WHS  •  H Chemistry

Unit 5.3  •  Stoichiometry

LEARNING OBJECTIVES

**Big Idea:** The following list is a GUIDE to what you should study in order to be prepared for the Unit 5.3 assessment on Stoichiometry. In order to be fully prepared you should seek help if required, refer to the relevant pages in the textbook, review ALL notes, homework, worksheets, classwork and other material. Good Luck!

**Objectives:**

The student will be able to...

- predict and balance a chemical equation.
- write mole ratios from a balanced chemical equation.
- use stoichiometry to convert between substances in a chemical reaction.
- interpret a chemical equation in terms of single particles, moles of particles, and volume.
- identify the principle behind balanced chemical equations.
- calculate molar mass of a compound and use it as a conversion between mass and moles of a substance.
- calculate the max amount of product from a given amount(s) of reactant(s).
- identify the limiting and excess reactants.
- define titration, standard/titrant, analyte, equivalence point, endpoint, indicator.
- interpret a titration curve by identifying the following: titrant, analyte, equivalence point, pH at equivalence point, volume of titrant needed to neutralize analyte.
- recognize when a weak acid or base is used in a titration against a strong base or acid and how the titration curve varies.
- calculate the unknown concentration or volume of an analyte in a titration when given the concentration and volume of titrant.
- identify the principle behind titrations.

**Additional Problems:**

1. Which of the following equations best represents the reaction shown in the diagram?
   a. \( A + B \rightarrow C + D \)
   b. \( 6A + 4B \rightarrow C + D \)
   c. \( A + 2B \rightarrow 2C + D \)
   d. \( 3A + 2B \rightarrow 2C + D \)
   e. \( 3A + 2B \rightarrow 4C + 2D \)

2. Silicon tetrachloride can be prepared by heating silicon in chlorine gas. In one reaction, 0.507 mole of silicon tetrachloride is produced. How many moles of molecular chlorine were used in the reaction?

3. Certain race cars use methanol, \((CH_3OH, \text{also called wood alcohol})\) as a fuel. The combustion of methanol occurs according to the following equation: \(2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)\) In a particular reaction, 9.8 moles of methanol are reacted with excess oxygen. Calculate the number of moles of water formed.
4. When baking soda (sodium bicarbonate or sodium hydrogen carbonate) is heated, it releases carbon dioxide gas, which is responsible for the rising of cookies, donuts, and bread.
   a. Write a balanced equation for the decomposition of the compound when the two additional products formed are solid sodium carbonate and water vapor (besides carbon dioxide gas)
   b. Calculate the mass of sodium bicarbonate required to produce 20.5 g of carbon dioxide

5. Fermentation is a complex chemical process of wine making in which glucose is converted into ethanol and carbon dioxide: \( C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 \). Starting with 500.4 g of glucose, what is the maximum amount of ethanol in grams and in liters that can be obtained by this process? (Density of ethanol = 0.789 g/mL)

6. Consider the reaction: \( N_2 + 3H_2 \rightarrow 2NH_3 \) pictured to the right. Assuming each model represents 1 mole of the substance, show the number of moles of each product and the excess reagent left after the complete reaction.

7. Ammonia and sulfuric acid (\( H_2SO_4 \)) react to form ammonium sulfate.
   a. Write a balanced equation for the reaction.
   b. Determine the starting mass (in g) of each reactant if 20.3 g of ammonium sulfate is produced and 5.89 g of sulfuric acid remains unreacted.

8. Consider the reaction: \( MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O \). If 0.86 mole of \( MnO_2 \) and 48.2g of HCl react, which reagent will be used up first (limiting reactant)? How many grams of \( Cl_2 \) will be produced (max amount)? What is in excess, and how much is in excess?

9. Describe the basic steps involved in an acid-base titration.

10. How does an acid-base indicator work?

11. Would the volume of a 0.10 M NaOH solution needed to titrate 25.0 mL of a 0.10M HNO\(_2\) (a weak acid) solution be different from that needed to titrate 25.0 mL of a 0.10 M HCl (a strong acid) solution?

12. Calculate the concentration (in molarity) of a sodium hydroxide solution if 25.0 mL of the solution are needed to neutralize 17.4 mL of a 0.312 M HCl solution.

13. What volume of a 0.500 M HCl solution is needed to neutralize each of the following?
   a. 10.0 mL of a 0.300 M NaOH solution
   b. 10.0 mL of a 0.200 M Ba(OH)\(_2\) solution

14. The concentration of a hydrogen peroxide solution can be conveniently determined by titration against a standardized potassium permanganate solution in an acidic medium according to the equation: \( 2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O \). If 36.44 mL of a 0.01652 M \( KMnO_4 \) solution are required to oxidize 25.00 mL of a hydrogen peroxide solution, calculate the molarity of the hydrogen peroxide.

15. Consider the reaction: \( NaOH + HCl \rightarrow NaCl + H_2O \). If 10.0 mL of a 0.10 M NaOH solution is needed to react with 10.0 mL of a 0.10 M HCl solution, calculate the concentration (in molarity) of the NaOH solution.

16. Describe the basic steps involved in a redox titration.

17. How does an oxygen sensor work?

18. Would the volume of a 0.10 M NaOH solution needed to titrate 25.0 mL of a 0.10M HNO\(_2\) (a weak acid) solution be different from that needed to titrate 25.0 mL of a 0.10 M HCl (a strong acid) solution?