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:

$I = 2,4\ A\ ,\quad \Delta t = 30s$

$Q = 3\Delta t$

$Q = 2,4\,(30)$

$Q = 72\,C$

1.2 In charging a storage battery it is found that energy of 1watt-hr is expended in 15 minutes in sending 150 coulombs through the battery. What is the voltage between the battery terminals? What is the magnitude of the average charging current?

SOLUTION:

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

= 150C/15 x 60s

= 1/6A

P = VI

1Whr/15min = V x 1/6

V = 24V

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:

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

$Q = I \Delta t$

$Q = 30{,}000\,(50\mu)$

$Q = 1.5\ \text{C}$

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:

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

a) $\Delta Q = \dfrac{\Delta W}{V} = \dfrac{100}{12}$

$\Delta Q = 8.33\ C$

b) $I = \dfrac{\Delta Q}{\Delta t} = \dfrac{8.33}{5}$

$I = 1.67A$

1.5 The charge entering the positive terminal is given by $q(t) = -10e^{-t}$ mC. The power delivered to the element is $p(t) = 2e^{-2t}$ mW. Calculate the current in the element, voltage across the element and the energy delivered to the element in the interval $0 < t < 100$ ms.

SOLUTION:

$$I = \frac{dq}{dt}$$

$= 10e^{-t}$mA

Now, P = VI

Thus V = $0.2e^{--t}$V is the voltage across the element.

E = $\int p(t)dt$

= $\int_0^{0.2} 2e^{-t}$dt

= 0.362 mJ

1.6 The current at a given point in a certain circuit may be written as $i(t) = -3 + t$ A. Find the total charge passing the point between $t = 99$ and $t = 102$ s.

SOLUTION:

The charge passing through the circuit is q $= \int_{99}^{102} i(t)dt$

$=\int_{99}^{102}(-3 + t)dt$

$= \left(-3 \times 102 + \frac{102^2}{2}\right) - \left(-3 \times 99 + \frac{99^2}{2}\right)$

=292.5C

1.7 Five coulombs of charge pass through the element in Fig. P1.7 from point A to point B. If the energy absorbed by the element is 150 J, determine the voltage across the element.

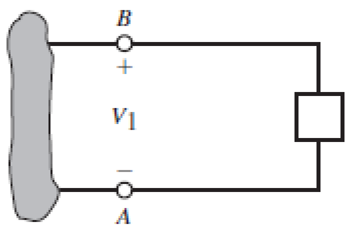
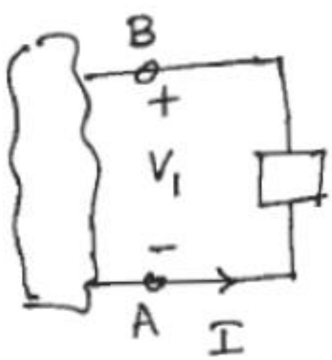


Figure P1.7

SOLUTION:



$Q = 5\ C$

$W = 150\ J$

For passive sign convention: $W = -V_1 Q$

$$V_1 = -\frac{W}{Q} \qquad \boxed{V_1 = -30\,V}$$

1.8 The current that enters an element is shown in Fig. P1.8. Find the charge that enters the element in the time interval $0 < t < 20$ s.

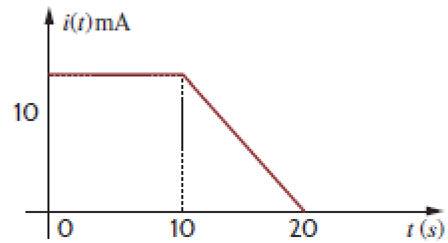


Figure P1.8

SOLUTION:

$$i(t) = m_1 t + b$$

$$m_1 = \frac{10-10}{10-20} = -1$$

$$i(t) = -t + b$$

$$10 = -10 + b$$

$$b = 20$$

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

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

$$q(t) = \int_0^{10} 10\times10^{-3}\,dt + \int_{10}^{20} \frac{20-t}{1000}\,dt$$

$$q(t) = 10\times10^{-3}t\Big]_0^{10} + \frac{1}{1000}\left[20t - \frac{t^2}{2}\right]_{10}^{20}$$

$$q(t) = 0.1 + \frac{1}{1000}\left[20(20) - \frac{(20)^2}{2} - 20(10) + \frac{(10)^2}{2}\right]$$

$$q(t) = 0.1 + \frac{1}{1000}\left[200 - 200 + 50\right]$$

$$q(t) = 0.15C$$

1.9 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:

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

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

$$W = \int_{t1}^{t2} P\,dt = \int_{t1}^{t2} Vi\,dt$$

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

$$i(t) = 120e^{-4t} \text{ mA}$$

$$W = \int_{t1}^{t2} (120e^{-2t})(120e^{-4t} m)\,dt$$

$$W = 14.4 \int_{0}^{50m} e^{-6t}\,dt$$

$$W = 14.4 \left[\frac{e^{-6t}}{-6} \right]^{50m}$$

$$W = 14.4 \left[\frac{e^{-6(50m)}}{-6} + \frac{e^{-6(0)}}{6} \right]$$

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

1.10 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:

$$q(t) = -12\, e^{-2t} \text{ mC}$$
$$p(t) = 2.4\, e^{-3t} \text{ W}$$
$$i(t) = \frac{dq(t)}{dt}$$
$$i(t) = 2(-12)e^{-2t}\ m$$
$$i(t) = 24\, e^{-2t} \text{ mA}$$
$$W = \int_{t1}^{t2} p(t)\, dt = \int_0^{100m} 2.4\, e^{-3t}\, dt$$
$$W = \frac{2.4}{-3}{}^{-3t}\Big]_0^{100m}$$
$$W = \frac{2.4}{-3}\left[e^{-3(100m)} - e^{-3(0)}\right]$$
$$W = 207.35 \text{ mJ}$$
$$V(t) = \frac{P(t)}{i(t)}$$
$$V(t) = \frac{2.4\, e^{-3t}}{24\, e^{-2t}\ m}$$
$$V(t) = 100\, e^{-t} \text{ V}$$

1.11 The charge entering the positive terminal of an element is $q(t) = -10e^{-2t}$ mC. If the voltage across the element is

$120e^{-2t}$ V. Determine the energy delivered to the element in the time interval $0 < t < 20$ ms.

