1.13 The manufacturer of a 1.5 V D flashlight battery says that the battery will deliver 9 mA for 40 continuous hours. During that time the voltage will drop from 1.5 V to 1.0 V. Assume the drop in voltage is linear with time. How much energy does the battery deliver in this 40 h interval?

1.17 The voltage and current at the terminals of the circuit element in Fig. 1.5 are zero for \( t < 0 \). For \( t \geq 0 \) they are

\[
v = 75 - 75e^{-1000t} \text{ V},
\]

\[
i = 50e^{-1000t} \text{ mA}.
\]

a) Find the maximum value of the power delivered to the circuit.

b) Find the total energy delivered to the element.

1.18 The voltage and current at the terminals of the circuit element in Fig. 1.5 are zero for \( t < 0 \). For \( t \geq 0 \) they are

\[
v = 50e^{-1600t} - 50e^{-400t} \text{ V},
\]

\[
i = 5e^{-1600t} - 5e^{-400t} \text{ mA}.
\]

a) Find the power at \( t = 625 \mu s \).

b) How much energy is delivered to the circuit element between 0 and 625 \( \mu s \)?

c) Find the total energy delivered to the element.

1.19 The voltage and current at the terminals of the circuit element in Fig. 1.5 are shown in Fig. P1.19.

a) Sketch the power versus \( t \) plot for \( 0 \leq t \leq 10 \text{ s} \).

b) Calculate the energy delivered to the circuit element at \( t = 1, 6, \text{ and } 10 \text{ s} \).
Figure P1.19

(a)

(b)
The voltage and current at the terminals of an automobile battery during a charge cycle are shown in Fig. P1.24.

a) Calculate the total charge transferred to the battery.

b) Calculate the total energy transferred to the battery.
1.26 The numerical values for the currents and voltages in the circuit in Fig. P1.26 are given in Table P1.26. Find the total power developed in the circuit.

![Circuit Diagram]

**Figure P1.26**

<table>
<thead>
<tr>
<th>Element</th>
<th>Voltage (kV)</th>
<th>Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>150</td>
<td>0.6</td>
</tr>
<tr>
<td>b</td>
<td>150</td>
<td>−1.4</td>
</tr>
<tr>
<td>c</td>
<td>100</td>
<td>−0.8</td>
</tr>
<tr>
<td>d</td>
<td>250</td>
<td>−0.8</td>
</tr>
<tr>
<td>e</td>
<td>300</td>
<td>−2.0</td>
</tr>
<tr>
<td>f</td>
<td>−300</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**1.28** Assume you are an engineer in charge of a project and one of your subordinate engineers reports that the interconnection in Fig. P1.28 does not pass the power check. The data for the interconnection are given in Table P1.28.

a) Is the subordinate correct? Explain your answer.

b) If the subordinate is correct, can you find the error in the data?
Figure P1.28

TABLE P1.28

<table>
<thead>
<tr>
<th>Element</th>
<th>Voltage (V)</th>
<th>Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>46.16</td>
<td>6.0</td>
</tr>
<tr>
<td>b</td>
<td>14.16</td>
<td>4.72</td>
</tr>
<tr>
<td>c</td>
<td>-32.0</td>
<td>-6.4</td>
</tr>
<tr>
<td>d</td>
<td>22.0</td>
<td>1.28</td>
</tr>
<tr>
<td>e</td>
<td>33.6</td>
<td>1.68</td>
</tr>
<tr>
<td>f</td>
<td>66.0</td>
<td>-0.4</td>
</tr>
<tr>
<td>g</td>
<td>2.56</td>
<td>1.28</td>
</tr>
<tr>
<td>h</td>
<td>-0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

1.31 Show that the power balances for the circuit shown in Fig. 1.7, using the voltage and current values given in Table 1.4, with the value of the current for component d changed to -1 A.
TABLE 1.4 Volatage and current values for the circuit in Fig. 1.7.

<table>
<thead>
<tr>
<th>Component</th>
<th>(v) (V)</th>
<th>(i) (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>120</td>
<td>-10</td>
</tr>
<tr>
<td>b</td>
<td>120</td>
<td>9</td>
</tr>
<tr>
<td>c</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>d</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>-10</td>
<td>-9</td>
</tr>
<tr>
<td>f</td>
<td>-100</td>
<td>5</td>
</tr>
<tr>
<td>g</td>
<td>120</td>
<td>4</td>
</tr>
<tr>
<td>h</td>
<td>-220</td>
<td>-5</td>
</tr>
</tbody>
</table>

Figure 1.7 ▲ Circuit model for power distribution in a home, with voltages and currents defined.

2.3 a) Is the interconnection of ideal sources in the circuit in Fig. P2.3 valid? Explain.

b) Identify which sources are developing power and which sources are absorbing power.

c) Verify that the total power developed in the circuit equals the total power absorbed.

d) Repeat (a)–(c), reversing the polarity of the 20 V source.

Figure P2.3
2.5 If the interconnection in Fig. P2.5 is valid, find the total power developed in the circuit. If the interconnection is not valid, explain why.

*Figure P2.5*

- 6 V
- 4 V
- 5 mA
- 8 mA
- 12 mA
- 8 V
- 10 V
- 12 V