P 1.13 [a] Looking from A to B the current i is in the direction of the voltage rise across the 12 V battery, therefore $p = vi = -12(30) = -360$ W.

Thus the power flow is from B to A, and Car A has the "dead" battery.

[b] $$w = \int_0^t p\,dx = \int_0^t 360\,dx$$

$$w = 360t = 360(1 \times 60) = 21.6 \text{ kJ}$$

P 1.15 [a] $p = vi = 30e^{-500t} - 30e^{-1500t} - 40e^{-1000t} + 50e^{-2000t} - 10e^{-3000t}$

$p(1 \text{ ms}) = 3.1 \text{ mW}$

[b] $$\begin{aligned} w(t) &= \int_0^t (30e^{-500x} - 30e^{-1500x} - 40e^{-1000x} + \\ &\qquad 50e^{-2000x} - 10e^{-3000x})dx \\ &= 21.67 - 60e^{-500t} + 20e^{-1500t} + 40e^{-1000t} - \\ &\qquad 25e^{-2000t} + 3.33e^{-3000t}\,\mu\text{J} \end{aligned}$$

$$w(1 \text{ ms}) = 1.24\,\mu\text{J}$$

P 1.21 [a] $$\begin{aligned} p &= vi \\ &= 400 \times 10^3 t^2 e^{-800t} + 700te^{-800t} + 0.25e^{-800t} \\ &= e^{-800t}[400{,}000t^2 + 700t + 0.25] \\ \frac{dp}{dt} &= \{e^{-800t}[800 \times 10^3 t + 700] - 800e^{-800t}[400{,}000t^2 + 700t + 0.25]\} \\ &= 3{,}200{,}000t^2 - 2400t - 5 \end{aligned}$$

Therefore, $\frac{dp}{dt} = 0$ when $3{,}200{,}000t^2 - 2400t - 5 = 0$

so p_{max} occurs at $t = 1.68$ ms.

[b] $$\begin{aligned} p_{max} &= [400{,}000(.00168)^2 + 700(.00168) + 0.25]e^{-800(.00168)} \\ &= 666 \text{ mW} \end{aligned}$$

[c] $$w = \int_0^t p dx$$

$$w = \int_0^t 400{,}000x^2 e^{-800x}\,dx + \int_0^t 700xe^{-800x}\,dx + \int_0^t 0.25e^{-800x}\,dx$$

$$= \frac{400{,}000e^{-800x}}{-512 \times 10^6}[64 \times 10^4 x^2 + 1600x + 2]\Big|_0^t + \frac{700e^{-800x}}{64 \times 10^4}(-800x - 1)\Big|_0^t + 0.25\frac{e^{-800x}}{-800}\Big|_0^t$$

When $t = \infty$ all the upper limits evaluate to zero, hence

$$w = \frac{(400{,}000)(2)}{512 \times 10^6} + \frac{700}{64 \times 10^4} + \frac{0.25}{800} = 2.97 \text{ mJ}.$$

P 2.6 The interconnection is valid because it does not violate Kirchhoff's laws.

$$i_\Delta = -25 \text{ A}; \quad 6i_\Delta = -150 \text{ V}$$

$$-200 + 50 - (-150) = 0$$

P 2.9 The interconnection is valid because it does not violate Kirchhoff's laws:

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

P 2.12 [a] $v_o = 8i_a + 14i_a + 18i_a = 40(20) = 800$ V

$$800 = 10i_o$$

$$i_o = 800/10 = 80 \text{ A}$$

[b] $i_g = i_a + i_o = 20 + 80 = 100$ A

[c] $p_g(\text{delivered}) = (100)(800) = 80{,}000$ W $= 80$ kW