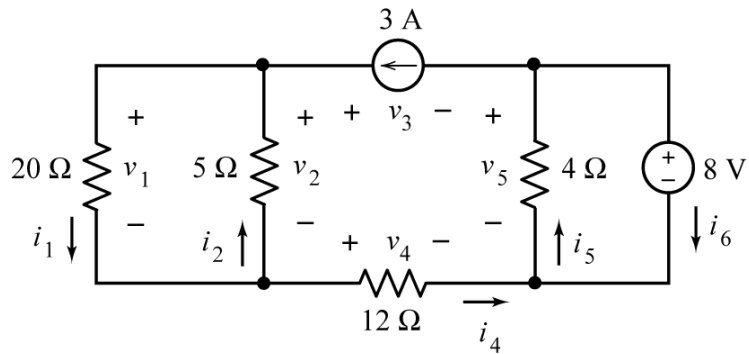


**Exercise 1:**

This circuit consists of 6 elements connected together at 4 nodes:



Write 6 element equations, one for each element.

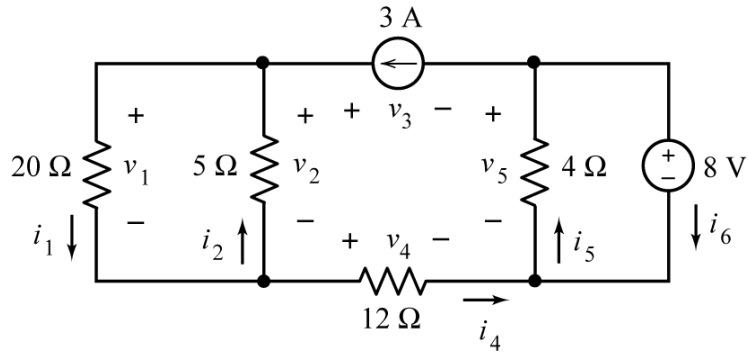
Write 4 KCL equations, one at each of the 4 nodes.

Write 4 KVL equations, one for each mesh and one for the outside loop.

Describe the following:  $v_1 i_1$ ,  $v_2 i_2$ ,  $v_3 i_3$  and  $v_6 i_6$ .

**Solution 1:**

This circuit consists of 6 elements connected together at 4 nodes:



Write 6 element equations, one for each element.

$$v_1 = 20i_1, \quad v_2 = -5i_2, \quad i_3 = 3 \text{ A}, \quad v_4 = 12i_4, \quad v_5 = -4i_5, \quad v_6 = 8 \text{ V}$$

Write 4 KCL equations, one at each of the 4 nodes.

$$i_2 + i_3 = i_1, \quad i_5 = i_3 + i_6, \quad i_4 + i_6 = i_5, \quad i_1 = i_2 + i_4$$

Write 4 KVL equations, one for each mesh and one for the outside loop.

$$v_2 - v_1 = 0, \quad v_3 + v_5 - v_4 - v_2 = 0, \quad v_6 - v_5 = 0, \quad v_3 + v_6 - v_4 - v_1 = 0$$

Describe the following:  $v_1 i_1$ ,  $v_2 i_2$ ,  $v_3 i_3$  and  $v_6 i_6$ .

$v_1 i_1$  is the power received by the 20 Ω resistor,

$v_2 i_2$  is the power supplied by the 5 Ω resistor,

$v_3 i_3$  is the power supplied by the current source,

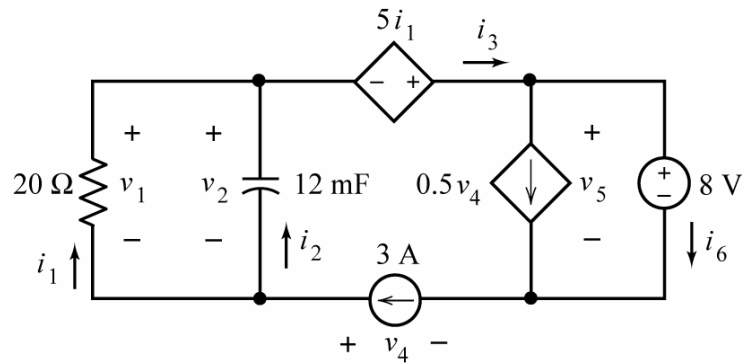
$v_6 i_6$  is the power received by the voltage source

**Remark:**

There are 12 unknowns in this exercise,  $v_1, v_2, v_3, v_4, v_5, v_6, i_1, i_2, i_3, i_4, i_5$ , and  $i_6$ , the element voltages and currents of 6 elements. We've written 6 element equations and 8 Kirchhoff's law equations for a total of 14 equations in 12 unknowns. That's a lot of equations, too many equations.

**Exercise 2:**

This circuit consists of 6 elements connected together at 4 nodes:



Write 6 element equations, one for each element.

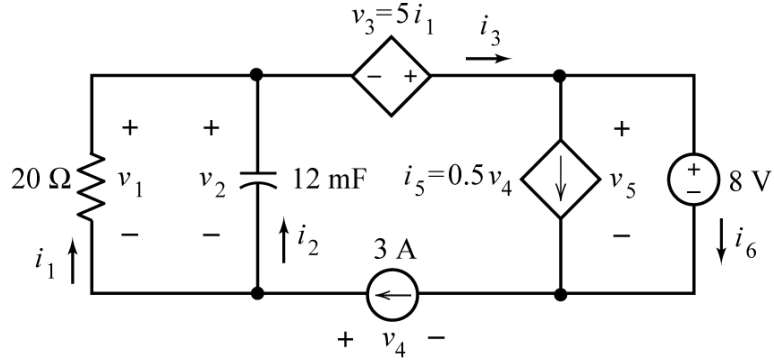
Write 4 KCL equations, one at each of the 4 nodes.

Write 4 KVL equations, one for each mesh and one for the outside loop.

Describe the following:  $v_1 i_1$ ,  $v_3 i_3$ ,  $v_5 i_5$  and  $v_6 i_6$ .

**Solution 2:**

It's helpful to add the names of the controlled voltage of the VCCS and the controlled current of the CCVS to the labels of these elements.



Write 6 element equations, one for each element.

$$v_1 = -20i_1, \quad i_2 = -0.012 \frac{dv_2}{dt}, \quad v_3 = 5i_1, \quad i_4 = 3 \text{ A}, \quad i_5 = 0.5v_4, \quad v_6 = 8 \text{ V}$$

Write 4 KCL equations, one at each of the 4 nodes.

$$i_1 + i_2 = i_3, \quad i_3 = i_5 + i_6, \quad i_5 + i_6 = i_4, \quad i_4 = i_1 + i_2$$

Write 4 KVL equations, one for each mesh and one for the outside loop.

$$v_2 - v_1 = 0, \quad -v_3 + v_5 - v_4 - v_2 = 0, \quad v_6 - v_5 = 0, \quad -v_3 + v_6 - v_4 - v_1 = 0$$

Describe the following:  $v_1 i_1$ ,  $v_3 i_3$ ,  $v_5 i_5$  and  $v_6 i_6$ .

$v_1 i_1$  is the power supplied by the  $20 \Omega$  resistor,

$v_3 i_3$  is the power supplied by the CCVS,

$v_5 i_5$  is the power received by the VCCS,

$v_6 i_6$  is the power received by the (independent) voltage source