SOLUTION:

$I = \frac{dq}{dt}$

$I = 20e^{-2t}$ mA

Now $E = \int VIdt$

$= \int_0^{20} 2.4e^{-4t}dt$

$= 0.011$ J

1.12 The power absorbed by the BOX in Fig. P1.12 is $2e^{-2t}$ W. Calculate the amount of charge that enters the BOX between 0.1 and 0.4 seconds.

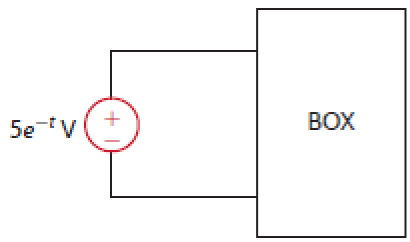
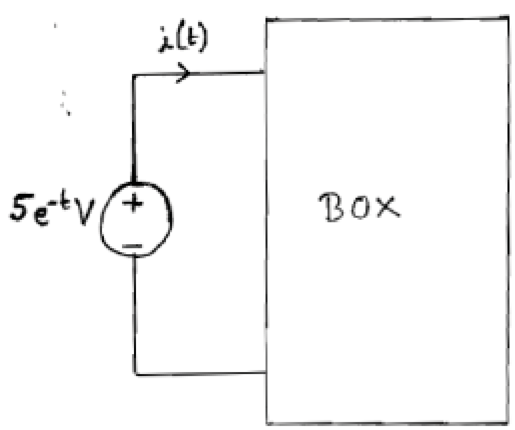


Figure P1.12

SOLUTION:



$$p = vi$$

$$2e^{-2t} = 5e^{-t} i$$

$$i = \frac{2e^{-2t}}{5e^{-t}} = 0.4e^{-t} \text{ A}$$

$$\Delta q(t) = \int_{0.1}^{0.4} i(t)\,dt$$

$$= \int_{0.1}^{0.4} 0.4e^{-t}\,dt$$

$$= -0.4e^{-t}\Big|_{0.1}^{0.4} = -0.4\left[e^{-0.4} - e^{-0.1}\right]$$

$$= 0.0938 \text{ C}$$

1.13 The charge flowing through a point in a circuit is given as a function of time as $q(t) = -t^3 + 6\,t^2 - 10t$, find $i(t)$ at $t = 5s$.

SOLUTION:

$$
\begin{aligned}
i(t) &= \frac{dq}{dt} \\
&= -3t^2 + 12t - 10 \\
&= -3 \times 5^2 + 12 \times 5 - 10 \\
&= -25A
\end{aligned}
$$

1.14 The current in a circuit $i(t)$ is given as e^{4t} A for $t < 0$ and e^{-4t} A for $t > 0$. Find:

(a) $i(0.25)$

(b) Average value of current over the interval $-0.25 < t < 0.25$

(c) The total charge that has passed during this interval

SOLUTION:

a. i(0.25) = e-4x0.25 = 0.368A

b. Average value of current = $\int_{-0.25}^{0.25} i(t)dt$

= 0.632A

c. Charge passed = Average current x Time

= 0.318A

1.15 The charge that enters the BOX is shown in Fig. P1.15. Calculate and sketch the current flowing into and the power absorbed by the BOX between 0 and 9 milliseconds. Also calculate the energy absorbed by the BOX between 0 and 9 milliseconds.

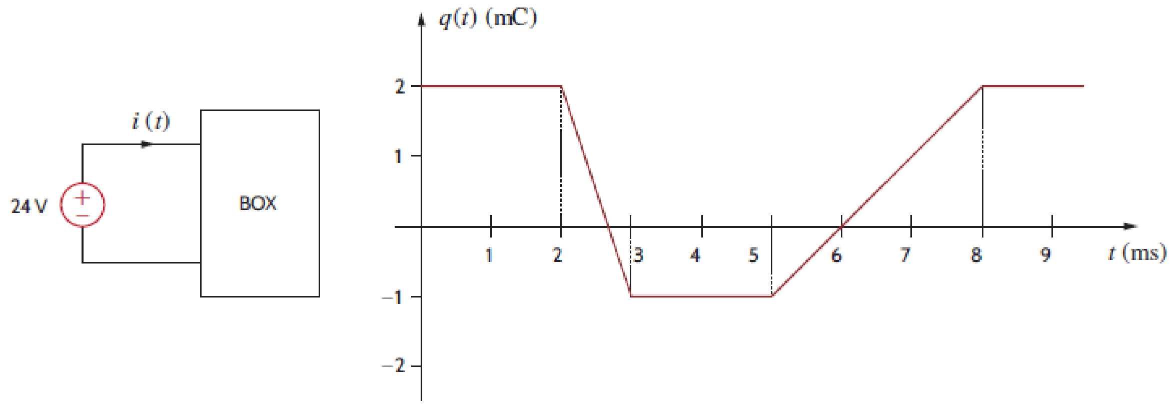


Figure P1.15

SOLUTION:

