6.5: Conversions Between Mass and Number of Particles

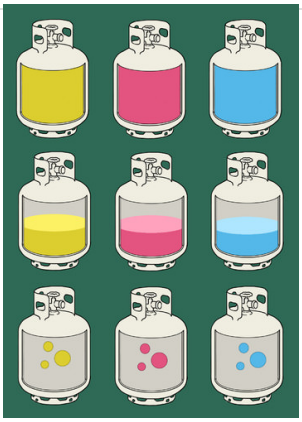

Figure 6.5.1 (Credit: Laura Guerin; Source: CK-12 Foundation; License: CC BY-NC 3.0(opens in new window))

How much gas is there?

Avogadro was interested in studying gases. He theorized that equal volumes of gases under the same conditions contained the same number of particles. Other researchers studied how many gas particles were in specific volumes of gases. Eventually, scientists were able to develop the relationship between number of particles and mass, using the idea of moles.

Conversions Between Mass and Number of Particles

In "Conversions Between Moles and Mass", you learned how to convert back and forth between moles and the number of representative particles. Now you have seen how to convert back and forth between moles and the mass of a substance in grams. We can combine the two types of problems into one. Mass and number of particles are both related to grams. In order to convert from mass to number of particles or vice-versa, a conversion to moles is required.

Figure 6.5.2: Conversion from number of particles to mass, or from mass to number of particles requires two steps. (Credit: Christopher Auyeung; Source: CK-12 Foundation; License: CC BY-NC 3.0(opens in new window))

Example 6.5.1: Converting Mass to Particles

How many molecules is $20.0\ \text{g}$ of chlorine gas, Cl_2?

Solution

Step 1: List the known quantities and plan the problem.

Known

- Molar mass $\text{Cl}_2 = 70.90\ \text{g/mol}$
- $20.0\ \text{g}\ \text{Cl}_2$

Unknown

- number of molecules of Cl_2

Use two conversion factors. The first converts grams of Cl_2 to moles. The second converts moles of Cl_2 to the number of molecules.

Step 2: Calculate.

$$20.0\ \text{g}\ \text{Cl}_2 \times \frac{1\ \text{mol}\ \text{Cl}_2}{70.90\ \text{g}\ \text{Cl}_2} \times \frac{6.02 \times 10^{23}\ \text{molecules}\ \text{Cl}_2}{1\ \text{mol}\ \text{Cl}_2} = 1.70 \times 10^{23}\ \text{molecules}\ \text{Cl}_2$$

The problem is done using two consecutive conversion factors. There is no need to explicitly calculate the moles of Cl_2.

Step 3: Think about your result.

Since the given mass is less than half of the molar mass of chlorine, the resulting number of molecules is less than half of Avogadro's number.

Summary

- Calculations are illustrated for conversions between mass and number of particles.

Review

1. Why can’t we convert directly from number of particles to grams?
2. How many atoms of chlorine are present in 1.70×10^{23} molecules Cl_2?
3. How many molecules of BH_3 are in 14.32 grams BH_3?
