# Contents

<table>
<thead>
<tr>
<th>Problem</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>L5P01</td>
<td>2</td>
</tr>
<tr>
<td>L5P02</td>
<td>2</td>
</tr>
<tr>
<td>L5P11</td>
<td>3</td>
</tr>
<tr>
<td>L5P21</td>
<td>3</td>
</tr>
<tr>
<td>L3P10</td>
<td>4</td>
</tr>
<tr>
<td>L3P11</td>
<td>5</td>
</tr>
<tr>
<td>L3P12</td>
<td>6</td>
</tr>
<tr>
<td>L5P04</td>
<td>7</td>
</tr>
<tr>
<td>L5P05</td>
<td>8</td>
</tr>
<tr>
<td>L6P01</td>
<td>8</td>
</tr>
<tr>
<td>L6P02</td>
<td>9</td>
</tr>
<tr>
<td>L6P10</td>
<td>10</td>
</tr>
<tr>
<td>L6P11</td>
<td>11</td>
</tr>
<tr>
<td>L6P12</td>
<td>11</td>
</tr>
<tr>
<td>L6P13</td>
<td>12</td>
</tr>
<tr>
<td>L5P03</td>
<td>12</td>
</tr>
<tr>
<td>L7P12</td>
<td>14</td>
</tr>
<tr>
<td>L7P13</td>
<td>15</td>
</tr>
<tr>
<td>L7P14</td>
<td>15</td>
</tr>
<tr>
<td>L7P15</td>
<td>16</td>
</tr>
</tbody>
</table>
The polarities of the voltage and current for elements 1-3 are shown in the figure below.

\[ v_1 = -22 \text{ V} \quad v_3 = -24 \text{ V} \quad i_2 = 3 \text{ A} \]

a) Use Kirchhoff’s Voltage Law to determine the voltage \( v_2 \) in the circuit above (in volts). 

\[ \text{Tries 0/4} \]

b) Use Kirchhoff’s Current Law to determine the current \( i_1 \) in the circuit above (in amps).

\[ \text{Tries 0/4} \]

c) Use Kirchhoff’s Current Law to determine the current \( i_3 \) in the circuit above (in amps).

\[ \text{Tries 0/4} \]

The polarities of the current and voltage are indicated for each circuit element, 1-4, below. Answer the following questions with respect to the indicated polarities.

\[ v_1 = 8 \text{ V} \quad v_4 = 2 \text{ V} \quad i_2 = -2 \text{ A} \quad i_3 = -5 \text{ A} \]
a) Use Kirchhoff’s Voltage Law to determine the voltage $v_3$ in the circuit above (in volts). $\square$ V
b) Use Kirchhoff’s Voltage Law to determine the voltage $v_2$ in the circuit above (in volts). $\square$ V

tries 0/4
c) Use Kirchhoff’s Current Law to determine the current $i_1$ in the circuit above (in amps). $\square$ A
c) Use Kirchhoff’s Current Law to determine the current $i_4$ in the circuit above (in amps). $\square$ A
tries 0/4

The circuit below contains two ideal voltage sources:

\[ V_1 = 22 \text{ V} \quad V_2 = 17 \text{ V} \quad R = 1 \text{ ohm} \]

a) Use Kirchhoff’s Voltage Law to determine the voltage $V_{AB}$ in the circuit above (in volts). $V_{AB}$ is the voltage drop from node A to node B, also stated as "the voltage at node A relative to node B". $V_{AB} = \square$ V
tries 0/4
b) Use Ohm’s Law to determine the current $I$ in the circuit above (in amps). $I = \square$ A
tries 0/4
The figures below show battery X and battery Y connected together two different ways. Battery X is a 12 volts battery and battery Y is a 6 volts battery. Determine the voltage $v_{AB}$ for each configuration. HINT: It may help to label the wire connecting the two batteries as node 'C'.

