

1.1 If the current in an electric conductor is 2.4 A, how many coulombs of charge pass any point in a 30-second interval?

SOLUTION:

$$I = 2.4 \text{ A}, \Delta t = 30 \text{ s}$$

$$Q = I \cdot \Delta t$$

$$Q = 72 \text{ C}$$

1.2 Determine the time interval required for a 12-A battery charger to deliver 4800 C.

SOLUTION:

$$I = 12 \text{ A} , \quad Q = 4800 \text{ C}$$

$$\Delta t = \frac{Q}{I}$$

$$\Delta t = 400 \text{ s}$$

1.3 A lightning bolt carrying 30,000 A lasts for 50 micro-seconds. If the lightning strikes an airplane flying at 20,000 feet, what is the charge deposited on the plane?

SOLUTION:

$$I = 30,000 \text{ A}, \Delta t = 50 \mu\text{s}$$

$$Q = I \cdot \Delta t$$

$$Q = 1.5 \text{ C}$$

1.4 If a 12-V battery delivers 100 J in 5 s, find (a) the amount of charge delivered and (b) the current produced.

SOLUTION:

$$V = 12\text{ V}, \Delta W = 100\text{ J in } 5\text{ s}$$

$$\text{a) } \Delta Q = \frac{\Delta W}{V}$$

$$\Delta Q = 8.33\text{ C}$$

$$\text{b) } I = \frac{\Delta Q}{\Delta t}, \Delta t = 5\text{ s}$$

$$I = 1.67\text{ A}$$

1.5 The current in a conductor is 1.5 A. How many coulombs of charge pass any point in a time interval of 1.5 minutes?

SOLUTION:

$$I = 1.5 \text{ A}, \Delta t = 1.5 \text{ min} = 90 \text{ s}$$

$$Q = I \cdot \Delta t$$

$$Q = 135 \text{ C}$$

1.6 If 60 C of charge pass through an electric conductor in 30 seconds, determine the current in the conductor.

SOLUTION:

$$Q = 60\text{C}, \Delta t = 30\text{s}$$

$$I = \frac{Q}{\Delta t}$$

$$I = 2\text{A}$$

1.7 Determine the number of coulombs of charge produced by a 12-A battery charger in an hour.

SOLUTION:

$$I = 12 \text{ A} , \Delta t = 1 \text{ hr} = 60 \text{ min} = 3600 \text{ s}$$

$$Q = I \cdot \Delta t$$

$$Q = 43.2 \text{ kC}$$

- 1.8 Five coulombs of charge pass through the element in Fig. P1.8 from point *A* to point *B*. If the energy absorbed by the element is 120 J, determine the voltage across the element.

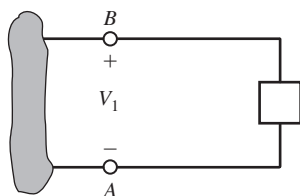


Figure P1.8

SOLUTION:

$$W = 120 \text{ J}, \quad Q = 5 \text{ C}$$

$$W = -V_1 \cdot Q$$

$$V_1 = -\frac{W}{Q}$$

$$V_1 = -24 \text{ V}$$

- 1.9 The current that enters an element is shown in Fig. P1.9. Find the charge that enters the element in the time interval $0 < t < 20$ s.

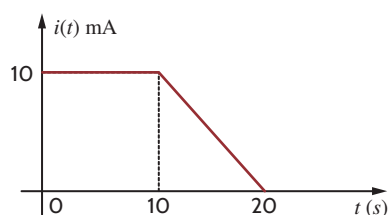


Figure P1.9

SOLUTION:

$$i(t) = m \cdot t + b$$

$$m = \frac{10\text{m} - 0}{10 - 20} = -1\text{m}$$

$$i(t) = -1\text{m} \cdot t + b$$

$$10\text{m} = -1\text{m} \cdot (10\text{s}) + b$$

$$b = 20\text{m}$$

$$i(t) = (-t + 20)\text{mA}$$

$$q(t) = \int_0^{20} i(t) dt$$

$$q(t) = \int_0^{10} 10 \times 10^{-3} dt + \int_{10}^{20} \frac{20-t}{1000} dt$$

$$q(t) = 10 \times 10^{-3} \cdot t \Big|_0^{10} + \frac{1}{1000} \cdot \left(20t - \frac{t^2}{2} \right) \Big|_{10}^{20}$$

$$q(t) = 0.15\text{C}, \quad 0 < t < 20\text{s}$$

- 1.10** The charge entering the positive terminal of an element is $q(t) = -30e^{-4t}$ mC. If the voltage across the element is $120e^{-2t}$ V, determine the energy delivered to the element in the time interval $0 < t < 50$ ms.

SOLUTION:

$$q(t) = -30e^{-4t} \text{ mC}$$

$$v(t) = 120e^{-2t} \text{ V}$$

$$W = \int_{t_1}^{t_2} P dt = \int_{t_1}^{t_2} v \cdot i dt$$

$$i(t) = \frac{dq(t)}{dt} = -4 \cdot (-30e^{-4t}) = 120e^{-4t} \text{ mA}$$

$$W = \int_0^{50\text{m}} (120e^{-2t}) \cdot (120e^{-4t} \times 10^{-3}) dt$$

$$W = 14.4 \cdot \left(\frac{e^{-6t}}{-6} \right) \Big|_0^{50\text{m}}$$

$$W = 622.04 \text{ mJ}$$

- 1.11 The charge entering the positive terminal of an element is given by the expression $q(t) = -12e^{-2t}$ mC. The power delivered to the element is $p(t) = 2.4e^{-3t}$ W. Compute the current in the element, the voltage across the element, and the energy delivered to the element in the time interval $0 < t < 100$ ms.

SOLUTION:

$$q(t) = -12e^{-2t} \text{ mC}$$

$$p(t) = 2.4e^{-3t} \text{ W}$$

$$i(t) = \frac{dq(t)}{dt} = -2 \cdot (-12e^{-2t})$$

$$i(t) = 24e^{-2t} \text{ mA}$$

$$W = \int_{t_1}^{t_2} p(t) dt = \int_0^{100\text{ms}} 2.4e^{-3t} dt$$

$$W = \left(\frac{2.4e^{-3t}}{-3} \right) \Big|_0^{100\text{ms}}$$

$$W = 207.35 \text{ mJ}$$

$$v(t) = \frac{p(t)}{i(t)}$$

$$v(t) = 100e^{-t} \text{ V}$$

- 1.12** The voltage across an element is $12e^{-2t}$ V. The current entering the positive terminal of the element is $2e^{-2t}$ A. Find the energy absorbed by the element in 1.5 s starting from $t = 0$.

SOLUTION:

$$v(t) = 12e^{-2t} \text{ V}$$

$$i(t) = 2e^{-2t} \text{ A}$$

$$W = \int_{t_1}^{t_2} v \cdot i \, dt = \int_0^{1.5} (12e^{-2t}) \cdot (2e^{-2t}) \, dt$$

$$W = \left. \frac{(24e^{-4t})}{-4} \right|_0^{1.5}$$

$$W = 5.99 \text{ J}$$

- 1.13 The power absorbed by the BOX in Fig. P1.13 is $2e^{-2t}$ W. Calculate the amount of charge that enters the BOX between 0.1 and 0.4 seconds.

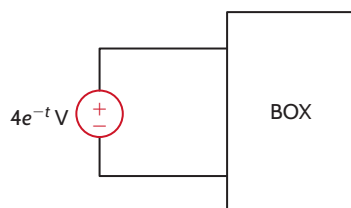


Figure P1.13

SOLUTION:

$$P(t) = 2e^{-2t} \text{ W}$$

$$V(t) = 4e^{-t} \text{ V}$$

$$i(t) = \frac{P(t)}{V(t)} = 0.5e^{-t} \text{ A}$$

$$\begin{aligned} \Delta q(t) &= \int_{0.1}^{0.4} i(t) dt \\ &= (-0.5e^{-t}) \Big|_{0.1}^{0.4} \end{aligned}$$

$$q(t) = 117.26 \text{ mC}, \quad 0.1\text{s} < t < 0.4\text{s}$$

- 1.14 The power absorbed by the BOX in Fig. P1.14 is $0.1e^{-4t}$ W. Calculate the energy absorbed by the BOX during this same time interval.

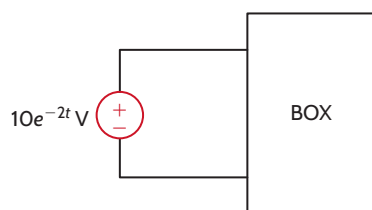


Figure P1.14

SOLUTION:

$$P(t) = 0.1e^{-4t} \text{ W}$$

$$W = \int p(t) dt = \int_0^{\infty} 0.1e^{-4t} dt$$

$$W = \left. \frac{0.1e^{-4t}}{-4} \right|_0^{\infty}$$

$$W = 25 \text{ mJ}$$

1.15 The energy absorbed by the BOX in Fig. P1.15 is shown below. How much charge enters the BOX between 0 and 10 milliseconds?

