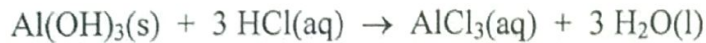


SIX STOICHIOMETRY PROBLEMS

General Stoichiometry

1. Several brands of antacid tablets use aluminum hydroxide to neutralize excess acid.



[Molar masses: 78.01 36.46 133.4 18.02]

What mass of HCl , in grams, can a tablet with 0.750 g of Al(OH)_3 consume?

$$0.750 \text{ g Al(OH)}_3 \times \frac{1 \text{ mol Al(OH)}_3}{78.01 \text{ g Al(OH)}_3} \times \frac{3 \text{ mol HCl}}{1 \text{ mol Al(OH)}_3} \times \frac{36.46 \text{ g HCl}}{1 \text{ mol HCl}} = 1.051 \text{ g HCl}$$

$$\boxed{1.05 \text{ g HCl}}$$

2. The equation for one of the reactions in the process of reducing iron ore to the metal is



[Molar masses: 159.7 28.01 55.85 44.01]

- (a) What is the maximum mass of iron, in grams, that can be obtained from 454 g (1.00 lb) of iron(III) oxide?

$$454 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.7 \text{ g Fe}_2\text{O}_3} \times \frac{2 \text{ mol Fe}}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{55.85 \text{ g Fe}}{1 \text{ mol Fe}} = 317.544 \text{ g}$$

$$= \boxed{318 \text{ g Fe}}$$

- (b) What mass of CO is required to reduce the iron(III) oxide to iron metal?

$$454 \text{ g Fe}_2\text{O}_3 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{159.7 \text{ g Fe}_2\text{O}_3} \times \frac{3 \text{ mol CO}}{1 \text{ mol Fe}_2\text{O}_3} \times \frac{28.01 \text{ g CO}}{1 \text{ mol CO}} = 238.88 \text{ g CO}$$

$$= \boxed{239 \text{ g CO}}$$

Limiting Reactants

3. The reaction of methane and water is one way to prepare hydrogen:



[Molar masses: 16.04 18.02 28.01 2.02]

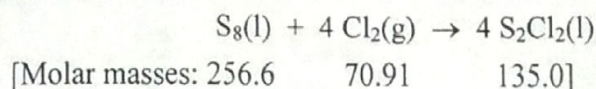
If you begin with 995 g of CH_4 and 2510 g of water, what is the maximum possible yield of H_2 ?

$$995 \text{ g CH}_4 \times \frac{1 \text{ mol CH}_4}{16.04 \text{ g CH}_4} \times \frac{3 \text{ mol H}_2}{1 \text{ mol CH}_4} \times \frac{2.02 \text{ g H}_2}{1 \text{ mol H}_2} = \boxed{375.9 \text{ g H}_2} = \boxed{376 \text{ g H}_2}$$

Limiting Reactant

$$2510 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \times \frac{3 \text{ mol H}_2}{1 \text{ mol H}_2\text{O}} \times \frac{2.02 \text{ g H}_2}{1 \text{ mol H}_2} = 844.09 \text{ g H}_2$$

4. Disulfur dichloride, S_2Cl_2 , is used to vulcanize rubber. It can be made by treating molten sulfur with gaseous chlorine:



Starting with a mixture of 32.0 g of sulfur and 71.0 g of Cl_2 , which is the limiting reactant? What mass of S_2Cl_2 (in grams) can be produced? What mass of the excess reactant remains when the limiting reactant is consumed?

$$32.0 \text{ g } S_8 \times \frac{1 \text{ mol } S_8}{256.6 \text{ g } S_8} \times \frac{4 \text{ mol } S_2Cl_2}{1 \text{ mol } S_8} \times \frac{135.0 \text{ g } S_2Cl_2}{1 \text{ mol } S_2Cl_2} = \boxed{67.34 \text{ g } S_2Cl_2} = \boxed{67.3 \text{ g}}$$

LIMITING REACTANT

$$71.0 \text{ g } Cl_2 \times \frac{1 \text{ mol } Cl_2}{70.91 \text{ g } Cl_2} \times \frac{4 \text{ mol } S_2Cl_2}{4 \text{ mol } Cl_2} \times \frac{135.0 \text{ g } S_2Cl_2}{1 \text{ mol } S_2Cl_2} = 135.17 \text{ g } S_2Cl_2$$

$$32.0 \text{ g } S_8 \times \frac{1 \text{ mol } S_8}{256.6 \text{ g } S_8} \times \frac{4 \text{ mol } Cl_2}{1 \text{ mol } S_8} \times \frac{70.91 \text{ g } Cl_2}{1 \text{ mol } Cl_2} = 35.37 \text{ g } Cl_2 \text{ used in rxn}$$

$$\text{Excess } Cl_2 = 71.0 \text{ g } Cl_2 - 35.4 \text{ g } Cl_2 = \boxed{35.6 \text{ g } Cl_2} \text{ "XS"}$$

Percent Yield

5. Diborane, B_2H_6 , is a valuable compound in the synthesis of new organic compounds. One of several ways this compound can be made is by the reaction



[Molar masses: 37.84 253.8 27.67 149.9 2.02]

Suppose you use 1.203 g of $NaBH_4$ with an excess of iodine and obtain 0.295 g of B_2H_6 . What is the percent yield of B_2H_6 ?

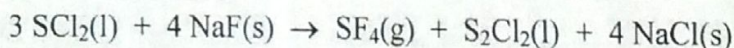
$$1.203 \text{ g } NaBH_4 \times \frac{1 \text{ mol } NaBH_4}{37.84 \text{ g } NaBH_4} \times \frac{1 \text{ mol } B_2H_6}{2 \text{ mol } NaBH_4} \times \frac{27.67 \text{ g } B_2H_6}{1 \text{ mol } B_2H_6} = 0.4398 \text{ g } B_2H_6$$

ACTUAL YIELD

THEORETICAL YIELD

$$\% \text{ YIELD} = \frac{\text{ACTUAL}}{\text{THEORETICAL}} \times 100 = \frac{0.295 \text{ g } B_2H_6}{0.4398 \text{ g } B_2H_6} \times 100 = 67.0759 = \boxed{67.1\% \text{ YIELD}}$$

6. Disulfur dichloride, which has a revolting smell, can be prepared by directly combining S_8 and Cl_2 , but it can also be made by the following reaction:



[Molar masses: 103.0 41.99 108.1 135.0 58.46]

Assume you begin with 5.23 g of SCl_2 and excess NaF . What is the theoretical yield of S_2Cl_2 ? If only 1.19 g of S_2Cl_2 is obtained, what is the percent yield of the compound?

$$5.23 \text{ g } SCl_2 \times \frac{1 \text{ mol } SCl_2}{103.0 \text{ g } SCl_2} \times \frac{1 \text{ mol } S_2Cl_2}{3 \text{ mol } SCl_2} \times \frac{135.0 \text{ g } S_2Cl_2}{1 \text{ mol } S_2Cl_2} = 2.28495 \text{ g } S_2Cl_2$$

THEORETICAL YIELD

$$\% \text{ YIELD} = \frac{1.19 \text{ g } S_2Cl_2}{2.28495 \text{ g } S_2Cl_2} \times 100 = \boxed{52.1\% \text{ YIELD}}$$