

Virden Collegiate Institute

30S

Chemistry

**Chemical Reactions:
Stoichiometry
Student Study Guide**

Stoichiometry

Before You Read

Review Vocabulary

Define the following terms.

mole

molar mass

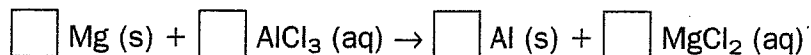
conversion factor

dimensional analysis

*law of conservation
of mass*

Chapter 10

Balance the following equation.



Chapter 11

Use the periodic table in the back of your text to complete the chart.

Pure Substance	Molar Mass
Carbon	12.011
	22.990
	15.999
Sodium carbonate	

Stoichiometry

Section 12.1 What is Stoichiometry?

Main Idea

Details

Skim Section 1 of your text. Write three questions that come to mind from reading the headings and the illustration captions.

1. _____
2. _____
3. _____

New Vocabulary

Use your text to define each term.

stoichiometry

mole ratio

Academic Vocabulary

Define the following term.

qualitative

Mole-Mass Relationships in Chemical Reactions

Use with page 354.

Explain the importance of the law of conservation of mass in chemical reactions.

Section 12.1 What is Stoichiometry? (continued)

Main Idea

Interpreting Chemical Equations

Use with Example
Problem 12-1, page 354.

Details

Summarize Fill in the blanks to help you take notes while you read Example Problem 12-1.

Problem

Interpret the equation in terms of _____,
and _____. Show that the law of conservation of mass is _____.

1. Analyze the Problem

Known: _____ \longrightarrow _____

Unknown: _____

2. Solve for the Unknown

The coefficients indicate the number of _____.

The coefficients indicate the number of _____.

Use the space below to calculate the mass of each reactant and each product. Multiply the number of moles by the conversion factor, molar mass.

$$\text{moles of reactant} \times \frac{\text{grams of reactant}}{1 \text{ mole of reactant}} = \text{grams of } \underline{\hspace{2cm}}$$

$$\text{moles of product} \times \frac{\text{grams of reactant}}{1 \text{ mole of reactant}} = \text{grams of } \underline{\hspace{2cm}}$$

Add the masses of the reactants.

$$\boxed{\hspace{1cm}} \text{ g C}_3\text{H}_8 + \boxed{\hspace{1cm}} \text{ g 5O}_2 = \boxed{\hspace{1cm}} \text{ g reactants}$$

Add the masses of the products.

$$\boxed{\hspace{1cm}} \text{ g CO}_2 + \boxed{\hspace{1cm}} \text{ g H}_2\text{O} = \boxed{\hspace{1cm}} \text{ g products}$$

Determine if the _____ is observed. Does the mass of the reactants equal the mass of the products? _____.

3. Evaluate the Answer

Each product or reactant has $\boxed{\hspace{1cm}}$ significant figures. Your answer must have $\boxed{\hspace{1cm}}$ significant figures.

Section 12.1 What is Stoichiometry? (continued)

Main Idea

Mole ratios

Use with page 356.

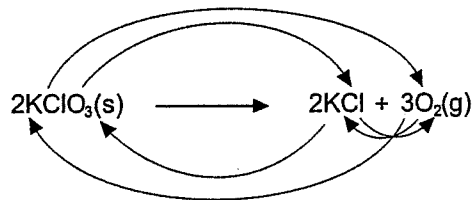
Details

Examine Relationships between coefficients can be used to write conversion factors called _____.

Example

Given the equation $2\text{KClO}_3(\text{s}) \longrightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$

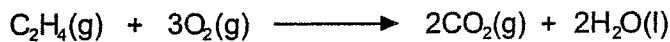
Each substance forms a _____ with the other substances in the reaction.



Write the mole ratios that define the mole relationships in this equation. (Hint: Relate each reactant and each product to each of the other substances.)

You Try It

Draw arrows with colored pencils that show the relationships of the substances in this equation.



Write the mole ratios for the above equation.

Stoichiometry

Section 12.2 Stoichiometric Calculations

Main Idea

Details

Scan Section 2, using the checklist below to preview your text.

- Read all section titles.
- Read all boldfaced words.
- Read all tables and graphs.
- Look at all pictures and read the captions.
- Think about what you already know about this subject.

