

Determining the Mole Ratios in a Chemical Reaction

A balanced chemical reaction equation gives the mole ratios of the reactants and the products as coefficients. When some of the chemical formulas are not known, an experiment must be conducted to help determine the mole ratios.

This experiment uses two substances, an unidentified acid and sodium hydroxide (NaOH), which react according to the unbalanced and incomplete reaction equation below.



It is possible to identify the coefficients, a and b , for the reactants, without knowing the identity of the acid and the products of the reaction. The process that you will use to determine the coefficients is called *continuous variations*. You will prepare a series of mixtures of the two reactants. Each mixture will have the same total volume and the same total number of moles of reactants. The reaction is exothermic, thus the mixture that generates the most heat energy will be the reaction that completely consumes both the unidentified acid and the sodium hydroxide. By analyzing the results of the series of reactions, you will determine the mole ratio of the reactants.

You will also be determining whether the unidentified acid is monoprotic, diprotic, or triprotic. *Monoprotic acids* are able to donate one proton per molecule. Common examples of monoprotic acids are hydrochloric acid (HCl) and acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$). *Polyprotic acids*, in contrast, can donate more than one proton per molecule. Sulfuric acid (H_2SO_4) and carbonic acid (H_2CO_3) are common diprotic acids that are able to donate two protons per molecule. Phosphoric acid (H_3PO_4) and citric acid ($\text{H}_3\text{C}_6\text{H}_7\text{O}_7$) are common triprotic acids.

OBJECTIVES

- Measure the temperature changes of a series of reactions.
- Determine the stoichiometry of an oxidation-reduction reaction in which the reactants are known but the products are unknown.
- Determine whether the unidentified acid is monoprotic, diprotic, or triprotic.

Hspi The Pogil Project Limiting Reactants

Yijin Wang



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