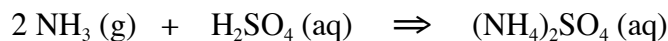


## CHM 130: Stoichiometry Practice Problems

1. The fertilizer ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ , is prepared by the reaction of ammonia,  $\text{NH}_3$ , with sulfuric acid:



- a. What mass of ammonium sulfate is produced if 50.0 L of ammonia gas reacts completely at STP?

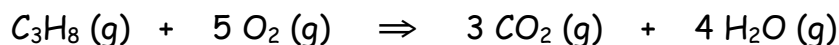
$$50.0 \text{ L NH}_3 \times \frac{\text{mol NH}_3}{22.4 \text{ L NH}_3} \times \frac{1 \text{ mol } (\text{NH}_4)_2\text{SO}_4}{2 \text{ mol NH}_3} \times \frac{132.17 \text{ g } (\text{NH}_4)_2\text{SO}_4}{\text{mol } (\text{NH}_4)_2\text{SO}_4} = 148 \text{ g } (\text{NH}_4)_2\text{SO}_4$$

- b. What mass of sulfuric acid is required to react completely with 50.0 L of ammonia?

$$50.0 \text{ L NH}_3 \times \frac{\text{mol NH}_3}{22.4 \text{ L NH}_3} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NH}_3} \times \frac{98.09 \text{ g H}_2\text{SO}_4}{\text{mol H}_2\text{SO}_4} = 109 \text{ g H}_2\text{SO}_4$$

2. Propane,  $\text{C}_3\text{H}_8$  (g), burns in oxygen to produce carbon dioxide gas and steam.

- a. Write the equation for this reaction, then balance the equation.



- b. If 5.000 g of propane burn completely in excess oxygen, what volume of carbon dioxide gas is produced at STP?

$$5.000 \text{ g C}_3\text{H}_8 \times \frac{\text{mol C}_3\text{H}_8}{44.11 \text{ g C}_3\text{H}_8} \times \frac{3 \text{ mol CO}_2}{1 \text{ mol C}_3\text{H}_8} \times \frac{22.4 \text{ L CO}_2}{\text{mol CO}_2} = 7.62 \text{ L CO}_2$$

- c. If 75.0 L of steam are produced at STP, what mass of propane must have burned completely in oxygen?

$$75.0 \text{ L H}_2\text{O} \times \frac{\text{mol H}_2\text{O}}{22.4 \text{ L H}_2\text{O}} \times \frac{1 \text{ mol C}_3\text{H}_8}{4 \text{ mol H}_2\text{O}} \times \frac{44.11 \text{ g C}_3\text{H}_8}{\text{mol C}_3\text{H}_8} = 36.9 \text{ g C}_3\text{H}_8$$

3. Fermentation is a complex chemical process of making wine by converting glucose into ethanol and carbon dioxide:



- a. Calculate the mass of ethanol produced if 5.00 kg of glucose decomposes completely.

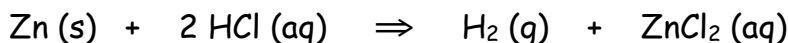
$$5.00 \text{ kg } C_6H_{12}O_6 \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{\text{mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6} \times \frac{2 \text{ mol } C_2H_5OH}{1 \text{ mol } C_6H_{12}O_6} \times \frac{46.08 \text{ g } C_2H_5OH}{\text{mol } C_2H_5OH} = 2.56 \times 10^3 \text{ g } C_2H_5OH$$

- b. Calculate the volume of carbon dioxide gas produced at STP if 100.0 g of glucose react completely.

$$100.0 \text{ g } C_6H_{12}O_6 \times \frac{\text{mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6} \times \frac{2 \text{ mol } CO_2}{1 \text{ mol } C_6H_{12}O_6} \times \frac{22.4 \text{ L } CO_2}{\text{mol } CO_2} = 24.9 \text{ L } CO_2$$

4. Consider the reaction of zinc metal with hydrochloric acid.

- a. Write the equation for this reaction, then balance the equation.



- b. Calculate the volume of hydrogen gas produced at STP if 25.00 g of zinc react with 25.00 g of hydrochloric acid.

$$25.00 \text{ g Zn} \times \frac{\text{mol Zn}}{65.39 \text{ g Zn}} \times \frac{1 \text{ mol } H_2}{1 \text{ mol Zn}} \times \frac{22.4 \text{ L } H_2}{\text{mol } H_2} = 8.56 \text{ L } H_2$$

so 7.68 L  $H_2$  produced

$$25.00 \text{ g HCl} \times \frac{\text{mol HCl}}{36.46 \text{ g HCl}} \times \frac{1 \text{ mol } H_2}{2 \text{ mol HCl}} \times \frac{22.4 \text{ L } H_2}{\text{mol } H_2} = 7.68 \text{ L } H_2$$

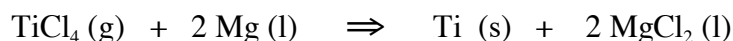
- c. Identify the limiting reagent and the reactant in excess.