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

$q(t) = 2, \quad 0 \leq t \leq 2ms$

$m = \frac{-1-2}{3-2} = \frac{-3}{1} = -3$

$q(t) = m(t) + b$

$q(t) = -3t + b$

$2 = -3(2) + b$

$b = 8$

$q(t) = -3t + 8, \quad 2ms \leq t \leq 3ms$

$q(t) = -1, \quad 3ms \leq t \; 5ms$

$q(t) = mt + b$

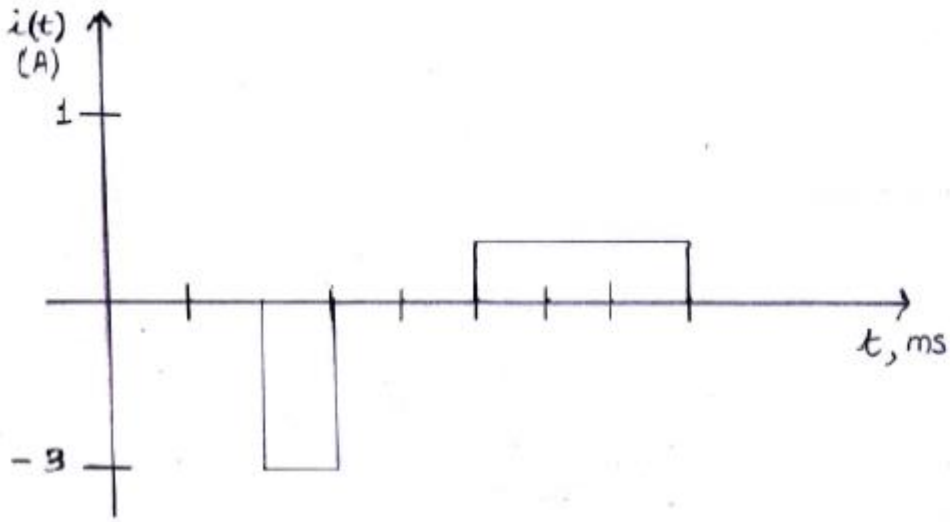
$m = \frac{2+1}{8-5} = 1$

$q(t) = t + b$

$2 = 8 + b$

$b = -6$

$q(t) = t - 6, \quad 5ms \leq t \leq 8ms$
$q(t) = 2, \quad 8ms \leq t \leq 9ms$



$$i(t) = \begin{cases} 0, & 0 \leq t \leq 2ms \\ -3, & 2ms \leq t \leq 3ms \\ 0, & 3ms \leq t \leq 5ms \\ 1, & 5ms \leq t \leq 8ms \end{cases}$$

$$p(t) = V(t)\, i(t)$$

$$p(t) = \begin{cases} 0\ W, & 0 \leq t \leq 2ms \\ -72\ W, & 2ms \leq t \leq 3ms \\ 0\ W, & 3ms \leq t \leq 5ms \\ 24\ W, & 5ms \leq t \leq 8ms \end{cases}$$

$$W(t) = \int_0^9 p(t)\, dt$$

$$= 0 + (-72) \times 1 + 0 + 24 \times 3 = 0\,J$$

1.16 The energy absorbed by the BOX in Fig. P1.16 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.

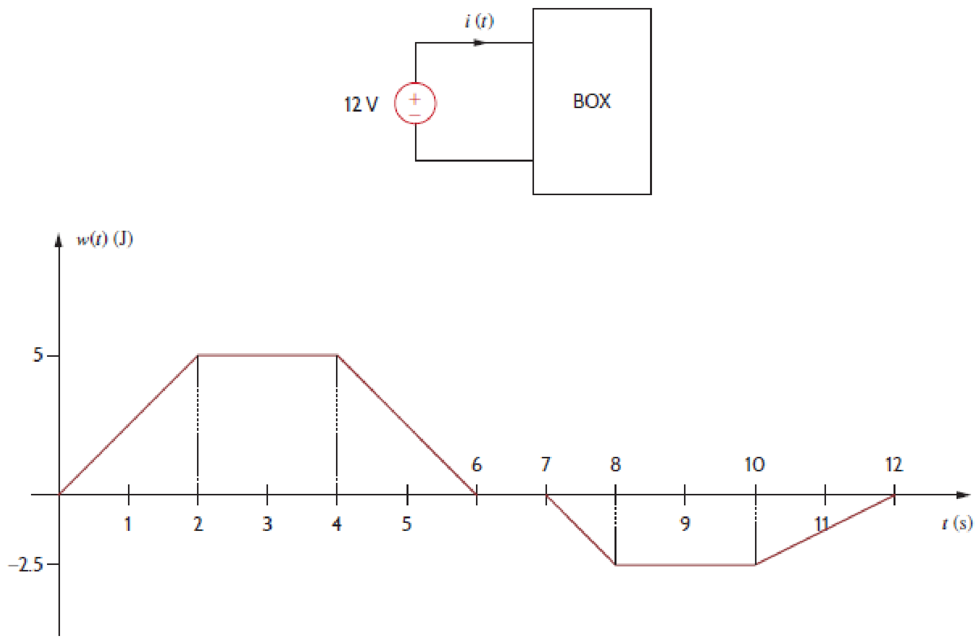


Figure P1.16

SOLUTION:

$P = \frac{dW}{dt}$ (slope of the curve)

$P = vi \Rightarrow i = \frac{P}{v} = \frac{P}{12}$

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

$P = \frac{5-0}{2-0} = 2.5\ W$, $i = \frac{2.5}{12} = 0.21\ A$

$\underline{2 \le t \le 4s:}$

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

$\underline{4 \le t \le 6s:}$

$$P = \frac{0-5}{6-4} = -2.5W, \quad i = \frac{-2.5}{12} = -0.21A$$

$\underline{6 \le t \le 7s:}$

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

$\underline{7 \le t \le 8s:}$

$$P = \frac{-2.5-0}{8-7} = -2.5W, \quad i = \frac{-2.5}{12} = -0.21A$$

$\underline{8 \le t \le 10s:}$

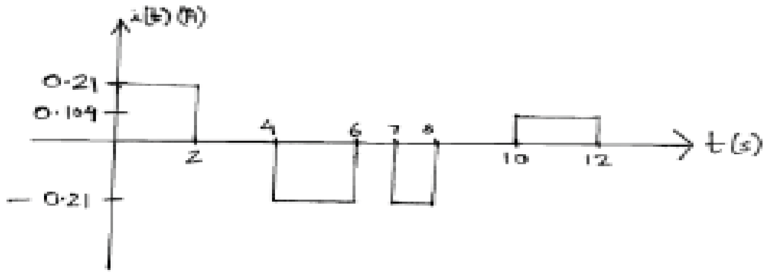
$$P = \frac{-2.5-(-2.5)}{10-8} = 0, \quad i = 0$$