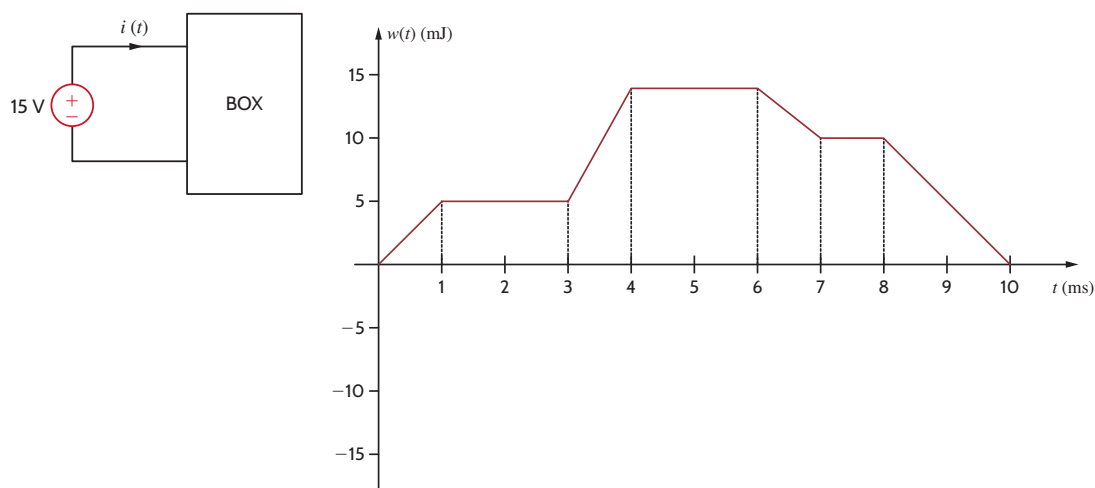


Figure P1.15

SOLUTION:

$$P = \frac{dw}{dt}$$

$$P = v \cdot i = (15) \cdot i$$

$$\underline{0 \leq t \leq 1 \text{ ms}}$$

$$P = \frac{5 \text{ m} - 0}{1 \text{ m} - 0} = 5 \text{ W}, \quad i = \frac{P}{V} = \frac{5}{15} = \frac{1}{3} \text{ A}$$

$$\underline{1 \text{ ms} \leq t \leq 3 \text{ ms}}$$

$$P = \frac{5 \text{ m} - 5 \text{ m}}{3 \text{ m} - 1 \text{ m}} = 0 \text{ W}, \quad i = 0 \text{ A}$$

$$\underline{3 \text{ ms} \leq t \leq 4 \text{ ms}}$$

$$P = \frac{15 \text{ m} - 5 \text{ m}}{4 \text{ m} - 3 \text{ m}} = 10 \text{ W}, \quad i = \frac{P}{V} = \frac{10}{15} = \frac{2}{3} \text{ A}$$

$$\underline{4 \text{ ms} \leq t \leq 6 \text{ ms}}$$

$$P = \frac{15 \text{ m} - 15 \text{ m}}{6 \text{ m} - 4 \text{ m}} = 0 \text{ W}, \quad i = 0 \text{ A}$$

$$\underline{6\text{ms} \leq t \leq 7\text{ms}}$$

$$P = \frac{10\text{m} - 15\text{m}}{7\text{m} - 6\text{m}} = -5\text{W}, \quad i = \frac{P}{V} = \frac{-5}{15} = -\frac{1}{3}\text{A}$$

$$\underline{7\text{ms} \leq t \leq 8\text{ms}}$$

$$P = \frac{10\text{m} - 10\text{m}}{8\text{m} - 7\text{m}} = 0\text{W}, \quad i = 0\text{A}$$

$$\underline{8\text{ms} \leq t \leq 10\text{ms}}$$

$$P = \frac{0 - 10\text{m}}{10\text{m} - 8\text{m}} = -5\text{W}, \quad i = \frac{P}{V} = \frac{-5}{15} = -\frac{1}{3}\text{A}$$

$$\Delta q = \int i \, dt$$

$$\Delta q = \left(\frac{1}{3}\right)(1\text{m}) + \left(\frac{2}{3}\right)(1\text{m}) + \left(-\frac{1}{3}\right)(1\text{m}) + \left(-\frac{1}{3}\right)(2\text{m})$$

$$\Delta q = 0\text{C}$$

1.16 The charge that enters the BOX in Fig. P1.16 is shown in the graph below. Calculate and sketch the current flowing into and the power absorbed by the BOX between 0 and 10 milliseconds.

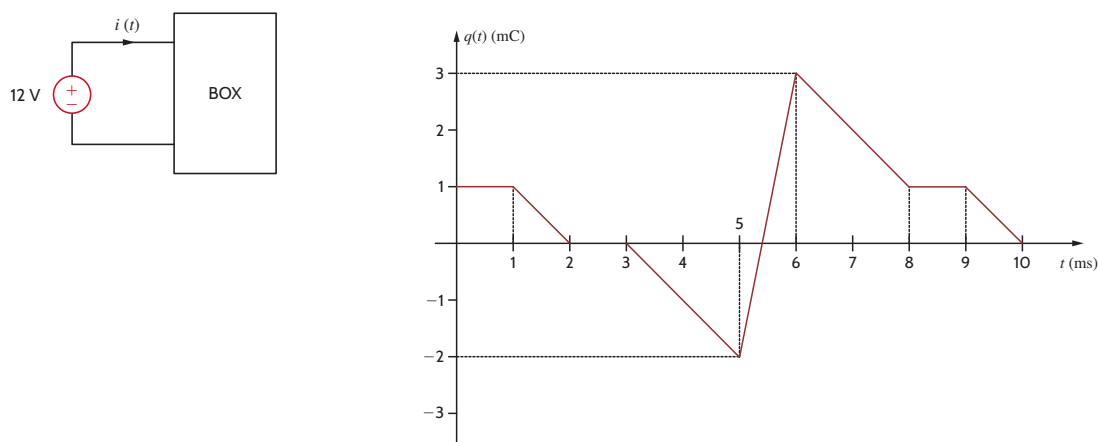


Figure P1.16

SOLUTION:

$$i(t) = \frac{dq}{dt}$$

$$P = V \cdot i = (12) \cdot i$$

$$\underline{0 \leq t \leq 1 \text{ ms}}$$

$$i = \frac{1 \text{ m} - 1 \text{ m}}{1 \text{ m} - 0} = 0 \text{ A}, \quad P = 0 \text{ W}$$

$$\underline{1 \text{ ms} \leq t \leq 2 \text{ ms}}$$

$$i = \frac{0 - 1 \text{ m}}{2 \text{ m} - 1 \text{ m}} = -1 \text{ A}, \quad P = (12) \cdot (-1) = -12 \text{ W}$$

$$\underline{2 \text{ ms} \leq t \leq 3 \text{ ms}}$$

$$i = \frac{0 - 0}{3 \text{ m} - 2 \text{ m}} = 0 \text{ A}, \quad P = 0 \text{ W}$$

$$\underline{3\text{ms} \leq t \leq 5\text{ms}}$$

$$i = \frac{-2\text{m} - 0}{5\text{m} - 3\text{m}} = -1\text{A}, \quad P = (12)(-1) = -12\text{W}$$

$$\underline{5\text{ms} \leq t \leq 6\text{ms}}$$

$$i = \frac{3\text{m} - (-2\text{m})}{6\text{m} - 5\text{m}} = 5\text{A}, \quad P = (12)(5) = 60\text{W}$$

