

GENERAL CHEMISTRY

STANDARD 8.7

8.7: Use the limiting reactant to determine the amount of product and calculate percent yield

DEFINITIONS

- **Actual Yield:** The amount of product created and measured in an experiment
 - Will always be less than or equal to the theoretical yield, assuming the actual yield is complete pure and all water has been removed
- **Percent Yield:** The ratio of the actual yield to the theoretical yield
 - A 100% yield means exactly as much product was produced as was theoretically possible to produce
 - Extremely rare to get 100% yield

EXAMPLE

- If 16.0 g of CaCO_3 are decomposed and 7.54 g of CaO are obtained, what is the percent yield of CaO obtained?



- Since there is only one reactant, there is no limiting reactant to consider

$$\frac{16.0 \text{ g CaCO}_3}{100.1 \text{ g CaCO}_3} \times \frac{1 \text{ mol CaCO}_3}{1 \text{ mol CaCO}_3} \times \frac{1 \text{ mol CaO}}{1 \text{ mol CaCO}_3} \times \frac{56.1 \text{ g CaO}}{1 \text{ mol CaO}} = 8.96 \text{ g CaO}$$

8.96 g CaO is the theoretical yield

To find the percent yield, divide the actual yield (7.54 g CaO) by the theoretical yield and convert to a percent:

$$7.54 / 8.96 = 84.2\% \text{ Yield}$$

ANOTHER EXAMPLE

- Determine the percent yield for 3.74 g of Na and excess O₂ if 5.34 g of Na₂O₂ is recovered.



- Since the limiting reactant is already stated, start with the limiting reactant:

$$\frac{3.74 \text{ g Na}}{23.0 \text{ g Na}} \times \frac{1 \text{ mol Na}}{2 \text{ mol Na}} \times \frac{1 \text{ mol Na}_2\text{O}_2}{2 \text{ mol Na}} \times \frac{78.0 \text{ g Na}_2\text{O}_2}{1 \text{ mol Na}_2\text{O}_2} = 6.34 \text{ g Na}_2\text{O}_2$$

6.34 g Na₂O₂ is the theoretical yield

To find the percent yield, divide the actual yield (5.34 g Na₂O₂) by the theoretical yield and convert to a percent:

$$5.34 \text{ g} / 6.34 \text{ g} = 84.2\% \text{ Yield}$$

ANOTHER EXAMPLE 2

- When 66.6 g of O₂ gas is mixed with 27.8 g of NH₃ gas and 25.1 g of CH₄ gas, 36.4 g of HCN gas is produced by the following reaction:



- Find the percent yield of HCN for this reaction

ANOTHER EXAMPLE 2 SOLUTION

- When 66.6 g of O₂ gas is mixed with 27.8 g of NH₃ gas and 25.1 g of CH₄ gas, 36.4 g of HCN gas is produced by the following reaction:



- Find the percent yield of HCN for this reaction

First, determine the limiting reactant:

66.6 g O ₂	1 mol O ₂	2 mol HCN	27.0 g HCN	= 37.1 g HCN
	32.0 g O ₂	3 mol O ₂	1 mol HCN	
27.8 g NH ₃	1 mol NH ₃	2 mol HCN	27.0 g HCN	= 44.2 g HCN
	17.0 g NH ₃	2 mol NH ₃	1 mol HCN	
25.1 g CH ₄	1 mol CH ₄	2 mol HCN	27.0 g HCN	= 42.4 g HCN
	16.0 g CH ₄	2 mol CH ₄	1 mol HCN	

So Oxygen is the limiting reactant and 37.1 g HCN is the theoretical yield

ANOTHER EXAMPLE 2 SOLUTION

To find the percent yield:

$$36.4 \text{ g} / 37.1 \text{ g} = 98.1\% \text{ Yield}$$