Script

Tutorial: Balancing Chemical Equations

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Chemical equations are made up of symbols and numbers. Each letter is a symbol for one of the chemical elements and corresponds to that element's symbol on the periodic table of the elements. For example S is for Sulfur and O is for oxygen. Here we have a chemical equation for the reaction of Hydrogen with chlorine. Hydrogen is represented the symbol H2 and chlorine is represented by the symbol Cl2. The product, which is called hydrochloric acid, is represented by the symbol HCl. Chemical equations also have numbers. A subscript, or small number written to the right of an element, tells you how many atoms of that element you have. Here we have two atoms of hydrogen in the reactants side of the equation. A subscript may be any whole number, but we usually only write it if it is larger than 1. A coefficient, or large number placed before a molecule, tells you how many molecules you have. Here we have 2 molecules of HCl. If a coefficient is not written, assume it is 1. A coefficient before a molecule applies to all elements in that molecule. In other words, if we have 2 molecules of HCl, then we have 2 atoms of hydrogen and 2 atoms of chlorine.

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To satisfy the law of conservation of matter, a chemical equation must have the same number of atoms on the products side as it does on the reactants side. Making sure that an equation meets this standard is called balancing an equation. Let's look at the combustion of methane gas in oxygen. When methane is burned it produces carbon dioxide and water. We can show this with this equation. Methane is represented here by CH4, oxygen is O2, carbon dioxide is CO2, and water is H20. We read the equation methane plus oxygen yields carbon dioxide plus water. Each letter represents a chemical element: C is carbon, H is hydrogen, and O is oxygen. The subscripts tell you how many atoms there are of each element. If there is no subscript beside an element's symbol, then there is 1 atom of that element. In methane there is one atom of carbon and there are 4 atoms of hydrogen. You can go all the way through the equation and write down how many atoms there are of each element. In the reactants there are 2 atoms of oxygen. In the products there is one atom of carbon and there are two atoms of oxygen plus 2 atoms of hydrogen and one more atom of oxygen. Let's see how this equation follows the conservation laws.

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Now let's count how many atoms of each element we have in the reactants. The table shows you that we have 1 atom of carbon, 4 atoms of hydrogen and 2 atoms of oxygen. Next, let's see how many atoms of each element there are in the products. We have 1 atom of carbon, 2 atoms of hydrogen, and 3 total atoms of oxygen, or 2 atoms of oxygen in CO2 and 1 atom of oxygen in H20, for a total of 3 atoms of oxygen. Is this equation balanced? Does it satisfy the law of conservation of matter? No, it doesn't. The law of conservation of matter demands that we have the same numbers of each element's atoms on both sides of the equation. In this equation, we have 1 more atom of oxygen in the products than we have in the reactants. We also have 2 more atoms of hydrogen in the reactants than we do in the products. This is not a balanced equation. We must rewrite this equation to make it balanced.

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You just learned that this is not a balanced equation because there is one extra oxygen atom in the products side of the equation and two extra hydrogen atoms in the reactant side. Whenever you see a chemical equation, you should ask yourself if it is balanced. If it is not balanced, you will need to add information to the equation to make it balanced. This means that you will add coefficients to the equation. For example, look at what happens when we add the coefficient 2 before oxygen and water in this equation. When a coefficient is added before a substance's chemical formula, it is multiplied by the subscripts for all elements in that substance. Now we have 2 times 2, or 4, atoms of oxygen in the reactants. And we have 2 times 2, or 4, atoms of hydrogen in water and 2 times 1, or 2, atoms of oxygen in water. The table shows you that we now have the same numbers of atoms of all elements in the products as we have in the reactants. The equation is now balanced. Take a moment to go through the table in your mind and make sure you understand where all the numbers come from. This picture may help you visualize this reaction. In the picture, Hydrogen atoms are shown with white balls, oxygen atoms with red balls, and carbon atoms with black balls. Again, there must be the same number of balls of each color on each side of the equation.

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Here are a few rules and tips for balancing equations. Never alter subscripts. Never alter the identities of any of the reactants or products. Read through an equation to determine which elements need to be balanced and add coefficients as necessary. This may take some trial and error. With practice, it comes quickly.