Chapter 1, Solution 1

(a) $q = 6.482x10^{17}$ x [$-1.602x10^{-19}$ C] = **–103.84 mC**

(b) $q = 1.24x10^{18}$ x [$-1.602x10^{-19}$ C] = **–198.65 mC**

(c) $q = 2.46x10^{19}$ x [$-1.602x10^{-19}$ C] = **–3.941 C**

(d) $q = 1.628x10^{20}$ x [$-1.602x10^{-19}$ C] = **–26.08 C**

Chapter 1, Solution 2

(a) i = dq/dt = 3 mA
(b) i = dq/dt = (16t + 4) A
(c) i = dq/dt = $(-3e^{-t} + 10e^{-2t})$ nA
(d) i=dq/dt = $1200\pi \cos 120\pi t$ pA
(e) i =dq/dt = $-e^{-4t}(80\cos 50t + 1000\sin 50t)$ μ**A**

Chapter 1, Solution 3

(a) $q(t) = \int i(t)dt + q(0) = \underline{(3t + 1)\ \ C}$

(b) $q(t) = \int (2t + s)\,dt + q(v) = \underline{(t^2 + 5t)\ \ mC}$

(c) $q(t) = \int 20\cos\left(10t + \pi/6\right) + q(0) = \underline{(2\sin(10t + \pi/6) + 1)\mu C}$

(d) $$q(t) = \int 10e^{-30t}\sin 40t + q(0) = \frac{10e^{-30t}}{900 + 1600}(-30\sin 40t - 40\cos t)$$

$$= \underline{-e^{-30t}(0.16\cos 40t + 0.12\sin 40t)\ C}$$

Chapter 1, Solution 4

$q = it = 7.4 \text{ x } 20 = \underline{\mathbf{148\ C}}$

Chapter 1, Solution 5

$$q = \int i dt = \int_0^{10} \frac{1}{2} t dt = \frac{t^2}{4}\Bigg|_0^{10} = \underline{25 \text{ C}}$$

Chapter 1, Solution 6

(a) At t = 1ms, $i = \frac{dq}{dt} = \frac{30}{2} =$ **<u>15 A</u>**

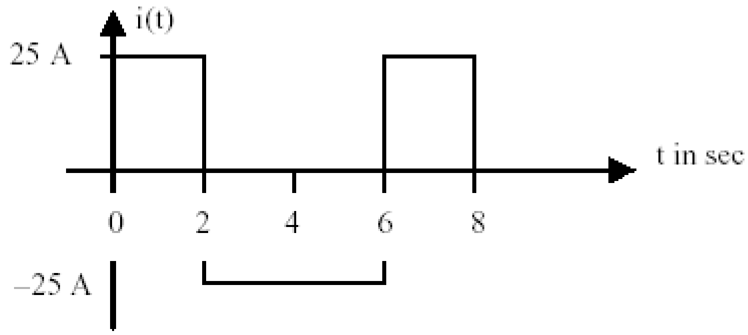
(b) At t = 6ms, $i = \frac{dq}{dt} =$ **<u>0 A</u>**

(c) At t = 10ms, $i = \frac{dq}{dt} = \frac{-30}{4} =$ **<u>–7.5 A</u>**

Chapter 1, Solution 7

$$i = \frac{dq}{dt} = \begin{cases} 25A, & 0 < t < 2 \\ -25A, & 2 < t < 6 \\ 25A, & 6 < t < 8 \end{cases}$$

which is sketched below:



Chapter 1, Solution 8

$$q = \int i dt = \frac{10 \times 1}{2} + 10 \times 1 = \underline{15\ \mu C}$$

Chapter 1, Solution 9

(a) $q = \int i dt = \int_0^1 10\, dt = \underline{10\ \text{C}}$

(b) $$q = \int_0^3 i dt = 10 \times 1 + \left(10 - \frac{5 \times 1}{2}\right) + 5 \times 1$$
$$= 15 + 7.5 + 5 = \underline{22.5\text{C}}$$

