Introduction to Stoichiometry

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. The study of the mass relationships of elements in compounds is known as (a) reaction stoichiometry; (b) composition stoichiometry; (c) percent yield; (d) Avogadro's principle.

2. The study of the mass relationships among reactants and products in a chemical reaction is known as (a) reaction stoichiometry; (b) composition stoichiometry; (c) electron configuration; (d) periodic law.

3. Determining how much lime (CaO) could be obtained from a known mass of limestone (CaCO₃) would involve the branch of chemistry known as (a) reaction stoichiometry; (b) qualitative analysis; (c) physical chemistry; (d) metallurgy.

4. Which of the following would not be studied in the branch of chemistry called stoichiometry? (a) the mole ratio of aluminum and chlorine in aluminum chloride (b) the amount of energy required to break the ionic bonds in calcium fluoride (c) the mass of carbon produced when a known mass of sucrose decomposes (d) the number of moles of hydrogen that will react completely with a known quantity of oxygen

5. A balanced chemical equation allows one 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.

6. The coefficients in a chemical equation represent the (a) masses, in grams, of all reactants and products; (b) relative numbers of moles of reactants and products; (c) number of atoms in each compound in a reaction; (d) number of valence electrons involved in the reaction.

7. The relative number of moles of hydrogen and oxygen that react to form water represents a(n) (a) mole ratio; (b) reaction sequence; (c) bond energy; (d) element proportion.

8. If one knows the mass of reactant A in a chemical reaction, one can determine the mass of product D produced by the use of the (a) mole ratio in the chemical equation; (b) group numbers of the periodic table; (c) bond energies involved in the reaction; (d) electron configurations of the elements involved.

9. In the reaction 2Al₂O₃(s) → 4Al(s) + 3O₂(g), the mole ratio of aluminum to oxygen is (a) 10:6; (b) 5:3; (c) 2:3; (d) 4:3.

10. In the reaction 2H₂ + O₂ → 2H₂O, the mole ratio of oxygen to water is (a) 1:2; (b) 2:1; (c) 8:1; (d) 1:4.

11. In the reaction Ca + Cl₂ → CaCl₂, the mole ratio of chlorine to calcium chloride is (a) 2:3; (b) 2:1; (c) 1:2; (d) 1:1.

12. In the reaction Zn + H₂SO₄ → ZnSO₄ + H₂, the mole ratio of zinc to sulfuric acid is (a) 1:6; (b) 1:1; (c) 1:2; (d) 3:1.

13. In solving mass-mass equation problems, the coefficients from the balanced equation are used to find the (a) number of atoms that are conserved; (b) given information; (c) amount of energy involved; (d) mole proportions of the chemicals involved.

14. A reaction stoichiometry problem in which you are given the number of moles of one substance and asked to calculate the mass of another substance is what type of problem? (a) mole-mass (b) mass-mole (c) mass-mass (d) mole-mole

15. For the equation A + B → C + D, if you are given the mass of B and asked to calculate the number of moles of C produced, you are solving a (a) mass-mass problem; (b) mole-mole problem; (c) mass-mole problem; (d) mole-mass problem.
Ideal Stoichiometric Calculations

DIRECTIONS: Write the answer to questions 1-13 on the line to the right, and show your work in the space provided.

1. The Haber process for the production of ammonia is represented by the unbalanced equation
   \[ \text{N}_2(g) + \text{H}_2(g) \rightarrow 2\text{NH}_3(g) \]. The complete conversion of 9.0 mol of hydrogen to ammonia
   would require how many moles of nitrogen?
   
   \[ \ldots \] 1

2. In the equation \( 2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2 \), how many moles of oxygen are produced when
   3.0 mol of \( \text{KClO}_3 \) decompose completely?
   
   \[ \ldots \] 2

3. For the reaction \( \text{C} + 2\text{H}_2 \rightarrow \text{CH}_4 \), how many moles of hydrogen are required to produce
   10 moles of methane (\( \text{CH}_4 \))?
   
   \[ \ldots \] 3

4. For the reaction \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \), how many moles of water can be produced from 6 moles
   of oxygen?
   
   \[ \ldots \] 4

DIRECTIONS: Questions 5-13 refer to the following table.

