

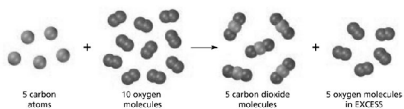
LIMITING REAGENTS AND PERCENT YIELD

Objectives

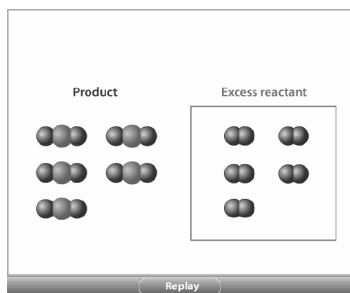
- **Describe** a method for determining which of two reactants is a limiting reactant.
- **Calculate** the amount in moles or mass in grams of a product, given the amounts in moles or masses in grams of two reactants, one of which is in excess.
- **Distinguish** between theoretical yield, actual yield, and percentage yield.
- **Calculate** percentage yield, given the actual yield and quantity of a reactant.

Limiting Reactants

- **The limiting reactant** is the reactant that limits the amount of the other reactant that can combine and the amount of product that can form in a chemical reaction.
- **The excess reactant** is the substance that is not used up completely in a reaction.



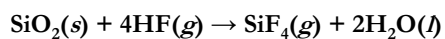
Limiting Reactants and Excess Reactants



Sample Problem

- Silicon dioxide (quartz) is usually quite unreactive but reacts readily with hydrogen fluoride according to the following equation.
- $\text{SiO}_2(s) + 4\text{HF}(g) \rightarrow \text{SiF}_4(g) + 2\text{H}_2\text{O}(l)$
- If 6.0 mol HF is added to 4.5 mol SiO_2 , which is the limiting reactant?

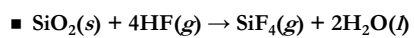
Sample Problem Solution



- **Given:** amount of HF = 6.0 mol
amount of SiO_2 = 4.5 mol
- **Unknown:** limiting reactant
- **Solution:**

mole ratio

Sample Problem Solution, *continued*



- HF is the limiting reactant.

Percentage Yield

- The **theoretical yield** is the maximum amount of product that can be produced from a given amount of reactant.
- The **actual yield** of a product is the measured amount of that product obtained from a reaction.
- The **percentage yield** is the ratio of the actual yield to the theoretical yield, multiplied by 100.

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

Comparing Actual and Theoretical Yield

Actual Yield < Theoretical Yield
231 g < 260.9 g

Play ▶

Percent Yield

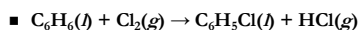
$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Play

Percentage Yield

Sample Problem

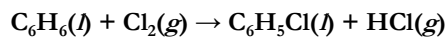
- Chlorobenzene, $\text{C}_6\text{H}_5\text{Cl}$, is used in the production of many important chemicals, such as aspirin, dyes, and disinfectants. One industrial method of preparing chlorobenzene is to react benzene, C_6H_6 , with chlorine, as represented by the following equation.



- When 36.8 g C_6H_6 react with an excess of Cl_2 , the actual yield of $\text{C}_6\text{H}_5\text{Cl}$ is 38.8 g.
- What is the percentage yield of $\text{C}_6\text{H}_5\text{Cl}$?

Percentage Yield

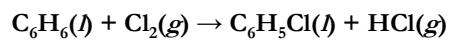
Sample Problem Solution



- Given:** mass of $\text{C}_6\text{H}_6 = 36.8 \text{ g}$
- mass of $\text{Cl}_2 = \text{excess}$
- actual yield of $\text{C}_6\text{H}_5\text{Cl} = 38.8 \text{ g}$
- Unknown:** percentage yield of $\text{C}_6\text{H}_5\text{Cl}$
- Solution:**
- Theoretical yield
molar mass factor mol ratio molar mass

Percentage Yield, *continued*

Sample Problem H Solution, *continued*



- Theoretical yield

$$= 53.0 \text{ g C}_6\text{H}_5\text{Cl}$$

- Percentage yield

73.2%