$$\underline{6\text{ms} \leq t \leq 8\text{ms}}$$

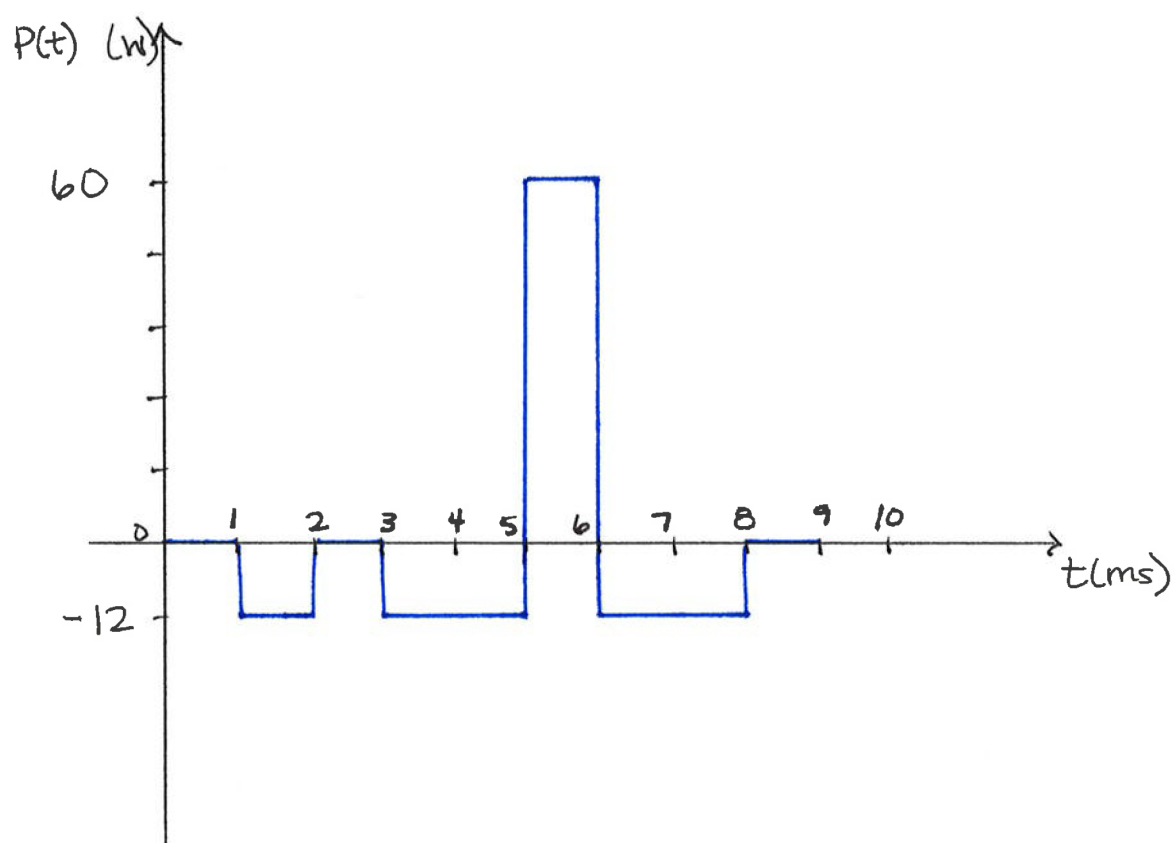
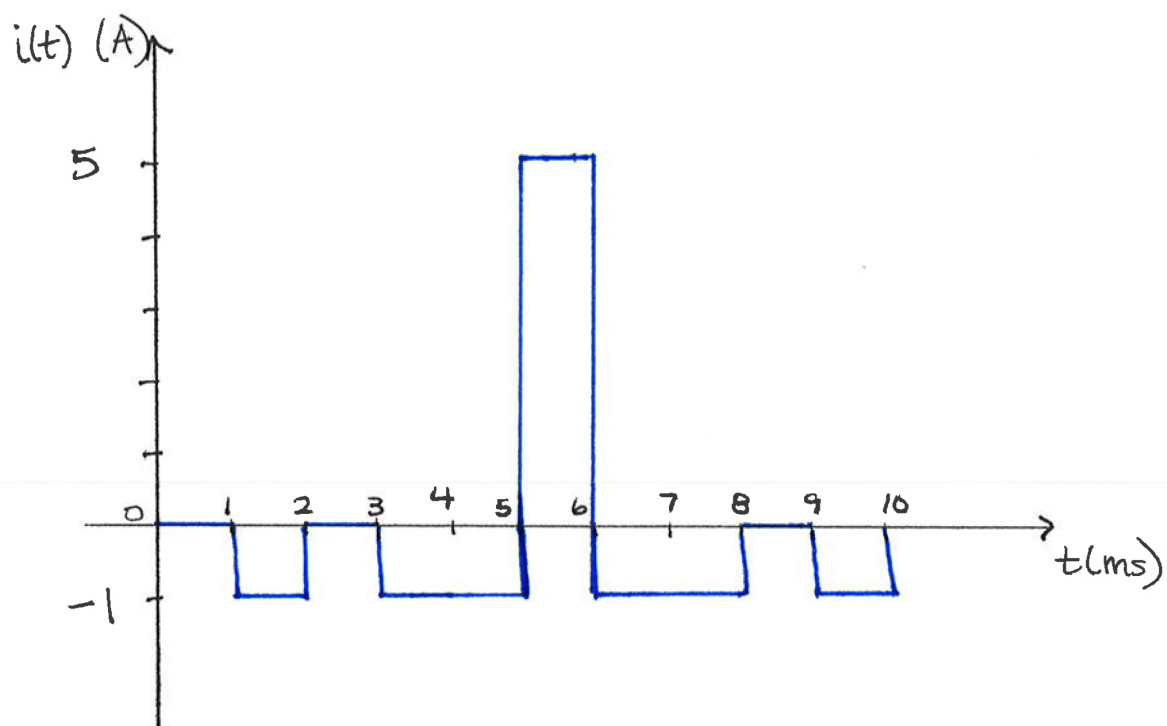
$$i = \frac{1\text{m} - 3\text{m}}{8\text{m} - 6\text{m}} = -1\text{A}, \quad P = (12)(-1) = -12\text{W}$$

$$\underline{8\text{ms} \leq t \leq 9\text{ms}}$$

$$i = \frac{1\text{m} - 1\text{m}}{9\text{m} - 8\text{m}} = 0\text{A}, \quad P = 0\text{W}$$

$$\underline{9\text{ms} \leq t \leq 10\text{ms}}$$

$$i = \frac{0 - 1\text{m}}{10\text{m} - 9\text{m}} = -1\text{A}, \quad P = (12)(-1) = -12\text{W}$$



- 1.17 The energy absorbed by the BOX in Fig. P1.17 is given below. Calculate and sketch the current flowing into the BOX. Also calculate the charge which enters the BOX between 0 and 12 seconds.

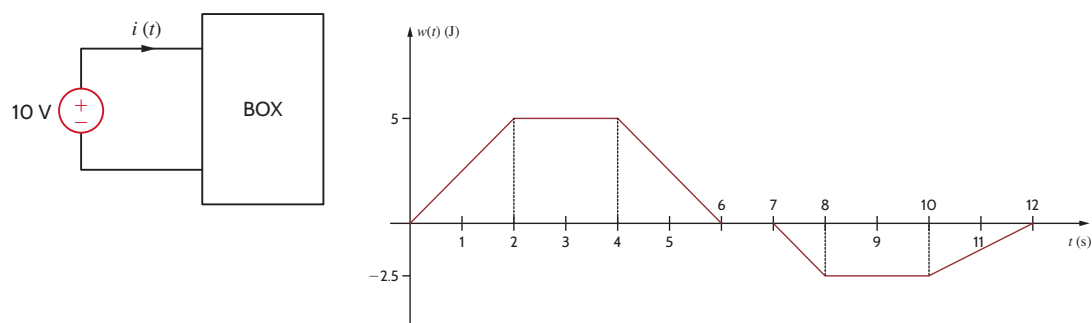


Figure P1.17

SOLUTION:

$$P = \frac{dW}{dt}$$

$$P = V \cdot i = (10) \cdot i$$

$$\underline{0s \leq t \leq 2s}$$

$$P = \frac{5-0}{2-0} = 2.5W, \quad i = \frac{P}{V} = \frac{2.5}{10} = \frac{1}{4}A$$

$$\underline{2s \leq t \leq 4s}$$

$$P = \frac{5-5}{4-2} = 0W, \quad i = 0A$$

$$\underline{4s \leq t \leq 6s}$$

$$P = \frac{0-5}{6-4} = -2.5W, \quad i = \frac{P}{V} = \frac{-2.5}{10} = -\frac{1}{4}A$$

$$\underline{6s \leq t \leq 7s}$$

$$P = \frac{0-0}{7-6} = 0 \text{ W}, \quad i = 0 \text{ A}$$

$$\underline{7s \leq t \leq 8s}$$

$$P = \frac{-2.5-0}{8-7} = -2.5 \text{ W}, \quad i = \frac{P}{V} = \frac{-2.5}{10} = -\frac{1}{4} \text{ A}$$

