

Lecture Notes – Ch 9.1 & 9.2 – mol-mol and ratios from formulas Std 3e

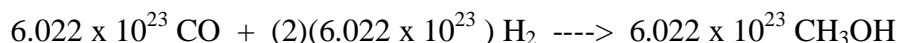
9.1 – Information from Chemical Equations

The following balanced chemical equation gives us a lot of information. Most importantly, it tells us the ratio of the reactants to the product. This allows us to predict how much product we can make with any amount of reactants.

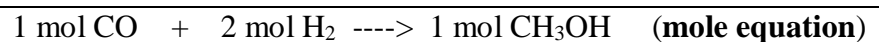


As you read this equation you can say: **one molecule** of CO reacts with **2 molecules** of H₂ to make **1 molecule** of CH₃OH. Each number (**coefficient**) actually represents how many **molecules of each reactant and product is involved in the reaction.**

If we rewrite the equation with moles of molecules, it will look like this:



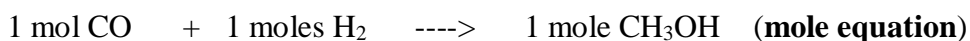
Since $6.022 \times 10^{23} = 1 \text{ mole}$, this equation can be rewritten as:



As you read this new equation you say: **one mole** of CO reacts with **2 moles** of H₂ to make **1 mole** of CH₃OH. Each number (**coefficient**) now represents how many **moles each reactant and product is involved in the reaction.**

Whether we have **molecules** or **moles** the ratios are the same. The only difference in the second equation is that we are talking about moles (Avogadro Numbers) of molecules or atoms instead of individual molecules or atoms.

In the second equation we have the following mole ratios:



There is one more type of equation, the **mass equation**. In this type of equation we change the mole to either gmw (gram molecular weights) or gaw (gram atomic weights). To do a mass equation we first must figure all of the gmw's for this equation (note: this equation has no gaw's).

For **CO** we find the mass by:

$$\begin{array}{l} 1 \text{ C} \times 12\text{g} = 12 \text{ g (gaw for C)} \\ 1 \text{ O} \times 16\text{g} = 16 \text{ g (gaw for O)} \\ \text{Total} = 28 \text{ g} \end{array}$$

total mass CO = 28g (the total gmw for one mole of CO molecules)

For **H₂** we find the mass by:

total mass $2 \text{ H}_2 \times 1 \text{ g} = 4 \text{ g}$ (gmw of one mole of H_2 molecules)

For CH_3OH we find the mass by:

1 C x 12g = 12g (gaw of 1 mole of C atoms)
4 H x 1g = 4g (gaw of 4 moles of H atoms)
1 O x 16g = 16g (gaw of 1 mole of O atoms)
Total = 32 g

total mass of one mole of $\text{CH}_3\text{OH} = 32 \text{ g}$ (gmw for 1 mole CH_3OH)

Rewriting the equation to show mass ratios, the equation would read:

7 : 1 : 8 (simplest mass ratios)
28g CO + 4g H_2 ----> 32g CH_3OH (mass equation)

The mass equation is what you need to get the weights for mixing the correct proportions, because we weigh everything in grams before mixing them for any reaction. As you see, you cannot figure out the mass equation without the mole equation. The mole equation only works because of molecular equation.

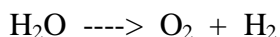
9.2 Mole-Mole Relationships

Example 9.2 (see page 262 - 263)

Question:

If I have 2 moles of H_2O , how many moles of O_2 can I make? The unbalanced equation for the reaction is as follows:

(Notice I've changed the starting number of moles from 5.8 to 2 moles of H_2O .)



Solution:

Here is my way of working this problem out. First we must balance the equation so it reads:

2 : 1 : 2 (simplest mole ratios)
2 H_2O ----> O_2 + 2 H_2 (molecular equation)

Next we use the simplest ratios (the coefficients) as the mole ratios because mole ratios are the same as molecule ratios. With this we can come up with several equalities, or ratios:

2 mol $\text{H}_2\text{O} = 1 \text{ mol O}_2$
2 mol $\text{H}_2\text{O} = 2 \text{ mol H}_2$
1 mol $\text{O}_2 = 2 \text{ mol H}_2$

The equality (ratio) we need to use in our grid is $2 \text{ mol H}_2\text{O} = 1 \text{ mol O}_2$

Using this equality in a grid we get:

Given	Use the equality I chose		Answer
2 mol H_2O	1 mol O_2		1 mol O_2
1	2 mol H_2		

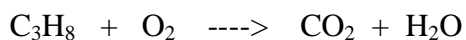
Now try working this same equation using these questions:

1. If you want to make 3 moles of O₂ , how many moles of H₂O do you need?
2. If you want to make 3 moles of O₂ , how many moles of H₂ will be made at the same time?

Example 9.3 (see page 263 – 264)

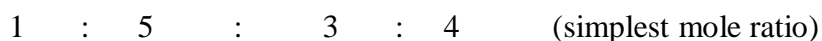
Question:

How many moles of O₂ are needed to react exactly with 2.15 moles of propane (C₃H₈) in the following reaction?



Solution:

First thing we must do is to balance the equation:



We want to find the moles of oxygen, so we need an equality to take us from the given 2.15 moles of propane to the moles of oxygen. So we use the ratio of the coefficients in the molecular equation to get:

$$1 \text{ mole C}_3\text{H}_8 = 5 \text{ mole O}_2$$

Given	mole ratio		Answer
2.15 mole C ₃ H ₈	5 moles O ₂		10.75 moles O ₂
1	1 mole C ₃ H ₈		

Now try working these problems using the same balanced equation:

1. If you have 2.15 moles C₃H₈ , how many moles of CO₂ can you make?
2. If you have 2.15 moles C₃H₈ , how many moles of H₂O can you make?