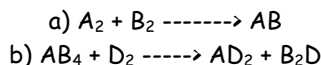


Workshop 3 – Station 1

Part I

For this first section of the workshop, work in pairs. Each student needs one bag of M&Ms.

Each letter in the formulas below corresponds to a different color M&M. Arrange your M&Ms as if they were participants in the chemical reactions below. Make sure you balance your reactions!



The coefficient in a balanced chemical reaction indicates either the number of molecules that react, or the number of moles that react in that reaction.

Part II

Now, let's move to actual chemicals. In reaction (b) above, A is carbon, B is hydrogen, and D is oxygen. First, rewrite reaction (b) in terms of its elements. Now, let's solve a problem using the balanced equation.

15.0 grams of methane gas, CH_4 , react with an excess of oxygen, O_2 , to produce carbon dioxide, CO_2 , and water, H_2O . How much H_2O in grams, is produced in this reaction?

Step 1: Convert the number of grams of CH_4 reacted to moles, using the molar mass of CH_4 . Why do we need to convert to moles?

Step 2: Convert the number of moles of CH_4 reacted to moles of H_2O produced, using the balanced chemical equation.

Step 3: Convert the moles of H_2O to grams of H_2O , using the molar mass of H_2O .

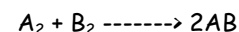
Will all of that H_2O be produced? Sometimes, less is produced if the reaction doesn't go to completion. We can calculate the percent yield by the following formula: % yield = actual yield (how much H_2O was actually produced) / theoretical yield (the amount we calculated could be produced) *100%.

Calculate the percent yield for the above reaction if 11.5 grams of H_2O are produced.

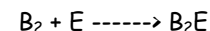
Workshop 3 – Station 2

If you have five socks and three pairs of clean underwear, how many days will it be before you have to do your laundry? Since two socks are needed for every pair of underwear, the socks are limiting how many days you can go without washing, even though you have more of them.

In Chemistry, the limiting reagent is the one that there's *stoichiometrically* less of. In other words, it's the one that limits the amount of product formed because it runs out first. Let's go back to the first M&M equation. If A is brown M&Ms, and B is green, which one limits how much AB can be formed? Your answer will depend on what combination of colors you have in your bag!



If a different reaction occurs, and E is orange M&Ms, which one limits how much product can be formed?



We will now work a chemical limiting reagent problem:

During the launch of a US space shuttle, high-pressure pumps deliver 4400 kg of liquid H_2 fuel and 31,000 kg of liquid O_2 to each of its main engines in the first minute. They react to form H_2O and a lot of energy!

a) Write a balanced chemical reaction for the process.

b) Without using your calculator, determine which is the limiting reagent.

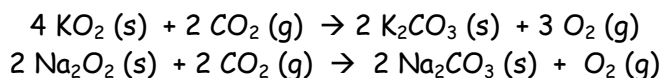
c) Without using your calculator, estimate the amount, in grams, of water that will form. There are lots of ways to do this calculation. Try it on your own first, but if you need a hint: Round all values to 1 sig fig.

d) Calculate how much water, in grams, will form.

Workshop 3 – Station 3

In the first episode of George Lucas' Star Wars series, Qui-Gon Jinn and Obi-Wan Kenobi can only visit the underwater world of the Gungans by using A99 Aquata Breathers that allow them to survive underwater for up to two hours.

While the tiny devices may be from the far-fetched world of science fiction, current technology exists for transforming carbon dioxide to oxygen. These self-contained re-breathers are used by a select group of underwater cave explorers and can act as self-rescue devices. The chemistry is based on the following chemical reactions using either potassium superoxide or sodium peroxide:

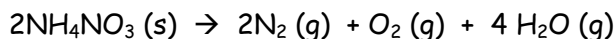


a) The respiratory rate at rest for an average, healthy adult is 12 breaths per minute. If the average breath takes in 0.020 moles of O_2 into our lungs, how many grams of KO_2 are needed to produce enough of oxygen for two hours underwater?

b) Would you need more or less grams of Na_2O_2 to produce an equivalent amount of oxygen?

c) Given the densities of KO_2 (2.14 g/mL) and Na_2O_2 (2.805 g/mL) which solid material would occupy less volume in a re-breather device that can last for two hours as in part (a)?

d) Breathing pure oxygen for any length of time can be dangerous to the human body so a better re-breathing apparatus would be one that also produces nitrogen. One possible reaction that produces both N_2 and O_2 is the thermal decomposition of ammonium nitrate:



How many grams of NH_4NO_3 is needed to satisfy the needs of the Jedi knight in part (a)?

Workshop 3 – Station 4 (to take home)

Unit conversion/dimensional analysis is an important concept in Chemistry. These problems will give you practice.

$$1 \text{ ounce} = 29.573 \text{ mL}$$

$$1 \text{ mile} = 1.609344 \text{ kilometer}$$

a) The price of a popular soda is \$1.25 for 20 fluid ounces or \$1.00 for 0.50L. Which is a better buy?

b) In nearby New Hampshire is Mount Washington, the largest mountain peak in the northeast. It is famous for its dangerously erratic weather. A wind gust of 231 miles/hour was recorded at the summit. Convert this wind speed to meters per second.