Stoichiometry 3.3
Mole to Mole Problems
Worksheet Answer Key

1) If 1.27 moles of bromine react with excess phosphorus, how many moles of phosphorus tribromide will be produced?

$3\ Br_2 + 2\ P \rightarrow 2\ PBr_3$

$= 0.847\ mol\ PBr_3$

2) If 2.32 moles of iron react with excess oxygen gas, how many moles of Fe_2O_3 can be produced?

$4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$

$= 1.16\ mol\ Fe_2O_3$

3) How many moles of hydrogen gas can be produced if 0.57 moles of hydrochloric acid reacts with excess solid zinc according to the following chemical equation?

$2\ HCl + Zn \rightarrow H_2 + ZnCl_2$

$= 0.29\ mol\ H_2$

4) Nitrogen gas will react with hydrogen gas to produce ammonia. How many moles of hydrogen gas are required to produce 0.86 moles of NH_3?

$3\ H_2 + N_2 \rightarrow 2\ NH_3$

$= 1.3\ mol\ H_2$

5) N_2O_5 reacts with water to produce nitric acid. If 1.93 moles of N_2O_5 react with excess water, how many moles of nitric acid can be produced?

$H_2O + N_2O_5 \rightarrow 2\ HNO_3$

$= 3.86\ mol\ HNO_3$

6) Suppose 1.65 moles of C_6H_6 react with excess oxygen to produce carbon dioxide and water.
   a. How many moles of carbon dioxide will be produced in this reaction?

$2\ C_6H_6 + 15\ O_2 \rightarrow 12\ CO_2 + 6\ H_2O$

$= 9.90 \text{ mol } CO_2$

b. How many moles of water will be produced in this reaction?

$= 4.95 \text{ mol } H_2O$

c. How many moles of oxygen gas will be consumed during the reaction?

$2\ C_6H_6 + 15\ O_2 \rightarrow 12\ CO_2 + 6\ H_2O$

$= 12.4 \text{ mol } O_2$

7) A 1.83 mol sample of carbon reacts with excess zinc oxide to produce zinc and carbon dioxide.

a. How many moles of zinc were produced?

$C + 2\ ZnO \rightarrow 2\ Zn + CO_2$

$= 3.66 \text{ mol Zn}$

b. How many mole of carbon dioxide were produced?

$= 1.83 \text{ mol } CO_2$

c. How many moles of zinc oxide were consumed?

$= 3.66 \text{ mol ZnO}$

8) Determine the number of moles of sodium iodide that are required to produce 3.59 moles of iodine according to the following chemical equation.

$Br_2 + 2\ NaI \rightarrow 2\ NaBr + I_2$

$= 7.18 \text{ mol } HNO_3$

9) How many moles of methane gas, CH_4, are required to produce 14 moles of water when it combusts in the presence of excess oxygen gas. The other product is carbon dioxide.

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

$= 7.0\ \text{mol}\ CH_4$

Stoichiometry 3.4
Mass to Mass Problems
Worksheet Answer Key

1) Air bags in cars operate according to the reaction below. How many grams of nitrogen gas are produces during the decomposition of 3.25 g Na_3N?

$$2\ Na_3N(s) \rightarrow 6\ Na(s) + N_2(g)$$

$= 0.549g\ N_2$

2) How many grams of lithium are needed to produce 45.0 g of lithium nitride, according to the following process?

$$6\ Li(s) + N_2(g) \rightarrow 2\ Li_3N(s)$$

$= 26.9g\ Li$

3) A 14.5 g sample of sodium chloride reacts with excess fluorine gas according to the following chemical equation.

$$2\ NaCl(s) + F_2(g) \rightarrow 2\ NaF(s) + Cl_2(g)$$

a. How many grams of sodium fluoride are produced?

$= 10.4\ g\ NaF$

b. How many grams of chlorine gas are produced?

$= 8.80\ g\ Cl_2$

4) What mass of P_2O_5 can be produced when a 172.1 g sample of phosphorus reacts with an excess of oxygen gas according to the following chemical equation.

$$4\ P + 5\ O_2 \rightarrow 2\ P_2O_5$$

$= 394.4\ g\ P_2O_5$

5) Determine the mass if lithium hydroxide that is produced when 12.87 g of lithium nitride reacts with an excess of water according to the following process.

$$Li_3N + 3\ H_2O \rightarrow 3\ LiOH + NH_3$$

= 26.55 g LiOH

6) Suppose 31.4 g of antimony (III) oxide reacts with excess carbon according to the following process.

$$Sb_2O_3 + 3\ C \rightarrow 2\ Sb + 3\ CO$$

a. What mass of antimony will be produced?

= 26.23 g Sb

b. What mass of CO will be produced?

= 9.05 g CO

c. What mass of carbon is consumed during the reaction?

= 3.88 g C

7) Suppose that 187.4 grams of $C_3H_5(NO_3)_3$ decompose according to the process below.

$$4\ C_3H_5(NO_3)_3 \rightarrow 12\ CO_2 + 10\ H_2O + O_2 + 6\ N_2$$

a. How many grams of carbon dioxide are produced?

= 108.9 g CO_2

b. How many grams of water are produced?

= 37.17 g H_2O

c. How many grams of oxygen gas are produced?

