Chemistry

Unit 8

Stoichiometry

1. Use the following equation:

$$2\ NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$$

How many grams of sodium sulfate (end) will be formed if you start with 200.0 grams of sodium hydroxide (start)?

$$200.0\ g\ NaOH \cdot \frac{1\ mol\ NaOH}{40.00\ g\ NaOH} \cdot \frac{1\ mol\ Na_2SO_4}{2\ mol\ NaOH} \cdot \frac{142.05\ g\ Na_2SO_4}{1\ mol\ Na_2SO_4} = 355.1\ g\ Na_2$$

2. Aluminum metal reacts with chlorine gas to form solid aluminum chloride, $AlCl_3$. What mass of (end) chlorine gas is needed to react completely with 163 g of aluminum (start)?

$$2Al + 3Cl_2 \longrightarrow 2AlCl_3$$

$$163\ g\ Al \cdot \frac{1\ mol\ Al}{26.98\ g\ Al} \cdot \frac{3\ mol\ Cl_2}{2\ mol\ Al} \cdot \frac{70.90\ g\ Cl_2}{1\ mol\ Cl_2} = 643\ g\ Cl_2$$

$K^{+1}ClO_3^{-1} = KClO_3$ $\quad$ $K^{+1}Cl^{-1} = KCl$ $\quad$ O_2

3. Potassium chlorate decomposes into potassium chloride and oxygen gas. How many moles of (end) oxygen gas can be produced by letting 2.03×10^{23} atoms of potassium chlorate (start) react? fgv

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

$$2.03 \times 10^{23}\ atoms\ KClO_3 \cdot \frac{1\ mol\ KClO_3}{6.02 \times 10^{23}\ atoms\ KClO_3} \cdot \frac{3\ mol\ O_2}{2\ mol\ KClO_3} = 0.506\ mol\ O$$

Introduction to Stoichiometry

1. Given the following equation: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$, show what the following molar ratios should be.

a. C_4H_{10} / O_2 _____:_____
b. O_2 / CO_2 _____:_____
c. O_2 / H_2O _____:_____
d. C_4H_{10} / CO_2 _____:_____
e. C_4H_{10} / H_2O _____:_____

2. Given the following equation: $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

How many moles of O_2 can be produced by letting 12.00 moles of $KClO_3$ react?

3. Given the following equation: $2\ K + Cl_2 \rightarrow 2\ KCl$

How many moles of KCl is produced from 2.50 g of K and excess Cl_2.

4. Given the following equation: $Na_2O + H_2O \rightarrow 2\ NaOH$

How many moles of NaOH is produced from 120 grams of Na_2O?

5. Given the following equation: $8\ Fe + S_8 \rightarrow 8\ FeS$

What mass of iron is needed to react with 16.0 grams of sulfur?

6. Given the following equation: $2\ NaClO_3 \rightarrow 2\ NaCl + 3\ O_2$

12.00 moles of $NaClO_3$ will produce how many grams of O_2?

7. Complete and balance the following equation: $Cu + 2\ AgNO_3 \rightarrow$

a) How many moles of Cu are needed to react with 3.50 moles of $AgNO_3$?

b) If 89.5 grams of Ag were produced, how many grams of Cu reacted?

8. Iron and carbon monoxide are produced in a blast furnace by the reaction of iron(III) oxide and coke (pure carbon). If 25.0 kilograms of pure iron(III) oxide is used, how many kilograms of iron can be produced?

9. The average human requires 120.0 grams of glucose ($C_6H_{12}O_6$) per day. How many grams of CO_2 (in the photosynthesis reaction) are required for this amount of glucose? The photosynthetic reaction is: $6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$

Moles and Stoich Classwork

This worksheet is due by the end of class. Answer should have correct sig figs and units. These problems might need balanced equations or they might only use mole island. After you finish this worksheet you should get started on your homework. (Page 2 in your unit book. Write the equations for 1a. 2a. and 3a. first and let me check them.)

1. How many grams of NaH_2PO_4 are in 5.02×10^{24} atoms of NaH_2PO_4?

2. Magnesium and hydrochloric acid combine in a single replacement reaction. How many grams of HCl are consumed by the reaction of 2.50 moles of magnesium?

   b. What is the mass in grams of hydrogen gas when 6.0 grams of hydrochloric acid is added to the reaction?