(c) $q = \int_0^5 i dt = 10 + 10 + 10 = \underline{30\ \text{C}}$

Chapter 1, Solution 10

$q = it = 10x10^3x15x10^{-6} =$ **150 mC**

Chapter 1, Solution 11

$q = it = 90 \times 10^{-3} \times 12 \times 60 \times 60 =$ **3.888 kC**

$E = pt = ivt = qv = 3888 \times 1.5 =$ **5.832 kJ**

Chapter 1, Solution 12

For 0 < t < 6s, assuming q(0) = 0,

$$q(t) = \int_0^t idt + q(0) = \int_0^t 3tdt + 0 = 1.5t^2$$

At t=6, q(6) = $1.5(6)^2$ = 54

For 6 < t < 10s,

$$q(t) = \int_6^t idt + q(6) = \int_6^t 18dt + 54 = 18t - 54$$

At t=10, q(10) = 180 – 54 = 126

For 10<t<15s,

$$q(t) = \int_{10}^t idt + q(10) = \int_{10}^t (-12)dt + 126 = -12t + 246$$

At t=15, q(15) = -12x15 + 246 = 66

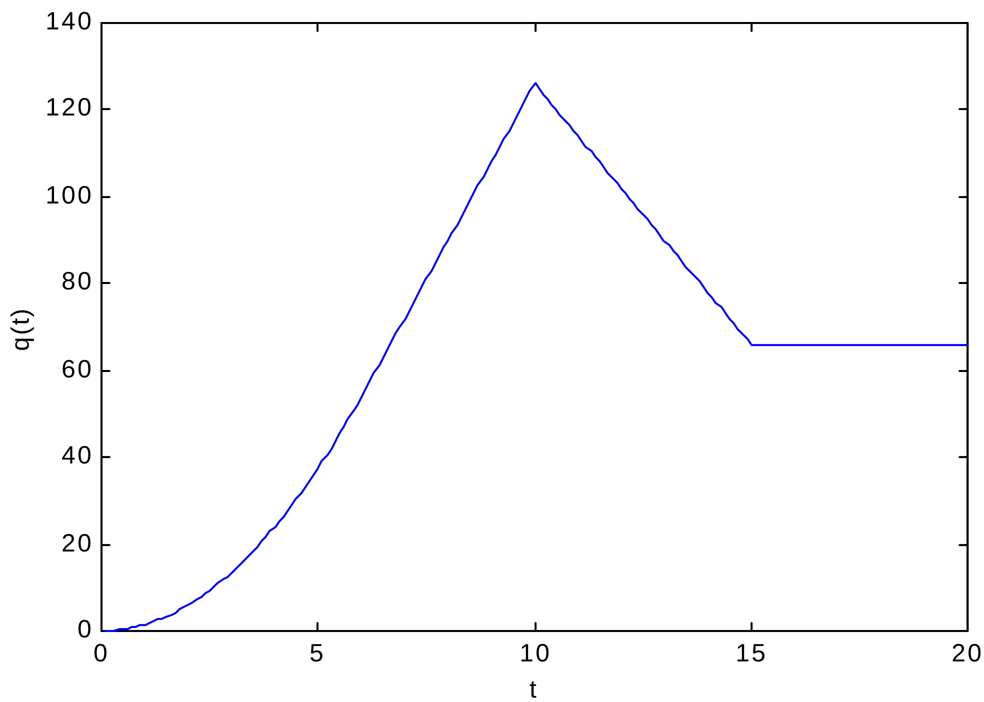
For 15<t<20s,

$$q(t) = \int_{15}^t 0dt + q(15) = 66$$

Thus,

$$q(t) = \begin{cases} 1.5t^2 \ \textbf{C}, & \textbf{0} < \textbf{t} < \textbf{6s} \\ 18t - 54 \ \textbf{C}, & \textbf{6} < \textbf{t} < \textbf{10s} \\ -12t + 246 \ \textbf{C}, & \textbf{10} < \textbf{t} < \textbf{15s} \\ 66 \ \textbf{C}, & \textbf{15} < \textbf{t} < \textbf{20s} \end{cases}$$

The plot of the charge is shown below.



140
120
100
80
60
40
20
0
q(t)
0
5
10
15
20
t

Chapter 1, Solution 13

(a) $i = [dq/dt] = 20\pi\cos(4\pi t)$ mA

$p = vi = 60\pi\cos^2(4\pi t)$ mW

At t=0.3s,

$$p = vi = 60\pi\cos^2(4\pi 0.3) \text{ mW} = \mathbf{123.37\ mW}$$

(b) $W = \int p\,dt = 60\pi \int_0^{0.6} \cos^2(4\pi t)\,dt = 30\pi \int_0^{0.6} [1 + \cos(8\pi t)]\,dt$

$$W = 30\pi[0.6+(1/(8\pi))[\sin(8\pi 0.6)-\sin(0)]] = \mathbf{58.76\ mJ}$$

Chapter 1, Solution 14

(a) $q = \int i dt = \int_0^1 0.02\left(1 - e^{-0.5t}\right)dt = 0.02\left(t + 2e^{-0.5t}\right)\Big|_0^1 = 0.02\left(1 + 2e^{-0.5} - 2\right) =$ **4.261 mC**

(b) p(t) = v(t)i(t)

p(1) = 10cos(2)x0.02(1–$e^{-0.5}$) = (–4.161)(0.007869)

