Balance the equation examples

Today we are talking about one of my favorite topics, which is balancing chemical equations. This is one of my favorite topics because it has elements of chemistry (since we are dealing with chemical equations), math (since we need to balance numbers on both sides of the equation), and puzzle-type fun (since we have to work to put all the pieces of the puzzle together to get a balanced equation). What could be better? Before we get too excited, though, let's take a step back and discuss this process systematically. Chemical Equations First, some background. When we talk about chemical equations, we are generally talking about the conversion, or chemical reaction, of starting materials into products. This means that before we do a reaction, we have a certain type of molecule (or types of molecules), and after the reaction, we have different molecules. How does this happen? The chemical transformation that occurs involves breaking certain chemical bonds and forming new bonds, all of which end up creating new molecules from the original starting materials. When we do these chemical reactions, we are following key laws of matter and energy. In particular, there is a law of conservation of matter, which states that matter cannot be created or destroyed; rather, it can only be converted from one form to another. This means that every atom that is in our starting materials needs to also be found in our products, and every atom found in our products must have come from atoms in the starting materials. Otherwise, we would be violating a fundamental law of matter! Not a good thing to do. How do we ensure that we are following the law of conservation of matter? We look at the chemical equation that represents the particular reaction, and we count the number and types of different atoms to ensure that we have the same number and types of atoms on both sides of the equation. Sometimes, however, when we do this counting, we will see that we do not actually have the same number and types of atoms on both sides of the equation. Rather than concluding that we have violated a fundamental law of matter, however, we can simply balance the chemical equation and correct the discrepancy between the number and types of atoms on both sides of the equation. What does it mean to balance the chemical equation? Let's use a real-world reaction to discuss this process in more detail. Consider the Haber process, which is a reaction between nitrogen gas and hydrogen gas to produce ammonia gas. We can represent each species involved in this chemical reaction by using the chemical formulas for these molecules: nitrogen is N2, hydrogen is H2, and ammonia is NH3. We use a subscript of (g) to indicate that all of the molecules are found in the gas phase, and an arrow to represent the fact that chemical transformation is occurring. N2(g) + H2(g) → NH3(g) This equation actually means that we are breaking bonds between the two nitrogen atoms in the nitrogen gas and the bonds between the hydrogen atoms in hydrogen gas, and forming new bonds between the nitrogen and hydrogen in the ammonia gas product. We can represent the bonds that exist in each molecule with straight lines between the atoms, and then re-write the equation as shown below. In order to check that we have followed the law of conservation of matter, we can count the number and types of atoms on both sides of the chemical equation, which gives us the following information: Starting materials: 2 nitrogen atoms, 2 hydrogen atoms Products: 1 nitrogen atom, 3 hydrogen atoms These numbers are not the same, which means that the chemical equation as written is not balanced. This is problematic, because we cannot write an equation that implies that one nitrogen atom has simply disappeared from the starting materials (going from two nitrogen atoms in the starting materials to one nitrogen atom in the product), nor can the equation imply that we have created a hydrogen atom from thin air in the product (going from two hydrogen atoms in the starting material to three in the product). We balance this equation by recognizing that often times, more than one molecule of each species can be involved in the chemical reaction. This means that