3. Laughing gas (nitrous oxide N_2O) is sometimes used as an anesthetic in dentistry.

   $$NH_4NO_3 \rightarrow N_2O + H_2O$$

   a. If 32.5 L of N_2O is in a dentist office (assume STP), how many grams of N_2O are present?

   b. How many grams of NH_4NO_3 are required to produce 23.0 grams of N2O

   c. There are 23.0 liters of water vapor at STP, how many molecules of NH_4NO_3 produced it?

4. Sodium hydroxide reacts with carbon dioxide produce sodium carbonate and water.

   a. If there are 4.00 moles of water present, how many molecules of water are present?

   b. 12.5 grams of sodium hydroxide react, how many grams of sodium carbonate can be produced?

   c. If there are 14.3 L of carbon dioxide present, how many molecules of sodium carbonate can be produced? Assume STP.

Name: _____ Date: _____

Stoichiometry Ws # 3: Mixed Conversions

Show all work and the balanced equations for each problem. Circle your final answer with correct units and label.

1. Methane burns in oxygen gas to produce carbon dioxide gas and water vapor. What volume of carbon dioxide gas is produced when 3.2 L of oxygen gas are consumed? (Assume STP)

2. How many molecules of sulfuric acid are needed to react with 15 moles of ammonium hydroxide in a double replacement reaction?

3. The body metabolizes glucose ($C_6H_{12}O_6$) by burning it with oxygen to produce carbon dioxide, water and energy. If 3 moles of glucose are burned, what volume of CO_2 (g) is produced at STP?

4. Candles are made of paraffin wax ($C_{25}H_{52}$) which burns in oxygen in a combustion reaction. If 1.20×10^{24} molecules of paraffin burn, what volume of carbon dioxide will be produced at STP?

Name: _____ Date: _____

Stoichiometry Ws # 4: Limiting Reagents

Show all work and the balanced equations for each problem. Circle your final answer with correct units and label.

1. Using the reaction, $4Al + 3O_2 \rightarrow 2Al_2O_3$, identify the limiting reactant in each of the following
   a) 2.5mol Al and 4.0mol O_2
   b) 100g Al and 100g O_2
   c) 58.5g Al and 98.0g O_2
   d) 13.2g Al and 12.3L O_2

2. Identify the limiting reactant when 10.0g H_2O reacts with 4.5g Na to produce NaOH and H_2.

3. Identify the limiting reactant when 12.5L of H_2S at STP is reacted with a solution containing 24.0g KOH to form K_2S and H_2O.

4. If 3.5g Zn and 3.5g S are mixed together and heated to produce ZnS –
   a. What is the limiting reactant?
   b. What mass of ZnS can be produced?

5. Barium nitride is produced from the combination reaction between 22.6g solid barium and 4.2g nitrogen gas? What mass of barium nitride would be produced?

6. Aluminum reacts with Oxygen gas to produce Aluminum Oxide.
   a. If a 200.0.g sample of Al is reacted with 175.0 L of O_2 at STP, what is the limiting reagent?
   b. What mass of Aluminum Oxide can be produced?

Name: _____ Date: _____

Stoichiometry Ws # 5: Percent Yield

Show all work and the balanced equations for each problem. Circle your final answer with correct units and label.

1. If 9.00 g of Al react with an excess of H_3PO_4 in a chemical reaction –
   a. Give a balanced chemical equation:

   b. What mass of $AlPO_4$ could theoretically be produced?

   c. What is the percent yield of this reaction if you actually recovered only 30.0 g of $AlPO_4$?

2. 100.0 g of H_3PO_4 react with 25.0 g Al to produce $AlPO_4$ and hydrogen gas? (use the equation from #1)
   a. What is the limiting reactant?

   b. What is the theoretical yield of $AlPO_4$ for this reaction?

   c. What is the % Yield for the reaction if you recovered 105.0 g of $AlPO_4$?

3. Octane (C_8H_{18}) burns in oxygen gas to produce carbon dioxide and water. When 320g of octane is burned in an oxygen rich environment, 392g of water is recovered, what is the percent yield of the experiment?
   a. Write a balanced equation

   b. Determine the theoretical yield of water.

   c. Determine the % yield.

4. When 2.80g $Al(NO_3)_3$ combines with excess NaOH, and 0.996g $Al(OH)_3$ is recovered.
   a. Write a balanced equation for this double replacement reaction.

   b. Determine the limiting reactant.

   c. Find the theoretical yield of $Al(OH)_3$.

   d. Determine the % yield.

