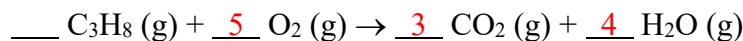


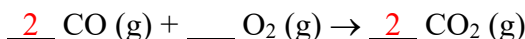
I. Gas Stoichiometry

1. What volume of oxygen gas at 20.0°C and 102.6 kPa is required to produce 640. L of CO₂, also at 20.0°C and 102.6 kPa? Balance the equation first.



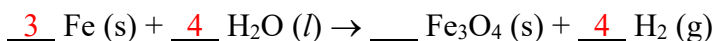
$$? \text{ L O}_2 = 640 \cancel{\text{ L CO}_2} \times \frac{5 \text{ L O}_2}{3 \cancel{\text{ L CO}_2}} = \boxed{1070 \text{ L O}_2 \left(1.07 \times 10^3 \text{ L O}_2\right)}$$

2. What volume of oxygen gas at 20.0°C and 0.953 atm is needed to react with 3.500×10³ L of CO, also at 20.0°C and 0.953 atm? First balance the equation.



$$? \text{ L O}_2 = 3.500 \times 10^3 \cancel{\text{ L CO}} \times \frac{1 \text{ L O}_2}{2 \cancel{\text{ L CO}}} = \boxed{1.750 \times 10^3 \text{ L O}_2}$$

3. What volume of hydrogen gas can be produced at STP by the reaction of 6.28 g of Fe according to the following equation? Balance the equation first.



$$? \text{ L H}_2 = 6.28 \cancel{\text{ g Fe}} \times \frac{1 \cancel{\text{ mol Fe}}}{55.85 \cancel{\text{ g Fe}}} \times \frac{4 \cancel{\text{ mol H}_2}}{3 \cancel{\text{ mol Fe}}} \times \frac{22.4 \text{ L H}_2}{1 \cancel{\text{ mol H}_2}} = 3.358 \text{ L H}_2 = \boxed{3.36 \text{ L H}_2}$$

0.1124 mol Fe
0.1499 mol H₂

4. If 0.270 g of sodium reacts with excess water according to the following equation, what volume of hydrogen gas at STP will be produced? First write and balance the equation.

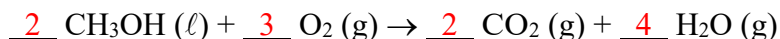


$$? \text{ L H}_2 = 0.270 \cancel{\text{ g Na}} \times \frac{1 \cancel{\text{ mol Na}}}{22.99 \cancel{\text{ g Na}}} \times \frac{1 \cancel{\text{ mol H}_2}}{2 \cancel{\text{ mol Na}}} \times \frac{22.4 \text{ L H}_2}{1 \cancel{\text{ mol H}_2}} = 0.1315 \text{ L H}_2 = \boxed{0.132 \text{ L H}_2}$$

0.01174 mol Na
0.005872 mol H₂

II. Theoretical & Percent Yield

5. Certain race cars can use methanol (CH₃OH) as a fuel. Liquid methanol burns in air (oxygen gas) according to the following equation. Balance the equation first.



- a. What is the theoretical yield of CO₂ (in g) when 35.4 mol CH₃OH reacts with excess O₂?

$$? \text{ g CO}_2 = 35.4 \cancel{\text{ mol CH}_3\text{OH}} \times \frac{2 \cancel{\text{ mol CO}_2}}{2 \cancel{\text{ mol CH}_3\text{OH}}} \times \frac{44.01 \text{ g CO}_2}{1 \cancel{\text{ mol CO}_2}} = \boxed{1560 \text{ g CO}_2}$$

35.4 mol CO₂

- b. If 1430 g CO₂ are actually obtained, what is the percent yield (equation on Chart B)?

$$\% \text{ Yield} = \frac{1430 \text{ g CO}_2}{1560 \text{ g CO}_2} \times 100\% = \boxed{91.7\%}$$

6. When bleach (aqueous sodium hypochlorite) is mixed with ammonia (also aqueous), it forms aqueous sodium hydroxide and the noxious gas nitrogen trichloride. Write and balance the equation first.



- a. What is the theoretical yield of nitrogen trichloride (in g) from 2.94 g of bleach and excess ammonia?

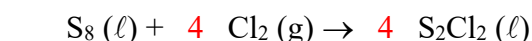
$$? \text{ g NCl}_3 = 2.94 \text{ g NaClO} \times \frac{1 \text{ mol NaClO}}{74.44 \text{ g NaClO}} \times \frac{1 \text{ mol NCl}_3}{3 \text{ mol NaClO}} \times \frac{120.36 \text{ g NCl}_3}{1 \text{ mol NCl}_3} = 1.5845 \text{ g NCl}_3 = \boxed{1.58 \text{ g NCl}_3}$$

$\underbrace{\hspace{150px}}_{0.03949 \text{ mol NaClO}}$
 $\underbrace{\hspace{150px}}_{0.01316 \text{ mol NCl}_3}$

- b. What is the percent yield if 1.35 g of nitrogen trichloride are actually isolated?

$$\% \text{ Yield} = \frac{1.35 \text{ g NCl}_3}{1.58 \text{ g NCl}_3} \times 100\% = \boxed{85.4\%}$$

7. Disulfur dichloride (S_2Cl_2) is a liquid that plays an important role in rubber production. It is produced by reacting liquid sulfur (S_8) with chlorine gas. Balance the equation first.



If the percent yield for this reaction is 92.7%, what mass of S_8 would you need to start with to obtain an actual yield of 10.0 kg S_2Cl_2 ?

Determine the theoretical yield of S_2Cl_2 needed:

$$? \text{ g S}_2\text{Cl}_2 = 10.0 \text{ kg S}_2\text{Cl}_2 \times \frac{1 \times 10^3 \text{ g}}{1 \text{ kg}} = 1.00 \times 10^4 \text{ g S}_2\text{Cl}_2$$

$$92.7\% = \frac{1.00 \times 10^4 \text{ g S}_2\text{Cl}_2}{\text{Theoretical Yield}} \times 100\% \Rightarrow \text{Theoretical Yield} = 1.00 \times 10^4 \text{ g S}_2\text{Cl}_2 \times \frac{100\%}{92.7\%} = 1.079 \times 10^4 \text{ g S}_2\text{Cl}_2$$

$$? \text{ g S}_8 = 1.079 \times 10^4 \text{ g S}_2\text{Cl}_2 \times \frac{1 \text{ mol S}_2\text{Cl}_2}{135.04 \text{ g S}_2\text{Cl}_2} \times \frac{1 \text{ mol S}_8}{4 \text{ mol S}_2\text{Cl}_2} \times \frac{256.6 \text{ g S}_8}{1 \text{ mol S}_8} = 5125 \text{ g S}_8 = \boxed{5130 \text{ g S}_8}$$

$\underbrace{\hspace{150px}}_{79.88 \text{ mol S}_2\text{Cl}_2}$
 $\underbrace{\hspace{150px}}_{19.97 \text{ mol S}_8}$

8. List the factors that can cause the percent yield to be less than 100%. What can cause the *apparent* percent yield to be greater than 100%?

Loss of/inability to collect all of product; impure reactant (less of expected substance), side reactions can all lead to lower % yield. Impurities in the product (such as water) or failure to completely separate two products can lead to an apparent (because the measured mass is too high) higher % yield.