CHAPTER 9 REVIEW

Stoichiometry

SECTION 1

SHORT ANSWER Answer the following questions in the space provided.

1. _____ 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. _____ 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 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. _____ 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:
   \( \text{N}_2\text{O}(g) + \text{O}_2(g) \rightarrow \text{NO}_2(g) \)
   a. Balance the equation.

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   b. What is the mole ratio of NO$_2$ to O$_2$?
   
   c. If 20.0 mol of NO$_2$ form, how many moles of O$_2$ must have been consumed?
   
   d. Twice as many moles of NO$_2$ form as moles of N$_2$O are consumed. True or False?
   
   e. Twice as many grams of NO$_2$ form as grams of N$_2$O are consumed. True or False?
PROBLEMS Write the answer on the line to the left. Show all your work in the space provided.

6. Given the following equation: \( \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \)

a. Determine to one decimal place the molar mass of each substance and express each mass in grams per mole.

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

7. Given the following equation: \( 4\text{NH}_3(g) + 6\text{NO}(g) \rightarrow 5\text{N}_2(g) + 6\text{H}_2\text{O}(g) \)

a. What is the mole ratio of NO to \( \text{H}_2\text{O} \)?

b. What is the mole ratio of NO to \( \text{NH}_3 \)?

c. If 0.240 mol of \( \text{NH}_3 \) 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:

\[
\text{C}_3\text{H}_4(g) + 4\text{O}_2(g) \rightarrow 3\text{CO}_2(g) + 2\text{H}_2\text{O}(g)
\]

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

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.
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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. The following equation represents a laboratory preparation for oxygen gas:
   \[2\text{KClO}_3(s) \rightarrow 2\text{KCl}(s) + 3\text{O}_2(g)\]
   How many moles of \(\text{O}_2\) form if 3.0 mol of \(\text{KClO}_3\) are totally consumed?

2. Given the following equation:
   \[\text{H}_2(g) + \text{F}_2(g) \rightarrow 2\text{HF}(g)\]
   How many grams of \(\text{HF}\) gas are produced as 5 mol of fluorine react?

3. Water can be made to decompose into its elements by using electricity according to the following equation:
   \[2\text{H}_2\text{O}(l) \rightarrow 2\text{H}_2(g) + \text{O}_2(g)\]
   How many grams of \(\text{O}_2\) are produced when 0.033 mol of water decompose?

4. Sodium metal reacts with water to produce \(\text{NaOH}\) according to the following equation:
   \[2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g)\]
   How many grams of \(\text{NaOH}\) are produced if 20.0 g of sodium metal react with excess oxygen?
SECTION 2 continued

5. ___________________ 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?

\[ \text{LiClO}_4(s) \rightarrow \text{LiCl}(s) + 2\text{O}_2(g) \]

__________________ 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:

\[ 2\text{NaN}_3(s) \rightarrow 2\text{Na}(s) + 3\text{N}_2(g) \]

__________________ a. The density of nitrogen gas is typically 1.16 g/L at room temperature. Calculate the number of grams of \( \text{N}_2 \) that are needed to inflate the air bag.

__________________ b. Calculate the number of moles of \( \text{N}_2 \) that are needed.

__________________ c. Calculate the number of grams of \( \text{NaN}_3 \) that must be used to generate the amount of \( \text{N}_2 \) necessary to properly inflate the air bag.
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. 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\textsubscript{2} are mixed with 12.0 mol of H\textsubscript{2} according to the following equation:

\[ \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]

- a. Which chemical is in excess? What is the excess in moles?

- b. Theoretically, how many moles of NH\textsubscript{3} will be produced?

- c. If the percentage yield of NH\textsubscript{3} is 80%, how many moles of NH\textsubscript{3} are actually produced?

3. 0.050 mol of Ca(OH)\textsubscript{2} are combined with 0.080 mol of HCl according to the following equation:

\[ \text{Ca(OH)}_2(aq) + 2\text{HCl}(aq) \rightarrow \text{CaCl}_2(aq) + 2\text{H}_2\text{O}(l) \]

- a. How many moles of HCl are required to neutralize all 0.050 mol of Ca(OH)\textsubscript{2}?
b. What is the limiting reactant in this neutralization reaction?

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

4. Acid rain can form in a two-step process, producing $\text{HNO}_3(aq)$.

\[ \text{N}_2(g) + 2\text{O}_2(g) \rightarrow 2\text{NO}_2(g) \]
\[ 3\text{NO}_2(g) + \text{H}_2\text{O}(g) \rightarrow 2\text{HNO}_3(aq) + \text{NO}(g) \]

a. A car burns 420. g of $\text{N}_2$ according to the above equations. How many grams of $\text{HNO}_3$ will be produced?

b. For the above reactions to occur, $\text{O}_2$ must be in excess in the first step. What is the minimum amount of $\text{O}_2$ needed in grams?

c. What volume does the amount of $\text{O}_2$ in part b occupy if its density is 1.4 g/L?