$$\underline{8s \leq t \leq 10s}$$

$$P = \frac{-2.5-(-2.5)}{10-8} = 0 \text{ W}, \quad i = 0 \text{ A}$$

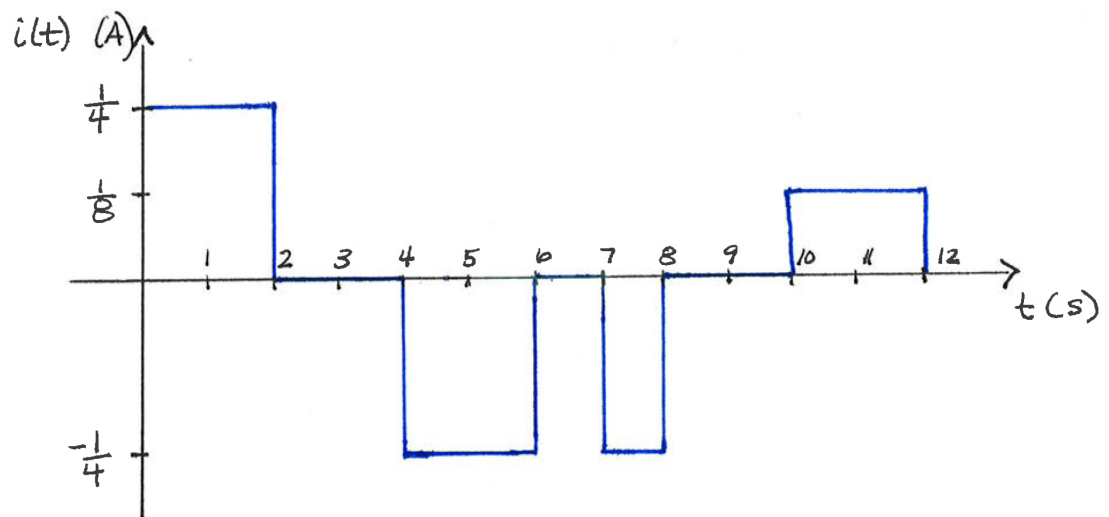
$$\underline{10s \leq t \leq 12s}$$

$$P = \frac{0-(-2.5)}{12-10} = 1.25 \text{ W}, \quad i = \frac{P}{V} = \frac{1.25}{10} = \frac{1}{8} \text{ A}$$

$$q = \int i \, dt$$

$$q = \left(\frac{1}{4}\right)(2) + \left(-\frac{1}{4}\right)(2) + \left(-\frac{1}{4}\right)(1) + \left(\frac{1}{8}\right)(2)$$

$$q = 0 \text{ C}$$



1.18 The charge entering the upper terminal of the BOX in Fig. P1.18 is shown below. How much energy is absorbed by the BOX between 0 and 9 seconds?

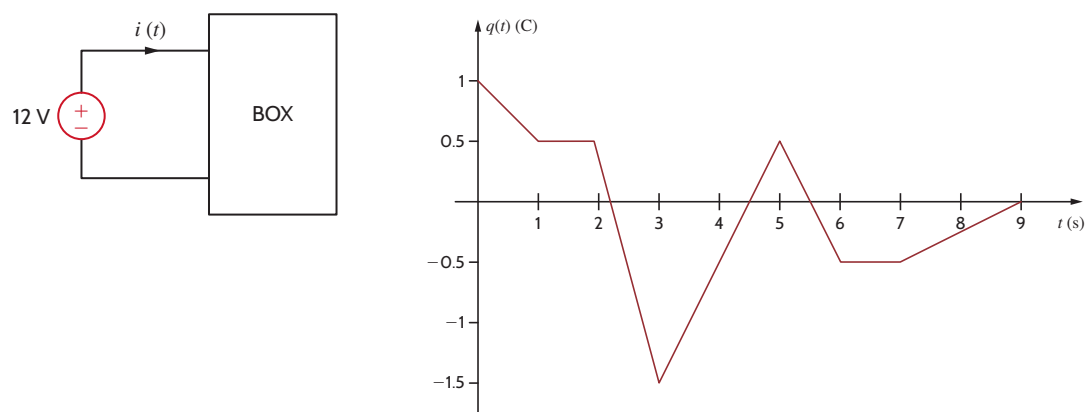


Figure P1.18

SOLUTION:

$$i(t) = \frac{dq}{dt}$$

$$P = V \cdot i = (12) \cdot i$$

$$\underline{0s \leq t \leq 1s}$$

$$i = \frac{0.5 - 1}{1 - 0} = -0.5A, \quad P = (12) \cdot (-0.5) = -6W$$

$$\underline{1s \leq t \leq 2s}$$

$$i = \frac{0.5 - 0.5}{2 - 1} = 0A, \quad P = 0W$$

$$\underline{2s \leq t \leq 3s}$$

$$i = \frac{-1.5 - 0.5}{3 - 2} = -2A, \quad P = (12) \cdot (-2) = -24W$$

$$\underline{3s \leq t \leq 5s}$$

$$i = \frac{0.5 - (-1.5)}{5 - 3} = 1A, \quad P = (12)(1) = 12W$$

$$\underline{5s \leq t \leq 6s}$$

$$i = \frac{-0.5 - 0.5}{6 - 5} = -1A, \quad P = (12)(-1) = -12W$$

$$\underline{6s \leq t \leq 7s}$$

$$i = \frac{-0.5 - (-0.5)}{7 - 6} = 0A, \quad P = 0W$$

$$\underline{7s \leq t \leq 9s}$$

$$i = \frac{0 - (-0.5)}{9 - 7} = 0.25A, \quad P = (12)(0.25) = 3W$$

$$W = \int P dt$$

$$W = (-6)(1) + (-12)(1) + (12)(2) + (-12)(1) + (3)(2)$$

$$W = -12J$$

- 1.19 The energy absorbed by the BOX in Fig. P1.19 is shown in the graph below. Calculate and sketch the current flowing into the BOX between 0 and 10 milliseconds.

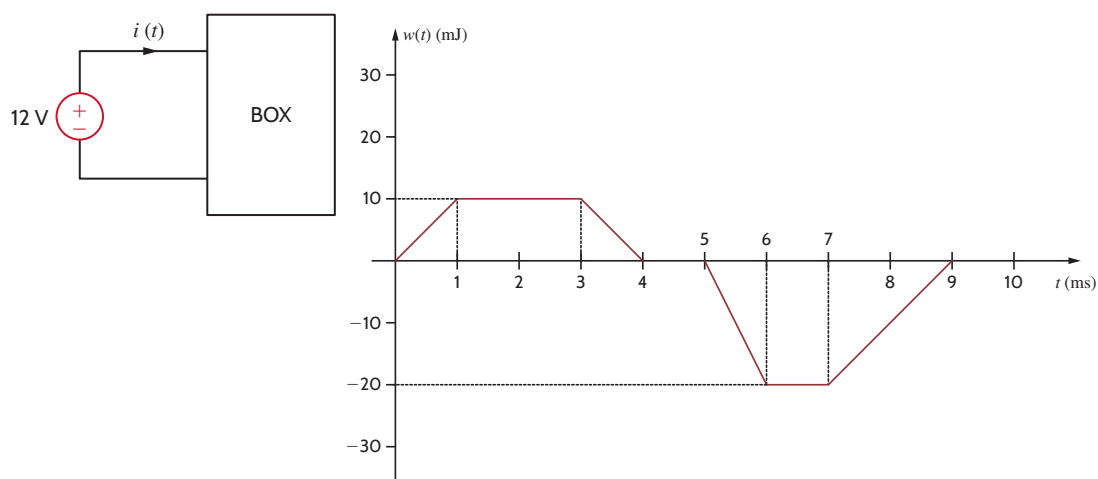


Figure P1.19

SOLUTION:

$$P = \frac{dW}{dt}$$

$$P = V \cdot i = (12) \cdot i$$

$$\underline{0 \leq t \leq 1 \text{ ms}}$$

$$P = \frac{10 \text{ m} - 0}{1 \text{ m} - 0} = 10 \text{ W}, \quad i = \frac{P}{V} = \frac{10}{12} = \frac{5}{6} \text{ A}$$

$$\underline{1 \text{ ms} \leq t \leq 3 \text{ ms}}$$

$$P = \frac{10 \text{ m} - 10 \text{ m}}{3 \text{ m} - 1 \text{ m}} = 0 \text{ W}, \quad i = 0 \text{ A}$$

$$\underline{3 \text{ ms} \leq t \leq 4 \text{ ms}}$$

$$P = \frac{0 - 10 \text{ m}}{4 \text{ m} - 3 \text{ m}} = -10 \text{ W}, \quad i = \frac{P}{V} = \frac{-10}{12} = -\frac{5}{6} \text{ A}$$

$$\underline{4\text{ms} \leq t \leq 5\text{ms}}$$

$$P = \frac{0-0}{5\text{m}-4\text{m}} = 0\text{W}, \quad i = 0\text{A}$$

$$\underline{5\text{ms} \leq t \leq 6\text{ms}}$$

$$P = \frac{-20\text{m}-0}{6\text{m}-5\text{m}} = -20\text{W}, \quad i = \frac{P}{V} = \frac{-20}{12} = -\frac{5}{3}\text{A}$$

