Problem 1.13 A steady flow resulted in 3×10^{15} electrons entering a device in 0.1 ms. What is the current?

Solution:

$$i = \frac{\Delta Q}{\Delta t} = \frac{n_{\mathrm{e}} e}{\Delta t} = \frac{3 \times 10^{15} \times 1.6 \times 10^{-19}}{0.1 \times 10^{-3}} = 4.8 \text{ A.}$$

Problem 2.14 Determine currents I_1 to I_3 in the circuit of Fig. P2.14.

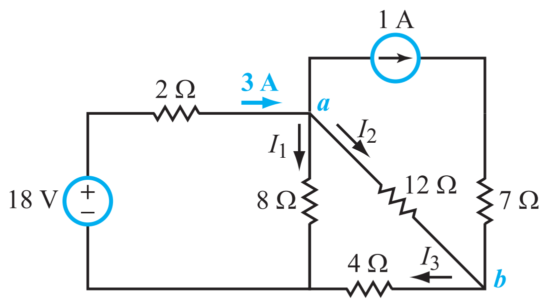

Figure P2.14: Circuit for Problem 2.14.

Solution: For the loop containing the 18-V source,

$$-18+3\times 2+8I_1=0.$$

Hence, $I_1=1.5$ A.

KCL at node a gives

$$3-1-I_1-I_2=0$$
$$I_2=2-I_1=2-1.5=0.5 \text{ A}.$$

KCL at node b gives

$$1+I_2-I_3=0$$
$$I_3=1+I_2=1+0.5=1.5 \text{ A}.$$

Problem 1.15 The plot in Fig. P1.15 displays the cumulative amount of charge $q(t)$ that has entered a certain device up to time t. What is the current at

(a) $t = 1$ s

(b) $t = 3$ s

(c) $t = 6$ s

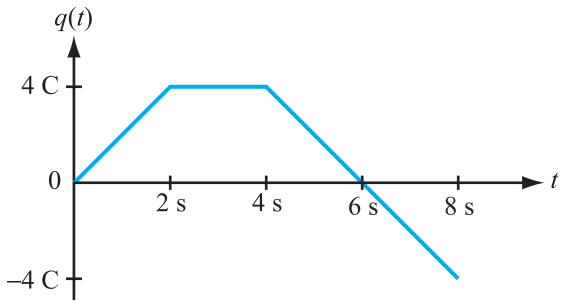

Figure P1.15: $q(t)$ for Problem 1.15.

Solution:

(a) $a = \frac{4}{2} = 2$ A @ $t = 1$ s (slope of first segment).

(b) $i = 0$ @ $t = 3$ s (slope of $q(t) = 0$ at $t = 3$ s).

(c) $i = \frac{-8}{4} = -2$ A @ $t = 6$ s (negative slope of third segment).

Problem 2.15 Determine I_x in the circuit of Fig. P2.15.

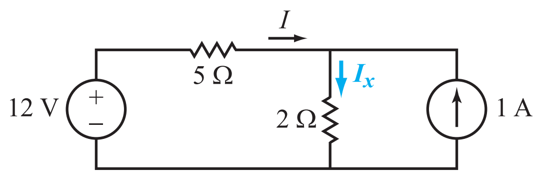

Figure P2.15: Circuit for Problem 2.15.

Solution:

KVL gives: $-12+5I+2I_x=0$.
KCL gives: $I+1-I_x=0$.
Solution of the two equations yields $I_x=\frac{17}{7}=2.43$ A.

Problem 2.16 Determine currents I_1 to I_4 in the circuit of Fig. P2.16.

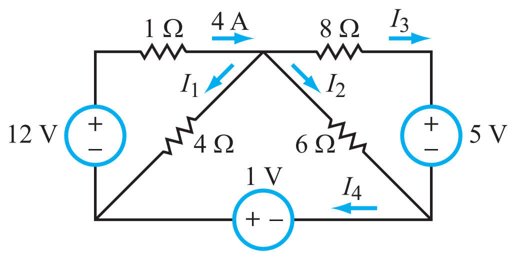

Figure P2.16: Circuit for Problem 2.16.