Write three facts you discovered about stoichiometric calculations.

1. _____
2. _____
3. _____

Academic Vocabulary

Define the following terms.

convert

process

significant

Using Stoichiometry

Use with page 358.

Identify the tools needed for stoichiometric calculations.

All stoichiometric calculations start with _____ based on a _____ . Finally, _____ are required.

Section 12.2 Stoichiometric Calculations (continued)

Main Idea

Stoichiometric Mole-to-Mole Conversion

Use with Example
Problem 12-2, page 359.

Details

Solve Read Example Problem 12-2 in your text.

You Try It

Problem

How many moles of aluminum oxide (Al_2O_3) are produced when 4.0 moles of aluminum (Al) are combined with oxygen gas (O_2)?

1. Analyze the Problem

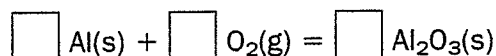
Known: _____

Unknown: _____

Both the known and the unknown are in moles, therefore, you will do a mole-to-mole conversion.

2. Solve for the Unknown

Write the balanced chemical equation. Label the known and unknown.



List the mole ratios for this equation. (Hint: Draw arrows that show the relationships of the substances in this equation.)

Circle the mole ratio that relates mol Al to mol of Al_2O_3 .

Multiply the known number of moles Al by the mole ratio to find the moles of unknown Al_2O_3 .

$$\square \text{ moles of Al} \times \frac{\square \text{ moles of Al}_2\text{O}_3}{\square \text{ moles of Al}} = \square \text{ moles of Al}_2\text{O}_3$$

3. Evaluate the Answer

The given number of moles has \square significant figures. Therefore, the answer must have \square significant figures.

Section 12.2 Stoichiometric Calculations (continued)

Main Idea

Stoichiometric Mole-to-Mass Conversion

Use with Example
Problem 12-3, page 360.

Details

Solve Read Example Problem 12-3 in your text.

You Try It

Problem

How many grams of solid iron (III) chloride (FeCl_3) are produced when 2.00 moles of solid iron (Fe) are combined with chlorine gas (Cl_2)?

1. Analyze the Problem

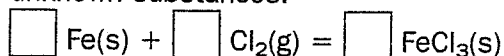
Known: _____

Unknown: _____

You are given the moles of the reactant, Fe , and must determine the mass of the product, FeCl_3 , therefore, you will do a mole to mass conversion.

2. Solve for the Unknown

Write the balanced chemical equation. Identify the known and unknown substances.



List the mole ratios for this equation. (Hint: Draw arrows that show the relationships of the substances in this equation.)

Circle the mole ratio that relates moles of Fe to FeCl_3 .

Multiply the number of moles of Fe by the mole ratio.

$$\square \text{ mol Fe} \times \frac{\square \text{ mol FeCl}_3}{\square \text{ mol Fe}} = \square \text{ mol FeCl}_3$$

Multiply the moles of FeCl_3 by the molar mass of FeCl_3 .

$$\square \text{ mol FeCl}_3 \times \frac{\square \text{ g FeCl}_3}{1 \text{ mol FeCl}_3} = \square \text{ g FeCl}_3$$

3. Evaluate the Answer

The given number of moles has \square digits, so the mass of FeCl_3 must have \square digits.

Section 12.2 Stoichiometric Calculations (continued)

Main Idea

Stoichiometric Mass-to-Mass Conversion

Use with Example
Problem 124, page 361.

Details

Solve Read Example Problem 12-4 in your text.

You Try It

• Problem

Determine the mass of ammonia (NH_3) produced when 3.75 g of nitrogen gas (N_2) react with hydrogen gas (H_2).

1. Analyze the Problem

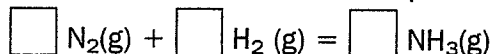
Known: _____

Unknown: _____

You are given the mass of the reactant, N_2 , and must determine the mass of the product NH_3 . Do a mass-to-mass conversion.

2. Solve for the Unknown

Write the balanced chemical equation for the reaction.



Convert grams of $\text{N}_2(\text{g})$ to moles of $\text{N}_2(\text{g})$ using the inverse of molar mass as the conversion factor.

$$\square \text{ g N}_2(\text{g}) \times \frac{1 \text{ mol N}_2}{\square \text{ g N}_2} = \square \text{ mol N}_2$$

List the mole ratios for this equation.