$$\underline{6\text{ms} \leq t \leq 7\text{ms}}$$

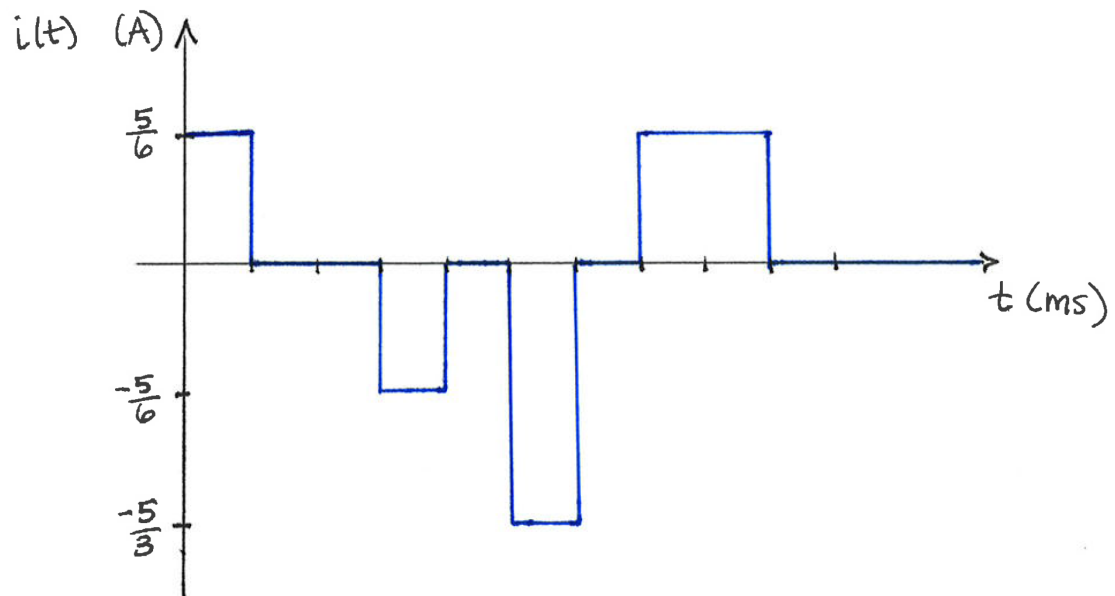
$$P = \frac{-20\text{m}-(-20\text{m})}{7\text{m}-6\text{m}} = 0\text{W}, \quad i = 0\text{A}$$

$$\underline{7\text{ms} \leq t \leq 9\text{ms}}$$

$$P = \frac{0-(-20\text{m})}{9\text{m}-7\text{m}} = 10\text{W}, \quad i = \frac{P}{V} = \frac{10}{12} = \frac{5}{6}\text{A}$$

$$\underline{t > 9\text{ms}}$$

$$P = 0\text{W}, \quad i = 0\text{A}$$



1.20 Determine the amount of power absorbed or supplied by the element in Fig. P1.20 if

- (a) $V_1 = 9 \text{ V}$ and $I = 2 \text{ A}$
- (b) $V_1 = 9 \text{ V}$ and $I = -3 \text{ A}$
- (c) $V_1 = -12 \text{ V}$ and $I = 2 \text{ A}$
- (d) $V_1 = -12 \text{ V}$ and $I = -3 \text{ A}$

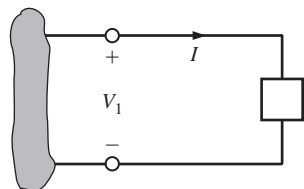


Figure P1.20

SOLUTION:

a) $V_1 = 9 \text{ V}, I = 2 \text{ A}$

$$P = V_1 \cdot I = 18 \text{ W absorbed}$$

b) $V_1 = 9 \text{ V}, I = -3 \text{ A}$

$$P = V_1 \cdot I = -27 \text{ W}$$

$$P = 27 \text{ W supplied}$$

c) $V_1 = -12 \text{ V}, I = 2 \text{ A}$

$$P = V_1 \cdot I = -24 \text{ W}$$

$$P = 24 \text{ W supplied}$$

d) $V_1 = -12 \text{ V}, I = -3 \text{ A}$

$$P = V_1 \cdot I = 36 \text{ W absorbed}$$

1.21 Calculate the power absorbed by element A in Fig. P1.21.

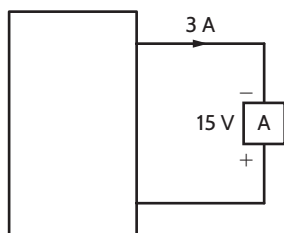
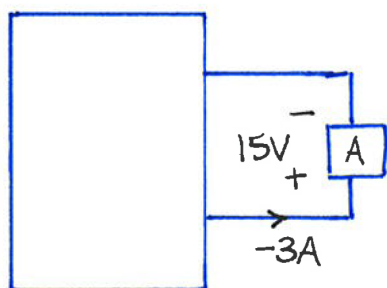


Figure P1.21

SOLUTION:



$$P_A = (15)(-3)$$

$$P_A = -45 \text{ W absorbed}$$

1.22 Calculate the power supplied by element A in Fig. P1.22.

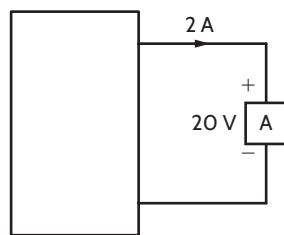
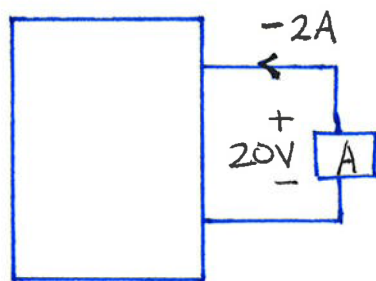


Figure P1.22

SOLUTION:



$$P_A = (20)(-2)$$

$$P_A = -40 \text{ W supplied}$$

1.23 Element A in the diagram in Fig. P1.23 absorbs 30 W of power. Calculate V_x .

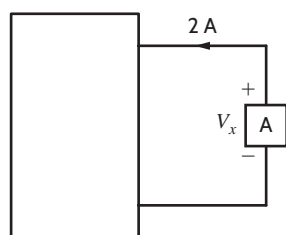
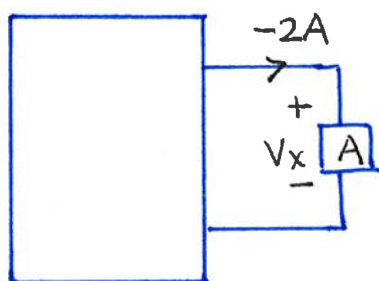


Figure P1.23

SOLUTION:



$$30 = V_x \cdot (-2)$$

$$V_x = -15 \text{ V}$$

1.24 Element B in the diagram in Fig. P1.24 supplies 60 W of power. Calculate I_x .

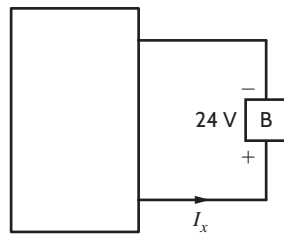
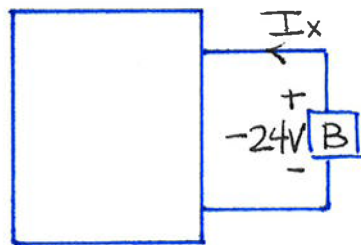


Figure P1.24

SOLUTION:



$$60 = (-24) \cdot I_x$$

$$I_x = -2.5 \text{ A}$$

1.25 Element B in the diagram in Fig. P1.25 supplies 72 W of power. Calculate V_A .

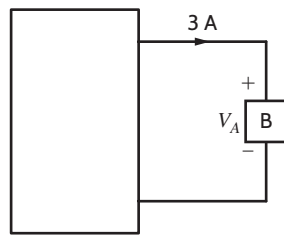
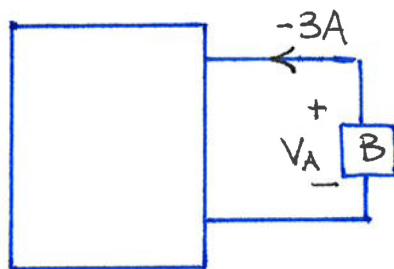


Figure P1.25

SOLUTION:



$$72 = V_A \cdot (-3)$$

$$V_A = -24 \text{ V}$$

1.26 Element B in the diagram in Fig. P1.26 supplies 72 W of power. Calculate I_x .

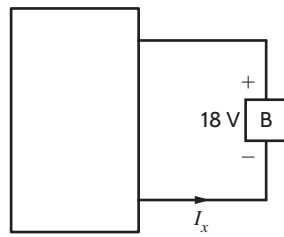


Figure P1.26

SOLUTION:

$$72 = (18) \cdot I_x$$

$$I_x = 4\text{A}$$

- 1.27 (a) In Fig. P1.27 (a), $P_1 = 36$ W. Is element 2 absorbing or supplying power, and how much?
 (b) In Fig. P1.27 (b), $P_2 = -48$ W. Is element 1 absorbing or supplying power, and how much?