multiple hydrogen or nitrogen molecules can be involved in creating multiple ammonia molecules, and that by balancing the equation, we can figure out how many of each molecules are involved in the overall chemical reaction. We balance the equation by changing the coefficients of each species (i.e., the number that appears in front of each molecule), because these coefficients represent the number of molecules involved in the overall reaction. Importantly, when there is no number there, it implies a number "1," meaning that one molecule is involved in the reaction. We cannot change the subscripts, i.e., the small numbers written on the right of the atom symbols, because changing the subscripts would change the actual molecules and thereby change the fundamental nature of the chemical reaction that is occurring. In this reaction, we see that if we add a 3 in front of H2, and a 2 in front of NH3, that leads to a reaction which has the same number and types of atoms on both sides of the chemical equation: N2(g) + 3H2(g) → 2NH3(g) We can also represent this reaction by showing the chemical structures of each species: Checking this reaction, we see that each molecule on both sides of the reaction has two nitrogen atoms and two hydrogen atoms, which means that the equation is balanced. It also means that the overall chemical reaction involves one molecule of nitrogen gas and three molecules of hydrogen gas reacting to form two molecules of ammonia gas. So overall, the process for balancing a chemical equation includes: Writing the correct chemical formulas for the reactants and products Manipulating the coefficients to ensure that the numbers and types of atoms on each side of the arrow are equal to each other. After you are done with step 2, checking to make sure that the values match up. Let's practice balancing chemical equations in a few other examples: Balancing Chemical Equations Example 1: Photosynthesis One of the most important chemical processes is photosynthesis, or the process by which plants take in carbon dioxide and water and convert that into glucose and oxygen. I can write the (unbalanced) chemical equation for photosynthesis by using the chemical formulas for each of these species, CO2 + H2O → C6H12O6 + O2, where CO2 = carbon dioxide, H2O = water, C6H12O6 = glucose, and O2 = oxygen. A quick glance at this equation indicates that it is not balanced in its current form, as there is a single carbon atom (C) on the left side of the equation but six carbon atoms on the right side. I can start to balance this by adding a coefficient of 6 in front of CO2: 6CO2 + H2O → C6H12O6 + O2 I also see that the left side has two hydrogen atoms (H) whereas the right side has 12, and so I add a coefficient of 6 in front of H2O to ensure 12 hydrogen atoms on the left side as well (multiplying the coefficient by the subscript = 6 x 2 = 12): 6CO2 + 6H2O → C6H12O6 + O2 Now I see that although my carbons and hydrogen atoms are balanced, I have more oxygen atoms on the left side (18 atoms) than on the right side (8 atoms). I want to address this issue without disturbing the balanced carbon and hydrogen atoms, and so I decide to add a coefficient to the O2 species on the right side (since that will only affect the oxygen atoms and not the carbon or hydrogen atoms). If I add a coefficient of 6 in front of the O2 molecule, I will end up with 18 oxygen atoms on the right side of the equation as well. 6CO2 + 6H2O → C6H12O6 + 6O2 I now do a final check to make sure that there is the same number and types of atoms on both sides of the chemical equation: 6 carbon atoms, 12 hydrogen atoms, and 18 oxygen atoms, which confirms that my equation is balanced correctly! Balancing Chemical Equations Example 2: Reaction of aluminum with hydrochloric acid This reaction can be used as a really exciting (albeit somewhat dangerous) demonstration of the reaction with a concentrated acid and a soda can. The (unbalanced) chemical reaction can be written as follows: Al + HCl → AlCl3 + H2 We can see right away that this isn't balanced, and so we will start by adding a 3 in front of the HCl. Al + 3HCl → AlCl3 + H2 We then see that the number of hydrogen atoms isn't balanced, and so we will add a "1.5" temporarily in