HCl is the limiting reagent, and Zn is in excess.

- d. Calculate the percent yield if 6.53 L are actually produced.

$$\frac{6.53 \text{ L } H_2}{7.68 \text{ L } H_2} \times 100\% = 85.0\%$$

5. Titanium metal can be produced from the reduction of titanium (IV) chloride with magnesium metal:



- a. What mass of titanium can be produced from 500.0 g of titanium (IV) chloride and 250.0 g of magnesium?

$$500.0 \text{ g TiCl}_4 \times \frac{\text{mol TiCl}_4}{189.68 \text{ g TiCl}_4} \times \frac{1 \text{ mol Ti}}{1 \text{ mol TiCl}_4} \times \frac{47.88 \text{ g Ti}}{\text{mol Ti}} = 126.2 \text{ g Ti}$$

$$250.0 \text{ g Mg} \times \frac{\text{mol Mg}}{24.31 \text{ g Mg}} \times \frac{1 \text{ mol Ti}}{2 \text{ mol Mg}} \times \frac{47.88 \text{ g Ti}}{\text{mol Ti}} = 246.2 \text{ g Ti}$$

so 126.2 g Ti produced

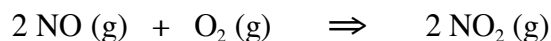
- b. Identify the limiting reagent and the reactant in excess.

TiCl<sub>4</sub> is the limiting reagent, and Mg is in excess.

- c. Calculate the percent yield if 117.0 g of titanium are actually produced.

$$\frac{117.0 \text{ g Ti}}{126.2 \text{ g Ti}} \times 100\% = 92.71\%$$

6. Nitric oxide, NO (g), reacts with oxygen according to the following equation:



- a. What volume (in L) of NO<sub>2</sub> is produced when 80.0 L of NO reacts with 35.0 L of oxygen?

$$80.0 \text{ L NO} \times \frac{2 \text{ L NO}_2}{2 \text{ L NO}} = 80.0 \text{ L NO}_2$$

so 70.0 L NO<sub>2</sub> is produced

$$35.0 \text{ L O}_2 \times \frac{2 \text{ L NO}_2}{1 \text{ L O}_2} = 70.0 \text{ L NO}_2$$

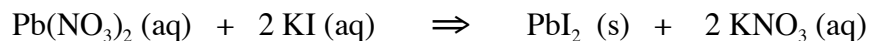
- b. Identify the limiting reagent and the reactant in excess.

O<sub>2</sub> is the limiting reagent, and NO is in excess.

- c. Calculate the percent yield of NO<sub>2</sub> if 68.4 L of NO<sub>2</sub> is actually produced.

$$\frac{68.4 \text{ L NO}_2}{70.0 \text{ L NO}_2} \times 100\% = 97.7\%$$

7. Lead (II) iodide can be produced from the reaction of lead (II) nitrate and potassium iodide:



a. What mass of lead (II) iodide can be produced from 100.00 g of lead (II) nitrate and 75.00 g of potassium iodide?

$$100.00 \text{ g Pb}(\text{NO}_3)_2 \times \frac{\text{mol Pb}(\text{NO}_3)_2}{331.22 \text{ g Pb}(\text{NO}_3)_2} \times \frac{1 \text{ mol PbI}_2}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{461.00 \text{ g PbI}_2}{\text{mol PbI}_2} = 139.18 \text{ g PbI}_2$$

$$75.00 \text{ g KI} \times \frac{\text{mol KI}}{166.00 \text{ g KI}} \times \frac{1 \text{ mol PbI}_2}{2 \text{ mol KI}} \times \frac{461.00 \text{ g PbI}_2}{\text{mol PbI}_2} = 104.1 \text{ g PbI}_2$$

so 104.1 g PbI<sub>2</sub> produced

b. Identify the limiting reagent and the reactant in excess.

KI is the limiting reagent, and Pb(NO<sub>3</sub>)<sub>2</sub> is in excess.

c. Calculate the percent yield if 89.4 g of lead (II) iodide are actually produced.

$$\frac{89.4 \text{ g PbI}_2}{104.1 \text{ g PbI}_2} \times 100\% = 85.9\%$$