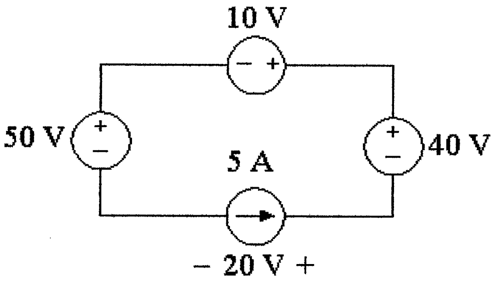
P 2.4 The interconnect is valid since the voltage sources can all carry 5 A of current supplied by the current source, and the current source can carry the voltage drop required by the interconnection. Note that the branch containing the 10 V, 40 V, and 5 A sources must have the same voltage drop as 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:



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

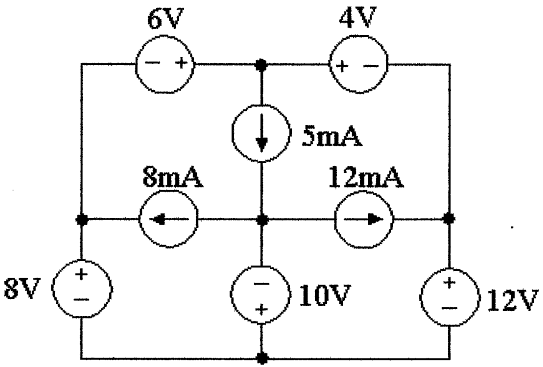
$$P_{10V} = (10)(5) = 50 \text{ W} \quad \text{(abs)}$$

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

$$P_{5A} = -(20)(5) = -100 \text{ W} \quad \text{(dev)}$$

$$\sum P_{\text{dev}} = 300 \text{ W}$$

P 2.6



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 2.12 The resistor value is the ratio of the power to the square of the current: $R = \frac{p}{i^2}$. Using the values for power and current in Fig. P2.12(b),

$$\frac{100}{2^2} = \frac{400}{4^2} = \frac{900}{6^2} = \frac{1600}{8^2} = \frac{2500}{10^2} = \frac{3600}{12^2} = 25\,\Omega$$

P 2.20 [a] Use KVL for the right loop to calculate the voltage drop across the right-hand branch v_o. This is also the voltage drop across the middle branch, so once v_o is known, use Ohm's law to calculate i_o:

$$v_o = 1000i_a + 4000i_a + 3000i_a = 8000i_a = 8000(0.002) = 16 \text{ V}$$

$$16 = 2000i_o$$

$$i_o = \frac{16}{2000} = 8 \text{ mA}$$

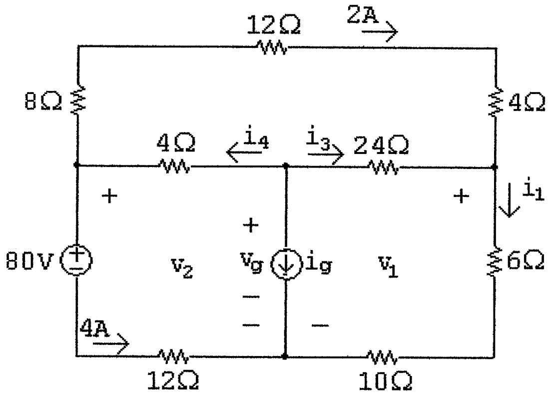
[b] KCL at the top node: $i_g = i_a + i_o = 0.002 + 0.008 = 0.010 \text{ A} = 10 \text{ mA}.$

[c] The voltage drop across the source is v_0, seen by writing a KVL equation for the left loop. Thus,

$p_g = -v_o i_g = -(16)(0.01) = -0.160 \text{ W} = -160 \text{ mW}.$

Thus the source delivers 160 mW.

P 2.25 [a]



$v_2 = 80 + 4(12) = 128\,\text{V}; \qquad v_1 = 128 - (8 + 12 + 4)(2) = 80\,\text{V}$

$i_1 = \dfrac{v_1}{6+10} = \dfrac{80}{16} = 5\,\text{A}; \qquad i_3 = i_1 - 2 = 5 - 2 = 3\,\text{A}$

$v_g = v_1 + 24 i_3 = 80 + 24(3) = 152\,\text{V}$

$i_4 = 2 + 4 = 6\,\text{A}$

$i_g = -i_4 - i_3 = -6 - 3 = -9\,\text{A}$

[b] Calculate power using the formula $p = Ri^2$:

$p_{8\,\Omega} = (8)(2)^2 = 32\,\text{W}; \qquad p_{12\,\Omega} = (12)(2)^2 = 48\,\text{W}$

$p_{4\,\Omega} = (4)(2)^2 = 16\,\text{W}; \qquad p_{4\,\Omega} = (4)(6)^2 = 144\,\text{W}$

$p_{24\,\Omega} = (24)(3)^2 = 216\,\text{W}; \qquad p_{6\,\Omega} = (6)(5)^2 = 150\,\text{W}$

$p_{10\,\Omega} = (10)(5)^2 = 250\,\text{W}; \qquad p_{12\,\Omega} = (12)(4)^2 = 192\,\text{W}$

[c] $v_g = 152\,\text{V}$

[d] Sum the power dissipated by the resistors:

$\sum p_{\text{diss}} = 32 + 48 + 16 + 144 + 216 + 150 + 250 + 192 = 1048\,\text{W}$

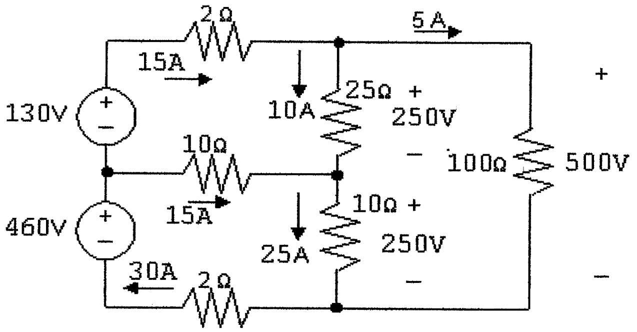
The power associated with the sources is

$p_{\text{volt-source}} = (80)(4) = 320\,\text{W}$

$p_{\text{curr-source}} = -v_g i_g = -(152)(9) = -1368\,\text{W}$

Thus the total power dissipated is $1048 + 320 = 1368$ W and the total power developed is 1368 W, so the power balances.

P 2.26 [a] Start by calculating the voltage drops due to the currents i_1 and i_2. Then use KVL to calculate the voltage drop across and $100\,\Omega$ resistor, and Ohm's law to find the current in the $100\,\Omega$ resistor. Finally, KCL at each of the middle three nodes yields the currents in the two sources and the current in the middle 10 Ω resistor. These calculations are summarized in the figure below:



$$p_{130} = -(130)(15) = -1950 \text{ W}$$

$$p_{460} = -(460)(30) = -13{,}800 \text{ W}$$

[b]

$$\sum P_{\text{dis}} = (15)^2(2) + (15)^2(10) + (30)^2(2) + (10)^2(25) + (25)^2(10) + (5)^2(100)$$

$$= 450 + 2250 + 1800 + 2500 + 6250 + 2500 = 15{,}750 \text{ W}$$

$$\sum P_{\text{sup}} = 1950 + 13{,}800 = 15{,}750 \text{ W}$$

Therefore, $\sum P_{\text{dis}} = \sum P_{\text{sup}} = 15{,}750$ W