front of the H2: Al + 3HCl → AlCl3 + 1.5H2 This equation is technically balanced, but it has a problem: the coefficient of 1.5 in front of H2. Our coefficients always have to be whole numbers (because they represent the number of molecules, and we can't have half of a molecule). In order to address this issue, we multiply all of the coefficients by 2, which allows us to keep the balance in the equation and arrive at a situation with whole number coefficients: 2Al + 6HCl → 2AlCl3 + 3H2 A quick check shows that we have the same number and types of atoms on both sides of the equation (2 Al atoms, 6 H atoms, and 6 Cl atoms), which means that the equation is balanced! Balancing Chemical Equations Example 3: Burning propane gas in the presence of oxygen to form carbon dioxide and water This reaction is a key part of how we use hydrocarbon gas as a source of fuel, but it is also part of how human activity is contributing to climate change. The unbalanced chemical reaction can be written as follows: C3H8 + O2 → CO2 + H2O Here we have to add a 3 in front of CO2, as well as a 4 in front of H2O: C3H8 + O2 → 3CO2 + 4H2O We have balanced the number of carbon and hydrogen atoms, and now need to balance the number of oxygen atoms, which we can do by adding a 5 in front of the O2: C3H8 + 5O2 → 3CO2 + 4H2O This balanced equation has 3 carbon atoms, 8 hydrogen atoms, and 10 oxygen atoms on both sides of the equation. Success! Balancing Chemical Equations Example 4: Rusting of iron in the presence of oxygen and water to produce iron oxide This chemical makes iron-containing objects turn color over time, from shiny metallic to a dull brown-red in color. Moreover, the properties of these materials can change as well, with reduced material strength and performance due to the rusting process. The unbalanced chemical equation for this rusting process is shown below: Fe + O2 + H2O → Fe(OH)3 We are going to start by balancing every atom except oxygen, because the fact that oxygen appears in multiple species on the left side of the equation means that it is more difficult to balance. We have to add a 3 in front of H2O and a 2 in front of Fe(OH)3 in order to balance the hydrogen atoms. This means that we also have to add a 2 in front of Fe, resulting in the following equation: 2Fe + O2 + 3H2O → 2Fe(OH)3 The only atom which is not balanced now is oxygen, because we have five oxygen atoms on the left side of the equation and six oxygen atoms on the right side. If we use the same "trick" of temporarily adding a non-whole number coefficient to the equation, we can write the following balanced equation: 2Fe + 1.5O2 + 3H2O → 2Fe(OH)3 This equation is now balanced, and so I can multiply every coefficient by 2 in order to arrive at a balanced equation with whole number coefficients: 4Fe + 3O2 + 6H2O → 4Fe(OH)3 Checking all atoms shows that we have succeeded in balancing the equation – 4 Fe atoms, 12 O atoms, and 12 H atoms on both sides of the equation. Success! Balancing Chemical Equations Example 5: Acid-base reaction with the production of carbon dioxide An interesting reaction occurs between sodium carbonate (a base) and hydrochloric acid (an acid), to produce sodium chloride, water, and carbon dioxide, according to the following unbalanced chemical equation: Na2CO3 + HCl → NaCl + H2O + CO2 I can start the balancing process by adding a 2 in front of NaCl in order to balance the Na atoms, and then adding a 2 in front of HCl to make sure that the Cl atoms are also balanced: Na2CO3 + 2HCl → 2NaCl + H2O + CO2 This reaction has the same number of hydrogen atoms (2) on both sides of the chemical equation, as well as the same number of carbon atoms (1) and oxygen atoms (3). This means that the equation is now balanced correctly. Success! Let's conclude with some general tips about balancing chemical equations: Generally, it makes sense to start the balancing by focusing on atoms that appear in only one species on each side of the equation. Although the final balanced equation needs to have whole numbers as coefficients, you can use non-whole numbers temporarily, particularly if it is easier to balance the chemical equation in that way. Multiplying all coefficients by the same number (or dividing by the same