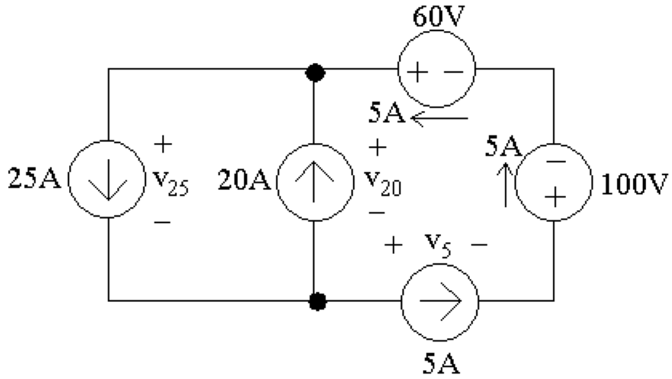
P 2.6



Write the two KCL equations, summing the currents leaving the node:

KCL, top node: $25\text{A} - 20\text{A} - 5\text{A} = 0\text{A}$

KCL, bottom node: $-25\text{A} + 20\text{A} + 5\text{A} = 0\text{A}$

Write the three KVL equations, summing the voltages in a clockwise direction:

KVL, left loop: $-v_{25} + v_{20} = 0$

KVL, right loop: $60\text{V} - 100\text{V} - v_5 - v_{20} = 0$

KVL, outer loop: $60\text{V} - 100\text{V} - v_5 - v_{25} = 0$

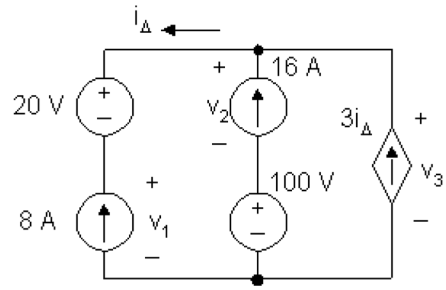
Note that since v_5, v_{20}, and v_{25} are not specified, we can choose values that satisfy the equations. For example, let $v_5 = -80\text{V}$, $v_{20} = 40\text{V}$, and $v_{25} = 40\text{V}$. There are many other voltage values that will satisfy the equations, too.
Thus, the interconnection is valid because it does not violate Kirchhoff's laws. We can now calculate the power developed by the two voltage sources:

$p_{\text{v-sources}} = p_{60} + p_{100} = -(60)(5) + (100)(5) = 200\,\text{W}$.

Since the power is positive, the sources are absorbing 200 W of power, or developing −200 W of power.

P 2.12 **[a]** Yes, Kirchhoff's laws are not violated. (Note that $i_\Delta = -8$ A.)

[b] No, because the voltages across the independent and dependent current sources are indeterminate. For example, define v_1, v_2, and v_3 as shown:



Kirchhoff's voltage law requires

$$v_1 + 20 = v_3$$

$$v_2 + 100 = v_3$$

Conservation of energy requires

$$-8(20) - 8v_1 - 16v_2 - 16(100) + 24v_3 = 0$$

or

$$v_1 + 2v_2 - 3v_3 = -220$$

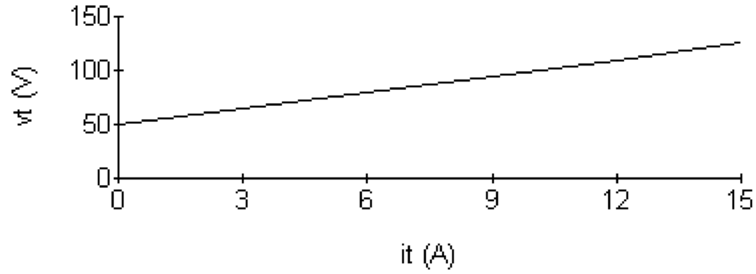
Now arbitrarily select a value of v_3 and show the conservation of energy will be satisfied. Examples:
If $v_3 = 200$ V then $v_1 = 180$ V and $v_2 = 100$ V. Then

$$180 + 200 - 600 = -220 \text{ (CHECKS)}$$

If $v_3 = -100$ V, then $v_1 = -120$ V and $v_2 = -200$ V. Then

$$-120 - 400 + 300 = -220 \text{ (CHECKS)}$$

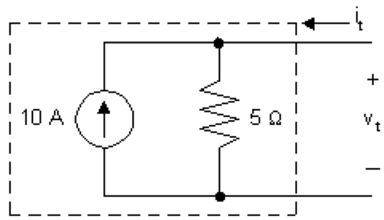
P 2.20 **[a]** Plot tl



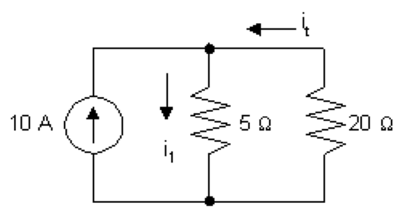
From the plot:

$$R = \frac{\Delta v}{\Delta i} = \frac{(125-50)}{(15-0)} = 5\,\Omega$$

When $i_t = 0$, $v_t = 50$ V; therefore the ideal current source has a current of 10 A



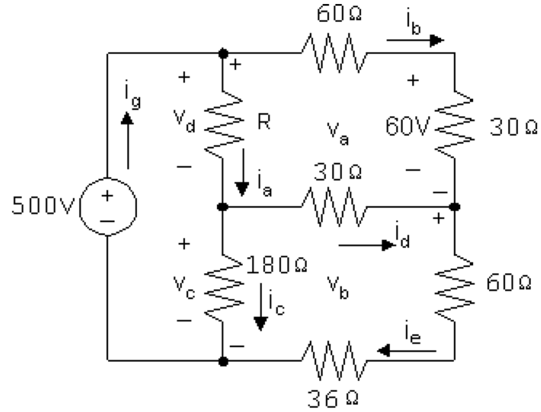
[b]



