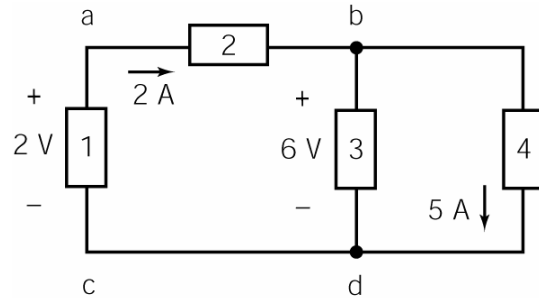
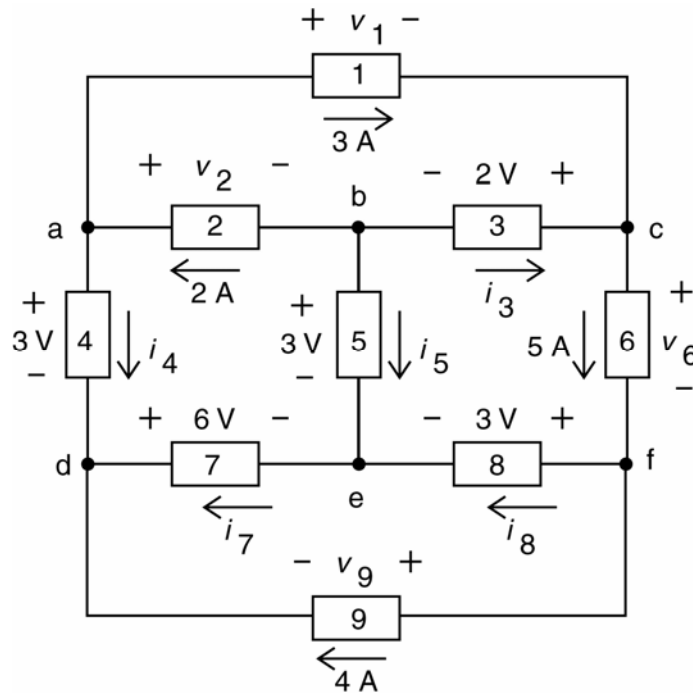


## Exercises

**Exercise 1.** This circuit that consists of 4 circuit elements, numbered from 1 to 4. These circuit elements are connected together at the nodes, labeled a thru d. Determine the power absorbed by each circuit element.



**Exercise 2.** This circuit that consists of nine circuit elements, numbered from 1 to 9. These circuit elements are connected together at six nodes, labeled a thru f.



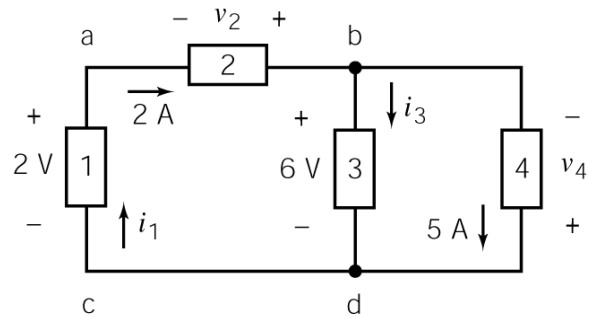
- a. Determine the values of the currents  $i_3$ ,  $i_4$ ,  $i_5$ ,  $i_7$  and  $i_8$  and of the voltages  $v_1$ ,  $v_2$ ,  $v_6$  and  $v_9$ .
- b. Determine the power absorbed each element.

## Solutions

### Solution 1:

We will need to calculate the current and voltage of each circuit element. How should we label the remaining element currents and voltages? Let's try a couple of different ways and see what happens.

