Percentage Yield

The amounts of products calculated in the ideal stoichiometry problems in this chapter so far represent theoretical yields. *The* **theoretical yield** *is the maximum amount of product that can be produced from a given amount of reactant.* In most chemical reactions, the amount of product obtained is less than the theoretical yield. There are many reasons for this result. Reactants may contain impurities or may form byproducts in competing side reactions. Also, many reactions do not go to completion. As a result, less product is produced than ideal stoichiometric calculations predict. *The measured amount of a product obtained from a reaction is called the* **actual yield** *of that product.*

Chemists are usually interested in the efficiency of a reaction. The efficiency is expressed by comparing the actual and theoretical yields. *The* **percentage yield** *is the ratio of the actual yield to the theoretical yield, multiplied by 100.*

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

SAMPLE PROBLEM H

Chlorobenzene, C_6H_5Cl, is used in the production of many important chemicals, such as aspirin, dyes, and disinfectants. One industrial method of preparing chlorobenzene is to react benzene, C_6H_6, with chlorine, as represented by the following equation.

$$C_6H_6(l) + Cl_2(g) \longrightarrow C_6H_5Cl(l) + HCl(g)$$

When 36.8 g C_6H_6 react with an excess of Cl_2, the actual yield of C_6H_5Cl is 38.8 g. What is the percentage yield of C_6H_5Cl?

SOLUTION

1 ANALYZE

Given: mass of C_6H_6 = 36.8 g
mass of Cl_2 = excess
actual yield of C_6H_5Cl = 38.8 g

Unknown: percentage yield of C_6H_5Cl

2 PLAN

First do a mass-mass calculation to find the theoretical yield of C_6H_5Cl.

$$\text{g } C_6H_6 \times \overset{\text{molar mass factor}}{\frac{\text{mol } C_6H_6}{\text{g } C_6H_6}} \times \overset{\text{mol ratio}}{\frac{\text{mol } C_6H_5Cl}{\text{mol } C_6H_6}} \times \overset{\text{molar mass}}{\frac{\text{g } C_6H_5Cl}{\text{mol } C_6H_5Cl}} = \text{g } C_6H_5Cl \text{ (theoretical yield)}$$

Then the percentage yield can be found.

$$\text{percentage yield } C_6H_5Cl = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$