$10 \le t \le 12s$:

$$P = \frac{0-(-2.5)}{12-10} = 1.25W, \quad i = \frac{1.25}{12} = 0.104A$$

$t > 12s$:

$$P = 0, \quad i = 0$$

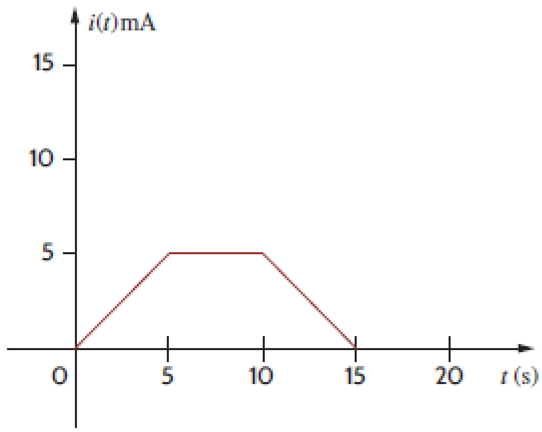


$$q = \int i\,dt$$

$$= (0.21)(2) + (-0.21)(2) + (-0.21)(1) + (0.104)(2)$$

$$= -0.002\,C$$

1.17 The plot of current entering an element is shown in the figure. Find the charge that enters the element from 5 to 15 seconds.



SOLUTION:

The charge through the element can be found by finding the area under the curve from 5 to 15 seconds.

Thus charge flown = 5 x (10-5) + ½ x 5 x (15-10)

= 37.5mC

1.18 Determine the amount of power absorbed or supplied by the element in Fig. P1.18 if

(a) $V_1 = 5$ V and $I = 6$A

(b) $V_1 = 5$ V and $I = -7$A

(c) $V_1 = -14$ V and $I = 6$A

(d) $V_1 = -14$ V and $I = -7$A

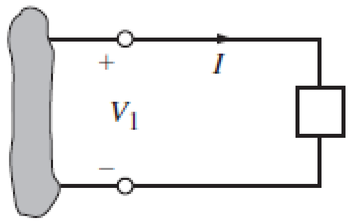
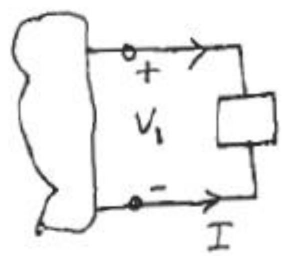


Figure P1.18

SOLUTION:

$V_1 = 5V, \quad I = 6A$



For passive sign convention,

$P = V_1 I$ is power absorbed.

$P = V_1 I = 5(6) = 30W$ absorbed

$\boxed{P = 30W \text{ absorbed}}$

b) $V_1 = 5V, \quad I = -7A$

$P = 5(-7) = -35W$ $\quad \boxed{P = 35 W \text{ supplied}}$

c) $V_1 = -14V, \quad I = 6A$

$P = -84W$ $\quad \boxed{P = 84 W \text{ supplied}}$

d) $V_1 = -14V$, $I = -7A$

$P = 98W$

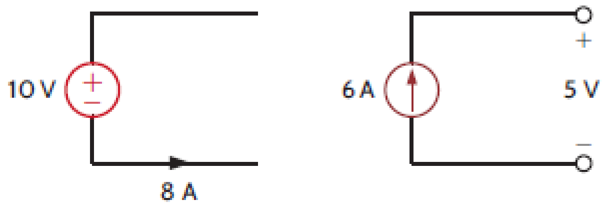
$\boxed{P = 98W \text{ absorbed}}$

1.19 Find the power absorbed by the circuit element at $t = 0$ if voltage across it is given by $v(t) = 23\cos 120\pi t$ V and current through it is $i(t) = 2.5\cos(120\pi t - 2\pi/3)$ A.

SOLUTION:

$P = VI$
$= 57.5\cos(-2\pi/3)$
$= -28.75\text{W}$

1.20 Determine the power supplied by the ideal sources shown in figures given.



SOLUTION:

Power supplied by 10V battery = 10V x -8A = -80W

Power supplied by 6A current source = 6A x 5V = 30V

1.21 Element A in the diagram in Fig. P1.21 absorbs 30 W of power. Calculate V_x.

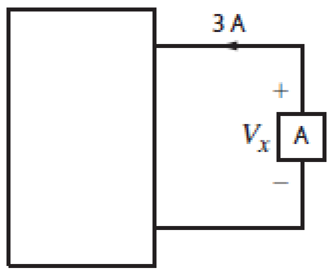
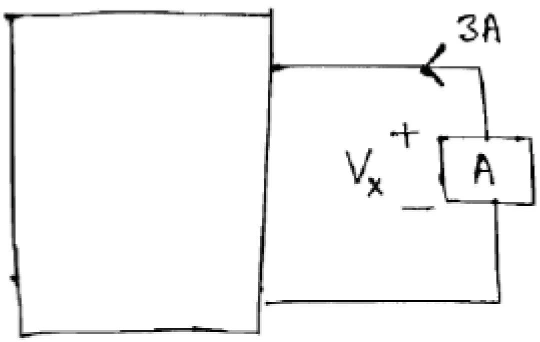
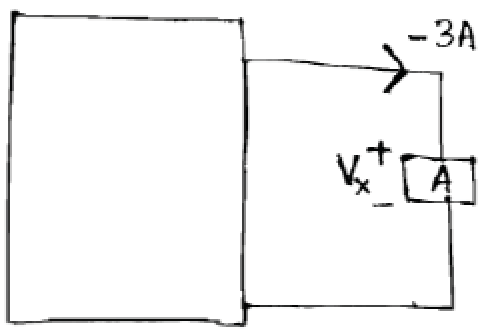