= **–32.74 mW**

Chapter 1, Solution 15

(a) $q = \int idt = \int_0^2 0.006e^{-2t}dt = \frac{-0.006}{2}e^{2t}\Big|_0^2$

$= -0.003\left(e^{-4} - 1\right) =$
2.945 mC

(b) $v = \frac{10di}{dt} = -0.012e^{-2t}(10) = -0.12e^{-2t}$ V this leads to p(t) = v(t)i(t) =
$(-0.12e^{-2t})(0.006e^{-2t})$ = **$-720e^{-4t}$ μW**

(c) $w = \int pdt = -0.72\int_0^3 e^{-4t}\,dt = \frac{-720}{-4}e^{-4t}10^{-6}\Big|_0^3$ = **–180 μJ**

Chapter 1, Solution 16

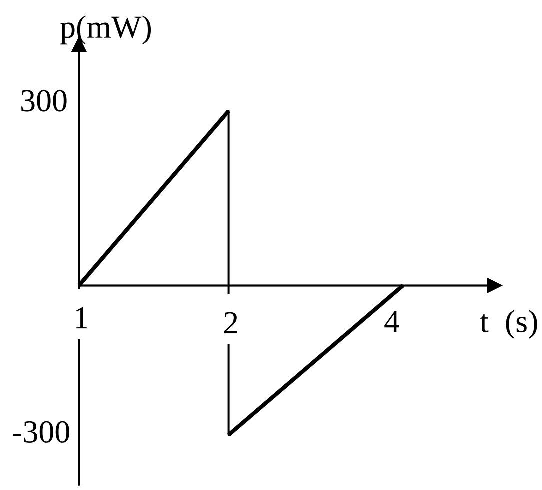
(a)

$$i(t) = \begin{cases} 30t \text{ mA}, & 0 < t < 2 \\ 120\text{-}30t \text{ mA}, & 2 < t < 4 \end{cases}$$

$$v(t) = \begin{cases} 5 \text{ V}, & 0 < t < 2 \\ -5 \text{ V}, & 2 < t < 4 \end{cases}$$

$$p(t) = \begin{cases} 150t \text{ mW}, & 0 < t < 2 \\ -600+150t \text{ mW}, & 2 < t < 4 \end{cases}$$

which is sketched below.



(b) From the graph of p,

$$W = \int_0^4 p\,dt = \underline{0 \text{ J}}$$

Chapter 1, Solution 17

Σ p = 0 $\rightarrow$ -205 + 60 + 45 + 30 + p_3 = 0

p_3 = 205 – 135 = 70 W

Thus element 3 receives **70 W.**

Chapter 1, Solution 18

$p_1 = 30(-10) =$ **-300 W**
$p_2 = 10(10) =$ **100 W**
$p_3 = 20(14) =$ **280 W**
$p_4 = 8(-4) =$ **-32 W**
$p_5 = 12(-4) =$ **-48 W**

Chapter 1, Solution 19

$$I = 8 – 2 = \mathbf{6\ A}$$

Calculating the power absorbed by each element means we need to find vi for each element.

$$p_{\text{8 amp source}} = –8x9 = \mathbf{–72\ W}$$
$$p_{\text{element with 9 volts across it}} = 2x9 = \mathbf{18\ W}$$
$$p_{\text{element with 3 bolts across it}} = 3x6 = \mathbf{18\ W}$$
$$p_{\text{6 volt source}} = 6x6 = \mathbf{36\ W}$$

One check we can use is that the sum of the power absorbed must equal zero which is what it does.

Chapter 1, Solution 20

$$p_{\text{30 volt source}} = 30x(-6) = \mathbf{-180\ W}$$
$$p_{\text{12 volt element}} = 12x6 = \mathbf{72\ W}$$
$$p_{\text{28 volt e.ement with 2 amps flowing through it}} = 28x2 = \mathbf{56\ W}$$
$$p_{\text{28 volt element with 1 amp flowing through it}} = 28x1 = \mathbf{28\ W}$$
$$p_{\text{the 5Io dependent source}} = 5x2x(-3) = \mathbf{-30\ W}$$

Since the total power absorbed by all the elements in the circuit must equal zero, or $0 = -180+72+56+28-30+p_{\text{into the element with Vo}}$ or

$$p_{\text{into the element with Vo}} = 180-72-56-28+30 = \mathbf{54\ W}$$

Since $p_{\text{into the element with Vo}} = V_o x3 = 54$ W or V_o = **18 V**.

