Example 11-1 illustrates an important point. In order to calculate the number of moles in a given mass of a chemical compound, it is necessary to know the chemical formula of the compound. A mole of any compound is defined only in terms of its chemical formula. If a substance (such as coal or wood) cannot be represented by a single chemical formula, then we can give only the mass of the substance.

11-2. One Mole of Any Substance Contains Avogadro's Number of Formula Units

It has been determined experimentally that one mole of any substance contains 6.022×10^{23} formula units (to four significant figures). This number is called **Avogadro's number** after the Italian scientist Amedeo Avogadro, who was one of the earliest scientists to distinguish between atoms and molecules (Chapter 13 Frontispiece). We say not only that one mole of any substance contains Avogadro's number of formula units but also that one mole is that mass of a substance containing Avogadro's number of formula units, or "elementary entities." For example, the atomic mass of the pure isotope carbon-12 is taken to be exactly 12, so 12.00 grams of carbon-12 contains 6.022×10^{23} atoms. Likewise, the molecular mass of water is 18.02, so 18.02 grams of water contains 6.022×10^{23} molecules.

A mole is simply a designation for Avogadro's number of "things" such as atoms and molecules, just as a dozen of eggs is a designation for twelve eggs. It is often helpful to think of one mole as a "counting unit" representing Avogadro's number of things, just as one dozen is a counting unit representing twelve things. But instead of the number 12 implied by the term dozen, the number of things in a mole is 6.022×10^{23}. A mole may be more intimidating because of the huge magnitude of Avogadro's number, but it is really the same concept as a dozen. A mole of eggs would be 6.022×10^{23} eggs, but it is not a practical measure of the number of eggs. A mole of atoms or molecules, on the other hand, is a practical measure of the number of atoms or molecules in a substance because of their small size. A few examples of things that we count in chemistry using moles are given in Table 11.1.

We now have an alternative definition for a mole: *One mole is the mass of a substance containing Avogadro's number of formula units.* For example, referring to

TABLE 11.1 Some things for which we use the counting unit "mole"

Counting unit	Number of things	Examples of things counted in moles	Mass of one mole
1 mole	6.022×10^{23}	atoms, such as aluminum, Al	26.98 g
		molecules, such as water, H_2O	18.02 g
		ions, such as Na^+	22.99 g
		elementary particles, such as electrons, e^-	0.5486 mg