Figure P1.21

SOLUTION:





$$30 = V_x(-3)$$

$$\Rightarrow V_x = -10V$$

1.22 Element B in the diagram in Fig. P1.22 supplies 60 W of power. Calculate I_x.

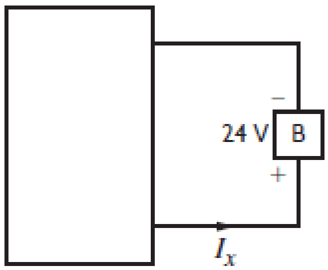


Figure P1.22

SOLUTION:

$$-60 = 24 I_x$$
$$I_x = -2.5A$$

1.23 Let $V(t) = 10\cos 250t$ be variable voltage across a circuit. Find.

(a) $V(1\text{ ms})$

(b) $V(8\text{ ms})$

(c) The energy required to move 4C charge across the circuit at 4 ms

SOLUTION:

a. V(1ms) = 9.69V

b. V(8ms) = -4.16V

c. Work done = q x V = 4C x V(4ms)

= -21.6J

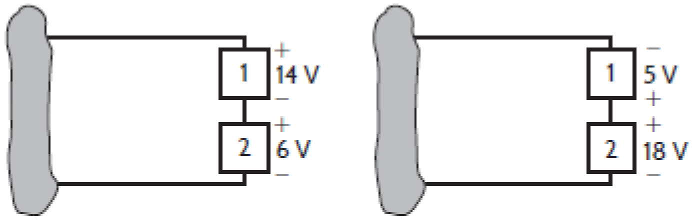
1.24 The voltage across a element varies with time as $5(t-2)^2$ V. A current of 2 A enters the +ve terminal and leaves the –ve terminal of the element. Find the power delivered to the element at 0.8 s.

SOLUTION:

Power delivered = V x I
= 5 x $(0.8-2)^2$V x -5A
= -34.68W

1.25 **(a)** In Fig. P1.25 (a), $P_1 = 42$ W. How much power is element 2 absorbing?

(b) In Fig. P1.25 (b), $P_2 = -72$ W. How much power is element 1 absorbing?

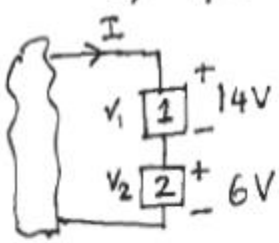


(a) (b)

Figure P1.25

SOLUTION:

a) $P_1 = 42\,W$. By default, using passive sign convention, since P_1 is positive, I flows as shown in the circuit diagram.



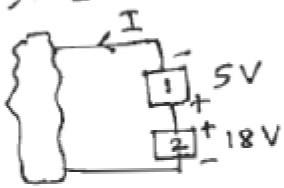
$P_1 = V_1 I \quad I = P_1/V_1 = 42/14 = 3A$

$I = 3\,A$

For element 2, V_2 and I are defined in passive sign convention: $P_2 = V_2 I = 6(3) = 18\,W$

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

b) $P_2 = -72W$.



Again passive sign convention is the default. Since $P_2 < 0$, element 2 supplies power and I flows as shown.

$P_2 = -V_2 I = -18I \quad I = \frac{-72}{-18} = 4A$

For element 1, V_1 and I are defined in passive sign convention. Power absorbed is $P_1 = V_1 I = 5(4) = 20W$

$\boxed{P_1 = 20W \text{ absorbed}}$

1.26 Two elements are connected in series, as shown in Fig. P1.26. Element 1 supplies 24 W of power. Is element 2 absorbing or supplying power, and how much?

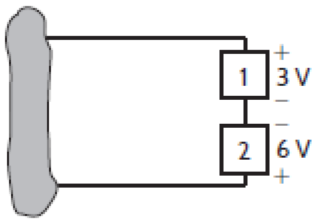


Figure P1.26

SOLUTION:

$P_1 = 24W$

$I = \frac{P_1}{V_1} = \frac{24}{3}$

$I = 8A$

$P_2 = V_2 I = 6(8)$

$P_2 = 48$ absorbed

1.27 Element 2 in Fig. P1.27 absorbed 32 W. Find the power absorbed or supplied by elements 1 and 3.

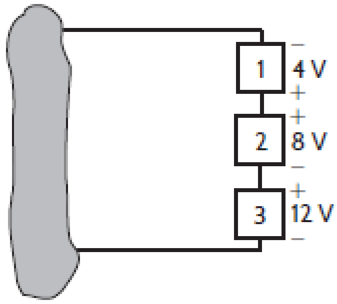


Figure P1.27

SOLUTION:

$P_2 = 32\,W \quad \therefore I\downarrow = 4A$

$P_1 = (-4)(4) = 16\,W$ Supplied

$P_3 = (4)(12) = 48\,W$ ABSORBED

1.28 Choose I_s such that the power absorbed by element 2 in Fig. P1.28 is 7 W.

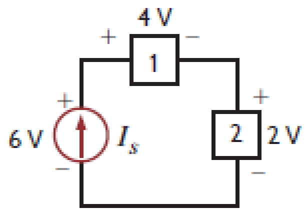


Figure P1.28

SOLUTION:

P_2 = 7W absorbed

$$P_2 = V_2 I_S$$

$$I_S = \frac{P_2}{V_2} = \frac{7}{2}$$

$$I_S = 3.5A$$

1.29 Find the power that is absorbed or supplied by the circuit elements in Fig. P1.29.

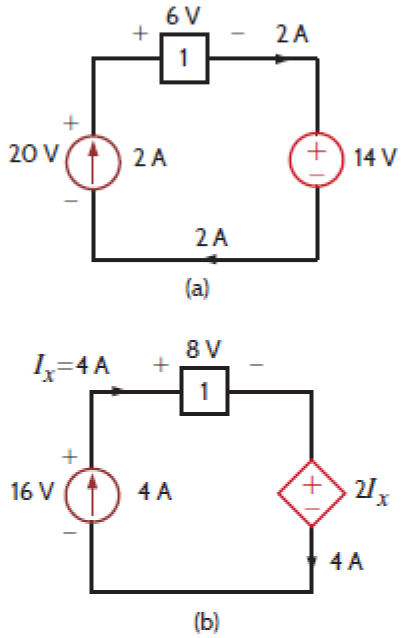


Figure P1.29

SOLUTION:

a) $P_{2A} = -20(2)$

$P_{2A} = -40W$

$P_{2A} =$ 40 W supplied

$P_1 = 6(2) = 12W$ absorbed

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

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

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

$P_1 = 8(4) = 32\,W$ absorbed

$P_{2I_x} = (2I_x)(4) = 2(4)(4)$

$P_{2I_x} = 32\,W$ absorbed

1.30 Find the power that is absorbed or supplied by the network elements in Fig. P1.30.

(a) Power of element 1 at figure (a).

