Name _____ Date _____ Class _____

CHAPTER 9 REVIEW

Stoichiometry

SECTION 1

SHORT ANSWER **Answer the following questions in the space provided.**

1. b The coefficients in a chemical equation represent the

(a) masses in grams of all reactants and products.
(b) relative number of moles of reactants and products.
(c) number of atoms of each element in each compound in a reaction.
(d) number of valence electrons involved in a reaction.

2. d Which of the following would not be studied within the topic of stoichiometry?

(a) the mole ratio of Al to Cl in the compound aluminum chloride
(b) the mass of carbon produced when a known mass of sucrose decomposes
(c) the number of moles of hydrogen that will react with a known quantity of oxygen
(d) the amount of energy required to break the ionic bonds in CaF_2

3. a A balanced chemical equation allows you to determine the

(a) mole ratio of any two substances in the reaction.
(b) energy released in the reaction.
(c) electron configuration of all elements in the reaction.
(d) reaction mechanism involved in the reaction.

4. c The relative number of moles of hydrogen to moles of oxygen that react to form water represents a(n)

(a) reaction sequence.
(b) bond energy.
(c) mole ratio.
(d) element proportion.

5. Given the reaction represented by the following unbalanced equation: $N_2O(g) + O_2(g) \rightarrow NO_2(g)$

a. Balance the equation.

$2N_2O(g) + 3O_2(g) \rightarrow 4NO_2(g)$

4 mol NO_2:3 mol O_2 **b.** What is the mole ratio of NO_2 to O_2?

15.0 mol **c.** If 20.0 mol of NO_2 form, how many moles of O_2 must have been consumed?

True **d.** Twice as many moles of NO_2 form as moles of N_2O are consumed. True or False?

False **e.** Twice as many grams of NO_2 form as grams of N_2O are consumed. True or False?

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SECTION 1 continued

PROBLEMS **Write the answer on the line to the left. Show all your work in the space provided.**

6. Given the following equation: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

28.0 g/mol N_2 **a.** Determine to one decimal place the molar mass of each substance and express each mass in grams per mole.

2.0 g/mol H_2

17.0 g/mol NH_3

b. There are six different mole ratios in this system. Write out each one.

3 mol H_2:1 mol N_2; 2 mol NH_3:1 mol N_2; 2 mol NH_3:3 mol H_2; or their reciprocals

7. Given the following equation: $4NH_3(g) + 6NO(g) \rightarrow 5N_2(g) + 6H_2O(g)$

1 mol NO:1 mol H_2O **a.** What is the mole ratio of NO to H_2O?

3 mol NO:2 mol NH_3 **b.** What is the mole ratio of NO to NH_3?

0.360 mol **c.** If 0.240 mol of NH_3 react according to the above equation, how many moles of NO will be consumed?

8. Propyne gas can be used as a fuel. The combustion reaction of propyne can be represented by the following equation:

$$C_3H_4(g) + 4O_2(g) \rightarrow 3CO_2(g) + 2H_2O(g)$$

a. Write all the possible mole ratios in this system.

4 mol O_2:1 mol C_3H_4; 3 mol CO_2:1 mol C_3H_4; 2 mol H_2O:1 mol C_3H_4;

3 mol CO_2:4 mol O_2; 2 mol H_2O:4 mol O_2; 2 mol H_2O:3 mol CO_2;

or their reciprocals

b. Suppose that x moles of water form in the above reaction. The other three mole quantities (*not* in order) are $2x$, $1.5x$, and $0.5x$. Match these quantities to their respective components in the equation above.

C_3H_4 is $0.5x$; O_2 is $2x$; and CO_2 is $1.5x$

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CHAPTER 9 REVIEW

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SECTION 2

PROBLEMS **Write the answer on the line to the left. Show all your work in the space provided.**

1. **4.5 mol** The following equation represents a laboratory preparation for oxygen gas:

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

How many moles of O_2 form if 3.0 mol of $KClO_3$ are totally consumed?

2. **200 g** Given the following equation: $H_2(g) + F_2(g) \rightarrow 2HF(g)$
How many grams of HF gas are produced as 5 mol of fluorine react?

3. **0.53 g** Water can be made to decompose into its elements by using electricity according to the following equation:

$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

How many grams of O_2 are produced when 0.033 mol of water decompose?

4. **34.8 g** Sodium metal reacts with water to produce NaOH according to the following equation:

$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

How many grams of NaOH are produced if 20.0 g of sodium metal react with excess oxygen?

