

Problem 1.21

A 60-W incandescent bulb operates at 120 V. How many electrons and coulombs flow through the bulb in one day?

Solution

60 W is the power of the bulb, and 120 V is the voltage. Use the basic definition of power to obtain the current.

$$p = vi \quad \rightarrow \quad i = \frac{p}{v} = \frac{60 \text{ W}}{120 \text{ V}} = 0.50 \text{ A} = 0.50 \frac{\text{C}}{\text{s}}$$

Convert this to coulombs per day.

$$i = 0.50 \frac{\text{C}}{\cancel{\text{s}}} \times \frac{60 \cancel{\text{s}}}{1 \cancel{\text{min}}} \times \frac{60 \cancel{\text{min}}}{1 \cancel{\text{h}}} \times \frac{24 \cancel{\text{h}}}{1 \text{ day}} \approx 4.3 \times 10^4 \frac{\text{C}}{\text{day}}$$

Use the fact that there are about 6.24×10^{18} electrons in one coulomb to convert this current to electrons per day.

$$i \approx 4.3 \times 10^4 \frac{\cancel{\text{C}}}{\text{day}} \times \frac{6.24 \times 10^{18} \text{ electrons}}{1 \cancel{\text{C}}} \approx 2.7 \times 10^{23} \frac{\text{electrons}}{\text{day}}$$