(b) Power of element 2 at figure (a).

(c) Power of element 3 at figure (a).

(d) Power of element 1 at figure (b).

(e) Power of element 2 at figure (b).

(f) Power of element 3 at figure (b).

(g) Power of element 4 at figure (b).

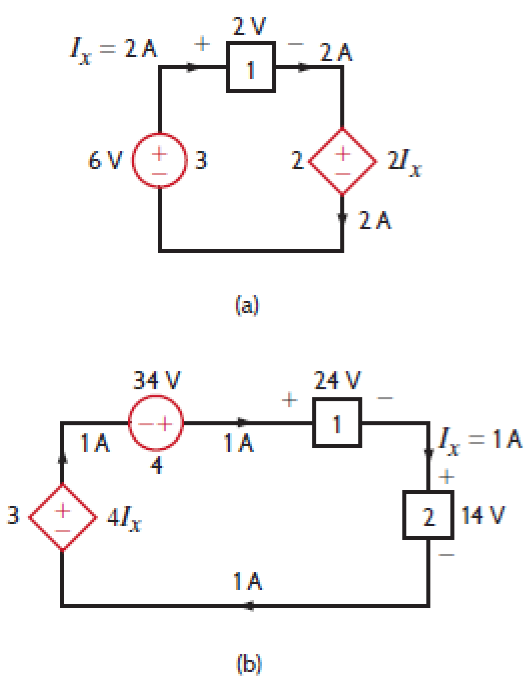


Figure P1.30

SOLUTION:

(See Next page)

a) Voltage and current for element 1 in fig. (a) are defined in the passive sign convention.

Power supplied by element 1 in fig. (a) is

$P_1 = -V_1 I_X = -2(2) = -4\,W$

$\boxed{P_1 = -4\,W \text{ supplied}}$

b) Voltage and current for element 2 in fig. (a) are defined in the passive sign convention.

Power supplied by element 2 in fig. (a) is

$P_2 = -(2I_X) = -4(2) = -8\,W$

$\boxed{P_2 = -8\,W \text{ supplied}}$

c) For element 3 in fig. (a) V and I are defined in active sign convention.

Power supplied by element 3 in fig. (a) is

$P_3 = 6\,I_X = 6(2) = 12\,W$

$\boxed{P_3 = 12\,W \text{ supplied}}$

d) V and I are defined in the passive sign convention for element 1 in fig. (b).

Power supplied by element 1 in fig. (b) is

$P_1 = -V_1 I_X = -24(1) = -24\,W$

$\boxed{P_1 = -24\,W \text{ supplied}}$

e) V and I are defined in the passive sign convention for element 2 in Fig. (b).
Power supplied by element 2 in fig. (b) is

$$P_2 = -V_2 I_x = -14(1) = -14W$$

$$\boxed{P_2 = -14W \text{ supplied}}$$

f) V and I are defined in the active sign convention for element 3 in fig. (b).
Power supplied by element 3 in fig. (b) is

$$P_3 = (4 I_X) I_X = 4W$$

$$\boxed{P_3 = 4W \text{ supplied}}$$

g) V and I are defined in the active sign convention for element 4 in fig. (b).
Power supplied by element 4 in fig. (b) is

$$P_4 = 34 (I_x) = 34W \text{ supplied}$$

$$\boxed{P_4 = 34W \text{ supplied}}$$

1.31 Compute the power that is absorbed or supplied by the elements in the network in Fig. P1.31.

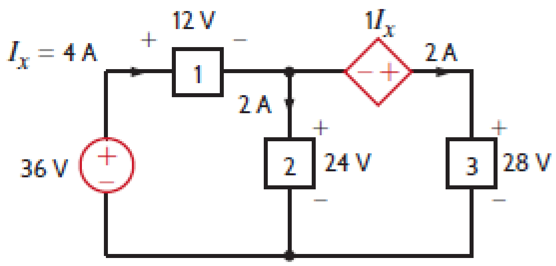


Figure P1.31

SOLUTION:

$P_{36V} = -36(4) = -144$ W

$P_{36V} = 144$ W supplied

$P_1 = 12(4) = 48$ W absorbed

$P_2 = 24(2) = 48$ W absorbed

$P_{1I_x} = (-I_x)(2) = -4(2) = -8$ W

$P_{1I_x} = 8$ W supplied

$P_3 = 28(2) = 56$ W absorbed

1.32 Find the power that is absorbed or supplied by element 2 in Fig. P1.32.

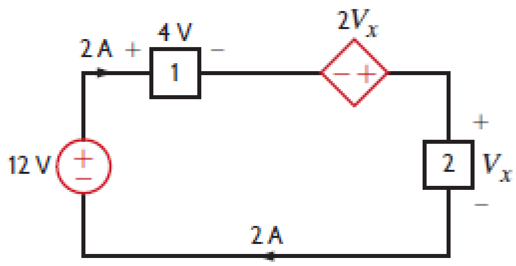


Figure P1.32

SOLUTION:

$$P_{12V} = -24\,W$$

$$P_1 = 8\,W$$

$$P_{2V_x} = -4V_x\,W$$

$$P_2 = 2V_x\,W$$

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

$$2V_x = -16$$

$$V_x = -8\,V$$

$$P_2 = -16\,W \text{ Supplied}$$

1.33 Find I_x in the network in Fig. P1.33.

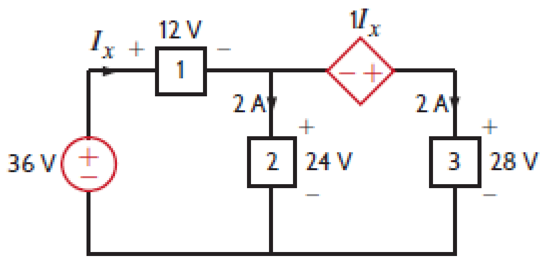


Figure P1.33

SOLUTION:

$$P_{36V} = -36I_x \text{ W}$$
$$P_1 = 12I_x \text{ W}$$
$$P_2 = 48 \text{ W}$$
$$P_{1I_x} = -2I_x \text{ W}$$
$$P_3 = 56 \text{ W}$$
$$P_{36V} + P_{1I_x} = P_1 + P_2 + P_3$$
$$I_x = 4\text{A}$$

