Problem 1.9

The current through an element is shown in Fig. 1.26. Determine the total charge that passed through the element at:

(a) $t = 1$ s   (b) $t = 3$ s   (c) $t = 5$ s
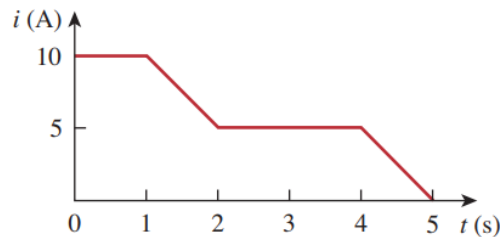

Figure 1.26
For Prob. 1.9.

Solution

Current and charge are related by

$$i(t) = \frac{dq}{dt} \quad \rightarrow \quad q(t) = \int_0^t i(t)\, dt,$$

so the total charge is the area under the current-versus-time graph up until the given time.

(a)   At $t = 1$: $q(t) = [10(1 - 0)]\ \mathrm{A \cdot s} = 10$ C

(b)   At $t = 3$: $q(t) = \left[10(1 - 0) + 5(2 - 1) + \frac{1}{2}(10 - 5)(2 - 1) + 5(3 - 2)\right] \mathrm{A \cdot s} = 22.5$ C

(c)   At $t = 5$: $q(t) = \left[10(1 - 0) + 5(2 - 1) + \frac{1}{2}(10 - 5)(2 - 1) + 5(4 - 2) + \frac{1}{2}5(5 - 4)\right] \mathrm{A \cdot s} = 30$ C