Chem1311Ch3Ep4

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Hello, and welcome to the 4th episode of Mass Relationships in chemical reactions.

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Previously, in mass relationships in chemical reactions.

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We learned to calculate the percent composition of a compound from its formula.

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We learn to calculate empirical and or molecular formulas from a compound's percent composition.

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In today's episode.

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We will learn to balance chemical equations in an organized, systematic way.

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A little background first.

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The process in which one or more substances change into one or more new substances is called a chemical reaction.

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A chemical equation.

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Is the written representation of such a chemical reaction.

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An arrow is used to represent these chemical changes.

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The starting substances are called reactants and are written to the left of the arrow.

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The new substances are called products.

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And are written to the right of the arrow.

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In a balanced equation, you will encounter two types of numbers.

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Subscripts, as you have already learned.

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Show the number of atoms of the elements in the molecule or formula unit.

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And coefficients show the number of molecules or formula units in the equation.

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It is important that both subscripts and coefficients be correct to reflect the law of conservation of mass.

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Notice that the masses of the products and reactants are exactly the same.

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A chemical equation such as the one in this slide can be interpreted in terms of particles or moles.

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You might read it as two atoms of magnesium and one oxygen molecule.

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React to form 2 magnesium oxide formula units.

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But it can also be read as two moles of magnesium and one mole of oxygen react to form 2 moles of magnesium oxide.

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That's a little bit of flexibility.

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It is also possible to express it in grams of each compound by using the molar masses from the periodic table.

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But for balancing purposes, moles seem to work best.

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Before attempting to balance, make sure that all your formulas on both products and reactants have the right subscripts.

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If they don't, it will simply not work.

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Here's an example of a chemical reaction.

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Let's write the equation.

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Notice that oxygen is O_2, not just O.

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And now is a great time to remember which seven elements form diatomic molecules when they are uncombined.

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That's back in Chapter 2.

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To make sure that the products and reactants sides have equal amounts of every atom, you must change the coefficients, never the subscripts.

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We will start by balancing elements that appear only once on both sides because they are easier.

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In the current example, that means carbon or hydrogen, because oxygen appears twice on the products side.

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Our first step is going to be to count all elements.

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Why? Because you should not add salt to your food until after you taste it.

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We need to know what's out of whack before we start randomly adding stuff.

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We will start balancing by multiplying our carbon dioxide by two.

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This changes the count for carbon and oxygen on the products side, so we need to make a correction.

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Next, we will multiply water by three.

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Which changes the hydrogen and oxygen counts on the product side again.

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That leaves us just oxygen.

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The reason why we ignored it before is because of the uncertainty.

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We don't know if we should change the oxygen count of the water and the carbon dioxide.

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Or just at the carbon dioxide.

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Or just at the water.

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We don't know, so we will start with the first option.

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If that doesn't work, we can try the others.

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Now the least common multiple for two and seven is 14.

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So we will multiply oxygen by 7.

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And we will multiply both carbon dioxide and water by two.

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And yes, that usually works, except when it doesn't.

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As you can see, both sides have now 14 oxygens.

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Next, we will multiply.

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Ethane by 2 to bring the carbon count on the reactants side and that balances both carbon and hydrogen.

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That was a lot of work, but sometimes it's easier, and sometimes it's harder.

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The next example has propane burning.

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We will start by counting the elements on both sides of the arrow.

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Once again, we will leave oxygen last because it shows twice on the products side.

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We multiply CO_2 by three and adjust the carbon and the oxygen counts on the products side.

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We then multiply water by 4.

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And we add just the hydrogen count and the oxygen count on the products side.

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We then multiply oxygen by 5.

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And adjust the oxygen count on the reactants side.

00:09:02

And done.

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The next example involves ammonia burning.

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And I now start to wonder whether the author of your textbook has an unhealthy obsession with burning stuff.

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We start by multiplying ammonia by two and water by three to balance the hydrogen.

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Because the least common multiple of three and two is 6.

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And we adjust the nitrogen and hydrogen counts on the reactants side.

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And the hydrogen and oxygen counts on the products side.

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Next, we multiply the nitrogen monoxide by two to balance the nitrogen, and we adjust the nitrogen and oxygen counts on the products side.

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Next, we multiply oxygen by 5.

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And both nitrogen monoxide and water by two.

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To balance the oxygen.

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Because the least common multiple between 2 and 5 is 10.

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We then adjust the oxygen count on the reactants side and the nitrogen, hydrogen and oxygen counts on the products side.

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And finally, we multiply ammonia by two to balance the nitrogen.