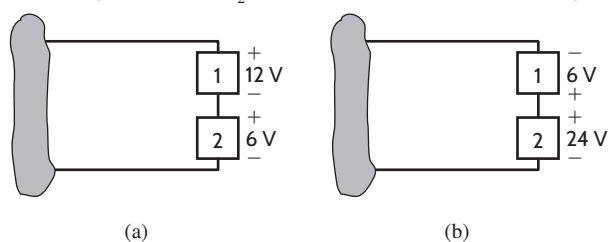


Figure P1.27

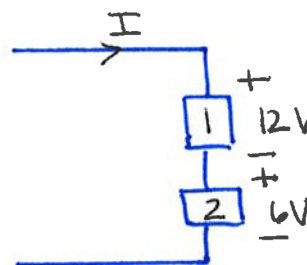
SOLUTION:

$$a) P_1 = 36 = V_1 \cdot I$$

$$I = \frac{36}{12} = 3 \text{ A}$$

$$P_2 = V_2 \cdot I = (6)(3)$$

$$P_2 = 18 \text{ W absorbed}$$

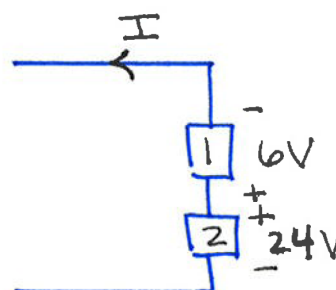


$$b) P_2 = -48 = -V_2 \cdot I$$

$$I = \frac{-48}{-24} = 2 \text{ A}$$

$$P_1 = V_1 \cdot I = (6)(2)$$

$$P_1 = 12 \text{ W absorbed}$$



- 1.28 Two elements are connected in series, as shown in Fig. P1.28. Element 1 supplies 24 W of power. Is element 2 absorbing or supplying power, and how much?

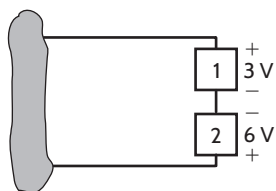


Figure P1.28

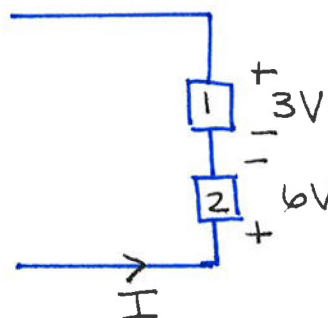
SOLUTION:

$$P_1 = 24 = V_1 \cdot I$$

$$I = \frac{24}{3} = 8 \text{ A}$$

$$P_2 = V_2 \cdot I = (6)(8)$$

$$P_2 = 48 \text{ W absorbed}$$



1.29 Element 2 in Fig. P1.29 absorbed 32 W. Find the power absorbed or supplied by elements 1 and 3.

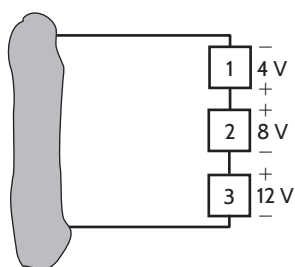


Figure P1.29

SOLUTION:

$$P_2 = 32 = V_2 \cdot I$$

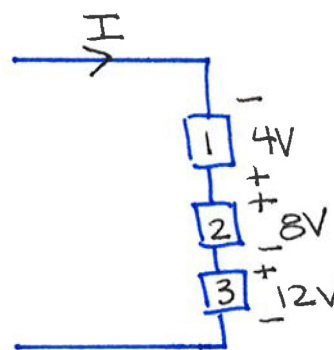
$$I = \frac{32}{8} = 4 \text{ A}$$

$$P_1 = V_1 \cdot (-I) = (4)(-4)$$

$$P_1 = 16 \text{ W supplied}$$

$$P_3 = V_3 \cdot I = (12)(4)$$

$$P_3 = 48 \text{ W absorbed}$$



1.30 Choose I_s such that the power absorbed by element 2 in Fig. P1.30 is 7 W.

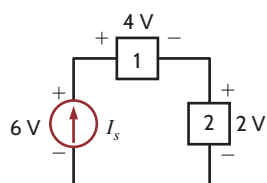


Figure P1.30

SOLUTION:

$$P_2 = 7 = V_2 \cdot I_s$$

$$I_s = \frac{7}{2}$$

$$I_s = 3.5 \text{ A}$$

1.31 Find the power that is absorbed or supplied by the circuit elements in Fig. P1.31.

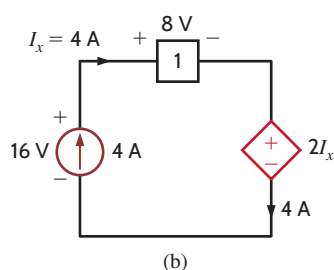
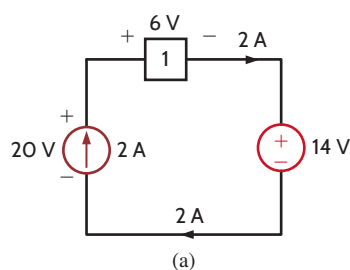


Figure P1.31

SOLUTION:

$$a) P_{2A} = (-20)(2) = -40 \text{ W}$$

$$P_{2A} = 40 \text{ W supplied}$$

$$P_1 = (6)(2) = 12 \text{ W absorbed}$$

$$P_{14V} = (14)(2) = 28 \text{ W absorbed}$$

$$b) P_{4A} = (-16)(4) = -64 \text{ W}$$

$$P_{4A} = 64 \text{ W supplied}$$

$$P_1 = (8)(4) = 32 \text{ W absorbed}$$

$$P_{2I_x} = [2(4)](4) = 32 \text{ W absorbed}$$

1.32 Find the power that is absorbed or supplied by the network elements in Fig. P1.32.

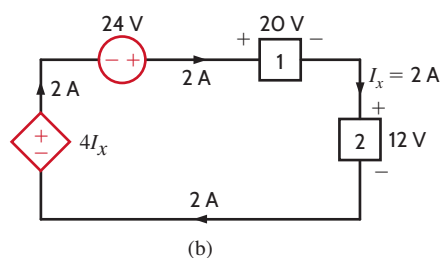
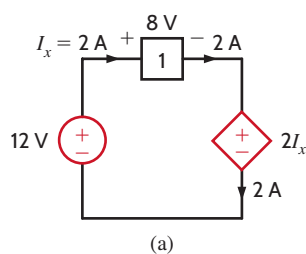


Figure P1.32

SOLUTION:

$$a) P_{12V} = (-12)(2) = -24 \text{ W}$$

$$P_{12V} = 24 \text{ W supplied}$$

$$P_1 = (8)(2) = 16 \text{ W absorbed}$$

$$P_{2I_x} = [2 \cdot (2)] \cdot (2) = 8 \text{ W absorbed}$$

$$b) P_{4I_x} = [-4(2)] \cdot (2) = -16 \text{ W}$$

$$P_{4I_x} = 16 \text{ W supplied}$$

$$P_{24V} = (-24)(2) = -48 \text{ W}$$

$$P_{24V} = 48 \text{ W supplied}$$

$$P_1 = (20) \cdot (2) = 40 \text{ W absorbed}$$

$$P_2 = (12) \cdot (2) = 24 \text{ W absorbed}$$

1.33 Compute the power that is absorbed or supplied by the elements in the network in Fig. P1.33.

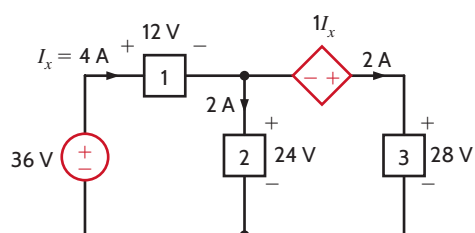


Figure P1.33

SOLUTION:

$$P_{36V} = (-36) \cdot I_x = (-36)(4) = -144 \text{ W}$$

$$P_{36V} = 144 \text{ W supplied}$$

$$P_1 = (12) \cdot I_x = (12)(4) = 48 \text{ W absorbed}$$

$$P_2 = (24) \cdot (2) = 48 \text{ W absorbed}$$

$$P_{1I_x} = [-1(4)] \cdot (2) = -8 \text{ W}$$

$$P_{1I_x} = 8 \text{ W supplied}$$

$$P_3 = (28) \cdot (2) = 56 \text{ W absorbed}$$

1.34 Find the power that is absorbed or supplied by element 2 in Fig. P1.34.

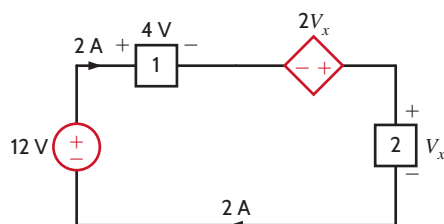


Figure P1.34

SOLUTION:

$$P_{12V} = (-12)(2) = -24 \text{ W} \rightarrow 24 \text{ W supplied}$$

$$P_1 = (4)(2) = 8 \text{ W} \rightarrow 8 \text{ W absorbed}$$

$$P_{2V_x} = (-2V_x)(2) = -4V_x \text{ W} \rightarrow 4V_x \text{ W supplied}$$

$$P_2 = (V_x)(2) = 2V_x \text{ W} \rightarrow 2V_x \text{ W absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$24 + 4V_x = 8 + 2V_x$$

$$V_x = -8 \text{ V}$$

$$P_2 = (-8)(2) = -16 \text{ W}$$

$$P_2 = 16 \text{ W supplied}$$

1.35 Find I_x in the network in Fig. P1.35.

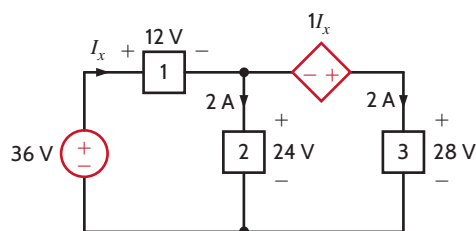


Figure P1.35

SOLUTION:

$$P_{36V} = (-36) \cdot I_x = -36I_x \text{ W} \rightarrow 36I_x \text{ W supplied}$$

$$P_1 = (12) \cdot I_x = 12I_x \text{ W} \rightarrow 12I_x \text{ W absorbed}$$

$$P_2 = (24) \cdot (2) = 48 \text{ W} \rightarrow 48 \text{ W absorbed}$$

$$P_{I_x} = [1(I_x)] \cdot 2 = 2I_x \text{ W} \rightarrow 2I_x \text{ W supplied}$$

$$P_3 = (28) \cdot (2) = 56 \text{ W} \rightarrow 56 \text{ W absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$36I_x + 2I_x = 12I_x + 48 + 56$$

$$I_x = 4 \text{ A}$$

1.36 Determine the power absorbed by element 1 in Fig. P1.36.

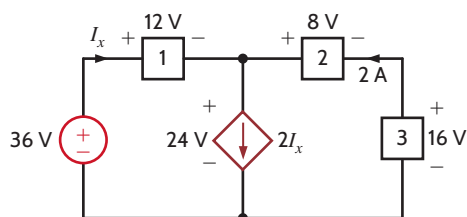


Figure P1.36

SOLUTION:

$$P_{36V} = (-36) \cdot I_x = -36 \cdot I_x \text{ W} \rightarrow 36I_x \text{ W supplied}$$

$$P_1 = (12) \cdot I_x = 12I_x \text{ W} \rightarrow 12 \cdot I_x \text{ W absorbed}$$

$$P_{2I_x} = (24) \cdot (2I_x) = 48 \cdot I_x \text{ W} \rightarrow 48I_x \text{ W absorbed}$$

$$P_2 = (-8)(2) = -16 \text{ W} \rightarrow 16 \text{ W supplied}$$

$$P_3 = (-16)(2) = -32 \text{ W} \rightarrow 32 \text{ W supplied}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$36I_x + 16 + 32 = 12I_x + 48I_x$$

$$I_x = 2 \text{ A}$$

$$P_1 = (12)(2) = 24 \text{ W absorbed}$$

1.37 Find the power absorbed or supplied by element 1 in Fig. P1.37.

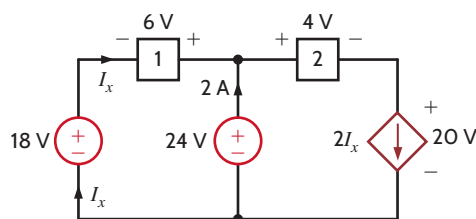


Figure P1.37

SOLUTION:

$$P_{18V} = (-18) \cdot I_x = -18I_x \text{ W} \rightarrow 18I_x \text{ W supplied}$$

$$P_1 = (-6) \cdot I_x = -6I_x \text{ W} \rightarrow 6I_x \text{ W supplied}$$

$$P_{24V} = (-24) \cdot (2) = -48 \text{ W} \rightarrow 48 \text{ W supplied}$$

$$P_2 = (4) \cdot (2I_x) = 8I_x \text{ W} \rightarrow 8I_x \text{ W absorbed}$$

$$P_{2I_x} = (20) \cdot (2I_x) = 40I_x \text{ W} \rightarrow 40I_x \text{ W absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$18I_x + 6I_x + 48 = 8I_x + 40I_x$$

$$I_x = 2 \text{ A}$$

$$P_1 = (-6) \cdot (2) = -12 \text{ W}$$

$$P_1 = 12 \text{ W supplied}$$

1.38 Find the power absorbed or supplied by element 3 in Fig. P1.38.

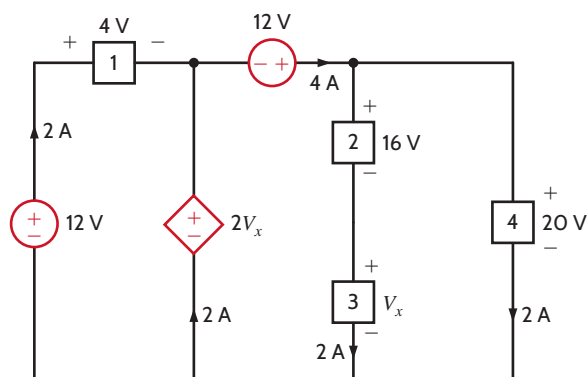


Figure P1.38

SOLUTION:

$$P_{12V} = (-12)(2) = -24 \text{ W} \rightarrow 24 \text{ W supplied}$$

$$P_1 = (4)(2) = 8 \text{ W} \rightarrow 8 \text{ W absorbed}$$

$$P_{2V_x} = (-2V_x)(2) = -4V_x \text{ W} \rightarrow 4V_x \text{ W supplied}$$

$$P_{12V} = (-12)(4) = -48 \text{ W} \rightarrow 48 \text{ W supplied}$$

$$P_2 = (16)(2) = 32 \text{ W} \rightarrow 32 \text{ W absorbed}$$

$$P_3 = V_x(2) = 2V_x \text{ W} \rightarrow 2V_x \text{ W absorbed}$$

$$P_4 = (20)(2) = 40 \text{ W} \rightarrow 40 \text{ W absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$24 + 4V_x + 48 = 8 + 32 + 2V_x + 40$$

$$V_x = 4 \text{ V}$$

$$P_3 = (4)(2) = 8 \text{ W absorbed}$$

1.39 Find the power absorbed or supplied by element 1 in Fig. P1.39.

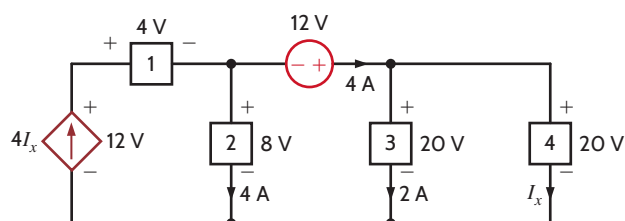


Figure P1.39

SOLUTION:

$$P_{4I_x} = (-12)(4I_x) = -48I_x \text{ W} \rightarrow 48I_x \text{ W supplied}$$

$$P_1 = (4)(4I_x) = 16I_x \text{ W} \rightarrow 16I_x \text{ W absorbed}$$

$$P_2 = (8)(4) = 32 \text{ W} \rightarrow 32 \text{ W absorbed}$$

$$P_{12V} = (-12)(4) = -48 \text{ W} \rightarrow 48 \text{ W supplied}$$

$$P_3 = (20)(2) = 40 \text{ W} \rightarrow 40 \text{ W absorbed}$$

$$P_4 = (20) \cdot I_x = 20I_x \text{ W} \rightarrow 20I_x \text{ W absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$48I_x + 48 = 16I_x + 32 + 40 + 20I_x$$