Multiply moles of N_2 by the mole ratio that relates N_2 to NH_3 .

$$\square \text{ mol N}_2 \times \frac{\square \text{ mol NH}_3}{\square \text{ mol N}_2} = \square \text{ mol NH}_3$$

Multiply moles of NH_3 by the molar mass.

$$\square \text{ mol NH}_3 \times \frac{\square \text{ g NH}_3}{1 \text{ mol NH}_3} = \square \text{ g NH}_3$$

3. Evaluate the Answer

The given mass has \square significant figures, so the mass of NH_3 must have \square significant figures.

Section 12.2 Stoichiometric Calculations (continued)

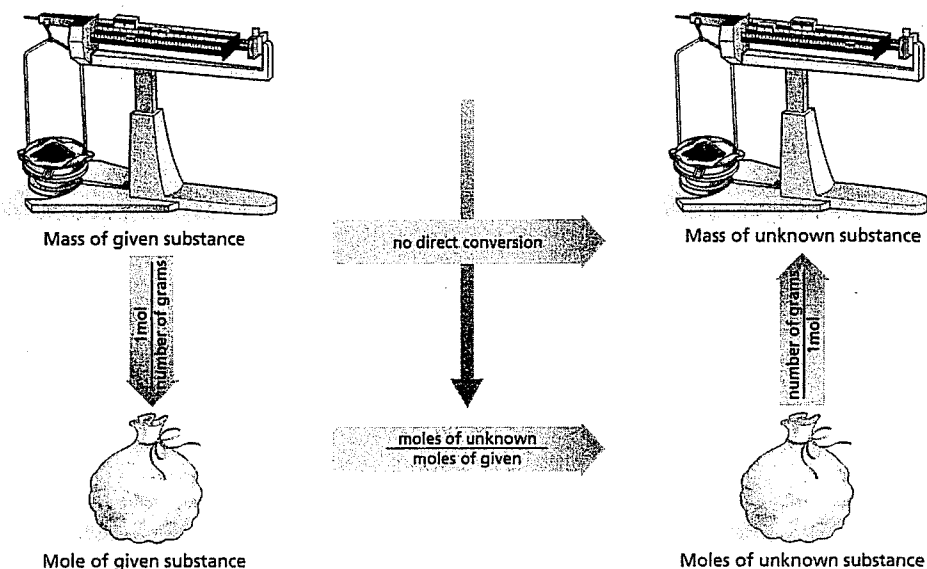
Main Idea

Steps in Stoichiometric Calculations

Use with page 363.

Details

Sequence the steps needed to convert from the balanced equation to the mass of the unknown.



Identify the steps in stoichiometric calculations by completing the summary below.

1. _____ . Interpret the equation in terms of _____ .
2. _____ . Use the _____ as the conversion factor.
3. _____ Use the appropriate mole ratio from the _____ as the conversion factor.
4. _____
_____ Use _____ as the conversion factor.

Stoichiometry

Section 12.3 Limiting Reactants

Main Idea

Details

Scan Section 3 of your text. Use the checklist below as a guide.

- Read all section titles.
- Read all boldfaced words.
- Read all tables and graphs.
- Look at all pictures and read the captions.
- Think about what you already know about limiting reactants.

Write three facts you discovered about limiting reactants.

1. _____
2. _____
3. _____

New Vocabulary

Use your text to define each term.

limiting reactant

excess reactant

Academic Vocabulary

Define the following term.

reassemble

Section 12.3 Limiting Reactants (continued)

Main Idea

Why do reactions stop?

Use with page 364.

Calculating the Product When a Reactant is Limited

Determining the Limiting Reactant

Use with Example Problem 12-5, page 364.

Details

What if you have six slices of bread, three tomato slices, and two cheese slices. How many tomato-cheese sandwiches can you make? Which ingredient(s) limit the number of sandwiches you can make?

Organize information about limiting reactants.