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And we adjust the nitrogen and hydrogen counts on the reactants side.

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The next example has heptane burning.

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And that's it!

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I'm getting my own examples.

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Forget Doctor Chang and his burning obsession.

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OK, maybe we finish this last one first.

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After counting all the atoms, we multiply carbon dioxide by 7 to balance the carbon.

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And we then adjust the count for the carbon and the oxygen on the products side.

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Next, we'll multiply water by 8 and we adjust the hydrogen and oxygen counts on the products side.

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And finally, we multiply the oxygen by 11 and adjust the oxygen count on the reactants side.

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And done.

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OK, no more burning.

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Here's our first equation.

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Go ahead and pause the video.

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Write down your answer and come right back.

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Do the same.

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For each of the following examples.

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All of them.

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I mean it, a ll of them.

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Welcome back.

00:13:01

The first step, of course, is to count all atoms.

00:13:07

Next, we multiply water by three to balance the oxygen and adjust the hydrogen and oxygen count on the reactants side.

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Next, I am forced to try to balance Florine, which I wisely left until the end because it shows twice on the products side; who knew the end would come so quickly.

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Same for hydrogen, by the way.

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I am not sure how to proceed.

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I have three options.

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Start with both hydrofluoric acid and lithium fluoride.

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Or just the hydrofluoric acid.

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Or just the lithium fluoride.

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Both usually works for me, so that's going to be my next move.

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If that doesn't work, I'll try something else.

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I multiply both hydrofluoric acid and lithium fluoride by two to balance the fluorine.

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Next, I multiply the lithium boron compound by two to balance lithium.

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Then I go back to multiply hydrofluoric acid and lithium fluoride by two again.

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And at this point I realize that it's never going to work, because if I try lithium again, I'll offset the fluorine, and if I then try the fluorine, it'll offset the lithium.

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And this turns into a spiral of death.

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So at this point, we cut our losses and we go back to try something else.

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We will next try only the hydrofluoric acid.

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To see how that goes.

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So we multiply hydrofluoric acid times three to balance the fluorine, and we adjust the fluorine and hydrogen count on the products siiide.

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And done. This feels very anti-climactic.

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Here's the next example.

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Pause the video.

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Write down your answer.

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Then come back and check.

00:15:51

Welcome back.

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The first step, of course, is to count all the atoms on both sides of the arrow.

00:16:01

We then multiply phosphorus trichloride times 4 to balance the phosphorus, and then we adjust the phosphorus and the chlorine counts.

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On the products side.

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We then multiply the chlorine gas by 6 to balance the chlorine, and we adjust the chlorine count on the reactants side.

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And done.

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Some of them are easier.

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The next example has oxygen in multiple places, so we will not start with that.

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The first step is to count all the atoms from both sides of the arrow.

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We multiply the rubidium hydroxide by two to balance the rubidium.

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We adjust the rubidium, oxygen and hydrogen counts on the reactants side.

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And Bob's your uncle.

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This is our next example.

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Again, lots of oxygen.

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We start by counting every atom on both sides of the arrow.

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We then multiply calcium phosphate by two to balance the phosphorus.

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And we adjust the phosphorus, oxygen and calcium counts on the products side.

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Next, we multiply calcium hydroxide by 6 to balance the calcium.

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And we adjust the calcium, oxygen and hydrogen counts on the reactants side.

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Next, we multiply the water by 6 to balance the hydrogen.

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And we adjust the hydrogen and oxygen counts.

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On the products side.

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And done.

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This example has lead in multiple places, so we should not start with lead.

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The first step, as always, is to count every atom on both sides of the arrow.

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We then multiply lead (II) oxide by two to balance the oxygen and adjust the lead and oxygen counts on the reactants side of the equation.

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Next, we multiply lead by three to balance lead.

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And we adjust the lead count on the products side.

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And done.

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This last example did come from your textbook, but I'm only using it because it does not involve burning.

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Here's the equation, let's balance.

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We start by counting all the atoms from both sides of the arrow.

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Then we multiply the aluminum by two to balance it and we adjust the aluminum count on the reactants side.

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Next, we multiply oxygen by three.

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An aluminum oxide by two to balance the oxygen.

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Because the least common multiple for two and three is 6.

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And we adjust the oxygen count on the reactants side and the aluminum and oxygen counts on the products side.

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Finally, we multiply aluminum by two to balance it.

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And we adjust the aluminum count on the reactants side.

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And Bob’s your uncle.

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And that's all there is.

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There isn't any more.