<table>
<thead>
<tr>
<th>TABLE OF ATOMIC MASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element</td>
</tr>
<tr>
<td>Hydrogen</td>
</tr>
<tr>
<td>Chlorine</td>
</tr>
<tr>
<td>Oxygen</td>
</tr>
<tr>
<td>Sulfur</td>
</tr>
<tr>
<td>Sodium</td>
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<tr>
<td>Carbon</td>
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<tr>
<td>Mercury</td>
</tr>
<tr>
<td>Fluorine</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Cobalt</td>
</tr>
</tbody>
</table>

5. For the reaction \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \), approximately how many grams of water can
   be produced from 6.00 mol of hydrogen?
   
   \[ \ldots \] 5

6. For the reaction \( \text{C} + 2\text{H}_2 \rightarrow \text{CH}_4 \), how many grams of hydrogen are required to produce
   3.00 mol of methane (\( \text{CH}_4 \))?
   
   \[ \ldots \] 6

7. For the reaction \( 2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2 \), how many grams of oxygen can be produced from 10.00 mole of mercury(II) oxide?
   
   \[ \ldots \] 7

8. For the reaction \( \text{H}_2 + \text{F}_2 \rightarrow 2\text{HF} \), how many grams of hydrogen fluoride can be produced
   from 8.00 mol of fluorine?
   
   \[ \ldots \] 8

9. How many moles of \( \text{O}_2 \) will react with 10.0 g of \( \text{H}_2 \) to form water in the equation
   \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \)?
   
   \[ \ldots \] 9

10. For the reaction \( \text{CaO} + \text{SO}_3 \rightarrow \text{CaSO}_4 \), how many moles of calcium sulfate are produced
    from 40 g of sulfur trioxide?
    
    \[ \ldots \] 10

11. For the reaction \( \text{Co} + \text{F}_2 \rightarrow \text{CoF}_2 \), how many moles of fluorine are required to produce
    290.8 g of cobalt fluoride?
    
    \[ \ldots \] 11

12. If 40.0 g of sulfur dioxide are formed in the reaction between sulfur and oxygen, what is the
    mass of oxygen used?
    
    \[ \ldots \] 12

13. In the equation \( 2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow 2\text{HCl} + \text{Na}_2\text{SO}_4 \), what is the mass of sodium chloride that
    reacts with 300.0 g of sulfuric acid?
    
    \[ \ldots \] 13
Limiting Reactants and Percent Yield

**DIRECTIONS:** Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. The reactant that controls the amount of product formed in a chemical reaction is called the
   (a) excess reactant; (b) mole ratio; (c) composition reactant; (d) limiting reactant.

2. In a chemical reaction, the limiting reactant (a) would be completely used first;
   (b) would not be completely used; (c) is unreactive; (d) must be in solution.

3. In a chemical reaction, the reactant remaining after all of the limiting reactant is completely
   used is referred to as the (a) product; (b) excess reactant; (c) controlling reactant; (d) catalyst.

4. In the reaction \( A + B \rightarrow C + D \), if there is an insufficient quantity of \( B \) to completely react
   with all of \( A \), then (a) \( A \) is the limiting reactant; (b) \( B \) is the limiting reactant; (c) there is no
   limiting reactant; (d) no product can be formed.

5. To determine the limiting reactant in a chemical reaction, one must know the
   (a) available amount of one of the reactants; (b) amount of product formed; (c) available
   amounts of both reactants; (d) speed of the reaction.

6. To determine the limiting reactant in a chemical reaction involving substances \( A \) and \( B \), one
   could first calculate (a) the mass of 100 moles of \( A \) and \( B \); (b) the masses of all products;
   (c) bond energy of \( A \) and \( B \); (d) the amount of moles of \( B \) required to react completely with \( A \).

7. The maximum amount of a product that can be produced from a given amount of reactant is
   called the (a) percent yield; (b) mole ratio; (c) theoretical yield; (d) actual yield.

8. In most chemical reactions the amount of product obtained is (a) equal to the theoretical yield;
   (b) less than the theoretical yield; (c) more than the theoretical yield; (d) more than the percent
   yield.

9. A chemist interested in the efficiency of a chemical reaction would want to calculate the
   (a) mole ratio; (b) energy released; (c) percent yield; (d) rate of reaction.

**DIRECTIONS:** Write the answer to questions 10-13 on the line to the right, and show your work in the space
provided.

10. In the reaction \( 2H_2 + O_2 \rightarrow 2H_2O \), how many moles of water will be produced if 6 mol of
    hydrogen and 2 mol of oxygen are available to react?

11. In the reaction \( Mg + 2HCl \rightarrow H_2 + MgCl_2 \), how many moles of magnesium chloride can
    be produced from 6 mol of magnesium and 8 mol of hydrochloric acid?

**DIRECTIONS:** Questions 12 and 13 refer to the following table.

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<td>Carbon</td>
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12. For the reaction \( 2H_2 + O_2 \rightarrow 2H_2O \)
    calculate the percent yield if 860. g of water
    are produced when 100. g of hydrogen react
    with an excess of oxygen.

13. For the reaction \( C + 2H_2 \rightarrow CH_4 \), calculate
    the percent yield if 98 g of methane are
    produced when 100. g of carbon react with an
    excess of hydrogen.