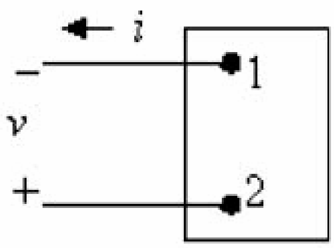
P 1.13 **[a]**



$$p = vi = (-20)(5) = -100 \text{ W}$$

Power is being delivered by the box.

[b] Leaving

[c] Gaining

P 1.15 **[a]** In Car A, the current i is in the direction of the voltage drop across the 12 V battery(the current i flows into the + terminal of the battery of Car A). Therefore using the passive sign convention, $p = vi = (-40)(12) = -480$ W.

Since the power is negative, the battery in Car A is generating power, so Car B must have the "dead" battery.

[b] $w(t) = \int_0^t p\,dx; \qquad 1.5 \text{ min} = 1.5 \cdot \frac{60 \text{ s}}{1 \text{ min}} = 90 \text{ s}$

$$w(90) = \int_0^{90} 480\,dx$$

$$w = 480(90 - 0) = 480(90) = 43{,}200 \text{ J} = 43.2 \text{ kJ}$$

P 1.21 **[a]** $p = vi = 200\cos(500\pi t)4.5\sin(500\pi t) = 450\sin(1000\pi t)$ W

Therefore, $p_{\max} = 450$ W

[b] $p_{\max}(\text{extracting}) = 450$ W

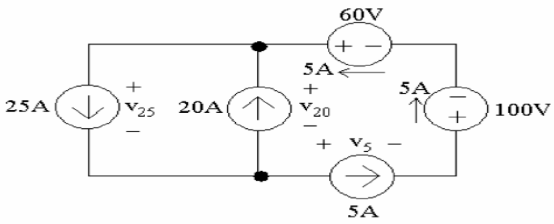
[c]

$$p_{\text{avg}} = \frac{1}{4\times10^{-3}}\int_0^{4\times10^{-3}} 450\sin(1000\pi x)\,dx = \frac{450}{4\times10^{-3}}\left[\frac{-\cos 1000\pi t}{1000\pi}\right]_0^{4\times10^{-3}}$$

$$= \frac{-450}{4\pi}[\cos 4\pi - \cos 0] = \frac{-450}{4\pi}[1 - 1] = 0 \text{ W}$$

[d] $p_{\text{avg}} = \frac{-450}{4\pi}[\cos 15\pi - \cos 0] = \frac{-450}{4\pi}[-1 - 1] = \frac{900}{4\pi} = 71.62$ W

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 2.9 First there is no violation of Kirchhoff's laws, hence the interconnection is valid. Kirchhoff's voltage law requires

$$-20 + 60 + v_1 - v_2 = 0 \qquad \text{so} \qquad v_1 - v_2 = -40\,\text{V}$$

The conservation of energy law requires

$$-(5 \times 10^{-3})v_2 - (15 \times 10^{-3})v_2 - (20 \times 10^{-3})(20) + (20 \times 10^{-3})(60) + (20 \times 10^{-3})v_1 = 0$$

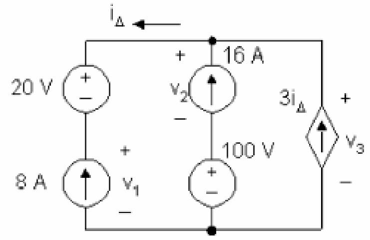
or

$$v_1 - v_2 = -40\,\text{V}$$

Hence any combination of v_1 and v_2 such that $v_1 - v_2 = -40\,\text{V}$ is a valid solution.

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

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