= 6.601 g O_2

d. How many grams of nitrogen gas are produced?

$= 34.68 \text{ g } N_2$

e. The law of conservation of mass states that mass is neither created nor destroyed in a chemical reaction. Verify the law of conservation of mass for the decomposition of 187.4 g $C_3H_5(NO_3)_3$.

$= 187.4 \text{ g } C_3H_5(NO_3)_3$

8) Iron reacts with hydrochloric acid to produce iron (II) chloride and hydrogen gas. What mass of hydrochloric acid is needed to produce 48.2 g $FeCl_2$?

$Fe + 2\ HCl \rightarrow FeCl_2 + H_2$

$= 21.7 \text{ g } HCl$

Stoichiometry 3.5
Limiting Reactant
Worksheet Answer Key

1) A 24.5 g sample of sodium chloride reacts with 41.3 g of fluorine gas according to the following chemical equation.

$$2\ NaCl(s) + F_2(g) \rightarrow 2\ NaF(s) + Cl_2(g)$$

a. What is the limiting reactant? Justify your answer.

NaCl is the limiting reactant.

33.44 g F_2 remains

b. How many grams of chlorine gas are produced?

14.9 g of chlorine gas would be produced in theory.

2) A 84.1 g sample of phosphorus reacts with 85.0 g of oxygen gas according to the following chemical equation.

$$4\ P(s) + 5\ O_2(g) \rightarrow 2\ P_2O_5$$

a. Find the limiting reactant? Justify your answer.

O_2 is the limiting reactant

18.46 g of P remains

b. How many grams of P_2O_5 are produced in theory?

151 g of P_2O_5 are produced in theory.

c. If only 123 g of P_2O_5 are produced, what is the percentage yield?

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

$\%Yield = 81.5\%$

3) Most nitrogen exists in a gaseous state. Plants require a soluble form of nitrogen so they can absorb it from the ground. Ammonia is a good fertilizer, as the mass percent of nitrogen in ammonia is very high. The following reaction is used to convert gaseous nitrogen into ammonia, which can be used as fertilizer.

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3$$

If 186.3 g of $N_2(g)$ react with 289.8 g of $H_2(g)$:

a. Which reactant is limiting? Justify your answer.

Nitrogen is the limiting reactant.

249.5g H_2 remains.

b. What mass of ammonia can be produced in theory?

226.6g NH_3

c. If this reaction is know to have a 73.8% yield, what mass of ammonia could you expect to produce?

167.2g NH_3

4) A 5.75 g sample of silicone dioxide reacts with 5.50 g of sodium hydroxide according to the following chemical equation.

$$SiO_2(s) + 2\ NaOH(aq) \rightarrow Na_2SiO_3(aq) + H_2O(l)$$

a. What is the limiting reactant? Justify your answer.

The limiting reactant is NaOH

1.64 SiO_2 remains

b. How many grams of $Na_2SiO_{3(aq)}$ are produced?

8.39g of $Na_2SiO_{3(aq)}$ would be produced in theory.

c. What is the % yield if only 7.24 g $Na_2SiO_{3(aq)}$ are produced.

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

$\%Yield = 86.3\%$

5) The reaction between phosphorus and liquid bromine is outlined below.

$2\ P(s) + 3\ Br_2(l) \rightarrow 2\ PBr_3(l)$

a. Identify the limiting reactant when 5.78 g of phosphorus react with 27.9 g of liquid bromine. Justify your answer.

Bromine is the limiting reactant.

2.18 g P remains

b. Based on your answer from part (I), determine the maximum mass of PBr_3 that can be produced in this reaction.

= 31.4 g PBr_3

c. If the actual yield of PBr_3 is found to be 22.3 g, find the percent yield in this reaction.

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

$$\%Yield =$$

$$\%Yield = 71.0\%$$

6) The reaction between dihydrogen sulfide and sulfur dioxide is outlined below.

$$2\ H_2S(g) + SO_2(g) \rightarrow 3\ S(s) + 2\ H_2O(g)$$

a. Identify the limiting reactant when 3.89 g of dihydrogen sulfide react with 4.11 g of sulfur dioxide. Justify your answer.

$$3.89\text{ g } H_2S \times \frac{1\text{ mol } H_2S}{34.09\text{ g } H_2S} \times \frac{3\text{ mol S}}{2\text{ mol } H_2S} = 0.171\text{ mol S}$$

$$4.11\text{ g } SO_2 \times \frac{1\text{ mol } SO_2}{64.07\text{ g } SO_2} \times \frac{3\text{ mol S}}{1\text{ mol } SO_2} = 0.192\text{ mol S}$$

Since the H_2S available will produce fewer moles of S than will SO_2, H_2S is the limiting reactant.

b. Based on your answer from part (I), determine the maximum mass of sulfur that can be produced in this reaction.

$$0.171\text{ mol S} \times \frac{32.07\text{ g S}}{1\text{ mol S}} = 5.48\text{ g S}$$

c. If the actual yield of sulfur is found to be 4.89 g, find the percent yield in this reaction.

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

$$\%Yield = \frac{4.89\text{ g}}{5.48\text{ g}} \times 100$$

$$\%Yield = 89.2\%$$