[a] Note that the current $i_b$ is in the same circuit branch as the 8 A current source; however, $i_b$ is defined in the opposite direction of the current source. Therefore,

$$i_b = -8 \text{ A}$$

Next, note that the dependent current source and the independent current source are in parallel with the same polarity. Therefore, their voltages are equal, and

$$v_g = \frac{i_b}{4} = \frac{-8}{4} = -2 \text{ V}$$

[b] To find the power associated with the 8 A source, we need to find the voltage drop across the source, $v_i$. Note that the two independent sources are in parallel, and that the voltages $v_g$ and $v_1$ have the same polarities, so these voltages are equal:

$$v_i = v_g = -2 \text{ V}$$

Using the passive sign convention,

$$p_s = (8 \text{ A})(v_i) = (8 \text{ A})(-2 \text{ V}) = -16 \text{ W}$$

Thus the current source generated 16 W of power.
AP 2.2

Note from the circuit that \( v_x = -25 \) V. To find \( \alpha \) note that the two current sources are in the same branch of the circuit but their currents flow in opposite directions. Therefore

\[
\alpha v_x = -15 \text{ A}
\]

Solve the above equation for \( \alpha \) and substitute for \( v_x \),

\[
\alpha = \frac{-15 \text{ A}}{v_x} = \frac{-15 \text{ A}}{-25 \text{ V}} = 0.6 \text{ A/V}
\]

To find the power associated with the voltage source we need to know the current, \( i_v \). Note that this current is in the same branch of the circuit as the dependent current source and these two currents flow in the same direction. Therefore, the current \( i_v \) is the same as the current of the dependent source:

\[
i_v = \alpha v_x = (0.6)(-25) = -15 \text{ A}
\]

Using the passive sign convention,

\[
p_s = -(i_v)(25 \text{ V}) = -(-15 \text{ A})(25 \text{ V}) = 375 \text{ W}.
\]

Thus the voltage source dissipates 375 W.

AP 2.3

The resistor and the voltage source are in parallel and the resistor voltage and the voltage source have the same polarities. Therefore these two voltages are the same:

\[
v_R = v_g = 1 \text{ kV}
\]
Note from the circuit that the current through the resistor is \( i_g = 5 \text{ mA} \). Use Ohm's law to calculate the value of the resistor:

\[
R = \frac{v_R}{i_g} = \frac{1 \text{ kV}}{5 \text{ mA}} = 200 \text{ k\Omega}
\]

Using the passive sign convention to calculate the power in the resistor,

\[
p_R = (v_R)(i_g) = (1 \text{ kV})(5 \text{ mA}) = 5 \text{ W}
\]

The resistor is dissipating 5 W of power.

[b] Note from part (a) the \( v_R = v_g \) and \( i_R = i_g \). The power delivered by the source is thus

\[
p_{\text{source}} = -v_g i_g \quad \text{so} \quad v_g = -\frac{p_{\text{source}}}{i_g} = -\frac{-3 \text{ W}}{75 \text{ mA}} = 40 \text{ V}
\]

Since we now have the value of both the voltage and the current for the resistor, we can use Ohm's law to calculate the resistor value:

\[
R = \frac{v_g}{i_g} = \frac{40 \text{ V}}{75 \text{ mA}} = 533.33 \text{ \Omega}
\]

The power absorbed by the resistor must equal the power generated by the source. Thus,

\[
p_R = -p_{\text{source}} = -(-3 \text{ W}) = 3 \text{ W}
\]

[c] Again, note the \( i_R = i_g \). The power dissipated by the resistor can be determined from the resistor's current:

\[
p_R = R(i_R)^2 = R(i_g)^2
\]

Solving for \( i_g \),

\[
i_g^2 = \frac{p_R}{R} = \frac{480 \text{ mW}}{300 \text{ \Omega}} = 0.0016 \quad \text{so} \quad i_g = \sqrt{0.0016} = 0.04 \text{ A} = 40 \text{ mA}
\]

Then, since \( v_R = v_g \)

\[
v_R = Ri_R = Ri_g = (300 \text{ \Omega})(40 \text{ mA}) = 12 \text{ V} \quad \text{so} \quad v_g = 12 \text{ V}
\]
AP 2.4

![Circuit Diagram]

[a] Note from the circuit that the current through the conductance $G$ is $i_g$, flowing from top to bottom, because the current source and the conductance are in the same branch of the circuit so must have the same current. The voltage drop across the current source is $v_g$, positive at the top, because the current source and the conductance are also in parallel so must have the same voltage. From a version of Ohm’s law,

$$v_g = \frac{i_g}{G} = \frac{0.5 \text{ A}}{50 \text{ mS}} = 10 \text{ V}$$

Now that we know the voltage drop across the current source, we can find the power delivered by this source:

$$p_{\text{source}} = -v_g i_g = -(10)(0.5) = -5 \text{ W}$$

Thus the current source delivers 5 W to the circuit.