$$I_x = 2 \text{ A}$$

$$P_1 = 16(2) = 32 \text{ W absorbed}$$

1.40 Find V_x in the network in Fig. P1.40 using Tellegen's theorem.

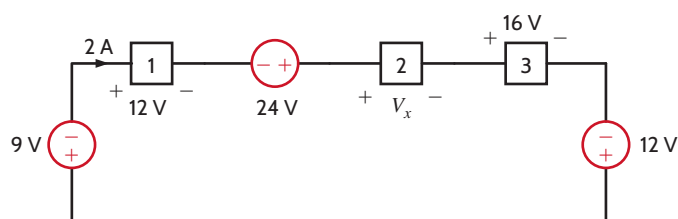


Figure P1.40

SOLUTION:

$$P_{9V} = (9)(2) = 18W \rightarrow 18W \text{ absorbed}$$

$$P_1 = (12)(2) = 24W \rightarrow 24W \text{ absorbed}$$

$$P_{24V} = (-24)(2) = -48W \rightarrow 48W \text{ supplied}$$

$$P_2 = V_x(2) = 2V_x W \rightarrow 2V_x W \text{ absorbed}$$

$$P_3 = (16)(2) = 32W \rightarrow 32W \text{ absorbed}$$

$$P_{12V} = (-12)(2) = -24W \rightarrow 24W \text{ supplied}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$48 + 24 = 18 + 24 + 2V_x + 32$$

$$V_x = -1V$$

1.41 Find I_x in the circuit in Fig. P1.41 using Tellegen's theorem.

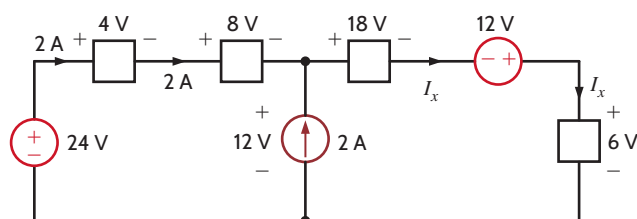


Figure P1.41

SOLUTION:

$$P_{24V} = (-24)(2) = -48W \rightarrow 48W \text{ supplied}$$

$$P_{4V} = (4)(2) = 8W \rightarrow 8W \text{ absorbed}$$

$$P_{8V} = (8)(2) = 16W \rightarrow 16W \text{ absorbed}$$

$$P_{2A} = (-12)(2) = -24W \rightarrow 24W \text{ supplied}$$

$$P_{18V} = (18)(I_x) = 18I_x W \rightarrow 18I_x W \text{ absorbed}$$

$$P_{12V} = (-12)(I_x) = -12I_x W \rightarrow 12I_x W \text{ supplied}$$

$$P_{6V} = (6)(I_x) = 6I_x W \rightarrow 6I_x W \text{ absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$48 + 24 + 12I_x = 8 + 16 + 18I_x + 6I_x$$

$$I_x = 4A$$

1.42 Is the source V_s in the network in Fig. P1.42 absorbing or supplying power, and how much?

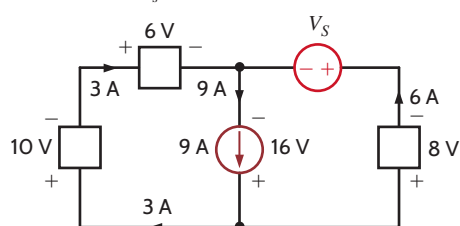


Figure P1.42

SOLUTION:

$$P_{10V} = (10)(3) = 30W \rightarrow 30W \text{ absorbed}$$

$$P_{6V} = (6)(3) = 18W \rightarrow 18W \text{ absorbed}$$

$$P_{9A} = (-16)(9) = -144W \rightarrow 144W \text{ supplied}$$

$$P_{V_s} = V_s(6) = 6V_s W \rightarrow 6V_s W \text{ absorbed}$$

$$P_{8V} = (8)(6) = 48W \rightarrow 48W \text{ absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$144 = 30 + 18 + 6V_s + 48$$

$$V_s = 8V$$

$$P_{V_s} = (8)(6) = 48W \text{ absorbed}$$

1.43 Find I_o in the network in Fig. P1.43 using Tellegen's theorem.

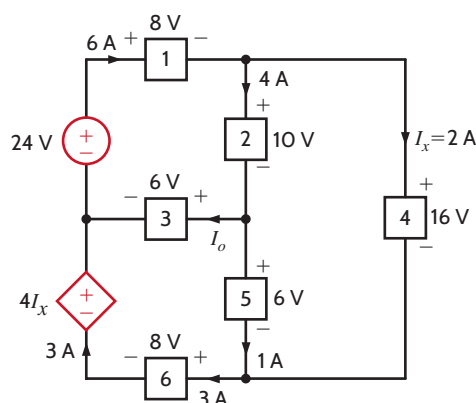


Figure P1.43

SOLUTION:

$$P_{24V} = (-24)(6) = -144 \text{ W} \rightarrow 144 \text{ W supplied}$$

$$P_{4I_x} = [-4(2)](3) = -24 \text{ W} \rightarrow 24 \text{ W supplied}$$

$$P_1 = (8)(6) = 48 \text{ W} \rightarrow 48 \text{ W absorbed}$$

$$P_2 = (10)(4) = 40 \text{ W} \rightarrow 40 \text{ W absorbed}$$

$$P_3 = (6) \cdot I_o = 6I_o \text{ W} \rightarrow 6I_o \text{ W absorbed}$$

$$P_4 = (16)(2) = 32 \text{ W} \rightarrow 32 \text{ W absorbed}$$

$$P_5 = (6)(1) = 6 \text{ W} \rightarrow 6 \text{ W absorbed}$$

$$P_6 = (8)(3) = 24 \text{ W} \rightarrow 24 \text{ W absorbed}$$

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$144 + 24 = 48 + 40 + 6I_o + 32 + 6 + 24$$

$$I_o = 3 \text{ A}$$

1.45 Calculate the power absorbed by each element in the circuit in Fig. P1.45. Also, verify that Tellegen's theorem is satisfied by this circuit.

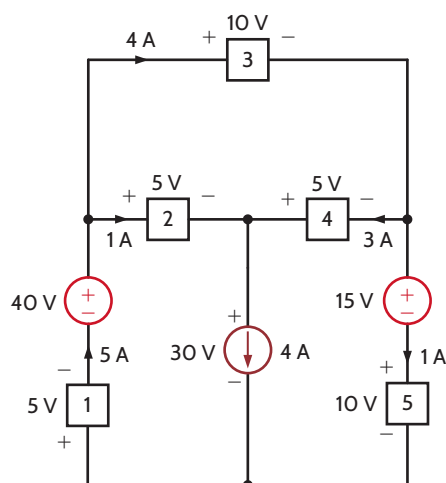


Figure P1.45

SOLUTION:

$$P_{40V} = (-40)(5) = -200 \text{ W} \rightarrow 200 \text{ W supplied}$$

$$P_{4A} = (30)(4) = 120 \text{ W} \rightarrow 120 \text{ W absorbed}$$

$$P_{15V} = (15)(1) = 15 \text{ W} \rightarrow 15 \text{ W absorbed}$$

$$P_1 = (5)(5) = 25 \text{ W} \rightarrow 25 \text{ W absorbed}$$

$$P_2 = (5)(1) = 5 \text{ W} \rightarrow 5 \text{ W absorbed}$$

$$P_3 = (10)(4) = 40 \text{ W} \rightarrow 40 \text{ W absorbed}$$

$$P_4 = (-5)(3) = -15 \text{ W} \rightarrow 15 \text{ W supplied}$$

$$P_5 = (10)(1) = 10 \text{ W} \rightarrow 10 \text{ W absorbed}$$

$$P_{\text{supplied}} - P_{\text{absorbed}} = 0$$

$$(200 + 15) - (120 + 15 + 25 + 5 + 40 + 10) = 0$$

$$(215) - (215) = 0 \checkmark$$

- 1.46 In the circuit in Fig. P1.46, element 1 absorbs 40 W, element 2 supplies 50 W, element 3 supplies 25 W, and element 4 absorbs 15 W. How much power is supplied by element 5?

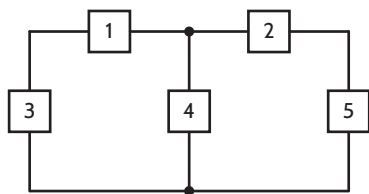


Figure P1.46

SOLUTION:

$$P_{\text{supplied}} = P_{\text{absorbed}}$$

$$P_2 + P_3 + P_5 = P_1 + P_4$$

$$50 + 25 + P_5 = 40 + 15$$

$$P_5 = -20\text{ W supplied}$$

OR

$$P_5 = 20\text{ W absorbed}$$