Solution: Application of KVL to the outer-parameter loop gives

$$-12+4\times 1+8I_3+5-1=0,$$

which gives

$$I_3=0.5 \text{ A}.$$

KVL for the left-most loop is

$$-12+4\times 1+4I_1=0,$$

which leads to

$$I_1=2 \text{ A}.$$

KCL at the top center node gives

$$4-I_1-I_2-I_3=0$$

or

$$I_2=4-I_1-I_3=4-2-0.5=1.5 \text{ A}.$$

KCL at the bottom left node gives

$$I_4+I_1-4=0,$$

or

$$I_4=4-I_1=4-2=2 \text{ A}.$$

Sections 1-4 and 1-5: Voltage, Power, and Circuit Elements

Problem 1.17 For each of the eight devices in the circuit of Fig. P1.17, determine whether the device is a supplier or a recipient of power and how much power it is supplying or receiving.

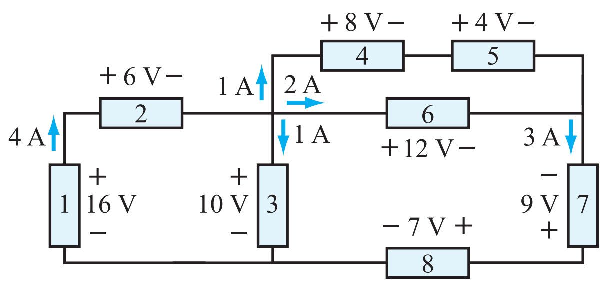

Figure P1.17: Circuit for Problem 1.17.

Solution:

Device 1: $p = vi = 16 \times (-4) = -64$ W (supplier)
Device 2: $p = vi = 6 \times 4 = 24$ W (recipient)
Device 3: $p = vi = 10 \times 1 = 10$ W (recipient)
Device 4: $p = vi = 8 \times 1 = 8$ W (recipient)
Device 5: $p = vi = 4 \times 1 = 4$ W (recipient)
Device 6: $p = vi = 12 \times 4 = 24$ W (recipient)
Device 7: $p = vi = 9 \times (-3) = -27$ W (supplier)
Device 8: $p = vi = 7 \times 3 = 21$ W (recipient)

Problem 1.7 Determine the current $i(t)$ flowing through a resistor if the cumulative charge that has flowed through it up to time t is given by

(a) $q(t) = 3.6t$ mC

(b) $q(t) = 5\sin(377t)$ μC

(c) $q(t) = 0.3[1 - e^{-0.4t}]$ pC

(d) $q(t) = 0.2t\sin(120\pi t)$ nC

Solution:

(a) $i(t) = \frac{dq}{dt} = \frac{d}{dt}(3.6t \times 10^{-3}) = 3.6 \times 10^{-3} = 3.6 \quad \text{(mA)}.$

(b) $i(t) = \frac{dq}{dt} = \frac{d}{dt}[(5\sin 377t) \times 10^{-6}] = 5 \times 377 \times 10^{-6}\cos 377t = 1.885\cos 377t$ (mA).

(c) $i(t) = \frac{dq}{dt} = \frac{d}{dt}[0.3(1 - e^{-0.4t}) \times 10^{-12}] = 0.3 \times 10^{-12} \times (-0.4) \times (-e^{-0.4t})$
$= 0.12e^{-0.4t} \quad \text{(pA)}.$

(d) $i(t) = \frac{dq}{dt} = \frac{d}{dt}[(0.2t\sin 120\pi t) \times 10^{-9}]$

$$= (0.2\sin 120\pi t + 0.2t \times 120\pi\cos 120\pi t) \times 10^{-9}$$

$$= 0.2\sin 120\pi t + 75.4t\cos 120\pi t \quad \text{(nA)}.$$