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SECTION 2 continued

5. 60.2 g **a.** What mass of oxygen gas is produced if 100. g of lithium perchlorate are heated and allowed to decompose according to the following equation?

$$LiClO_4(s) \rightarrow LiCl(s) + 2O_2(g)$$

42.1 L **b.** The oxygen gas produced in part **a** has a density of 1.43 g/L. Calculate the volume of this gas.

6. A car air bag requires 70. L of nitrogen gas to inflate properly. The following equation represents the production of nitrogen gas:

$$2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$$

81 g **a.** The density of nitrogen gas is typically 1.16 g/L at room temperature. Calculate the number of grams of N_2 that are needed to inflate the air bag.

2.9 mol **b.** Calculate the number of moles of N_2 that are needed.

1.3×10^2 g **c.** Calculate the number of grams of NaN_3 that must be used to generate the amount of N_2 necessary to properly inflate the air bag.

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CHAPTER 9 REVIEW

Stoichiometry

SECTION 3

PROBLEMS **Write the answer on the line to the left. Show all your work in the space provided.**

1. 88% The actual yield of a reaction is 22 g and the theoretical yield is 25 g. Calculate the percentage yield.

2. 6.0 mol of N_2 are mixed with 12.0 mol of H_2 according to the following equation:

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

N_2; 2.0 mol **a.** Which chemical is in excess? What is the excess in moles?

8.0 mol **b.** Theoretically, how many moles of NH_3 will be produced?

6.4 mol **c.** If the percentage yield of NH_3 is 80%, how many moles of NH_3 are actually produced?

3. 0.050 mol of $Ca(OH)_2$ are combined with 0.080 mol of HCl according to the following equation:

$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

0.10 mol **a.** How many moles of HCl are required to neutralize all 0.050 mol of $Ca(OH)_2$?

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SECTION 3 continued

HCl **b.** What is the limiting reactant in this neutralization reaction?

1.4 g **c.** How many grams of water will form in this reaction?

4. Acid rain can form in a two-step process, producing $HNO_3(aq)$.

$$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$$

$$3NO_2(g) + H_2O(g) \rightarrow 2HNO_3(aq) + NO(g)$$

1.26×10^3 g **a.** A car burns 420. g of N_2 according to the above equations. How many grams of HNO_3 will be produced?

960. g **b.** For the above reactions to occur, O_2 must be in excess in the first step. What is the minimum amount of O_2 needed in grams?

6.9×10^2 L **c.** What volume does the amount of O_2 in part **b** occupy if its density is 1.4 g/L?

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CHAPTER 9 REVIEW

Stoichiometry

MIXED REVIEW

SHORT ANSWER **Answer the following questions in the space provided.**

1. Given the following equation: $C_3H_4(g) + xO_2(g) \rightarrow 3CO_2(g) + 2H_2O(g)$

4 **a.** What is the value of the coefficient x in this equation?

40.07 g/mol **b.** What is the molar mass of C_3H_4?

2 mol O_2:1 mol H_2O **c.** What is the mole ratio of O_2 to H_2O in the above equation?

0.20 mol **d.** How many moles are in an 8.0 g sample of C_3H_4?

3z **e.** If z mol of C_3H_4 react, how many moles of CO_2 are produced, in terms of z?

2. **a.** What is meant by *ideal conditions* relative to stoichiometric calculations?

The limiting reactant is completely converted to product with no losses, as dictated by the ratio of coefficients.

b. What function do ideal stoichiometric calculations serve?

They determine the theoretical yield of the products of the reaction.

c. Are actual yields typically larger or smaller than theoretical yields?

smaller

PROBLEMS **Write the answer on the line to the left. Show all your work in the space provided.**

3. Assume the reaction represented by the following equation goes all the way to completion:

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

4 mol **a.** If 6 mol of H_2 are consumed, how many moles of NH_3 are produced?

8.5 g **b.** How many grams are in a sample of NH_3 that contains 3.0×10^{23} molecules?

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MIXED REVIEW continued

c. If 0.1 mol of N_2 combine with H_2, what must be true about the quantity of H_2 for N_2 to be the limiting reactant?

At least 0.3 mol of H_2 must be provided.

4. **75%** If a reaction's theoretical yield is 8.0 g and the actual yield is 6.0 g, what is the percentage yield?

5. Joseph Priestley generated oxygen gas by strongly heating mercury(II) oxide according to the following equation:

$$2HgO(s) \rightarrow 2Hg(l) + O_2(g)$$

0.0693 mol **a.** If 15.0 g HgO decompose, how many moles of HgO does this represent?

0.0346 mol **b.** How many moles of O_2 are theoretically produced?

1.11 g **c.** How many grams of O_2 is this?

0.786 L **d.** If the density of O_2 gas is 1.41 g/L, how many liters of O_2 are produced?

1.05 g **e.** If the percentage yield is 95.0%, how many grams of O_2 are actually collected?