number) will not affect the balance of the chemical equation, and can be used to address non-whole number coefficients (that you may have introduced temporarily). Always double check your equation at the end, to make sure that the number and types of atoms on both sides of the equation are equal to each other. Only then will you be able to conclude that you have successfully balanced the equation. Author: Mindy Levine, Ph.D. Balancing chemical equations helps in learning chemistry by ensuring atoms are the same before and after.Practicing with specific equations helps improve your skills in balancing chemical reactions.Use coefficients to balance chemical equations, ensuring the same number of atoms on each side of the equation. Balancing chemical equations questions is a basic skill in chemistry and testing yourself helps retain important information. This collection of ten chemistry test questions will give you practice in how to balance chemical reactions. Pro-tip: Chemical reactions have the same number of atoms before the reaction as after the reaction. Balance the following equation: __ SnO2 + __ H2 → __ Sn + __ H2O Balance the following equation: __ KOH + __ H3PO4 → __ K3PO4 + __ H2O Balance the following equation: __ KNO3 + __ H2CO3 → __ K2CO3 + __ HNO3 Balance the following equation:__ Na3PO4 + __ HCl → __ NaCl + __ H3PO4 Balance the following equation: __ TiCl4 + __ H2O → __ TiO2 + __ HCl Balance the following equation: __ C2H6O + __ O2 → __ CO2 + __ H2O Balance the following equation: __ Fe + __ HC2H3O2 → __ Fe(C2H3O2)3 + __ H2 Balance the following equation: __ NH3 + __ O2 → __ NO + __ H2O Balance the following equation: __ B2Br6 + __ HNO3 → __ B(NO3)3 + __ HBr Balance the following equation: __ NH4OH + __ Kal(SO4)2·12H2O → __ Al(OH)3 + __ (NH4)2SO4 + __ KOH + __ H2O 1. 1 SnO2 + 2 H2 → 1 Sn + 2 H2O2. 3 KOH + 1 H3PO4 → 1 K3PO4 + 3 H2O3. 2 KNO3 + 1 H2CO3 → 1 K2CO3 + 2 HNO34. 1 Na3PO4 + 3 HCl → 3 NaCl + 1 H3PO45. 1 TiCl4 + 2 H2O → 1 TiO2 + 4 HCl6. 1 C2H6O + 3 O2 → 2 CO2 + 3 H2O7. 2 Fe + 6 HC2H3O2 → 2 Fe(C2H3O2)3 + 3 H28. 4 NH3 + 5 O2 → 4 NO + 6 H2O9. 1 B2Br6 + 6 HNO3 → 2 B(NO3)3 + 6 HBr10. 4 NH4OH + 1 Kal(SO4)2·12H2O → 1 Al(OH)3 + 2 (NH4)2SO4 + 1 KOH + 12 H2O When balancing chemical equations, remember chemical reactions must satisfy conservation of mass. Check your work to make certain you have the same number and type of atoms on the reactants side as on the products side. A coefficient (number in front of a chemical) is multiplied by all the atoms in that chemical. A subscript (lower number) is only multiplied by the number of atoms it immediately follows. If there is no coefficient or subscript, that is the same as a number "1" (which is not written in chemical formulas).

Of all the skills to know about in chemistry, balancing chemical equations is perhaps the most important to master. So many parts of chemistry depend on this vital skill, including stoichiometry, reaction analysis, and lab work. This comprehensive guide will show you the steps to balance even the most challenging reactions and will walk you through a series of examples, from simple to complex. The ultimate goal for balancing chemical equations is to make both sides of the reaction, the reactants and the products, equal in the number of atoms per element. This stems from the universal law of the conservation of mass, which states that matter can neither be created nor destroyed. So, if we start with ten atoms of oxygen before a reaction, we need to end up with ten atoms of oxygen after a reaction. This means that chemical reactions do not change the actual building blocks of matter; rather, they just change the arrangement of the blocks. An easy way to understand this is to picture a house made of blocks. We can break the house apart and build an airplane, but the color and shape of the actual blocks do not change. But how do we go about balancing these equations? We know that the number of atoms of each element needs to be the same on both sides of the equation, so it is just a matter of finding the correct coefficients (numbers in front of each molecule) to make that happen. It is best to start with the atom that shows up the least number of times on one side, and balance that first. Then, move on