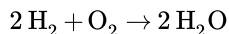


11.1: General Stoichiometry

The only new information we need to be able to carry out stoichiometric calculations is to understand that the coefficients in the chemical equation may be used as conversion factors. Consider the equation for the formation of water from hydrogen and oxygen.



We can read this reaction as “two moles of hydrogen react with one mole of oxygen to produce two moles of water.” Any of the following ratios may be deduced from this equation.

$$\frac{2 \text{ mol H}_2}{1 \text{ mol O}_2} \text{ or } \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2} \quad (11.1.1)$$

$$\frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2} \text{ or } \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} \quad (11.1.2)$$


$$\frac{2 \text{ mol H}_2}{2 \text{ mol H}_2\text{O}} \text{ or } \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} \quad (11.1.3)$$

We can use these ratios to determine what amount of a substance, in moles, will react with or produce a given number of moles of a different substance.

✓ Example 11.1.1

How many moles of oxygen react with hydrogen to produce 27.6 mol of H_2O ?

Solution

| Steps for Problem Solving | How many moles of oxygen react with hydrogen to produce 27.6 mol of H_2O ? |
|--|--|
| Find a balanced equation that describes the reaction. | Unbalanced: $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$ Balanced: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ |
| Identify the "given" information and what the problem is asking you to "find." | Given: moles H_2O Find: moles oxygen |
| List other known quantities. | $1 \text{ mol O}_2 = 2 \text{ mol H}_2\text{O}$ |
| Prepare a concept map and use the proper conversion factor. |  $\frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}}$ |
| Cancel units and calculate. | $27.6 \text{ mol H}_2\text{O} \times \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} = 13.8 \text{ mol O}_2$ <p>To produce 27.6 mol of H_2O, 13.8 mol of O_2 react.</p> |
| Think about your result. | Since each mole of oxygen produces twice as many moles of water, it makes sense that the produced amount is greater than the reactant amount |

As we know, however, chemical quantities are not usually stated in moles of a compound, but in grams of a solid, liters of a solution, etc. For this, we will need to use the tools learned in previous sections to help us to first convert into moles. Any easy way to think about this is as follows.

Stoichiometric calculations are generally as easy as 1-2-3.

1. **Convert into moles (if not already in moles).**
2. **Change substances (mole ratio from balanced chemical equation).**

3. Convert out of moles (if needed).

Many people appreciate a graphical representation like the one below. To use it, just look at your given information to figure out where to start and where you want to end up, then apply the steps to carry it out. The following three pages will explain how to apply the different pathways.

Stoichiometry Map

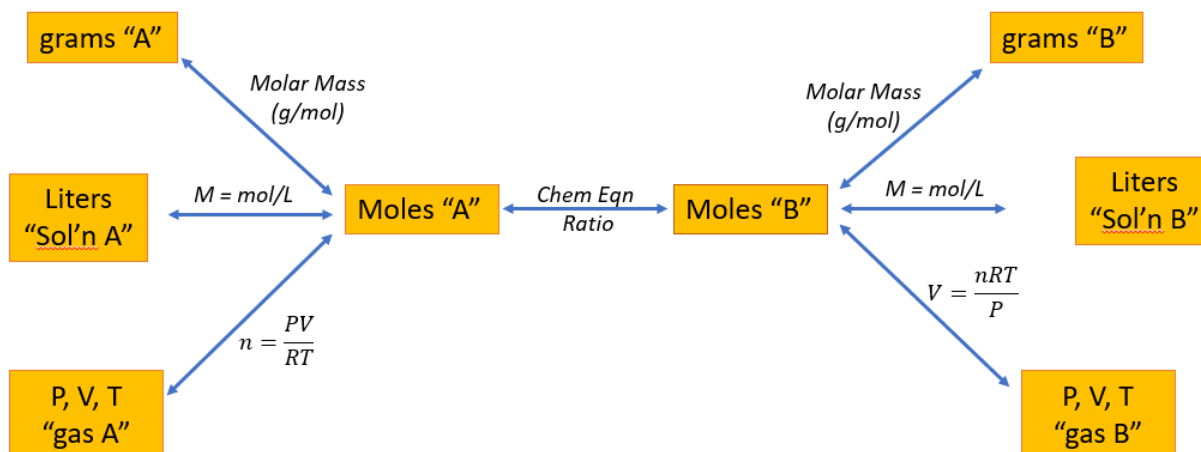


Figure 11.1.1: Stoichiometry Map

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