

General Chemistry Lab Experiment 4

Limiting Reactant

INTRODUCTION

Two factors affect the yield of products in a chemical reaction: (1) the amounts of starting materials (reactants) and (2) the percent yield of the reaction. Many experimental conditions, for example, temperature and pressure, can be adjusted to increase yield of a desired product in a chemical reaction. The reactant determining the amount of product generated in a chemical reaction is called the limiting reactant. Sometimes only a limited amount of the one of the reactants needed for the reaction is available, or perhaps it is easier to carry out a reaction by adding an excess of one of the reactants. The maximum amount of product that can be formed is determined by the amount of reactant that is used up first.

Chemicals react according to fixed mole ratios (stoichiometrically), so only a limited amount of product can form from given amounts of starting materials. To better understand the concept of the limiting reactant, let us look at the situation where a toy store is trying to assemble bicycles. Suppose that each bicycle requires six nuts, six bolts, and six washers. If the shipment of parts includes 60 nuts, 60 washers and only 59 bolts, then the bolts become the limiting factor and only 59 bicycles can be assembled.

In his experiment, the reaction of sodium phosphate dodecahydrate, $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$, and barium chloride dihydrate, $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$, in an aqueous system produces solid barium phosphate, $\text{Ba}_3(\text{PO}_4)_2$. The molecular form of the equation for the reaction in aqueous solution is



The two reactant salts and sodium chloride are soluble in water but barium phosphate is insoluble. The ionic equation for the reaction is



Presenting only the ions that show evidence of a chemical reaction occurring, i.e., the formation of a precipitate (and removing spectator ions from the equation), the net ionic equation for the observed reaction is



Spectator ions, cations or anions, do not participate in any observable or detectable chemical reaction.

Net ionic equation is an equation that includes only those ions that participate in the observed chemical reaction. From the balanced net ionic equation, 2 moles of phosphate ion (from the 2 mol of $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$, molar mass = 380.12 g/mol, or 760.24 g) react with 3 moles of barium

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