**Example 1:**
Consider the circuit shown in Figure 1. Determine the power supplied by element $D$ and the power received by element $F$.

![Circuit Diagram](image)

**Figure 1.** The circuit considered in Example 1

**Solution:** Figure 1 provides a value for the current in element $D$ but not for the voltage, $v$, across element $D$. The voltage and current of element $D$ given in Figure 1 do not adhere to the passive convention so the product of this voltage and current is the power supplied by element $D$.

Similarly, Figure 1 provides a value for the voltage across element $F$ but not for the current, $i$, in element $F$. The voltage and current of element $F$ given in Figure 1 do adhere to the passive convention so the product of this voltage and current is the power received by element $F$.

We need to determine the voltage, $v$, across element $D$ and the current, $i$, in element $F$. We will use Kirchhoff’s laws to determine values of $v$ and $i$. First, we identify and label the nodes of the circuit as shown in Figure 2.

![Circuit Diagram](image)

**Figure 2.** Labeling the nodes of the circuit from Figure 1.

Apply Kirchhoff’s voltage law (KVL) to the loop consisting of elements $C, E, D$ and $B$ to get
\[ 3 + 6 + v + (-3) = 0 \quad \Rightarrow \quad v = -6 \text{ V} \]

The value of the current in element \( D \) in Figure 2 is 6 A. The voltage and current of element \( D \) given in Figure 2 do not adhere to the passive convention so

\[ p_D = v \times (6) = (-6) \times (6) = -36 \text{ W} \]

is the power supplied by element \( D \). (Equivalently, we could say that element \( D \) receives 36 W.)

Next, apply Kirchhoff’s current law (KCL) at node \( c \) to get

\[ -6 + i = 1 \quad \Rightarrow \quad i = 7 \text{ A} \]

The value of the voltage across element \( F \) in Figure 2 is -6 V. The voltage and current of element \( F \) given in Figure 2 adhere to the passive convention so

\[ p_F = (-6) \times i = (-6) \times (7) = -42 \text{ W} \]

is the power received by element \( F \). (Equivalently, we could say that element \( F \) supplies 42 W.)

**Example 2:**
Consider the circuit shown in Figure 3. Determine the power supplied by element \( B \) and the power supplied by element \( C \).

![Figure 3](image-url)

**Figure 3.** The circuit considered in Example 2

**Solution:** Figure 3 provides a value for the current in element \( B \) but not for the voltage, \( v \), across element \( B \). The voltage and current of element \( B \) given in Figure 1 do not adhere to the passive convention.
convention so the product of this voltage and current is the power supplied by element $B$. Similarly, Figure 3 provides a value for the voltage across element $C$ but not for the current, $i$, in element $C$. The voltage and current of element $C$ given in Figure 1 do not adhere to the passive convention so the product of this voltage and current is the power supplied by element $C$.

We need to determine the voltage, $v$, across element $B$ and the current, $i$, in element $C$. We will use Kirchhoff’s laws to determine values of $v$ and $i$. First, we identify and label the nodes of the circuit as shown in Figure 4.

![Figure 4. Labeling the nodes of the circuit from Figure 3.](image)

Apply Kirchhoff’s voltage law (KVL) to the loop consisting of elements $B$, $C$ and $A$ to get

$$-v - (-3) - 6 = 0 \quad \Rightarrow \quad v = -3 \text{ V}$$

The value of the current in element $B$ in Figure 4 is $3$ A. The voltage and current of element $B$ given in Figure 4 do not adhere to the passive convention so

$$p_B = v (3) = (-3) (3) = -9 \text{ W}$$

is the power supplied by element $B$. (Equivalently, we could say that element $B$ receives $9$ W.)

Next, apply Kirchhoff’s current law (KCL) at node $b$ to get

$$2 + i = 3 \quad \Rightarrow \quad i = 1 \text{ A}$$

The value of the voltage across element $C$ in Figure 4 is $-3$ V. The voltage and current of element $C$ given in Figure 4 do not adhere to the passive convention so

$$p_C = (-3) i = (-3) (1) = -3 \text{ W}$$

is the power supplied by element $C$. (Equivalently, we could say that element $C$ receives $3$ W.)
Example 3:
Consider the circuit shown in Figure 5. Determine the values of the currents in and voltages across the various circuit elements.

![Figure 5](image)

**Figure 5.** The circuit considered in Example 3

**Solution:** First, we identify and label the nodes of the circuit as shown in Figure 6.

![Figure 6](image)

**Figure 6.** Labeling the nodes of the circuit from Figure 5.

Apply Kirchhoff’s current law (KCL) at node $b$ to get

$$ i_5 + (-3) = 0 \quad \Rightarrow \quad i_5 = 3 \text{ A} $$

Apply KCL at node $a$ to get

$$ -2 = -3 + 5 + i_4 \quad \Rightarrow \quad i_4 = -4 \text{ A} $$

Apply KCL at node $d$ to get
Apply Kirchhoff’s voltage law (KVL) to the loop consisting of elements $A$, $B$ and $E$ to get
\[ v_2 - (-5) - 6 = 0 \Rightarrow v_2 = 1 \text{ V} \]

Apply KVL to the loop consisting of elements $B$ and $C$ to get
\[ v_3 - v_2 = 0 \Rightarrow v_3 = v_2 = 1 \text{ V} \]

Finally, apply KVL to the loop consisting of elements $C$, $D$ and $F$ to get
\[ -v_4 + 4 - v_3 = 0 \Rightarrow v_4 = 4 - v_3 = 4 - 1 = 3 \text{ V} \]

**Example 4:**
Consider the circuit shown in Figure 7. Determine the power supplied by element $B$ and the power received by element $F$.