to the atom that shows up the second least number of times, and so on. In the end, make sure to count the number of atoms of each element on each side again, just to be sure. Let's illustrate this with an example by balancing this chemical equation: P4O10 + H2O → H3PO4 First, let's look at the element that appears least often. Notice that oxygen occurs twice on the left-hand side, so that is not a good element to start out with. We could either start with phosphorus or hydrogen, so let's start with phosphorus. There are four atoms of phosphorus on the left-hand side, but only one on the right-hand side. So, we can put the coefficient of 4 on the molecule that has phosphorous on the right-hand side to balance them out. P4O10 + H2O → 4 H3PO4 Now we can check hydrogen. We still want to avoid balancing oxygen, because it occurs in more than one molecule on the left-hand side. It is easiest to start with molecules that only appear once on each side. So, there are two molecules of hydrogen on the left-hand side and twelve on the right-hand side (notice that there are three per molecule of H3PO4, and we have four molecules). So, to balance those out, we have to put a six in front of H2O on the left. P4O10 + 6 H2O → 4 H3PO4 At this point, we can check the oxygens to see if they balance. On the left, we have ten atoms of oxygen from P4O10 and six from H2O for a total of 16. On the right, we have 16 as well (four per molecule, with four molecules). So, oxygen is already balanced. This gives us the final balanced equation of P4O10 + 6 H2O → 4 H3PO4 Try to balance these ten equations on your own, then check the answers below. They range in difficulty level, so don't get discouraged if some of them seem too hard. Just remember to start with the element that shows up the least, and proceed from there. The best way to approach these problems is slowly and systematically. Looking at everything at once can easily get overwhelming. Good luck! CO2 + H2O → C6H12O6 + O2 SiCl4 + H2O → H4SiO4 + HCl Al + HCl → AlCl3 + H2 Na2CO3 + HCl → NaCl + H2O + CO2 C7H6O2 + O2 → CO2 + H2O Fe2(SO4)3 + KOH → K2SO4 + Fe(OH)3 Ca3(PO4)2 + SiO2 → P4O10 + CaSiO3 KClO3 → KClO4 + KCl Al2(SO4)3 + Ca(OH)2 → Al(OH)3 + CaSO4 H2SO4 + HI → H2S + I2 + H2O The first step to balancing chemical equations is to focus on elements that only appear once on each side of the equation. Here, both carbon and hydrogen fit this requirement. So, we will start with carbon. There is only one atom of carbon on the left-hand side, but six on the right-hand side. So, we add a coefficient of six to the carbon-containing molecule on the left. 6CO2 + H2O → C6H12O6 + O2 Next, let's look at hydrogen. There are two hydrogen atoms on the left and twelve on the right. So, we will add a coefficient of six on the hydrogen-containing molecule on the left. 6CO2 + 6H2O → C6H12O6 + O2 Now, it is time to check the oxygen. There are a total of 18 oxygen molecules on the left (6×2 + 6×1). On the right, there are eight oxygen molecules. Now, we have two options to even out the right-hand side: We can either multiply C6H12O6 or O2 by a coefficient. However, if we change C6H12O6, the coefficients for everything else on the left-hand side will also have to change, because we will be changing the number of carbon and hydrogen atoms. To prevent this, it usually helps to only change the molecule containing the fewest elements; in this case, the O2. So, we can add a coefficient of six to the O2 on the right. Our final answer will be: 6CO2 + 6H2O → C6H12O6 + 6O2 The only element that occurs more than once on the same side of the equation here is hydrogen, so we can start with any other element. Let's start by looking at silicon. Notice that there is only one atom of silicon on either side, so we do not need to add any coefficients yet. Next, let's look at chlorine. There are four chlorine atoms on the left side and only one on the right. So, we will add a coefficient of four on the right. SiCl4 + H2O → H4SiO4 + 4HCl Next, let's look at oxygen. Remember that we first want to analyze all the elements that only occur once on one side of the equation. There is only one oxygen atom on the left, but four on the right. So, we will add a coefficient of four on the left-hand side