- I. _____
 - A. Limiting reactant
 1. _____
 2. _____
 - B. _____
- II. Calculating the product when a reactant is limited
 - A. _____
 1. convert the masses to moles
 2. multiply each mass by the inverse of the molar mass
 - B. _____
 - C. _____
 - D. Determine the amount of product that can be made with the moles of the limiting reactant.

Solve Read Example Problem 12-5 in your text.

You Try It

Problem

If 100.0g of sulfur reacts with 50.0g of chlorine, what mass of disulfur dichloride is produced?

1. Analyze the Problem

Known: _____

Unknown: _____

2. Solve for the Unknown

Write the balanced chemical equation.

Section 12.3 Limiting Reactants (continued)

Main Idea

Details

List the mole ratios for this equation.

Multiply each mass by the inverse of molar mass.

Calculate the actual ratio of available moles.

Determine the limiting reactant.

Multiply the number of moles of the limiting reactant by the mole ratio of the product to the limiting reactant.

Multiply moles of the product by the molar mass.

Multiply moles of the excess reactant by the molar mass.

Subtract the mass of the excess reactant needed from the mass available.

3. Evaluate the Answer

The given mass has significant figures, so the mass of the unknown must have significant figures.

Stoichiometry

Section 12.4 Percent Yield

Main Idea

Details

Skim Section 4 of your text. Focus on the headings, subheadings, and boldfaced words. Summarize the main ideas of this section.

New Vocabulary

In the left margin, write the terms defined below.

the ratio of actual yield to theoretical yield (from stoichiometric calculations) expressed as a percent

in a chemical reaction, the maximum amount of product that can be produced from a given amount of reactant

the amount of product actually produced when a chemical reaction is carried out in an experiment

Academic Vocabulary

Define the following term.

maximize

How much product?

Use with page 370.

Write the formula for percent yield.

_____ (from an experiment)
_____ (from stoichiometric calculations) \times _____ = percent yield

Section 12.4 Percent Yield (continued)

Main Idea

Calculating Percent Yield

Use with page 371.

Details

Solve Read Example Problem 12-6 in your text.

You Try It

• Problem

When 100.0 kg sand (SiO_2) are processed with carbon, CO and 51.4 kg SiC are recovered. What is the percent yield of SiC?

1. Analyze the Problem

Known: _____

Unknown: _____

2. Solve for the Unknown

Write the balanced chemical equation.

Determine the mole ratio that relates ____ to ____.

Convert kg to g. \longrightarrow

100 kg SiO_2 = _____ g, 51.4 kg SiC = _____ g

Convert mass to moles using the inverse of molar mass.

Use the appropriate mole ratio to convert mol SiO_2 to mol SiC.

Calculate the theoretical yield. Multiply mol SiC by the molar mass.

Divide the actual yield by the theoretical yield and multiply by 100.

3. Evaluate the Answer

The quantities have significant figures, so the percent yield must have significant figures.

Stoichiometry

SYNTHESIZE

Stoichiometry and the Stock Market

In the left margin, write the stoichiometry concepts that parallel the daily activities of a Wall Street professional.

1. A stock analyst keeps a close eye on the earnings of corporations. She has determined how much each company should accomplish.
2. The same analyst tracks whether companies meet expectations or fall short.
3. A grain trader wants to be sure to have 100 000 bushels in reserve for the winter selling season. He places an order for 120 000 bushels because he knows spoilage may damage a percentage of the crop.
4. A livestock futures trader knows that one cattle car holds 10 steers averaging 1200 lbs. each. He wants to bid on an identical car full of sheep, which average about 200 lbs. each. He needs to know how many sheep are on the car.
5. A stockbroker learns that a medical supply company has acquired several tons of a rare silver compound that will allow it to make superior dental equipment. The question is whether the company will have enough of the product to meet the demands of the marketplace.

Stoichiometry Chapter Wrap-Up

Now that you have read the chapter, review what you have learned. Write the key equations and relationships.

Review

Use this checklist to help you study.

- Use this Science Notebook to study this chapter.
- Study the vocabulary words and scientific definitions.
- Review daily homework assignments.
- Reread the chapter, reviewing the tables, graphs, and illustrations.
- Review the Section Assessment questions at the end of each section.
- Look over the Study Guide at the end of the chapter.

REAL-WORLD CONNECTION

to air bags and your safety.

Explain how stoichiometry is important