(a)

$v_{AB} (V) =$

(b)

$v_{AB} (V) =$

An electric wheelchair is powered by two 12 V lead acid batteries. Each battery has an energy capacity of 600 W-hrs. These two batteries operate an electric motor rated at a maximum output power (useful power to the wheels) of 1 hp (horsepower). The motor has an efficiency rating of 87%. Assuming that the batteries are fully charged and that the motor is running at maximum power, how many minutes can the batteries power the motor before they must be recharged?

In this problem, we are asking all intermediate steps. In later problems, you will need to recognize useful intermediate steps on your own.

a) When operating from fully charged to fully discharged, what is the energy produced by the source?

Energy produced =

b) What is the useful energy dissipated by the motor? (take the efficiency ratio into account!)

Useful energy dissipated =

c) What is the useful output power of the motor in Watts?

Power =

d) For how long will the motor run?
Time = \[\text{(in minutes)}\]

HINT: this is similar to the previous problem except that you must produce the steps to solve it, and the time is in hour (not minutes).

An ECE110 student decides to "go off the grid" and powers his house by batteries. On the first day, the electric power usage for the household was 28 kW-h. He must recharge his batteries using a bicycle-powered generator with 90% efficiency. For how many hours must he now pedal the bicycle at a peak power of 560 W in order to recharge to the batteries?
Time = \[\text{hours}\]

HINT: this is similar to the previous problem except that you must produce the steps to solve it, and the time is in hour (not minutes).
<table>
<thead>
<tr>
<th>Battery Size</th>
<th>Alkaline</th>
<th>NiCd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal Voltage</td>
<td>Energy Available</td>
</tr>
<tr>
<td>AAA</td>
<td>1.5 volts</td>
<td>0.5 watt-hours</td>
</tr>
<tr>
<td>AA</td>
<td>1.5 volts</td>
<td>1.5 watt-hours</td>
</tr>
<tr>
<td>C</td>
<td>1.5 volts</td>
<td>5.0 watt-hours</td>
</tr>
<tr>
<td>D</td>
<td>1.5 volts</td>
<td>15 watt-hours</td>
</tr>
</tbody>
</table>

The table above details the nominal cell voltage and energy available for several different sizes and types of batteries. The figure below represents the circuit of a hand-held flashlight. The bulb in the flashlight consumes 4.2 watts.

If size **AAA alkaline** batteries have been put in the flashlight, how long will it remain on (in minutes) before the batteries die?

Tries 0/4

minutes
\[ v_2 = 25 \text{ V}, \ v_4 = 21 \text{ V}, \ v_5 = 75 \text{ V} \ i_1 = -5 \text{ A}, \ i_3 = -1 \text{ A}, \ i_6 = -5 \text{ A} \]

Find \( v_1, v_3, v_6, i_2, i_4, i_5 \).

\[ v_1 \text{ (in volts)} = \quad \text{V} \]
\[ v_3 \text{ (in volts)} = \quad \text{V} \]
\[ v_6 \text{ (in volts)} = \quad \text{V} \]

\text{Tries } 0/4

\[ i_2 \text{ (in amps)} = \quad \text{A} \]
\[ i_4 \text{ (in amps)} = \quad \text{A} \]
\[ i_5 \text{ (in amps)} = \quad \text{A} \]

\text{Tries } 0/4
v2 = -25 V, v4 = 14 V, v6 = -7 V i1 = -4 A, i3 = -5 A, i5 = -4 A

Find v1, v3, v5, i2, i4, i6. The current and voltage polarities are shown for each component.

v1 (in volts) = 

v3 (in volts) = 

v5 (in volts) = 

Tries 0/4

i2 (in amps) = 

i4 (in amps) = 

i6 (in amps) = 

Tries 0/4

In the laboratory, and for many topics in the lecture, it will be very useful to recognize series and parallel connections.

Answer the following questions for the circuit above.
Element 1 and Element 2 are in series:
A. Yes
B. No

Element 2 and Element 3 are in series:
A. Yes
B. No

Tries 0/4

Element 1 and Element 3 are in parallel:
A. Yes
B. No

Element 3 and Element 4 are in parallel:
A. Yes
B. No

Tries 0/4

One could imagine a voltage source (battery) is connected between the nodes a and b to supply power to the set of resistances.

