02 Stoichiometry

Background

A chemical equation like $2\ H_2 + O_2 \rightarrow 2\ H_2O$ is balanced when both the reactant side and the product side of the equation show exactly the same number of each type of atom. A balanced reaction shows the molar relationship between the amount of each reactant used and the amount of each product produced. The use of the coefficients in a balanced chemical equation as a ratio to predict how much reactant is consumed or how much product is formed is called Stoichiometry. A correctly balanced equation describes the ideal ratio of reactants required in order to form products to the greatest possible extent, with no excess reactant.

The coefficients in the above reaction tell you the relative amounts of the reactants consumed, i.e. that two moles of hydrogen are consumed every time one mole of oxygen in consumed. It also allows you to answer questions about reactions, for instance, if you started with 15 moles of hydrogen and 15 moles of oxygen, would all of the reactants be consumed? Since, according the balanced equation, you need twice as many hydrogens as oxygens, you would not have enough hydrogens to use 15 moles of oxygen (you would have needed 30 moles of hydrogen). In this case, all of the hydrogen would be used (called the limiting reagent because it limits the amount of product that can be produced) and you would have excess oxygen. The production of water would stop when the hydrogen was used up even though there is still oxygen.

In the reaction you will perform in this lab, one of the products is energy. When one of the reactants is used up, all production of products, including energy, is stopped. When one of the reactants is limiting (and the other is "wasted" as excess) the reaction will produce less than the maximum amount of product possible. In this lab, you will try to determine the coefficients that produce no "wasted" reactants and therefore produce the maximum amount of released energy. You will mix a variety of volumes of sodium hypochlorite and sodium thiosulfate. The solutions will have the same molarity (they will be equimolar) so that the same volume of each solution will contain equal numbers of moles of the reactants. As a result, the ratio of volumes that produces the most energy, will be the same ratio as in the balanced equation. We will also be careful to maintain the same total volume of solution for each reaction so that the energy produced will be directly proportional to the temperature change.

Purpose

In this activity, you will use a temperature sensor to determine the coefficients of a balanced chemical equation.