4.3: Mole-Mass Conversions

As described in the previous section, molar mass is expressed as "grams *per* mole". The word *per* in this context implies a mathematical relationship between grams and mole. Think of this as a ratio. The fact that a *per* relationship, ratio, exists between grams and moles implies that you can use dimensional analysis to interconvert between the two. For example, if we wanted to know the mass of 0.50 mole of molecular hydrogen (H_2) we could set up the following equations:

The ***known*** molar mass of H_2 is:

$$\left(\frac{2.06 g\ H_2}{1\ mol\ H_2}\right)$$

We are ***given*** that we have 0.50 moles of H_2 and we want to ***find*** the number of grams of H_2 that this represents. To perform the dimensional analysis, we arrange the *known* and the *given* so that the units cancel, leaving only the units of the item we want to *find*.

$$(0.5 mol\ H_2) \times \left(\frac{2.06 g\ H_2}{1\ mol\ H_2}\right) = x\ g\ H_2 = 1.0 g\ H_2$$

> **Exercise 4.3.1**
>
> a. Determine the mass of 0.752 mol of H_2 gas.
> b. How many *moles* of molecular hydrogen are present in 6.022 grams of H_2?
> c. If you have 22.414 grams of Cl_2, how many *moles* of molecular chlorine do you have?

We can also use what is often called a *per* relationship (really just a **ratio**) to convert between number of *moles* and the number to *things* (as in 6.02 x 10^{23} *things per mole*). For example, if we wanted to know how many *molecules* of H_2 are there in 3.42 moles of H_2 gas we could set up the following equations:

The ***known*** ratio of molecules *per* mole is :

$$\left(\frac{6.02 \times 10^{23} molecules\ H_2}{1\ mol\ H_2}\right)$$

We are ***given*** that we have 3.42 moles of H_2 and we want to ***find*** the number of molecules of H_2 that this represents. To perform the dimensional analysis, we arrange the *known* and the *given* so that the units cancel, leaving only the units of the item we want to *find*.

$$(3.42 mol\ H_2) \times \left(\frac{6.02 \times 10^{23} molecules\ H_2}{1\ mol\ H_2}\right) = x\ molecules\ H_2 = 2.06 \times 10^{24}\ molecules\ H_2$$

And finally, we can combine these two operations and use the *per* relationships to convert between *mass* and the *number* of atoms or molecules. For example, if we wanted to know how many *molecules* of H_2 are there in 6.022 *grams* of H_2 gas we could set up the following series of equations:

The ***known*** molar mass of H_2 is

$$\left(\frac{2.016 g H_2}{1 mol H_2}\right)$$

The ***known*** ratio of molecules *per* mole is

$$\left(\frac{6.02 \times 10^{23} molecules\ H_2}{1\ mol\ H_2}\right)$$

We are ***given*** that we have 6.022 grams of H_2 and we want to ***find*** the number of molecules of H_2 that this represents. As always, to perform the dimensional analysis, we arrange the *known* ratios and the *given* so that the units cancel, leaving only the units of the item we want to *find*.

$$(6.022 gH_2) \times \left(\frac{1 mol H_2}{2.016 gH_2}\right) \times \left(\frac{6.02 \times 10^{23} molecules\ H_2}{1\ mol\ H_2}\right) = x\ molecules\ H_2 = 1.80 \times 10^{24}$$

Exercise 4.3.1

a. A sample of molecular chlorine is found to contain 1.0 x 10^{20} molecules of Cl_2. What is the *mass* (in grams) of this sample?
b. How many moles of sand, silicon dioxide (SiO_2), and how many molecules of sand are found in 1.00 pound (454g) of sand?
c. You add 2.64 x 10^{23} molecules of sodium hydroxide (Drano™; NaOH), to your drain. How many moles are this and how many grams?