Answer the following questions for the circuit above.
Element R1 and Element R2 are in series:
A. Yes
B. No

Element R2 and Element R3 are in series:
A. Yes
B. No

Element R1 and Element R3 are in parallel:
A. Yes
B. No

Element R2 and Element R4 are in parallel:
A. Yes
B. No

\[ V_s = 4.5 \text{ V}, \ R_1 = 3 \text{ \Omega}, \ R_2 = 6 \text{ \Omega} \]

Find the voltages.

\[ V_1 = \boxed{\text{volts}} \]

\[ V_2 = \boxed{\text{volts}} \]
\( I_s = 70 \text{ mA}, \ R_1 = 3 \ \Omega, \ R_2 = 6 \ \Omega \)

Find the currents.

\( I_1 = \ \text{mA} \)

\( I_2 = \ \text{mA} \)

\( \text{Tries 0/4} \)

\( V_s = 6 \ \text{V}, \ R_1 = 1 \ \Omega, \ R_2 = 6 \ \Omega \)

Find the values requested below.

\( I_s = \ \text{A} \)

\( V_1 = \ \text{V} \)

\( \text{Tries 0/4} \)
\[ R_{eq} = 75 \, \Omega \]

Find the value of \( R_2 \) that makes \( R_{eq} = 75 \, \Omega \).

\[ R_2 = \square \, \Omega \]

_Tries 0/8_

\[ v_1 = -16 \, V, \ v_4 = -12 \, V, \ i_2 = -2 \, A, \ i_3 = 4 \, A, \ i_5 = 5 \, A \]

In all components the current polarity is shown by the arrow and the voltage polarity is shown by the symbols. You may need to reference, in addition to the current course notes, the notes on power.

Use Kirchhoff’s laws to find the following voltages and currents.
\[ v_2 = \underline{\text{volts}} \]
\[ v_3 = \underline{\text{volts}} \]
\[ v_5 = \underline{\text{volts}} \]

**Tries 0/4**

\[ i_1 = \underline{\text{amps}} \]
\[ i_4 = \underline{\text{amps}} \]

**Tries 0/4**

Compute the power in each component and check whether or not it is dissipating (load) or supplying (source) energy, or neither (implying that \( P = 0 \)). Please don’t forget to include the sign for each power value entered.

\[ P_1 = \underline{\text{watts}} \]

A. Absorbing
B. Supplying
C. Neither

\[ P_2 = \underline{\text{watts}} \]

A. Absorbing
B. Supplying
C. Neither

**Tries 0/4**
The graph above shows about two complete periods of a certain power profile (it goes on forever in both directions). The graph is drawn to scale. Answer these questions about this waveform:

What is the maximum height of the graph (in Watts)? __________ W

What is the period for the function? __________ s

What is the average value of this function? __________ W
The graph above shows nearly two periods of a certain periodic signal (it goes on forever in both directions). The graph is drawn to scale. Answer these questions about this signal:

What is the period for the function? [Blank] s

Tries 0/12

What is the RMS value of this function? [Blank] V_{rms}

Tries 0/12

for the voltage source: V_s = 1.6 V, R = 150 Ω, and for the current source: I_s = 35 mA.

Find the values of power that describe each element. Be sure to include the proper sign to indicated delivering/absorbing.

For the voltage source, P_V=[Blank] mW

For the resistor, P_R=[Blank] mW

For the current source, P_I=[Blank] mW

Tries 0/8
For the voltage source, $V_s = 1.6 \text{ V}$, $R = 150 \Omega$, and for the current source, $I_s = 35 \text{ mA}$.

Find the values of power that describe each element. Be sure to include the proper sign to indicated delivering/absorbing.

For the voltage source, $P_V =$ mW

For the resistor, $P_R =$ mW

For the current source, $P_I =$ mW

Tries 0/15