1.34 Determine the power absorbed by element 1 in Fig. P1.34.

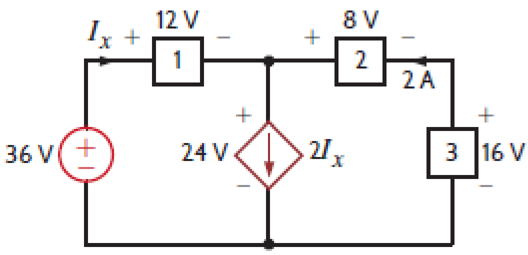


Figure P1.34

SOLUTION:

$$P_{36V} = -36 I_x \, W$$
$$P_1 = 12 I_x \, W$$
$$P_{2I_x} = 48 I_x \, W$$
$$P_2 = -16 W$$
$$P_3 = -32 W$$

$$36 I_x + 16 + 32 = 12 I_x + 48 I_x$$
$$48 = 24 I_x$$
$$I_x = 2A$$

$$P_1 = 24 W$$

1.35 Find the power absorbed or supplied by element 3 in Fig. P1.35.

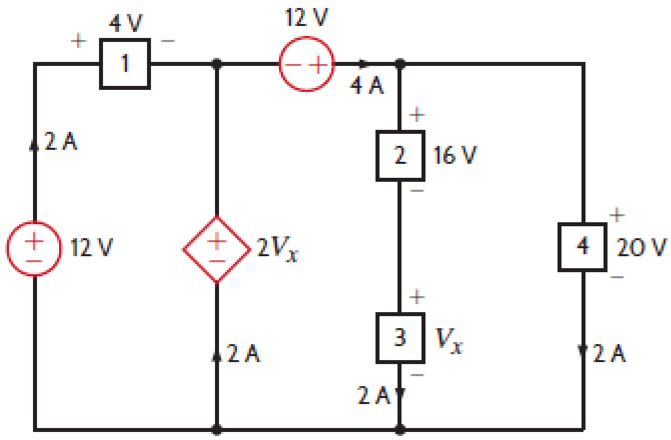


Figure P1.35

SOLUTION:

$P_{12V} = -24 \qquad P_{12V} = -48 \qquad P_4 = 40$

$P_1 = 8 \qquad P_2 = 32$

$P_{2V_x} = -4V_x \qquad P_3 = 2V_x$

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

$P_3 = 8W$ ABSORBED

1.36 Find V_x in the network in Fig. P1.36 using Tellegen's theorem.

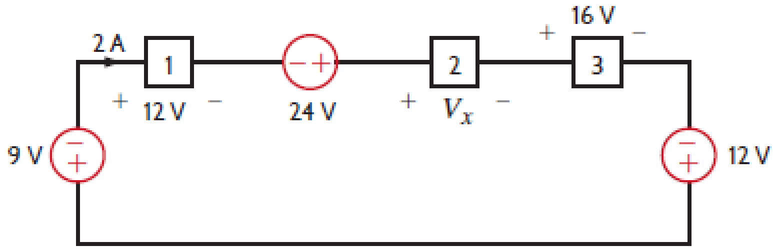


Figure P1.36

SOLUTION:

Power supplied = Power absorbed

$$P_{24} + P_{12} = P_{9V} + P_1 + P_2 + P_3$$

$$24I + 12I = 9I + 12I + P_2 + 16I$$

$$36I = 37I + P_2$$

$$P_2 = (-1)(I)$$

$$V_x(I) = -1(I)$$

$$V_x = -1V$$

1.37 Find I_x in the circuit in Fig. P1.37 using Tellegen's theorem.

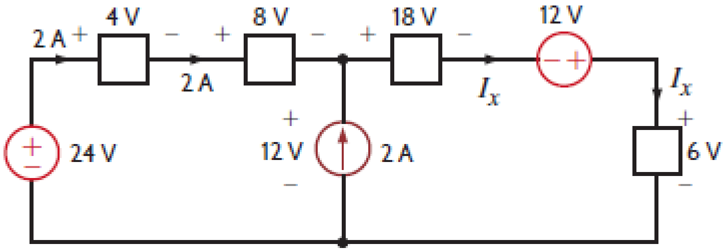


Figure P1.37

SOLUTION:

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

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

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

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

$P_{2A} = 12(-2) = -24\,W$

$P_{2A} = 24\,W$ supplied

$P_{18V} = 18 I_x$ absorbed

$P_{12V} = 12(-I_x) = -12 I_x$

$P_{12V} = 12 I_x$ supplied

$P_{6V} = 6I_x$ absorbed

Power supplied = Power absorbed

$$P_{24V} + P_{2A} + P_{12V} = P_{4V} + P_{8V} + P_{18V} + P_{6V}$$

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

$$12I_x = 48$$

$$I_x = 4A$$

1.38 Is the source V_s in the network in Fig. P1.38 absorbing or supplying power, and how much?

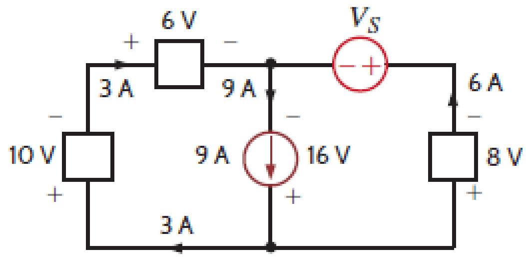


Figure P1.38

SOLUTION:

