**Stoichiometry**

What is Stoichiometry?

Stoichiometry is defined as the numerical relationship between chemical quantities in a balanced chemical reaction. It allows chemists to design and perform chemical reactions in order to obtain a desired amount of product. Stoichiometry is used to predict how much product will form in a chemical reaction given the amount of reactant. It is also useful in determining how much reactant is needed to form a specific amount of product. The importance of stoichiometry to chemistry cannot be understated. In this handout, you will see how to solve various types of stoichiometry problems. In addition, you will develop skills that will allow you to solve additional types of stoichiometry problems that you will encounter later in the semester.

Solving Stoichiometry Problems

Step #1: Start with a BALANCED equation.
Step #2: Identify what is given. Call this letter A. Identify what you are trying to find. Call this letter B.
Step #3. Decide which steps are necessary to get from A to B. Always start with what you are given.
Step #4. Solve the problem using dimensional analysis to cancel your units. The desired unit should be the only one remaining.
Step #5. Round your answer to the correct number of significant figures.

Sample Problem #1: Mole – Mole

How many moles of HCl are needed to react with 0.87 moles of Al?

\[ 2\text{Al} + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2 \]

\[
0.87 \text{ mol Al} \times \frac{6 \text{ mol HCl}}{2 \text{ mol Al}} = 2.61 = 2.6 \text{ mol HCl}
\]

1. The equation is already balanced.
2. Label Al letter A and HCl letter B.
3. You are converting from mol A → mol B. You can do this in a single step.
4. Use the coefficients in the balanced equation to cancel mol Al so you are left with mol HCl.
5. Your answer must have 2 significant figures because 0.87 has 2 significant figures.

Sample Problem #2: Mass – Mass

How many grams of Al can be created from the decomposition of 9.8g of Al\(_2\)O\(_3\)?

\[ 2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2 \]

\[
9.8 \text{ g Al}_2\text{O}_3 \times \frac{1 \text{ mol Al}_2\text{O}_3}{101.96 \text{ g Al}_2\text{O}_3} \times \frac{4 \text{ mol Al}}{2 \text{ mol Al}_2\text{O}_3} \times \frac{26.98 \text{ g Al}}{1 \text{ mol Al}} = 5.1864 = 5.2 \text{ g Al}
\]

1. The equation is already balanced.
2. Label Al\(_2\)O\(_3\) letter A and Al letter B.
3. All mass-mass problems are solved the same way (mass A → mol A → mol B → mass B).
4. Cancel units until you are left with g Al. The 4 and the 2 are the coefficients from the balanced equation.
5. The answer must have 2 significant figures because 9.8 has 2 significant figures.
**Sample Problem #3: Mass –Volume**

How many liters of H\(_2\) are created from the reaction of 20.0 g K? Assume STP.

\[
2K + 2H_2O \rightarrow 2KOH + H_2
\]

\[
20.0 \text{ g K} \times \frac{1 \text{ mol K}}{39.10 \text{ g K}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol K}} \times \frac{22.4 \text{ L H}_2}{1 \text{ mol H}_2} = 5.7289 = 5.73 \text{ L H}_2
\]

1. The equation is already balanced.
2. Label K letter A and H\(_2\) letter B.
3. All mass-volume problems are solved the same way (mass A → mol A → mol B → volume B).
4. Cancel units until you are left with L H\(_2\). The 1 and the 2 are the coefficients from the balanced equation. 22.4 is the volume of 1 mole of any gas at STP (standard temperature and pressure).
5. The answer must have 3 significant figures because 20.0 has 3 significant figures.

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**Sample Problem #4: Volume –Volume**

How many liters of SO\(_2\) will be produced from 26.9 L O\(_2\)? Assume STP.

\[
S_2 + 2O_2 \rightarrow 2SO_2
\]

\[
26.9 \text{ L O}_2 \times \frac{1 \text{ mol O}_2}{22.4 \text{ L O}_2} \times \frac{2 \text{ mol SO}_2}{2 \text{ mol O}_2} \times \frac{22.4 \text{ L SO}_2}{1 \text{ mol SO}_2} = 26.9 \text{ L SO}_2
\]

1. The equation is already balanced.
2. Label O\(_2\) letter A and SO\(_2\) letter B.
3. All volume-volume problems are solved the same way (volume A → mol A → mol B → volume B).
4. Cancel units until you are left with L SO\(_2\). The 2 and the 2 are the coefficients from the balanced equation. 22.4 is the volume of 1 mole of any gas at STP (standard temperature and pressure).
5. The answer must have 3 significant figures because 26.9 has 3 significant figures.