of the equation. SiCl4 + 4H2O → H4SiO4 + 4HCl We are almost done! Now, we just have to check the number of hydrogen atoms on each side. The left has eight and the right also has eight, so we are done. Our final answer is SiCl4 + 4H2O → H4SiO4 + 4HCl As always, make sure to double-check that the number of atoms of each element balances on each side before continuing. This problem is a bit tricky, so be careful. Whenever a single atom is alone on either side of the equation, it is easiest to start with that element. So, we will start by counting the aluminum atoms on both sides. There is one on the left and one on the right, so we do not need to add any coefficients yet. Next, let's look at hydrogen. There is also one on the left, but two on the right. So, we will add a coefficient of two on the left. Al + 2HCl → AlCl3 + H2 Next, we will look at chlorine. There are now two on the left, but three on the right. Now, this is not as straightforward as just adding a coefficient to one side. We need the number of chlorine atoms to be equal on both sides, so we need to get two and three to be equal. We can accomplish this by finding the lowest common multiple. In this case, we can multiply two by three and three by two to get the lowest common multiple of six. So, we will multiply 2HCl by three and AlCl3 by two: Al + 6HCl → 2AlCl3 + H2 We have looked at all the elements, so it is easy to say that we are done. However, always make sure to double-check. In this case, because we added a coefficient to the aluminum-containing molecule on the right-hand side, aluminum is no longer balanced. There is one on the left but two on the right. So, we will add one more coefficient. 2Al + 6HCl → 2AlCl3 + H2 We are not quite done yet. Looking over the equation one final time, we see that hydrogen has also been unbalanced. There are six on the left but two on the right. So, with one final adjustment, we get our final answer: 2Al + 6HCl → 2AlCl3 + 3H2 Hopefully, by this point, balancing equations is becoming easier and you are getting the hang of it. Looking at sodium, we see that it occurs twice on the left, but once on the right. So, we can add our first coefficient to the NaCl on the right. Na2CO3 + HCl → 2NaCl + H2O + CO2 Next, let's look at carbon. There is one on the left and one on the right, so there are no coefficients to add. Since oxygen occurs in more than one place on the left, we will save it for last. Instead, look at hydrogen. There is one on the left and two on the right, so we will add a coefficient to the left. Na2CO3 + 2HCl → 2NaCl + H2O + CO2 Then, looking at chlorine, we see that it is already balanced with two on each side. Now we can go back to look at oxygen. There are three on the left and three on the right, so our final answer is Na2CO3 + 2HCl → 2NaCl + H2O + CO2 We can start balancing this equation by looking at either carbon or hydrogen. Looking at carbon, we see that there are seven atoms on the left and only one on the right. So, we can add a coefficient of seven on the right. C7H6O2 + O2 → 7CO2 + H2O Then, for hydrogen, there are six atoms on the left and two on the right. So, we will add a coefficient of three on the right. C7H6O2 + O2→ 7CO2 + 3H2O Now, for oxygen, things will get a little tricky. Oxygen occurs in every molecule in the equation, so we have to be very careful when balancing it. There are four atoms of oxygen on the left and 17 on the right. There is no obvious way to balance these numbers, so we must use a little trick: fractions. Now, when balancing chemical equations, we cannot include fractions as it is not proper form, but it sometimes helps to use them to solve the problem. Also, try to avoid over-manipulating organic molecules. You can easily identify organic molecules, otherwise known as CHO molecules, because they are made up of only carbon, hydrogen, and oxygen. We don't like to work with these molecules, because they are rather complex. Also, larger molecules tend to be more stable than smaller molecules, and less likely to react in large quantities. So, to balance out the four and seventeen, we can multiply the O2 on the left by 7.5. That will give us C7H6O2 + 7.5O2 → 7CO2 + 3H2O Remember, fractions (and decimals) are not allowed in formal