$10 + i_t = i_1$ and $5i_1 = -20i_t$

Therefore, $10 + i_t = -4i_t$ so $i_t = -2$ A

P 2.25 **[a]**



$i_b = 60\,\text{V}/30\,\Omega = 2\,\text{A}$
$v_a = (30 + 60)(2) = 180\,\text{V}$
$-500 + v_a + v_b = 0$ so $v_b = 500 - v_a = 500 - 180 = 320\,\text{V}$
$i_e = v_b/(60 + 36) = 320/96 = (10/3)\,\text{A}$
$i_d = i_e - i_b = (10/3) - 2 = (4/3)\,\text{A}$
$v_c = 30i_d + v_b = 40 + 320 = 360\,\text{V}$
$i_c = v_c/180 = 360/180 = 2\,\text{A}$
$v_d = 500 - v_c = 500 - 360 = 140\,\text{V}$
$i_a = i_d + i_c = 4/3 + 2 = (10/3)\,\text{A}$
$R = v_d/i_a = 140/(10/3) = 42\,\Omega$

[b] $i_g = i_a + i_b = (10/3) + 2 = (16/3)$ A
p_g (supplied) $= (500)(16/3) = 2666.67$ W

P 2.26 **[a]** Start with the $22.5\,\Omega$ resistor. Since the voltage drop across this resistor is 90 V, we can use Ohm's law to calculate the current:

$$i_{22.5\,\Omega} = \frac{90\,\text{V}}{22.5\,\Omega} = 4\,\text{A}$$

Next we can calculate the voltage drop across the $15\,\Omega$ resistor by writing a KVL equation around the outer loop of the circuit:

$$-240\,\text{V} + 90\,\text{V} + v_{15\,\Omega} = 0 \qquad \text{so} \qquad v_{15\,\Omega} = 240 - 90 = 150\,\text{V}$$

Now that we know the voltage drop across the $15\,\Omega$ resistor, we can use Ohm's law to find the current in this resistor:

$$i_{15\,\Omega} = \frac{150\,\text{V}}{15\,\Omega} = 10\,\text{A}$$

Write a KCL equation at the middle right node to find the current through the $5\,\Omega$ resistor. Sum the currents entering:

$$4\,\text{A} - 10\,\text{A} + i_{5\,\Omega} = 0 \qquad \text{so} \qquad i_{5\,\Omega} = 10\,\text{A} - 4\,\text{A} = 6\,\text{A}$$

Write a KVL equation clockwise around the upper right loop, starting below the $4\,\Omega$ resistor. Use Ohm's law to express the voltage drop across the resistors in terms of the current through the resistors:

$$-v_{4\,\Omega} + 90\,\text{V} + (5\,\Omega)(-6\,\text{A}) = 0 \qquad \text{so} \qquad v_{4\,\Omega} = 90\,\text{V} - 30\,\text{V} = 60\,\text{V}$$

Using Ohm's law we can find the current through the $4\,\Omega$ resistor:

$$i_{4\,\Omega} = \frac{60\,\text{V}}{4\,\Omega} = 15\,\text{A}$$

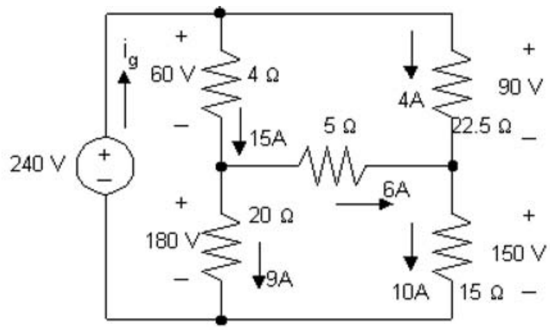
Write a KCL equation at the middle node. Sum the currents entering:

$$15\,\text{A} - 6\,\text{A} - i_{20\,\Omega} = 0 \qquad \text{so} \qquad i_{20\,\Omega} = 15\,\text{A} - 6\,\text{A} = 9\,\text{A}$$

Use Ohm's law to calculate the voltage drop across the $20\,\Omega$ resistor:

$$v_{20\,\Omega} = (20\,\Omega)(9\,\text{A}) = 180\,\text{V}$$

All of the voltages and currents calculated above are shown in the figure below:



Calculate the power dissipated by the resistors using the equation $p_R = Ri_R^2$:

$p_{4\Omega} = (4)(15)^2 = 900\,\text{W} \qquad p_{20\Omega} = (20)(9)^2 = 1620\,\text{W}$

$p_{5\Omega} = (5)(6)^2 = 180\,\text{W} \qquad p_{22.5\Omega} = (22.5)(4)^2 = 360\,\text{W}$

$p_{15\Omega} = (15)(10)^2 = 1500\,\text{W}$

[b] We can calculate the current in the voltage source, i_g by writing a KCL equation at the top middle node:

$i_g = 15\,\text{A} + 4\,\text{A} = 19\,\text{A}$

Now that we have both the voltage and the current for the source, we can calculate the power supplied by the source:

$p_g = -240(19) = -4560\,\text{W} \qquad \text{thus} \qquad p_g\text{ (supplied)} = 4560\,\text{W}$

[c] $\sum P_{\text{dis}} = 900 + 1620 + 180 + 360 + 1500 = 4560\,\text{W}$

Therefore,

$\sum P_{\text{supp}} = \sum P_{\text{dis}}$