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

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

$P_{9A} = 16(-9) = -144W$

$P_{9A} = 144W$ supplied

$P_{V_S} = V_S(6) = 6V_S$ absorbed

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

Power supplied = Power absorbed

$$P_{9A} = P_{10V} + P_{6V} + P_{V_S} + P_{8V}$$

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

$$144 = 96 + 6V_S$$

$$24 = 16 + V_S$$

$$V_S = 8V$$

$P_{V_S} = 8(6) = 48W$ absorbed

1.39 Find I_o in the network in Fig. P1.39 using Tellegen's theorem.

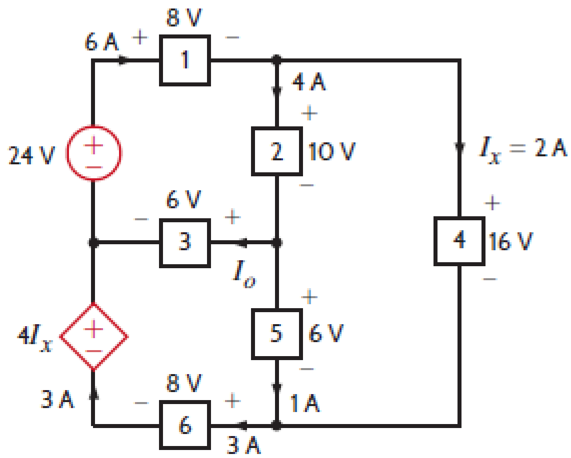


Figure P1.39

SOLUTION:

$P_{24V} = 24(-6) = -144$ W

$P_{24V} = 144$ W supplied

$P_1 = 8(6) = 48$ W absorbed

$P_2 = 10(4) = 40$ W absorbed

$P_3 = 6I_0$ ABSORBED

$P_4 = 16(2) = 32$ W absorbed

$P_5 = 6(1) = 6$ W absorbed

$P_6 = 8(3) = 24$ W absorbed

$P_{4I_X} = 4I_X(-3) = -12(2) = -24$ W

$P_{4I_X} = 24$ W supplied

Power supplied = Power absorbed

$P_{24V} + P_{4I_X} = P_1 + P_2 + P_3 + P_4 + P_5 + P_6$

$144 + 24 = 48 + 40 + 6I_0 + 32 + 6 + 24$

$I_0 = 3$A

1.40 Calculate the power absorbed by each element in the circuit in Fig. P1.40. Also, verify that Tellegen's theorem is satisfied by this circuit.

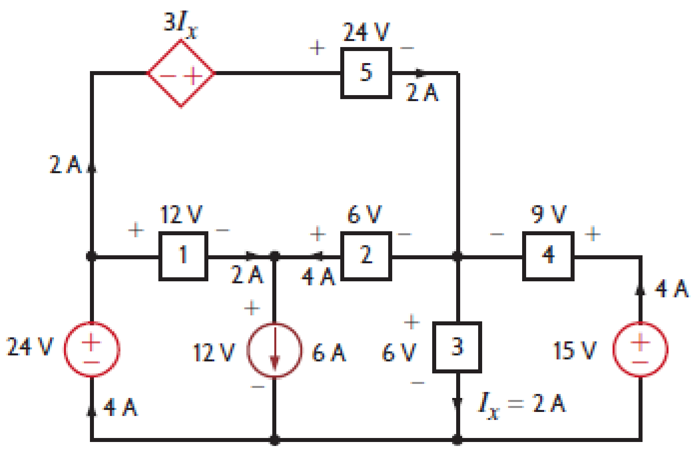


Figure P1.40

SOLUTION:

$\#1: P = (12)(2) = 24W$

$\#2: P = (6)(-4) = -24W$

$\#3: P = (6)(2) = 12W$

$\#4: P = (9)(4) = 36W$

$\#5: P = (24)(2) = 48W$

$24V: P = (24)(-4) = -96W$

$15V: P = (15)(-4) = -60W$

$6A: P = (12)(6) = 72W$

$3I_x: P = [(3)(2)](-2) = -12W$

0

1.41 Calculate the power absorbed by each element in the circuit in Fig. P1.41. Also, verify that Tellegen's theorem is satisfied by this circuit.

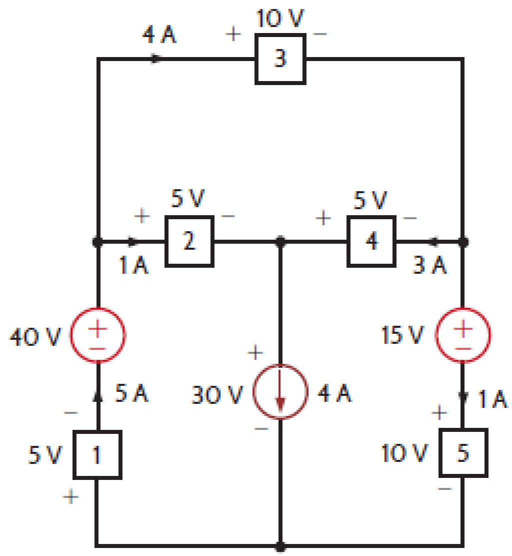


Figure P1.41

SOLUTION:

#1 : $P = (5)(5) = 25W$

#2 : $P = (5)(1) = 5W$

#3 : $P = (10)(4) = 40W$

#4 : $P = (5)(-3) = -15W$

#5 : $P = (10)(1) = 10W$

4A : $P = (30)(4) = 120W$

40V : $P = (40)(-5) = -200W$

15V : $P = (15)(1) = \underline{15W}$

0

1.42 In the circuit in Fig. P1.42, 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?

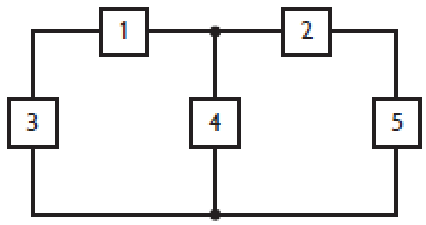


Figure P1.42

SOLUTION:

$$\sum P_{absorbed} = 0$$

$$40 - 50 - 25 + 15 + P_5 = 0$$

$$-20 + P_5 = 0$$

$$P_5 = 20\,W$$

Power absorbed by element 5 is 20 W.

Power supplied by element 5 is $\underline{-20\,W}$.