balanced equations, so multiply everything by two to get integer values. Our final answer is now 2C7H6O2 + 15O2 → 14CO2 + 6H2O We can start by balancing the iron on both sides. The left has two while the right only has one. So, we will add a coefficient of two to the right. Fe2(SO4)3 + KOH → K2SO4 + 2Fe(OH)3- Then, we can look at sulfur. There are three on the left, but only one on the right. So, we will add a coefficient of three to the right-hand side. Fe2(SO4)3 + KOH → 3K2SO4 + 2Fe(OH)3- We are almost done. All that is left is to balance the potassium. There is one atom on the left and six on the right, so we can balance these by adding a coefficient of six. Our final answer, then, is Fe2(SO4)3 + 6KOH → 3K2SO4 + 2Fe(OH)3- Looking at calcium, we see that there are three on the left and one on the right, so we can add a coefficient of three on the right to balance them out. Ca3(PO4)2 + SiO2 → P4O10 + 3CaSiO3 Then, for phosphorus, we see that there are two on the left and four on the right. To balance these, add a coefficient of two on the left. 2Ca3(PO4)2 + SiO2 → P4O10 + 3CaSiO3 Notice that by doing so, we changed the number of calcium atoms on the left. Every time you add a coefficient, double check to see if the step affects any elements you have already balanced. In this case, the number of calcium atoms on the left has increased to six while it is still three on the right, so we can change the coefficient on the right to reflect this change. 2Ca3(PO4)2 + SiO2 → P4O10 + 6CaSiO3 Since oxygen occurs in every molecule in the equation, we will skip it for now. Focusing on silicon, we see that there is one on the left, but six on the right, so we can add a coefficient to the left. 2Ca3(PO4)2 + 6SiO2 → P4O10 + 6CaSiO3 Now, we will check the number of oxygen atoms on each side. The left has 28 atoms and the right also has 28. So, after checking that all the other atoms are the same on both sides as well, we get a final answer of 2Ca3(PO4)2 + 6SiO2 → P4O10 + 6CaSiO3 This problem is particularly tricky because every atom, except oxygen, occurs in every molecule in the equation. So, since oxygen appears the least number of times, we will start there. There are three on the left and four on the right. To balance these, we find the lowest common multiple; in this case, 12. By adding a coefficient of four on the left and three on the right, we can balance the oxygens. 4KClO3 → 3KClO4 + KCl Now, we can check potassium and chlorine. There are four potassium molecules on the left and four on the right, so they are balanced. Chlorine is also balanced, with four on each side, so we are finished, with a final answer of 4KClO3 → 3KClO4 + KCl We can start here by balancing the aluminum atoms on both sides. The left has two molecules while the right only has one, so we will add a coefficient of two on the right. Al2(SO4)3 + Ca(OH)2 → 2Al(OH)3 + CaSO4 Now, we can check sulfur. There are three on the left and only one on the right, so adding a coefficient of three will balance these. Al2(SO4)3 + Ca(OH)2 → 2Al(OH)3 + 3CaSO4 Moving right along to calcium, there is only one on the left but three on the right, so we should add a coefficient of three. Al2(SO4)3 + 3Ca(OH)2 → 2Al(OH)3 + 3CaSO4 Double-checking all the atoms, we see that all the elements are balanced, so our final equation is Al2(SO4)3 + 3Ca(OH)2 → 2Al(OH)3 + 3CaSO4 Since hydrogen occurs more than once on the left, we will temporarily skip it and move to sulfur. There is one atom on the left and one on the right, so there is nothing to balance yet. Looking at oxygen, there are four on the left and one on the right, so we can add a coefficient of four to balance them. H2SO4 + HI → H2S + I2 + 4H2O There is only one iodine on the left and two on the right, so a simple coefficient change can balance those. H2SO4 + 2HI → H2S + I2 + 4H2O Now, we can look at the most challenging element: hydrogen. On the left, there are four and on the right, there are ten. So, we know we have to change the coefficient of either H2SO4 or HI. We want to change something that will require the least amount of tweaking afterwards, so we will change the coefficient of HI. To get the left-hand side to have ten atoms of hydrogen, we need HI to have eight atoms of