2.10: The Avogadro Constant

Although chemists usually work with moles as units, occasionally it is helpful to refer to the actual number of atoms or molecules involved. When this is done, the symbol N is used. For example, in referring to 1 mol of mercury atoms, we could write

$$n_{\text{Hg}} = 1\text{mol}$$

and

$$N_{\text{Hg}} = 6.022 \times 10^{23}$$

Notice that N_{Hg} is a unitless quantity, which requires the use of a conversion factor to obtain. This conversion factor involves the number of particles per unit amount of substance and is given the symbol N_A and called the **Avogadro constant**. It is defined by the equation

$$N_{\text{A}} = \frac{N}{n} \tag{2.10.1}$$

Since for any substance there are 6.022×10^{23} particles per mole,

$$N_{\text{A}} = \frac{6.022 \cdot 10^{23}}{1 \text{ mol}} = 6.022 \times 10^{23} \text{ mol}^{-1}$$

Example 2.10.1: Moles to Molecules

Calculate the number of O_2 molecules in 0.189 mol O_2.

Solution

Rearranging Equation 2.10.1, we obtain

$$N = n \times N_{\text{A}} = 0.189 \text{ mol} \times 6.022 \times 10^{23} \frac{1}{\text{mol}} = 1.14 \times 10^{23}$$

Alternatively, we might include the identity of the particles involved:

$$\begin{aligned} \text{N} &= 0.189 \text{ mol O}_2 \cdot \left(\frac{6.022 \times 10^{23} \text{ O}_2 \text{ molecules}}{1 \text{ mol O}_2} \right) \\ &= 1.14 \cdot 10^{23} \text{ O}_2 \text{ molecules} \end{aligned}$$

Notice that Equation 2.10.1, which defines the Avogadro constant, has the same form as the equation which defined density. The preceding example used the Avogadro constant as a conversion factor in the same way that density was used. As in previous examples, all that is necessary is to remember that number of particles and amount of substance are related by a conversion factor, the Avogadro constant.

$$\text{Number of particles} \xleftrightarrow{\text{Avogadro constant}} \text{amount of substance} \tag{2.10.2}$$

$$N \xleftrightarrow{\text{N}_\text{A}} n$$

As long as the units *mole* cancel, N_{A} is being used correctly.