5. Determine the percent yield for the reaction between 5.0g N_2 and 1.0g H_2 if 5.5g NH_3 is produced.

NAME_____ PER_____

Limiting Reactant and Percent Yield Worksheet

(Show your work)

1. Consider the following reaction: $2\ Al + 6\ HBr \rightarrow 2\ AlBr_3 + 3\ H_2$
   When 3.22 moles of Al reacts with 6.96 moles of HBr, what are the limiting and excess reactants?

2. Consider the following reaction: $4\ FeS_2 + 11\ O_2 \rightarrow 2\ Fe_2O_3 + 8\ SO_2$
   When 26.62 moles of FeS_2 reacts with 59.44 moles of O_2, what are the limiting and excess reactants?

3. Consider the following reaction: $3\ Si + 2\ N_2 \rightarrow Si_3N_4$
   When 600 g of Si reacts with 500 g of N_2, What are the limiting and excess reactants?

4. Given the following equation: $Al_2(SO_3)_3 + 6\ NaOH \rightarrow 3\ Na_2SO_3 + 2\ Al(OH)_3$
   If 10.0 g of $Al_2(SO_3)_3$ is reacted with 10.0 g of NaOH, determine the limiting and excess reactants.

NAME_____ PER_____

5. Given the following equation: $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
   If I perform this reaction with 3.6 moles of C_3H_8 and an excess of oxygen gas, what is my theoretical yield of Water in moles? If I actually isolated 12 moles of water what is my percent yield?

6. Given the following equation: $2\ FePO_4 + 3\ Na_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ Na_3PO_4$
   If I perform this reaction with 25 g of Iron (III) phosphate and an excess of Sodium sulfate, what is my theoretical yield in grams of Iron (III) sulfate? If I make 18.5 g of Iron (III) sulfate, what is my percent yield?

7. Given the following reaction: $2\ K_3PO_4 + Al_2(CO_3)_3 \rightarrow 3\ K_2CO_3 + 2\ AlPO_4$
   If I perform this reaction with 150 g of Potassium phosphate and 90 g of Aluminum carbonate, what is my theoretical yield in grams of Potassium carbonate? If the reaction results in 125 g of Potassium carbonate, what is my percent yield?

Study Guide

Name: _____ Date: _____

Stoichiometry Ws # 6: Review

Show all work and the balanced equations for each problem. Circle your final answer with correct units and label.

1. A reaction between hydrazine, N_2H_4, and dinitrogen tetroxide, has been used to launch rockets into space. The reaction produces nitrogen gas and water vapor.
   a. Write the balanced chemical equation for the reaction.

   b. What is the mole ratio of N_2H_4 to N_2?

   c. What amount of water will be produced from 14,000 moles of hydrazine used by the rocket?

2. Oxygen gas and solid potassium chloride can be produced by decomposing potassium chlorate.
   a. Write a balanced equation for the reaction.

   b. If 125g of $KClO_3$ is heated and decomposes quickly, what amount of oxygen gas is produced?

3. Oxygen gas and water are produced by the decomposition of hydrogen peroxide (H_2O_2). If 10.0 mol of H_2O_2 decomposes, what volume of oxygen will be produced?

4. Differentiate a limiting reactant from an excess reactant.

5. Do all reactions have a limiting reactant? Explain.

6. When copper metal is added to a silver nitrate solution, silver metal and copper II nitrate are produced. If 100g of copper metal is added to a solution containing 1000.0g of silver nitrate, what mass of silver metal will be produced.

Study Guide

Name: _____ Date: _____

7. Identify the limiting reactant and the excess reactant in the following situations.
   a. Firewood burning in a campfire
   b. Sulfur compounds from the air tarnishing silver
   c. NO_2 gas reacting with oxygen and water vapor in air to produce acid rain

8. Hydrochloric acid secreted in your stomach can be neutralized in a double replacement reaction by taking an antacid such as aluminum hydroxide.
   a. Write a balanced equation for the reaction.

   b. If 34.0g HCl are secreted and 12.0g $Al(OH)_3$ are taken, is there enough antacid to react with all the acid?

9. Ammonia, NH_3, is used throughout the world as a fertilizer. To manufacture ammonia, nitrogen gas is combined with hydrogen gas in a synthesis reaction.
   a. Write a balance equation for the reaction.

   b. If 92.7kg N_2 and 265.8kg H_2 are used, which is the limiting reactant?

10. a. Differentiate theoretical yield from actual yield.

    b. How is actual yield determined?

    c. How is theoretical yield determined?