hydrogen, since H2SO4 already has two. So, we will change the coefficient from 2 to 8. H2SO4 + 8HI → H2S + I2 + 4H2O However, this also changes the balance for iodine. There are now eight on the left, but only two on the right. To fix this, we will add a coefficient of 4 on the right. After checking that everything else balances out as well, we get a final answer of H2SO4 + 8HI → H2S + 4I2 + 4H2O As with most skills, practice makes perfect when balancing chemical equations. Keep working hard and try to do as many problems as you can to help you hone your balancing skills. A balanced chemical equation has the same number of atoms of each element on both sides of the reaction arrow. (photo: Polina Tankilevitch)A balanced chemical equation represents a chemical reaction as chemical formulas and numbers. Here is a collection of more than 10 balanced chemical equations. Use them as homework examples or to review the principles of balancing equations.Elements are represented using their element symbols.The left side of the reaction lists the reactants, the right side lists the products, and the reaction arrow indicates the direction in which the reaction proceeds.In a balanced chemical equation, the same number and type of atoms are present on both sides of the reaction arrow.The number in front of a chemical formula is its coefficient and is the number of moles of that element or compound. If there is 1 mole of a substance, the number is omitted (e.g., write CO instead of 1 CO).Subscripts after an element symbol indicate the number of atoms of the element in a substance. If there is no subscript, it means there is one atom of that element.The total number of atoms in a compound is the subscript multiplied by the coefficient (e.g., 4H2O contains 4 x 2 = 8 atoms of hydrogen and 1 x 4 = 4 atoms of oxygen).6 CO2 + 6 H2O → C6H12O6 + 6 O2 (balanced equation for photosynthesis)2 AgI + Na2S → Ag2S + 2 NaIBa3N2 + 6 H2O → 3 Ba(OH)2 + 2 NH33 CaCl2 + 2 Na3PO4 → Ca3(PO4)2 + 6 NaCl4 FeS + 7 O2 → 2 Fe2O3 + 4 SO2PCl5 + 4 H2O → H3PO4 + 5 HCl2 As + 6 NaOH → 2 Na3AsO3 + 3 H23 Hg(OH)2 + 2 H3PO4 → Hg3(PO4)2 + 6 H2O12 HClO4 + P4O10 → 4 H3PO4 + 6 Cl2O78 CO + 17 H2 → C8H18 + 8 H2O10 KClO3 + 3 P4 → 3 P4O10 + 10 KClSnO2 + 2 H2 → Sn + 2 H2O3 KOH + H3PO4 → K3PO4 + 3 H2O2 KNO3 + H2CO3 → K2CO3 + 2 HNO3Na3PO4 + 3 HCl → 3 NaCl + H3PO4TiCl4 + 2 H2O → TiO2 + 4 HClC2H6O + 3 O2 → 2 CO2 + 3 H2O2 Fe + 6 HC2H3O2 → 2 Fe(C2H3O2)3 + 3 H24 NH3 + 5 O2 → 4 NO + 6 H2OB2Br6 + 6 HNO3 → 2 B(NO3)3 + 6 HBr4 NH4OH + KAl(SO4)2·12H2O → Al(OH)3 + 2 (NH4)2SO4 + KOH + 12 H2OSometimes you may be asked to say a balanced chemical equation as a word equation. To read an equation aloud, you need to know the chemical name of the substance. The coefficients are read as "X moles of", the subscripts aren't stated because they are implied in the chemical name, and the reaction arrow is read as "yields" or "forms".For example, the following equation:4 NH3 + 5 O2 → 4 NO + 6 H2OIs read as:Four moles of ammonia plus five moles of oxygen yields four moles of nitric oxide plus six moles of water.When you write a balanced equation, you should check your work to make certain it's balanced and that it is written in its most-reduced form.Count the number of atoms of each element on both sides of the reaction arrow. They should be the same.Make certain all elements are included. If an element appears on one side of the reaction, it must also appear on the other side.Check to see if you can factor out the coefficients. For example, if all coefficients can be divided by 2, the equation may be balanced, but it could be written as a simpler balanced equation. Ideally, the equation should list the smallest mole ratios of reactants and products.Brady, James E.; Senese, Frederick; Jespersen, Neil D. (2007). Chemistry: Matter and Its Changes. John Wiley & Sons. ISBN 9780470120941.Crosland, M.P. (1959). "The use of diagrams as chemical 'equations' in the lectures of William Cullen and Joseph Black". Annals of Science. 15 (2): 75–90. doi:10.1080/00033795900200088Thorne, Lawrence R. (2010). "An Innovative Approach to Balancing Chemical-Reaction Equations: A Simplified Matrix-Inversion Technique for Determining the Matrix Null Space". Chem. Educator. 15: 304–308.Related Posts