Chemistry Chapter 9 Study Guide

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. 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.

2. The units of molar mass are
   a. g/mol.
   b. mol/g.
   c. amu/mol.
   d. amu/g.

3. In the reaction represented by the equation \( \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \), what is the mole ratio of nitrogen to ammonia?
   a. 1:1
   b. 1:2
   c. 1:3
   d. 2:3

4. In the reaction represented by the equation \( 2\text{Al}_2\text{O}_3 \rightarrow 4\text{Al} + 3\text{O}_2 \), what is the mole ratio of aluminum to oxygen?
   a. 10:6
   b. 3:4
   c. 2:3
   d. 4:3

5. In the reaction represented by the equation \( \text{C} + 2\text{H}_2 \rightarrow \text{CH}_4 \), what is the mole ratio of hydrogen to methane?
   a. 1:1
   b. 2:1
   c. 1:2
   d. 2:4

6. In the reaction represented by the equation \( \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \), what is the mole ratio of hydrogen to ammonia?
   a. 1:1
   b. 2:1
   c. 3:2
   d. 6:8

7. The Haber process for producing ammonia commercially is represented by the equation \( \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \). To completely convert 9.0 mol hydrogen gas to ammonia gas, how many moles of nitrogen gas are required?
   a. 1.0 mol
   b. 2.0 mol
   c. 3.0 mol
   d. 6.0 mol

8. 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?
   a. 1.0 mol
   b. 2.5 mol
   c. 3.0 mol
   d. 4.5 mol

9. For the reaction represented by the equation \( \text{C} + 2\text{H}_2 \rightarrow \text{CH}_4 \), how many moles of hydrogen are required to produce 10 mol of methane, \( \text{CH}_4 \)?
   a. 2 mol
   b. 4 mol
   c. 10 mol
   d. 20 mol

10. For the reaction represented by the equation \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \), how many moles of water can be produced from 6.0 mol of oxygen?
    a. 2.0 mol
    c. 12 mol
b. 6.0 mol

d. 18 mol

11. For the reaction represented by the equation \( \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \), how many moles of nitrogen are required to produce 18 mol of ammonia?
   a. 9.0 mol  
   b. 18 mol  
   c. 27 mol  
   d. 36 mol

12. For the reaction represented by the equation \( \text{AgNO}_3 + \text{NaCl} \rightarrow \text{NaNO}_3 + \text{AgCl} \), how many moles of silver chloride, AgCl, are produced from 7.0 mol of silver nitrate AgNO\(_3\)?
   a. 1.0 mol  
   b. 2.3 mol  
   c. 7.0 mol  
   d. 21 mol

13. For the reaction represented by the equation \( 2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O} \), how many grams of water are produced from 6.00 mol of hydrogen?
   a. 2.00 g  
   b. 6.00 g  
   c. 54.0 g  
   d. 108 g

14. For the reaction represented by the equation \( 2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \), how many grams of sodium hydroxide are produced from 3.0 mol of sodium with an excess of water?
   a. 40. g  
   b. 80. g  
   c. 120 g  
   d. 240 g

15. For the reaction represented by the equation \( \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 \), how many grams of sulfur trioxide are required to produce 4.00 mol of sulfuric acid in an excess of water?
   a. 80.0 g  
   b. 160. g  
   c. 240. g  
   d. 320. g

16. For the reaction represented by the equation \( 2\text{Fe} + \text{O}_2 \rightarrow 2\text{FeO} \), how many grams of iron(II) oxide are produced from 8.00 mol of iron in an excess of oxygen?
   a. 71.8 g  
   b. 575 g  
   c. 712 g  
   d. 1310 g

17. For the reaction represented by the equation \( 2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl} \), how many grams of chlorine gas are required to react completely with 2.00 mol of sodium?
   a. 35.5 g  
   b. 70.9 g  
   c. 141.8 g  
   d. 212.7 g

18. For the reaction represented by the equation \( 2\text{HNO}_3 + \text{Mg(OH)}_2 \rightarrow \text{Mg(NO}_3)_2 + 2\text{H}_2\text{O} \), how many grams of magnesium nitrate are produced from 8.00 mol of nitric acid, \( \text{HNO}_3 \), and an excess of \( \text{Mg(OH)}_2 \)?
   a. 148 g  
   b. 445 g  
   c. 593 g  
   d. 818 g

19. For the reaction represented by the equation \( \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \), how many moles of carbon dioxide are produced from the combustion of 100. g of methane?
   a. 6.23 mol  
   b. 10.8 mol  
   c. 12.5 mol  
   d. 25 mol

20. For the reaction represented by the equation \( \text{Pb(NO}_3)_2 + 2\text{KI} \rightarrow \text{PbI}_2 + 2\text{KNO}_3 \), how many moles of lead(II) iodide are produced from 300. g of potassium iodide and an excess of \( \text{Pb(NO}_3)_2 \)?
   a. 0.904 mol  
   b. 1.81 mol  
   c. 3.61 mol  
   d. 11.0 mol
21. For the reaction represented by the equation \( \text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2 \), how many moles of potassium chloride are produced from 119 g of potassium bromide?
   a. 0.119 mol  
   b. 0.236 mol  
   c. 0.581 mol  
   d. 1.00 mol

22. For the reaction represented by the equation \( 3\text{Fe} + 4\text{H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2 \), how many moles of iron(III) oxide are produced from 500. g of iron in an excess of \( \text{H}_2\text{O} \)?
   a. 1.04 mol  
   b. 2.98 mol  
   c. 8.95 mol  
   d. 12.98 mol

23. For the reaction represented by the equation \( 2\text{KIO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2 \), how many moles of potassium chlorate are required to produce 250. g of oxygen?
   a. 2.00 mol  
   b. 4.32 mol  
   c. 4.97 mol  
   d. 5.21 mol

24. Ozone, \( \text{O}_3 \), is produced by the reaction represented by the following equation:
   \[ \text{NO}_2(g) + \text{O}_2(g) \rightarrow \text{NO}(g) + \text{O}_3(g) \]
   What mass of ozone will form from the reaction of 2.0 g of \( \text{NO}_2 \) in a car's exhaust and excess oxygen?
   a. 1.1 g \( \text{O}_3 \)  
   b. 1.8 g \( \text{O}_3 \)  
   c. 2.1 g \( \text{O}_3 \)  
   d. 4.2 g \( \text{O}_3 \)

25. For the reaction represented by the equation \( \text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2 \), how many grams of potassium chloride can be produced from 300. g each of chlorine and potassium bromide?
   a. 98.7 g  
   b. 111 g  
   c. 188 g  
   d. 451 g

26. For the reaction represented by the equation \( 2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \), how many grams of hydrogen are produced if 120. g of sodium and 80. g of water are available?
   a. 4.5 g  
   b. 45 g  
   c. 80. g  
   d. 200 g

27. For the reaction represented by the equation \( 2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl} \), how many grams of sodium chloride can be produced from 500. g each of sodium and chlorine?
   a. 112 g  
   b. 319 g  
   c. 409 g  
   d. 824 g

28. For the reaction represented by the equation \( \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 \), how many grams of sulfuric acid can be produced from 200. g of sulfur trioxide and 100. g of water?
   a. 100. g  
   b. 200. g  
   c. 245 g  
   d. 285 g

29. Which reactant controls the amount of product formed in a chemical reaction?
   a. excess reactant  
   b. mole ratio  
   c. composition reactant  
   d. limiting reactant

30. A chemical reaction involving substances A and B stops when B is completely used. B is the
   a. excess reactant.  
   b. limiting reactant.  
   c. primary reactant.  
   d. primary product.

31. When the limiting reactant in a chemical reaction is completely used, the
   a. excess reactants begin combining.  
   b. reaction slows down.  
   c. reaction speeds up.  
   d. reaction stops.
32. 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 amount of each reactant.
   d. speed of the reaction.

33. What is the ratio of the actual yield to the theoretical yield, multiplied by 100%?
   a. mole ratio
   b. percentage yield
   c. Avogadro yield
   d. excess yield

34. What is the measured amount of a product obtained from a chemical reaction?
   a. mole ratio
   b. percentage yield
   c. theoretical yield
   d. actual yield

35. 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 percentage yield.

36. What is the maximum possible amount of product obtained in a chemical reaction?
   a. theoretical yield
   b. percentage yield
   c. mole ratio
   d. actual yield

37. If the percentage yield is equal to 100%, then
   a. the actual yield is greater than the theoretical yield.
   b. the actual yield is equal to the theoretical yield.
   c. the actual yield is less than the theoretical yield.
   d. there was no limiting reactant.

38. For the reaction represented by the equation \( \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 \), calculate the percentage yield if 500. g of sulfur trioxide react with excess water to produce 575 g of sulfuric acid.
   a. 82.7%
   b. 88.3%
   c. 91.2%
   d. 93.9%

39. For the reaction represented by the equation \( \text{Cl}_2 + 2\text{KBr} \rightarrow 2\text{KCl} + \text{Br}_2 \), calculate the percentage yield if 200. g of chlorine react with excess potassium bromide to produce 410. g of bromine.
   a. 73.4%
   b. 82.1%
   c. 91.0%
   d. 98.9%

40. For the reaction represented by the equation \( \text{CH}_4 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{CO}_2 \), calculate the percentage yield of carbon dioxide if 1000. g of methane react with excess oxygen to produce 2300. g of carbon dioxide.
   a. 83.88%
   b. 89.14%
   c. 92.76%
   d. 96.78%

41. For the reaction represented by the equation \( \text{Mg} + 2\text{HCl} \rightarrow \text{H}_2 + \text{MgCl}_2 \), calculate the percentage yield of magnesium chloride if 100. g of magnesium react with excess hydrochloric acid to yield 330. g of magnesium chloride.
   a. 71.8%
   b. 74.3%
   c. 81.6%
   d. 84.2%

**Completion**
*Complete each statement.*
1. The expression below converts the quantity, mass HCl, to the quantity, ________________.

\[
\text{mass HCl} \times \frac{1 \text{ mol HCl}}{\text{molar mass HCl}} \times \frac{1 \text{ mol Cl}_2}{2 \text{ mol HCl}}
\]

2. The unit of the following expression is ________________.

\[
100 \text{ g H}_2\text{O} \times \frac{\text{mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}}
\]

3. The expression below converts the quantity, mass HCl, to the quantity, ________________.

\[
\text{mass HCl} \times \frac{1 \text{ mol HCl}}{\text{molar mass HCl}} \times \frac{1 \text{ mol Cl}_2}{2 \text{ mOL HCl}} \times \frac{\text{molar mass Cl}_2}{1 \text{ mol Cl}_2}
\]

4. If two moles of each reactant are available for the reaction described by the following equation,
\[
\text{SiO}_2(\ell) + 3\text{C}(\ell) \rightarrow \text{SiC}(\ell) + 2\text{CO}(g),
\]

______________ is the substance that is the limiting reactant.

5. If four moles of each reactant are available for the reaction described by the following equation,
\[
\text{SiO}_2(\ell) + 3\text{C}(\ell) \rightarrow \text{SiC}(\ell) + 2\text{CO}(g)
\]

______________ is the substance that is the excess reactant.

6. The efficiency of a reaction is described by the ________________ yield.

**Short Answer**

1. Describe a way to determine which reactant in a chemical reaction is the limiting reactant.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. Comparing limiting and excess reactants, explain why the flame would go out in the Bunsen burner shown below if either of the indicated valves were tightened too much.
3. Explain why it is false to say that the limiting reactant is the reactant that is present in the smaller amount.

Problem

1. What mass is grams of potassium chloride is produced if 100. g of potassium chlorate decompose according to the following equation?

   \[ 2\text{KClO}_3(s) \xrightarrow{heat} 2\text{KCl}(s) + 3\text{O}_2(g) \]

2. What mass of PCl\textsubscript{3} forms in the reaction of 75.0 g P\textsubscript{4} with 275 g Cl\textsubscript{2}?

   \[ \text{P}_4 + 6\text{Cl}_2 \rightarrow 4\text{PCl}_3 \]
3. What mass in grams of sodium hydroxide is produced if 20.0 g of sodium metal react with excess water according to the chemical equation \(2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g)\)?

4. What mass in grams of 1-chloropropane (\(\text{C}_3\text{H}_7\text{Cl}\)) is produced if 400. g of propane react with excess chlorine gas according to the equation \(\text{C}_3\text{H}_8 + \text{Cl}_2 \rightarrow \text{C}_3\text{H}_7\text{Cl} + \text{HCl}\)?

5. What mass in grams of hydrogen gas is produced if 20.0 mol of Zn are added to excess hydrochloric acid according to the equation \(\text{Zn}(s) + 2\text{HCl}(aq) \rightarrow \text{ZnCl}_2(aq) + \text{H}_2(g)\)?
6. How many grams of ammonium sulfate can be produced if 30.0 mol of H₂SO₄ react with excess NH₃ according to the equation 2NH₃(aq) + H₂SO₄(aq) → (NH₄)₂SO₄(aq)?

7. How many moles of Ag can be produced if 350. g of Cu are reacted with excess AgNO₃ according to the equation Cu(s) + 2AgNO₃(aq) → 2Ag(s) + Cu(NO₃)₂(aq)?

8. The reaction of 100. g of salicylic acid, C₇H₆O₃, with excess acetic anhydride produces 50.0 g of aspirin, C₉H₈O₄, according to the equation below. What is the percentage yield for this reaction?
   C₇H₆O₃ + C₄H₆O₃ → C₉H₈O₄ + C₂H₄O₂

9. In the decomposition of hydrogen peroxide, the percentage yield of oxygen is 93.0%. What is the actual yield in grams of oxygen if you start with 100. g of H₂O₂? The reaction proceeds according to the equation 2H₂O₂(l) → 2H₂O(l) + O₂(g).
10. In the reaction represented by the equation $2\text{NH}_3 + \text{CO}_2 \rightarrow \text{CO(NH}_2)_2 + \text{H}_2\text{O}$, 30.7 g of CO(NH$_2$)$_2$ forms per 1.00 mol of CO$_2$ that reacts when NH$_3$ is in excess. What is the percentage yield?