11. Coal gasification is a process that converts coal into methane gas. If this reaction has a percentage yield of 85%, how much methane can be obtained from 1.26gof coal?

$$C(s) + H_2O(l) \rightarrow CH_4\ (g) + CO_2\ (g)$$

12. When phosphorous burns in the presence of oxygen, P_4O_{10} is produced. In turn, P_4O_{10} reacts with water to produce phosphoric acid.
   a. Write a balanced equation for the reaction producing phosphoric acid.

   b. When 100g of P_4O_{10} reacts with 200g of H_2O, what is the theoretical yield of phosphoric acid?

   c. If the actual yield is 126.2g of phosphoric acid, what is the percentage yield for the reaction?

Extra practice

Name: _____ Date: _____

Stoichiometry Ws # 1: Basic Stoichiometric Conversions

Show all work and the balanced equations for each problem. Circle your final answer with correct units and label.

MOLE TO MOLE CONVERSIONS

1. Iron III nitrate solution reacts with lithium hydroxide solution to produce solid iron III hydroxide and lithium nitrate solution.
   A. Write a balanced equation.

   B. How many moles of lithium nitrate are produced when 3 moles of iron III nitrate react?

   C. How many moles of lithium hydroxide are needed to produce 6.3 moles of iron III hydroxide?

MOLE TO MASS CONVERSIONS

2. Sodium reacts with chlorine gas to produce sodium chloride.
   A. Write a balanced equation.

   B. How many grams of chlorine gas are needed if 4.0 moles of sodium react?

   C. How many grams of each reactant are needed to produce 2.0 moles of the product?

MASS TO MOLE CONVERSIONS

3. Lead II nitrate and sodium iodide react to form sodium nitrate and lead II iodide.
   A. Which product is the precipitate?

   B. Write a balanced equation.

   C. How many moles of sodium iodide react with 250. grams of lead II nitrate?

   D. If 140. grams of lead II iodide are produced, how many moles of sodium iodide were used?

EP

Name: _____ Date: _____

MASS TO MASS CONVERSIONS

4. Solid Magnesium oxide reacts with liquid water to produce magnesium hydroxide.
   A. Write a balanced equation for the reaction.

   B. How many grams of MgO are needed to produce 264. grams of $Mg(OH)_2$?

   C. How many grams of magnesium hydroxide are produced when 57.0 grams of water are used?

   D. How many grams of water are needed to react completely with 10.0 grams of magnesium oxide?

YOU CHOOSE THE TYPE OF CONVERSION

5. Aqueous solutions of barium nitrate and ammonium carbonate are combined to produce solid barium carbonate and ammonium nitrate solution.
   A. Write the balanced equation.

   B. How many grams of barium nitrate are needed to react with 220 grams of ammonium carbonate?

   C. How many moles of ammonium nitrate will be produced from 110 grams of ammonium carbonate?

   D. How many moles of ammonium nitrate can be produced from 3 moles of Barium Nitrate?

   E. How many moles of barium carbonate would be produced from 6 moles of ammonium carbonate?

   F. How many grams of barium nitrate are needed to produce 5 grams of barium carbonate?

EP

Name: _____ Date: _____

Stoichiometry Ws # 2: Stoichiometric Conversions

Show all work and the balanced equations for each problem. Circle your final answer with correct units and label.

1. Copper I oxide solid is produced in a combination reaction with solid copper and oxygen gas
   A. Write a balanced chemical equation for this reaction.

   B. How many moles of copper are needed to produce 13 moles of copper I oxide?

   C. How many moles of copper I oxide would be produced if only .25 moles of oxygen were available?

   D. You produced 11.7 grams of copper I oxide. How many grams of oxygen did you need?

2. Iron III oxide will decompose in the presence of hydrogen gas and heat to produce free iron and water.
   A. Write a balanced equation for the reaction.

   B. What mass of iron is produced when 450.0 grams of iron III oxide decomposes?

   C. How many moles of hydrogen gas are needed to produce 90.0 grams of iron?

   D. How many grams of water will be produced when .01 moles of iron III oxide decomposes?

3. Solid calcium combines with oxygen gas to form solid calcium oxide.
   A. Write a balanced equation for the reaction.

   B. How many moles of calcium oxide would be produced if only .33 moles of oxygen were available?

   C. If 4.5 grams of oxygen were used, how many grams of calcium are needed for the reaction to go to completion?

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES