1.15 The current flowing into a box is given by the waveform shown in Fig. P1.15. Calculate the following quantities: (a) the amount of charge which has entered the box at $t = 1$ s, $t = 3$ s, and $t = 4.5$ s, (b) the power absorbed by the box at $t = 1$ s, 2.5 s, 4.5 s, and 5.5 s and (c) the amount of energy absorbed by the box between 0 and 6 s.

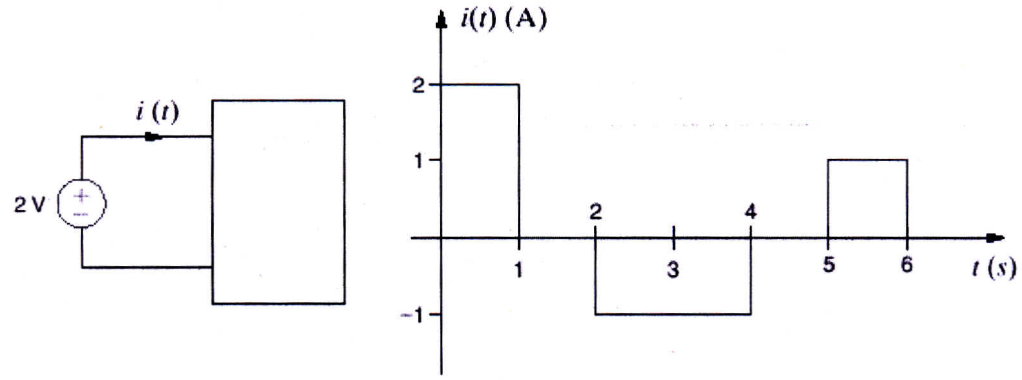

Figure P1.15

SOLUTION:

a) $q(t) = \int_{-\infty}^{t} i(x)\,dx$

$q(t) = \int_{0}^{t} 2\,dx = 2t\Big]_0^1 = 2C$

$q(1) = 2C$

$q(t) = \int_0^1 2\,dx + \int_2^t -1\,dx$

$q(t) = 2 - x\Big]_2^t$

$q(t) = 2 + [-t + 2]$

$q(t) = -t + 4$

$q(3) = 1C$

By counting the areas:

$q(4.5) = 2(1) + 2(-1)$

$q(4.5) = 0C$

b) At $t = 1s$

$v(t) \cdot i(t) = 2 * 2 = 4W$

At $t = 2.5s$

$v(t) \cdot i(t) = 2 * (-1) = -2W$ (power is given out by the box)

At $t = 4.5s$

$i(t) = 0 \Rightarrow$ Power $= 0W$

At $t = 5.5s$

$v(t) \cdot i(t) = 2 * 1 = 2W$

c)

$$W = \int_1 v(t)\, i(t)\, dt$$

$$W = \int_0^1 2(2)\, dt + \int_2^4 2(-1)\, dt + \int_5^6 2(1)^2\, dt$$

$$W = 4t\Big]_0^1 - 2t\Big]_2^4 + 2t\Big]_5^6$$

$$W = 4 - 2[2] + 2[6-5]$$

$$W = 4 - 4 + 2 = 2J$$