[b] We can find the value of the conductance using the power, and the value of the current using Ohm’s law and the conductance value:

$$p_g = Gv_g^2$$  so  $$G = \frac{p_g}{v_g^2} = \frac{9}{15^2} = 0.04 \text{ S} = 40 \text{ mS}$$

$$i_g = Gv_g = (40 \text{ mS})(15 \text{ V}) = 0.6 \text{ A}$$

[c] We can find the voltage from the power and the conductance, and then use the voltage value in Ohm’s law to find the current:

$$p_g = Gv_g^2$$  so  $$v_g^2 = \frac{p_g}{G} = \frac{8 \text{ W}}{200 \mu\text{S}} = 40,000$$

Thus  $$v_g = \sqrt{40,000} = 200 \text{ V}$$

$$i_g = Gv_g = (200 \mu\text{S})(200 \text{ V}) = 0.04 \text{ A} = 40 \text{ mA}$$
Problems

P 2.1  [a] Yes, independent voltage sources can carry the 8 A current required by the connection; independent current source can support any voltage required by the connection, in this case 20 V, positive at the top.

[b] 30 V source: absorbing
10 V source: delivering
8 A source: delivering

[c] \[ P_{30V} = (30)(8) = 240 \text{ W (abs)} \]
\[ P_{10V} = -(10)(8) = -80 \text{ W (del)} \]
\[ P_{8A} = -(20)(8) = -160 \text{ W (del)} \]
\[ \sum P_{\text{abs}} = \sum P_{\text{del}} = 240 \text{ W} \]

[d] The interconnection is valid, but in this circuit the voltage drop across the 8 A current source is 40 V, positive at the top; 30 V source is absorbing, the 10 V source is absorbing, and the 8 A source is delivering

\[ P_{30V} = (30)(8) = 240 \text{ W (abs)} \]
\[ P_{10V} = (10)(8) = 80 \text{ W (abs)} \]
\[ P_{8A} = -(20)(8) = -320 \text{ W (del)} \]
\[ \sum P_{\text{abs}} = \sum P_{\text{del}} = 320 \text{ W} \]

P 2.2  The interconnection is valid. The 10 A current source has a voltage drop of 100 V, positive at the top, because the 100 V source supplies its voltage drop across a pair of terminals shared by the 10 A current source. The right hand branch of the circuit must also have a voltage drop of 100 V from the left terminal of the 40 V source to the bottom terminal of the 5 A current source, because this branch shares the same terminals as the 100 V source. This means that the voltage drop across the 5 A current source is 140 V, positive at the top. Also, the two voltage sources can carry the current required of the interconnection. This is summarized in the figure below:
From the values of voltage and current in the figure, the power supplied by the currents sources is calculated as follows:

\[ P_{10A} = -(100)(10) = -1000 \text{ W} \quad \text{(dev)} \]

\[ P_{5A} = -(140)(5) = -700 \text{ W} \quad \text{(dev)} \]

\[ \sum P_{\text{dev}} = 1700 \text{ W} \]

P 2.3 The interconnection is not valid. Note that both current sources in the right hand branch supply current through the 100 V source. If the interconnection was valid, these two current sources would supply the same current in the same direction, which they do not.

P 2.4 The interconnect is valid since the voltage sources can all carry 5 A of current supplied by the current source, and the current source can carry the voltage drop required by the interconnection. Note that the branch containing the 10 V, 40 V, and 5 A sources must have the same voltage drop as the branch containing the 50 V source, so the 5 A current source must have a voltage drop of 20 V, positive at the right. The voltages and currents are summarize in the circuit below:

\[ P_{50V} = (50)(5) = 250 \text{ W} \quad \text{(abs)} \]

\[ P_{10V} = (10)(5) = 50 \text{ W} \quad \text{(abs)} \]

\[ P_{40V} = -(40)(5) = -200 \text{ W} \quad \text{(dev)} \]

\[ P_{5A} = -(20)(5) = -100 \text{ W} \quad \text{(dev)} \]
\[ \sum P_{\text{dev}} = 300 \text{ W} \]

P 2.5 The interconnection is valid, since the voltage sources can carry the 10 A current supplied by the current source, and the current sources can carry whatever voltage drop is required by the interconnection. In particular, note the the voltage drop across the three sources in the right hand branch must be the same as the voltage drop across the 20 A current source in the middle branch, since the middle and right hand branch are connected between the same two terminals. In particular, this means that

\[ v_1 (\text{the voltage drop across the middle branch}) = 100V - 50V - v_2 (\text{the voltage drop across the right hand branch}) \]

Hence any combination of \( v_1 \) and \( v_2 \) such that \( v_1 + v_2 = 50V \) is a valid solution.

P 2.6

The interconnection is invalid. The voltage drop between the top terminal and the bottom terminal on the left hand side is due to the 6 V and 8 V sources, giving a total voltage drop between these terminals of 14 V. But the voltage drop between the top terminal and the bottom terminal on the right hand side is due to the 4 V and 12 V sources, giving a total voltage drop between these two terminals of 16 V. The voltage drop between any two terminals in a valid circuit must be the same, so the interconnection is invalid.

P 2.7 [a] Yes, each of the voltage sources can carry the current required by the interconnection, and each of the current sources can carry the voltage drop required by the interconnection. (Note that \( i_\Delta = 5 \text{ A.} \))

[b] No, because the voltage drop between the top terminal and the bottom terminal cannot be determined. For example, define \( v_1, v_2, \) and \( v_3 \) as