#### First try:



Apply KCL at nodes a and b to get:

$$i_1 = 2 \Rightarrow i_1 = 2 \text{ A} \quad \text{and} \quad 2 = i_3 + 5 \Rightarrow i_3 = -3 \text{ A}$$

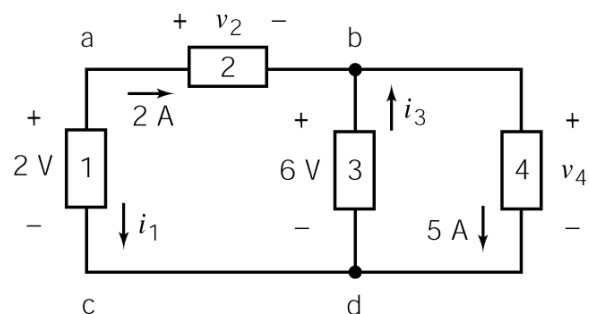
Apply KVL to the meshes to get:

$$-v_2 + 6 - 2 = 0 \Rightarrow v_2 = 4 \text{ V} \quad \text{and} \quad -v_4 - 6 = 0 \Rightarrow v_4 = -6 \text{ V}$$

Then

$$p_1 = -(2)(2) = -4 \text{ W}, \quad p_2 = -(2)(4) = -8 \text{ W}, \quad p_3 = (-3)(6) = -18 \text{ W} \quad \text{and} \quad p_4 = -(5)(-6) = 30 \text{ W}.$$

**Second try:** (The reference directions of the currents  $i_1$  and  $i_3$  and of the voltages  $v_2$  and  $v_4$  are all different from what they were in the first try.)



Apply KCL at nodes a and b to get:

$$0 = i_1 + 2 \Rightarrow i_1 = -2 \text{ A} \quad \text{and} \quad 2 + i_3 = 5 \Rightarrow i_3 = 3 \text{ A}$$

Apply KVL to the meshes to get:

$$v_2 + 6 - 2 = 0 \Rightarrow v_2 = -4 \text{ V} \quad \text{and} \quad v_4 - 6 = 0 \Rightarrow v_4 = 6 \text{ V}$$

Then

$$p_1 = (-2)(2) = -4 \text{ W}, \quad p_2 = (2)(-4) = -8 \text{ W}, \quad p_3 = -(3)(6) = -18 \text{ W} \quad \text{and} \quad p_4 = (5)(6) = 30 \text{ W}.$$

**Observations:**

1. The values of the currents  $i_1$  and  $i_3$  and of the voltages  $v_2$  and  $v_4$  in the second try are all -1 times the corresponding value in the first try. That is to be expected because the reference directions of the currents  $i_1$  and  $i_3$  and of the voltages  $v_2$  and  $v_4$  have all changed. For example,  $i_1$  in the first try and  $i_1$  in the second try refer to different currents.
2. The values of the power absorbed by the circuit element did not depend on the choice of reference direction.

**Solution 2.** Apply KCL at nodes a, b, c, d and e to get:

$$\begin{aligned} 2 &= 3 + i_4 \Rightarrow i_4 = -1 \text{ A} \\ \left. \begin{aligned} 0 &= 2 + i_5 + i_3 \\ i_3 + 3 &= 5 \Rightarrow i_3 = 2 \text{ A} \end{aligned} \right\} &\Rightarrow 0 = 2 + i_5 + 2 \Rightarrow i_5 = -4 \text{ A} \\ i_4 + i_7 + 4 &= 0 \Rightarrow -1 + i_7 + 4 = 0 \Rightarrow i_7 = -3 \text{ A} \\ i_5 + i_8 &= i_7 \Rightarrow -4 + i_8 = -3 \Rightarrow i_8 = 1 \text{ A} \end{aligned}$$

Apply KVL to the meshes to get:

$$\left. \begin{aligned} v_1 + 2 - v_2 &= 0 \\ v_2 + 3 - 6 - 3 &= 0 \Rightarrow v_2 = 6 \text{ V} \end{aligned} \right\} \Rightarrow v_1 + 2 - 6 = 0 \Rightarrow v_1 = 4 \text{ V}$$

$$\begin{aligned} -2 + v_6 + 3 - 3 &= 0 \Rightarrow v_6 = 2 \text{ V} \\ 6 - 3 + v_9 &= 0 \Rightarrow v_9 = -3 \text{ V} \end{aligned}$$

element	1	2	3	4	5	6	7	8	9
current	3	2	2	-1	-4	5	-3	1	4
voltage	4	6	2	3	3	2	6	3	-3
power absorbed	12	-12	-4	-3	-12	10	18	3	-12