

# Using Chemical Formulas

## SECTION 3

### OBJECTIVES

- Calculate the formula mass or molar mass of any given compound.
- Use molar mass to convert between mass in grams and amount in moles of a chemical compound.
- Calculate the number of molecules, formula units, or ions in a given molar amount of a chemical compound.
- Calculate the percentage composition of a given chemical compound.

### Formula Masses

In Chapter 3, we saw that hydrogen atoms have an average atomic mass of 1.007 94 amu and that oxygen atoms have an average atomic mass of 15.9994 amu. Like individual atoms, molecules, formula units, or ions have characteristic average masses. For example, we know from the chemical formula  $\text{H}_2\text{O}$  that a single water molecule is composed of exactly two hydrogen atoms and one oxygen atom. The mass of a water molecule is found by adding the masses of the three atoms in the molecule. (In the calculation, the average atomic masses have been rounded to two decimal places.)



average atomic mass of H: 1.01 amu  
average atomic mass of O: 16.00 amu

$$2 \text{ H atoms} \times \frac{1.01 \text{ amu}}{\text{H atom}} = 2.02 \text{ amu}$$

$$1 \text{ O atom} \times \frac{16.00 \text{ amu}}{\text{O atom}} = 16.00 \text{ amu}$$

average mass of  $\text{H}_2\text{O}$  molecule = 18.02 amu

The mass of a water molecule can be correctly referred to as a *molecular mass*. The mass of one NaCl formula unit, on the other hand, is not a molecular mass because NaCl is an ionic compound. The mass of *any* unit represented by a chemical formula, whether the unit is a molecule, a formula unit, or an ion, is known as the formula mass. **The formula mass of any molecule, formula unit, or ion is the sum of the average atomic masses of all atoms represented in its formula.**



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