![Figure 7](image)

**Figure 7.** The circuit considered in Example 4

**Solution:** Figure 7 provides a value for the voltage across element $B$ but not for the current, $i$, in element $B$. The voltage and current of element $B$ given in Figure 7 adhere to the passive convention so the product of this voltage and current is the power received by element $B$. Similarly, Figure 7 provides a value for the current in element $F$ but not for the voltage, $v$, across element $F$. The voltage and current of element $F$ given in Figure 7 do not adhere to the passive convention so the product of this voltage and current is the power supplied by element $F$. 
We need to determine the current, \( i \), in element \( B \) and the voltage, \( v \), across element \( F \). We will use Kirchhoff’s laws to determine values of \( i \) and \( v \). First, we identify and label the nodes of the circuit as shown in Figure 8.

**Figure 8.** Labeling the nodes of the circuit from Figure 7.

Apply Kirchhoff’s current law (KCL) at node \( a \) to get

\[
i = -3 + (-4) + 10 \quad \Rightarrow \quad i = 3 \text{ A}
\]

The value of the voltage across element \( B \) in Figure 8 is 6 V. The voltage and current of element \( B \) given in Figure 8 adhere to the passive convention so

\[
p_B = (6) i = (6)(3) = 18 \text{ W}
\]

is the power received by element \( B \). Therefore element \( B \) supplies -18 W.

Next, apply Kirchhoff’s voltage law (KVL) to the loop consisting of elements \( D, F, E \) and \( C \) to get

\[
4 + v + (-5) - (6) = 0 \quad \Rightarrow \quad v = 7 \text{ V}
\]

The value of the current in element \( F \) in Figure 8 is 10 A. The voltage and current of element \( F \) given in Figure 8 do not adhere to the passive convention so

\[
p_D = v (10) = (7)(10) = 70 \text{ W}
\]

is the power supplied by element \( F \). Therefore element \( F \) receives -70 W.
Example 5:
Consider the circuit shown in Figure 9. Determine the values of the currents in and voltages across the various circuit elements.

![Figure 9](image)

**Figure 9.** The circuit considered in Example 5

**Solution:** First, we identify and label the nodes of the circuit as shown in Figure 10.

![Figure 10](image)

**Figure 10.** Labeling the nodes of the circuit from Figure 9.

Apply Kirchhoff’s current law (KCL) at node $a$ to get

$$i_2 + (-3) = 0 \quad \Rightarrow \quad i_2 = 3 \text{ A}$$

Apply KCL at node $d$ to get
Apply Kirchhoff’s voltage law (KVL) to the loop consisting of elements $A$, $B$ and $C$ to get

$$i_3 + (-3) = 0 \Rightarrow i_3 = 3 \text{ A}$$

Apply KCL at node $c$ to get

$$i_6 = 2 \text{ A}$$

Apply KCL at node $f$ to get

$$i_5 + i_6 = 0 \Rightarrow i_5 = -i_6 = -2 \text{ A}$$

Apply KVL to the loop consisting of elements $D$, $E$ and $F$ to get

$$-(-2) - (v_6) + 4 = 0 \Rightarrow v_6 = 6 \text{ V}$$

Finally, apply KCL at node $b$ to get

$$i_2 = i_7 + 2 \Rightarrow i_7 = i_2 - 2 = 3 - 2 = 1 \text{ A}$$

**Example 6:**
Consider the circuit shown in Figure 11. Determine the values of the currents in and voltages across the various circuit elements.

**Figure 11.** The circuit considered in Example 6
**Solution:** First, we identify and label the nodes of the circuit as shown in Figure 12.

![Figure 12. Labeling the nodes of the circuit from Figure 11.](image)

Apply Kirchhoff’s current law (KCL) at node $b$ to get

$$i_2 + 2 = 0 \Rightarrow i_2 = -2 \text{ A}$$

Apply KCL at node $a$ to get

$$i_1 = i_2 = -2 \text{ A}$$

Apply Kirchhoff’s voltage law (KVL) to the loop consisting of elements $A$, $B$ and $C$ to get

$$-2 + 8 - v_1 = 0 \Rightarrow v_1 = 6 \text{ V}$$

Apply KCL at node $c$ to get

$$i_6 = 2 + 2 = 4 \text{ A}$$

Apply KVL to the loop consisting of elements $E$ and $F$ to get

$$-12 - v_5 = 0 \Rightarrow v_5 = -12 \text{ V}$$

Finally, apply KVL to the loop consisting of elements $D$ and $E$ to get

$$v_5 - v_4 = 0 \Rightarrow v_4 = v_5 = -12 \text{ V}$$
Example 7:
Verify that power is conserved in the circuit shown in Figure 11.

Solution: The values of the currents in and voltages across the various circuit elements were determined in Example 6. Let’s summarize what we know in the following table.

<table>
<thead>
<tr>
<th>Element</th>
<th>Current, A</th>
<th>Voltage, V</th>
<th>Adhere to passive convention?</th>
<th>Power received, W</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-2</td>
<td>6</td>
<td>Yes</td>
<td>-12</td>
</tr>
<tr>
<td>B</td>
<td>-2</td>
<td>-2</td>
<td>No</td>
<td>-4</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>8</td>
<td>Yes</td>
<td>16</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>-12</td>
<td>No</td>
<td>24</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>-12</td>
<td>No</td>
<td>24</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>12</td>
<td>No</td>
<td>-48</td>
</tr>
</tbody>
</table>

The sum of the power received by all of the elements in the circuit is zero so power is conserved.