Chapter 1, Solution 21

$$p = vi \quad \longrightarrow \quad i = \frac{p}{v} = \frac{60}{120} = 0.5 \text{ A}$$

q = it = 0.5x24x60x60 = **43.2 kC**

$$N_e = qx6.24x10^{18} = \underline{2.696x10^{23} \text{ electrons}}$$

Chapter 1, Solution 22

$$q = it = 40x10^3 x1.7x10^{-3} = \mathbf{68\ C}$$

Chapter 1, Solution 23

$W = pt = 1.8x(15/60)\ x30\ kWh = 13.5kWh$
$C = 10cents\ x13.5 =$ **$1.35**

Chapter 1, Solution 24

$W = pt = 60 \text{ x} 24 \text{ Wh} = 0.96 \text{ kWh} = 1.44 \text{ kWh}$

$C = 8.2 \text{ centsx} 0.96 = \mathbf{11.808 \text{ cents}}$

Chapter 1, Solution 25

$$\text{Cost} = 1.5\text{ kW} \times \frac{3.5}{60}\text{hr} \times 30 \times 8.2\text{ cents/kWh} = \mathbf{21.52\ cents}$$

Chapter 1, Solution 26

(a) $i = \dfrac{0.8\text{A}\cdot\text{h}}{10\text{h}} = \mathbf{80\ mA}$

(b) p = vi = 6 × 0.08 = **0.48 W**

(c) w = pt = 0.48 × 10 Wh = **0.0048 kWh**

Chapter 1, Solution 27

(a) Let $T = 4h = 4 \times 3600$

$$q = \int idt = \int_0^T 3dt = 3T = 3 \times 4 \times 3600 = \underline{43.2\ kC}$$

(b) $W = \int pdt = \int_0^T vidt = \int_0^T (3)\left(10 + \frac{0.5t}{3600}\right)dt$

$$= 3\left(10t + \frac{0.25t^2}{3600}\right)\Bigg|_0^{4\times3600} = 3[40 \times 3600 + 0.25 \times 16 \times 3600]$$

$$= \underline{475.2\ kJ}$$

(c) $W = 475.2\ kWs, \quad (J = Ws)$

$$\text{Cost} = \frac{475.2}{3600}\ kWh \times 9\ \text{cent} = \underline{1.188\ \text{cents}}$$

Chapter 1, Solution 28

(a) $i = \frac{P}{V} = \frac{60}{120}$

$= \mathbf{500\ mA}$

(b) $W = pt = 60 \times 365 \times 24\ \text{Wh} = 525.6\ \text{kWh}$

$\text{Cost} = \$0.095 \times 525.6$

$= \mathbf{\$49.93}$

Chapter 1, Solution 29

$$w = pt = 1.2\text{kW}\,\frac{(20+40+15+45)}{60}\,\text{hr} + 1.8\,\text{kW}\left(\frac{30}{60}\right)\text{hr}$$

$$= 2.4 + 0.9 = 3.3\,\text{kWh}$$

$$\text{Cost} = 12\,\text{cents} \times 3.3 = \underline{39.6\ \text{cents}}$$

Chapter 1, Solution 30

Monthly charge = \$6

First 250 kWh @ \$0.02/kWh = \$5

Remaining 2,436–250 kWh = 2,186 kWh @ \$0.07/kWh= \$153.02

Total = **\$164.02**

Chapter 1, Solution 31

Total energy consumed = 365(120x4 + 60x8) W
Cost = \$0.12x365x960/1000 = **\$42.05**

Chapter 1, Solution 32

$i = 20\ \mu A$

$q = 15\ C$

$t = q/i = 15/(20x10^{-6}) =$ **$750x10^3$ hrs**

Chapter 1, Solution 33

$$i = \frac{dq}{dt} \rightarrow q = \int i dt = 2000 \times 3 \times 10^{-3} = \underline{6\ C}$$

Chapter 1, Solution 34

(a) Energy = $\sum pt$ = 200 x 6 + 800 x 2 + 200 x 10 + 1200 x 4 + 200 x 2
= **10 kWh**

(b) Average power = 10,000/24 = **416.7 W**

Chapter 1, Solution 35

energy = (5x5 + 4x5 + 3x5 + 8x5 + 4x10)/60 = **2.333 MWhr**

Chapter 1, Solution 36

(a) $i = \frac{160\text{A} \cdot \text{h}}{40} = \underline{4\text{ A}}$

(b) $t = \frac{160\text{Ah}}{0.001\text{A}} = \frac{160{,}000\text{h}}{24\text{h / day}} = \underline{6{,}667\text{ days}}$

Chapter 1, Solution 37

$W = pt = vit = 12x\ 40x\ 60x60 =$ **1.728 MJ**

Chapter 1, Solution 38

$P = 10 \text{ hp} = 7460 \text{ W}$

$W = pt = 7460 \times 30 \times 60 \text{ J} = \mathbf{13.43 \times 10^6 \text{ J}}$

Chapter 1, Solution 39

W = pt = 600x4 = 2.4 kWh
C = 10cents x2.4 = **24 cents**