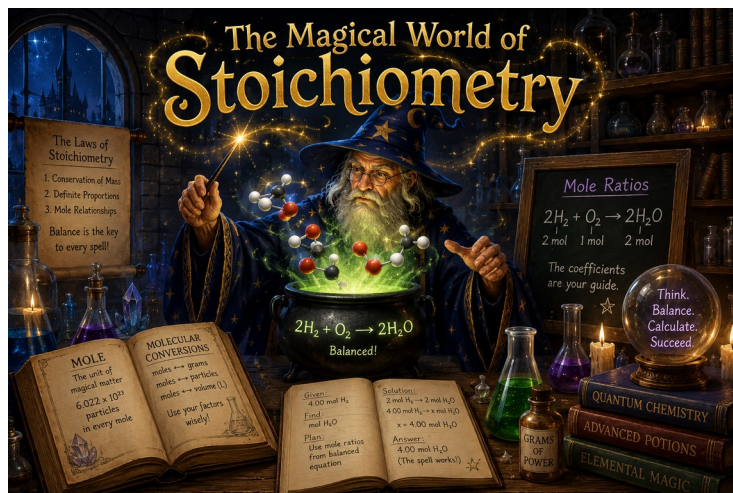


The magic of stoichiometry

So, you've finally, done it: You've entered the realm of stoichiometry. Or as some people pronounce it, "stoi-shee-oh-met-tree." Don't pronounce it that way, it'll make you sound silly. The actual pronunciation: "stoy-key-ah-meh-tree."

Now that we've got that out of the way, let's learn about the magical world of stoichiometry!



The magical world of stoichiometry

In this tutorial:

- **What is stoichiometry?**
 - **How can we do simple calculations?**
 - **More stoichiometry resources**
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What is stoichiometry?

One time I was making sandwiches for some of my son's friends who had inexplicably been invited over to my house on a "playdate". All I had was crackers and cheese in the house, and the kids all decided that the proper way to eat them was to put one piece of cheese between two crackers to make a little sandwich. It's a miracle I didn't kill any of them.

Anyway, I looked in the fridge and found about a zillion pieces of cheese, and the package of crackers had a sleeve of 20 remaining. The question: How many cracker sandwiches can I make?¹

Here's the math:

- If I have 20 crackers and assume that I have infinite quantities of cheese, I can make 10 cracker sandwiches.

Because I run out of crackers at 10 cracker sandwiches, that's the maximum quantity I can make. And that's what I made them. And the fat one cried.²

Believe it or not, this story actually answers the question of what stoichiometry is. Here's a more explicit version for those of you who didn't like the story:

Stoichiometry is a set of calculations you perform to figure out how much stuff you can make in a reaction, or how much stuff you will need to make the reaction occur.

In other words, stoichiometry is used to figure out if you've got enough crackers to make 30 sandwiches, or how much cheese you'll need to make 15 sandwiches. Of course, since chemistry uses fancy symbols, we'll deal with all of that in a second. However, that's the basic idea.

How to do stoichiometry

Before we do anything, we're going to make a modified version of the diagram we saw back when we were doing mole calculations. If you don't remember that stuff, you might want to go back and take a look at it again.

Let's see what it all means using the following example:

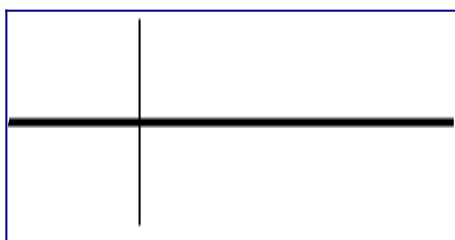
Example: Using the equation $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, determine how many grams of water can be formed from 45.0 grams of oxygen and an excess of hydrogen gas.

