

INSTRUCTOR: How do chemists represent chemical reactions so that we can talk about them and understand them better? In this tutorial, you learn how to write and balance chemical reactions as a way to communicate about processes that we cannot see with our eyes. Chemical equations represent chemical reactions showing the reactant and product formulas and a reaction arrow that generally points towards the products to indicate the direction the reaction is progressing. Chemical equations must be balanced. This means that they must have equal numbers of each atom on both sides of the arrow.

Let's learn how to balance chemical reactions by looking a little more closely at the reaction between hydrogen and oxygen to produce water. This reaction releases energy that can be used to produce electricity. New technologies are under development that harness the energy from this reaction to do useful work.

The energy is shown here on the product side because it is released as the chemical reaction occurs. Notice that the states of matter are also included in the equation. In this case, the reactants and products are in the gaseous state, so a lowercase g is used with each substance in the reaction. Sometimes you see a lowercase l used for liquid, a lowercase s for solid, or an aq, which stands for aqueous and means that the substance is in a solution with water.

To balance a chemical equation, you use coefficients, or a number placed in front of a reactant or product, such as this 2 in front of a water molecule. Placing this 2 in front of water is interpreted as having two full water molecules, which translates to four hydrogen atoms and two oxygen atoms. If there is not a coefficient in front of a reactant or product in a chemical equation, then you assume a coefficient of 1.

To balance a reaction, start by counting the number of atoms of each element in each reactant and product. On the reactant side, there are 1 times 2 hydrogen atoms, for a total of 2 hydrogen atoms, and 1 times 2 oxygen atoms, for a total of 2 oxygen atoms. On the product side, there are 1 times 2 hydrogen atoms, and there is only 1 oxygen atom. The reaction is not balanced.

In order to balance this reaction, let's try placing a coefficient of 2 in front of the water molecule. This will balance the oxygen atoms, but may cause hydrogen to be unbalanced. This part of the process is trial and error. Just keep trying things out.

You may cause something that is already balanced to become temporarily unbalanced. But this isn't always a problem. Be sure to only add or change the coefficients to balance your equation. We do not balance chemical equations by changing subscripts.

Recount the atoms on both sides. There are now two hydrogen atoms and two oxygen atoms on the reactant side, but four hydrogen atoms and two oxygen atoms on the product side. To address the uneven number of hydrogen atoms, place a 2 in front of the hydrogen molecule. This leaves you with four hydrogen atoms and two oxygen atoms on the reactant side and four hydrogen atoms and two oxygen atoms on the product side. The reaction is balanced.