Problem 1.61

Estimate the number of atoms in your body. (*Hint:* Based on what you know about biology and chemistry, what are the most common types of atom in your body? What is the mass of each type of atom? Appendix D gives the atomic masses of different elements, measured in atomic mass units; you can find the value of an atomic mass unit, or 1 u, in Appendix E.)

Solution

The body is about 60% water by mass. Assume that the rest of the mass in the body consists of carbon (25% by mass), nitrogen (10% by mass), oxygen (4% by mass), and hydrogen (1% by mass). Also, assume the body weight is 170 pounds. Convert it to grams using the conversion factor in Appendix E.

$$m = 170\,\cancel{\text{lb}} \times \frac{1\,\cancel{\text{kg}}}{2.205\,\cancel{\text{lb}}} \times \frac{1000\text{ g}}{1\,\cancel{\text{kg}}} \approx 77\,098\text{ g}$$

Calculate the number of atoms with the assumed composition.

$$\text{Carbon:} \quad 0.25(77\,098)\text{ g} \times \frac{1\text{ mol C}}{12.01\text{ g}} \times \frac{6.022045 \times 10^{23}\text{ atoms}}{1\text{ mol}} \approx 9.66 \times 10^{26}\text{ C atoms}$$

$$\text{Nitrogen:} \quad 0.1(77\,098)\text{ g} \times \frac{1\text{ mol N}}{14.00\text{ g}} \times \frac{6.022045 \times 10^{23}\text{ atoms}}{1\text{ mol}} \approx 3.32 \times 10^{26}\text{ N atoms}$$

$$\text{Oxygen:} \quad 0.04(77\,098)\text{ g} \times \frac{1\text{ mol O}}{16.00\text{ g}} \times \frac{6.022045 \times 10^{23}\text{ atoms}}{1\text{ mol}} \approx 1.16 \times 10^{26}\text{ O atoms}$$

$$\text{Hydrogen:} \quad 0.01(77\,098)\text{ g} \times \frac{1\text{ mol H}}{1.008\text{ g}} \times \frac{6.022045 \times 10^{23}\text{ atoms}}{1\text{ mol}} \approx 4.61 \times 10^{26}\text{ H atoms}$$

The numbers of hydrogen and oxygen atoms, respectively, from the water (H_2O) are

$$\text{Hydrogen:} \quad 0.6(77\,098)\text{ g} \times \frac{1\text{ mol H}_2\text{O}}{18.016\text{ g H}_2\text{O}} \times \frac{2\text{ mol H}}{1\text{ mol H}_2\text{O}} \times \frac{6.022045 \times 10^{23}\text{ atoms}}{1\text{ mol}} \approx 3.09 \times 10^{27}\text{ H atoms}$$

$$\text{Oxygen:} \quad 0.6(77\,098)\text{ g} \times \frac{1\text{ mol H}_2\text{O}}{18.016\text{ g H}_2\text{O}} \times \frac{1\text{ mol O}}{1\text{ mol H}_2\text{O}} \times \frac{6.022045 \times 10^{23}\text{ atoms}}{1\text{ mol}} \approx 1.55 \times 10^{27}\text{ O atoms}$$

Adding up all the atoms results in roughly

$$6.52 \times 10^{27}\text{ atoms}$$

in the body.