So, where do we begin? We begin by figuring out what that diagram above means:

- The box that says "grams of what you've got" refers to the number of grams that you've been given in the problem. In our example, we literally see "45.0 grams of oxygen", so that's where we start.
- The box that says "moles of what you've got" means that before we even start talking about water, we've got to figure out how many moles of oxygen we have. Since you already know how to do mole calculations (using the molar mass of what you've got, shown above), you should be OK.
- The box that says "moles of what you want" refers to the fact that, using the equation for this reaction, you can convert "moles of oxygen" to "moles of water." We do this using the mole ratio, which literally just consists of the numbers written down in the equation. We'll get back to that in a sec.
- The box that says "grams of what you want" refers to what is likely your desired answer. To get this value, convert the moles of water to grams of water using water's molar mass. When you're finished with this, you're done!

Let's just go ahead and do this example, using the methods you've seen before to do conversions:
The T-chart method:

Step 1: Draw a t



There it is!

Step 2: Put whatever the problem tells you in the top left of the t.

In this case, the problem tells you that you have 45.0 grams of oxygen, so write “45.0 grams of oxygen” in the top left of this t.

45.0 g O ₂	

Step 3: Write the units of whatever was in the top left at the bottom right.

Since “grams of oxygen” was written at the top left, write “grams of oxygen” at the bottom right.

45.0 g O ₂	
	g O ₂

Step 4: Write the units of whatever the next step is on the top right.

In the first step of this calculation we use our table to see that we’re converting from grams of oxygen to moles of oxygen. As a result, write “moles of oxygen” in the top right:

45.0 g O ₂	mol O ₂
	g O ₂

Step 5: Put numbers before each blank on the right side of the t, corresponding to the conversion factors you need.

This is *exactly* the same as grams/moles conversions, except that we’ll do more later. What this means is that we’ll put “1” in front of “moles” (because we always do during mole calculations) and the molar mass of O₂ in front of “grams” (it’s 32.0 g for those of you playing at home):

45.0 g O ₂	1 mol O ₂
	32.0 g O ₂

Step 6: Repeat these steps until you're done.

You'll get the hang of what to do before long, but I'll keep going through all of these steps in this example to make sure you're comfortable with the calculations.

Step 7: Add another section to the t, and write the units of the thing in the top left on the bottom right:

45.0 g O ₂	1 mol O ₂	
	32.0 g O ₂	mol O ₂

Step 8: Write the units of the thing you want to find in this step in the top right.

We're converting from moles of oxygen to moles of water here, so write "moles of water" in the top right:

45.0 g O ₂	1 mol O ₂	moles H ₂ O
	32.0 g O ₂	mol O ₂

Step 9: Add the conversion factors in the blanks on the right.

Now, given that we have "moles" on both the top and the bottom, it doesn't really make sense to put "1" in each spot as we usually do. Instead, realizing that the equation gives us a ratio of the number of moles of oxygen to number of moles of water (these are the coefficients in the equation), we'll put these numbers in front of each number. This ratio is called the "mole ratio", because it's a ratio of moles. In this balanced equation, there is an invisible 1 in front of O₂ and a 2 in front of H₂O.

45.0 g O ₂	1 mol O ₂	2 moles H ₂ O
	32.0 g O ₂	1 mol O ₂

Step 10: Do the last conversion from moles of water to grams of water, using the standard t-chart method.

45.0 g O ₂	1 mol O ₂	2 moles H ₂ O	18.0 g H ₂ O
	32.0 g O ₂	1 mol O ₂	1 mol H ₂ O

Step 11: Do the math:

The whole t-chart thing you just did is just a big bunch of fractions being multiplied together, so think of it like this:

$$\left(45.0 \text{ g O}_2\right) \left(\frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2}\right) \left(\frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2}\right) \left(\frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}}\right) = \mathbf{50.6 \text{ g H}_2\text{O}}$$

And that's how you do stoichiometry!

Footnotes:

1. The other question: Did I really care? No.
 2. For the record: He didn't cry because he was fat. He cried because he was a crybaby.
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